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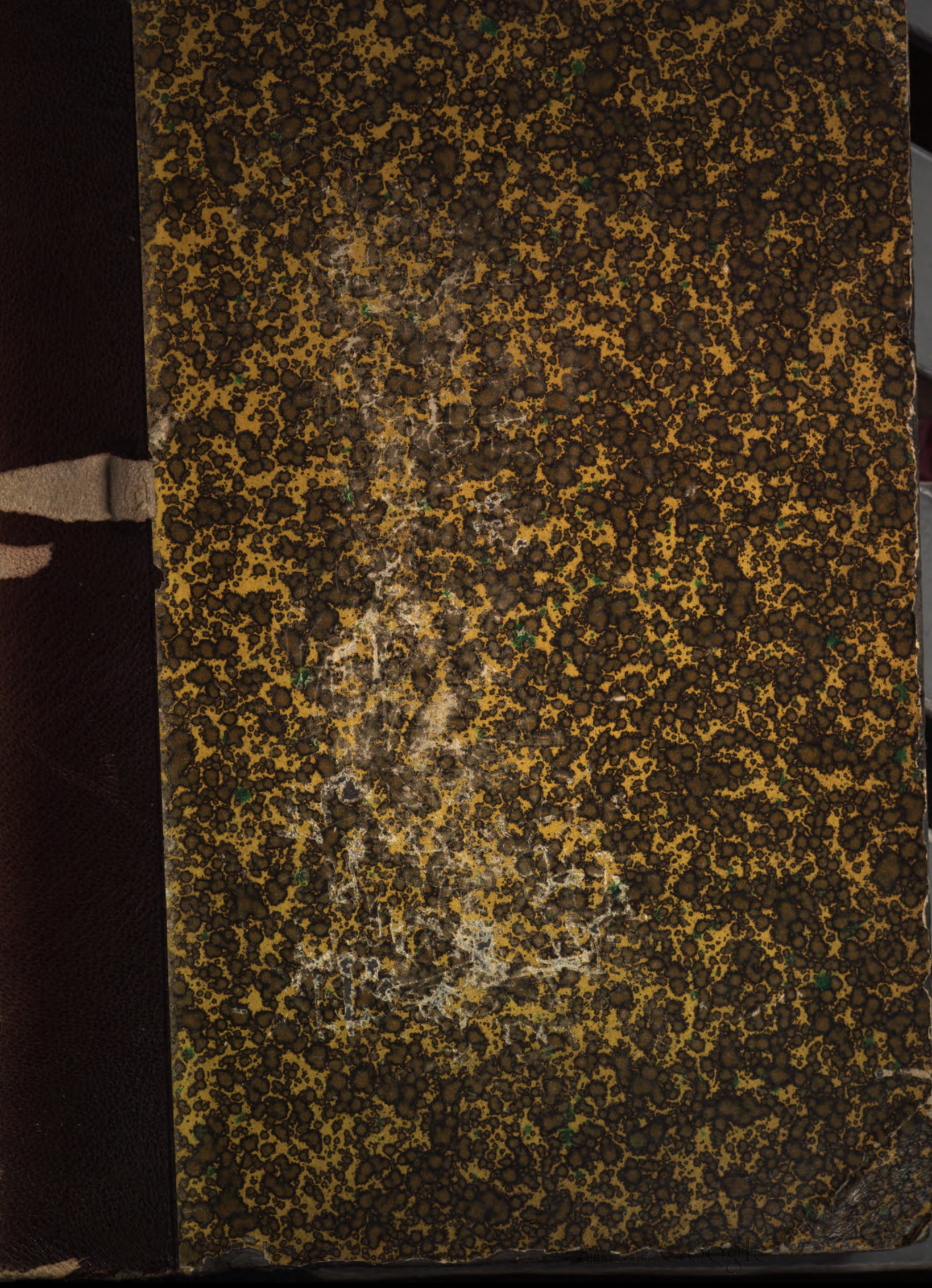

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NOTES.

The Competent Person.

[illegible] of a qualifying adjective has often given rise to [illegible] legal documents for the reason that the mean[illegible] word frequently depends upon the connection in [illegible] used. A case in point is the word "competent" [illegible] Home Office rules relating to mines. Recently a [illegible] was inaugurated against some mining officials [illegible] for employing a responsible man who, it was [illegible] not competent. Mr. Robert Nelson, H.M. [illegible] Inspector of Mines, in giving evidence, stated [illegible] found a haulage motor of which the commutator was insufficiently protected, and that the earthing was defective; further, the jointing and supporting of certain cable was not all that was to be desired. On the other hand it was stated in evidence for the defence, that the official in question had had a lengthy experience, first in mechanical work and subsequently in electrical work, and in the result a decision was given in favour of the defendants.

We do not suppose for a moment that there was any question that the defects mentioned by Mr. Nelson really existed. On the other hand, the term "competent" has not been defined, and thus prosecution is difficult. The fact is a man may be perfectly competent to overhaul motors and carry out general electrical work, and yet be incompetent within the meaning of the word really intended by the Home Office rules. "Competent" in this connection really means that the official in charge realises what is dangerous from the electrical point of view, and knows how to render installations safe. Unfortunately, this is rather special knowledge, and is not necessarily acquired by a man who may have excellent experience in general electrical work. In other words, it is not likely that the Home Office rules will be carried out quite satisfactorily until there has been something akin to an educational campaign for the purpose of instructing officials in the electrical conditions found particularly in mines.

Wireless Interferences.

It is an interesting coincidence that the discussion on Mr. J. E. Taylor's Paper on "Wireless Telegraph Working in relation to Interferences and Perturbations" should synchronise with some editorial remarks in the "Electrical World" on the same subject. But whereas our contemporary, in the issue which has come to hand this week, is concerned regarding the meddlesome antennae of amateurs (antennae which are stated to exist by the score round American cities), the interference experienced by the Post Office stations in this country originates, apart from atmospherics, from licensed installations on board ship, and from public stations in this and other countries. The activities of the casual experimenter evidently require some restriction in the States, since they go so far as the sending out of false news, whilst good communication, even over short distances, is reported to be by no means always

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possible. The ease with which wireless signals can at present be rendered unintelligible must certainly be disconcerting to the British Admiralty, and Sir OLIVER LODGE's doubt as to the efficacy of wireless communication in time of war is a little disturbing.

AT the Institution meeting last week Commander LORING drew attention to the number of unskilled operators who are now in charge of installations on board ship, owing to the recent great demand for operators. The discussion, however, mainly centred around atmospheric interferences, and those due to the Lodge-Muirhead system. The former certainly seem connected with electrical disturbances in the atmosphere, possibly distant thunderstorms; but, on the other hand, it is difficult to explain their diurnal variation. Mr. DUDDELL's suggestion for overcoming present difficulties by increasing the power of transmitters tenfold did not find favour with Sir OLIVER LODGE or Mr. TAYLOR, the former preferring more accurate tuning and directive transmission; whilst Mr. SÖRENSEN advocated the adoption of the Poulsen system, which, he claimed, caused practically no interference. It is to be hoped, however, that as operators become more skilled, and as tuning is improved, many of the difficulties will disappear, to which end the Post Office will have materially contributed by placing their experience at the disposal of the members of the Institution.

A New Cause of Fires.

OUR contemporary, the "Journal of Gas Lighting," had quite a field day in a recent issue; and all because of that horrid electric light, which it finds so dangerous and whose drawbacks it is for ever doing its best to make the public realise. At Middlesbrough, so we are told, something went wrong with an electrically driven fan in a picture palace; the fan thereupon emitted blue sparks and caused a stampede among the audience Two people were killed and several others injured. Now, apart from the fact that even the "Journal of Gas Lighting" can scarcely expect a ventilating fan to be driven by gas, just such a similar panic might have been caused in a variety of other ways; by a taxi-cab back-firing outside, or a gas mantle in the passage beginning to waggle on its crutch, for instance. The next thing that pleased our contemporary was a possible electrical origin of a "disastrous conflagration at the New York State Capitol at Albany, in which damage was incurred estimated at between £1,600,000 and £2,000,000." And we are almost ashamed to mention the suggested cause; it was the "fusing of an electric wire." Really we are surprised at our contemporary; we thought they had more originality. They might at least have produced another electric fan; we are getting so tired of that wire.

WE understand, however, that the fire was not really due to electrical causes at all. Mr. H. B. RENWICK on hearing the report, and knowing from experience how easily such statements obtain currency in this country, communicated by cable with reliable and authoritative sources in America. He was thereupon assured that there was no evidence to the effect that the fire was caused electrically. But after all, why worry about a little thing like evidence? Evidence went out with the Victorian era. The phrase "fusing of an electric wire" rolls trippingly off the tongue, so why not go on using it? Mr. RENWICK informs us that it is thought the fire was due to the dropping of a lighted match by a careless smoker. We should think it very possible, and we recommend this possible cause of fire to the attention of our contemporary. They might use it occasionally, and vary it by the phrase "caused by looking for a gas leak with a lighted candle," which we believe is quite a favourite occupation in some circles of society.

Symbol for Current.—The "Electrical World" states that the United States Committee of the International Electrotechnical Commission has suggested to the National Electric Light Association that the letter "C" be changed to "I" on the Association's badge.

Paris-Vienna Telephone.—It is announced from Vienna that the telephone line connecting Paris and that city will be opened to the public on the 20th of this month. The tariff is to be 6s. 8d. for an ordinary communication and £1 for an urgent communication.

Simply-made Apparatus for Wireless Telegraphy.—In the current number of "Work" appears the first of a series of articles dealing with this subject. The object of the series is to describe the working principles of wireless telegraphy and to give all the necessary particulars for construction of a short-distance station. A perusal of the first article shows that the idea is well carried out, though the usefulness of the series would be greatly increased if reference were made here and there to standard works on the subject. The series is to be concluded in 12 parts.

"Steering Gear Experiments on the Turbine Yacht 'Albion.'"—In a Paper with this title, read before the Institution of Naval Architects by Dr. Hele-Shaw, F.R.S., and Mr. F. L. Martineau, a description was given of a new electro-hydraulic gear. This gear has been tested in connection with a 20 H.P. steam-steering gear, and it has been found possible to change over from one to the other by merely operating a clutch. Comparative results were very much in favour of the new gear, the essential feature of which consists of a new form of multi-radial plunger pump with eccentric adjustment for the variation of stroke and reversal of flow. An electric motor of about 3 H.P. was shown to be powerful enough for operating the gear, and the quickness of the action and ease of handling were much improved with the new apparatus.

Apparatus for Demonstrating the Kelvin Effect.—Two recent Papers in the "Physikalische Zeitschrift" and in the "Archives" of the Swiss Société de Physique contain an account of a very simple optical means of demonstrating the existence of the above effect. The method is due to Prof. W. König, of Giessen. The material is a U-shaped wire, the bend of which dips into a mercury bath. The current passes down one and up the other side of the U, and its magnitude is so adjusted that the wire becomes red hot for a short portion of its length. The two red patches are found to be displaced upwards or downwards with respect to each other, according to the sign of the Kelvin effect in the material of the wire. Owing to the complicated nature of the heat losses from such a wire, Prof. König has not been able to make the method quantitative.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair
Assab—Perim	July 8, 1909 ...	
Malta—Tripoli	April 20, 1910 ...	—
Latakia—Palura	May 26, 1910 ...	—
Tourane—Amoy	Sept 25, 1910 ...	—
Cayenne—Salinas	Mar. 13, 1911 ...	April 7, 1911
Bonny—Duala	Mar. 30, 1911 ...	—
Port de France—Paramaribo	April 10, 1911 ...	—

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Squirrel-Cage Rotor with Automatically Varying Resistance.—In a patent recently issued in the United States to Mr. Burton McCollum a description is given of a squirrel-cage secondary for an induction motor so built that it possesses high effective resistance at starting and low resistance under running conditions, the change in resistance taking place automatically as the speed increases. The end-rings are constructed of an alloy of steel containing more than 2·5 per cent. of tungsten. The inventor states that this material has a low resistance for low-frequency currents and a high resistance for high-frequency currents by reason of the magnetic hysteresis loss and skin effect.

Crossing the St. Lawrence with High-Tension Lines.—The "Canadian Engineer" describes in a recent issue the high-tension transmission lines of the Canadian Light & Power Co., which are to extend from St. Timothee to Montreal, a distance of about 26 miles. With the exception of certain points where greater height is required, these lines, consisting of bare cables, are carried on steel towers 52 ft. high, spaced at intervals of 500 ft. The crossing of the St. Lawrence River was, by necessity, one of these special points. The river at this point is about 1,100 yds. wide, the depth at the deepest part being about 30 ft., with a current running at from 7 to 9 miles an hour. The crossing was made by means of erecting on each shore of the river two steel towers approximately 150 ft. in height, and building at the centre of the river two concrete piers extending about 15 ft. above water level, surmounted by a steel tower of 150 ft. in height. The span of the cables from the Caughnawaga side to the river piers will be 1,200 ft., and that from the river tower to the Highlands shore approximately 1,800 ft.

Electrification of Hoosac Tunnel.—The electrification of the Hoosac Tunnel, in western Massachusetts, on the Fitchburg Division of the Boston & Maine Railroad, is rapidly approaching completion, and it is expected that an electric service will be run through the tube within a fortnight. The electrified section will extend from Williamstown to a point seven miles east of the tunnel portal, the length of the tunnel proper being about 5 miles. Both tracks will be electrified and the single-phase system will be employed, with overhead distribution. Electrical energy will be generated by a steam turbine-generator plant located at Zylonite. The construction work in the tunnel is handled by two gangs of 75 men each, and strings of electric lamps are employed extensively on the motor cars which serve as construction trains. A small generating plant is installed on each train for supplying the lamps. The train movements are controlled by electric signals and a continuous telephone connection is maintained between the trains and the tunnel dispatcher's office. The overhead trolley wire will be located 15½ ft. above the track and will be supported at points 100 ft. apart.

Reduction of Tin Dross in an Electric Furnace.—In a Paper on this subject read before the American Electrochemical Society by Mr. R. S. Wile, the author stated that electrical energy was resorted to for the smelting of tin dross because the heat could be internally applied to the slag, which was on the bottom of a shaft-type of furnace, thus enabling the dross to be kept on top of the slag instead of being mixed with it, as was done in the old style of furnace. The dross, being on top, came in contact with the slag only at the point of reduction. The metal then filtered through the dross, while any tin oxide that was volatilised condensed in the colder portion of the furnace. The globules of tin produced in smelting passed down through the slag and lost most of their impurities, so very little refining of the resultant product was necessary. In operation the movable top carbon was brought into contact with the lower stationary carbon, and an arc formed. The slag was thus melted, and the carbon was raised until the proper amount of slag was added. The dross, mixed with the proper percentage of carbon, was added, and the tin tapped from the furnace from time to time. The loss of tin had been kept down to ·25 of 1 per cent., and the average below 1 per cent. The amount of tin recovered varied largely on account of the different percentages in the drosses treated. The average was approximately 2,500 lbs. per day. The plant consisted of two furnaces, connected in series, both being 20 in. in diameter and 80 in. high inside, two 50 kw. transformers and the necessary electrical apparatus. In operation they consumed about 44 kw. During the run it was desired to keep the current as constant as possible, the voltage varying. At the start the voltage of each furnace was about 80 volts, but toward the end, as the slag became less refractory, due to the combination of the iron and zinc of the dross and the slag, the voltage of each furnace dropped as low as 45 to 50 volts. This and an analysis of the slag denoted the end of the operation, when the slag must be drawn out and new put in. This was done alternately with each furnace. The furnaces ran continuously until they had to be relined, which was about every three or four months.

Chemically-Active Modification of Nitrogen Produced by the Electric Discharge.—In the Bakerian Lecture on this subject, which was delivered by the Hon. R. J. Strutt, F.R.S., on Thursday last, it was pointed out that the leading facts established were: (1) That pure nitrogen from whatever source, subjected at a low pressure to the jar discharge, underwent some modification which caused it to glow for a short time after it had been sucked away from the discharge. (2) The glow which was emitted while the gas returned to its normal condition was not destroyed by the removal of ions. It was weakened by heating, intensified by cooling. This seemed to favour the view that it was due to the re-combination of dissociated atoms. (3) The modified nitrogen acted on ordinary phosphorus, combining with it, and at the same time forming much red phosphorus. (4) It combined with sodium and also with mercury at a gentle heat (say, 150°C.), forming in the latter case an explosive compound, and in each case developing the line spectrum of the metal concerned. It also developed the line spectra of other metals, probably combining with them. (5) It developed the band spectra of compounds, when these were vaporised in it, giving in many cases spectra of substances too unstable to be examined at the temperature of the Bunsen flame. (6) It attacked acetylene, and substances like ethyl iodide or chloroform, setting the halogen free when there was one, and combining with the carbon to form cyanogen. This was proved by the brilliant cyanogen spectrum produced, and by direct chemical tests, such as the formation of Prussian blue. (7) It attacked nitric oxide, with the formation, strangely enough, of nitrogen peroxide, a more oxidised substance.

The Lighting of a Small Room.—In a Paper read recently before the Chicago Section of the Illuminating Engineering Society, Mr. J. R. Cravath described in detail certain comparative tests of illuminating equipments conducted in a living room 16·5 ft. long, 12 ft. wide and 8·5 ft. high. The colour of the ceiling was very light cream; the walls were covered with light green rough paper. Red portières were placed over the door spaces and green window shades were drawn down over the windows during the tests. In the geometrical centre of the ceiling was placed a single lighting unit, consisting during all tests of a 160-watt tungsten lamp giving 78·9 mean horizontal candle-power, equivalent to 773 lumens. Observations of the illumination obtained over a plane 3·5 ft. above the floor were made with the lamp equipped with various shades and reflectors. The author expressed the opinion that the semi-indirect system with opal reflector was far preferable to the opal ball arrangement, because it was not only more restful to the eyes, but more efficient. He said that the semi-indirect system occupied a place midway between the direct system using opal reflectors and the indirect with opaque reflectors; it was not as comfortable as the indirect, and it caused more pronounced shadow, but it was more efficient and did not hide the source of light entirely where some light was wanted for decorative effects. The author concluded from the tests that the ratio of measured efficiency between a direct system using efficient translucent reflectors and an efficient indirect system in a room of the kind tested was as 3 to 5. What the practical working efficiency or "efficacy" of the two systems was for different purposes depended on the particular conditions and uses of the room. The tests indicated that the measured efficiency of a direct system using enclosing globes was a little higher than an

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indirect system with opaque reflectors, although lower than a semi-indirect system with translucent reflectors. Tests were also made to determine the effect of shadows thrown by an 8 in. disc placed 15 in. from the test plate between this plate and the light source. The shadow reduced the illumination on the test plate by 86 per cent. when the opal reflector was used at the ceiling; 50 per cent. with the indirect lighting arrangement with mirror reflector, and 61 per cent. with the semi-indirect system with opal reflector pointed upwards. The shadow with the indirect system was less objectionable than with the direct system.

Surface Combustion and its Industrial Applications.—At the Royal Institution on Thursdays, March 30th and April 6th, Prof. W. A. Bone, F.R.S., delivered a lecture on this subject. In the first lecture he dealt with the scientific aspects of surface combustion, a phenomenon which was due to the accelerating influence of hot surfaces at all temperatures upon chemical changes in gaseous systems. Davy, in 1816, had discovered that certain substances when brought into contact with hot platinum burnt without flame, while knowledge of the subject was still further advanced in 1823 by a discovery of Dulong and Thénard, which showed that all hot solids accelerated combustion, though platinum did so in an eminent degree. Further, in contact with platinum, hydrogen was burnt preferentially to hydro-carbons in a defective supply of oxygen, which was the opposite of what was now known to occur in ordinary explosive combustion. Various theories were advanced in the early days by Fusinieri, Döbereiner, de la Rive and Faraday to account for this phenomenon. Döbereiner found that platinum black absorbed oxygen, which could be burnt out by hydrogen. He, therefore, thought that platinum acted only as a carrier, while Fusinieri considered that platinum condensed the hydrogen. Other investigators were found in support of both views; no definite decision was come to, however, between 1836 and a comparatively recent date. The view expressed by Frederick Siemens that surfaces in contact with flame not only hindered combustion, but promoted dissociation, was doubtless largely the cause of this. The lecturer then performed a number of experiments to show the stimulation of the activity of a surface by hydrogen and by carbon monoxide, the formation in certain cases of protective layers of oxygen at the surface which retard combustion, the hindering influence of moisture on the surface combustion of carbon monoxide and the electrical condition of surfaces during combustion. In his second lecture Prof. Bone gave a demonstration of a process of "Incandescent Surface Combustion." For this purpose a bed of refractory granular material was used. This was first heated externally by a flame, but when the bed became fairly warm the flame was withdrawn, and the bed was then brought to incandescence by a blast of fuel and air which was passed into it. In this way very efficient combustion was obtained entirely without flame, but giving radiant heat. This process was shown to be applicable to a number of uses, including diaphragm heating, especially in relation to the concentration of aqueous solutions by radiant heat from an incandescent surface in a plane above the surface of the liquid. It was also shown how the process could be adapted to the heating of muffle and crucible furnaces by surface combustion in a bed of refractory granular material of the kind mentioned above, how copper could be brazed by radiant heat from a similar incandescent bed, and how multitubular boilers could be fired "gaseously" by surface combustion, whereby a high rate of evaporation, 21 lb. per square foot of heating surface, combined with a high thermal efficiency of 94 per cent. on the net calorific value of the gas, might be obtained.

PERSONAL NOTES.

Mr. Charles L. Edgar, president and general manager of the Edison Electric Illuminating Co., of Boston, U.S.A., and party sailed from New York on March 30 for an extended period of rest in Europe. Mr. Edgar brings his car with him. He visits England, France, Italy and Germany. Mrs. Edgar and Mr. Edgar, jun., are of the party.

Current Topics.

Subjects of current interest dealt with in this issue include the following:—

Mr. G. F. C. Searle continues his article entitled "On Resistances with Current and Potential Terminals."

Mr. J. Härdén contributes an article on "A Curious Coherer Phenomenon."

Electric lighting has been adopted for the extensions of Victoria Barracks, Windsor. A description is given of the installation.

At the meeting of the Institution of Electrical Engineers last week an interesting discussion took place on Mr. J. E. Taylor's Paper entitled "Wireless Telegraph Working in Relation to Interferences and Perturbations."

Mr. W. B. Woodhouse read a Paper last week before the Yorkshire Local Section of the Institution of Electrical Engineers on "Public Electric Supply in Country Districts." This subject is also considered in our Leading Article.

We give an account of the discussion at the meeting of the Birmingham Local Section when Mr. S. P. Smith read his Paper on "The Non-salient Pole Turbo-alternator and its Characteristics."

We give an account of Sir J. J. Thomson's concluding Royal Institution lectures on "Radiant Energy and Matter"; and also of his discourse last Friday evening on a "New Method of Chemical Analysis."

We have received an interesting communication from Mr. J. T. Irwin on the subject of "Electricity Meters."

At a recent meeting of the Physical Society Prof. G. W. O. Howe read a Paper on "Oscillatory Currents in Coupled Circuits."

Announcement is made of the registration of a combination of the well-known engineering firms of Stothert & Pitt (Ltd.) and Wellman, Seaver & Head (Ltd.), under the style of "Wellman, Head, Stothert & Pitt (Ltd.)."

In a report to the Tramways Committee at Bradford, Mr. C. J. Spencer made some interesting observations as to the discrimination between, and rewarding of, tramway employés.

Leeds City Council have decided to make reductions in the charges for electricity for power and heating.

Parliamentary.—Select Committees of the House of Commons have approved the preambles of the Northampton Corporation, the Liverpool Overhead Railway and the Nottinghamshire and Derbyshire Tramways Bills.

Legal.—On Saturday Mr. Justice Joyce delivered judgment in the action brought by the London Electric Supply Corpn. to restrain the Westminster Electric Supply Corpn. from inducing plaintiffs' consumers in the Westminster area to take electric current from the defendant company. After reviewing the facts, his lordship dismissed the action, with costs.

An interesting point came before the Judge at Hastings County Court, raising the question of what constitutes "passengers' luggage" on a tramcar.

Companies' Meetings and Reports.—At the meeting of the Metropolitan Electric Tramways last week the chairman, Mr. E. Garcke, gave an interesting account of the progress of the company, and also of the development of the undertaking of the North Metropolitan Electric Power Supply Co., in which the Company is interested.

In another portion of the Paper will be found a number of interesting reports of the meetings and abstracts of the directors' reports of provincial electric supply and tramway companies.

OBITUARY.

WILLIAM MIDDLETON.—We regret to record the death of Mr. Wm. Middleton, A.M.I.E.E., assistant works superintendent to the Newcastle & District Electric Lighting Co. Mr. Middleton was examining the back of a switchboard at the Close power station on Thursday afternoon last when a short-circuit occurred. His face and hands were badly burned and the upper part of his clothing caught fire. A doctor was immediately sent for and the injured man was conveyed to the Gresham private hospital, where he succumbed to his injuries on Friday morning. At the coroner's inquest the jury returned a verdict of "Death from shock following electric burns accidentally sustained." The jury expressed the opinion that a partition between the positive and negative bars should be provided in future to prevent danger from any accident or short-circuit. Mr. Middleton was only 37 years of age at his death and had been in the service of the above Company for 14 years. He served his apprenticeship with Messrs. C. A. Parsons & Co., and when quite a young man occupied responsible positions. He was married in 1899 and leaves a widow and four young children.

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APPOINTMENTS VACANT AND FILLED.

One or two draughtsmen are wanted by a large electrical firm. See an advertisement.

The Electrical Power Storage Co., 4, Great Winchester-street, London, E.C., require a qualified sales manager. Applicants must have had experience of storage batteries, and possess a good connection. See an advertisement.

An electrician is required to take charge of an electric lighting installation and control of three assistants at a North of England cement factory. See an advertisement.

The Yorkshire Electric Power Co. have vacancies for a sales engineer (salary £200 per annum), and for an assistant construction engineer (salary £156). Further particulars are given in an advertisement. Applications to Mr. W. B. Woodhouse, chief engineer of the Company, Thornhill, Dewsbury.

London County Council require two charge shift engineers for the Greenwich generating station. Salary (in each case) £250, rising to £300. Council offices, Spring-gardens, S.W., to whom applications by 11 a.m. April 20.

Mr. F. H. Dent took up his position as general manager of the South Eastern & Chatham Railways on April 1.

Mr. J. E. Jinks (traffic superintedent of Bendigo (Victoria) tramways) has been appointed to a similar position in the Launceston (Tasmania) municipal tramways department.

INSTITUTIONS AND SOCIETIES.

Institution of Civil Engineers.—The monthly ballot at this Institution in March resulted in the election of three honorary members, viz., Lord Brassey, G.C.B., Alfred Noble, and the Duke of Northumberland, K.G., P.C.

British Science Guild.—The fifth annual meeting of this association took place at the Mansion House on Friday last, the Lord Mayor (Sir Vezey Strong) being in the chair. Sir Wm. White, in submitting the report, drew attention to a statement which had been prepared by Mr. R. A. Gregory, giving a full statement of endowments for higher education and research announced during the past year. Considering first the gifts for purposes of research, it appeared that in England they amounted to about £70,000 (omitting Mr. Otto Beit's munificent gift in 1909 of £215,000 for medical research fellowships). A comparison of this amount with the funds available for the same purposes in Germany and the United States was instructive. In the United States the gifts to research amounted to nearly one million pounds; and the actual grants for research made by the Carnegie Institution alone amounted to £90,000, or £20,000 more than the addition to our endowments. A single donor gave £284,000 for the advancement of science in France; half a million sterling had been subscribed in Germany for the newly formed Society for the Promotion of Scientific Research. As regards educational endowments, gifts amounting to about one and a quarter million pounds were made for buildings and equipment of places of higher education in England. The gifts for similar purposes in the United States during the same period amounted to [illegible] sterling. Prussia added a new technical university to those previously established in Germany, and the ordinary endowments to the other universities had increased by an amount of [illegible] in excess of what it was five years ago. The report also drew attention to the need of better organisation in those Government departments dealing with education. At present the primary, secondary and technical education of the country was controlled by the Board of Education, while the Treasury was supreme in matters connected with the Universities. One way out of the difficulties which arose would be to transfer certain services to the Board of Education and to appoint an advisory committee to deal with university education. Another way would be to appoint a Minister of Education. The Technical Education Committee had drawn up a report insisting upon the need of co-operation and co-ordination in technical education. At present a great deal of money was wasted owing to overlapping and clashing of interests. The report having been adopted, the president, Lord Haldane, delivered an address in which he dealt with technical education. He took up the position that things were not so bad as were made out and altogether endorsed the opinions expressed in the report.

The Tramways and Light Railways Association.—The "Journal" of the Association for April contains a report on "Speed Indicators," made at the suggestion of the Board of Trade. The members of the Committee signing the report are the following: Messrs. [illegible], chief engineer, Metropolitan Electric Tramways (chairman); R. W. Cramp, general manager, Birmingham and Midland Tramways Joint Committee; H. England, general manager, Wakefield & District Light Railways Co.; W. E. Ireland, rolling stock superintendent, L.C.C. Tramways; C. W. Mallins, general manager, Liverpool Corporation Tramways; and S. Sellon. The "Journal" is a "special" number, copies of which can be obtained by non-members at 2s. 6d. each. The report is fully illustrated, and covers 43 pages. The announcement is made that the annual congress of the Association will be held at Edinburgh on July 13th and 14th next.

Röntgen Society.—The problem of secondary X-radiation—the radiation emitted from a metal or other substance when placed in the path of the primary beam from an X-ray tube—formed the subject of an address by Prof. C. G. Barkla, of King's College, London, at the meeting of the Röntgen Society on April 6th. The value therapeutically of the rays obtained in this manner is that they are very soft, or readily absorbable, whereas in the case of the direct sheaf of rays from the tube these ultra-soft rays have no influence, being filtered away before reaching the exterior of the glass. Prof. Barkla divided this secondary radiation into three species: radiation which was entirely scattered; secondary fluorescent radiation, which was by far the most valuable; and corpuscular radiation. The first of these emissions was that which proceeded from air or from gases containing elements of the lighter atomic weights—carbonic acid gas, for example—and was simply scattered in every direction. The second type was that which proceeded from heavier gases, such as those containing bromine or iodine, or metals, such as copper, zinc, lead and iron, when placed in the path of the primary beam. A distinction must be made, Prof. Barkla remarked, between the effect of filtration and that of secondary radiation. With radiation going through filters of metal the primary rays as well as the secondary rays had a place in the residue. In order to get pure secondary radiation one must have the surface of incidence—i.e., the metal plate—at a certain angle so that, to speak in terms of light, the radiation was reflected from it. The difference between the primary and the secondary radiation lay in the almost complete homogeneity of the latter. The essential condition for its production—a law which was also true of the fluorescence of ordinary light—was that the primary beam should be of a more penetrating type than the secondary radiation characteristic of the particular element—lead, for example—employed. Every element had its own characteristic radiation, and it was possible even to plot out a kind of spectrum, using degrees of absorbability instead of wave-lengths. The thickness of aluminium necessary to absorb half the secondary radiation varied from 1/350 cm. in the case of iron to 1/22 cm. in the case of cerium. The thickness of water absorbing half the radiation was 1/25 cm. in the case of iron and varied more or less according to the atomic weight of the metal until, in the case of silver, 3 cm. were required before the radiation would fall to half value, and 6 cm. in the case of cerium. In therapeutics the particular metal would be chosen according to the thickness of the part of the tissues to be penetrated. The X-rays being electro-magnetic in nature, it followed that there was a third type of secondary radiation, to which he might be given the name of corpuscular. It corresponded to the β radiation of radium but was much less available for practical use. All heavy substances exposed to the primary beam emitted this particular radiation, but the rays passed to only an infinitesimal distance.

Liverpool British Insulated Engineering Society.—This Society held their usual fortnightly meeting in the George Holt Physics Theatre, Liverpool University, on March 29, Mr. W. Aitken, M.I.E.E., being in the chair. Dr. Gwilym Owen gave a most interesting lecture on "Electrons and Röntgen Rays." The lecture was fully illustrated by experiments, Dr. Owen being assisted in these by the University demonstrators, Messrs. Pye and Welch. The thanks of the meeting were conveyed to the University authorities and Dr. Owen for their kindness in allowing the B.I. Engineering Society to meet there that evening, and for the interest taken in the work and aims of the Society generally.

Metropolitan Electric Supply Co.—The annual staff dinner of the Company was held on Friday last when there was a numerous gathering of staff and guests, and a very enjoyable evening was spent under the chairmanship of Mr. J. S. Highfield. The proceedings gained through not being too formal, and there was plenty of humour in the speeches of Mr. Cunliffe Owen who proposed "Our Guests," Mr. A. Diósy who responded, Mr. Robert Hammond who proposed "The Company," the reply being in the hands of Mr. Frank Bailey, and Sir Robert Cranston, K.C.V.O., who proposed "The Chairman." Mr. F. Hipwell, who was mainly responsible for organising the dinner, gave a humorous description of the worried looks of members of the staff as portrayed by dinner photographs; but judging by the prosperous condition of the Company there does not seem to be much cause for complaint. An excellent musical programme was intermingled with the speeches.

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THE ELECTRICAL PRODUCTION OF STEEL AT THE WORKS OF THE EICHER-HÜTTENVEREINS LE GALLAIS METZ & CO. AT DOMMELDINGEN.*

On account of their favourable position in the valley of the Grand Duchy of Luxemburg, Dommeldingen and its vicinity are specially suitable places for the erection of large iron works, the more so as the native ore, which contains from 40 to 45 per cent. of iron, can be used without any great transport expenses being necessary.

The Eicher-Hüttenverein have three ordinary furnaces in use at Dommeldingen at the present time, which are each capable of producing about 100 tons of pig-iron per day. The furnace gas is supplied to gas engines, which in turn provide electrical energy for the furnaces.

Generating and Transforming Plant.

The transformer equipment, which is used in connection with the two 4-ton single-phase furnaces, described below, is usually supplied with energy from a gas-driven generator, delivering three-phase current at a pressure of 5,000 volts and a frequency of 25, when running at 94 revs. per min. Energy from the same set is also supplied to the town of Luxemburg, so that in the operation of the new installation care has to be taken not too greatly to reduce the power factor. For this reason an over-excited synchronous motor is used in the converter set. The high-tension current from the power house is stepped down to a pressure of 500 volts by a 600 kw. static transformer, whence it is supplied through suitable switchgear to the two converter sets.

Each convertor set consists of an asynchronous three-phase starting motor designed for intermittent working, and having a capacity of 140 H.P. when supplied with current at 500 volts and a frequency of 50; a single-phase generator with a capacity of 825 to 950 k.v.a., with pressure varying from 3,000 to 3,500 volts; a 715 H.P. synchronous three-phase motor with a power factor of unity and supplied with current at 5,000 volts and a frequency of 50; and an exciting set. The whole of these machines are fixed on a common bedplate

A special coupling, which is worked by a hand lever, allows the starting motor to be cut off from the set during the working period, while, should its speed exceed during starting the synchronous speed of the synchronous motor, a centrifugal arrangement fixed at the end of the shaft, cuts it out of circuit, so that the machine cannot be strained by the high speed. After synchronism has been obtained between the asynchronous motor and the generator at the central station, the starting motor is cut out by means of the coupling. On account of the load being thus taken off the speed of this motor rises to a certain value, when the centrifugal arrangement, mentioned above, short-circuits two of its phases. The decrease in voltage which occurs on this account causes an automatic cut-out behind the switchboard to come into action. This in turn operates a three-pole switch, and cuts out the motor from the network. This switch is fitted with coils which during the usual course of working act as hold-off magnets, and keep the switch closed. The short-circuiting arrangement consists of simple contacts against which brushes of thin copper strip are pressed by means of a knee-jointed lever. When a pressure of 500 volts is reached a resistance is placed in series with each of the magnets, and when the voltage has risen about another 20 per cent. the switch operates. This arrangement is necessary, as cutting of the voltage off only one phase would not be sufficient. To guard against arcing at these switches the upper contact is provided with a spark arrester, the circuit on which is closed before the main brushes come into action, while it opens after them. Switching in is effected by means of a rod switch from the front of the switchboard.

The switchgear, which is arranged in the basement of the transformer house, includes, besides that dealing with the cables going out to the furnaces, the generator oil switches. These are fitted with maximum cut-outs, and their position is made known by means of control lamps on the switchboard. Further, there are the usual current and pressure transformers for the measuring instruments, as well as selector switches on the high pressure bus bars. In connection with the oil switches used, it may be mentioned that these are fitted with automatic overload cut-outs. The switch is automatically returned to its off position by means of spring power, the spring being released by an electromagnet. The winding of this magnet is placed directly in series with the high pressure system. The contact arrangement by means of which the signal lamps are switched on and off is arranged at the back of the switchboard. The switchboard consists of five panels, two of which are provided with instruments in connection with the synchronous motor. On the third is mounted an aperiodic ammeter which is placed in the three-phase furnace circuit, an aperiodic voltmeter for the 500-volt three-phase network, an aperiodic voltmeter for the exciter circuit, and a voltmeter change-over switch, as well as phase and frequency measurers. The arrangements of the latter are shown in Fig. 1.

Furnace Installation.

The steel furnace building is of girder construction filled in with bricks, and is divided into two shops each 60 ft. wide by 450 ft. long. The southern shop contains the two single-phase furnaces, three-phase furnace No. II, and the space for a fourth furnace. The general arrangement is shown in Fig. 2. In this space at the present time a ¾-ton test furnace is installed. There is also a Wellmann mixer, fitted with tipping gear, of from 15 to 20 tons capacity, a drying oven for cores and moulds, the core factory and foundry, as well as an automatically working apparatus for mixing the foundry sand. In front of each furnace, which is raised 10 ft. from the floor, and on the tipping side, are tracks for the trucks carrying the molten metal, and immediately behind them a pit into which the slag can be poured.

Adjacent to this shop is another in which are placed various machines for working the castings. The largest and most complicated pieces can be cleaned here, and leave the works quite ready for use. The machines themselves are practically exclusively driven by motors, the larger ones being worked on the individual drive system.

The incoming cables from the convertor house are run in ducts direct to the south wall of the furnace house, whence each goes singly to the place where it is employed. In order to allow plenty of room comfortably to work on the furnaces the latter are placed some distance apart, as shown in Fig. 2. The furnace platform is built out from the south wall of the furnace room on reinforced concrete platforms. On the outer side it is provided with iron railings, and is supported by eight square pillars. The furnace platfrom is reached from the floor by means of concrete steps.

The most important part of an induction furnace is the transformer, which, as is well known, works on the following principle: The single-phase current flowing through the primary winding induces a large current in the melting rings which, to a certain extent, forms a short-circuited secondary winding. This secondary current brings the whole content to a molten condition. Alterations in the current strength, or the temperature, can be easily effected by varying the machine voltage by means of the exciter regulator. In the case of three-phase furnaces voltage regulation may be effected by means of a regulating transformer and rheostat.

The two single-phase furnaces at Dommeldingen are of the same type and construction. Each furnace contains a furnace transformer with a maximum output of 950 k.v.a., the pressure being 3,500 volts and the frequency 25. The iron core, which is built up of transformer sheet iron and is insulated with paper, carries on each limb a well-insulated primary winding. This surrounds the secondary winding, whose ends are fastened to the cast-steel pole plates. Round the transformer windings on each leg are placed protective coverings, which rest on projections from the lower yoke. This covering is surrounded at a short distance by a second covering, whose lower flange rests on the brickwork of the wall foundations. This second covering affords a special protection to the winding against heat radiating from the brick work, while the inner covering acts principally as a cooling cover, and by it cold air is brought in. As the covering cannot, of course, be closed, the separating pieces are bridged over with micanite. By means of a ventilator cold air is drawn through the space between the winding and the inner covering and between the air ducts on the transformer core, so that the temperature of the winding is kept within certain limits. By this arrangement of the protective covering combined with the great cooling effect obtained by the blast, the temperature of the windings never exceeds that laid down in the V.D.E. rules, in spite of the fact that a furnace working at a temperature of from 1,600°C. to 1,700°C. is within a foot. As the furnace is arranged for tipping, the tube through which the blast is brought in must be provided with a telescopic arrangement and draw-out pieces fitting into the main pipe through which both transformers arms are fed. Care is taken to provide a similar division and distribution of the air inside the cooling cover. By a special arrangement of the parts, which prevents the escape of the air, the windings are cut off from the atmosphere, and the falling in of foreign bodies and dust is thus prevented, while owing to the care taken, any contact with the current-carrying part is rendered impossible. The primary winding on both legs is held fast to the foundations by means of process screws and plates, and rests on coil carriers. The connections come in through the lower air duct being insulated at this point by stabilit brushes. Connection to the secondary winding are made from above, and are fixed to the pole plate ends which project from the furnace cover. It is especially important so to arrange the windings that any deformation and short-circuits, which might thus occur, are prevented. The primary coils are connected together by means of copper strips placed under the furnace. On each side of the furnace is placed a semi-circula

* Abstract of an article in the "Electrotechnische Zeitschrift."

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brass bar, which is connected to one pole of the winding, and which is used for conveying the current from the brush carriers. On this bar slide three carbon brushes, whose holders are fixed to a gas pipe by means of screwed plugs, insulated with stabilit bushes. The feeder cable is led through this pipe to the brushes.

In order to be able to measure the blast temperature at different places in the transformer winding three thermo-elements of copper-constantan are arranged in each of the cooling covers. Conductors from these are led to a multi-way switch on the wall of the switchboard, and are there connected to a galvanometer. The galvanometer is calibrated both in milli-volts and degrees.

A 75 H.P. three-phase motor connected to the 500-volt network, and running at 975 revs. per min. is placed at an angle of 75 deg. to the horizontal and drives a centrifugal ventilator. The capacity of this latter is 26,000 cubic ft. per min., the air being drawn through a filter house placed outside the south wall. Filter cloths catch any dust, so that the air, when it finally reaches the pipes, is practically clean. The regulation of the air supplied is effected by altering the speed of the ventilator motor. Behind the ventilator and immediately in front of the first furnace dampers are fixed to regulate the supply of air to each single furnace. A second ventilator of the same size as the first serves as a reserve. The ventilator is housed in with sheet iron, while the motor is so arranged that the flywheel can quickly and simply be removed.

Tipping is mechanically effected by means of a 10 H.P. three-phase crane motor working off the 500-volt circuit, and running at a speed of 710 revs. per min. It is switched in or out from a motor switchboard fixed to the wall. It is controlled from the platform by means of a controller placed near the instrument switchboard for the fur-

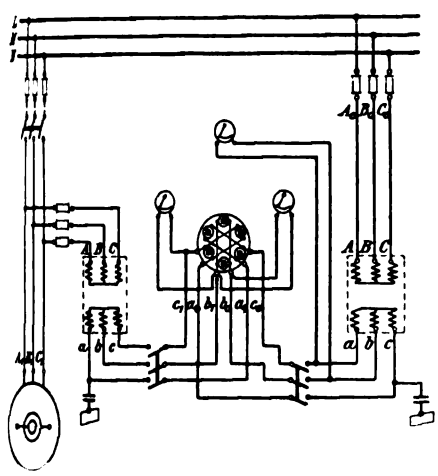

FIG. 1.—DIAGRAM OF PHASE AND FREQUENCY METERS.

nace. Great emphasis has been laid on the exact operation of the tipping equipment, seeing what would be the direful consequences of any breakdown. A differential hand brake worked by a magnet automatically provides a practically instantaneous stoppage of the tipping equipment directly the motor is cut out, and this fine subdivision of the control allows very small tipping movements to be made. The method of operation of the brake magnet, which is in parallel with the motor, is such that on starting the motor the brake magnet is switched in and the brake lifted. When the motor is cut out the counterpoise falls and the brake comes into action. The brake magnet consists of a three-limbed solenoid. The brake weight is both raised and let drop softly and without jerks by means of an air damping arrangement, its very simple construction allowing it to be easily protected against dirt and rough handling. At the moment of switching on a certain wattless current flows through it. As the pull of the magnet falls with the decreasing voltage, the leads have to be so arranged that there is no great voltage drop. When the crane is drawn up the current is greatly choked so that the energy consumed is very small, even when the coil is left on for some time. It is easy to avoid the winding burning out, owing to the brake rod of the magnet being overloaded, fuses are provided.

The maximum tipping angle of the furnace is 45 deg. for pouring steel and 17 deg. in a backward direction for pouring slag. In order that these limits may not be exceeded, overrunning switches which break the circuit are provided. These are fitted with automatic working in gear.

The furnaces are built after the general form of the Martin furnace. The mechanical part includes a roller-way carrying the furnace, and the furnace proper with the two doors for charging, pouring, removing the slag and puddling. The tipping arrangement consists mechanically of two upper and two lower cast-steel runways, on which there are two sets of rollers, each consisting of 11 cast-iron rollers 160 mm. in diameter. A geared wheel is fixed rigidly to these rollers and engages with two steel driving wheels fixed on a shaft which is driven through a leather coupling by means of the motor mentioned above.

The furnace body proper consists of iron plates ¾ in. thick, which are surrounded by the transformer core and are coated on the inner side with fire-resisting brickwork.

In Dommeldingen, owing to the continuous working, basic coating material was used. The heating of furnace rings requires, when working in the ordinary way, a load of about 180 kw. on the 350 kw. furnace for about 8 hours. The furnace is then fed with molten pig-iron, so that the energy taken becomes nearly the standard value, and can be brought by regulating the machine voltage to any desired amount, according to the requirements of the charge. On the puddling side of the furnace platform are provided two doors which can be drawn up by means of a winch and the space in front of the pouring snout left free for tipping. The molten metal is poured into a large cauldron of 20 tons capacity, which is brought up by a travelling crane. In order easily to get rid of the slag, gullies are arranged in front of the furnace leading below, whence the slag is taken away in special barrows.

The position of the furnaces and the switchboards is shown in Fig. 2. One of these panels is used for controlling the single-phase furnaces and the other for controlling the three-phase furnace and the ¾-ton experimental furnace. A switch pillar has been erected for each furnace. The pillars for the single-phase furnaces are each fitted with a power indicator, an ammeter and a voltmeter (which are connected to current and pressure transformers in the cells under the furnace floor), and a hand lever for working the oil switch, as well as two coupled hand-wheels for the remote control of the main exciter regulators. Near the switch pillar is the controller for the tipping motor and a loud speaking telephone mounted on a pillar. On the wall are fixed the ammeter and voltmeters for the tipping motor, as well as the motor switchboard

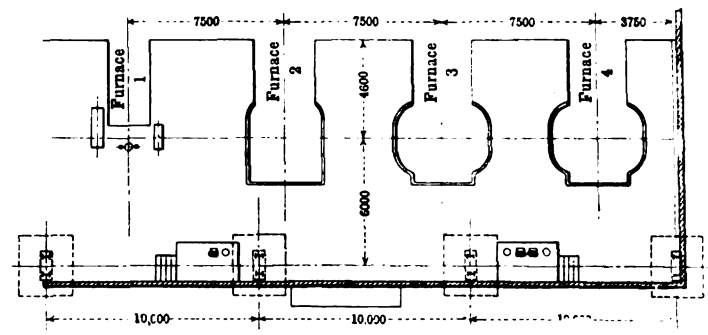

FIG. 2.—GENERAL ARRANGEMENTS OF THE FURNACES AT DOMMELDINGEN.

and the temperature galvanometer with its three-way switch which was mentioned above. The wooden floor of the platform is insulated with rubber matting.

Underneath the furnace floor is a room in which are fixed the switch cells for the furnace and the regulators. Here also are the ventilators mounted on concrete foundations, as well as the pipes in connection therewith. The regulating transformer for the three-phase furnace is also fixed here. The switch cells for the single-phase furnaces are each 3 ft. 6 in. wide, and are separated from each other by a concrete wall 6 in. thick. The two-core cable from the power house ends in a sealing off box, whence each cable passes through the cell and is fitted with a single-pole separating switch, current transformer, voltage transformer whose fuses are in parallel with the main circuit, and a double-pole oil switch remotely controlled from the switchboard. All the high-tension gear is contained in this room, and the instruments on the switch pillars carry only low-pressure currents. The walls of the switch-room are plastered and the room is kept free from dust by the doors. From the cells the cables go in a trench to the brush holders on the furnaces. The bars on the furnaces are of semicircular shape to allow the current to be kept on during tipping.

The general arrangement of the three-phase furnace is similar to that of the single-phase furnace. The furnace is of circular shape. Naturally three-wound cores are used and three induction rings. The yoke is of horseshoe shape, so that it encloses the working space on three sides. The three-phase furnace has the important advantage over the single-phase type that, owing to the arrangement of the cores in the molten bath, a regular revolving field is set up, which causes the molten material to be kept in motion, thus leading to a good mixture of the contents. Fresh portions of the charge are

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always, therefore, coming in contact with the slag, so that the refining process is much accelerated. A melting of the scrap also takes place, thanks to the good mixing together of the bath content in a short time, as continually fresh fluid masses are flowing over the scrap pieces and bringing them to the melting point. Combined direct and induction heating is employed in this case also by means of pole plates. The transformer cores are wound with the primary and secondary windings. One end of the latter is connected to a neutral point and the free ends are fixed to wide copper bars which are connected to the pole plates. These are fixed in the furnace foundations at the places where the two melting rings cross the working hearth—that is, at the crossing point of the secondary circuits in that part of the middle hearth which acts as a heating resistance. The charging and tipping of the slag is effected through the two doors at the back. Slag producing ingredients can be introduced through either door. Mechanical tipping of the furnace is effected in the same way as in the case of the single-phase furnace.

The transformer which supplies the three-phase furnace has a maximum output of 400 k.v.a. with a power factor of 0·7. The working voltage is 500 volts and the frequency 50.

In this case, too, the windings are surrounded with induction free covering, through which air from the ventilators is supplied. The furnace voltage is regulated very easily by a transformer, which is connected to the primary 500-volt circuit and to a three-pole rheostat, which allows six different voltages to be used at the furnace. This transformer is air-cooled through an offshoot from the main pipe. In general, the tipping and switching arrangement are similar to those used on the single-phase furnaces.

For communication between central station, transformer house and furnaces a loud-speaking telephone installation is in use. In the furnace house, as mentioned above, a telephone is placed on a pillar near the switchboard, while at the central station and convertor house wall instruments are used. The two furnace positions and the central station can all ring up the transformer station, and can be rung up from thence by using a line-selector drop-annunciator instrument. No arrangement is made for the furnace house to speak to the central station, as this is not necessary.

OSCILLATORY CURRENTS IN COUPLED CIRCUITS.*

BY G. W. O. HOWE, M.SC.

Summary.—The author describes the method of demonstrating with an oscillograph the currents in coupled oscillatory circuits containing capacity and inductance. The oscillation of energy between the circuits is discussed mathematically and the conditions are shown to agree with experimental results. The quenching of the spark in the primary circuit is finally considered.

If a condenser with a capacity of K farads be charged and then discharged through an inductance of L henries, the resultant current is oscillatory if the resistance of the circuit is less than $2\sqrt{L/K}$. The oscillatory current has a logarithmetic decrement of $R/2\sim L$ per period, and if R is small compared with L, a frequency of $\frac{1}{2\pi\sqrt{KL}}$.

By taking condensers and inductances of suitable values, these oscillatory currents can be shown on the lecture screen by means of the Duddell projection oscillograph. To do this conveniently, the ordinary charge and discharge key is replaced by three brushes rubbing on a special commutator which is fixed to the spindle of oscillograph motor, so that a number of similar wave-trains are superimposed on the screen. As shown in Fig. 1, the commutator consists of a brass cylinder, B, certain parts of which are cut away and replaced by insulating material, I. During a short interval the condenser is connected across a direct-current supply, from which it is then disconnected and discharged through an inductance, in series with which is placed the strip OS of the oscillograph, suitably shunted. This oscillatory circuit is only broken while the condenser is being charged. In the experiments shown, the capacity consists of four Western Electric Co. condensers, nominally of 5 mfds., connected in parallel, while the inductance is an air-core choking coil of 28 millihenries with a resistance of 0·32 ohm. The oscillations have a frequency of 220 per second. The curves accompanying this Paper were obtained by placing a photographic film on the tracing desk of the oscillograph and exposing for a few seconds. The measured resistance of the circuit was in all cases about half an ohm, while the resistance calculated from the decrement is about 1·5 ohms. The condensers are, therefore, the main cause of damping in the circuits. By placing a variable resistance in the circuit the damping can be increased until the circuit is made non-oscillatory. When a circuit contains a spark-gap the conditions are somewhat modified, as the resistance in the gap, and therefore the decrement of the circuit, increases as the current decreases in amplitude.

We shall consider the case in which the two oscillatory circuits are adjusted to have the same natural frequency. The second strip of the double oscillograph is put in the new oscillatory circuit, and the two inductances so placed that they mutually affect each other (*see* Fig. 1). When a discharge passes through the primary circuit, energy will be transferred from the primary to the secondary circuit. If the mutual inductance between the coils is low, the rate of this transfer of energy will be small compared with the rate at which energy is fritted away by the damping in the primary circuit. The secondary current will then never be strong enough to have any marked effect on the primary circuit beyond a slight increase in its damping. In the secondary circuit we shall have a train of the natural frequency, increasing in amplitude up to a certain point and then gradually decreasing.

If now the coupling between the two circuits be tightened—*i.e.*, if their mutual inductance be increased—the transfer of energy takes place at a greater rate and goes on until the energy is entirely transferred to the secondary circuit, the amplitude of the primary current being reduced to zero. The action then reverses, the role of primary and secondary being interchanged until the energy has been entirely dissipated.

It can be shown mathematically that, although the two circuits may be tuned to have exactly the same periodic time, T, when oscillating alone, the oscillatory current in each circuit will now be the resultant of two superimposed harmonic oscillations of different frequencies. If T_1 and T_2 be their periodic times, $T_1=\sqrt{T^2+\tau^2}$ and $T_2=\sqrt{T^2-\tau^2}$, where $\tau^2=4\pi^2M\sqrt{K_1K_2}$. We have already seen that $T^2=4\pi^2K_1L_1=4\pi^2K_2L_2$. The ratio $M/\sqrt{L_1L_2}$ is generally known as the coupling and designated by k, so that $\tau^2=kT^2$ and $T_1=T\sqrt{1+k}$ and $T_2=T\sqrt{1-k}$.

The superposition of these two harmonic oscillations of different frequencies will result in beats, and if T_B be the periodic time of

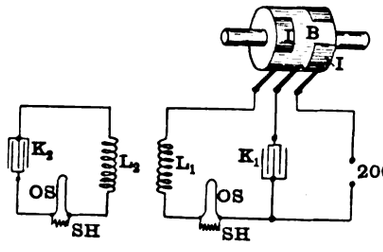

FIG. 1.

these beats, it is evident that $T_B=T_1T_2/(T_1-T_2)$, and that the number of waves in each beat is

$$\frac{T_B}{T}=\frac{\sqrt{1+k}\cdot\sqrt{1-k}}{\sqrt{1+k}-\sqrt{1-k}}$$

A half of this number will be the number of oscillations made by the primary current before the energy has been all transferred to the secondary circuit, which is very important from the point of view of the probability of the spark in a radio-telegraphic sending apparatus being quenched at this moment. In the table the complete oscillations per half-beat is given for various values of the coupling. It will be seen that when the coupling is less than a third, which is always the case in practice, the number of complete oscillations per beat is the reciprocal of the coupling. This agrees very well with the experimental results given in the Paper.

k.	No. of waves per half-beat.	k.	No. of waves per half-beat.
0·05	0·10	0·4	1·1
0·1	0·5	0·5	0·84
0·2	2·4	0·6	0·63
0·3	1·6		

If the coupling is tight it seems to be immaterial whether the damping resistance is placed in the primary or in the secondary circuit. When the coupling is loose it still seems immaterial so far as the secondary circuit is concerned, but not entirely so in respect of the primary circuit. If the frequency of the oscillations is increased beyond a certain point, the Duddell oscillograph will be unable to follow the rapid variations of the current. The only form of oscillograph which can then be used is that depending on the deflection of the cathode rays in a vacuum tube. In radio-telegraphy the high-frequency oscillations are always investigated indirectly by means of a so-called wave meter, which is simply an oscillatory circuit, the natural frequency of which can be varied over a wide range. It will act as a harmonic analyser, picking out and responding to any oscillations of its own frequency in the circuit with which it is loosely coupled.

* Abstract of a Paper read before the Physical Society.

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In the sending apparatus of a radio-telegraph station we are met with this difficulty. If the primary oscillating circuit containing the spark-gap be loosely coupled with the aerial, the electromagnetic waves sent out will have one definite frequency, but the transfer of energy to the aerial will take place so slowly that the major portion of the primary energy will be frittered away in the spark-gap. If, on the other hand, the circuits be coupled tightly, the energy will surge backwards and forwards between the two circuits and powerful electromagnetic beats will be sent through the ether. This will reduce both the efficiency and the possibility of sharp tuning. The obvious way out of the difficulty is to break the primary oscillating circuit at the first moment that all the energy is transferred to the

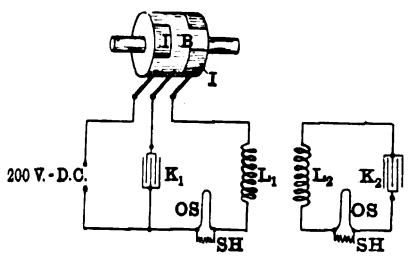

FIG. 2.

aerial, and thus make its return to the primary circuit impossible. Marconi, in 1906, found that by making the spark-gap very short and thus ensuring that no part of the spark-path was very far removed from a large mass of cold metal, the disruptive strength of the gap is so quickly restored that the circuit is effectually broken if the current in it fall to a small value for a short time. The more efficient the quenching of the spark, the shorter will be the time during which the amplitude of the current must remain small in order to prevent the spark restriking, and therefore the tighter can be the coupling. This is of great advantage, as it lessens the time during which energy is being dissipated in the spark.

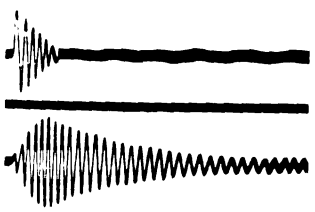

FIG. 3.

To represent this on the oscillograph it is only necessary to break the primary oscillating circuit at the moment when the amplitude of the primary current has fallen to zero. The simplest way of doing this is to rearrange the connections to the commutator as shown in Fig. 2. The speed of the motor must then be adjusted so that the short interval during which the primary current is closed is equal to the time taken for the transfer of energy from the primary to the secondary circuit. The result obtained is shown in Fig. 3. If the quenching of the spark is not effective enough to quench it at the first opportunity it may succeed in so doing the next time the primary amplitude falls to zero. In Fig. 4 the quenching occurs at the third

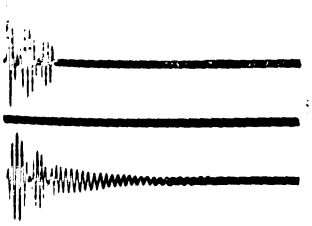

FIG. 4.

current. As a matter of fact a spark-gap would cause the decrement to be much greater than that shown in Fig. 4. The spark may be looked upon as a minimum current cut-out which we try to make as quick-acting as possible.

Attention should perhaps be drawn to the ironless choking coils used in the oscillatory circuits. They were designed by Prof. Mather for general laboratory use. They are wound with six-cored cables, the cores being brought out to a plug-board. The frame work is of wood and fibre and entirely free from metal. The range of inductance is from 7 to 250 millihenries. The power-factor at 50 cycles per second is only 0·03.

ELECTRICITY METERS.

In connection with the recent discussion on Messrs. Ratcliff and Moore's Paper we received the following communication from Mr. J. T. Irwin, which was unfortunately crowded out of our last issue :—

In the Paper presented to the Institution of Electrical Engineers on March 23rd the authors bring out many points which are well worth careful consideration, especially as their conclusions are supported by carefully carried out experiments.

In considering the effect of a rapidly varying load on shunted ampere-hour mercury type meters it is necessary to divide the meters into two classes; first, those like the Ferranti (old) type where the torque is proportional to the square of the current, and, second, those where the torque is proportional to the current.

In the first case, if the ratio L R in the shunt is equal to L R in the bath circuit the currents will divide up proportionally to their resistances and the torque will be proportional to the square of the current in the mains. If the fluctuations of the current are rapid, as for a motor driving a punching machine, then the speed of the meter will not have time to change as the current changes and the meter will have a mean torque proportional to the mean square of the current, and as the voltage is assumed constant it will register proportional to the *root-mean-square* current. But the power taken from the mains is proportional to the mean current, and if the meter has been calibrated with a steady current the meter will always register *too fast* by an amount depending on the ratio $C_{R.M.S.}/C_{mean.}$; a ratio that could be theoretically very large, but in quite ordinary cases might give an error of 5 to 10 per cent.

If a non-inductive shunt is put across the meter the current from the mains divides between the two circuits; but owing to the induction in the bath circuit and series magnet the variation of current and the ratio $C_{R.M.S.}/C_{mean.}$ is less in the meter than in the shunt, but the mean current in the bath circuit is determined by the ratio of resistances only, so the effect of putting non-inductive shunts across the meter would be to decrease any inaccuracies that might crop up owing to rapid variations of load.

In the second class of meter where the torque is proportional to the current, the introduction of inductance into either of the circuits will introduce no error as long as the voltage remains constant, as the current (mean) in each circuit is determined only by the ratio of resistances, and the torque is proportional to the true power.

In the latter part of their Paper the authors show the effect of wave form on the reading of an induction meter. These results can be easily explained. The current flowing in an alternating-current circuit and the pressure across it at any instant can be written as follows :—

$$V = v_1 \sin(pt) + v_3 \sin(3pt + \alpha) + v_5 \sin(5pt + \beta),$$
$$A = A_1 \sin(pt + \phi_1) + A_3 \sin(3pt + \phi_3) + A_5 \sin(5pt + \phi_5),$$

and the mean power over a complete cycle is equal to

$$A_1 V_1 \cos\phi_1 + V_3 A_3 \cos(\alpha - \phi_3) + V_5 A_5 \cos(\beta - \phi_5),$$

since terms involving different frequencies when multiplied together and integrated give zero value. We, therefore, get the result that the total power is the sum of the powers due to the fundamental 3rd, 5th, 7th . . . . . waves, each considered separately, and if the reading of a meter is made independent of frequency it will also be independent of wave form as long as there is no appreciable change in the permeance of the magnetic circuits. We also get the result that, if only the meter reads correctly at one particular frequency and if one of the curves is a sine wave of this frequency, it does not matter how distorted the other is, the meter will still register correctly. That is to say, if the pressure wave form of an alternating-current system is kept a sine wave, then an induction type meter can be used to register the energy on very distorted waves of current such as arc lamp circuits, rectifiers, &c., but this is by no means true where the voltage differs from a sine wave. It would be equally true that for a sine wave of current it would not matter how much the voltage was distorted.

In the cases the authors consider, they are dealing with a non-inductive load, and the shape of the wave is the same for both current and pressure. When the harmonic is superimposed on the fundamental the two waves, according to the above equation, could be considered quite separately as giving power to the resistance. Reversing *both* the current and pressure waves of either component should produce no change in the reading since the power is not altered, and it will be seen in Table II. of their Paper that this is practically the case. The reason it is not absolutely true is that the generator giving the fundamental has also a third harmonic, and that this will be added vectorially to the impressed third harmonic due to

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the second machine, and will not give quite the same value of the third harmonic when the terminals of the second machine are reversed.

It is seen that in practice the meters always read slow, and the higher the value of the harmonic in the resultant wave the slower the meters read. This is undoubtedly due to the fact that they do not register correctly the power given by the higher harmonics.

The curve herewith was obtained by the writer for an induction meter, tested on a varying frequency at unity power factor. It shows that a meter which was correct at its normal frequency of 50 was 15 per cent. slow at 150 ∿, and 23 per cent. slow at 250 ∿. Therefore, we can tell at once, if we know the composition of any wave, how much the error in reading will be.

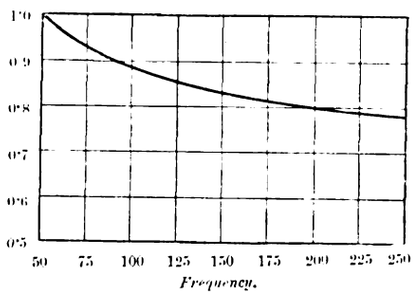
The arrangement the authors adopted in building up their wave was to put two machines in series and to measure the voltage across each machine, the voltage across the two and the wave form of the resultant on load. It is evident in this case that the composition of the wave cannot be judged by the voltage across each machine, since each machine will act as an inductive resistance to the current sent by the other machine and increase the reading of the voltmeters across each, but will decrease the voltage across the two. In this case the only satisfactory way to find the composition of the resultant wave is by analysis. On analysing out wave No. 4 the writer finds the amplitude of the third harmonic about 40 per cent. of the fundamental and the fifth harmonic about 10 per cent., and, therefore, according to the above curve the meter should read

$$\frac{(1\cdot0)^2+(0\cdot85)(0\cdot4)^2+(0\cdot77)(0\cdot1)^2}{(1\cdot0)^2+(0\cdot4)^2+(0\cdot1)^2}$$

of the true energy—*i.e.*, about 2·3 per cent. slow. This gives about the same value as meter A tested by the authors. The analysis of curve No. 5 gives the third harmonic equal in value to the fundamental, and, therefore, the meter would read

$$\frac{(1\cdot0)^2+0\cdot85(1\cdot0)^2}{(1\cdot0)^2+(1\cdot0)^2}=0\cdot925$$

of true value, or 7·5 per cent. too slow, which agrees again with meter A. It is inferred from these curves that meters A and B would



vary with frequency in about the same way as shown in the curve, but that meters C and D would be largely affected.

For the meter tested by the writer the current in the disc due to the current coil was displaced from the flux in the disc due to the pressure coil at normal frequency by an angle equal to the phase displacement of the current and pressure in the mains—*i.e.*, at zero power factor it did not turn, but as the frequency increased the phase displacement became larger, until at 200 ∿ the phase displacement was 11 deg., and the flux in the disc was lagging behind the current in the disc.

These results explain why it is that on an inductive load the meter reads more correctly than on unity power factor; because if a large inductance is put in to make the current lag the inductance has three times the impedance to the third harmonic that it has to the fundamental and, in addition, the phase displacement is greater; so the actual power due to the third, fifth, &c., harmonics is very small, and, therefore, the meter will register nearly correctly. The fact that the flux for the harmonics lags in the disc tends to make the meter read too fast for lagging currents and so compensated at some particular power factor for the reduction in flux in the disc.

If the current in the meter is leading on the pressure the reverse holds, for not only are the harmonics in the current wave exaggerated, but the meter would not read the total power of these harmonics even at unity power factor. As the frequency increases the flux in the disc due to the pressure coil lags more and more, and, therefore, for currents leading their pressure waves by nearly 90 deg. the torque will be negative and will oppose the main torque.

The effect of this is very evident to distributing engineers, as they very often find that at the sending end of a high-tension underground main where there is a capacity current flowing in to the main the meter reads *less than* the one at the receiving end by as much as 10 per cent., and this even when the meters have been carefully calibrated beforehand.

The conclusion to be drawn is that each type of meter should be tested at frequencies much higher than those at which it is to be used, and rejected if not up to a definite standard. The standard need not be a very rigid one. A meter as good as meter B would be quite accurate enough for any practical case, whereas meters C and D would be ruled out.

THE ELECTRICAL EQUIPMENT OF VICTORIA BARRACKS, WINDSOR.

The construction of barracks for the accommodation of troops has of recent years been undergoing many modifications, all of which are for the better. The old arrangement was to provide such accommodation as the canteen, reading and recreation rooms in blocks separate from those in which the men slept. It was usual, too, for the men to sleep, eat and generally live in the same rooms, a not altogether healthy or pleasant arrangement. Further, any provision for sanitary requirements in these older buildings left much to be desired.

The new system of barrack construction is very different from the old, and may be said to be exemplified in the new block which has recently been added to Victoria Barracks, Windsor. These barracks at present accommodate a battalion of Foot Guards, and it is proposed to substitute the accommodation in the new block for that in one of the old blocks, which is to be pulled down. The scheme of the new building has been planned on the basis of accommodating two half battalions, each unit being complete in itself in relation to day, cooking and lavatory accommodation. Both units have, however, the use of the recreation room. The buildings cover an area of 47,600 sq. ft., and consist of two parallel blocks 75 ft. apart, open at the end. The space thus formed between these blocks is roofed over and lighted by large ventilating lanterns, and is used for the dining and recreation rooms. The result is certainly preferable to the old arrangement.

We shall probably be not far wrong in saying that the distinctive feature of the new building is the provision of electricity for lighting purposes. This modern method of illumination has only recently begun to be used by the War Office, but, nevertheless, it is already established on a firm footing, so that all new, and many of the existing, buildings have been, or are being, wired.

The arrangement of the new barracks in two halves simplifies the wiring scheme to be adopted. Energy is obtained from the mains of the Windsor Installation Co., who supply on the continuous-current three-wire system, the pressure being 220 volts across the outers. After passing through the usual cut-outs, the mains are led into a three-way link box, whence the two lighting circuits are tapped off from one outer and the neutral, while a power circuit for the lift is taken from the two outers. This link box makes it possible to change half the building from one side of the system to the other, if necessary. From this box the two main lighting circuits are divided, and each pass through a double-pole iron-clad switch fuse, which is so arranged that it can only be opened when the switch is "off" and the fuse terminals are dead. The switch cannot be again inserted until the box is closed. The two sets of mains then pass up from the basement to the ground floor, where they are connected in a special switch room to a 13-way double-pole main switch and fuse board, and to an 11-way double-pole main switch and fuse board respectively. Meter bights are also provided in this room. These boards are very well designed, and are contained in substantial iron boxes. The fuses are of the enclosed type, and the double-pole switches, which are worked through links, are arranged to break circuit in two places on each pole. The switch itself consists of a

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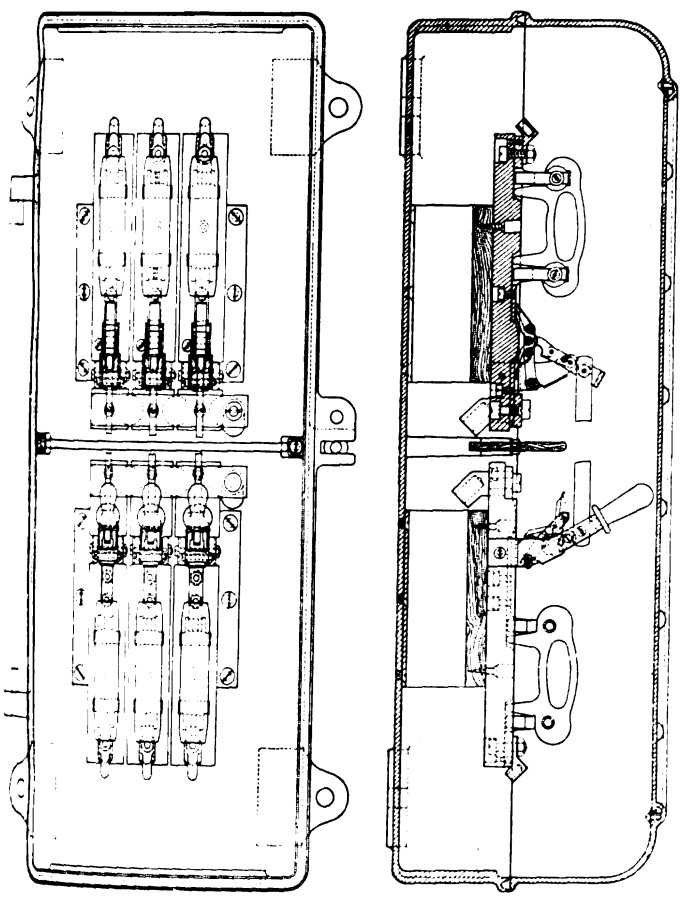
substantial copper brush, which in its off position is entirely dead. When the switch is operated its ends are pressed down against the bus bar on one side and against brass plates on the other, to which ends of the circuit are connected. This obviates the use of terminals on the switches themselves. The switches themselves are capable of breaking a circuit carrying 20 amperes at 220 volts without injury. This arrangement of switches allows the lights to be turned on or off from a central point by the man in charge.. Certain circuits on these boards, too, control "police" lights, which remain on all night for purposes of supervision. A drawing of one of these boards is shown in the accompanying illustration.

As regards living accommodation, the ground floor of the building is divided arbitrarily into two halves, each of which is fed from one side of the three-wire system. On the other floors the division is natural, and is taken advantage of in arranging the mains.

As regards the system of wiring employed, solid drawn steel



Z-Ampere D.P. Switchboard in Cast-iron Case. Scale: One-sixth full size.

screwed tube is used throughout. Not more than 25 ft. of tube on a straight run has been erected without a junction box, while there are never more than two bends between each box. Great care has been taken with regard to earthing. Not only is all the conduit earthed, but arrangements have been made so that all the switch covers and other metal parts are connected through to the conduit. The only case where metal parts are not earthed is when metal shades and lamp-holders on flexible pendants are used. Arrangements are, however, being made to earth these also. The conduit is fixed to the wall or ceiling surface by means of enamelled corrugated metal saddles. These are in many cases of the double type; that is, they support the conduit away from the wall. A universal pattern of junction box has been used throughout. The local switches, too, are fixed inside these boxes, and the latter are in that case provided with domed shape metal covers. This box, besides possessing a universality of pattern, allows individual switches, when a number are mounted together, to be repaired without disturbing the others. The same boxes are used for fixing the ceiling roses, while the back plates of the other fittings and brackets were designed to fasten to similar boxes. Metal filament lamps are used throughout.

The accommodation for which this lighting scheme has been provided would certainly satisfy the most impassioned upholder of the soldier's rights. It may be divided into five sections: Dining and canteen, recreation, day lavatories, sleeping accommodation and accessories.

Two dining rooms are provided, each with accommodation for half a battalion (approximately 500 men). At the end of each room six arches give access to six food locker corridors, which are fitted with a number of lock-up lockers. These rooms are lighted by 60 16 c.p. lamps, arranged on 12 pendants, each containing five lights. One light on each pendant is a police light, and these 12 lights are controlled by 4 special switches. The food locker corridors are each lighted with one 16 c.p. lamp.

It is proposed to use the eastern dining room as a supper and entertainment room, and with this end in view a small but neat stage has been erected at one end. This is lighted by the usual foot and wing lights, the former being fixed on a movable bar so that they can be raised from or lowered into a reflecting trough before and after use. Two small dressing rooms are provided at the back of the stage.

Kitchens, wash-up rooms and service corridors are accommodated along one of the longer sides of the dining room. Here are also to be found a supper cooking room, canteen, and grocery store. The last two have independent access from outside the building for the benefit of soldiers' wives and children. All these rooms are adequately lighted throughout, the lamps being capable of individual control, subject to the system of main control mentioned above.

The recreation division comprises rooms for reading, writing, smoking and games, as well as a billiard room and a room for the corporals. A library is also provided, and this, too, is accessible from the outside. As will be seen from the plan, the corridors give access between the various rooms. These are lighted from pendants, some of which are kept in circuit throughout the night.

The lavatory accommodation is very ample. It is divided into two halves, one of which is placed at the extreme end of each building. This accommodation comprises lavatories, shaving rooms, baths of various sorts, drying rooms and latrines. These places are in general lighted by stiff pendants with a ball joint that allows for movement in a horizontal direction.

Doubtless the most interesting part of these barracks is the sleeping accommodation. Each man is provided with a cubicle, there being altogether 450 in the building. These are arranged in 10 blocks on five floors, three in the southern and two in the northern part of the building, with two N.C.O.'s rooms on each floor and the necessary store adjoining. Each block of cubicles is lighted by 12 16 c.p. lamps, which are controlled from the switches on the distribution boards. Washing and lavatory accommodation is provided at the top of each of three staircases on each floor.

Besides the accommodation mentioned above a number of stores are provided, while small cleaning sheds and a reception station for sick men are provided in separate buildings, and are at present unlighted.

We have to thank Mr. H. Measures, Director of Barrack Construction at the War Office, and Mr. A. Kirk, his assistant, for giving our representative the opportunity of inspecting this installation.

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ON RESISTANCES WITH CURRENT AND POTENTIAL TERMINALS.

(*Continued from page 1033, Vol. LXVI.*)

BY G. F. C. SEARLE, M.A., F.R.S.

Summary.—Although conducting systems with current and potential terminals have been in use for many years, the general theory of conduction through such systems has received little attention. The usual proof of the important theorem that current and potential terminals may be interchanged without affecting the P.D. on the main resistance involves the condition that the whole of any one junction is at the same potential. This condition is approximately satisfied in the case of a network of fine wires, but not in a "low resistance" or "shunt." In dealing with such a system we need a proof of the reciprocal relation which shall be independent of the form of the system. Helmholtz has given such a proof, and a simple, direct one is here given due to Heaviside. Dr. Bromwich, employing Green's theorem, also gives a solution. Useful information regarding the properties of conducting systems with three and four terminals is obtained, and it is shown that a triangle of resistances may be replaced for all purposes by a three-rayed star of resistances. In the case of a four-terminal resistance we can construct even low resistance systems such that the want of infinite conductivity at the junctions can produce no sensible error. The discussion of the design of such resistances shows the great advantage of connecting each current and each potential terminal to the main resistance by a rod or wire, the length of such being at least three times its greatest width. The resistance of such a system is very definite. In the case of low resistances capable of carrying currents of the order of 1,000 amperes, slight changes in the connections at the terminal lugs have been found to produce appreciable changes in the P.D. on the main resistance. These defects are easily remedied. Potential "tongues" in sheet resistances are shown to be an advantage. For the comparison of four-terminal resistances with other resistances five methods are discussed, the most important of them being the Thomson bridge, which possesses an advantage not previously realised.

§ 21. *Potential Terminals.*—The great practical advantages gained by placing the terminal screws used in the potential

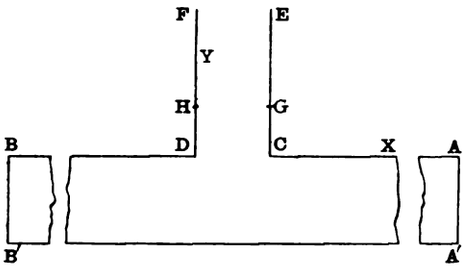

FIG. 15.

measurements at the ends of "potential leads" in the manner indicated in Fig. 13 may be illustrated by the following mathematical example. Let ABB′A′ (Fig. 15) be a strip of metal furnished with a potential lead CEFD of infinite length of uniform thickness t and of uniform width a. Let DA and DF be taken as rectangular axes of x and y. When a current flows along the strip from AA′ to BB′, the lines of flow spread out to some extent into the potential lead, as indicated in Fig. 16, and set up differences of potential between points on that lead. We shall now show how the potential of every point of the lead may be found by Fourier's method when the potential along DC is known.

If V_0 be the potential at any point on DC, we can write

$$V_0=\tfrac{1}{2}T_0+T_1\cos\frac{\pi x}{a}+T_2\cos\frac{2\pi x}{a}+T_3\cos\frac{3\pi x}{a}+\ldots,$$

where the constants T_0, T_1 .... are given by

$$T_n=\frac{2}{a}\int_0^a V_0\cos\frac{n\pi x}{a}dx.$$

The solution of the problem is then given by

$$V=\tfrac{1}{2}T_0+T_1\cos(\pi x/a)e^{-\pi y/a}+T_2\cos(2\pi x/a)e^{-2\pi y/a}+\ldots,$$

where V is the potential at the point x, y. For this quantity satisfies Laplace's equation,

$$\frac{d^2V}{dx^2}+\frac{d^2V}{dy^2}=0.$$

and satisfies the boundary conditions. These are that $V=V_0$ when $y=0$, and that, when $x=0$ and when $x=a$, the current has no component perpendicular to CE. The second condition requires that $dV/dx=0$ when $x=0$ and when $x=a$; and so we see the reason for the choice of the cosine-series for the Fourier expansion of V_0.

Without knowing the value of V_0 at every point of DC, we can find a superior limit to $|T_n|$, where $|T_n|$ is the positive numerical value of T_n. Integrating by parts we see that, when n is not zero,

$$T_n=\frac{2}{n\pi}\left[V_0\sin\frac{n\pi x}{a}\right]_{x=0}^{x=a}-\frac{2}{n\pi}\int_0^a\frac{dV_0}{dx}\sin\frac{n\pi x}{a}dx.$$

Thus, assuming that V_0 steadily increases from D to C (that is, from $x=0$ to $x=a$), we have

$$|T_n|<\frac{2}{n\pi}\int_0^a\frac{dV_0}{dx}=dx,$$

or

$$|T_n|<(2/n\pi)(V_C-V_D).$$

If G and H be two points on CE and DF at a distance y from CD, we have

$$V_G-V_H=-2[T_1e^{-\pi y/a}+T_3e^{-3\pi y/a}+T_5e^{-5\pi y/a}+\ldots].$$

By the inequalities just established

$$\frac{V_G-V_H}{V_C-V_D}<Q,$$

where

$$Q=\frac{4}{\pi}\left(e^{-\pi y/a}+\frac{1}{3}e^{-3\pi y/a}+\frac{1}{5}e^{-5\pi y/a}\ldots\right).$$

When y is not less than a, we see that we may neglect all but the first exponential term. The very rapid manner in which V_G-V_H diminishes as y increases may be seen from the table

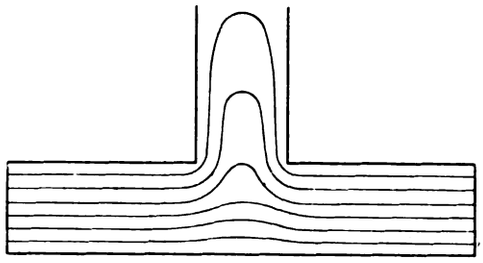

FIG. 16.

in § 20. Thus, when GC is four times CD, V_G-V_H is certainly ess than $\frac{1}{100000}$th part of V_C-V_D. Since the distance between the two potential leads is usually at least 100 times the width of each lead, it will be seen that the differences of potential which can be found between any two points on either lead whose distances from the junctions of lead and strip exceed four times the width of the lead are quite inappreciable compared with the difference of potential between two points, one on each lead.

When the strip ABB′A′ is of uniform width b, except for the potential lead, and AC, BD are great compared with a and b, we can express V_C-V_D in terms of the fall of the potential per unit length at points on A′B′ at a great distance from CD. If the thickness of the metal be t and the specific resistance be σ, this fall of potential per unit length is $i\sigma/bt$, where i is the current flowing from AA′ to BB′. By the Schwarzian transformation it can be shown that

$$V_C-V_D=\frac{4i\sigma}{\pi t}\sinh^{-1}\left(\frac{a}{2b}\right)=\frac{2i\sigma}{bt}\cdot\frac{b}{\pi}\log\left[\frac{\sqrt{4b^2+a^2}+a}{\sqrt{4b^2+a^2}-a}\right],$$

$$=\frac{i\sigma}{bt}\cdot\frac{2a}{\pi}\left[1-\frac{1}{2}\cdot\frac{1}{3}\left(\frac{a}{2b}\right)^2+\frac{1.3}{2.4}\cdot\frac{1}{5}\left(\frac{a}{2b}\right)^4-\frac{1.3.5}{2.4.6}\cdot\frac{1}{7}\left(\frac{a}{2b}\right)^6+\ldots\right]$$

When a/b is small, this gives approximately

$$V_C-V_D=\frac{i\sigma}{bt}\cdot\frac{2a}{\pi},$$

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so that $V_C - V_D$ is equal to the fall of potential over a length of AB equal to $2/\pi$ times CD.

If the strip be 5 cm. in width and the potential lead be 0·1 cm. in width, while GC is 2 cm., we have

$$V_G - V_H < Q(V_C - V_D) < \frac{i\sigma}{bt} \times 1{\cdot}4 \times 10^{-6}.$$

Thus the greatest difference of potential which can exist between any two points on the part of the potential lead beyond GH is less than that between two points on A′B′ (at a distance from GH separated by the microscopic space of $1{\cdot}4 \times 10^{-6}$ cm.

The Schwarzian process also gives the rather closer limit

$$V_G - V_H = \frac{i\sigma}{bt} \cdot \frac{4a}{\pi} e^{-(1+\pi y/a)}$$

when a/b is small and y is at least equal to a.

When b/a is small the series for $V_C - V_D$ becomes

$$V_C - V_D = \frac{i\sigma}{bt} \cdot \frac{2a}{\pi}\left[\frac{b}{a}\log\frac{a}{b} + \frac{b^3}{a^3} - \frac{3}{2}\frac{b^5}{a^5} + \frac{10}{3}\frac{b^7}{a^7} - \cdots\right].$$

Potential Tongues.—If A, B be the current terminals and C, D potential terminals of a low resistance, the resistance [AB . CD] must be known if the instrument is to serve as a

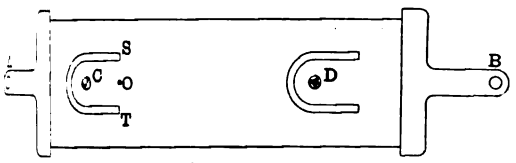

Fig. 17.

standard. The adjustment of [AB . CD] to a definite value can be accomplished in a variety of ways; the most satisfactory method is perhaps that in which potential tongues are employed. A sheet of manganin is attached to two stout copper end-pieces which serve to convey the current into and out of the sheet. Two U-shaped cuts are made in the manganin as in Fig. 17, and the potential terminals C D are attached to the tongues so formed. The resistance [AB . CD] can be adjusted to a definite value by means of these cuts, for [AB . CD] can be increased by lengthening the cuts of the tongue, and can be diminished by lengthening the cuts of the tongue.

In order that the whole of the terminal screw fixed at C may be practically at one potential, it is necessary that there should be no appreciable differences of potential in the parts of the tongue in the immediate neighbourhood of the terminal screw. This condition will be very accurately secured if the length of the tongue be two or three times its width, provided, of course, that the screw is placed near the end of the tongue.

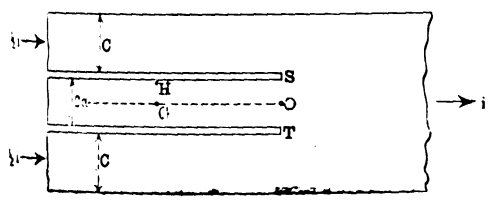

Fig. 18.

If S and T be the ends of the cut of the C-tongue and if O be the middle point of the straight line ST, the straight line OC is a line of flow (provided C is symmetrically placed), and thus we may suppose the tongue to be cut along OC. When the length of the tongue is great compared with its width, we can apply the method of § 21 to determine a superior limit to the difference of potential between two points on the tongue when we know the difference of potential $V_S - V_0$ between S and O. This difference of potential, for a given current between A and B can be found experimentally. If the width of the tongue be $2a$, and y be the distance from ST of two points G H, one on OC and the other on the edge of the tongue, it follows from § 21 that when y is not less than a, we may write

$$\frac{V_H - V_G}{V_S - V_0} < \frac{4}{\pi} e^{-\pi y/a}.$$

Dr. T. J. I'a. Bromwich, F.R.S., has kindly worked out the Schwarzian transformation for the case, in which the potential tongue is of infinite length, as indicated in Fig. 18. If the whole width of the strip be $2a + 2c$, if the total current along the strip be i, and if the slits be symmetrically placed, we have

$$V_S - V_0 = \frac{\sigma i}{2ct} Na.$$

Here N is a number depending upon the ratio of c to a such that $V_S - V_0$ is equal to the fall of potential over a length Na along the parts of width c which are separated from the potential tongue by the slits; the length Na is to be taken at a great distance from S. If we write

$$n = c/(a + c)$$

we have

$$N = \frac{n}{\pi(1-n)} \log\left(\frac{1}{p}\right),$$

where p is to be found in terms of n from the equation

$$\log p = (1-n)\log\frac{n-p}{1-n}.$$

For values of n less than unity the value of p can be found by the process of trial and error. When c/a becomes infinite, the limiting value of N is q/π, where q is given by the equation

$$-q = \log(q-1).$$

Hence, the limiting value of N is 0·4070. The table gives the values of N for some values of c/a.

c/a	n	p	N
1		0·414	0·281
2		0·596	0·330
3		0·692	0·352
4		0·752	0·363
9	$\frac{9}{10}$	0·874	0·386
99	$\frac{99}{100}$	0·987	0·406
∞	1	1·000	0·407

The value of $V_H - V_G$ can then be estimated by means of the former inequality; or by the Schwarzian process we find the closer approximation (when $y > a$)

$$V_H - V_G = \frac{\sigma i}{2ct} Ma$$

where

$$M = \frac{2}{\pi}\left(1 - \frac{1}{m}\right)^m e^{-\pi y/a},$$

if $m = 1 + c/a$ or $n = 1 - 1/m$.

The results obtained by Dr. Bromwich are not strictly applicable to potential tongues of finite length, such as that shown in Fig. 17. In this case the current which enters at A has to

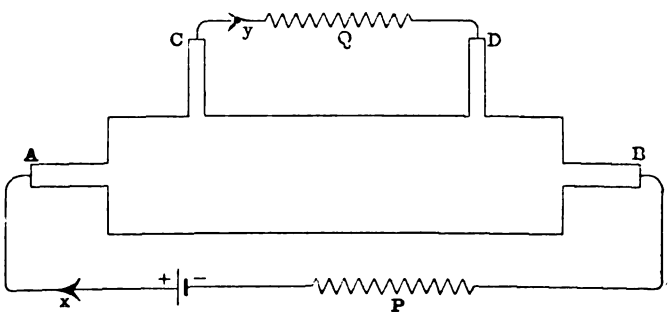

Fig. 19.

divide in order to flow past the U-cut, and consequently the distribution of flow near the sides of the tongue will not be quite the same as in the case considered by Dr. Bromwich. The difference will be more marked as the distance from S (Fig. 17) to the side of the strip becomes large compared with the length of the tongue, but the results will be sufficiently near the truth to give a fairly good idea of the magnitudes involved.

§ 23. *Combinations of a Four-terminal Resistance with Other Resistances.*—We shall consider the case represented in Fig. 19. Here the current terminals A B are joined by a wire of resistance P, in which is inserted an E.M.F. of amount E, the positive pole of the cell being connected to A. The potential terminals C D are connected by a wire of resistance, Q. Let x be the current in the wire P from B to A, and y the current in the wire Q from C to D.

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Applying Ohm's law to the two wires, we have

$$V_A - V_B = E - Px. \qquad V_C - V_D = Qy.$$

If we consider the conducting system, we see that $V_A - V_B$ is due to the current x, which enters at A and leaves at B, and to the current y, which enters at D and leaves at C. The first contributes x[AB] to $V_A - V_B$, while the second contributes $+y$[AB . DC], or $-y$[AB . CD]. Thus,

$$V_A - V_B = x[AB] - y[AB \cdot CD],$$

and hence

$$E - Px = x[AB] - y[AB \cdot CD].$$

Similarly, from $V_C - V_D$ we obtain

$$Qy = x[AB \cdot CD] - y[CD]. \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Here [AB], [CD] and [AB . CD] are the values which hold good when the wires P and Q are removed.

Solving these equations for x and y we obtain

$$x = \frac{E\{Q + [CD]\}}{\{P + [AB]\}\{Q + [CD]\} - [AB \cdot CD]^2}. \quad . \quad . \quad . \quad (2)$$

$$y = \frac{E[AB \cdot CD]}{\{P + [AB]\}\{Q + [CD]\} - [AB \cdot CD]^2}. \quad . \quad . \quad . \quad (3)$$

Since the last expression is symmetrical with respect to P+[AB] and Q+[CD], it follows that if E had been placed in the wire Q instead of in the wire P, the current in P from A to B would have the value given by (3). Thus, we have the important reciprocal relation :—

If the ends of a wire P, *and the ends of a wire* Q *are connected to a conducting system of any form, an E.M.F. of amount* E *placed in* P *produces in* Q *a current equal to that which an equal E.M.F. placed in* Q *produces in* P.

An important practical case is that in which a voltmeter of resistance Q, is connected to the potential terminals C D of a four-terminal low resistance, the current terminals being A B. From (1) we obtain the relation between the current y through the voltmeter and the current x which enters and leaves the low resistance by the current terminals. Thus,

$$y = \frac{x \cdot [AB \cdot CD]}{Q + [CD]}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

The P.D. between the voltmeter terminals is *not* x . [AB . CD] and *not* xQ[AB . CD]/{Q+[AB . CD]}. The true value is

$$V_C - V_D = \frac{xQ[AB \cdot CD]}{Q + [CD]}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Thus, for practical work with a voltmeter and a standard of low resistance, it is necessary to know [CD] the resistance of the standard measured between the terminals C D, as well as the four-terminal resistance [AB . CD], and hence no certificate granted for the standard is complete unless it gives the value of [CD] as well as the fundamental resistance [AB . CD]. In many cases Q will be large compared with [AB . CD], but if the potential terminals C D are connected to the rest of the system by *wires*, it may easily happen that Q may not be large compared with [CD].

In some cases it may be necessary to make a slight adjustment in the P.D. between C and D due to unit current from A to B. From (5) we see that this can be done by joining the terminals CD by a wire of resistance, Q. If $[AB \cdot CD]_Q$ denote the new value of $(V_C - V_D)/x$, we have

$$[AB \cdot CD]_Q = \frac{[AB \cdot CD]}{1 + [CD]/Q}. \quad . \quad . \quad . \quad . \quad . \quad (6)$$

Since [CD] and Q are both positive, it follows that $[AB \cdot CD]_Q$ and [AB . CD] are both positive or both negative, and that $[AB \cdot CD]_Q$ is numerically less than [AB . CD].

We will next find how the resistance between A and B is affected by the presence of the wire Q. The value of $V_A - V_B$ is $x[AB] - y[AB \cdot CD]$, and hence, by (4)

$$V_A - V_B = x\left\{[AB] - \frac{[AB \cdot CD]^2}{Q + [CD]}\right\}.$$

If $[AB]_Q$ denote the resistance between A and B when C and D are connected by Q and P is absent, $V_A - V_B = x[AB]_Q$. Thus,

$$[AB]_Q = [AB] - \frac{[AB \cdot CD]^2}{Q + [CD]}. \quad . \quad . \quad . \quad . \quad . \quad (7)$$

Since Q, [CD], [AB] and $[AB]_Q$ are all *positive*, it follows that $[AB]_Q$ is less than [AB] by an amount proportional to the square of the P.D. between C and D due to unit current. Thus we obtain the important result :—

The resistance between two points AB *of a conducting system is diminished by connecting any other two points* C D *by a wire of finite resistance, unless a current entering at* A *and leaving at* B *causes no difference of potential between* C *and* D, *in which case the resistance between* A *and* B *remains unchanged.*

If we solve (7) for $[AB \cdot CD]^2$ we obtain

$$[AB \cdot CD]^2 = \{[AB] - [AB]_Q\}\{Q + [CD]\}. \quad . \quad . \quad . \quad (8)$$

Thus, [AB . CD] can be found when the four two-terminal resistances [AB], $[AB]_Q$, [CD] and Q are known. The *sign* of [AB . CD] depends upon which of the two potential terminals is denoted by C.

If $[CD]_P$ be the resistance between C and D when A and B are joined by a wire of resistance P, the wire Q being absent, we have

$$[AB \cdot CD]^2 = \{[CD] - [CD]_P\}\{P + [AB]\}. \quad . \quad . \quad . \quad (9)$$

Hence, it follows from (8) and (9), if P and Q are adjusted so that P+[AB]=Q+[CD],

$$[AB] - [AB]_Q = [CD] - [CD]_P.$$

In this case the change in the resistance between A and B caused by connecting C and D by the wire Q is equal to the change in the resistance between C and D caused by connecting A and B by the wire P.

§ 24. *Use of Auxiliary Terminals for Shunting.*—In measurements upon a four-terminal resistance with current terminals A B and potential terminals C D, it is sometimes necessary to

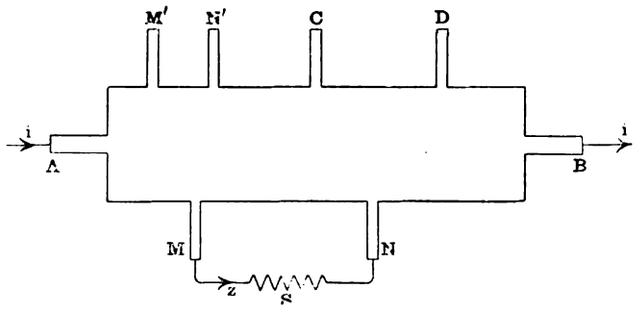

Fig. 20.

make a fine adjustment of the resistance [AB . CD] or [CD . AB] by shunting ; the formulæ are given in § 23. In § 23 the shunt wire is connected to the terminals CD, but it may happen that it is more convenient to attach the shunt wire of resistance S to a pair of auxiliary terminals M N, as in Fig. 20. Let [CD . AB]s be the value of $V_C - V_D$ when unit current enters at A and leaves at B, and M and N are connected by S. Then, if z be the current through S from M to N, when the current entering and leaving at A and B is i, we have

$$[CD \cdot AB]_S i = [CD \cdot AB]i - [CD \cdot MN]z = [CD \cdot AB]i - [MN \cdot CD]z$$
$$Sz = [MN \cdot AB]i - [MN \cdot MN]z = [MN \cdot AB]i - [MN]z.$$

Hence,

$$[CD \cdot AB]_S = [CD \cdot AB] - \frac{[MN \cdot CD][MN \cdot AB]}{S + [MN]}.$$

In Fig. 20 [CD . AB], [MN . CD] and [MN . AB] are all positive ; in this case $[CD \cdot AB]_S$ will be positive and less than [CD . AB] unless the product [MN . CD] [MN . AB] is greater than [CD . AB] {S+[MN]}, when $[CD \cdot AB]_S$ would be negative.

If the auxiliary terminals are at M′ and N′ in Fig. 20, [M′N′ . CD] and [M′N′ . AB] have *opposite* signs ; in this case $[CD \cdot AB]_S$ will be *greater* than [CD . AB].

Thus, if two pairs of auxiliary terminals be provided, it is possible to either increase or diminish the value of [CD . AB]. The maximum change occurs when S is zero and has the numerical value [MN . CD] [MN . AB]/[MN]. Since [MN] is numerically greater than either [MN . CD] or [MN . AB], it follows that the maximum change is numerically less than the numerical value of either [MN . AB] or [MN . CD].

(*To be concluded.*)

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PUBLIC ELECTRIC SUPPLY IN COUNTRY DISTRICTS.*

BY W. B. WOODHOUSE.

Abstract.—The author, after discussing the growth of electric supply and the development of the power companies, emphasises the importance of using overhead mains for distributing energy in country districts. Interesting examples of such work, and of street lighting, together with particulars as to cost, are mentioned. The use of electricity on farms is explained.

The history of the electric industry covers a period of some 30 years. In the early "eighties" electricity was supplied for lighting in a small number of towns, and from 1881 to 1883 electric supply companies were registered with a total capital of £16,000,000. In 1882 the first Electric Lighting Act was passed, and its effect on the industry was disastrous, for although 70 Electric Lighting Orders were granted in 1883 under the conditions of this Act, yet nearly all were subsequently revoked, and in 1888 only seven supply undertakings were in existence.

The Act contained three clauses which were objectionable. The first gave the local authority a veto on any application for a Provisional Order, and this veto was in many cases used as a means of extortion from the promoters; the trafficking in Provisional Orders at a later date to be suppressed by the Board of Trade. The second gave the local authority a veto on the use of overhead wires; a third gave the local authority the power to purchase a company's undertaking at the end of 21 years at practically break-up value. The effect of this clause so seriously interfered with the raising of capital that in 1888 an amending Act was passed extending the period to 42 years. From 1888 to 1898 the industry flourished and a large number of Provisional Orders were granted.

The chief effect of output on the cost of production next came to be realised. A large output means low costs, but to obtain this large output it is necessary to supply over large areas. This was the underlying reason for the granting of Electric Power Acts. A Joint Committee of the two Houses of Parliament under the presidency of Lord Cross sat in 1898, and their recommendations were so strongly in favour of supply on a large scale that in 1900, 1901 and 1902 Power Acts were passed for all the important industrial counties in England. Unfortunately for the country as a whole the recommendations of the Committee did not appeal to many local authorities, who set themselves to oppose the passing of the Acts, or to endeavour to have districts cut out from its operations. In some cases the restrictions were so serious that no development has taken place.

The state of affairs when the Power Acts were passed was that many small towns, boroughs and urban districts had taken out Provisional Orders. Some had erected works; others, more fortunate, adopted a waiting policy. The former class found that a small generating station was not always profitable, and, more serious still, that they could not offer so supply power at as cheap a rate as the power companies. Fortunately we learn by our mistakes, and the present tendency now is for local authorities holding Provisional Orders to offer to transfer their powers to a company taking a bulk supply from the power company, or themselves to take the supply. In Yorkshire, when the power company started operations in 1905, there were 25 districts in which local authorities had taken out Electric Lighting Orders. Of these Orders 12 have been revoked by the Board of Trade, seven transferred to a company taking a bulk supply, and four put into force by the local authorities taking a bulk supply from the power company. In not a single case has a small generating station been erected.

The author next referred briefly to the conditions which govern the cost of electricity. In a typical case the total costs are divided in the following proportion: Capital charges, 50 per cent.; coal, 25 per cent.; wages, &c., 15 per cent.; management, 10 per cent.

The capital expenditure on small undertakings is about equally divided between generating machinery and mains it is obvious that a generating station can be avoided, as by taking a bulk supply, expenditure and the risk is immediately halved. The generating plant has to be provided by the power company, but the economies which permit of a cheaper supply being purchased in bulk are: (1) Machinery used in the larger power station costs less per unit; (2) the machinery is more efficient and costs less to run; (the cost of production in a station of 10,000 H.P. will be about one-third of that in a small station); and (3) the machinery can be employed due to the use of current by so many varied industries.

Having then the advantages of generating on a large scale we have now to consider the distribution of electricity. The author confines himself to the consideration of distribution in country districts. In a rural or agricultural district the needs for electricity may be divided under three main heads: Street lighting, cottage and house lighting, power supply to farmhouses.

In such districts as these electricity supply can only be given at a cheap rate by the use of overhead mains. The comparative cost of underground and overhead wires will vary with the nature of the district, but an estimate of the cost of lighting a village street 1 mile long may be of interest. It is assumed that the maximum demand will not exceed 20 kw., and a 4 per cent. pressure variation is allowed for:—

Overhead Wires.

Cost of mains per mile, using wooden poles	£200
Cost of house service (each) and meters	3
Cost of street lamp	2
Mains, with wooden poles	£200
40 services with meters	140
36 street lamps	80
Switching wire for street lamps	10
	—£440

Underground Mains.

Mains	£370
40 services at £5	200
36 street lamps	150
Switching cable	40
	—£760

That is to say, underground mains would cost 75 per cent. more; or, to regard the matter in another way, current could be supplied for private lighting at 1d. per unit less if overhead wires are used. The use of overhead wires in other countries is much more general than in England, and if electricity is ever to be sold at as cheap a price as engineers hope, overhead wires must be used except in the centre of towns.

Objections have been raised to overhead wires on the score of unsightliness; the same argument was used when telegraph wires were first put up, and more recently when electric tramways started. In both cases the wires are more unsightly than the electric supply wires need be. The second objection is that such wires are dangerous. This argument is based on insufficient knowledge of the conditions. Any overhead electric wires erected in this country must be put up in a manner approved by the Board of Trade, and the Board's regulations are so severe, that it is safe to say that in no other country is overhead wire construction carried out in such a substantial and safe manner as in England.

The use of such wires is extending rapidly, and it will be of interest to mention a few cases of their use. The Yorkshire Electric Power Co. has over 90 miles of such lines in use. Low-pressure wires for street lighting are used in a number of towns. In Leeds the street lighting is carried out by means of overhead wires in many of the principal streets. In Barnsley a recent extension of street lighting of a neat and excellent design has been made overhead. In Honley, both street and private lighting is carried out by overhead wires; in Whitwood, the same plan is being adopted.

The lighting of country roads by electricity has many advantages over gas lighting. Freedom from disturbance or flickering due to wind, rain or frost, better distribution of light between lamps and, therefore, more satisfactory illumination and lessened cost are among them. As an example of street lighting carried out by the Yorkshire Electric Power Co. that of Horsforth may be mentioned. The contract for lighting included the provision of the necessary mains, the conversion of existing gas lamps, lighting, cleaning and extinguishing for £2 per lamp per annum. The electric lamps are lighted and extinguished automatically in groups by means of time switches.

Photometric tests of the illumination from these lamps as compared with neighbouring gas lamps showed the following:—

Electric lamp	81 c.p.
Single incandescent gas (new)	68 ,,
Single incandescent gas (old)	35 ,,
Flat flame gas	38 ,,

The Mirfield Council, who are taking a bulk supply from the power company, have converted a number of street lamps to electric lighting on similar lines to those at Horsforth. The number is still growing. The Whitwood Council, who are taking a bulk supply from the power company, are converting all their street lamps to electric lighting—230 lamps in all. The supply will be given by means of overhead wires.

As an example of the cost of equipping electric street lamps, two typical cases are quoted and are given on the next page.

The use of electricity on farms is steadily increasing. Apart from the saving in cost the greatest advantage to the farmer is the fact that power is available whenever needed, and when threshing is to be done there is no delay such as frequently happens when a portable engine is required. Electric power may be tapped from an overhead line at any convenient point; the electric motor may be mounted on a farm waggon and set to drive a threshing machine, a turnip or hay

* Abstract of a Paper read before the Yorkshire Local Section of the Institution of Electrical Engineers.

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Each lantern fitted with one 35-watt lamp, used for 2,000 hours a year.

	s.	d.
Current at 1½d. per unit	8	9
Cleaning and lamp renewals	5	6
Maintenance of lanterns and wires	1	3
Interest on expenditure at 6 per cent.	5	9
	21	3

Two 35-watt lamps in lantern.

	s.	d.
Current at 1½d.	17	6
Cleansing and renewals	8	0
Maintenance	1	3
Interest at 6 per cent.	6	0
	32	6

chopper, a pump, or any of the many purposes for which power is required on a farm. Light and power are both obtainable from the same wires, and the farmhouse and buildings may be well and cheaply lighted. The small first cost of equipment, the general simplicity and ease of operation, and the small cost of upkeep are all important advantages, while the use of electric light in barns and buildings reduces fire risk to the lowest level. Where the need for power is small or infrequent, a joint arrangement between neighbouring farmers may be made to fix a motor at some convenient centre available for all in turn. The healthiness and cleanliness of electric light is nowhere more apparent than in cottages, where roofs are often low and rooms are small.

In a number of cases the power company's supply has been used for cottage lighting, an inclusive charge per week being made for the supply of current and lamps, there being no restriction on the hours of lighting. In one such case a group of 14 cottages is supplied, each cottage being lighted by two 60-watt lamps and two 120-watt lamps. The annual consumption of current per cottage is 160 units. The current consumption is very large on account of the use of carbon lamps. The same illumination from metal lamps would reduce the consumption to 54 units per annum, or 18s. per annum at 4d. per unit. In another case a group of 12 cottages are lighted each by three 16 c.p. tantalum lamps at an annual cost of 15s. 1d. Six other cottages each lighted with four 60-watt lamps use an average of 78 units per annum, costing 6d. a week at a price of 4d. per unit.

Finally, mention is made of the effect of the use of electric power and electric light on the reduction of the smoke nuisance.

THE NON-SALIENT POLE TURBO-ALTERNATOR AND ITS CHARACTERISTICS.

We give below an account of the discussion that took place at the recent meeting of the Birmingham Local Section of the Institution of Electrical Engineers, when Mr. S. P. Smith read his Paper on this subject. An abstract of this Paper appeared in our issue of March 31st.

Mr. A. M. Taylor (Birmingham Corporation Electricity Department) was most interested in the question of regulation. In Table XV. the author gave 15 per cent. regulation with 935 k.v.a. and 28 per cent. with 1,135 k.v.a. Presumably the object was to bring home to engineers how much cheaper it was for a given k.v.a. output to put in a machine having a poor regulation. The reduction of the short-circuit current was closely linked up with this question of regulation, and in fact was the pretext for introducing the poor regulation. Taking the second of the two outputs quoted, the drop from no load to full load would apparently be, in the case of a 5,000 volt machine, from 5,000 to 3,900 volts. If, however, instead of the full load current there was a short-circuit current of, say, ten times this amount, a terminal voltage of zero would be reached (given sufficient time) before the short-circuit current had attained to the dimensions of 4½ times the full load current. No doubt such a drop in voltage as that indicated would not actually occur even with ten times the full load current, owing to the fact that the eddy currents induced in the rotor would prevent the wiping out of the rotor flux. It would be interesting if the author could give an estimate of the actual reduction in voltage that might be expected in, say, the 200th part of a second. Considering, however, that there would be twice the number of demagnetising ampere-turns in the stator that were necessary to reduce the rotor field to zero, it seemed highly probable that the reduction in the rotor flux would be of the order of from 50 to 70 per cent. This raised the point as to whether such a drop, supposing the short-circuit to occur between the generating station and a sub-station, would not be sufficient to throw the rotaries at the sub-station out of step; and before engineers agreed to sacrifice all regulation in the generators at the main station, they ought to be assured on this point.

Dr. M. Kahn (Loughborough) thought the Paper was a useful addition to previous Papers in which the perfect mechanical qualities and the good heat dissipation of the non-salient pole type of rotor had been explained. He wished to mention the name of Charles Brown, to whose inventive spirit they were indebted for the type of rotor in question. The precise mathematical treatment of this type of rotor was to-day of greater importance than ever. The speed of turbo-alternators had been increased considerably in recent years, and machines of 2,000 and 3,000 k.v.a. had now to be designed at 3,000 revs. per min., and 5,000 and 6,000 kw. machines at 1,500 revs. per min. This could only be done if the material in the rotor was used to the best advantage. A very serious consideration in the design of these rotors was the selection of the correct value, β, for the ratio of the wound portion to the unwound portion of the rotor circumference. In the case of two pole machines a value of β of 0·7 to 0·8 would probably be found to give the most economic designs. In four pole machines, a smaller value might often be sufficient to accomodate the rotor winding. The Paper did not show sufficiently what influence regulation had on the size of an alternator. Table XV. indicated that if the regulation were increased from 15 per cent. to 28 per cent. the output was increased from 935 to 1,135 k.v.a. He thought the difference in output would be considerably greater.

Mr. N. Pensabene-Perez (E.C.C.) considered the author's method of investigation was lengthy, tedious and inaccurate. In his desire to decompose the field curve into its harmonics the author had been obliged to assume a very simple trapezium curve by neglecting the M.M.F. steps, the saturation of the iron and the reluctance of the slots. The speaker considered the graphical method, in which it was possible to trace the shape of the flux curve by taking into consideration the above mentioned elements, was much more accurate and infinitely simpler. The effect of slot reluctance in the E.M.F. wave form was very important in turbo-alternators where the slots were generally larger than the teeth. He had had occasion to compare two machines of the axial slot type, built by the Electric Construction Company, one fitted with phosphor bronze wedges and the other fitted with steel wedges. While a larger third harmonic was present in the first mentioned machine, an almost sinusoidal curve was obtained in the other type. Deep steel wedges were most desirable in turbo-alternators, because by doing away with sudden changes of flux density no sudden drop of E.M.F. took place between coils in the adjacent armature slots. This practice also tended to increase the rotor leakage and permitted higher saturation to be reached. The armature leakage was also increased; and this was a very welcome element in turbo-alternators in which short-circuit currents might reach enormous magnitude. He agreed with the author that in the non-salient pole type the E.M.F. wave form was not deformed by the load, but doubted if this constituted a serious advantage. In his opinion the real advantage of the non-salient pole type was purely mechanical, and electrical in so far as it would be possible with such construction to push much further the losses in the field winding, as the cooling of the distributed winding was much more effective, taking place principally by conduction to the iron mass.

Mr. H. W. Taylor (B.T.-H. Co.) felt that although the author's method might be sound, many of the conclusions, stated as of general application to the non-salient pole type of machine, should only be applied to the particular type dealt with. He did not agree with the statement that the leakage of the stator windings was comparatively low in modern machines. He was surprised to see a machine suggested with a regulation of 15 per cent. or even 20 per cent. at 80 per cent. power factor. Manufacturers had for some time been trying to get central station engineers to adopt a machine with coarse regulation, and to have the voltage maintained constant within a small percentage by means of an automatic regulator. The object of this from a designer's point of view was that, owing to the high speed and to the construction that had been adopted to withstand it, a short-circuit on the machine would be very severe and very large mechanical and electrical forces were brought to bear upon the various parts of the machine. Such a machine would probably be cheaper than the close regulating machine by an amount more than equal to the extra price of the regulator. Engineers objected that the regulator might fail; but, while not admitting such a possibility with the perfected regulator of to-day, it might be pointed out that a rise of pressure of 15 per cent. would be as disastrous to lamps and other apparatus on the circuit as the coarsest regulation which designers might offer. It must be remembered further that on large machines the variations in power were small in proportion to the ratings of the machines, so that even without a regulator a hand control of the voltage was quite easy even with a coarse regulation between full and no load. From a practical point of view he was afraid that the scheme of standardisation briefly outlined by the author would not be so simple as might at first sight appear. It need only be pointed out that a manufacturer had to consider the question of standardisation much more broadly and with reference to all his various customers' needs, which included, amongst others, machines for 25, 40, 50 and 60 cycles, low, medium and high voltages; normal and low temperatures rises, &c.

Mr. S. P. Smith, in reply, thought that, with the exception of Dr. Kahn all the speakers had entirely failed to grasp the spirit of the Paper, which was not intended to be a comparison of the cylindrical type of rotor with the salient pole-type. The purpose of the Paper was to bring out a full description of the electrical properties, both good and bad, of the non-salient pole rotor, and this quite apart from its superiority or otherwise. There was no intention to advocate a machine with close regulation more than one with coarse regulation. Mr. Pensabene-Perez did not seem to agree with the method of treatment. It was quite true that the simple trapezium curve had been assumed, which necessitated neglecting the effect of the slots; that this small simplification, however, should make the whole investigation unreliable was absurd, firstly, because the effect of the slots in a case like that in Fig. 2 had very little effect on the *main* shape of the flux or the E.M.F. wave, and, secondly, because in most

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modern designs, magnetic wedges were used for closing the slots to avoid the prominence of any tooth ripple. Also the objection of Mr. H. W. Taylor that the method adopted could not be applied to every type of salient pole machine had been dealt with in the Paper itself, where it was clearly pointed out that only the general case of the uniformly slotted rotor with a uniform air-gap and a partially distributed winding could be considered.

ELECTRICALLY-DRIVEN REVERSING MILLS AT THE WORKS OF MESSRS. ALFRED HICKMAN.

The rolling mills at the works of Messrs. Alfred Hickman are amongst the largest in the world, certainly the largest yet laid down in this country. They consist of a 30 in. cogging mill and a 24 in. bar mill, and the electrical equipment comprises two reversing mill motors and a flywheel-motor-generator set. The plant presents new and interesting features, since it is the only equipment in which the variable voltage generators and the motors work at ±1,000 volts pressure, and in which, contrary to Continental practice, mills of so large a size are driven by single motors. The driving losses are considerably lower than those which usually occur in plant of corresponding output, and the space occupied is smaller. Under the important head of reversibility, we may mention that when the contract was made for the supply of the equipment a guarantee was given that the time of reversal for each mill motor should not exceed six seconds from the maximum speed in one direction to the maximum speed in the opposite direction. In practice the machines are able to reverse well within this guarantee.

The driving set consists of a motor-generator running at high speed, coupled to a heavy flywheel. The motor-generator transforms the electrical energy supplied by the central station into electrical energy at any voltage from zero to the maximum in either direction, according to the speed and direction required by the mill motor. When the mill motor requires energy for a peak load, then, by means of a special automatic regulator, the speed of the flywheel-motor-generator is allowed to drop, so that the flywheel supplies the extra power to the generator. When the mill motor does not require power, the energy from the central station is absorbed by the flywheel whilst the set is rising to its maximum speed.

The flywheel-motor-generator set (shown in Fig. 1) consists of one motor, two flywheels and two generators, each generator being in direct electrical connection with its own mill motor. Power is supplied from the central station to the motor of the flywheel set at 460 to 500 volts, continuous current. The motor is shunt wound, and is designed to develop 2,000 B.H.P., as a continuous working load. The magnetic circuit of the motor is laminated throughout, so that the speed follows directly any movement of the automatic regulator, described later. The generators are both separately excited, and supply current to the mill motors at a pressure of from 0 to ±1,000 volts. The efficiency of each of the three machines is 94·5 per cent. at full load. Each of the two flywheels is 14 ft. in diameter, and weighs 28 tons, the peripheral speed being about 15,400 ft. per minute; each is built of three separate steel castings only, and is machined and polished to reduce the air friction losses. The maximum speed of the set is 350 revs. per min., which speed may be decreased by means of the automatic regulator to 290 revs. per min.

For starting the flywheel-motor-generator set an arrangement is provided which connects the armature of the cogging mill generator in series with the armature of the motor. This arrangement is economical both in current consumption and in the time required for starting, while it allows a comparatively small starting resistance to be used. The motor of the flywheel-motor-generator set is excited from the 460 to 500 volt 'bus-bars, and an efficient emergency electric brake is obtained by connecting its armature across the starting resistance.

As indicated above, the speed of the flywheel set is made to vary from 15 to 18 per cent. below the maximum in order that the flywheels may supply the power required to equalise the peaks in the load. To obtain this variation in speed, the motor of the flywheel set has a resistance in the shunt field magnet circuit, the amount of this resistance being varied by an automatic regulator operated by the current taken by the motor. This regulator is arranged to come into operation whenever the current input rises above or falls below a predetermined value, and is guaranteed to equalise the load on the generating station to within 20 per cent. of the average load.

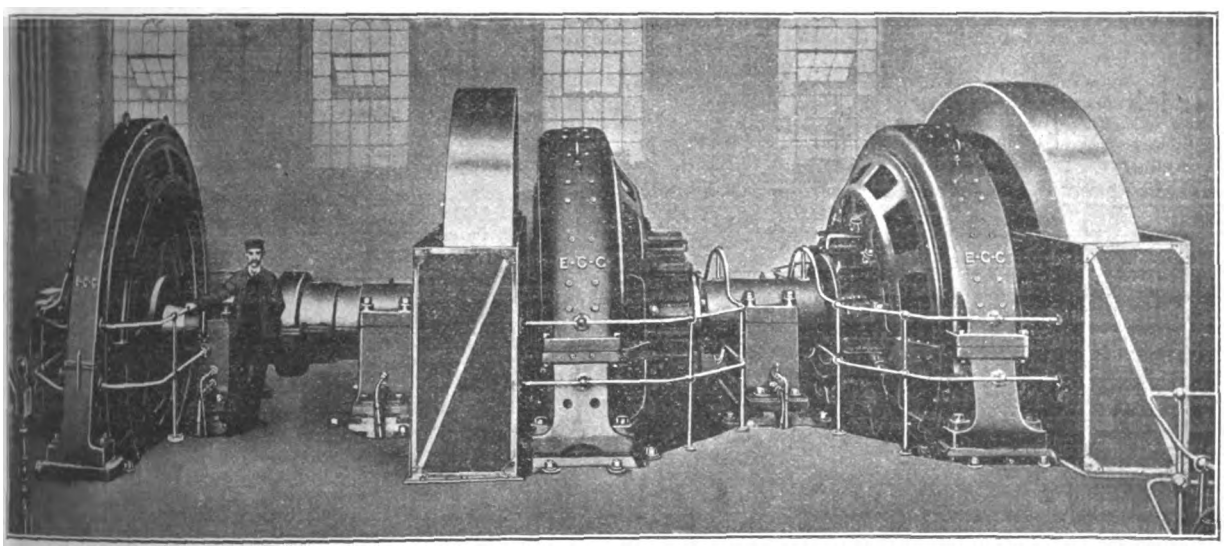

FIG. 1.—FLYWHEEL MOTOR-GENERATOR SET.

The cogging mill and live rolls are used for cogging 2½ ton ingots to blooms of 4½ in. to 6 in. section. The motor is in the same building as the flywheel-motor-generator set, and, as shown in Fig. 2, is connected to the rolls through two-to-one gearing. This motor can develop 4,800 B.H.P. when supplied with current at 1,000 volts for five-second periods six times per minute as a rolling load, and can sustain a maximum load of 9,600 B.H.P. for two-second periods once every hour. The speed of the motor is ± 120 revs. per min., at which speed the output is measured, and it is excited off the 460 to 500 volt circuit. This machine was designed to reverse from +120 to −120 revs. per min. in six seconds, and, as already stated, it has been found in practice that this is easily accomplished. The efficiency of the motor is 94½ per cent. at full load.

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The bar mill contains two sets of housings and rolls, and is built for rolling sheet bars, billets, rounds, angles, &c. The motor is placed in a light building to protect it from dust and damp, and is connected directly to the rolls. The motor will develop 6,000 B.H.P. for five-second periods six times per minute, and a maximum load of 12,000 B.H.P. for two seconds, once an hour. The speed of the motor is ± 120 revs. per min., and it is excited off the 460 to 500-volt circuit. The reversing tests and efficiency are the same as for the cogging mill motor.

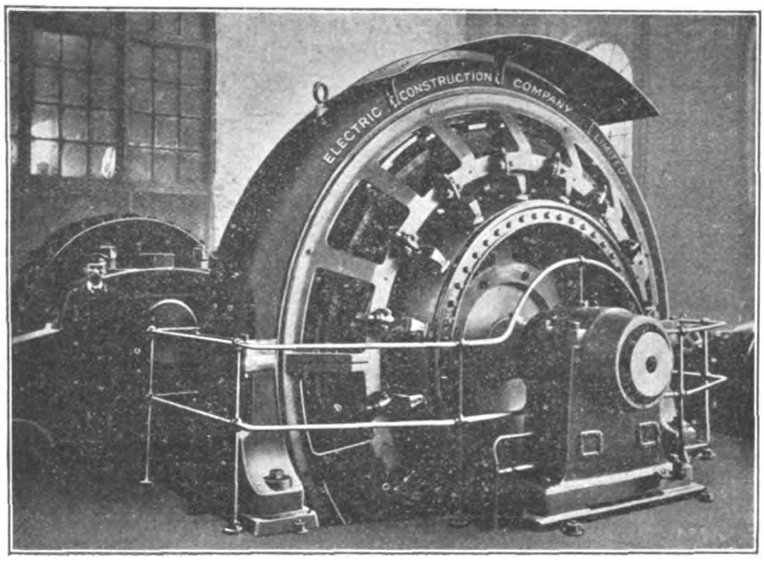

FIG. 2.—BAR MILL REVERSING MOTOR.

The speed and reversal of the mill motors is controlled by a system similar to the Ward-Leonard system, the voltage of the generators being varied between a positive and negative maximum. The voltage variation of each generator is obtained by the operation of a single controller at the corresponding mill platform. This controller varies the field excitation of a small motor-driven exciter, which in turn varies the excitation of its variable voltage generator. Each mill motor has constant field excitation, and the speed therefore depends upon the voltage applied to the armature. Thus each position of the controller handle corresponds to a definite speed of the mill motor. The controller used does not deal with a current greater than 1 ampere. This is obviously a great advantage, since manipulation is easy, and there is no arcing. The vital importance of a good controller for the successful operation of a mill will be readily appreciated, and it is worthy of mention that during two years' continuous work the "E.C.C." controllers in these mills have required no renewals or adjustments, nor do they show signs of requiring such attention. It should be pointed out that with the above system of control only a small amount of energy is lost in reversing the mill, since the energy expended in accelerating the rotating masses is largely returned in the form of electric energy when the speed is decreased.

Circuit breakers are placed in the main circuits in order to safeguard the machines. These breakers are of the "E.C.C." standard type, and are mounted on the main switchboard. Switches, which can be operated by the mill driver or by the switchboard attendant, are provided for breaking the field circuits of the generators. In addition to these safeguards, the connections are so arranged that it is impossible to excite the generator field unless the field of the corresponding motor has been previously excited. Indicators showing the speed of the rolls and of the flywheel motor-generator set are fitted at each mill platform, whilst the speed of the flywheel set can also be read from an indicator on the switchboard.

The exciter set consists of two exciters, direct coupled to, and driven by, one 75 B.H.P. motor. The motor is connected to the 500 volts supply, and runs at a speed of 1,500 revs. per min. The armatures of the two exciters are respectively connected direct to the field circuits of the two variable voltage generators of the converter set. The current in the field circuit of the exciters is varied in magnitude and direction by the position of the controller handle. The magnetic circuits of the exciters are laminated, in order to obtain the necessary quick reversal of flux.

An important point in the equipment of a reversing mill is the control of the live-roll motors. For this purpose we have designed a special controller, which has met very severe working conditions with success. The type embodies the following important features:—The controller is convenient and easy to operate, and is of substantial construction. A long range of speed with even acceleration is obtained. All wearing parts are accessible, and may be quickly renewed. The insulation is suitable for working in the presence of the large amount of metallic oxide dust which abounds everywhere in a rolling mill. In Fig. 3 we give typical current and voltage curves of the cogging mill motor at Messrs. Hickman's, from which the quick reversal of the motor, in spite of the heavy work performed, can easily be observed.

It is satisfactory to be able to give a description of this installation, as it is one more proof of how rapidly the employment of electricity in the iron and steel industry is increasing. For many years it has held the field as the best medium for artificial lighting and for the transmission of power to cranes, roller gear, hot and cold saws and other auxiliary apparatus. But recently its value in the operation of heavy reversing mills has been recognised.

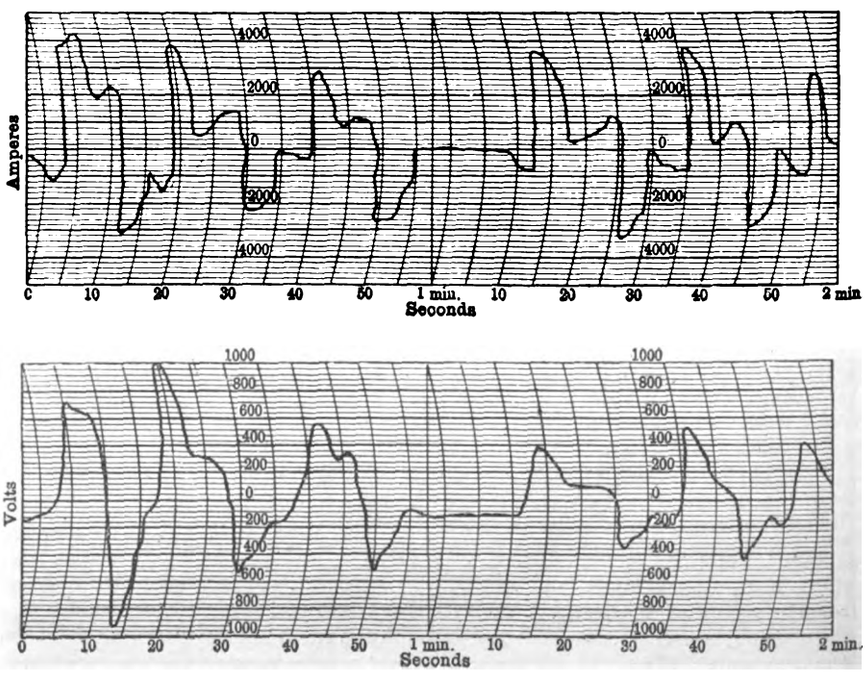

FIG. 3.—TYPICAL CURRENT AND VOLTAGE CURVES OF COGGING MOTOR MILL.

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A NEW METHOD OF CHEMICAL ANALYSIS.

The "New Method of Chemical Analysis," on which Sir J. J. Thomson lectured at the Royal Institution last Friday evening, is new only in its application, physical in its method. He deflects the positive rays (the kanalstrahlen of Goldstein) by the magnetic and electric fields, and he thus separates the residual gas in the vacuum tube into a variety of atomic, molecular and complex aggregates or systems; this variety, it will be seen, is greater than would have been expected, and the method, which has some features of spectroscopy, deduces the atomic or molecular weights of the substances from the amount of the deflection. The possibilities of the method [which is also applied in Germany] are astounding; that conclusions will have to be drawn with great caution need not be emphasised.

If electromagnetic field, the lecturer explained, would deflect a positively charged particle in the direction of the ordinate, and the electric field would deflect it in the direction of the abscissæ. If both fields were excited, the particle would be shifted to a point, P, such that $x^2 = Cy$, where C was a constant depending upon the intensities of the fields and the size of the tube. Each particle would produce its own P, and if they were all of the same kind and speed, there would be as many P as particles. But the particles of the same kind do not move at the same speed, and each spot was drawn out into a parabola. They had at first measured the deflections directly on the fluorescent screen of the bulb; afterwards they had made the parabolas photograph themselves on a plate inside the discharge tube. F. W. Aston, his assistant, had constructed a slide shutter box, in which the photographic plate was suspended by a silk thread wound round a top worked in a glass-ground joint. Thus they obtained a series of parabolic curves, and by photographing first with the magnetic deflection directed upwards, and then with the magnetic deflection directed downwards, they obtained full parabolas and determined, on which zero was more easily ascertained. The photographs exhibited were striking. They were produced with the discharge passing through gases at 0·03 mm. of mercury, the gases being nitrogen from the atmosphere, nitrogen from ammonium nitrate, carbon monoxide, carbon dioxide, methane, chloromethane, carbon oxychloride, &c. The general appearance was that of curved streamers issuing from the original position of the undeflected spot, some bright, some faint, increasing and decreasing in intensity in, sometimes heady. Most of the curves were on the expected side where they would be expected; a few faint curves on the other side. Calculating the e/m from measurements of the curve, Sir J. J. Thomson interpreted the curves for atmospheric nitrogen (starting with the positive side) as follows: Positive side: 1·00 H, 1·99 H_2, 6·80 N_{++}, 13·95 N_+, 28 N_{2+}, 39·0 A_+, 101 Hg_{++}, 198 Hg_+; negative side: 1·0 H, 11·2 C, 15·2 O. These figures agreed very closely with the known atomic weights (N = 14, C = 12, A = 40, Hg = 200). The method had the advantage over spectroscopy that it was exceedingly sensitive (0·03 milligramme could be detected), the purity of the substance was of no consequence, since no other substance would only give an additional curve, and results were produced almost instantaneously, so that the successive groups like 12·9 CH_+, 14·05 CH_{2+}, 14·9 CH_{3+} (never isolated before) had been demonstrated. It was intended to study the transformation products of radium in this novel way. Some curves were peculiar; a faint 65·5 Hg_{+++} (?) curve was persistent. Naphthalene and other compound curves 1·5 and 3 (possibly 4) had been found. The curves observed on the negative side belonged to the atoms—hydrogen, carbon, oxygen, chlorine. These curves, notably those of H, also of O, C, Hg were almost persistent, no matter what substance they started from. Quite apart from impurities, however, the analyses demonstrated that a number of atomic and molecular aggregations or systems, single or several charges or uncharged, were always formed. To explain such modifications, including ozone, O_+ and O_{-6}, would account for the different kinds of spectra emitted by the same substance under different conditions; the different kinds give rise to different spectra. That some substances gave on the negative side, indicated that negatively charged particles carried through the kathode, having apparently been struck and attracted by uncharged particles. As these were all in the ultimate condition, it would appear that only the atom, or single, was capable of temporarily exerting a powerful magnetic field. This peculiarity might be connected with the greater freedom of motion in the atom. A magnetic sphere would be like a magnet, because the electricity within it could freely respond to the magnetic induction.

To illustrate his meaning Sir Joseph had mounted a number of needles, each on its vertical pivot, on a piece of cardboard, which was suspended from the ceiling in proximity to the electromagnet. When the electromagnet was excited, the whole system was attracted; but when the needles had been taken off their pivots and placed on the board, there was hardly any attraction. The molecule arising from the combination of atoms which had freedom of motion was a comparatively stiff system in which the bonds were linked. The new line of research promises to help in the solution of the problems of chemical combination.

PHYSICAL SOCIETY.

At the Meeting, held on March 24th, at The Imperial College of Science, Prof. H. L. CALLENDAR, F.R.S., President, in the Chair, an exhibition of a

"Sensitive Thermo-Regulator"

and some

"Experiments on the Measurement of Electrolytic Resistance using Alternating Currents,"

were shown by Dr. H. F. HAWORTH.

The "thermo-regulator" consists of a toluene thermometer with mercury platinum contacts in a capillary tube; these contacts operate, through a Siemens telegraph relay, an electromagnetic switch, which cuts in or out the heating circuit. On account of the very small current required to operate the relay a fine capillary may be used, so ensuring a high magnification with low thermal capacity.

This Paper was discussed by Messrs. Lowry, F. E. Smith and Whipple.

Experiments were also shown illustrating the ease with which a bridge containing an electrolytic cell could be balanced by placing a variable self-induction in series with the cell and adjusting it and the resistance of the bridge simultaneously, as in Wien's experiments, except that a vibration galvanometer was used in place of the optical telephone originally employed by Wien.

The author's deduction from his experiments that the resistance of an electrolyte varies with the frequency of the alternating E.M.F. applied, was discussed by Messrs. Campbell, Duddell, Lowry, F. E. Smith and the Secretary.

A Paper on the "OSCILLATORY CURRENTS IN COUPLED CIRCUITS," was then read by Prof. G. W. O. HOWE. An abstract of this Paper will be found on p. 8 of this issue.

"Some Radio-Telegraphic Apparatus in Use at the City and Guilds College,"

was also briefly exhibited by Prof. G. W. O. HOWE.

The wireless telegraph receiving apparatus was shown connected to the aerial, which is 260 ft. high. A transformer specially designed for experimental work at long wave-lengths was shown. By means of a Brown telephone relay and special trumpets fitted to the telephone receiver, the time signals and messages sent out from Norddeich and from the Eiffel Tower can be plainly heard anywhere in the lecture theatre. The various types of receiving apparatus in use at the College were shown.

Owing to lack of time the discussion on these two Papers was omitted.

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from *The Electrician* office, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published under 2s., and 5 per cent. for books published nett. Add 10 per cent. for abroad or for foreign books.]

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"A Handbook of Testing Materials." By C. A. M. Smith. (London, 1911: Constable & Co.) 6s. nett.

Simmance and Abady's Tables of Corrections for Harcourt's 10-Candle Pentane Lamp. (London: Alexander Wright & Co.)

"Electric Crane Construction." By C. W. Hill. (London, 1911: C. Griffin & Co.) 25s. net.

"Hypochlorite und elektrische Bleiche." By W. Ebert and J. Nussbaum. (Halle a. S., 1910: Wilhelm Knapp.) M.18.

"Die Metallurgie des Zinns mit spezieller Berücksichtigung der Elektrometallurgie." By Dr. H. Mennicke. (Halle a. S., 1910: Wilhelm Knapp.) M.10.

"Science Abstracts." Vol. XIV. Part III., No. 159. Section A. "Physics." Section B. "Electrical Engineering." (London, 1911: E. & F. N. Spon.) 1s. 6d. each.

"Arc Lamps and Accessory Apparatus." By J. H. Johnson. (London, 1911: Constable & Co.) 1s. 6d. net.

"Motors, Secondary Batteries, Measuring Instruments and Switchgear." By S. H. Broadfoot. (London, 1911: Constable & Co.) 1s. net.

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With "THE ELECTRICIAN" for Sept. 14, 1906, was issued the first of a series of "Industrial Supplements," to be published from time to time with "THE ELECTRICIAN." The fifty-third issue of the Supplement published (Gratis) with the number of "THE ELECTRICIAN" for September 23, 1910, was the last of the monthly issues. "THE COMMERCIAL AND INDUSTRIAL SUPPLEMENT" to "THE ELECTRICIAN" is now issued weekly (Gratis). It will be found towards the end of the present issue.

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ELECTRICITY SUPPLY IN COUNTRY DISTRICTS.

If we are to make good progress towards that time of the universal use of electrical energy, as pictured by Mr. S. Z. DE FERRANTI in his Presidential Address to the Institution of Electrical Engineers, there is no question that country districts must not be left out of consideration. The towns have very naturally received the first attention; and it is perhaps, due to the fact of our towns being very large that our country districts have been left largely on one side The quest, however, for fresh fields and pastures new, as the more profitable parts have become occupied, has caused the supply engineer to turn his attention to the less populated districts.

This subject is discussed in a short Paper read by Mr W. B. WOODHOUSE before the Yorkshire Local Section of the Institution of Electrical Engineers, and from the abstract given on another page our readers will find that good progress is being made in this direction. To the power company the subject is of more than usual interest

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because the area of such a company is very much greater than that of the usual local authority and necessarily embraces extensive country districts as well as towns. The ultimate aim of the power company should be so to cover its area with mains that electrical energy is available to practically everyone who desires it. If such a desirable state of things is to be reached it is to the power company that we must look, because such an undertaking is better suited for the purpose than is one supplying a small area. The lower cost of the plant, the larger station, and the greater diversity factor all make for lower costs per unit sold. The capital cost of the station per kilowatt having been reduced to a minimum, the cost of mains becomes more than ever a governing factor of the price at which electrical energy can be supplied.

Here fortunately, overhead mains provide a solution of the difficulty and reduce the cost to a very material extent. In the instance given by Mr. WOODHOUSE for the lighting of a mile of village street, underground mains would cost 75 per cent. more than overhead; or, in other words, current could be supplied for private lighting at a penny per unit less if overhead wires are used. Of course, frequent objections have been made to the use of such wires, but these objections cannot be very well supported. Anyone can realise how very much the telegraph and telephone services would have been hampered if overhead wires had not been allowed; and the attempts to prohibit them in these days. In due time, no doubt, following Continental practice, such mains will come into extensive use in this country, and we are glad to see that they are being used increasingly at the present time. Even in such a town as Leeds the street lighting is being carried out by overhead wires in many of the principal streets.

It is interesting to notice how cheaply street lighting can be supplied when such mains are adopted. Thus, the Yorkshire Electric Power Company are charging £2 per lamp per annum at Horsforth, including mains, conversion of existing gas lamps, lighting, cleaning and extinguishing; the electric lamps are of 81 c.p., and are doubtless metal filament. Naturally, such a low price is appealing to the Urban Councils, and further business is resulting.

Apart from street lighting, the use of electrical energy in country districts is required chiefly for the lighting of houses and cottages and for a power supply to farms. It is necessary to effect the lighting of cottages very cheaply if custom is to be obtained, and therefore the system adopted by the Yorkshire Electric Power Company has been to make an inclusive charge for the supply of current and lamps, there being no restriction on the hours of lighting. The removal of this restriction is probably wise, as such restrictions are liable to cause annoyance without effecting any saving to the supply undertaking. In the case cited by Mr. WOODHOUSE the cottages are provided with two 8-watt lamps and two 120-watt lamps (carbon), the annual consumption per cottage being 160 units. In two other cases the lighting is mentioned as being 6d. per week and 15s. 1d. per quarter respectively, with energy at 4d. per unit.

With regard to farmhouses, more seems to have been done on the Continent and in America in giving a supply than in this country. It appears, however, that a distinct demand is arising for power to drive farm machinery, and we do not think there is much doubt that if overhead lines are used freely the British farmer will soon see the advantage of having a supply of power which is always at hand, and from which light can be obtained just as easily as power, although his buildings may be situated a considerable distance from other public means of illumination.

REVIEWS.

(Copies of the undermentioned works can be had from THE ELECTRICIAN Office, post free, on receipt of published price, adding 1d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.)

The Law Relating to Electrical Energy in India. By J. W. MEARES, M.Inst.C.E., M.I.E.E., assisted by N. N. BLOMFIELD. (Calcutta: Government of India Central Press, for the Author). Rs.10 (15s. nett).

This is an interesting and useful work on the legislation affecting electricity supply in the Empire of India. The law on the subject is now to be found in the Indian Electricity Act, 1910, which repealed, but re-enacted with certain amendments and additions, the 1903 Act. As the author is a practical engineer, and also the electrical adviser to the Government of India, his notes on historical and technical points are of exceptional value. When we reviewed the author's commentary on "The Indian Electricity Act, 1903," we pointed out that Indian legislation relating to electricity supply was in advance of our own, but, frankly, we are disappointed that the electrical industry has not made more progress in India than it has. In the meantime a considerable advance has been made in long distance power transmission, and bulk supply schemes, in the application of electricity to traction, &c., in various parts of the world, and we regret to see that India has not shared to any material extent in this progress. This may have been due to certain defects in the 1903 Act which have been removed by the 1910 Act, but we are inclined to think that the comparatively slow progress of the industry in India is due to the fact that English models were followed on certain points. There was nothing which retarded the growth of electricity supply in England so much as the Electric Lighting Act of 1882, and the effect of that piece of legislation would be even more injurious in India, where the economic, industrial and social conditions are widely different from those which prevail in this country. Consequently, legislation relating to electricity supply which would be quite suitable for this country would be totally inapplicable to India. However, last year's Act seems to be a great improvement upon that of 1903, and we expect that greater progress, especially in traction and power schemes, will be made in future. The principal modifications made by the 1910 Act relate to bulk supply schemes, the regulation of the powers of the Local Governments and the Government of India, the purchase of electricity undertakings, the supply of electricity to districts outside the area of supply and the amendment of licences. In nearly all cases the conditions have been made more favourable to promoters of schemes.

The arrangement of the present edition is practically the same as that of the author's commentary on the 1903 Act, but the book has been rewritten and the information carefully checked. After an introductory chapter, which gives an interesting historical sketch of electrical legislation in India, the author proceeds to give an outline of the general arrangement of the 1910 Act, and to deal with the position of licensed and unlicensed undertakings, the general provisions of the Act applicable to all parties. A useful summary of the law relating to electric railways and tramways follows, and the text of the Indian Electricity Act, 1910, is accompanied by useful notes on clauses, the work concluding with a group of appendices, containing the Rules made under the 1910 Act, general specification for electric wiring, &c. The whole work bears evidence of careful preparation, and it should prove

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indispensable to companies and engineers connected with electricity supply work in India.

History of the Theories of Æther and Electricity. By E. T. WHITTAKER. (London: Longmans, Green & Co.) Pp. xvi+475. 12s. 6d. net.

This great work grapples with some of the most fascinating and difficult problems that have engaged the attention of workers in physical science during the last three centuries. No reader of ordinary mental calibre can hope to assimilate all its contents; but the book is so ably written that the serious student of average ability will derive great profit from its perusal, and, as the author succeeds in individualising men as well as ideas, the general reader will find much to interest him in its pages.

The headings of the chapters are as follows: I. The theory of the æther in the seventeenth century. II. Electric and magnetic science, prior to the introduction of potentials. III. Galvanism, from Galvani to Ohm. IV. The luminiferous medium from Bradley to Fresnel. V. The æther as an elastic solid. VI. Faraday. VII. The mathematical electricians of the nineteenth century. VIII. Maxwell. IX. Models of the æther. X. The followers of Maxwell. XI. Conduction in solutions and gases, from Faraday to J. J. Thomson. XII. The theory of the æther and electrons in the closing years of the nineteenth century.

The first chapter contains a more lucid account of the earlier theories of light than the reviewer remembers to have read in any special treatise on light. The second chapter narrates the efforts made by Gilbert, Gray, Du Fay, Watson, Cavendish, Poisson and others to develop theories which give results approximating to the facts. The third chapter shows the anatomist, the chemist and the mathematician all engaged in elucidating electrical phenomena. Galvanic and frictional electricity prove to be the same thing; Ampere opens the subject of electrodynamics; and Ohm states a law, which, with a slight modification, is the same as that associated with his name. Chapter IV. pays special attention to polarised light. Chapter V., on the æther as an elastic solid, is very stiff: but it appears to be important, and although the elastic solid theory does not at present hold the position of honour, it is doubtful whether the modern theories of reflection and refraction would have been developed if the great mathematicians of the past had not prepared the way by their ponderous works on more or less imaginary solids. It is a relief to come to Chapter VI. which deals with the researches of Faraday, who was not a mathematician. Succeeding chapters are comparatively modern. They are specially valuable in showing, to some extent, the sources of inspiration of great men like Helmholtz, Maxwell and W. Thomson, and the relative importance of their work. Towards the end of the book the names of men who are happily still with us appear, and anyone who wishes to understand the evolution of the wonderful ideas of J. J. Thomson, and to appreciate the importance and influence of the work of his great contemporaries, cannot do better than study the work under review. A. G.

Modern Lightning Conductors. By KILLINGWORTH HEDGES. (London, 1910: Crosby Lockwood & Son.) Pp. vi.+133.

This book consists partly of the Phœnix Fire Office Rules for Lightning Conductors, but in addition contains much useful information on the subject of lightning which, unfortunately, is not so well understood as it should be. One chapter is a report of the Lightning Research Committee, giving experiments due to Sir Oliver Lodge. The rules are followed by two chapters on Methods of Protection (including Testing) and on Costs and Specifications. Some notes are given on American and Continental practice, and there is a long chapter giving many interesting examples of lightning stroke, illustrated by sketches and photographs. Finally some account is given of the effects of lightning on mankind, upward discharges, fulgurites, globular lightning and other phenomena. The notes that are given contain all kinds of observations and popular ideas, including the essentially American case of a Methodist minister who invoked lightning upon a neighbouring brewery, and was duly sued for the success of his invocation; but whether damages were given against him we are not told. Lightning is one of those interesting subjects that ought to be investigated more closely, but we fear that even an aeronaut would be shy of handling the natural product after reading the experiences of Messrs. Hutchinson & Ward in the heart of a thunderstorm at an altitude of 15,000 ft. in the Alps.

Simmance and Abady's Copyright Tables of Corrections for Harcourt's Ten Candle-power Pentane Lamp. (London: Alex. Wright & Co.)

This book consists of a series of tables printed on strong card and bound together into a folder which can be hung on the wall of the laboratory. The Harcourt standard pentane lamp gives a light of exactly 10 c.p. when the atmosphere contains 0·8 of 1 per cent. by volume of water, and the barometric height is 760 mm. Corrections have therefore to be made in actual practice for both humidity and pressure. These corrections are made by the following formulæ, which are both due to Mr. C. C. Paterson, of the National Physical Laboratory, and have been confirmed by other observers:—

Candle-power $= 10 + 0{\cdot}066\ (8 - \epsilon)$, where ϵ is the number of litres of water per cubic metre of air.

Candle-power $= 10 - 0{\cdot}008\ (760 - b)$, where b is the height of the barometer in millimetres.

The amount of water vapour is determined from readings of a ventilated hygrometer subjected to an air current of minimum speed of 2 metres per second. The tables are arranged in Fahrenheit degrees and inches, though the equivalents on the Centigrade and C.G.S. systems are also given. There can be no doubt that these tables will prove exceedingly useful, while they are admirably designed to withstand heavy wear and tear.

A CURIOUS COHERER PHENOMENON.

BY JOHN HÄRDÉN.

Some time ago the author had the opportunity of observing a curious case of coherer action which may be of some interest.

As is well known, high potential protectors for long distance power lines are often used in which resistance rods of specially prepared carbon mixtures are employed in the earth connection. The phenomenon in question was observed on such rods.

Each rod was a round bar of about ¾ in. by 6 in. to 7 in. in length, with copper plated end caps. They were squirted in a hydraulic press, dried and fired in an electric carbon tube furnace. The mixture used originally was composed chiefly of graphite together with other non-conductive materials.

The resistance value of each rod varied somewhat according to the nature of the power line to be protected and how many were used in series, but as an average they measured about 200 to 250 ohms.

Each rod was carefully tested before passing for delivery, and faulty ones were rejected. In spite of this, grave complaints came in to the office some little time after the first deliveries, all to the effect that rods bought under guarantee to have 250 ohms resistance now showed several megohms. On the return of the rods to the works this fact was verified, yet other unused rods from the same delivery still maintained their proper conductivity.

It was soon found that the faulty rods had invariably been subjected to a high potential discharge, usually of atmospheric or static origin, and consequently a certain amount of current had passed through the rod. To test the effect of this, current was sent through a fresh rod and gradually increased until it was nearly red hot, but this did not cause any permanent change in the resistance.

Tests were then made to imitate the natural conditions, and it was thereby found that one single discharge of oscillatory sparks would cause the resistance to increase to several megohms and remain so. It was of no consequence if the spark entered the rod through the end clip, thus passing through the rod from end to end or if it entered the rod at the middle, the result was the same.

Subsequent tests proved that this remarkable increase in resistance, due to the action of the spark, could be effectively

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cooled by means of a thick coating of a glassy enamel extended over the whole rod, though not thoroughly eliminated.

On the other hand, if some other poor conductor was used instead of graphite, and a thin enamel coating applied, the above-mentioned effect of the spark was entirely nullified, and no further complaint was heard of since such rods were introduced.

The author has since corresponded in the matter with a prominent and well-known scientist, who expressed his opinion that the phenomenon was a coherer action. No doubt some kind of coherer effect must have been responsible for the behaviour; but it is indeed difficult to explain satisfactorily the actual mechanism of this action. On the one hand, it would be thought that the oscillatory discharge would pass chiefly along the *surface* of the rod only, and the effect of the latter seems to indicate such; but, on the other hand, why should the total resistance of the whole rod be so materially and permanently changed if this was the case?

Again, it is rather strange to note that if the Acheson artificial graphite was excluded, and other non-carbonaceous materials substituted, this action ceased to appear. In any case this behaviour might perhaps be worth some further investigation, as it may eventually throw light on other similar actions.

RADIANT ENERGY AND MATTER.

(Concluded from page 957, Vol. LXVI.)

In the fourth lecture Sir J. J. Thomson referred again to the energy distribution in the spectrum and to the steep ascent and descent of the energy curve in Fig. 3 [the curve is much steeper for higher temperatures]. A little distance off the ordinate of maximum energy the curve was exceedingly weak. In a body at room temperature (say 300 C. abs.) the maximum was at 10μ, in a red hot body (900 C. abs.) at 3.3μ; the latter body would affect a photographic plate intensely in a fraction of a second than the former would require if the exposure lasted as long as the world had existed according to the most extravagant estimate, even if that estimate were multiplied by a million. This calculation assumed that the product of intensity of light and duration of exposure was constant, and that the effective rays were shorter than 0.5μ.

Equations for the very important shape of the curve had been given by Rayleigh; $E_\lambda \propto (\theta \lambda^4)(e^{-\frac{c}{\lambda\theta}})$; Planck, $E_\lambda \propto \frac{1}{\lambda^5} \cdot e^{\frac{c}{\lambda\theta}-1}$; and J. J. Thomson; $E_\lambda \propto (\theta \lambda^4) \cdot I_4^2(c/\lambda\theta)$. The c of the formulæ were the same, and the I was a Bessel function.

Planck's formula was the most generally applied. The experimental confirmation was very difficult; the formulæ agreed, however, in showing that for long waves the energy was simply proportional to the absolute temperature θ, not to θ^4. The formulæ applied to a perfect black body which absorbed and radiated all the energy it received. Such a body was not easily produced, and the relations between absorption and emission required explanation. The latter depended only on the temperature of the body, and if a piece of salt, giving out energy under ordinary conditions, kept its temperature constant in spite of this loss, the explanation was that it received an equal amount of energy. This was known as the "exchanges of Prévost," which had been a necessary forerunner of the wave views, and it was to be understood in the sense, that a man could spend money and yet keep his expenditure equal to his income. The radiation at a certain temperature was equal to the absorption at that temperature, and that held for the whole amount of energy of any special quality of radiation (of particular wave-length). A body placed within an enclosure would ultimately attain the temperature of the enclosure, and the character of the radiation must everywhere be the same within that enclosure. Differences in quality were possible, and there were an excess of blue at the top and an excess of red light at the bottom of the enclosure. A piece of blue glass placed at the bottom should absorb more there and become as warm as the enclosure; shifted to the blue portion, it would absorb less blue light (to which it would be transparent) than it radiated, and should become cooler as it received less energy than it sent out. But such a change of temperature merely by displacement in an enclosure at the same temperature was contrary to all experience, and we hence concluded that the quality of the radiation must be uniform throughout the enclosure, and that the radiation within an enclosure, whatever its nature must be that of a "black body." The name "black" was a misnomer, for the radiating body was bright, and it would be better to speak of "full" radiation. Just because absorption and emission were equal within an enclosure, bodies within it lost all outline, when temperature equilibrium had been attained; when we saw nothing but a glare, looking through an aperture in an enclosure, we knew that constant temperature had really been established. If the universe were of the same temperature throughout it would be invisible, just as a cavity in the glowing coal fire was invisible. This was demonstrated by holding a piece of nickel in a tubular electric furnace by means of a wire; when the nickel was red hot like the tube, it became invisible.

The lecturer then repeated several experiments of Tyndall in exemplification of the relations between radiation and absorption. A Leslie cube, filled with hot water, the right side bright, left side black, was placed between two metal plates, right side black, left side bright, so that black and bright faced one another; the galvanometer joined to thermal junctions was not deflected. For the black surface radiated more than the bright, but the bright opposite reflected more, so that balance was established. If the symbols b and s denoted black and shiny (bright), E emission, and R reflection, E_b being the energy emitted by a black surface, then the black body received energy $E_b = E_s + E_b \cdot R_s$, or $E_s = E_b(1 - R_s)$, or $E_b = E_s/(1 - R_s)$. If A_s further denoted the assumed proportion of the energy absorbed by a reflecting body, such that $R_s + A_s = 1$, we found $E_b = E_s \cdot A_s$, or $E_s = E_b \cdot A_s$. That meant that for any temperature a body (not an ideal black body) would emit as much energy as it would absorb from a black body [or the emissive power of a body for radiation of a certain wave-length is proportional to the absorptive power for the same radiation at the same temperature].

This was known as the law of Kirchhoff (1860), who had drawn the full consequences of the laws of radiation. His old teacher, Balfour Stewart, the lecturer added, had, however, anticipated Kirchhoff in the publication of this law, and it was interesting to mention that the two scientists had independently given some identical experimental confirmations. Thus, tourmaline absorbed light polarised in one plane, but was transparent to light polarised in a plane at right angles to this plane. Now, emission should be equal to absorption, and they observed that heated tourmaline actually emitted polarised radiations. Further, any substance should radiate fully like a black body, if the layer were of sufficient thickness; in the case of glass, however, that layer should be so thick that the glass would appear opaque.

Absorption, the lecturer proceeded, was mostly selective. Glass, which was transparent to ordinary light, would not permit long-wave heat rays of low temperature to pass. In the demonstration a thermopile with two faces was placed between a Leslie cube containing hot water and a limelight. When balance had been effected, a piece of glass was held in front of the cube; the balance was disturbed, while the glass made little difference if interposed between the limelight and the cube. It was generally believed that, owing to this property of the glass, greenhouses became so warm; the glass would catch the sun light as in a trap, not allowing the long-wave rays from the warm moist earth to travel back outside. But R. W. Wood had questioned this, and had shown that there was another chief cause—the glass really imprisoned the air and prevented circulation of the air; if the doors of the green house were left open, the effect vanished. Wood had built himself a small green house of cardboard and rock salt, and had observed an even greater green-house effect, though rock salt was transparent to heat rays, because it allowed more heat to enter.

That some vapours and gases were powerful absorbents of heat Sir J. J. Thomson then demonstrated by old experiments of Tyndall's, partly with Tyndall's apparatus. That water vapour absorbed heat rays had been denied by Magnus, but in the end Tyndall had been victorious in the controversy. A few puffs of ammonia vapour, introduced into a glass tube closed by rock salt discs, also effected a remarkable absorption, which disappeared as the ammonia was replaced by air again, while nitrogen and hydrogen mixed in the proportion so as to make NH_3 had no such effect. Tyndall had also shown that scents like musk absorbed heat rays; but the phenomena were complicated by the presence of water vapour. Carbon dioxide was a powerful absorbent, and Arrhenius had attempted to explain the existence of glacial epochs extending almost to the Equator by the asumption that the percentage of CO_2 in the air had fluctuated. Volcanic eruptions would, in certain epochs, send much CO_2 into the atmosphere and raise its temperature by the greenhouse effect. How a fall of the temperature had been produced, the lecturer did not explain; but he said that a few million tons of CO_2 would bring about temperature differences of 10° C. without necessitating our believing in gigantic forces powerful enough to shift the position of the axis of the earth.

The presence of water vapour in our atmosphere, Sir Joseph continued, in the fifth lecture, was very important meteorologically,

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It prevented the rapid loss of heat from the earth, and when the air was dry the temperature would fall quickly at sunset. That radiation and absorption were selective had already been stated; it was further demonstrated by placing aqueous solutions of didymium salts in the arc beam. The infra-red was particularly affected by selective absorption. This was investigated by passing a wire bolometer over the spectrum, when sometimes strong deflections and sometimes no current at all were observed. Investigating gases and vapours by this method W. W. Coblentz (Washington) had found CH_2 bands at 3·43, 6·86, 13·6, 14μ; NH_2 bands at 2·96, 6·1μ; NO_2 bands at 7·46 and 9·08μ; C_6H_6 bands at 3·25, 6·78, 8·68, 9·8μ; and an NCS band at 4·78 and an OH band at 2·95μ. It would be noticed that some of these wave-lengths (especially in the CH_2 group) were multiples of one another ($6·86 = 2 \times 3·43$); but these apparent octaves might merely be accidental, for the fine exploring wire was much broader than the line it covered. The method was rather rough, and it might result, that those regularities did not exist any more than the many harmonic groups of spectrum lines, in which we had formerly believed.

If we heated the substance some absorption bands would appear as emission bands, so that something in the vapours must be able to vibrate in series of bands. The relations were not so simple as sometimes stated in text books, however, according to which absorption bands would arise when the body contained a system capable of vibrating at periods corresponding to that of the disturbance passing through it or by it. That was true, but not sufficient. The absorption phenomena were not to be accounted for merely on the tuning-fork analogy. If we had many tuning-forks in a room between the ear and the source of sound, they would enfeeble the intensity of the sound, though strengthening it for people in certain parts of the room; the note was not destroyed, but scattered, and there was a similar optical scattering when light passed through ground glass or through a fog. Absorption, on the other hand, meant definite destruction of the light, a transformation of the energy into something else. It did not suffice that there was something in tune; a mechanism was required which was not light. As a rule the light energy was transformed into heat. The energy absorbed by the sodium vapour was apparently transformed into heat, and that required a mechanism which would work both ways, and would transform heat into light again in the corresponding emission bands. Such emission bands could be produced by heating the substance. But not all lines or bands could be produced by heat; the hydrogen lines, for instance, could only be produced by other means, and, conversely, their light was not absorbed by being passed through hydrogen gas in the ordinary way. In this sense absorption was not always thermal; the light could also produce chemical change or decomposition.

Two demonstrations of such chemical changes were given. In the first the arc light beam was sent through a flask containing amyl-nitrite, when a cloud formed; when the light was first filtered through a flask containing a few drops of the amyl-nitrite a faint cloud was observed, which became much denser when the filter was removed. In the second demonstration, due to C. T. R. Wilson, a beam of ultra-violet light was passed along a tube containing some water and air; the beam was first filtered through a plate of glass, when no cloud appeared. After the removal of this filter for ultra-violet rays the cloud was observed to form, but the effect was weak. This cloud was probably due to the formation of hydrogen peroxide, which had a smaller vapour pressure than pure water, so that a drop once formed would not readily evaporate, but continue to grow in size.

The criterion, Prof. Thomson continued, which should allow us to distinguish between transformation of radiated energy into thermal energy and transformation into chemical separation energy, in cases in which the resulting products could not be collected, was the relation between absorption and emission. A merely thermal change was not a permanent change of the chemical conditions. If no lasting change were effected, the laws of absorption and emission should apply; in the case of a chemical change they would not apply. The radiation of a black body for any wave-length had a maximum at a certain temperature. No substance could radiate more light than the black body, which absorbed and radiated all the energy. If we, therefore, found that a body emitted at a certain temperature more radiation of a certain quality than a black body at the same temperature, then the energy could not be all thermal in that case. But the determination was not by any means so easy as it might be thought. Thus it had been asked, whether the D line of sodium in a salt flame was more intense than the D radiation of a black body. Trying bolometer experiments the lecturer had not been able to decide whether there was any difference in brightness. Paschen had in a series of comparative experiments found, that the D line of sodium salt seemed to be brighter than the D radiation of a platinum wire in the same flame. Quite recently E. Bauer had, however, come to the conclusion that there was no difference. If that were confirmed, we should be justified in regarding the radiation of the sodium flame as merely thermal.

A further question was, whether in a luminous flame or vacuum discharge tube all the sodium or the gas particles were really luminous, or whether the luminosity was confined to a small portion of the total number of molecules. The latter assumption, which seemed to be correct, implied that the luminosity was due, not to the normal molecules, but to systems produced by some agency which excited luminosity. These systems would be few in number. One of the reasons leading to this assumption was found in the connection between the refractive index of a body and the quality of the light it emitted. If light originated, as we believed, in the motion of electrified bodies, then the relations between the refractive index (which was given by the square root of the specific inductive capacity of the body) for waves of infinite lengths and the wave-length of the light emitted should be

$$\mu_\infty^2 = 1 + \Sigma N e^2 \lambda^2 / 4\pi^2 m,$$

where N was the number of particles actually emitting the light (per unit volume), e the charge and m the mass of the particles. The Σ had to be introduced because there would be lines of different wave-lengths, and as spectra were known with hundreds of lines it was clear that only a very small number of the molecules present could actually be concerned in the production of light, especially in consideration of the recent discovery of infra-red rays of very large wave-length. For if all the molecules were to be concerned, the value for the refractive index would become far greater than experiments proved it to be.

The appearance of the spectra themselves afforded further ground in support of this argument. A spectrum was in one respect a very definite thing; it was very constant as to wave-length. But the relative intensities of the lines varied very much with the experimental conditions, and that could be accounted for on the view that special systems of molecules produced the lines, each series of lines being probably emitted by a separate system. The vibration period (or wave-length—not the intensity, of course) was to a surprising degree independent of the temperature.

Going back to the character of the absorption, Sir Joseph repeated that hydrogen gas would not absorb the hydrogen lines, even when under pressure. But it had been shown three years ago that hydrogen would absorb certain lines of the spectrum, the red lines, when a strong electric current was passed through the hydrogen. Thus the electric discharge transformed hydrogen into something abnormal which was able to emit or to absorb the hydrogen lines. It could not yet be said how far these considerations were true for the infra-red; but a few aggregates of molecules only seemed to be concerned in the selective absorption of infra-red rays. The recent experiments of Rubens and Wood on the relative absorptive powers of liquid water and of water vapour suggested that assumption. They found that a layer of water $\frac{1}{2}$ mm. in thickness was opaque to their long waves of $\lambda = 108\mu$, or about 0·1 mm. (method of soap bubbles), while a column of water vapour many feet long, but containing the same number of molecules, would allow one-fourth of the light to pass through. The complex aggregates of liquid water thus seemed to be highly absorptive.

In addition to thermal and chemical changes light absorption might also produce phosphorescence. A phosphorescent substance changed the quality of the light it received. For the demonstration a few crystals of iodine had been put into a large glass flask previously exhausted. At room temperature the flask contained only a little iodine vapour. When the beam of the arc lamp was thrown on the flask, a yellow phosphorescence was seen. This phosphorescence Prof. Thomson said, had been studied by R. W. Wood with monochromatic light, and he had found that the case formed one of the few known exceptions to Stokes' law. According to Stokes, the light given out by a phosphorescent substance was of longer wave-length than the light of the existing source; but Wood obtained light of shorter wave-length.

In the last lecture (April 9th) Prof. Thomson announced that Prof. Rubens had just isolated infra-red rays of $\lambda = 0·3$ mm., so that radiation waves might soon be measured by the foot rule, and the gap between heat and light waves on the one side and electric waves on the other was being bridged over.

Referring then to his own discourse of the previous evening [which we abstract on p. 19], he said that the electric discharge passing through a gas at low pressure disclosed the existence of atoms and molecules with one and more charges, of aggregations like ozone and of more complex arrangement of molecules in great variety; they all seemed to be in special states and, being themselves manufactured by the process which made the gas luminous, they seemed to give rise to the luminous radiations. The different spectra associated with the elements arose from different aggregations,

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In many spectra the various lines appeared to be associated to several series, principal and subordinate series, the members of which were characterised by a similarity in their behaviour as to fluctuations of pressure, as to the Zeeman effect, &c. Numerical relations between the wave-lengths of these series were first found by Balmer for hydrogen. According to Balmer's law, the wave-lengths of the hydrogen spectrum were $\lambda = Cm^2/(m^2-1)$; all the wave-lengths could be calculated by putting m equal to 1, 2, . . . 32; and although the law was merely empirical, it held so accurately that more reliance was often placed upon the law than upon measurement. The relations were not so simple for other substances, but became simpler when the frequency n (number of vibrations per second) was substituted for λ. Then $n = C'(1-4/m)^2$; here the first value to be taken for m was 3. Rydberg had modified this formula into $n = C - C'/(m+a)^2$, where a had to be determined for each element, while the second constant C was the same for all elements and orders of spectra. Recently W. Ritz had improved the formula by substituting for the bracket the factor $(m+a+\beta/m)^2$; a similar formula formed the basis of the studies of W. M. Hicks [Sheffield]. Ritz and Hicks also) had suggested a physical explanation for the empirical formulæ. Ritz (1908) regarded light as produced by the motion of a negatively electrified particle under the influence of a magnet force. If the particle were situated above a bar magnet (like the dot over the İ), the particle would describe a circle; and since $Hv = m^2 r$ (where r was the radius of this circle), the frequency was H/r m, that is, proportional to the magnetic force. Now if there were only one magnet, the moment would depend, among other things, upon the distance c between the particle and the magnet; if there were a chain of equal magnets, all joined to form a straight line, the moment would depend upon $(1+c)^2$ for two magnets, upon $(2+c)^2$ for three magnets, and so on, and thus the different values for m came in. The Zeeman effect certainly suggested rotation of the particles in the magnetic field. Another suggestion of molecular magnetism had been made by P. Weiss. Each atom was to contain a permanent magnet of the same kind for all the elements, and his magnetic calculations of the vibration frequency of radiations were in fair agreement with other calculations.

Turning to the formation of special substances in connection with luminescence, Prof. Thomson demonstrated thermo-luminescence. Powdered sulphate of calcium and magnesium were put in a little platinum boat which was placed in a glass tube that was sealed with an open end to the open end of a Röntgen tube; this had been done before the lecture. The mixed salts were now exposed to Röntgen rays for a minute or so; the sealing wax was then melted in a small flame, and the boat taken out. It was faintly luminescent, and the luminescence increased at once, when the boat was heated over a burner, to die out again. The Röntgen rays had formed a new unstable compound, which went back to its original state and was luminescent while the transition lasted; the change was hastened by heating. In another demonstration the lower bulb of a dumb-bell tube was placed within a coil joined to a Leyden jar circuit; the bulbs were filled with oxygen. Each spark discharge in the circuit caused the oxygen in the upper (visible) bulb luminous for a little while owing to the formation of ozone; but heating destroyed this luminescence because it destroyed the ozone.

Asking, finally, what was the nature of radiation and of light waves, Prof. Thomson said, one might think of sound. Mathematically the sound compression-waves were very simple things, depending merely on the pressure and velocity of the air. That was sufficient for the theory to explain everything, without any reference to the molecular theory of gases. But the phenomena were more complicated than the theory, which regarded the whole problem as hardly more than merely statistical, like a census. An intelligent molecule would not know on that theory, that a sound wave was passing near to it, and that the molecules (population) were crowded in certain directions. It was only when we had to deal with sounds so shrill that the sound wave became comparable to the free path, however, that the mathematical treatment might not remain adequate. It was similar with light. Everything concerning purely optical effects was explained by a mathematical representation of a light wave, as were other physical effects. When we considered the latter, it was at first sufficient to regard light as something continuous advancing with a wave front; we had to represent light as a series of bright spots on dark ground. For one reason: If all the space which the light traversed were to be filled by the full energy which the light carried, we wanted too much energy; if the energy were all concentrated in spots, we wanted less. We could deduce the maximum electric force and maximum energy in any kind of light; the electric force, we found, was not nearly sufficient for some purely optical effects. For instance. Ultra-violet light falling on a sheet of zinc (or freshly cleaned zinc first) rapidly discharged the zinc when charged negatively, but not when charged positively, nor did ordinary light (ultra-violet rays filtered through a glass screen) produce a discharge. The ultra-violet rays thus caused the negative particles to shoot off at a velocity; this velocity, as well as the electric force required to produce it, could be calculated. But light would have to vibrate at billions and billions of times per second to produce that velocity, unless we conceded, that the maximum energy was greater in spots than it would be with uniform distribution. Another reason: Even the feeblest light would affect a photographic plate, if the exposure were long enough. But the corresponding electric force of, say, 0·00001 volt would produce no effect at all, though its equivalent in the electromagnetic theory of light was optically active. Hence light would appear to be concentrated in spots or specks which would be few in number and widely scattered in weak light.

Concluding, under pressure of time, Sir Joseph mentioned some quite recent experiments of C. T. R. Wilson's, which would not absolutely prove, but support, the just-expressed view. In the well-known old experiment of Wilson a vapour cloud was observed, when ionised air was expanded. The experiment had been improved by using a very accurate piston and by expanding a thin slab of air so as to avoid all eddy currents; it had taken many months to achieve this. When the ionisation was effected by β rays in a strong field and observed in a strong light, Wilson saw a few fine lines like spider threads marking the particles which had traversed the cloud in the moment of expansion. When Röntgen rays (ether waves like light) were used, a series of bright specks, not a uniform cloud, was seen.

CORRESPONDENCE.

LEPEL AND TELEFUNKEN WIRELESS TELEGRAPH PATENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of March 3, 1911, is published a decision of the German Patent Office, regarding the application of Herr von Lepel for the revocation of three applications of the Telefunken Co.

As regards these I may perhaps remark that the decision in this matter has been disputed by the Telefunken Co., and that there are still two outstanding points to be dealt with before the transaction is invalidated.

Count Arco has promised to return to the subject only after the Courts have given their decision, and will fulfil his promise. As, however, I am mentioned in the article quoted above as the representative of the Telefunken Co., and am not bound by the same restriction as is Count Arco, I feel it my duty to make known five of the determining decisions of the German Patent Office, which relate to Herr von Lepel's inventions.

1. Decision of the Application Branch of the German Patent Office on July 27, 1910, in the matter of the patent application G. 26,612 (Telefunken):—

Arrangement for the Generation of Electric Oscillations.

The protest L. 24,757 VIII./21a4 made by von Lepel does not invalidate this patent under §3, subsection 1 of the Patent Law. This patent also refers, it is true, to the working of a short spark gap by means of alternating current with Wien's shock excitation, but that is not the subject dealt with in the application. Under the circumstances it is therefore superfluous to decide the further demand of the applicant in the above application as to the validity of the application L. 24,757 VIII. 21a4, and in the meantime publication of the patent by the Application Branch has been determined upon.

2. Decision of the Application Branch of the German Patent Office on October 29, 1910, in the matter of patent application G. 26,744 (Telefunken):—

Spark Gaps for carrying out Wien's Methods for Generating Electric Oscillations.

The prior use claimed by Ruhmer consists of experiments which the applicant carried out in the year 1907 with Lepel's generator. In the publications dealing with application L. 24,757 which relates to the Lepel arrangement the Application Branch has laid down already that this arrangement is not identical with that of Wien. Arco's lecture at Cologne (published in THE ELECTRICIAN for July, 1909) alluded to by the applicant, contains nothing which contradicts the view taken by the Application Branch. It is therefore superfluous to bring in the question of prior use.

3. Decision of the Application Branch of the German Patent

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Office on October 28, 1910, in the matter of the patent application G. 27,164 (Telefunken) :—

Arrangement for carrying out Wien's Method of Generating Electric Oscillations—Hissing Spark Gaps—in which several Spark Gaps are connected in series.

The application of the "Polyfrequenz" Elektrizitäts Gesellschaft, P. 19,596, cannot be considered as invalidating this patent, for the patent fails on this application, and the complaint submitted has been withdrawn. In this application the grounds of invalidation are not, in the opinion of the Application Branch, sufficient, as they do not deal with the identical arrangement, but with some other. As regards the objection against application L. 24,757 the Application Branch has laid down in the arrangement published that the object of that application has nothing to do with Wien's arrangement. Also that it is not principally concerned with series spark gaps.

The assertion made by von Lepel in his objection of illegal borrowing, rests upon tests which the applicant carried out for the respondent in 1907 with the above-mentioned application L. 24,757 in view. It was afterwards made evident that the object of this application neither concerned an identical spark gap or an identical method. There is, from the Application Branch point of view, no case of illegal borrowing. The same conclusion arises from tests carried out later—namely, those of Lepel, who has the further only "imagined" illegal borrowing.

4. Decision of the Application Branch of the Patent Office on November 5, 1910, in the matter of patent application G. 28,198 (Telefunken) :—

Spark Gaps for carrying out Wien's Arrangement for Generating Electric Oscillations.

The Poulsen lamp indicated in the protest of the C. Lorenz Aktien Gesellschaft is not used for the generation of oscillations in Wien's system, and is therefore not identical with the object of the application.

The same applies to the Lepel spark gap dealt with in application L. 24,757/21a4, as published by the Application Branch, which has nothing to do with Wien's arrangement. The description given by the "Polyfrequenz" Elektrizitäts Gesellschaft of this spark gap in "Electrical Engineering" during 1909, does not affect the question as regards the present application, as it was first published about a year after the date of application.

Also if the use of the Wien arrangement is taken into consideration, then the Lepel spark gap is not identical with the subject of the application, as the insulation lying between the electrodes as mentioned at the end of the application L. 24,757 is not used for keeping the sparking chambers air-tight.

As, therefore, application L. 24,757/21a4 deals neither with the identical arrangement nor with an identical spark gap, there is no occasion for the Application Branch to admit the illegal borrowing from von Lepel of the subject of the above application.

5. Decision of the Application Branch of the Patent Office on June 20, 1910, in the matter of patent application L. 24,757 (v. Lepel) :—

Arrangement for Generating Rapid Electric Oscillations by Alternating or Direct Current.

It should be noted with regard to the oft-reiterated objection to Wien's well-known method of generating shock excitation that in this application there is no mention of this arrangement. On the other hand, in this application short discharge gaps are used which makes it in no way certain that it deals with shock excitations. Further, to generate shock excitations requires, besides the short discharge gap, close coupling of the secondary circuit with the primary circuit containing the spark gap, and this is not the case in this application.

The last quotation makes it clear that the Application Branch of the German Patent Office has explicitly acknowledged that the Lepel arrangement has nothing whatever to do with that of Wien.

If the periodical literature is perused, or that part which has been published by Herr von Lepel, it will be found that this falls into two categories. The first contains all that of date previous to June 4, 1909, and the second all that of later date.

In the first category attention is only paid to undamped oscillations, as will be seen by referring to the following articles in THE ELECTRICIAN, Vol. LX., p. 623, Vol. LXIII., pp. 52, 53, 142, 174, 175, 332, 333.

In the latter publications only Wien's arrangement is mentioned. This division is interesting in so far as, on June 4, 1909, Count Arco delivered his lecture at Cologne, when for the first time the Telefunken Co. came out into the open, and made public suitable arrangements for the practical use of Wien's invention.—I am, Sir, yours &c.,

P. PICHON,
Chief Engineer of the Telefunken Co.

Berlin, March 29.

YORKSHIRE *v.* LANCASHIRE BOILERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of March 31st you give extracts from a Paper on steam boilers read by Mr. Mountain, the borough electrical engineer for Huddersfield, before the Yorkshire branch of Electrical Engineers at the Sheffield University. Mr. Mountain, in referring to the Yorkshire boiler said:—"There seems to be little doubt that the same evaporation can be obtained from a Yorkshire boiler 24 ft. *long* as from a Lancashire boiler 30 ft. long, shell diameters being equal. The gradual enlargement of the furnace tubes at the back of the Yorkshire enables the gases to pass through the boiler more freely, and consequently with the same chimney draught the consumption of coal *per* foot of grate must be increased."

It is a sign of progress when a prominent engineer like Mr. Mountain has the courage to speak in such a convincing manner, as he evidently quite understands that the contracted rear end of the furnace flues of a Lancashire boiler acts as a permanent brake, which not only keeps down the evaporation but also detracts from the efficiency of the boiler. It is only common justice to the Yorkshire Boiler Co., however, to state that Mr. Mountain has under-estimated the duty and efficiency of the Yorkshire, as a boiler 20 ft. long will give an equal hourly evaporation to that of a 30 ft. Lancashire, and for 8 per cent. less fuel; and four 24 ft. Yorkshire will give an equal hourly evaporation to that of five 30 ft. Lancashire, draught conditions and fuel being equal, maintaining the same efficiency.

I would also point out that at the same meeting the overall efficiency of a 24 ft. Yorkshire boiler and economiser was stated to be 65 per cent. A boiler of this size, however, when evaporating 1,500 gallons of water per hour will maintain an efficiency of approximately 63 per cent., so that with boiler and economiser the overall efficiency would be 73 per cent. A 20 ft. by 8 ft. 6 in. Yorkshire boiler will give an evaporation of 8,000 lbs. of water per hour, and maintain an efficiency of 70 per cent. The same boiler can be worked up to an evaporation of 1,380 gallons, and the drop in efficiency will not be more than 10 per cent.

The thermal efficiency of any boiler depends on the quality of combustion, and this is controlled by thick fires and a powerful draught, such as are secured in a Yorkshire boiler by expanding the furnace flues; hence the reason of this boiler's greater efficiency and evaporative power as compared with the now (from a scientific point of view) obsolete Lancashire.—I am, &c.

Standard Buildings, Leeds, April 3. W. H. CASMEY.

SYNTONY OF A QUENCHED SPARK.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: On reading Messrs. Eccles & Makower's answer to me in your issue of March 24, I gather that they are under the impression that my article was based on only one set of observations. If such had been the case my statements of conditions of experiment, which form the premise of my arguments, could scarcely be accepted by them, on account of the character of novelty which they attribute to the phenomena under discussion. As a matter of fact, the measurements mentioned in my article are an intentional reproduction of cases with which I was quite familiar owing to previous observation and experiment.

From my article Messrs. Eccles & Makower arrive at the *theorem* "that the root-mean-square of the current in the receiving antenna is proportional to the simple mean square of the current in the sending antenna." On the contrary, I gave the following experiment:—"Always keeping the same point of relative syntony, an absolutely non-inductive resistance of 0·5 ohm was switched in and out of the aerial, with the result that the *relative variations* of comparative mean square readings of aerial currents were identical for both transmitting and receiving, that is 10 per cent., while the indications of the primary current and supply current ammeters remained unvaried."

This sentence, I believe, is clear, but I am sorry that an error of expression (*ratios* for *relative variations*) on my part should

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... led Messrs. Eccles & Makower astray. So the *ratios* ... also identical, transmitting and receiving, and equal to ... as appeared in the equation

$$(r+H)\,1{\cdot}1 = r + H + 0{\cdot}5$$

... that sentence. Whenever I varied the transmitting ... square aerial current without altering the syntony ... aerial and primary, I produced direct proportional ... at the receiving station on the Duddell thermo-... meter scale; whenever I altered the syntony I obtained ... which departed widely from the direct proportion.

Categorically, the relationship between transmitting and ... current involves three coefficients of energy transfer-...:—

(1) Out of the transmitting aerial = radiation coefficient.

(2) Wave propagation.

(3) Into the receiving aerial.

To account for the table (THE ELECTRICIAN, page 570) showing ... departure from direct proportion when syntony was ... one of these three coefficients had to change. I ... (3) after investigation (paragraphs 6 and 7, THE ELECTRICIAN, p. 570). I did not take into consideration (2) in ... the short distance (8 km.) between the two stations. ... assumed (1), radiation coefficient.

... even following Messrs. Eccles & Makower's ... thought, "out of all imaginable causes. . ." it ... not have been what they think, a mere assumption on ... to have connected the departures, when syntony was ... from direct proportionality, with variations of radiation ... coefficient.

However, the transmitting data alone of the experiment ... paragraph 9 of my article and explained again in my ... THE ELECTRICIAN, p. 957), confronted with the experi-... stated in the sentence which I have corrected, prove that ... radiation coefficient did change with change of syntony.

I believe therefore that I have not committed any fault of ... and if my exposition has been unsatisfactory, I find my ... in Whateley's "*Elements of Logic*": "In all reason-... which regard matters of fact we introduce, almost at ... step fresh and fresh propositions, which have not been ... in the course of our reasoning, . . . so it is no ... that the longest mathematical demonstration should be ... more easily constructed and understood, than a much ... of just reasoning concerning real facts."—I am, &c.

... April 4. R. C. GALLETTI.

WIRELESS TELEGRAPH WORKING IN RELATION TO INTERFERENCES AND PERTURBATIONS.

We give below an abstract of the discussion that took place ... meeting of the Institution of Electrical Engineers last ... Mr. J. E. Taylor's Paper on the above subject. An ... of this Paper appeared in our last issue. An account ... given of the discussion at a meeting of the Newcastle ... Section.

DISCUSSION.

... C. LORING, R.N. (Inspector of Wireless Telegraphy to the ...) ... under the section in the Paper headed "Mutual ... between Stations" Mr. Taylor omitted to make any refe-... who installed the apparatus or the operator who ... were equipped according to the standard specified ... thought there was no reason why there should be any ... between the 600 metre and the 300 metre wave-lengths ... were about 3 miles apart. Last week he had observa-... in the Channel of 13 ships equipped with 300 and ... wave-lengths. These were measured by the Marconi mul-... and the results varied from 1,000 ft. all the way through ... However good the apparatus might be, if it was not pro-... get all kinds of wave-lengths given off, and no amount ... prevent interference. In the last two years, however, ... great improvement in the fitting of ships, and most of the ... within 5 or 6 per cent. of the 300 or 600 metres wave-... they were designed. Another difficulty was in regard to ... Some of them were good, some mediocre, and too many ... due to the rapid development of wireless telegraphy. In ... there had been so many ships fitted that it had been impos-... the supply of experienced operators. He was of opinion that the best types of apparatus supplied to ships were in advance of the personnel who were required to use it. For ship-to-shore work the apparatus must remain very simple, and the immediate improvements should take the line of greater simplicity and greater reliability, especially as regards detectors. One of the great troubles was in the receiving apparatus. An operator would not believe his own apparatus was wrong. He always believed "the other fellow's" was. He thought another improvement would be to adopt universally a musical note in transmission. All the operators he had questioned were of the opinion that a musical note would help them very much both as regards the facility of handling traffic and the working through an interference. The note should have a pitch that was capable of variation, and should be aggressive or jarring like the sound of a brass instrument, as opposed to the clear tones of a flute. He agreed with Mr. Taylor that some means of varying the strength of signals was desirable, and the idea of a variable coupling was very good, but he was afraid that an indifferent operator would not make any use of such a device (a variable coupling)—the worse the operator the more he clung to all available power. It was the same with the multiple tuner; the percentage of operators on ships who really understood the use of it was much smaller than it should be. He had collected notes on atmospherics for several years, and he found the worst months were from May to October, especially June, July and September. The best were January, February and March. The worst hours of the day were from sunset to sunrise, and the disturbances were most pronounced at sunset. The best hours were from sunrise to noon. Other things being equal, short wave-lengths say, under 2,000 ft., were less affected by atmospherics than longer ones. Atmospherics appeared to be troublesome on very long wave-lengths all the year round. When two stations equipped with the same type of aerial kept watch on, say, 2,000 ft. and 20,000 ft., the relative hours of interference from atmospherics had been noted on one occasion as 2 to 20. Their Irish stations noted atmospherics to be stronger with a westerly wind, and those on the East Coast of England found they were worst with an easterly wind. Disturbances often seemed to come up with the wind. Hunstanton was remarkable for "freak" signals, which usually occurred on still nights when ordinary signals were of a low strength. They sometimes heard ship stations to the west of Crookhaven, and though the ships lost touch with Crookhaven the signals at Hunstanton still remained strong. They had also got signals from Africa from a ship 2,800 miles distant. North Foreland, Bolt Head and Crookhaven had never inter-communicated, yet they could all communicate, as a rule, with ships in the Mediterranean at night, and the received signals were sometimes as strong as from a ship 20 or 30 miles away. Then there were three stations on the Morocco coast which at one time absolutely jammed the traffic for Crookhaven, but they were only heard at night. Judging from the wide range of the interference at the receiving station, he was sure these Morocco coast stations were not tuned according to the best practice. He had a table giving the number of hours during a year in which atmospherics occurred. These were recorded by two stations which were always in touch with each other. One station gave 670 hours of disturbance: 221 hours of moderate, 285 of strong and 385 of atmospherics in which it was impossible to work, a total of 670 strong to violent atmospherics. The other station working simultaneously and independently gave 658 hours strong to violent atmospherics, which was in remarkably close agreement under the circumstances. The accompanying table showed the number of hours each month that atmospheric disturbances were noted at a station in the Channel:—

Month.	Moderate.*	Strong.*	Violent.*
January	—	—	½
February	—	—	1
March	—	2	—
April	18¾	3	13¾
May	17	43	60
June	13	46½	17¼
July	44	52	53
August	20	51	71
September	27	42	94
October	63	25	71
November	15	18	2
December	4	3	2

Sir OLIVER J. LODGE, F.R.S., congratulated the Institution on getting information derived from the valuable experience of those in authority at the Post Office—as in the present Paper and in a previous one by Major O'Meara—information which it was hardly feasible for private people to collect. The whole subject of interference must be of great interest to everybody connected with wireless telegraphy, because in practice they seemed, at present, to be largely dependent on the skill of the operators. The way the latter picked out what they wanted to attend to in the midst of a babel of other communications struck him as very skilful. They managed to do it in times of peace, but he did not know what would happen in war time, when everybody was trying to disturb everybody else. He did not think the Admiralty ought to be satisfied with what might turn out to be a dangerous state of things. He asked Com. Loring whether there would be an insuperable objection to a lower capacity aerial on a ship. At present the custom was for the lower aerial to be the earth—or the sea in the case of a ship. His experience had been mostly gained on land, and he found that when he was using the earth as a lower capacity aerial it spoilt the tuning. Dr. Muirhead had designed an aerial somewhat in the shape of a Maltese cross, which proved an advantageous shape. The wire was brought

* *Moderate*, not affecting signalling; *strong*, signalling difficult; *violent*, signalling impossible.

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down from the centre, and the individual impulses, after reflection, returned to the centre together and descended the aerial in one complete rush of considerable intensity. On the other hand, in the case of a more ordinary shape, the alternative paths would differ widely and the impulses would descend in a procession. If an earth was employed the impulses went to various depths in the earth, and returned in a procession; moreover, the energy would be dissipated by the resistance of the earth, however well the earth connection was made. At any rate, his experience was that the tuning, though not gone altogether, was greatly vitiated. He expected that this was also the case at sea, where instead of earth they had salt water. The experience recorded in the Paper seemed to show that tuning was very imperfect in most systems. The use of a lower capacity aerial would give better tuning on land, and would also do it on sea unless the sailors objected, or saw no way of fixing the aerial. The Paper stated that there was some difficulty in tuning out a Lodge-Muirhead station; but there ought not to be any such difficulty. Such a station could tune the ships in with their 600 metre wave, or tune them out, at pleasure, but the ships could not tune the station out. They laid the blame on the Lodge-Muirhead system, but he suggested the defect was really theirs. Mr. Taylor interestingly remarked on the difference between what he called a pre-charged system and a system charged by sympathetic resonance worked up in a closed circuit; and he apparently thought the difficulty of tuning out a Lodge-Muirhead station was because of its pre-charged aerial, this having an electrostatic influence on other stations in the neighbourhood—what had been called a "return stroke" in connection with lightning discharges. He (Sir Oliver Lodge) had always doubted that that influence was really an effect of electrostatic induction in the case of lightning, because if one considered how much electrostatic energy there was stored in objects on the earth and what the effect of liberating a small induced charge would be, he did not think it would do any damage. The question now was whether it would effect a coherer. He did not deny that the Lodge-Muirhead station did disturb other stations, but he doubted whether that was the explanation. The coherer did feel the effect, but he suggested that an electrostatic charge was only sufficient to do that if the collector itself was untuned. If a damped vibrator were used as a collector it would take up all disturbances in the neighbourhood and bring them perilously near the coherer circuit, which, although properly tuned, would respond to sufficiently violent disturbances. The disturbance of wireless systems was due to shocks, so to speak, through their untuned collectors. This was not so on the Lodge-Muirhead system. He had experimented with two stations in adjacent fields; one station listening to distant signals was able to tune out the other, although the latter was shouting (transmitting signals to a distance). In another test they split the aerial into two and brought down two wires to two receiving stations. By putting a little different self-induction into the two and using a different lower aerial they could listen with half the aerial to one set and with the second to another set of signals without any interference or overhearing. By that means one got diplex (not duplex) telegraphy. He would be sorry to attempt any of these things if they had an earth connection. They did not generally need the closed receiving circuit, because they had a collector which was very accurately tuneable. One advantage of this was that they had only one thing to tune, and another was that the collector would not respond easily to anything except its own note. The phenomenon of the two wave-lengths was curious, but it was perfectly understood. When you coupled a free vibrator and a damped vibrator together they would not have the same period, or rather if you made them have the same period they would not emit a pure tune, but would emit two tones giving the phenomenon of beats. He could put this mathematically and also show the way to get over it, but he was always giving things away and he was not going to give that away.

Mr. W. Duddell, F.R.S., thought attempts were being made to receive signals using too small an amount of power. If they could use 10 times the amount of power in their transmitters and a corresponding increase in the received energy, all the interferences would become insignificant except those due to other stations, which would remain in exactly the same ratio so that with less sensitive detectors they would be in the same position as now. Present regulations, which tended to tie engineers down to use less power, were really in the wrong direction. It was marvellous that such good results were obtained with such small amounts of energy in the receivers as a fraction of a microwatt. The author had referred to the multiple tuner of the Marconi Co.; he (Mr. Duddell) had always had a difficulty in seeing what was the electrical advantage of this type of apparatus. What was really wanted to obtain good tuning in the receiver was a very freely oscillating circuit and some means of connecting the detector so that it would not introduce too much damping into the circuit. That was all that was effected by the multiple circuit methods. He thought any means by which they could uncouple the detector from the oscillating circuit would give sharper tuning. He asked, Did atmospherics propagate themselves with the velocity of light, and if so, could the direction in which they came be investigated? Was it possible to determine the difference of time between the arrival of an atmospheric at places some hundred miles apart? If one transmitted from a station a "dot" at the time an atmospheric took place, and the atmospheric and the dot were recorded at a receiving station, then with the next atmospheric the experiment was repeated in the opposite direction, one might get some indication of the rate of propagation of the atmospheric. It was stated that long waves were much more affected by atmospherics than short waves. Did it apply to the same station with a short aerial for both the short and long waves, or was it a comparison between stations with small and large aerials? There was no doubt the pre-charged aerial did tend to upset the ordinary coupled receiving station, but, on the other hand, the Lodge type of aerial with insulated lower capacity aerial seemed to be able to tune out the ordinary stations fairly well. He asked Sir Oliver whether that was connected with the shape of the waves sent out by these systems. He thought the large upper capacity and the lower capacity connected together by a self-inductance formed an extremely good oscillator and sent out waves (current) as shown in the accompanying sketch (Fig. 1). On the other hand, the coupled circuit sent out an oscillation of the type illustrated in Fig. 2 herewith. The first oscillation of the directly charged aerial was very large. That, however, did not seem quite to account for the whole difference. An aerial such as that used by Sir Oliver with a large amount of inertia between the upper and lower capacity was little affected by a small but prolonged force slightly out of tune such as one got from a coupled transmitter. Most of the coupled receivers were generally coupled moderately tight. They could not work very loose, or they would not receive enough energy. They could thus get two periods in the oscillating circuits, which would upset the coupled receiver. The coupled receiver was not able to cut the Fig. 1 waves out, but the Lodge aerial was able to cut out the waves

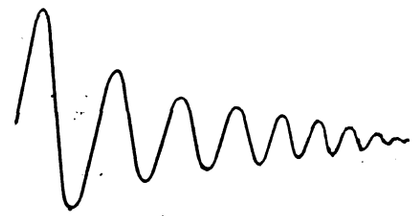

Fig. 1.

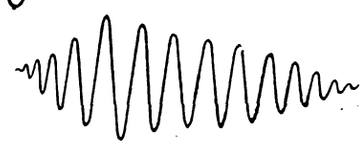

Fig. 2.

emitted by a coupled transmitter. He asked Sir Oliver whether that was the reason why the pre-charged aerial affected receivers of the coupled type more strongly than others. The direct electrostatic action could not be the real explanation because the difficulty occurred over distances of a mile or two.

Sir Oliver Lodge said he thought Mr. Duddell had given the right explanation. He imagined it was the same explanation that Mr. Taylor had intended to indicate in the Paper. Experience showed that the Lodge-Muirhead system was efficient over fairly long distances, because the Indian Government had officially reported its successful use for years between Burma and the Andaman Islands—over 300 miles—less than ½ H.P. being sufficient power. He did not altogether acquiesce in Mr. Duddell's remarks about the desirability of applying very great power. He would prefer to recommend accurate tuning and moderate power. He did not like the idea of everybody shouting at the top of their voice. He would rather speak distinctly, without energy, and discriminate between different recipients.

Although the ordinary Lodge-Muirhead was what Mr. Taylor called a pre-charged system, they were not limited to that. They had another plan which had not that characteristic—the disruptive rush method of charging—which was roughly shown in the following diagram (Fig. 3). They had not had so much experience of this arrangement as of the other, but he would be glad for Mr. Taylor to come and see how far it overcame the objection the Post Office and the Admiralty apparently felt to any pre-charged system. It was unfortunate that they were unable to tune out such stations, though every Lodge-Muirhead station could tune others out easily.

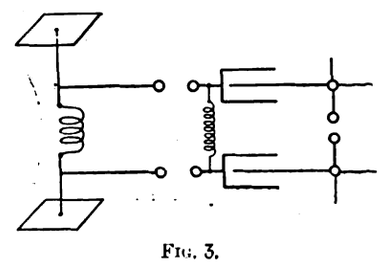

Fig. 3.

Dr. J. Erskine-Murray said he did not think Mr. Duddell had drawn his diagram quite correctly. When he (Dr. Erskine-Murray) was in charge of the Marconi station at Chelmsford, 12 years ago, he found that when a transformer was used as the primary source of power the charge slowly increased before the spark occurred, and thus the current changed from a low to a high frequency at the maximum voltage. The impulse occurred as shown in Fig. 4 herewith. It did not seem to have occurred to Mr. Duddell or Sir Oliver Lodge that signals might be received from the part of the curve marked "*a*." The speaker and Mr. Andrew Gray frequently got signals between Harwich and Chelmsford from this primary charge of the aerial when no oscillatory discharge occurred at all; the charge simply leaking back to earth through the secondary of the induction coil. The author had spoken of blunt resonance curves. He did not think Mr. Taylor had emphasised sufficiently the fact that a blunt resonance curve did not necessarily represent an impure wave. Although a receiver responded for quite a considerable range of variation of its natural frequency it should not be concluded that the waves from the transmitter had a large variety of frequencies. The fact was that there was as a rule only one wave, having one definite frequency, transmitted; but owing to its damping, and to that of the receiver, it was able to excite current in the receiver, although the latter was considerably out of tune

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with it. The same was true of the double hump curve. Two definite ... arrived through the ether, but each could excite the receiver ... the latter was somewhat out of tune. The blunt resonance ... this represented shock excitation of the receiver throughout a con... range of frequencies by the action of a damped wave-train of one ... only. He had not found quenched sparks difficult to tune out. ... Company had had reports recently from ships which had com... with a quenched spark station in Jamaica, stating that they ... tuning extremely sharp. He might add that he had found this ... true in his own experience, except at very short distances. At the ... there were disturbances, but at the ordinary working distances the ... was so sharp that Marconi ships could always pick up the quenched ... station, although some of the other ships could not do so. Per... there was too much resistance in the receivers of the latter. In ... to tuning with continuous waves, he thought if everyone stuck to ... waves, which Mr. Duddell showed them how to produce, the con... wave was an extremely good method. The trouble was that they ... produce as much high frequency energy as possible from an arc ... the arc by means of a magnet and other methods, thus causing ... of complex waves. He illustrated roughly by sketches ... between the type of wave obtained in the arc under ... circumstances. Dr. Burstyn told him that seven harmonics ... obtained from the ordinary Poulsen arc, a fact which he had ... confirmed. He thought one cure of atmospherics was the use of ... aerials. Waves came from all directions, and therefore a ... aerial picked up fewer than a non-directive aerial. He was ... to try an aerial with larger capacity as Mr. Duddell suggested. He ... there was not the slightest doubt a large number of " X's " were shock disturbances due to thunderstorms at a distance. Their experience at the Haven proved this. He did not think they could avoid the other kind of disturbance—the frizzling and frying noises which were more or less continuous, and were probably due to ordinary brush discharges from the top of the aerial. The long wave stations were obviously most affected by ... disturbances, which comprised very long waves even if very ... damped. Prof. Fitz Gerald had pointed out that there was a ... that they might get oscillations if the outer part of the atmo... sufficiently conductive. In conclusion, he would be glad if ... would expand the definition of the *coefficient of mutual dis...* between stations, as a fuller understanding of the factors con... led to a search for more definite information as to methods ... the trouble.

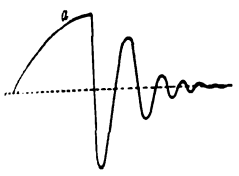

Fig. 4.

A. S. M. SÖRENSEN *said* that with reference to the question of inter... between Poulsen and spark stations he had no experimental data ... but the following points should be observed. The Poulsen ... as such, possessed in a high degree those desirable qualities *for* ... interference advocated in Mr. Taylor's Paper. In favour of ... were the comparative smallness of amplitude, the con... of the waves and the sharpness of tune. In this connection it ... remarked that although the oscillations taken *singly* were not ... by a pure sine curve (due to the arc being extinguished ... oscillation), yet as the damping was generally referred to as ... between amplitudes of consecutive oscillations, and as the ... generated a train of continuous and *uniform* oscillations, the ... damped " seemed not altogether out of place. Further, the ... transmitter only produced audible signals, when a special device ... Poulsen's Tikker), and the small difference between signalling ... wave was only detected by sharply tuned receivers. For ... great freedom from interference should be expected with ... system. At the discussion at Newcastle Mr. Taylor had said ... because the Poulsen system of causing interference over any ... but only meant that the hissing noise might start inter... inside a circle of the order of a mile. In this case the sus... expressed in Mr. Taylor's Paper did not seem well justified. If ... however, was not sufficient freedom, the speaker would suggest a ... To abandon the spark method and adopt the Poulsen system ... at.

W. E. TAYLOR, in reply to the discussion, said that Com. Loring ... some very useful information in regard to the wave-lengths ... and as to atmospherics. There was a great difference ... various types of musical note transmitted, as regards their ... penetrate atmospheric and other disturbances, but no doubt ... or trumpet note was a good one, although he (Mr. Taylor) ... "scratch" took a lot of beating. With regard to what ... had told them, there was no doubt much could be said ... about the earth connection. He surmised that a good deal ... depended on how it was made. Mr. Duddell wanted liberty to use ... amount of power, but the understanding reached by the ... Radio-Telegraphic Conference had to be considered. With ... Mr. Duddell's suggestion as to the time intervals of atmos... changes, he did not quite see how they were to get accurate ... of a 10,000th part of a second at stations 1,000 miles ... possibly it might be done. There had been a little mis... as to what he had meant by " forced oscillations." What ... meant was that a pure sine wave might become distorted ... was fed from a high-tension source of current. His ... if you had pure sine waves, due to a non-damped oscilla... of which was simply oscillating without dissipation, and then began to drive with a direct source of current you would have an impure wave which would produce a different effect on a non-damped receiver from that which would be produced by a pure sine wave. That was what he intended to convey by his remarks on the plain aerial system of transmission. He was glad Mr. Sorensen had come to the conclusion that the Poulsen system was the system of the future, which was not going to interfere with anybody. With regard to interference between continuous wave systems and spark systems, one would, at first sight, suppose they would work together harmoniously. In practice, however, that did not quite turn out to be the case.

DISCUSSION AT NEWCASTLE-ON-TYNE.

Prof. H. STROUD believed that the disturbances due to atmospherics were less pronounced when using the undamped wave system.

Mr. A. S. M. SÖRENSEN (Cullercoats Station) had never heard any complaints that the Poulsen station interfered with others.

Mr. H. KEMPE (G.P.O.) related some experiences he had had when assisting Mr. Marconi.

Mr. H. MORRIS AIREY said that the Armstrong College was only some 8 miles from Cullercoats, and they had thus ample opportunities of testing for interferences. He had found, however, that it was only by the most careful tuning for the known wave-length that it was possible to detect that the Cullercoats station was working at all. Dr. W. H. Eccles and he had spent a considerable amount of time last summer in studying atmospherics, when these were at their worst. Observations were taken during the morning and at night over a period of three months. The actual number of atmospherics was not counted, but the character and intensity of each atmospheric was noted. Observing stations were situated in London and Newcastle, and their watches were synchronised by means of the time signals sent out from Norddeich, Eiffel Tower and Poldhu. Over 70 per cent. of the atmospherics observed corresponded individually: thus, if a long rumble was heard at one station a corresponding rumble was heard at the other. It was concluded that most of the disturbances were not due to local weather conditions, but to discharges taking place in the upper atmosphere and at a very great distance from both stations. He thought that it would eventually be proved that these atmospherics were connected with magnetic disturbances, and that they had the same common origin—*i.e.*, the arrival of negatively charged electrons from the outer space into the earth's atmosphere. The wave-length to which a receiving circuit was tuned had a great influence on the number and character of the atmospherics detected. He had experimented with receivers on the same antenna, but tuned to 2,000 and 600 metres respectively. He asked Mr. Taylor if he had made any observations regarding the connection between atmospherics and the state of the weather. He was inclined to think that disturbances were not liable to occur with a cirrus sky.

Mr. J. B. JOHNSON (G.P.O. Telephones) pointed out the desirability of running sheathed telephone wires into wireless telegraph stations. The open wires originally run between the Cullercoats station and the Whitley Bay exchange were a continual source of trouble, due to false calls and the heat coils operating. Substituting rubber-covered cable made no improvement, and the only cure was found to be a lead-sheathed cable run right into the building.

Mr. B. A. ROBINSON confirmed that some of the atmospherics detected at Cullercoats were tuned and others were not.

Mr. J. M. ROBB (G.P.O. Telephones) said that so far as telephones were concerned, telegraph wires were analogous to pre-charged aerials, and the effects were not unlike those met with in wireless telegraphy. He asked if it was probable that a proportion of the unexplained failures of telephone lightning arresters was due to wireless telegraphy.

Mr. A. L. E. DRUMMOND (National Telephone Co.) said that atmospherics gave trouble analogous to that met with on telephone systems having an earth return.

Mr. A. PATTERSON (P.O. Telegraphs) said that many years ago he was associated with Mr. Taylor in connection with the first wireless telegraph installation in this country. The system had parallel wires, and suffered from atmospherics, sometimes for weeks on end. It invariably became troublesome during stormy weather, and a current of 2 to 3 milliamperes was generated in the receiving wire by the tide, the direction depending upon whether the tide was rising or falling. A similar phenomenon was mentioned in a book on cable testing by Wilson and Purdie.

Mr. C. VERNIER (Newcastle Power Supply Co.) thought that the Poulsen system was less complicated than the spark system, and that it had many other advantages. He suggested enclosing the spark contacts in a metal box, instead of shunting by a condenser as proposed under " Local inductive disturbances." Regarding the origin of atmospherics he asked if these could not be traced to lightning storms in the tropics.

Mr. TAYLOR, in reply, said that he preferred to get a good " scratchy " note in the receiver, as this made the signals easier to read. It was possible to get a slightly hissing note by tuning up the receiving circuit. He had been quite unable to connect atmospherics with local weather conditions. Wireless telegraph working might account for the failure of telephone lightning arresters, but these would have to be very near the station, and in the case of systems using the " precharged " aerial they would have to be within the influence of the electrostatic field. He agreed that there was probably some common factor in atmospherics and magnetic storms. The Poulsen system was useful for certain purposes, but could not be worked from a few dry cells; and on account of the amount of power required it was not suitable for installations in inaccessible places. Regarding the suggestion that disturbances might be due to storms in the tropics, he pointed out that one characteristic of disturbances was that they had a diurnal variation.

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CHARGES FOR ELECTRIC ENERGY AT LEEDS.

Last week the City Council made some reductions in the prices charged for electricity for power and heating.

In a report on the subject it was stated that the lowest price now charged for power was 0·8d. per unit (less 5 per cent.) and it was advisable to reduce the minimum price. It was also suggested that the concessions should not be entirely limited to the class of large power consumers but that the opportunity should be taken to offer concessions to other consumers. With the exception of the largest users, the prices for power were based upon the maximum demand system. In the early stages of the business such a system was very advantageous for two reasons. Firstly, the cost of furnishing a regular supply for long hours was less than the cost of furnishing an intermittent supply. Secondly, the forms of power with which electricity had to compete were much more economical in the case of steady loads. In the case of intermittent loads the advantages of electric driving would be sufficient to ensure its adoption even at a comparatively high price. So far as the first reason is concerned, at the stage at which the undertaking had now arrived, the advantage in cost of production with an individual consumer's steady load over an intermittent load was greatly diminished, because with a total demand of 15,000 H.P., the consumers' loads, however intermittent individually, might be relied upon to a large extent to level themselves out in the aggregate. The second reason, that of meeting the keenest competition with the lowest price, still remained.

There were, however, some disadvantages in the system which became more evident as the number of consumers increased. The maximum demand was supposed to be ascertained by a member of the staff of the electric lighting department, who, however efficient, could not, in the nature of things, be expected to always obtain it with absolute accuracy. Room was left for dispute with consumers as to the amount of the maximum demand, and there was a possibility of pressure being brought to bear to have it understated, with a view to the consumer being charged at a lower price than he should be. A large amount of time was occupied in obtaining and revising the maximum demands, and in calculating the proper charge quarter by quarter. The system was not so easily understood by consumers as one based simply upon the quantity used. It was not practicable at present to abolish the maximum demand system, because a considerable number of consumers were obtaining great benefits from it which they were fairly entitled to, and much dissatisfaction would be caused by an attempt to deprive them of that advantage. It was worth noting that during the 18 years running of the undertaking no alteration of prices had ever been made which caused a single consumer to pay a higher rate than before.

The object should be, therefore, not to abolish immediately the maximum demand system, but to supersede it partially by giving greater advantages to the majority of the consumers in another way, and ultimately to give everyone a power supply at a figure not exceeding the lowest price now charged under the maximum demand system (0·9d. per unit). The effect of the proposed amendments in the scale of charges was therefore :—(*a*) To reduce the maximum price from 1¾d. to 1½d. per unit. There were over 50 towns in which the maximum price for power was less than 1¾d. per unit, and it was advisable to remove the handicap upon the small power users of Leeds. (*b*) To give concessions, based solely upon the quantity used, to all consumers using 3,000 units or upwards (say, £17 worth) in a quarter. (*c*) To reduce the minimum price from 0·8d. per unit to 0·75d. per unit, less 5 per cent. discount, and to bring the minimum price within the reach of a somewhat larger number of consumers. It was estimated that the result of these concessions would be a loss of revenue amounting to £2,350 per annum, based upon the present output, and without allowing for the countervailing gain by the resulting increase of business.

In order to obtain an extended demand for current for heating purposes it appeared necessary to reduce the price from 1½d. to 1d. per unit. The present revenue from that source is about £450 per annum, and, therefore, the reduction would represent £150 per annum. The estimate of income and expenditure for the ensuing year allowed for the proposed reductions in prices. It was suggested, however, that they should be brought into force on July 1 next.

The revised scale of charges is as follows :—

Power.—The price of energy used in motors (when the installation is not less than ¼ H.P.) is based upon the number of units consumed per kilowatt of the consumer's maximum load. In any quarter when units consumed are less than 450 per kilowatt, 1½d. per unit, less than 600 units 1¼d., less than 720 units 1⅛d., less than 850 units 1d., less than 1,000 units 0·95d., when units consumed per kilowatt are 1,000 or upwards 0·9d.

Provided that in any quarter when the units consumed are 3,000 or upwards the price shall not exceed 1⅜d. per unit, 5,000 1¼d., 10,000 1⅛d., 20,000 1d., 50,000 0·95d., 100,000 to 149,999 units 0·9d., 150,000 to 199,999 units 0·85d., 200,000 to 399,999 units 0·8d., and 400,000 units or upwards 0·75d. per unit.

For ascertaining the price to be charged users of motive power are asked to state their maximum load, but in case of any difference of opinion on the point, the decision of the manager of the department shall be final.

Heating.—Electricity used for cooking or other heating purposes is supplied at 1d. per unit. A discount of 5 per cent. is allowed upon all accounts for payment within one month of rendering.

LEGAL INTELLIGENCE.

London Electric Supply Corpn. (Ltd.) v. Westminster Electric Supply Corpn. (Ltd.)

Mr. Justice Joyce delivered his reserved judgment in this case on Saturday. The facts were reported in THE ELECTRICIAN for March 3 and 10.

In delivering his judgment, his Lordship recapitulated the circumstances under which plaintiffs entered into an agreement with the defendant company on May 4, 1910. It was an elaborate and complicated document, well considered and carefully prepared, each party no doubt having the best legal advice and assistance. Speaking broadly, the effect of it was that the defendant company took over, for its own benefit, the working of plaintiff company's undertaking in the Westminster area, so far as the law allowed, until it should be purchased by the local authority, the consideration being a fixed annual payment of about £22,000 per annum, and certain other arrangements; with reference to various incidental matters, and, in particular, in reference to the proceeds of sale upon purchase by the authority, the arrangement as to that was, in substance, that upon the purchase by the local authority plaintiff company should receive the price of their undertaking notwithstanding the agreement for working by defendant company, and if the price were less than £100,000 defendant company were to pay plaintiff company the difference. It was provided by clause 11 of the agreement that defendant company should fulfil all conditions and requirements in respect to the supply of electrical energy to which the plaintiff company was or might become subject within the Westminster area, and should indemnify plaintiff company in respect of all claims against plaintiff company by reason of any default in such supply, provided that such default did not arise from the default or neglect of plaintiff company. Upon the sanction of the agreement by the Board of Trade plaintiff company handed over to defendant company and the latter assumed the management and working of plaintiff company's undertaking in the Westminster area. Plaintiff company first asked for an injunction to restrain defendant company from soliciting or attempting to induce any consumer in the Westminter area, who now took, or might hereafter take plaintiff company's alternating current, to cease to take same and in lieu thereof to take defendant company's continuous current. The claim to the injunction was based upon the contention that defendant company (as managers of plaintiff company's undertaking) were in a fiduciary position to them and bound even to prefer the plaintiff company's interest to their own. Certain authorities were quoted in support, but in his Lordship's opinion the claim was founded upon an entire misconception of the relation between the two companies. Defendant company were entitled (subject to their statutory obligations, and to clause 11 and fulfilling the explicit stipulations of the agreement) to work plaintiff company's undertaking for their own benefit. The defendant company, broadly speaking, purchased so far as the law would allow the right to work and take the profits for themselves of plaintiff company's undertaking in the Westminster area, managing it in their own interest entirely. That was in substance the object and intention of the whole arrangement. In regard to the contention that defendant company was precluded by the agreement from doing anything directly or indirectly to reduce or diminish the requirements of plaintiff company's consumers for alternating current, his lordship came to the conclusion that that contention could not be supported, and held, as a matter of fact, that defendant company had not really done anything intended or calculated to induce any consumers in the area, who at the date of the agreement took plaintiff company's alternating current, to cease or discontinue doing so, or to induce any such consumers to take defendant company's continuous current instead. He also held that plaintiffs had not established their claim for a declaration that, according to the true construction of the agreement, defendant company, not as between themselves and the public, but as between the two companies, was bound to supply electric energy by means of plaintiff company's alternating current to any consumer in the Westminster area who might apply to plaintiff company for a supply of electrical energy by means of alternating current. The action was accordingly dismissed with costs.

National Telephone Co. and the Postmaster-General.

On Friday last the Railway and Canal Commissioners (Mr. Justice A. T. Lawrence, the Hon. A. E. Gathorne-Hardy and Sir J. Woodhouse) heard an appeal by the National Telephone Co. from an order of the Registrar granting the Postmaster-General leave to administer interrogatories with reference to land, plant and buildings in various parts of the country which the company alleged that the Postmaster-General had to purchase at the end of the present year, when (under agreement) he acquired the whole of the undertaking of the company.

Mr. E. MORTEN, K.C. (with him Mr. Gaine), in support of the appeal said the Postmaster-General had entered into an agreement to acquire the undertaking of the National Co. at the end of 1911, and under that agreement the Postmaster-General had the right to object to purchase land, plant and buildings which he considered unsuitable for the telephone business. The Postmaster-General had given notices that he objected to purchase certain land, plant and buildings in different parts of the country, on the ground that they would not be suitable for the telephone business at Dec. 31 next. A dispute had arisen between the parties, and the court had to decide the matters in dispute, as arbitrators. The company had filed an application alleging that the notices of the Postmaster-General were not specific, and, consequently, not good. The case for the

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...was that the Postmaster-General was seeking to interpret the ... "unsuitable" as meaning "unnecessary." The Registrar had ... the Postmaster-General liberty to administer certain interrogatories to the company with reference to certain of these matters. Those interrogatories placed an enormous burden on the company for no good reason, and asked for information which was irrelevant and immaterial to the present application, but which would be material when the Commissioners came to value the property of the company. At present there ... men at work preparing an inventory of the property to be ... by the Postmaster-General. They had been at work for ... and not more than 20 per cent. of the work had been done. It was estimated that it would take 15 months to complete the inventory.

Mr. Justice LAWRENCE: Your contention is that for the purpose of ... arbitration the information asked for would be superfluous?

Mr. MORTEN: Yes. But he would be prepared before the arbitration ... to give the Postmaster-General a list of the points which the ... proposed to put in evidence in support of their contention that ... were bad.

Mr. Justice LAWRENCE said the Court was of opinion that the company ... be called upon to answer the interrogatories. If during the ... it was shown that further information ought to be supplied ... company to the Postmaster-General an order to that effect would ...

The appeal was accordingly allowed.

Re Connolly Bros. (Ltd.); Wood v. Connolly Bros. and Others.

On Tuesday last week the Court of Appeal (the Master of the Rolls ... Lords Justices Moulton and Buckley) dismissed the appeal of ... Mr. J. J. O'Reilly) from an order of Mr. Justice Parker ... appellant from proceeding in the County Palatine Court of Lancaster for the appointment of a receiver over certain mortgaged property of the company. On Feb. 17 last plaintiffs (holders of a £30,000 ... debentures) issued a writ to enforce their security, and Mr. Justice Parker appointed a receiver and manager. Appellant, who ... an equitable charge over a plot of land in Manchester acquired by the company, obtained the appointment of a receiver in the County Palatine Court, both parties being desirous of enforcing their security. ... applied to restrain Mr. O'Reilly from continuing his action in the County Palatine Court, and Mr. Justice Parker made the order ... Mr. O'Reilly from proceeding with his action, but said that ... debenture holders' receiver desired possession of the plot of land ... to pay the appellant rent for it, and if he did not desire possession ... be at liberty to make an income from it in some other way.

At the conclusion of arguments their lordships upheld the decision of Mr. Justice Parker and dismissed the appeal, but said taht there was ... in the order of the court which would prevent appellant from ... an application (if necessary) to discharge the receiver.

Fry v. Wilson.

On Friday Mr. Draper, on behalf of the defendant (Mr. W. H. Wilson), ... a committal order against plaintiff (Mr. J. T. Fry) on the ground ... plaintiff had grossly interfered with the receiver appointed on the ... of defendant to take charge of partnership assets.

... stated that the parties carried on business as electrical ... &c., at Bromley, Kent, and plaintiff lived at the back of the ... The receiver appointed by the court (Mr. Hicks) informed ... that he was not to go into the shop, but afterwards he had reason ... that papers, &c., belonging to the business were being tampered ..., and he decided to put a barrier between the shop and plaintiff's ... apartments. Plaintiff and plaintiff's son, however, claim the ... This defendant submitted was a gross interference with ...

... (through counsel) expressed regret for the damage, but denied ... in any way interfered with the papers, &c., of the business or ... to obstruct the receiver.

Mr. Justice SWINFEN EADY said there was no evidence to show that ... had tampered with the papers, &c., but he was satisfied that ... in regard to the barrier did amount to gross interference ... receiver in his duties, and he made an order committing Fry to ...

Trade Secrets.

... the Court of Appeal (the Lord Chief Justice, Mr. Justice ... Mr. Justice Coleridge) heard the appeal of F. Kurt Huessener ... Schroeder, who were sentenced at the recent Newcastle ... and four months' imprisonment respectively for corrupt... servants of the Thermal Synd. (Wallsend) by offering them ... extracting information from them about the prosecuting ...

... (for appellants) said the Thermal Synd. were manufac... and their only competitors in England were Silica Ware ... Company of which Mr. Huessener was managing director. ... against appellants was that they met two servants of the ... at Newcastle, and, by giving them small sums of money ... them employment at the company's works at Zürich, ... to extract from them information regarding the manu... certain kinds of silica. He contended that there was not ... evidence to prove that the sums offered were bribes. The ... employment were bona-fide, and, having regard to the fact that even if defendants had gained any information, they had gained it prematurely only. If they had underhandedly enticed the Thermal Synd.'s employés away and got secrets out of them after having employed them, that would not be illegal.

The LORD CHIEF JUSTICE said it was true that the sums offered to the men were small, but, together with the suggested offer of employment, they were tempting. He thought the case was one for the jury. Such offences as those were very difficult to prove, and only a small number of the offences were discovered. In those circumstances the judge was bound to deal with the matter severely, for it may have been that that was the first of a series of attempts to get trained men with secrets away from a rival manufactory by bribery. The appeal was accordingly dismissed.

Arc Lamps (Ltd.)—On Tuesday Mr. Justice Swinfen Eady had before him the petition of Siemens Bros. Dynamo Works (Ltd.) for the compulsory winding up of this company. Mr. Edwards appeared, and said he was instructed to withdraw the petition, having received no notice of support. The petition was, therefore, dismissed, without costs.

PARLIAMENTARY INTELLIGENCE.

NORTHAMPTON CORPORATION BILL.

The consideration of this bill has been continued by a Select Committee of the House of Commons.

Mr. STANLEY CLEGG, city electrical engineer and tramways manager, Lincoln, said electric tramcars were run satisfactorily over a level crossing at Lincoln, where both the road and railway traffic was greater than in the Northampton case.

Mr. LLOYD, K.C., said he had witnesses who could give similar evidence with regard to Birmingham, Gloucester and Glasgow, but the Chairman did not think it necessary to call them.

Mr. ROBT. TURNBULL, superintendent of the line (L. & N.W. Railway), said the company strongly objected to the proposed crossing. The number of trains crossing it was 32 per day. Throughout their system of 2,000 miles there was only one tramway crossing the line on the level—viz., at Manington. The railway traffic would probably be increased, as it was in contemplation to bring the Midland trains into Northampton N.W. station.

Sir CHARLES OWENS, general manager of the L. & S.W. Railway, said he viewed the level crossing proposal with grave apprehension.

Mr. TALBOT, K.C., having addressed the Committee on behalf of the L. & N.W. Railway Co.,

The CHAIRMAN said the Committee regretted that the parties had not been able to come to an arrangement, because they thought the erection of a bridge would be the most satisfactory solution. Failing that, they decided to give the Corporation the right to lay this tramway down, because they thought in that case it could be done without any injury.

The Committee subsequently passed the proposals with regard to other tramway extensions, and also the provision for running rail-less trolley vehicles, but amended the latter so that the use of such vehicles should not commence before Jan. 1913.

Mr. GOTTSCHALK (tramways manager at Northampton) said they would not go on with the last-mentioned proposal if the experiments with the rail-less trolley cars at Leeds and Bradford were unsuccessful.

Nottinghamshire & Derbyshire Tramways Bill.—Last week the Select Committee of the House of Commons dealing with unopposed bills passed the preamble of this Bill. The Parliamentary agent, Mr. Bell, explained that by arrangement with Nottingham Corporation and other bodies, they were now able to produce something like a complete scheme, and all opposition had been met. Nottingham Corporation was to construct the portion of the lines within the city, and the company was to work it.

Liverpool Overhead Railway Bill.—The House of Commons Committee on unopposed Bills has passed the preamble of this Bill, which gives the company further capital powers.

Croydon and Southern District Rail-less Traction Bill.—The promoters have intimated that they will not proceed with this bill.

National Telephone Co's Employes.—In the House of Commons on Tuesday the Postmaster-General (Mr. H. Samuel) stated, in reply to a question, that the employés of the National Telephone Co., on their transfer to the Post Office, would enjoy the advantages of the rank and grade to which they were admitted, and, in so far as their salaries had not been raised on account of duties connected with the transfer or in any way abnormally since Jan. 1, 1909, he thought he could say that the rates of pay would not be less—and in many cases would be greater—than had been paid by the company.

Private Bill Legislation.—A Bill is being promoted to authorise the transfer of the powers of the Kent Electric Power Co. in regard to a portion of their area to a company to be incorporated (or any company or persons to be named in the Bill), and to authorise extensions of the company's area from time to time, the acquisition of lands, the execution of works, the letting on hire of machinery, plant, apparatus, &c.

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COMMERCIAL AND INDUSTRIAL SECTION.

MUNICIPAL, FOREIGN & GENERAL NOTES.

BRITISH NOTES.

Ashton-under-Lyne.—Owing to the increasing demand for electrical energy for power and lighting, the Council are recommended to expend £30,000 on various extensions of generating plant and supply mains.

Barmouth.—At a meeting of tradesmen last week, presided over by the Reb. G. Davies, a sub-committee was appointed to report upon an electricity scheme submitted by Mr. C. Balbiani, electrical engineer.

Barnsley.—The Corporation have decided to apply for sanction to a loan of £16,100 for extensions of the electricity supply undertaking.

The Chairman of the Electric Lighting Committee (Ald. Brady) stated at the Council meeting on Tuesday that Mr. J. F. C. Snell had reported that there was great scope in the borough for an increased output of electricity, and that the electricity department was financially sound. Last year the revenue increased by £916.

Bradford.—At a meeting of the Tramways Committee on Monday the manager (Mr. C. J. Spencer) reported on the effect of the alterations in wages and service conditions of employés sanctioned by the Council in December.

At the time it was suggested that many employés could make themselves worth considerable more pay by better attention to work, and that a scheme of increased payment and holidays in which such employés were discriminated from others would tend to higher efficiency. Mr. Spencer gives tables showing number of advances in wages on March 31, compared with Jan. 17, were: Drivers, 168 granted ½d. an hour increase, against 128; 74 granted ¼d., against 49; 15 applications refused or deferred, against 66. Conductors, 42 granted ½d., against 28; 59 granted ¼d., against 41; 33 deferred or refused, against 62. The wages bill for the quarter was about £760 higher than the average, and as the various increases came into operation that figure would advance, so that the original estimate of extra cost (£4,561) would probably be slightly increased.

The summarised results of the operation of the scheme during the quarter were put at: 52·17 per cent. decrease in number of irregularities of drivers and conductors, 14·29 per cent. decrease in accidents, 39 per cent. reduction in number of cars taken out of service for defects, and 6·2 per cent. reduction in consumption of current.

The Committee inspected a new brake, the invention of the manager, expressed their approval of it, and decided to ask the Board of Trade to examine it.

At the last meeting of the Electricity Committee the city electrical engineer (Mr. T. Roles) reported in favour of installing a third 3,000 kw. turbo-generator, as an addition to the two already installed, together with switchgear, &c., at an estimated cost of £20,000. Consideration of the matter was adjourned.

It is estimated that the output of electricity in the year which has just closed will have reached 20,000,000 units for the first time in the history of the department, or about 2,000,000 units in excess of last year.

Bristol.—The salary of the city electrical engineer (Mr. H. Faraday Proctor, M.I.C.E., M.I.E.E.) is to be increased from £700 to £750 per annum and subsequently by two annual increments of £25 to £800 per annum.

Burnley.—The following reductions have been made in the charges for electricity, as from the 1st inst.

For traction, from 1·25d. to 1·2d. per unit; lighting from 3¼d. flat rate to 3d., less 5 per cent. discount for cash within 21 days; Coronation illuminations 1½d. per unit.

Carnarvon.—The Castle is to have the electric light installed in time for the investiture of the Prince of Wales.

Coronation Illumination.—*Westminster* City Council will expend about £1,000 on the illumination of Constitution Hill and St. James's-street.—*Stepney* (London) Council have decided to spend £300 on the illumination of public buildings.—*Burnley* Electricity Committee have decided to supply consumers with current for Coronation illumination purposes at 1½d. per unit.—*Leeds* Tramways and Electricity Committee are arranging for the running of illuminated cars in the latter half of Coronation Week. There will also be special illumination, including a searchlight at the Town Hall.—*Deptford* (London) General Purposes Committee recommend the expenditure of £150 on the illumination and decoration of the Town Hall.

Eccles.—The Council have received sanction to a loan of £360 for the extension of a h.t. feeder and £500 for the provision of electric motors.

Electricity in Mining.—At the meeting of the Ooregum Gold Mining Co. (Ltd.) on Tuesday the chairman (Mr. Malcolm Low) said that the supply of electrical energy from the Cauvery River was so satisfactory that it was highly desirable that it should be extended. Electric power was well suited for the purposes of the mine, and it would mean a further decrease in costs if further supplies could be arranged.

Negotiations had been in hand for some considerable time, and as a result of interviews which he had with officials of the Mysore State, terms were agreed upon which would be acceptable to the companies. The completion of the scheme now awaited the concurrence of the Madras Government, who had certain rights in the Cauvery River. The electrical work on the field was carried on through a department representing all the companies, and was under the supervision of a capable head in Mr. F. M. Nicholl.

Fatality.—An unfortunate fatality occurred in Abington-street, Blackpool, on Monday evening.

A young electrician named George Lewis and another employé of the Corporation were fixing a number of arc lamps near to the new post office when Lewis, who was coupling up the cables in the ground at the foot of one of the posts, received a fatal shock from a "live" electric cable, which was carrying current at 2,000 volts. Deceased had been asked shortly before the accident to put on rubber gloves for protection, but replied that he would be finished in five minutes, and the current could then be switched on.

Glasgow.—The tramways manager (Mr. Jas. Dalrymple) has reported to the Tramways Committee that the experiment of issuing two-stage tickets has considerably reduced the number of penny fares; but, on the other hand, a great many passengers who formerly took only half-penny tickets are now using two-stage tickets.

The tickets also appear to have had the effect of increasing the number of travellers for short distances. The result is that the increase in revenue from the increased traffic has more than met any reduction in revenue caused by the falling off in the number of penny passengers. Consequently the two-stage tickets will now become permanent.

Halifax.—Electric current for heating is to be supplied at power rates.

Hornsey.—Another boiler and two coal bunkers will have to be provided at a cost of £3,500 to meet next winter's demand for electrical energy. Further extensions of buildings may also be required, and the estimated cost of these is £5,450. Application is to be made to the L.G. Board for sanction to borrow £9,600.

Hulton Colliery Disaster.—The representatives of the Miners' Federation (Messrs. R. Smillie and W. Straker), who were present at the recent Government inquiry into the circumstances attending the disastrous explosion at the Pretoria Pit in December, have prepared their report on the matter, which will be submitted to the next meeting of the Executive Council of the Federation.

The report declares that the miners' representatives are satisfied that the fire originated at No. 1 heading, North Plodder seam, and was due to an electric spark from the conveying switch coming in contact with gas or gas and coal dust. The management of the mine is criticised, and, in regard to the system of ventilation, it is pointed out that under the Coal Mines Regulation Act all mechanical ventilating appliances are required to be in such a position as will make it impossible for them to be destroyed by a serious explosion. In the case of the Pretoria Pit, it is alleged that the ventilation was not in accordance with this regulation, being obtained from underground high-speed electric fans placed in such position as to ensure their being amongst the first things to be destroyed by a serious explosion.

The report condemns the use of electricity in the pit under the circumstances, alleging that electrically-driven machinery was used in parts of the mine where there was an abnormal proportion of gas. The report calls for more stringent regulations respecting the use of electricity and their more general enforcement. The need for a large increase of the inspectorial staff is also urged.

Inquest.—An inquest was held on Saturday into the death of Mr. Wm. Middleton, station superintendent of the Newcastle & District Electric Lighting Co., who died at a private hospital in Newcastle

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...e result of burns received while examining a switchboard on the ...ernoon of 16th inst.

...evidence showed that deceased was investigating a fault behind ... switchboard when a report was heard. A witness named MURRAY said ... and Mr. Middleton's coat and waistcoat on fire. He thought a ... had occurred.

Mr. J. LISTER, electrical superintendent of the Newcastle & District ..., said the switchboard would have been safer with a slate partition ... the terminals, and that was the practice now usually followed. ... jury returned a verdict of accidental death, and added that the ...board was dangerous and a partition should be put in.

Limerick.—In the estimates of the Electric Lighting Committee for ... coming year, provision is made for a deficit of £1,662. 9s. 10d. on ... working.

Lincoln.—At the last meeting of the City Council Mr. W. S. White, ... of the Electricity Works Committee, in moving the adop... the minutes of the Committee, announced that £2,000 would ... from the electricity profits to the reduction of rates. In ... £1,000 was voted for the same purpose, so that £3,000 of the ... of the department had gone in this relief.

... Committee, Mr. WHITE said, they would have liked to ... that to their depreciation account. They had sunk about ... electricity supply and £45,000 in the tramways undertaking. ... fund now stood at about £7,500. They were very anxious ... as low as possible, and for that reason the Committee ... vote the £2,000 to the rates.

London County Council.—On Tuesday the Finance Committee ... that the net debt attributable to revenue-producing under... over 50 per cent. of the total, and showed an increase ... for the previous year of £1,374,909. On the tram... London County Council) the debt was £8,899,099, and on ... lighting (metropolitan borough councils) £5,468,409. The ... important revenue-producing undertakings (water and ... had not so far necessitated a charge on the rates. The ... debt outstanding on rate services on March 31, 1910, was ..., or 121·58 per cent. of the rateable value.

Holloway-road and Grove-road Tramways.—The Highways Committee ... have been unsuccessful in their efforts to get Stepney Borough ... to the overhead system for the proposed reconstruction ... traction of the above tramways, and having regard to the ... limited extent to which the tramways are used, and the ... that would ensue if they were adapted for the conduit system, ... considering the question of asking the Council to discontinue the ... of the lines. They expect to be in a position too report after ...

Manchester Tramway Workers' Grievances.—Sir D. Harrel, who ... arbitrator in the differences between Manchester Corpora... their tramway employés, sat on Monday at the Town Hall, ... to hear the parties.

Mr. T. Jackson, general secretary of the Tramway & Vehicle ... Association, claimed for the men an eight-hour working day; ... Corporation's case was stated by the chairman (Ald. Bowes) ... and manager (Mr. McElroy).

Marylebone (London).—Mr. A. Hugh Seabrook estimates that ... will be required for short extensions of distributors during ... next 12 months.

Nelson.—Burnley's offer for renting the Nelson section of the ... has been accepted by Nelson Council. The rent is £692 ... annum, and electricity is to be supplied by Nelson at 2d. per ... Nelson Corporation will maintain the track in consideration ... annual payment of £150, and Burnley will maintain the over... plant.

Union Broad.—For some time the Council have been in negotia... with the local electricity company, Lowestoft Corporation and ... Anglian Ice Co. in regard to a supply of electricity, and the ... have now adopted a recommendation of their Electric Light... Committee to accept the offer of the Ice Co., subject to an agree... to be entered into, and upon the necessary borrowing powers ... obtained. Sanction is to be obtained for borrowing not ex... £4,000, to enable the Council to carry out their powers under ... Provisional Order.

Prestwood.—Somerset County Council have decided not to object ... application for a provisional electric lighting order provided ... parties agree that the cables should be underground in ... streets in Walton Park, that the streets in which mains are ... laid within two years include a length of one mile in the village ... half a mile in the village of Long Ashton, and half a mile in ... Leigh Woods.

Presentations.—The Chelmsford staff of Crompton & Co. have ... a marble clock and ornaments to Mr. T. L. Bowles, on his ... On retiring after 38 years' service at Woolwich with Messrs. Siemens Bros. & Co., Mr. G. Forrest has been presented by the Woolwich and London staffs and the Woolwich employés with a gold watch and chain, a chiming clock, two arm chairs and a case of pipes.

Scarborough.—The electric tramway service was re-commenced on Monday.

The Corporation have given notice to the local electric supply company that on the termination of the existing agreement they will pay for electrical energy supplied to the Corporation depot by meter.

South Shields.—On Monday a scheme of extensions at the electricity works, estimated to cost about £11,000, has been drawn up by the borough electrical engineer, Mr. J. H. Cawthra. The scheme, which has been approved by the consulting engineer (Mr. J. F. C. Snell) provides for the erection of a 1,500 kw. turbine direct coupled to a 1,000 kw. d.c. generator, and an 1,100 kw. alternator with pipework, switchboard, &c. The L.G. Board will be asked to grant a loan of £7,580, the balance to be provided out of the reserve fund.

Swansea.—The Electricity Committee recommend the Council to proceed with the proposed extension of the plant at the electricity supply works. The slaughter house and cattle market are to be wired.

Telephone Authority.—Mr. H. Laws Webb returns to the subject of a central telephone authority to organise, conduct and develop the telephone service in this country in a communication to the "Times" of the 8th, where the views of Mr. T. N. Vail, president of the American Telephone and Telegraph Co., (as expressed in a report regarding that company's operations for the year 1910), are set out. In this report it is stated that the "Bell" telephone system of the United States increased during 1910 by 740,027 stations, bringing the total to 5,882,710, and Mr. Webb points out that the total number of stations in this country does not yet nearly represent this increase made in the United States during 1910, that is to say, our total is 644,000 stations after 31 year's public use of the telephone. Mr. Webb points out that, so far, his proposal for a Central Telephone Authority has not received a single unfavourable comment.

Watford.—The Finance Committee, having again considered the comparative cost of street lighing by electricity and gas, unanimously recommend that no change be made.

At the last meeting of Council, when the recommendation was adopted, the chairman of the Electricity Committee (Mr. Goodrich) said the department was paying its way, and he thought he could forecast that the financial year which had just closed would show a profit of about £500. In 1906 the Council were paying £4,174 for 16,000 c.p. for street lighting, whereas, before next winter, they would be having 70,000 c.p. for the same sum.

Wimbledon.—A sub-committee, appointed to consider alternative routes for laying cables to the Maldens and Coombe, have submitted three alternative schemes, the cost being respectively £3,719, £3,241 and £7,459.

A draft agreement has been approved as to a supply of energy to the sewage pumping station and works of Merton Council in West Barnes-lane.

Wireless Telegraph Notes.—The Netherlands East Indies have adhered to the International Wireless Telegraph Convention of Berlin.

The Société Française Radio-Electrique, 128, Rue de la Boétie, Paris, state ("The Times," 12th inst.) that the emission from the Eiffel Tower by means of their singing sparks has been clearly heard by the Glace Bay station in Canada, a distance of over 3,000 miles, with an expenditure of energy at the Eiffel Tower of only 13 H.P. They claim that this result is of great importance, because up to the present 150 H.P. has been required to communicate to such a distance, and that it shows the improvement which has been effected. They state, further, that the receiving conditions were unfavourable, in that while the wave-length employed at the Eiffel Tower was just over 2,000 metres, the Glace Bay station received the messages with a wave-length of 4,000 metres.

Woodbridge.—At the last meeting of the Council representatives of Messrs. Foote & Milne attended to give particulars of the proposed electricity scheme for the district. After discussion the Council appointed an Electricity Committee to go into the details of the subject and to report to the Council.

Worthing.—It is reported that, instead of an anticipated deficit of £124 on the past year's working of the electricity undertaking, there was a net profit of about £7.

York.—In moving the adoption of the minutes of the Electricity Committee at the City Council meeting on Monday the chairman

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(Ald. Meyer) said they were of opinion that a reserve fund should be formed as soon as possible.

Ald. MEYER also said the amount of the sinking fund on their borrowed capital was £5,326, while the interest only came to £4,500. They were bound by the regulations of the L.G. Board, and they not only had to renew their plant out of revenue, but had also to pay the whole of the capital cost of the plant in a certain number of years. It was the last regulation which made it necessary to form a renewal fund.

Social.—The employés of Messrs. Elliott Bros., Century Works, Lewisham, S.E., held a successful social evening at the Blackheath Concert Hall on April 1.

The hall was filled to its utmost capacity, a number of local residents kindly giving their services for the entertainment, which was entirely to the liking of the audience. The music rendered by the Century Works Orchestra added to the enjoyment of the evening.

Dinner.—The electrical engineer ex-apprentices and apprentice at Devonport have formed themselves into an association, and the inaugural dinner was held at Plymouth on Saturday. Mr. Z. H. Kingdon presided, and among those present were Messrs. E. E. Benham, G. R. Battle, J. C. Uglow and W. J. Wotton.

In addition to a large gathering of ex-apprentices and apprentices of the electrical engineer's department, representatives of similar associations in other departments, and Mr. Maker, chairman of the Electrical Fitters' Association, attended.

COLONIAL AND FOREIGN NOTES.

Angola (West Africa).—It is proposed to use water power at Katanga for the generation of electrical energy for haulage and lighting in the Star of the Congo Mine.

Austria-Hungary.—The Severoceske Elektrárny Spolecnost has been formed at Leitmeritz with a capital of £62,500 to promote electricity supply undertakings.

The Elektrizitätswerk Semmering Gesellschaft has obtained a concession for the construction of electric tramways of Semmering.

Batavia (East Indies).—A group of Chinese capitalists (represented by a European) have applied to the Netherlands East Indies Government for a concession for the construction and working of electric tramways in Batavia.

Chinese Telegraphs.—The important announcement is made that the Eastern Extension, Australasia & China Telegraph Co. and the Great Northern Telegraph Co. have arranged to provide the Chinese Telegraph Administration with the sum of £500,000 by way of advance on the receipts which will become due to the Chinese Administration on the foreign traffic during the next 18 years. The interest payable to the Companies is 5 per cent. It is a stipulation of the advance that the money shall be used only for the development of the Chinese telegraphs and telephones. The arrangement is regarded in financial and telegraph circles as a departure in the best interests of all parties concerned.

Russia.—Kharkov Municipality have applied to the Ministry of the Interior for authority to borrow £654,000 for the extension of their electricity works, construction of tramways, water works, &c.

South Africa.—The "British and South African Export Gazette" states that there is likely to be an increased demand for electric lighting appliances in Pietermaritzburg, as the Municipality has decided to assist householders in making installations.

Electricity supply works have been equipped at Ceres (Cape Province) and water power is used for driving the generating plant.

The estimates of the Finance Committee of Johannesburg Corporation for the five years 1911-1915 include £289,680 for electricity supply and £298,236 for electric tramway purposes.

Turin International Exhibition.—The British section of the Turin Exhibition is self-contained, and British-made machinery need not be looked for in the International Machinery Hall, for examples of the most recent developments in electrical plant, agricultural and textile machinery, gas and oil engines and machine tools will be found in a hall which forms, facing the river, the left wing of the British Pavilion.

Leaving the machinery hall a visitor will first pass through the land transport court, which contains fine examples of the advance made of late years by Great Britain in the manufacture of motor cars. This court contains 35 cars. He will next reach the court of chemical and scientific industries, where everything is to be shown, as far as possible, under actual working conditions. Two completely-equipped laboratories are shown, and mark the inauguration of a novel and eminently practical method of exhibition. So far as the pottery industry is concerned, Great Britain has recently taken a decided lead. In one or two cases, after years of patient experimental research, her potters claim to have re-discovered the long-lost secrets of the art of the ancients in this respect, and what is shown may, therefore, be regarded as being among the most valuable contributions to the section.

TRADE NOTES AND NOTICES.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1911 Edition of the Big Blue Book is READY, price 15s., post free in the United Kingdom, 15s. 9d. The volume brings a great mass of very valuable statistical and technical data quite up to date, and the Directorial Division has been thoroughly revised and amplified up to February 24th.

All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters receive every attention in the new volume, which aggregates more than 2,000 pages. The Directory Division is complete and thoroughly accurate, and has been completely revised. The Big Blue Book contains more names of live electrical firms and persons than any other Directory published, and this notwithstanding that all mere lists of members of Societies and Institutions (so easily and cheaply available) are excluded, as unreliable and of little value for Manufacturers' and Dealers' purposes. The full set of valuable Statistical and Engineering Tables, &c., have been very carefully revised and extended, and are now issued in a handy form. These are included in the 1910 Big Blue Book, making it the most complete work of the kind ever published.

TENDERS INVITED.

FULHAM (London) Borough Council invite tenders for the supply, delivery and erection of a 1,500 kw. turbo-alternator with condensing plant. Specification plan and form of tender from the borough electrical engineer, Mr. A. J. Fuller. Tenders by noon of Wednesday, April 26 to the town clerk, Mr. J. Percy Shuter, Town Hall, Fulham, S.W. See an advertisement.

ST. PANCRAS (London) Borough Council invite tenders for three-phase h.t. cable. Copies of specification, conditions of contract and form of tender from the Electricity Department, Offices, 57, Pratt-street, Camden Town, N.W. Tenders to the town clerk, Mr. C. H. F. Barrett, Town Hall, Pancras-road, N.W., by noon Monday May 15. See advertisement.

ST. PANCRAS (London) Council also invite tenders for stoneware ducts. Specification, &c., from the Electricity Department, 57, Pratt-street, N.W. Tenders to the Town Clerk, Mr. C. H. F. Barrett, Town Hall, Pancras-road, N.W., by noon, May 15. See advertisement.

DERBY Corporation invite tenders for supply of inverted rotary converters, e.h.t. cable and switchgear. Specifications and forms of tender from the borough electrical engineer, Mr. T. P. Wilmshurst, 16, Full-street, Derby. See also an advertisement.

Tenders are invited up to May 30 for the supply of one portable petrol-driven desiccating plant to the Postmaster-General's department in Victoria, and up to May 31 for the supply of 7,000 insulators and wire and line material to the Postmaster-General's department in SOUTH AUSTRALIA. Tender forms and specifications from the Commonwealth Office, 72, Victoria-street, London, S.W. See also advertisements.

Tenders are invited up to May 16 for the supply of 10,000 protectors for use at subscribers' telephone stations to the Postmaster-General's Department in VICTORIA. Tender forms and specifications from the Commonwealth Office, 72, Victoria-street, London, S.W. See also advertisement.

Tenders are invited up to July 25 for the supply of 12 sections of a branching multiple magneto lamp signalling switchboard, &c., or one automatic or semi-automatic switchboard, &c., to the Postmaster-General's Department in VICTORIA. Tender forms and specifications from the Commonwealth Office, 72, Victoria-street, London, S.W. See also advertisement.

Tenders are invited for supply of new or second-hand transformers and rotary converters, or motor-generator sets for transforming three-phase 25-cycle 13,200, 2,200 or 550-volt a.c. into 240-300-volt d.c. in output capacities ranging from 100 to 1,000 kw. See an advertisement.

The EGHAM & DISTRICT ELECTRIC LIGHT CO. (LTD.) invite tenders for supply of two high-speed Diesel oil engines, coupled to two 100 kw. single-phase alternators, with direct-coupled exciters, piping, tanks and accessories; one 4-ton overhead traveller and main h.t. switchboard. Specifications, drawings and forms of tender may be seen at,

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but not obtained from the offices of the company's consulting engineers (Messrs. Handcock & Dykes), 1, Victoria-street, Westminster, S.W., and copies of specifications, &c., may be obtained from the secretary (Mr. H. T. Manwaring), 53, Cannon-street, London, E.C., to whom tenders by noon Monday, April 24.

Tenders are wanted for supply and erection of about 20 high candle-power arcs, four searchlights, about 200 incandescents, &c., and supply of field telephones, for the United Services Tournament camp at Watford. Particulars from Secretary, 76, Victoria-street, London, S.W.

BURY (Lancs.) Corporation invite tenders for supply and fixing of cranes and fittings for the electric lighting of the Chamber Hall power station, together with the provision of certain motor supply circuits. Specifications, &c., from the manager, Mr. S. J. Watson. Tenders to the Town Clerk by noon, April 21.

KETTERING Urban District Council invite tenders for supply, delivery and erection at their electricity generating station of a cooling tower and tank and extension switchboard panels. Copies of specification, &c., from the clerk to the Council, Mr. John Bond, to whom tenders by Wednesday, April 19.

The Electricity Committee of ST. HELENS Corporation invite tenders for supply and erection of a 1,500 kw. high-pressure turbo-alternator, with condensing plant and switchgear. Drawings, specifications and forms of tender from the borough electrical engineer, Mr. E. M. Hollingsworth, Croppers-hill, St. Helens. Tenders to the Chairman of the Electricity Committee, Town Hall, St. Helens, by noon Thursday, April 20.

GLASGOW Corporation invite tenders for supply and erection of a steam turbo-alternator, with condensing plant for Pinkston generating station. Tenders to town clerk, Mr. A. W. Myles, City-chambers, Glasgow, by 10 a.m. April 24.

HORNSEY Town Council require tenders by 4 p.m. April 24 for supply and erection of flame arc lamps. Forms of tender, &c., from the Borough Electrical Engineer.

WALTHAMSTOW Council want tenders by 5 p.m. April 28 for a cooling tower and switchboard extension (two panels). Specifications &c., from Mr. G. R. Spurr, Electricity Works, Walthamstow.

GLASGOW Parish Council and Lunacy Board want tenders by 10 a.m. April 24 for 12 months' supply of electric lamps and fittings. Forms, &c., from Mr. J. R. Motion, 266, George-street, Glasgow.

DUDLEY Corporation require tenders by noon April 19 for 12 months' supply of service cables and accessories, i.r. cables, electrical fittings, carbons, carbon brushes, carbon filament lamps, &c.

TONBRIDGE Council want tenders by noon April 21 for electric pumping plant and about 1,600 yds. of electric mains in connection with sewerage works.

DUBLIN Public Libraries Committee want tenders by noon April 26 for the electric lighting of the new portion of Charleville Mall Public Library. Specification, &c., from the City Electrical Engineer.

SWANSEA Corporation require tenders by noon April 24 for the supply of 2,000 brass condenser tubes for the electricity department. Forms of tender, &c., from the Borough Electrical Engineer.

LEYTON Corporation want tenders by 7 p.m. April 24 for supply and erection of turbine generators, condensing plant, and cooling tower. Specifications, &c., from the Borough Electrical Engineer.

HEYWOOD Electricity Committee require tenders by noon April 19 for iron stores. Particulars from the Electricity Works.

Tenders are invited by the City of MELBOURNE for supply of 120 single-phase 200 volt a.c. watt-hour meters. Copies of specification and forms of tender from the agents for the City Council, Messrs. McIlwraith, McEacharn & Co. Proprietary (Ltd.), Billiter Square-buildings, London, E.C., where tenders are to be sent by noon, April 21.

Tenders are also invited by the MELBOURNE City Council for the supply, delivery and erection of a battery of accumulators with boosters and switchboards. The battery is to be capable of daily maintaining a normal capacity of 4,000 amperes for one hour, during which discharge the voltage of each cell shall not be lower than 1·7, the number of cells to be sufficient to maintain a total voltage across the whole battery of 475 volts at any time during discharge at the specified rate. Tenders are also invited for three years' maintenance. Tender forms, &c., from Messrs. McIlwraith, McEacharn & Co. Proprietary (Ltd.), Billiter Square-buildings, London, E.C., to whom tenders by noon May 8.

Tenders are invited up to April 25 for supply of 175 miles of lead-sheathed cable (lead covered, paper insulated) and 717,000 paper insulators, and up to June 14 for supply of a branching multiple electric lamp signalling switchboard at Ballarat, to the Postmaster-General's Department in VICTORIA; and up to June 14 for supply of a C.B. multiple switchboard to the Postmaster-General's Department, SOUTH AUSTRALIA. Tender forms, &c., from 72, Victoria-street, London, S.W.

Tenders will be received until 11 a.m. May 1 by Mr. M. Peterson, Board of Control, WINNIPEG, Canada, for supply of ornamental lighting standards. Specifications, &c., from the City Electrician, or may be seen at 73, Basinghall-street, London, E.C.

The Norwegian State Railway Department, Statsbaneme, CHRISTIANIA, require tenders by April 21 for supply of telegraph material, including g.i. wire, sal ammoniac, insulators, carbon plates, insulated copper cable and wire. Specifications (in Norwegian) can be seen at 73, Basinghall-street, London, E.C.

Tenders will be received at the Burgermeisteramt, VARNA (Bulgaria), on April 19 for erection and equipment of electricity works at Varna. Conditions (in French) at 73, Basinghall-street, London, E.C.

Tenders will be received at the Tiefbauamt, FRANKFORT-ON-MAIN, on April 23 for supply of 15 electric capstans.

The Turkish Ministry of Public Works, Constantinople, invite tenders until 2 p.m. June 14 (June 1 O.S.) for a concession for the supply of electrical energy for tramway and other purposes in JERUSALEM and its suburbs. Local representation necessary.

The date for receiving tenders for concessions for construction and working electric tramways in ADRIANOPLE and ADANA (Turkey) has been postponed until May 2. Local representation necessary.

TENDERS RECEIVED AND ACCEPTED.

London County Council have accepted the following tenders for supply of tramway parts, equipment, &c., for 12 months ending April, 1912:—

Dyer & Young, motor and generator spares, £265. 10s.; Brecknell, Munro & Rogers, switchgear spares, £101. 13s. 10d.; Dyer & Young, contact fingers, &c., £206. 3s. 6d.; E. Showell & Sons, ditto, £273. 5s. 5d.; M. Mole & Son, pressed brass and steel articles, £161; Sloan Electrical Co., motor and generator brushes, £53. 7s. 3d.; Morgan Crucible Co., ditto, £387; Liverpool Electric Cable Co., electric cable, fuse wire, &c., £980. 18s.; London Electric Wire Co. & Smiths, ditto, £676. 10s.; Midland Electric Wire Co., ditto, £599. 2s.; British Insulated & Helsby Cables, ditto, from £2,848. 10s. to £3,230. 10s.; Western Electric Co., h. and l.t. cable, £1,787. 17s. 3d.; W. T. Henley's Telegraph Works, ditto, £406. 12s. 4d.; Forest City Electric Co., copper bonds, £90; British Westinghouse Co., moulded insulated materials, £98. 3s.; Crystalate Mfg. Co., ditto, £84; British Isola & Micanite Co., ditto, £123. 6s.; Maritime & General Improvements Co., finishing insulating material, £112. 10s.; E. Showell & Sons, car parts, £96. 17s. 3d.; Player & Mitchell, ditto, £86. 17s.; Anti-Attrition Metal Co., bronze bearings, £1,740. 16s. 8d.; Player & Mitchell, machine finished articles (brass, gunmetal, &c.), £227. 17s.; E. Showell & Sons, ditto, £63. 12s.; Anti-Attrition Metal Co., ditto, £154. 6s. 8d.; J. Holroyd & Co., ditto (iron, steel, &c.), £55. 4s.; Bevan Lock Nut Co., ditto, £252. 1s.; Wilkes, Ltd., ditto, £221. 8s.; Horton & Son, ditto, £67. 0s. 6d.; Smethwick Stamping Co., iron and steel stampings, £92. 12s.; J. B. Brooks & Co., ditto, £89. 15s.; Vaughan Bros., ditto, £190. 4s. 2d.; Charles Bunn, ditto, £80. 10s. 4d.; Central Marine Engine Works, ditto, £59. 13s.; Woodall & Co., iron and steel forgings, £92. 2s.; Bayliss, Jones & Bayliss, ditto, £238. 9s.; J. Holroyd & Co., machine iron castings, £50. 10s.; H. Newton, Knights & Co., ditto, £153; J. Crowley & Co., ditto, £67. 3s.; Carron Co., ditto, £255; Rodney Foundry Co., ditto, £108. 6s. 8d.; Wilson, Pease & Co., special iron castings, £241. 10s.; E. Allen & Co., steel castings, £125. 5s.

Hammersmith (London) Council have received the following tenders for steam raising plant:—

Stirling Boiler Co., £5,602, £5,007 and £6,979; Jas. Howden & Co., £5,790, £6,510 and £5,110; Clarke, Chapman & Co., £6,279, £6,686, £6,999 and £8,000; Babcock & Wilcox, £6,713 and £7,613; Fraser & Chalmers, £9,510; British Niclausse Co., (boiler only) £3,490; Hawksley, Wild & Co., £9,602.

The Electricity Committee reported that the most favourable schemes were those submitted by the Stirling Boiler Co. (£5,602) and Fraser & Chalmers (£9,510). In regard to the offer of the latter firm the electrical engineer (Mr. G. Gilbert Bell) pointed out that that furnace was constructed to burn coal dust and the coal was pulverised as required. The labour item was reduced to a minimum. The plant gave a larger output than any other offered. The smoke stack was, however, too short, and an economiser was an essential part of the boiler, the output being reduced about 25 per cent. if dispensed with. After carefully considering the details of this tender Mr. Bell came to the conclusion that the extra price asked outweighed the advantages. The lowest tender, in comparison with the size of the boiler, was that of the Stirling Co., which with hot-air forced draught and all necessary auxiliaries, was £5,602. He recommended that a larger air heater be supplied, and so obtain a greater efficiency. The committee agreed with Mr. Bell's recommendation, and report that it is desirable to obtain the 2½ per cent. higher efficiency guaranteed upon the extra outlay of £229 on large heaters, and that the tender of the Stirling Co. (at £5,602) be accepted, subject to any modifications considered desirable.

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The following tenders have also been accepted by Hammersmith (London) Council :—

British Electric Transformer Co., two 100 kw. transformers, £179; two 200 kw. transformers, £298; Spagnoletti (Ltd.), 24 panels of substation switchgear, £269; Universal Electric Mfg. Co., supply of fittings for conversion of arc lamps into metallic filament lamps, £25. 185 sets tinned copper joint box connections, £18. 15s., 17 c.i. feeder pillars with switches and fuses, £86. 15s.

Wimbledon Council has accepted the following tenders for annual supplies :—

Western Electric Co., cables and pilot wires; Albion Clay Co., Sykes conduits; Doulton & Co., Doulton conduits; Dussek Bitumen Co., compound; British Insulated & Helsby Cables, tapes, sealing ends and rubber mats; W. Lucy & Co., house service boxes, main and link joint boxes and lead sleeves; Sykes & Sugden, house fuse-boxes; Callender's Co., copper bars and frames and covers; Foster Eng. Co., transformers; General Electric Co., and Ferranti Limited, meters; Siemens Bros. & Co., v.i.r. cables; General Electric Co., accessories; J. & H. Grevener, flame arc lamp carbons.

Watford Council have accepted the tender of W. T. Henley's Telegraph Works Co. for one year's supply of h.t. and l.t. paper insulated cables. Tenders were also submitted by Siemens Bros. & Co., Union Cable Co., British Insulated & Helsby Cables, General Electric Co., Callender's Cable & Construction Co., W. T. Glover & Co., and Johnson & Phillips.

Birchip (Victoria) Electric Supply Co. have accepted the tenders of Pfaff, Pinshoff & Co. (agents for the Ganz Co.) for three panel main switchboard and 500 metallic filament lamps; the Welsbach Light Co. of Australia, for E.C.C. dynamo, booster and rheostat; R. Hornsby & Sons, for 50 H.P. suction gas engine and producer; and Warburton, Franki & Co., for accumulators.

York Council have accepted the tender of the British Thomson-Houston Co. for supply of a 1,000 kw. turbo-alternator, converters and switchgear at £7,451, and the tender of Babcock & Wilcox for the supply of a watur tube boiler, automatic stoker and pipework for £2,080.

The British Westinghouse Electric & Mfg. Co. have been favoured with an order from R. Jeffry (for Pedro Perfetti, Valparaiso, for Tres Marias oficina) for two 75 kw. 230-volt d.c. generators and control gear, one 80 H.P., four 13 H.P., two 31 H.P. 220-volt d.c. motors and control gear.

The Metropolitan Asylums Board has placed an order with W. J. Fryer & Co. for wiring the new operating room in the Park Hospital at £27. 18s., and an agreement has been entered into with Pritchetts & Gold for the renewal of their maintenance of the storage battery at the Grove Hospital for five years at £75 per annum.

Belfast, Barrow and West Hartlepool Corporations have accepted tenders of Venner & Co. for Hookham meters for the ensuing 12 months. Belfast Corporation have also accepted the firm's tender for Venner time switches.

Yarmouth Council have accepted the tender of the British Griffin Chilled Iron and Steel Co. for 60 steel tyres at 34s. each, and that of the British Westinghouse Electric & Mfg. Co. at 52s. 6d. each for 36 gear wheels.

Tonbridge Council have placed orders with the Electrical Apparatus Co. for meters above 5 amperes and with the Bastian Meter Co. for meters up to 5 amperes. The contract for cables has been let to the Western Electric Co.

Marylebone (London) Council has accepted the following tenders :

Babcock & Wilcox, two superheaters, £250 each; Tudor Accumulator Co., additional cells (78) at Manchester-square and Rathbone-place substations, batteries, £2,541.

London County Council have accepted the tender of G. Weston & Sons for electric light fitting at Belvedere-place School, at £275.

London County Council have also accepted the tender of the Frodingham Iron & Steel Co. for 520 tons of rolled steel ties for magnetic brake shoes, at £6. 19s. 6d. a ton and £6. 17s. a ton, according to place of delivery.

Bray (Ireland) Council have accepted the tender of the General Electric Co., Crompton & Co., Cryselco (Ltd.), and Wakefield & Co. for supply of electrical stores. There were 34 tenders.

Gisborne (N.Z.) Council have placed an order with the General Electric Co. for generating plant comprising two Diesel oil engines and two Witton generators.

Yarmouth Education Committee have accepted the estimate of the borough electrical engineer (Mr. G. Bryant) for installing auto-transformers and metal filament lamps at Horthgate schools, at £29. 11s.

Crewkerne Engineering & Foundry have obtained the contract for the electric lighting plant of the Crewkerne Grammar School.

Torquay Council has accepted the tender of the Rees Roturbo Mfg. Co. at £352 for a motor-driven pumping plant.

Penistone Council have accepted the tender of Chapman & Sons for electrically-driven pumping plant at £369

Gloucester Council have placed an order with J. Brown & Co. for tramcar wheel tyres and with the Tyne Metal Co. for brake blocks.

Stockport Council have accepted the tender of Geo. Robson & Co. for a tram rail grinder and driller.

BUSINESS NOTICES.

The Bombay Electric Co. ask us to announce that Mr. Donald Macleod is no longer connected with the company.

Messrs. Wright & Wood, Halifax, have appointed Messrs. Berry, Skinner & Co., 78, Upper Thames-street, E.C., and Mr. Bertram T. Dale, 18, Bigg-market, Newcastle-on-Tyne, as their sole agents for London and district and the North-East Coast respectively for their motors and dynamos, motor-generators, converters and other specialities.

The offices of the Dowsing Radiant Heat Co. have been removed to 105, Gt. Portland-street, London, W.

Messrs. Tetley & Co. have appointed Mr. H. B. Done as their representative for Birmingham and Midlands, with offices at 137A, Suffolk-street, Birmingham.

The Bell Rock Belting Co., Salford, have appointed Mr. James Woolcott as their representative.

John Bullivant and Jas. Lindsay (trading as Lindsay & Co.), electrical engineers, Crown Works, 78, Lees-road, Oldham, have dissolved partnership.

Sale by Auction.—Messrs. Horne & Co., 35, Old Queen-street, Westminster, S.W., will sell by auction at the Royal Arsenal, Woolwich, at 11 a.m. on Tuesday, April 25, unserviceable and obsolete stores, including iron and steel scrap, brass, gunmetal, lead and antimony, manganese bronze, zinc, &c., electric cable, lathes and tools, pumps, engines, electrical instruments, lamps, &c. May be viewed at the Royal Arsenal, Woolwich, on Friday and Monday, prior to and on morning of sale. Catalogues at the War Office, Whitehall, the Ordnance Office, Tower, and the Ordnance Office, Royal Arsenal, Woolwich. See also an advertisement.

Patent Development.—The proprietors of patents Nos. 9,413, 9,418, 9,423 and 9,424, of 1906, for "Improvements in pneumatic tube systems" and "Improvements in governing mechanism for pneumatic tube systems," desire to make arrangements, by way of licence and otherwise, for exploiting and developing same in this country. Applications to Messrs. Haseltine, Lake & Co., patent agents and consulting engineers, 7 and 8, Southampton-buildings, London, W.C.

"The Marconigraph."—This is the title of a new monthly publication issued by the Marconi Wireless Telegraph Co. to keep the staff of the company, spread all over the world, in touch with the parent company and officials in London. No. 1 of the new publication (price 2d.) is before us, and the frontispiece is an excellent likeness of Mr. Marconi, who, despite the strenuous character of his labours and the enthusiasm with which he engages upon new problems, and such incidentals as heavy legal cases, does not seem to age. Those of us who remember him in the old St. Margaret's-Wimereux days are almost as surprised at his continued youthfulness as we are at the strides his system has made and the great accomplishments achieved. There is an interesting biographical sketch of Mr. Marconi in the new publication and an interesting budget of news. The illustrations are interesting, and we have no doubt "The Marconigraph" has come to stay.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during March, 1911, and (*b*) during the current year from Jan. 1 to March 31, with the increases or decreases compared with the corresponding periods of 1910 :—

Electrical machinery (*a*) £114,250 (increase £59,975), (*b*) £267,684 (increase £130,265); telegraph and telephone cables (*a*) £33,828 (increase £24,140), (*b*) £91,843 (increase £54,665); telegraph and telephone apparatus (*a*) £13,182 (decrease £3,539), (*b*) £38,944 (decrease £2,957); other electrical wires and cables, rubber insulated (*a*) £10,776 (decrease £1,645), (*b*) £23,739 (decrease £12,501); with other insulations (*a*) £4,699 (increase £1,971), (*b*) £11,552 (increase £5,483); carbons (*a*) £11,115 (decrease £1,227), (*b*) £36,688 (increase £942); glow lamps (*a*) £27,045 (decrease £28,535), (*b*) £85,208 (decrease £54,760); arc lamps and electric searchlights (*a*) £247 (increase £146), (*b*) £429 (decrease £847); parts of arc lamps and searchlights (other than carbons) (*a*) £9,530 (increase £4,535), (*b*) £29,221 (increase £11,847); primary and secondary batteries (*a*) £4,166 (increase £542), (*b*) £13,391 (increase £3,934). Total of electrical goods and apparatus, other than machinery and telegraph and telephone wire (*a*) £126,001 (decrease £394), (*b*) £357,550 (increase £9,173).

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Exports.—The exports of electrical machinery, material, &c. (*a*) during March, 1911, and (*b*) during the current year from Jan. 1 to March 31, and the increases and decreases compared with the corresponding periods of 1910, are as follows:—

Electrical machinery (*a*) £154,891 (increase £36,800), (*b*) £437,710 (increase £119,949); telegraph and telephone cables (*a*) £89,759 (decrease £550,245), (*b*) £195,261 (decrease £547,979); telegraph and telephone apparatus (*a*) £23,291 (increase £11,070), (*b*) £69,605 (increase £34,251); other electrical wires and cables, rubber insulated (*a*) £32,910 (increase £9,122), (*b*) £102,747 (increase £4,550); with other insulations (*a*) £40,464 (increase £19,813), (*b*) £108,140 (increase £61,452); carbons (*a*) £1,835 (increase £820), (*b*) £5,576 (increase £998); glow lamps (*a*) £12,270 (increase £1,541), (*b*) £42,055 (increase £10,225); arc lamps and searchlights (*a*) £1,047 (decrease £482), (*b*) £4,531 (decrease £437); parts of arc lamps and searchlights (other than carbons) (*a*) £1,339 (increase £432), (*b*) £3,461 (decrease £57); primary and secondary batteries (*a*) £7,707 (increase £11,465), (*b*) £31,732 (increase £5,363). Total of electrical goods and apparatus, other than machinery and telegraph and telephone wire, (*a*) £268,598 (decrease £489,562), (*b*) £697,322 (decrease £1,3?74).

BANKRUPTCIES, LIQUIDATIONS, &c.

Last week the public examination took place of Charles J. Marrian and Harry E. Wells, lately trading as Marrian, Wells & Co.

Debtors failed in February with joint liabilities £2,758 and no assets, and the partners return separate debts of £2,983 and £3,193 respectively. Mr. Marrian stated that the business came to an end in August, 1908, when they offered their creditors, in satisfaction of their claims, shares in the British Photo Lexigraph Co. (Ltd.). They promoted that company in January, 1908, with a nominal captial of £12,500, to acquire and develop an electrical apparatus for advertising purposes. It had been very successful on the Continent, but it was vetoed in London by the London County Council.

A first and final dividend of 5s. 6d. will be payable on April 25 at 132, York-road, Westminster Bridge-road, London, S.E., to creditors of Arthur Driffel Poulter, electrical engineer, &c., late of Alton Lodge, Ewell-road, Surbiton.

A second and final return (2s. 1½d. is payable at 8, Frederick's-place, Old Jewry, London, E.C., to contributories of the Phosphor Bronze Co. (Ltd.), 87, Sumner-street, Southwark, London, S.E.

A meeting will be held at 3, London Wall Buildings, London, E.C., to receive an account of the winding-up of the Allan Electrical Synd. Ltd.

COMPANIES' MEETINGS AND REPORTS.

ALDERLEY EDGE & WILMSLOW ELECTRIC SUPPLY (LTD.)—The profit for 1910 was £2,201, against £1,856 in 1909. The equivalent of 2,23? 8-c.p. lamps was connected during the year, and there are now 434 consumers.

BRISBANE ELECTRIC TRAMWAYS & INVESTMENT CO. (LTD.)—Subject to audit, the revenue account for 1910 (including £1,951. 13s. 6d brought forward) shows an available balance of £98,014. 18s. 5d., which the directors have dealt with as follows: Payment of debenture interest (£?0,?. 15s.), preference dividend (£17,656. 5s.), an interim dividend of ?s. per share on the ordinary shares (£15,000). Out of the balance (£?,?. 18s. 5d.) £27,783. 15s. 3d. added to reserve, and a balance dividend of ?s. per share (tax free) is paid on the ordinary shares (making for the year ? per cent.). £3,506. 3s. 2d. is carried forward.

CALCUTTA TRAMWAYS CO. (LTD.)—The report for 1910 states that the gross receipts were £186,506, and the working expenses, £106,355, leaving £80,151, which, with £435 from 1909, makes £80,586. Interest on debenture stock, &c., dividend on preference and ordinary shares paid and expenses share issue account written off absorb £46,842, leaving £33,?. The directors propose to pay a final dividend of 3s. 6d. per share, making 6 per cent. for the year, adding £8,000 to depreciation fund and carrying forward £1,661. The directors report a steady expansion of business, the past year's receipt being a record, but in spite of the larger business, the outgoings show a decrease.

CORK ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.)—The receipts for 1910 amounted to £55,199. 10s. 7d. and the expenses to £?. 17s. 4d., with £514. 9s. 8d. brought forward, and after deducting debenture interest (£4,600) the balance is £18,854. 2s. 11d. The half-year's preference dividends absorbed £6,163. 10s., £5,000 was added to depreciation reserve and £1,771. 12s. 4d. written off. The directors recommend a 4 per cent. dividend on the ordinary shares (£4,600), leaving £?. ?s. 7d. to be carried forward. The lighting and power business continues to show satisfactory progress. There has been a substantial increase in the number of consumers, agreements for 168 additional consumers being concluded during the year for an equivalent of 11,786 8 c.p. lamps, compared with 9,430 8 c.p. lamps for 1909. There is also an increased demand for power. The additional lighting and power connections represent a total gain of 300 kw., against 204 kw. in 1909. The lighting of Blackrock and Douglas districts has been completed, and the results are so satisfactory that the District Council have increased the number of public lamps originally contemplated. The total lighting and power receipts are £1,300 in excess of 1909, and the traffic receipts show an increase of £2,054. The gross profits show an increase of £2,761. Owing to increased demands it has been recently necessary to instal an additional 1,000 H.P. boiler and this has been put into satisfactory operation. The capital expenditure during the year has been mainly expended on the Blackrock and Douglas district lighting, additional plant in power station, house services and cables.

DUDLEY, STOURBIDGE & DISTRICT ELECTRIC TRACTION CO. (LTD.)—At the meeting on Monday the chairman (Mr. S. R. Blundstone) said that the result of the working for 1910 showed disappointing results, there being no profit available out of which to pay a dividend on the ordinary shares. The falling off in profits was due to the adverse conditions that prevailed, partly due to the unpopularity of the new system of fares. The system had now been modified to suit local conditions and was working satisfactorily. Further shrinkage in profits had arisen from the fact of the purchase of the Kinver light railway and to the payment to the Birmingham & Midland Tramways (Ltd.) of £59,000.

FOLKESTONE ELECTRICITY SUPPLY CO. (LTD.)—At the meeting last week Ald. Spurgen said there was an increase in the gross receipts of £2,211. That was a larger increase than they had had in previous years since 1903 and 1904. The increase was mainly due to the large hotels adopting their system. The amount available for dividend was £8,949, an increase of £1,358 over last year. They proposed to carry £5,000 to depreciation, because they felt it incumbent upon them to have a substantial sum in the depreciation fund. They had carried £600 to reserve, and proposed to pay 8 per cent. (making 6 per cent. for the year) compared with 5½ per cent. in 1909.

GUILDFORD ELECTRICITY SUPPLY CO. (LTD.)—At the recent meeting Mr. H. P. Smallpiece said the gross receipts had been £7,885, compared with £7,490 for 1909. Expenditure showed an increase of £243, and the gross profit had increased £152. Supply had been extended to Shalford, and the directors felt sanguine that sufficient income would be derived from customers in that parish to well repay the expense incurred. A new battery had been installed of double the capacity of the previous ones, and the directors had decided that the figure at which the old battery stood in the books (£1,432) should be written off this year out of reserve.

INDO-EUROPEAN TELEGRAPH CO. (LTD.)—The directors' report for the year ended Dec. 31 states that the company's traffics continue to show a gratifying increase, and have been carried with the accuracy and speed rendered possible only by the use of direct Wheastone working over the whole system, particularly between London and Karachi. An additional allocation towards the cost of increasing the carrying capacity of the system is proposed. The question of additional cross-channel cable communications is still occupying the attention of the directors. The revenue from message account and other sources amounts to £155,549. 3s. 8d., compared with £145,603. 17s. 5d. for 1909, an increase of £9,945. 6s. 3d. The expenses on commercial and general account are £53,848. 9s. 8d., and on maintenance account, £27,020. 17s., a total of £80,869. 6s. 8d., against £78,296. 3s. 4d. for 1909, an increase of £2,573. 3s. 4d. This, however, includes a special bonus of £3,406 voted by the directors to the commercial and maintenance staffs. The balance is £74,679. 17s., but after deduction of income-tax paid this is reduced to £70,477. 1s. 9d. Adding balance brought forward of £7,978. 1s. 11d., the total is £78,455. 3s. 8d. The sum of £4,627. 13s. 8d. has been provided to meet depreciation of securities. Deducting this sum and the interim dividend of £10,625 already paid, the balance available for distribution is £63,202. 10s. The directors now propose to declare a dividend for the six months ended Dec. 31, 1910, of 17s. 6d. per share (making with the interim dividend already paid 6 per cent. for the year) and a bonus of 20s. per share, both tax free, and to make a special distribution to the shareholders of £12,750, equivalent to 15s. per share, out of interest upon certain investments and advance accounts. This distribution, also, will be tax free. They also propose to set aside the further sum of £20,000 towards cost of increasing the carrying capacity of the system, carrying forward £11,327. 10s.

METROPOLITAN ELECTRIC TRAMWAYS (LTD.)—The Chairman (Mr. E. Garcke) stated at the meeting on Friday that the past year had been one of continued progress, both in regard to the conveyance of passengers and to the business of electricity supply. Four miles of additional line had been opened up, and their system had been brought into contact with the metropolis at a further point. Since the closing of the accounts they had opened up a further line at Ponder's End, joining Enfield with the main line on the Great North-road. They had had running 262 cars, compared with 237 in 1909, and they had found that even that number had been inadequate to cope with the traffic, and had had to hire cars. They had carried 76,000,000 passengers, compared with 62,000,000 in 1909, and the traffic receipts were £393,000, compared with £326,000. The average profit had been larger in the past year than in 1909, £2,417 against £2,342. With regard to electricity supply, carried on by a separate company (of which they held practically all the ordinary shares, £365,000), they had received a dividend of 6 per cent., besides the bonus (£26,000), or rather more than the sum required to pay the dividend on the whole of the company's ordinary shares for the year. The power company supplied 21,000,000 units of electricity during the year, an increase of 30 per cent. Southgate and Kingsbury had been added to the area of supply. They were supplying electricity in bulk to the subsidiary company which had provisional orders in Enfield, Barnet, Hertford and St. Albans, and the business of that company was developing satisfactorily. It paid 4 per cent. for the past year on the shares which the power company held, the first dividend they had received from that company since its property was acquired. The amount spent in repairs and maintenance was £44,500, and they had provided for future renewals to the extent of £21,900. The profit and loss account also included

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£76,700 paid to the local authorities; and they had reduced the preliminary expenses by £3,000, they had paid debenture and other interest amounting to £35,900, and they had a surplus of £53,767. The board suggested that £8,000 be added to reserve, and after paying the preference dividend (£25,000), a dividend on the ordinary shares of 5½ per cent. (or ½ per cent. more than in 1909) was recommended, carrying forward £2,800. The directors had decided to pay an interim dividend on the ordinary shares. They had practically completed the tramway system as originally designed, only a few small junctions remaining to be completed. With regard to extensions in sparsely-populated districts, they had made experiments and had carefully considered the rail-less traction system, and had come to the conclusion that the system offered a fair substitute for electrical tramways.

SLOUGH & DATCHET ELECTRIC SUPPLY CO. (LTD.)—At the recent meeting the directors reported that 332,295 units of electric current were sold in 1910, against 335,983 in 1909, the equivalent of 17,976 8 c.p. lamps was connected, against 16,380 8 c.p. The total net profit available for distribution was £4,087, out of which £750 was set aside for depreciation. A dividend of 4 per cent. with a bonus of 1 per cent. was recommended. The report was adopted on the motion of the chairman (Mr. H. L. Prior), who gave an analysis of the accounts.

SOUTH STAFFORDSHIRE TRAMWAYS LESSEE CO. (LTD.)—At the meeting on Monday the chairman (Mr. W. S. Schuster) said the profit for 1910 was £253, against a loss of £1,493 in 1909. The introduction of the "fair fare" system had met with considerable opposition, but modifications had been made and the system was now working satisfactorily. The increase in receipts was probably due to the introduction of that system, as the number of passengers carried was nearly 500,000 less. It appeared as if the company had at last turned the corner.

TYNEMOUTH & DISTRICT ELECTRIC TRACTION CO. (LTD.)—The total revenue for the year to Dec. 31 was £13,723. After deducting expenses and debenture interest, and placing £600 to renewals, the surplus was £4,919. The directors recommend that £500 be placed to reserve and £1,000 to sinking fund for debenture redemption, payment of preference dividend, and a ordinary dividend of 4 per cent.

At the meeting Mr. H. S. Day said the trade during the year on Tyneside was unsettled, but a better condition of affairs now prevailed, and he thought they would see an expansion. 2,056,390 passengers has been carried in the company's cars during the past year, compared with 2,044,034 during 1909. The average traffic receipts per passenger had increased 0·07d., chiefly due to the introduction of the "fair fare" system, while the average expenditure per passenger remained the same. The proportion of expenses to receipts had dropped from 60 to 58 per cent.

WILLANS & ROBINSON (LTD.)—At the meeting on Tuesday Mr. James C. Peache, M.Inst.C.E., presided. The Chairman expressed the directors' regret that the accounts again showed an adverse balance due to the deplorable condition of the electrical trade during the last two years or more. Compared with the prices obtainable for turbine plant three years ago the price to-day showed a drop of about 30 per cent., while there had been a considerable rise in the rates of wages during that period. The misfortunes which had befallen the company in the past had left no resources for meeting the present time of adversity. Their shops were fairly well supplied with orders, and although these orders had to be taken on a low scale of prices, yet the returns to be made on this work, if not yielding an actual profit, will be sufficient to provide for the carrying on of the business. Notwithstanding this absence of profit, the directors had considered it right to adhere to the very liberal provision for depreciation which had been traditional in the history of the company. The option for the purchase of Queen's Ferry Works, which ran to November last year, was not taken up, but negotiations were still in progress and there was a fair prospect of their being completed in the near future. The possibility of amalgamation with another concern had been spoken of at previous meetings, and serious negotiations were now in progress. These negotiations might mature into a definite proposition, and if so the scheme would be submitted for their ratification. The proposed changes in the management of the company were set out in the report. They had been very carefully considered, and were commended to the shareholders as effecting a material reduction in their outgoings without impairing efficiency. The report and accounts, as set out in the last issue of THE ELECTRICIAN, were then unanimously adopted.

WINDSOR ELECTRICAL INSTALLATION CO.—The director's report states that the capital expenditure during the year was £4,202, making total £89,313. Profit for the year (£421. 5s. 11d. brought forward) was £5,930. 17s. 7d., and after providing for debenture interest, preference dividend on shares, depreciation, &c. (£1,500), there was a balance of £2,239. 18s. 11d. A dividend of 4 per cent. (less tax) on the ordinary shares allowed £356. 10s. to be carried forward. During the year 1,769 (equivalent) 8 c.p. lamps were connected, the total at Dec. 31 being 47,641 8 c.p. At the meeting last week Sir W. Shipley said the net profit showed an increase of about £500, notwithstanding that the receipts from sale of current were nearly £600 less owing to the introduction of metal filament lamps and other causes. A Diesel oil engine of 100 kw. had been installed.

WOLVERHAMPTON DISTRICT ELECTRIC TRAMWAYS (LTD.)—At the meeting on Monday the chairman (Mr. S. R. Blundstone) said that a severe trade depression had prevailed in the district during a large part of the past year, and the traffic receipts were adversely affected, although they were £500 better off than in 1909.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

COUNTY LIGHT (LTD.) (115,067.)—Reg. April 4, capital £7,000 in 6,703 preference shares of £1 each and 5,940 ordinary shares of 1s. each, to carry on the business of contractors for the supply of power, light and heat, &c. Private company. First directors, B. E. Mayhew, C. F. P. Blatchley (chairman), E. Scott Snell, H. E. Cohen and J. R. Horton. Reg. office, Alderman's House, Bishopsgate, London, E.C.

WELLMAN, HEAD, STOTHERT & PITT (LTD.) (115,083.)—Reg. April 3, capital £100 in £1 shares, to carry on the business of ironfounders, mechanical, hydraulic, electrical, telegraph and general engineers, manufacturers of and dealers in steam engines, boilers, &c., and to adopt an agreement with Stothert & Pitt and Wellman, Seaver & Head. Private company. First directors, W. Pitt, P. K. Stothert, B. W. Head and F. I. Sanderson.

MORTGAGES AND CHARGES.

CARMARTHEN ELECTRIC SUPPLY CO. (LTD.)—Issue, on March 25, of £50 debentures, part of a series of which particulars have already been filed.

COWPER COLES ENGINEERING CO. (LTD.)—Issue, on Feb. 27, of £300 debentures part of series of which particulars have already been filed.

LANDAULET CO. (LTD.)—Memorandum of satisfaction in full, on March 30, of debenture dated March 8, 1910, securing £4,000, has been filed. A debenture, dated March 30, 1911, to secure £6,000, charged on company's undertaking and property, present and future, including uncalled capital, has been registered. Holder: F. W. Stanley.

RECEIVERSHIPS.

BAILEY ELECTRIC CARBONISING CO. (LTD.)—Notice of appointment of H. Appleyard, Prudential-buildings, Dewsbury, as receiver, on March 31, 1911, under powers contained in debentures dated Feb. 12, 1909, has been filed.

F. A. GLOVER & CO. (LTD.)—Notice of appointment of A. F. Whinney, 4B, Frederick's-place, Old Jewry, London, E.C., as receiver and manager, by order of court dated March 27, 1911, has been filed.

CITY NOTES.

MEMORANDA (April 12).—**Bank rate 3 per cent. (March 9, 1911) Price of silver, 24⅛d. per oz. Consols 81⅛–81⅜ for money; 79½–79⅞ for account. Consols Pay Day, May 4; Stock and Shares Continuation Days, April 25 and May 10; Ticket Days, April 26 and May 11; Pay Days, April 27 and May 12; Mining Shares Carry Over Day, April 24.**

PRICES OF METALS (London).—*Copper*, cash, 53⅛; three months, 51⅝. *Lead*, English, 13⅛–13⅜; foreign, 12⅝–13 cash, 13⅛–13⅜, three months. *Spelter*, 23½–23¾. *Tin*, English, 190–192; foreign, 192¼ cash, 187½ three months. *Iron*, Cleveland, cash, 47/2, three months, 47/11.

ANGLO AMERICAN TELEGRAPH CO. (LTD.)—The directors have resolved, after placing £5,000 to credit of renewal fund, to declare an interim dividend for the quarter ended March 31 of 15s. per cent. on the ordinary stock and £1. 10s. per cent. on the preferred stock (less tax), payable May 1.

BABCOCK & WILCOX (LTD.)—The directors have declared a further dividend of 8 per cent. (making 18 per cent. for 1910) and also a bonus of 8 per cent. The preceding year's distribution amounted to 24 per cent.

CALCUTTA ELECTRIC SUPPLY CORP. (LTD.)—526,960 units were delivered to consumers during the four weeks ended Feb. 24, compared with 439,285 units in the corresponding four weeks of 1910.

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD.)—The transfer books and register of holders of second debenture stock will be closed from the 17th to the 30th inst. inclusive, preparatory to payment of interest due May 1.

DIRECT UNITED STATES CABLE CO. (LTD.)—The board have resolved upon the payment of an interim dividend of 2s. per share (tax free), being at the rate of 4 per cent. per annum for the quarter ended March 31, payable 26th inst.

NORTH OF ENGLAND COAL & IRON INDUSTRIES.—Messrs. Wise, Speke & Co., Newcastle-on-Tyne, have compiled a brochure giving particulars of the financial position of the principal companies and firms engaged in the coal, steel and iron industries. In addition to lists of directors and officials, particulars are given of the share and debenture capital, an analysis of the balance sheets for the past five years, &c.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed April 27 a special settling day in, and granted a quotation to a further issue of $726,200 common stock of the *Canadian General Electric Co. (Ltd.)* The Committee have also ordered 160,000 £1 fully-paid shares of the *Waste Heat and Gas Electrical Generating Stations (Ltd.)* to be quoted.

TELEPHONE CO. OF EGYPT (LTD.)—**The directors recommend a dividend of 6 per cent. (6s. per share), tax free, on the preferred and deferred shares for the past half-year (making 10 per cent. for year), placing £1,000 to reserve for contemplated pension scheme.**

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ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
…rdeen Corporation	April 5	1,282	+ 19	44	61,306	+ 1,603
…rdrie	March 31	205	− 22	13	2,719	− 29
Anglo-Argentine	April 8	52,485	+ 7,979	14	696,589	+ 92,561
…-under-Lyne	..	..	..	..	..	..
…r Corporation	„ 8	192	− 8	47	13,503	+ 322
…ley	March 31	175	− 43	13	2,186	− 16
…row	„ 31	241	− 39	13	2,945	+ 8
…Electric Trams, Ltd.	April 5	682	+ 4	14	9,090	− 678
…ngham Corporation	..	..	..	..	..	..
…ngham & Midland	March 31	861	− 181	13	11,021	+ 618
…burn Corporation	April 5	985	+ 73	†2	1,495	− 554
…ton Corporation	„ 9	2,218	+ 85	2	3,056	− 38
…bay	March 10	3,026	+ 197	10	28,125	+ 1,536
…mouth Corporation	April 5	1,431	− 133	1	1,431	− 133
…ton Corporation	„ 6	4,812	− 1,773	1	4,812	− 1,773
…ton Corporation	„ 9	720	− 84	¶1	937	− 220
…Trams & Carriage	„ 7	5,397	+ 61	1	5,397	+ 61
…ey Corporation	„ 8	1,230	+ 54	1	1,236	+ 54
…ton Corporation	„ 9	235	− 13	§1	306	− 13
…Corporation	..	..	..	..	..	..
…tta Tramways Co.	„ 8	R57,164	+ R4,830	14	R778,024	+ R43,810
…borne-Redruth	„ 8	109	− 1	14	1,558	− 66
…Corporation	..	..	..	..	..	..
…	March 31	66	− 223	13	784	− 161
…ral London Railway	April 8	5,541	− 139	14	75,591	− 1,447
…ham & Dist. Lt. Rys.	„ 6	727	− 27	14	10,209	− 461
…& South London Rly.	„ 9	3,455	+ 219	14	48,308	+ 1,892
…of Birmingham	March 31	2,798	− 561	13	35,909	− 494
…ester Corporation	..	..	..	..	..	..
…Electric Trams Co.	„ 6	459	+ 5	14	5,877	− 169
…port & Dist. Trams	March 31	428	− 54	13	5,414	+ 266
…Corporation	..	..	..	..	..	..
…& Lucan Railway	April 7	110	− 11	14	1,474	− 105
…United	„ 7	5,009	− 65	14	69,035	− 522
…ley-Stourbridge	March 31	739	− 381	13	9,324	+ 277
…dee Corporation	April 5	1,096	− 68	§46	54,883	+ 237
East Ham Council	„ 8	939	− 30	1	939	− 30
Exeter Corporation	..	..	..	..	..	..
…stead & Dist. Trams	March 31	984	− 49	13	12,686	+ 466
…gow Corporation	April 8	18,403	+ 1,134	45	798,343	+ 43,176
…p Trams	„ 8	121	+ 20	14	1,568	+ 43
…ster Corpn.	„ 5	260	+ 16	1	260	+ 16
…send-Northfleet	March 31	177	− 79	13	2,255	− 157
…Northern & City Rly.	April 8	1,571	+ 101	14	22,277	+ 1,057
…ck & Port Glasgow	March 31	649	− 36	13	7,686	+ 1,099
…pool Tramways	„ 31	212	− 53	13	2,701	+ 54
…ings Elec. Trams Co.	April 6	695	− 159	15	9,784	− 1,185
…Kong	„ 8	$9,225	+ $517	15	$111,344	+ $512
…Corpn.	„ 8	1,868	+ 293	1	1,868	+ 293
…Corporation	„ 8	2,785	+ 199	1	3,391	− 52
…District Council	„ 8	460	− 14	1	460	− 14
…District Council	„ 5	123	+ 20	1	123	+ 20
…Corporation	„ 8	325	− 16	1	325	− 16
…Thanet Co.	„ 8	255	− 58	27	7,931	− 194
…	March 31	112	− 51	13	1,425	+ 10
…Corporation	April 6	145	− 4	1	145	− 4
…& District	March 31	84	− 82	13	1,058	− 62
…Corporation	April 8	143	+ 4	47	7,065	+ 264
…Corporation	„ 5	267	..	1	+ 267	..
…Trams Co.	„ 6	1,355	+ 19	14	18,461	− 32
…United	„ 5	1,250	+ 156	14	16,463	− 505
…	March 31	152	− 50	13	1,668	− 168
…Corporation	April 8	6,889	+ 492	1	6,889	+ 492
…Corporation	„ 8	2,284	+ 89	1	2,284	+ 89
…Corporation	„ 8	559	+ 15	47	27,630	− 2
…Corporation	..	..	..	..	..	..
…Corporation	„ 8	10,775	+ 388	14	151,662	+ 3,816
…Overhead Rly.	„ 9	1,381	+ 59	14	19,287	+ 1,172
…ColwynBayRy.	„ 7	145	− 7	§18	2,278	− 269
…County Council	March 29	41,069	− 346	¶52	2,163,467	+ 205,727
…Elec. Ry. Co.	April 8	14,240	+ 1,100	14	198,935	+ 12,195
…United	„ 8	5,058	− 552	14	73,875	− 4,153
…Corporation	„ 8	125	− 12	27	4,190	+ 156
…Corporation	„ 8	224	+ 19	1	224	+ 19
…ster Corporation	„ 8	14,814	+ 933	1	18,149	+ 2,321
…Railway	„ 8	2,233	+ 92	14	28,641	+ 753
…	March 31	192	− 98	13	2,340	− 116
…politan Dist. Railway	April 8	11,605	+ 803	..	165,314	+ 13,558
…politan Elec. Trams	March 31	7,748	− 1,094	13	97,445	+ 10,894
…	„ 31	287	− 203	13	3,599	+ 28
…Corporation	..	..	..	..	..	..
…-on-Tyne Corp.	April 8	3,887	+ 314	1	3,887	+ 314
…	„ 8	644	+ 33	1	644	+ 33
…Corporation	„ 7	433	+ 7	1	433	+ 7
…& Hyde	March 31	531	− 256	13	6,619	− 183
…Corporation	April 9	1,737	+ 185	2	4,202	− 465
…Corporation	„ 5	134	− 15	46	7,570	+ 361
…Elec. Trams	„ 7	1,621	+ 51	14	22,960	+ 853
…	March 31	102	− 40	13	1,270	+ 6
…Corporation	April 8	1,584	− 239	1	1,584	− 239
…	March 31	1,938	+ 35	13	24,000	+ 2,155
…Corporation	April 5	688	+ 33	1	688	+ 33
…Corporation	..	..	..	..	..	..
…	March 31	51	− 283	13	562	− 287
…Corporation	..	..	..	..	..	..
…	„ 31	41	− 13	13	535	− 2
…Corporation	April 9	6,115	+ 556	2	12,910	− 485
…Trams	„ 8	$10,876	− $334	10	$93,036	+ $2,432
…Metropolitan	March 31	676	− 371	13	8,698	− 651
…	„ 31	815	− 291	13	10,782	+ 463
…	..	..	..	..	..	..
…Corporation	April 5	394	− 30	1	394	− 30
…Tramways	March 31	233	− 219	14	2,885	+ 207
…Jt. Bd.	..	..	..	..	..	..
…Corporation	April 9	1,466	+ 40	1	1,466	+ 40
…and District	„ 5	407	+ 48	23	9,964	+ 574
…Corporation	March 31	1,020	− 182	13	13,203	+ 668
…	April 5	137	+ 14	1	137	+ 14
…and District	March 31	36	− 16	13	468	− 12
…Trams Co.	„ 31	137	− 169	13	1,864	− 113
…	April 5	403	+ 57	14	5,265	− 82
…Corporation	„ 8	921	+ 123	1	921	+ 123
…Corporation	..	..	..	..	..	..
West Ham Corporation	March 30	374	− 42	52	20,318	+ 498
Weston-super-Mare	„ 30	2,385	− 667	32	128,597	+ 5,814
W…ton Co.	„ 31	28	− 154	13	237	− 245
Wolverhampton Corpn.	„ 31	410	− 181	13	5,307	+ 89
Worcester	April 6	883	+ 27	27	25,765	+ 1,003
Wrexham	March 31	225	− 120	13	2,931	− 151
Yorkshire W.R. Trams	„ 31	92	− 37	13	1,117	− 33
Yorkshire Woollen District	April 9	1,143	+ 73	15	18,149	..
	March 31	946	− 308	13	12,534	+ 622

ELECTRICAL COMPANIES' SHARE LIST

Shrs	Last Dividend	Name.	Price Tues., April 11.	Rate per cent. Yielded.	Dividend Due.	Business 6 Days April. Highest.
		Electricity Supply.		£ s. d.		
10	6/0	†Bournemouth & Poole Elec. Sup. Ord.	8¼—8¾	6 0 0	Mar, Sep	..
10	4/6	Do. 4½ per Cent. Cum. Pref.	9¼—9¾	4 12 3	Feb, Aug	..
10	6/0	Do. 6 per Cent. Cum. Second Pref.	10—10½	5 13 0	Feb, Aug	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101—103	4 7 6	Jan, July	..
5	5/6	†Brompton & Kensington Elec. Sup. Ord.	7⅛—7⅝	6 11 3	March....	7 1/16
5	3/6	†Do. 7 per Cent. Pref.	7⅛—7⅝	4 11 6	Mar, Sept	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Deb. Stock	99—103	3 17 6	June, Dec	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	4—4½	5 11 0	Feb, Aug	..
5	2/3	Do. 4½ per Cent. Pref.	4⅛—4⅝	4 17 0	Feb., Aug	4⅛
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	96—98	4 1 6	Jan, July	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	100½—102½	4 8 0	..	..
5	2/3	Do. City Undertaking 4½% Cum. Pref.	3⅞—4⅜	5 3 0	Jan, July	–
5	3/0	Chelsea Electric Supply Ord.	4—4½	5 11 0	March	4⅛
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	100—102	4 8 6	June, Dec	..
10	8/0	†City of London Electric Lighting Ord.	11½—12	5 15 9	Feb, Aug	11⅛
10	6/0	†Do. 6 per Cent. Cum. Pref.	12—13	4 12 3	Jan, July	12⅛
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	119—123	4 1 0	June, Dec	–
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	101—104	4 6 6	Jan, July	..
5	..	County of Durham Elec. P. D. Ord.	1½—2	..	April, Oct	..
5	5%	Do. 5 per Cent. non Cum. Pref.	2⅝—3⅛	8 0 0	April, Oct	..
10	6/0	†County of London Elec. Supply Ord.	7⅝—8⅛	6 3 0	Feb, Aug	..
10	6/0	†Do. 6 per Cent. Cum. Pref.	10¾—11¼	5 6 6	Mar, Sept	11⅛
St.	4½%	Do. 4½ per Cent. Deb Stock (red.)	108½—111½	4 0 9	Jan, July	..
St.	4½%	Do. Second Deb. Stock	101—104	4 6 6	May, Nov	..
5	2/0	Folkestone Electricity Supply Co. Ord.	4¼—4¾	5 16 0	April, Oct	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅞—5⅜	4 13 0	Mar, Sept	..
St.	4½%	Do. 4½ 1st Deb. Stock (red)	97—100	4 10 0	Feb, Aug	..
5	4/0	Hove Electric Lighting Ord.	6¾—7¼	6 4 0	April, Oct	..
St.	4½%	Isle of Wight E. L. & P. Co. Deb. Stk.	90—93	4 16 9	..	..
5	5/0	Kensington & Knightsbridge Ord.	7—7½	5 16 0	Feb, Aug	..
5	6%	Do. 6 per Cent. 1st Pref.	5½—6	5 0 0	Jan, July	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	93—95	4 4 0	..	–
St.	4%	†Kensington & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	96—99	4 1 0	April, Oct	..
St.	4½%	Kent Elec. Power Co. Irred Deb. Stk.	80—84	5 7 0	Jan, July	..
3	1/2½	London Electric Supply Ord.	1 3/16—1 11/16	3 1 6	Mar, Sept	..
5	3/0	Do. 6 per Cent. Pref.	4⅝—5⅛	5 17 0	Mar, Sept	5
St.	4%	Do. 4 per Cent. 1st Mort. Deb	91—94	4 5 0	Jan, July	92½
5	3/0	†Metropolitan Electric Sup. Ord.	3 13/16—4 7/16	5 12 9	April, Oct	4
5	2/3	Do. 4½ per Cent. Cum. Pref.	4⅜—4⅞	4 17 6	Jan, July	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	101—104	4 6 6	June, Dec	..
St.	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	86—89	3 18 6	Jan, July	..
..	4½%	Midland Elec. Corp. for Power Dist. 4½ 1st Mort. Debs.	97—99	4 11 0	..	..
5	1/6	Newcastle Elec. Supply Ord.	4—4½	4 9 0	Feb, Aug	..
5	5%	Do. 5 per Cent. non Cum. Pref.	4⅜—4⅞	5 2 6	Feb, Aug	..
100	4½%	Do. 4½ per Cent. 1st Mort. Deb.	98—100	4 10 0	Jan, July	..
100	5%	North Metro. Elec. Power Sup. 5 Morts.	97½—99½	5 0 6	..	..
1	6%	Northampton Elec. Lt. & P. Ord.	1 7/32—1 9/32	4 13 9	Feb, Aug	..
1	5%	Do. 5% Pref.	1 3/32—1 5/32	4 6 0	Feb, Aug	..
St.	4%	Do. 4% Debs.	99—101	3 19 0	June, Dec	..
10	10/0	Notting Hill Electric Ord.	12—12½	5 17 6	March	..
5	4/3	Oxford Electric Ord.	6—6½	5 11 6	March	6¼
St.	4%	Do. 4% Deb. Stk.	93—96	..	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	8½—9	5 11 0	Feb, Aug	..
5	3/6	Do. 7 per Cent. Pref.	6¾—7¼	4 16 6	Feb, Aug	–
St.	3½%	Do 3½ per Cent. Deb. Stock (red.)	85—88	3 19 6	Jan, July	..
5	..	Smithfield Markets Electric Sup. Ord.	1⅜—1⅞	..	Feb.	..
5	4/0	†South London Electric Supply Ord.	2 13/16—3 5/16	6 5 6	April	..
St.	5%	Do 5% 1st Mort. Stock (red.)	101—104	4 16 0	..	..
1	..	South Metrop'n Elec. Lt. & Power Ord.	5/16—⅜	..	..	..
1	0/8¾	Do. 7 per Cent. Cum. Pref.	1 1/16—1 3/16	5 18 0	Feb, Aug	..
St.	4½%	†Do. 4½ 1st Deb. Stock (red.)	95—98	4 11 6	April, Oct	..
5	1/3	†Urban Electric Supply Ord.	¼—¾	..	April, Oct	..
5	1/3	†Do. 5 per Cent. Cum. Pref.	2—2½	7 10 0	April, Oct	..
St.	4½%	†Do. 4½ per Cent. 1st Mort. Deb.	85—87	5 3 6	April, Oct	.
5	5/0	Westminster Elec. Sup. Ord.	7⅞—8⅜	5 19 6	Mar, Sept	7
5	2/3	Do. 4½ per Cent. Cum. Pref.	5—5½	4 3 6	Jan, July	5
		Electric Railways and Tramways.				
1	..	Bath Elec. Trams Pref. Ord.	½—9/16	..	April	.
1	0/6	Do. 5 per Cent. Cum. Pref.	½—¾	6 13 6	Jan, July	.
St.	4½%	†Do. 4½ 1st Mort. Deb. Stock (red.)	79—83	5 8 6	April, Oct	.
St.	4½%	B'ham & Midland Trams 4½ 1st Deb. Stock.	91—94	4 16 0	Jan, July	.
10	4%	Bristol Tramways & Carriage Ord.	7¼—7¾	5 3 0	Feb, Aug	.
10	4%	Do Cum. Pref.	7¾—8¼	4 17 0	..	.
St.	4%	Do. 4 per Cent. Debs.	101—102	3 18 3	Feb, Aug	.
10	..	British Electric Traction Ord.	1 13/16—2 1/16	..	June, Dec	
10	..	Do. 6 per Cent. Cum. Pref.	4⅝—5⅛	..	Feb, Aug	5
St.	5%	†Do. 5 per Cent. Perpetual Debs.	91—98	5 2 0	April, Oct	9
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	79—84	5 6 3	May, Nov	7
St.	3%	Central London Ordinary Stock	72—74	4 1 3	Feb, Aug	7
St.	4%	Do. 4 per Cent. Pref. Stock	88—90	4 9 0	Feb, Aug	9
St.	2%	Do. Deferred Stock	58—60	3 6 6	Feb.	5
100	4%	Do. 4 per Cent. Debs.	102—104	3 17 0	Jan, July	.
5	2/6	City of Birmingham Trams, 5% Cum. Pref.	4¾—5	5 0 0	April, Oct	.
100	4%	Do 4 per Cent. 1st Mort. Debs	99—103	3 17 9	April, Oct	.
St.	1¼%	City & South London Rly. Con. Ord.	33½—34½	4 6 0	Feb, Aug	
St.	5%	Do. 5 per cent. Perp. Pref. (1891)	108—110	4 11 0	Feb, Aug	1…
St.	5%	Do. (1896)	104—106	4 12 6	Feb, Aug	
St.	5%	Do. (1901)	98—101	4 19 0	Feb, Aug	
St.	5%	Do. (1903)	99—102	4 18 0	Feb, Aug	
St.	4%	Do. 4 per Cent. Perpetual Debs.	101—103	3 17 9	May, Nov	1…
10	6/0	Dublin United Trams. 6 per Cent. Pref.	12½—13½	4 10 6	Feb, Aug	
10	12/0	Gateshead and District Trams Ord.	8½—9½	6 10 0	..	
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	1¼—1½	..	Feb, Aug	
5	..	Hastings & District Elec. Trams, 6% C. P.	1⅜—1⅞	..	Mar. Sept	
St.	4½%	†Do. 4½ Deb. Stock	73—78	5 14 6	April, Oct	
10	..	Imperial Tramways Ord.	3—3½	..	Mar, Sept	
10	..	‡Do. 6 per Cent. Pref.	4¼—4¾	..	Mar, Sept	
St.	4½%	Do. 4½ per Cent. Debs.	70—72	6 5 0	Jan, July	
..	2/0	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	2—2½	5 5 0	Mar, Sept.	
St.	4%	Do. 4 per Cent. Deb. Stock	79—84	4 15 0	Jan, July	
10	6/0	Lanarkshire Tramways	9½—10½	5 12 3	Feb, Aug	
St.	5%	Lancs Utd. Trams, 5% Prior Lien Deb. Stk.	82—84	5 19 0	Jan. July	
St.	4%	London Electric 4% Deb. St.	97—99	4 1 0	..	
St.	4%	Do. 4% Pref.	82—84	4 15 3	..	
10	..	London United Trams, 5% Cum. Pref.	2¾—3¼	..	Jan, July	
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	74—77	5 3 6	Jan, July	
St.	..	Mersey Con. Ord. Stock	6—8	..	Feb, Aug	
1	1/0	Metropolitan Elec. Tramways Ord.	⅞—1	5 10 0	..	
1	..	Do. Deferred	[illegible]	..	April	
1	0/6	Do. 5 per Cent. Cum. Pref.	13/16—15/16	5 7 0	Feb, Aug	
St.	4½%	Do. 4½ per Cent. Deb. Stock	102½—104½	4 6 0	Jan, July	
St.	5%	†Do 5 per Cent. Db. Stk	99½—101½	4 18 6	..	
St.	1½%	Metropolitan Railway Consolidated	54¼—55¼	2 9 9	Feb, Aug	
St.	2½%	Do. Surplus Lands Stocks	66—68	4 1 0	Feb, Aug	
St.	3½%	Do. 3½ per Cent. Preference	90—92	3 16 0	Feb, Aug	
St.	3½%	Do. 3½ per Cent. "A" Preference	89—91	3 17 0	Feb, Aug	
St.	3½%	Do. 3½ per Cent. Convertible Pref.	89—91	3 17 0	Feb, Aug	
St.	3½%	Do. 3½ per Cent. Debenture Stock	93—95	3 13 6	!	

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...LECTRICAL COMPANIES' SHARE LIST.—*Continued.*

NAME.	Price Tues., April 11.	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business 6 Days to April 11. Highest.	Lowest.
...Railways and Tramways—*Continued.*					
...v. 3½ per Cent. "A" Deb. Stock..	92 —94	3 14 6	Jan, July	93¼	..
...litan District Railway Ord......	31½—32¼	..	Feb, Aug	32⅝	31¼
...½% First Pref.	88 —90	5 0 0	Feb, Aug	89¼	89
...ssented Ext. Pref. (Int. Guar. by Elec. Rlys. Co. of London, Ltd.)	74 —76	4 12 0	Feb, Aug	75½	74½
...per Cent. Consoltd. Rent-charge	76 —78	3 13 0	Jan, July	..	..
...per Cent. Midland Rent-charge	103 —105	3 16 0	Jan, July	..	..
...per Cent. Perp. Deb. Stock......	148 —150	4 0 0	Jan, July	149¾	149
...per Cent. Ditto..............	97 —99	4 1 6	Jan, July	98	..
...Electric Traction Ord.	[illegible]	..	April, Oct	—	..
...per Cent. Cum. Pref............	[illegible]	7 5 0	Feb, Aug	[illegible]	..
...per Cent, Deb. Stock..........	87 —90	5 0 0	May, Nov	..	..
...lec. Trams. & Ltg. 6% Cm. Pref.	[illegible]	..	..	—	..
...per Cent. Deb. Stock..........	75 —80	5 0 0	Jan, July	..	..
...d Dist. Elec. Trms. 5% 1stMtDb.	..	8 4 0	Jan, July	..	..
...Rys.Lon.6% In. bds with coup 7	56 —58	2 11 6	June, Dec	57	56½
... Prior Lien Bonds............	102 —103	4 17 0	..	102¾	..
...% Bonds with coup. 7	98 —100	4 10 0	..	99	98½
...per Cent. 1st Power Ho. Dbs. ..	99 —101	3 19 3	..	..	..
...(W.R.) Elec. Trams. Ord.......	[illegible]	..	March ..	..	..
...per Cent. Cum. Pref...........	2⅜—2⅞	..	..	..	..
...per Cent. 1st Debs............	81 —84	5 7 0	Jan, July	..	..
...ic Manufacturing, &c.					
...ble Co. 4½ % Deb. Stock	99 —101	4 9 0	—	..	..
...tricity Meter Ord............	[illegible]	..	..	..	—
...Cum. Pf.	[illegible]	7 4 0	April, Oct	..	..
...Wilcox Ord...................	5 11/16—5 13/16	4 7 9	April, Oct	5 27/32	5¾
....	1⅛—1¼	4 0 0	..	..	..
...ulated & Helsby Cables Ord...	6¾—7¼	6 18 0	July, Feb	5 1/32	..
...r Cent. Pref.................	5¾—6¼	4 16 0	Jan, July	..	—
...er Cent. 1st Mort. Deb. (rcd.)..	101 —103	4 7 6	Jan, July	..	..
...ms'n-Houst'n 4½% 1st Mt.Db.	96 —99	4 11 0	Mar, Sept	—	..
...tinghouse 6 per Cent. Pref.....	5/16—7/16	..	Feb, Aug	..	..
...r Cent. Prior Lien Dbs. (rd.)..	99 —102	5 18 0	..	..	..
...Cent. Mort. Deb. Stock......	59 —62	6 9 0	Jan, July	..	—
...Co. 4½% Perp. 1st Deb.Stock	58 —63	7 3 0	Mar, Sept	..	..
...etual 2nd Deb. Stock.........	40 —45	10 0 0	Jan, July	..	..
...Cable Con. Ord..............	9⅛—9⅞	7 12 0	Jan, July	9⅛	..
...Cent. Cum. Pref.............	4¾—5¼	4 17 6	Jan, July	—	..
...r Cent. 1st Mort Debs. (red.)..	102 —104	4 6 6	Nov, May	..	..
...ner Alkali Co................	3 3/16—3 5/16	5 6 6	May, Nov	3 9/32	3 7/32
...r Cent. 1st Mort. Deb. (red.)..	103 —106	4 3 6	Feb. Aug	..	..
...(Ship) Telegraph Ord.	1 1/16—1 3/16	5 19 0	March ..	..	..
...Electrical Co...............	[illegible]	10 0 0	August ..	—	..
...Signal Co...................	11/16—13/16	5 7 0	April, Oct	..	..
...cent. Cum. Pref.	15/16—1	6 0 0	April, Oct	..	..
...Co (Nos. 1 to 85,000)	[illegible]	..	Jan, July	..	..
...Cent. 1st Mort. Debs. (red.)..	70 —80	6 5 0	Jan, July	..	..
...mins	⅞—1⅛	..	Mar, Sept	..	..
...Co. Ord.....................	⅞—1	5 0 0	Sept	..	..
...Cent. Cum. Pref.............	1 —1⅛	5 6 6	Sept	..	..
...Cent. Deb. Stock............	97 —100	4 10 0	Jan, July	..	..
...n United ("A" Sh.) (£3 pd.)	[illegible]	..	Feb, Aug	17/32	..
...id)	1⅞—2⅛	9 3 0	Feb. Aug	..	..
...ent. Mort. Deb. Stock (red.)	69 —73	5 9 9	June, Dec	..	..
...Cent. 2nd Deb. Stock......	78 —81	6 3 6	Mar, Sept	..	..
...Elec. Corp. Ord............	[illegible]	..	Jan, July	..	..
...Cent. Cum. Pref.	3 —3¼	..	May, Nov	..	—
...cent. 1st Mort. Deb. (red.)..	84 —87	5 3 3	Jan, July	..	..
...truction Co................	¾—1	..	Jan, July	..	..
...Cent. Cum. Pref............	1¾—2	7 0 0	July	[illegible]	1⅞
...ent. Perp. 1st Mort. Debs...	69 —72	5 11 0	Jan, July	..	..
...ic (1900) 5% Cum. Pref. ..	8 —8½	5 18 0	June, Dec	..	..
...ent. 1st Mort. Debs........	83 —88	4 11 0	Mar, Sept	..	..
...graph Works Ord...........	12 —12½	5 17 9	Feb, Aug	..	..
...Cent. Pref.	4 13/16—5 3/16	4 7 0	Feb, Aug	..	..
...Cent. 1st Mort. Deb. Stock	108 —110	4 2 0	Mar, Sept	..	..
...Gut. Per., &c., Works....	16¼—17	5 17 9	Feb, Aug	..	..
...ent. Cum. Pref.	10¼—10¾	4 14 0	..	10 5/16	—
...nt. Debs. (red.)	96 —98	4 1 6	April, Oct	98	..
...Construction Co.	1/16—3/16	..	April	..	..
...Vestgarth & Co., Ltd. Ord.	[illegible]	..	Nov	..	..
...nt. Cum. Pref.	[illegible]	..	May, Nov	..	..
...ent. Perp. Deb. Stock....	78 —82	5 10 0	Jan, July	..	..
...ts 6 per Cent. Cum. Pref.	4⅞—5	..	..	..	..
...truction & Maintenance..	35 —38	5 15 0	Mar, July	37¾	36½
...t. Deb. Bonds (1909)	100 —102	3 18 6	Jan, July	..	..
...Maxim, Ltd., Ord........	2¼—2 5/16	4 14 0	..	[illegible]	2¼
...t. non-Cum. Preference..	1 1/16—1 3/16	4 3 0	..	1⅛	..
...t. non-Cum. Preferred ..	111 —114	4 7 9	..	113¾	..
...t. 1st Mort. Db. Sk. (red)	102 —104	3 17 0	June, Dec	103	..
...nt. 2nd Mort. Deb. (red.)	104 —106	4 5 0	June, Dec	..	—
...t. 3rd Mort. Debs Scrip...	105 —107	4 13 6	..	..	..
...Co. 6% Cum. Pref.	13 —14	7 3 0	..	13⅜	..
...son Ord..............	¼—⅜	..	Apr, Oct	..	..
...t. Cum. Pref..........	¾—1	..	Apr, Oct	..	..
...t. 1st Mort. Debs.......	55 —65	6 3 0	May, Nov	..	—
...graphs.					
...h	6⅛—6⅜	..	June, Dec	6¾	..
...t. Debs. (red.)	97 —99	5 1 0	Jan, July	97⅜	..
....	70 —72	5 4 3	F,My,Ag,N	69⅜	..
....	115 —116	5 3 6	F,My,Ag,N	115	112½
....	27⅛—27⅜	5 8 6	F,My,Ag,N	27 5/16	26¾
...4 per Cent. Deb. Stk...	87 —89	4 10 0	Jn,Ap,Jy,O	88¼	87¾
...rd.	9½—10¼	5 17 0	Feb, Aug	..	..
...10 per Cent.	17¼—18¼	5 10 0	Feb, Aug	..	..
....	3½—4	5 0 0	April, Oct	..	..
...Cum. Pref..............	8¼—8¾	5 14 6	April, Oct	..	..
...Deb.	100 —102	4 8 0	Jan, July	..	..
...s Cable................	7⅞—8⅛	5 16 0	Ja,Ap,Jy,O	7⅞	..
...Cable 4½%Rg.Db.(rd.).	100 —102	4 8 3	June, Dec	..	..
....	136 —139	5 0 9	Ja,My,Jy,O	137¾	136
...Pref. Stock............	81 —85	4 1 6	Ja,My,Jy,O	85½	84¾
...Mort. Deb. Stk. (red.)..	102 —104	3 17 0	May, Nov	103	102¼
....	13⅜—13⅝	5 1 0	Ja, Ap,Jy,O	13⅝	13 5/16
...Deb. Stock	100 —102	3 18 3	Feb, Aug	101½	100
...% Mauritius Sub.Debs	101 —103	3 17 6	May, Nov	101½	..
...h), with Coupon 81 ..	32¼—33¼	6 0 0	Jan, July	..	..
....	58 —60	5 8 0	May, Nov	..	..
...Common	93 —96	5 4 0	Ja,Ap,Jy,O	..	..
....	78 —80	5 0 0	Ja,Ap,Jy,O	..	..
...Teleg. Co.	15/16—1 [illegible]				

Shre	Last Dividend	NAME.	Price Tues., April 11.	Rate per Cent. Yielded. £ s. d.	Dividend Due.
		Telephones.			
100	2$	†Amer. Telephn. & Telegh. Cap. St.	150 —152	5 5 3	..
St.	4%	Do. Coll. Trust $1,000 4 per Cent. Bds.	93 —95	4 4 0	Jan, July
St.	4%	Do. 4% Cons. *Bonds* 1936	111½—113½	3 10 3	..
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	100 —102	4 18 0	Mar, Sept
5	3/0	Chili Telephone	7 1/16—7 3/16	5 11 6	August ..
1	0/7⅕	Monte Video Telephone Ord............	15/16—1 1/16	5 13 0	Nov ....
1	0/6	Do. 5 per Cent. Pref.	[illegible]	5 12 0	May, Nov
St.	6%	National Co. Pref. Stock..............	104 —105	5 14 3	Feb, Aug
St.	6%	Do. Def. Stock	136 —138	4 7 0	Feb, Aug
10	6/0	Do. 6 per Cent. Cum. 1st Pref..........	10 —10½	5 11 6	Feb, Aug
10	6/0	Do. 6 per Cent. Cum. 2nd Pref..........	10½—11	5 9 0	Feb, Aug
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.....	5 5/16—5 11/16	4 6 0	Feb, Aug
St.	3½%	Do. Deb. Stock 3½ per Cent. (red.)....	99 —101	3 9 3	June, Dec
St.	4%	Do. 4 per Cent. Deb. Stock (red.)......	99 —101	3 19 3	Jan, July
..	4½%	New York Telephone Co. 30 yr. Bnds....	100½—101½	4 8 6	..
1	7⅕d.	Oriental	1⅛—1¼	4 11 6	April, Oct
1	0/7½	Do 6 per Cent. Cum. Pref.	1 1/16—1 3/16	4 11 6	April, Oct
St.	4%	Do. 4 per Cent. Red. *Deb.* Stock.......	87½—89½	4 9 6	Jan, July
St.	4½%	Telephone Co. of Egypt 4½%Db.Stk.(red.)	99 —101	4 9 0	Jan, July
5	3/0	United River Plate Ord. (1—150,000) ...	7½—7¾	5 3 0	July ....
5	4½%	Do. (150,001—190,000)................	7⅜—7⅝	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅛—5⅜	4 9 0	June, Dec
St.	4½%	Do. 4½ Deb. St. Red...................	103 —105	4 5 9	Jan, July
		Financial, Investment, &c.			
5	3/0	Elec. & Gen. Investment 6% Cum. Pref...	3⅝—3⅞	7 14 9	Jan, July
10	2/0	†Globe Telegraph & Trust	10¾—11¼	5 5 6	Sp,DcMrJu
10	3/0	†Do. 6 per Cent. Pref.	13 —13½	4 9 0	Sp,DcMrJu
10	6%	Submarine Cables Trust (Cert.)	134 —137	4 8 0	April, Oct
		Colonial and Foreign Electric Railways, Tramways, &c.			
5	2/6	Anglo-Argentine 5% Cum. 1st Pref.	5 —5¼	4 15 3	April, Oct
5	2/6	Do. 5% Cum. 2nd Pref.................	4¾—5	5 0 0	Jan, July
St.	4%	Do. 4% Deb. Stock	92 —93½	4 5 6	June, Dec
St.	4½%	Do. 4½% Deb. Stock	98 —100	4 10 0	..
St.	21 9	Do. 5% Deb' Stock	100 —102	4 18 0	..
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)....	104½—105½	4 14 6	Jan, July
5	4/0	Brisbane Electric Trams. Invest. Ord	6⅞—7⅛	5 19 3	May ....
5	2/6	Do. 5 per Cent. Cum. Pref.	4¾—5¼	4 16 6	May, Nov
St.	4½%	Do. 4½ per Cent. Db. Prov. Certs......	102 —105	4 6 0	Jan, July
St.	8%	British Columbia El..Rly. Df.Ord.	151 —155	5 3 6	Mar, Sept
St.	6%	Do. Pref. Ord. Stock	125 —128	4 13 9	May, Nov
St.	5%	Do. 5% Cum. Perp. Pref. Stock........	108 —111	4 10 0	Jan, July
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.......	102 —105	4 5 9	April, Oct
100	4½%	Do. Vancouver Power Debs.	102 —105	4 5 9	Jan, July
St.	4½%	†Do. 4½% Perp. Con. Deb. St.	100½—102½	4 2 6	..
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	99½—101½	4 18 6	Mar, Sept
St.	6%	Buenos Ayres Port & City Tram, 1st Mt. Deb. Stock	93 —98	6 2 6	Feb, Aug
5	2/6	Calcutta Tramways (1 to 137,610).........	5⅛—5⅞	4 5 0	Mar, Sept
100	2/6	Do. 5 per Cent. Cum. Pref.	4⅞—5⅛	4 17 6	Jan, July
1	4½%	Do. 4½% 1st Deb. Stock (red).........	93 —101	4 9 0	Jan, July
St.	..	Cape Electric Tram Shares	7/16—9/16	..	..
5	1/3	City of Buenos Ayres Trams Co. (1904) Sh.	5⅜—5⅝	4 5 0	F,My,A,N
St.	4%	Do 4 per Cent. Deb. Stock...........	98 —101	3 19 3	June, Dec
..	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.......	97 —100	5 0 0	May, Nov
1	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	99½—101½	4 18 6	Feb, Aug
100	5%	Hong Kong Tramways Co. 5 per Cent. 1st Mort. Debs.	78 —82	6 1 6	June, Dec
1	..	Kalgoorlie Elec. Trams Sh.	[illegible]	..	..
100	5%	Do. 5 per Cent. "A" Deb. Stock.......	91 —97	5 3 0	Jan, July
5	6%	Do. 6 per Cent. "B" Ditto	66 —70	4 5 9	Jan, July
5	0/7½	Lisbon Elec. Trams. Ord.	1 —1¼	4 16 0	July ....
100	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1¼	4 16 0	Jan, July
St.	5%	Do. 5 per Cent. Reg. Mort. Debs.	93 —102	4 18 0	Jan, July
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	96 —98	5 2 0	Jan, July
100	5%	Manaos Trams and Lt. Co. 5% Debs	92½—94½	5 6 0	..
..	5%	Manila Elec. Ry. $1,000 Gold Bonds......	99 —101	4 19 0	Feb, Aug
100	$1½	Mexico Trams Co. Com. St.	126½—127½	5 10 0	..
..	5%	Do. Gen. Con. 1st Mort. 5% Gold Bds.	95 —97	5 2 6	..
St.	6%	Do. 6% 50 yr. Mort. Bds................	101½—102½	5 17 0	—
St.	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922) (Nos. 601 to 2,000)	101 —103	4 7 6	Feb, Aug
St.	4½%	Do. do. (Nos. 1 to 4,600)	103 —106	4 5 0	..
1	0/6	Perth Elec. Trams Ord.	[illegible]	3 1 6	May ....
St.	5%	Do 1st Mt. Db. Stock	103 —105	4 16 0	Jan, July
5	3/0	Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	5 5/16—5 11/16	5 3 0	..
St.	4½%	Do. 4½% 1st Mort. Deb. Stk.	99 —102	4 8 0	..
100	$1½	Rio Janeiro Tram, Lt. & P. Co............	110½—111½	4 9 9	..
..	5%	Do. 30 yr. Gold Bnds.	101½—102½	4 17 6	..
100	5%	Do. 50 yr. Mt. Bnds	94½—95½	5 4 6	—
..	$2½	Sao Paulo Tramway, Light & Power Co. $100 Stock	169 —171	5 17 0	..
..	5%	Do. 5 per Cent. 1st Mt. $500 Db.	102½—103½	4 16 3	June, Dec
100	4½%	Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	93 —100	4 10 0	Feb, Aug
		Colonial and Foreign Electricity Supply, &c.			
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.......	5¾—6	5 0 0	Mar, Sept
10	6/0	Bombay E.S. & T. 6% Cm. Pf.............	10¾—11¼	5 5 6	..
St.	4½%	Do. 4½ per Cent. Deb. Stk. (red).......	96 —98	4 11 3	Jan, July
..	5%	Do. 5 per Cent. 2nd Mort. Deb. Stock..	97 —99	5 1 0	..
5	3/6	Calcutta Elec. Supply Ord.	6½—7	5 0 0	April, Oct
5	2/6	Do. 5% Cum. Pref	4¾—5¼	4 13 0	..
100	5%	Calgary Power Co. 5% 1st Mort. Bnds...	95 —97	5 3 0	—
100	7/2½	†Canadian Gen. Elec. Co. Com. St.........	103 —111	6 6 0	..
100	$3½	†Do. 7% Cm. Pf. Stock	119 —122	5 14 9	..
100	5%	Castner Electrolytic Alkali Co.(of U.S.A.) 1st Mort. Stl. Debs.	97 —102	4 18 0	Jan, July
500	5%	Elect Development Co. of Ontario......	81½—83½	6 0 0	..
St.	5%	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	87 —90	5 11 0	Jan, July
5	..	Indian Elec. Sup. & Trac. Co.	1 —1¼	..	..
10s	..	Kalgoorlie Elec. Power & Ltg. Ord.	[illegible]	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	[illegible]	8 0 0	April, Oct
..	5%	Kaministiquia Power Co.5% Gold Bnds...	102 —104	4 16 0	..
5	..	Madras E. S. Corp. Ord................	2¾—3¼	..	..
St.	..	Melbourne E. S. Co. 6%Cum. Pref......	36 —41	..	..
St.	5%	Do. 5% 1st Mortg Deb. Stock	93 —95	5 5 0	..
500	5%	Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	89½—90½	5 10 6	..
St.	$1	Mexican Lt. & Power Co. Com. St.	83 —90	4 9 0	..
St.	$3½	Do. 7% Cum. Pref. St.	110 —112	6 5 0	..
500	5%	Do 5% 1st Mort. Gold Bnds	[illegible]		

* Partly electrical. These comparisons are with the corresponding period last year. † Minus 3 days. ‡ Minus 2 days. ‖ Plus 3 days. ¶ Plus 2 days.

† Ex Dividend. ‡ The London Stock Exchange Committee have ... In calculating the yield allowance has been made for accrued in...

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NOTES.

Tramway Accidents.

We are pleased to notice that serious tramway accidents in this country have been much less frequent during the past year than was the case a little time ago. The accident at Highgate on Friday last, however, is a reminder that the problem of controlling a tramcar under all circumstances on steep gradients has apparently not yet been satisfactorily solved. The hill on which the accident in question occurred has previously been the scene of mishaps, and is certainly a dangerous length of track to negotiate, a steep incline terminating in a curve. As the result of a previous accident of a more serious nature, a number of posts have been erected at the foot of the hill to prevent any cars that may leave the rails from dashing into the shops opposite; on the present occasion, however, the derailed car collided with an electric standard, fortunately without such serious results as might have been anticipated, the traffic at the time being comparatively light.

In view of previous accidents at this spot we expect that the braking equipment of the cars has received particular attention, but it would seem that the precautions taken for operating the cars safely on this hill are still insufficient. As the necessity of more powerful control on steep gradients, particularly in view of the heavier cars now employed, is widely felt, it is interesting to note that the slot rails of the conduit have been successfully employed during the past year for braking purposes on a short length of track of the London County Council tramways at Highgate Hill. Cast-iron brake blocks operate against the upper and lower surfaces of the slot rails (these being strengthened for the purpose) and are hand-operated by a cam coupled to hand wheels on the front and rear platforms of the cars. The slot brake gear is raised or lowered in a special hatchway at the foot of the hill, and as the cars are provided with magnetic track and hand wheel brakes in addition, there should be little chance of a car attaining a dangerous speed. With the overhead trolley system this additional means of braking is not available, but we do not doubt that dangerous gradients will be avoided in future, certainly where the danger in the case of a car getting out of control would be increased by a sharp curve at the foot of the gradient.

High Candle-power Metal Lamps.

A NUMBER of the manufacturers of metal lamps are making announcements this week of reductions in the prices of the higher candle-power sizes of lamp. This is a development which is not altogether unexpected, and we feel sure that it will be welcomed by the industry generally. The movement must not be regarded as an attempt to cut prices, because it does not affect what may be described as the domestic pattern of lamp. After all, the electricity consumer is deriving immense benefit from the metal lamp and he can hardly expect to purchase the smaller sizes at prices proportional to the candle-power. The new

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prices introduced by lowering the initial cost of the high candle-power lamp, will enable tradesmen and central station engineers more effectively to meet the competition of the inverted gas mantle. The standardisation of fittings in which clusters of, say, 100 c.p. metal lamps can be used has encouraged the tradesman to employ this class of illuminating unit for both interior and exterior shop lighting. In this direction the gas interests are especially active, and while we shall not discuss for the moment the methods which they adopt to persuade the tradesman to fit gas lanterns or "gas arcs," we shall be content with saying that with high candle-power metal lamps at the new price the electrical contractor and central station engineer will be able to do infinitely more in this field than previously.

In the province of street lighting this development will be of enormous assistance to electricity supply authorities in the vigorous campaign which they are waging against gas. The price of the high candle-power metal lamp has, after all, an important bearing on the general cost of street lighting by electricity, and the station man who has been hitherto unable to recommend the conversion of gas lanterns or the equipment of new posts with metal lamps mainly on the score of high cost will be in a better position to proceed. We should be glad to hear from station engineers upon this point, and should welcome their opinion on the difference which the new prices will make in the furtherance of any scheme that they may have in hand. The coming winter will see the competition between gas and electricity at its keenest, and we are anxious to publish facts which will assist the station engineer and the electrical contractor in the conduct of this important campaign.

A Street Lighting Compromise.

Our readers will learn with interest that the lion and the lamb are lying down together in amity even before the advent of the millenium; in other words, without specifying which is the lion and which the lamb, the Metropolitan Electric Supply Co. and the Gas Light & Coke Co. have joined hands in tendering for the lighting of the Holborn district instead of continuing a cut-throat competition. Although some electrical engineers might prefer open antagonism to the gas industry, the compromise reached by the two competing companies in this case will doubtless be generally welcomed; the more so, since it may act as a salutary lesson to those Councils which have a weakness for playing off competing interests against one another. It must surely have come as a bombshell to the Holborn Borough Council at their meeting last week to find a joint communication and tender from the two Companies concerned, submitting a scheme for lighting the borough partly by gas and partly by electricity. Moreover, the Companies have actually dared to dictate to the Council as to certain onerous clauses of the specification. Under such circumstances it is rather surprising to find that the joint scheme is to cost the Council less than the amount of the original tender recommended by the Works Committee for acceptance; but the explanation is perhaps to be found in the fact that the Companies refuse to adopt improved burners, lamps or appliances unless the Council agree to pay the extra cost entailed by such improvements, and that the penalties mentioned in the specification will not be enforced. In the event of the Council determining to adhere to these penalties the contract price is to be increased by 10 per cent. The tender has been referred to the Works Committee for report, the Council to consider such report in committee, so that the public and the press will doubtless be deprived of much entertaining recrimination.

Reliability of Overhead Lines.

At a time when much attention is being paid to the development of transmission lines in this country it is interesting to read in a recent issue of the "Electrical World" some editorial remarks on the experience of a correspondent as set forth in an article in our American contemporary. The supply company with which the writer in question was connected purchased energy in bulk, the energy having to be transmitted over a considerable distance. Their experience seems to have been particularly unfortunate, for in one year no less than 120 interruptions of supply were recorded, totalling over 90 hours. The energy was generated by hydro-electric plant but this was not at fault, the troubles arising in practically all cases in connection with the transmission of the energy more especially as regards the failure of subsidiary apparatus and on the branch lines. A duplicate transmission line moreover, did not provide the security against failures that was anticipated, the writer describing it as a "snare and a delusion." Surges on the lines and sudden fluctuations of voltage frequently resulted in the synchronous machinery falling out of step, in addition to failures caused by storms, broken insulators and discharges over lightning arresters. The company finally found it desirable to instal a steam plant and to use the transmitted energy as a stand-by.

Our contemporary remarks that "if the solemn truth were told the records of interruptions on many transmission lines would not make pleasant reading," although "some companies by the exercise of eternal vigilance, succeed in getting through the year with remarkably clean records. Allowing for the fact that transmission distances are greater and pressures higher in the States than in this country, such a state of affairs would not be tolerated over here, particularly in view of the keen competition of other forms of power. Reliability of supply is invariably considered as of first importance by engineers in this country, and that overhead transmission lines can be made reliable is proved by the satisfactory experience of the Newcastle-on-Tyne and Yorkshire Power Companies.

Wireless Station at Wick.—It is officially announced that the wireless station at Wick is now almost completed. During the progress of the work rigid secrecy has been maintained regarding the design, machinery and equipment of the station, but it is understood that the installation is made in connection with the systematic control of the fleets operating in northern waters, and especially from the naval bases at Scapa Flow, Orkney, and the Cromarty Firth.

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Old "Ferrantians" Dinner.—This will be held on Saturday, [illegible] 29th, at the Trocadero Restaurant, London. Mr. C. P. [illegible] will be in the chair.

Railway Electrification.—A meeting of the Joint Committee of the East London Railway Co. will be held on Wednesday next, to consider the question of electrification. Reports of engineers as to cost and methods of electrification are to be discussed.

The Telephone as an Aid to Business.—According to the "Telephone Engineer" a large wholesale lumber dealer [illegible] states that during the past year he has sold about [illegible] feet of lumber, fully 1,500 of which were sold by means of long-distance telephone calls, the sales aggregating more than [illegible].

German Arc Lamp Patents.—We are informed that in the [illegible] between the Deutsche Beck-Bogenlampen-Gesellschaft of Frankfort and the Regina Elektrizitäts Gesellschaft of [illegible] it was decided, on March 27th, that the claim of the [illegible] to have patent No. 156,363 (issued to the Beck Co.) set [illegible] was disallowed. We understand that the ground of the [illegible] was on account of prior publication of the patent in [illegible].

30-ton Electric Locomotive.—"Engineering News" [illegible] 30-ton electric locomotive for heavy goods service. It [illegible] 100 H.P. 700 volt direct-current interpole motors, [illegible] fitted with forced ventilation. The equipment will [illegible] double-end multiple-unit control and combined straight [illegible] automatic air brakes. The engine is designed to handle [illegible] load of 400 tons (behind the engine) at 17½ miles per [illegible] an average gradient of 0·7 of 1 per cent.

Best Thickness for Laminations.—In a communication to "Elektrotechnische Zeitschift," Mr. E. Jasse deduces the [illegible] suitable relation between the thickness of the steel [illegible] in laminated cores and the thickness of the [illegible] separating them. The Steinmetz equation for the [illegible] is assumed, and it is found that this will be a minimum [illegible] the thickness of the sheet bears to the thickness of the [illegible] in the same ratio as four-fifths of the hysteresis loss [illegible] the eddy-current loss.

The Post Office and Telephones.—The forthcoming transfer [illegible] the telephone service to the Post Office has aroused a [illegible] criticism of that department, as may be gathered from [illegible] of THE ELECTRICIAN for the past few weeks. The [illegible] for the other side has now been put by Mr. John Lee, [illegible] Traffic Manager at the Post Office (who was, however, careful to say that he spoke unofficially), in an address [illegible] before the Liverpool Chamber of Commerce last [illegible]. Mr. Lee defended the Post Office from the charge of [illegible] tardiness, and pointed out that that department provided [illegible] a service unequalled by any other country in the world, [illegible] contributed some £4,000,000 yearly to the revenue of the [illegible]. In dealing with the trunk telephone system the [illegible] pointed out that the number of messages was now five [illegible] that it was in 1897, the year after the Post Office had [illegible] over, while the revenue per mile had increased from [illegible] 26 12s. A brief consideration of the development of [illegible] telephony showed that the Post Office were not [illegible] unenterprising as had been stated. As in the case [illegible] telegraph, the Telephone Department was now engaged [illegible] building up an organism, and every small place would have [illegible] access to the main system of working. The purpose of [illegible] was to divide England into zones, and to give pre[illegible] the same service to each place in the zone, whatever its [illegible] distance. The result would be the creation of a [illegible] whereby the period of waiting for a call was consis[illegible] based upon radial distance. American telephone offi[illegible] studying that system with a view to its adoption. [illegible] American theory was that the public preferred a prompt [illegible] to distant routes at a high charge to a slower service at a [illegible] But he was sure of this—that, wonderful though [illegible] telephone service was in America and splendidly [illegible] it was, if the Post Office attempted to establish such a system in England it would be the signal for protest by the public. The fee for a call from New York to Boston, 200 miles, was 5s., as compared with 2s. from Liverpool to London; the fee from New York to Philadelphia was 3s. for 83 miles; in England the Post Office gave communication over a distance of 100 miles for 1s. The same development was taking place in the short-distance services. Wonderful new apparatus had recently been devised, and changes of immense importance were inevitable. The department were studying the influence of these devices on tariffs, and always protecting the interests of the small consumer. In America telephone interests were seeking a way to merge all the telephone interests into one vast State-controlled organisation. Private and competitive enterprise in telephones there, as here, had reached its limit, and the public were putting forward stronger claims, while inventive genius was making apparatus obsolete at such a rate that expenditure of capital would be entailed on a scale which no private company could possibly undertake.

Train Despatching by Telephone in Canada.—The "Engineer" announces that the Canadian Pacific Railway Co. have decided still further to increase the method of train despatching by telephone over its system, and authority has been given for the equipment this year of 1,528 additional miles. This will make a total of 3,782 miles of telephone train-despatching circuits. In connection with the installation of the system, two new copper wires are erected, each weighing 200 lb. per mile, while in the stations the very best apparatus obtainable is used. On all sections where there are telephone train-despatching circuits every train, whether passenger or freight, is equipped with a telephone set and a jointed pole, by which, in case of necessity, telephonic communication with the train despatcher for the district can be established almost immediately, and, in the event of a train being "stalled" between stations, a great deal of delay in obtaining assistance is avoided. These train telephone sets are also used a great deal by goods trains at sidings where there is no regular train operator, and frequently many hours' delay to a freight train is saved.

Electric Locomotive for the Pennsylvania Railroad.—The "Electric Railway Journal" states that nine more electric locomotives, aggregating in capacity about 40,000 H.P., have been ordered by this Company. They will be of the same type as those which are now being operated in the Manhattan Terminal, New York city, and will supplement the 24 already in use. These locomotives are said to be the most powerful ever built for electric working. They are articulated machines of double cab design. Each half carries its own motor and complete equipment, and the two halves are coupled together at their driving-wheel ends. The frames, driving wheels and trucks of the running gear are similar in general character to those of the "American type" steam locomotive. The coupled ends are fitted with permanent couplings of twin drawbars and friction draught gears, so arranged that the front half serves as a leading truck and the other half as a trailer in whichever direction the locomotive may be moving. Each cab is complete with automatic and air brake equipment, apparatus for train lighting, electric headlights, pneumatically operated whistle and sanders, as well as its motor, unit switches and master controller. The machines are so arranged that if one motor is cut out the entire machine can be operated from either cab with the remaining motor. The halves are interchangeable. The unit switch field control permits two or more locomotives to be coupled together, and all to be operated from either end of any one cab, and affords flexibility of speed regulation. It gives two additional running notches and at the same time economises power consumption during acceleration. The normal full speed with a full train is 60 miles an hour, and a 550-ton train can be started on a 2 per cent. gradient by exerting the maximum contract horse-power of 4,000.

"The Present Position of Electric Traction on Main Lines in Europe."—A Paper with the above title was read by Mr. J. B. Sparks on April 12th, before the Students' Section of the Institution of Electrical Engineers. The author gave the

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main conclusions of the various Government Commissions appointed to consider the introduction of electric traction on main line railways, and summarised the present position in Europe as detailed briefly in the following abstract. In Germany, the Prussian authorities have adopted the single-phase system at 10,000 volts, 15 cycles, and a large sum of money has been granted for the equipment of some 95 miles of double track between Magdeburg, Leipsic and Halle. A 16-mile section of this line has already been equipped and several different types of locomotives are undergoing trials. Some 180 miles of line in Silesia will also shortly be equipped on the same system. The State Railway authorities of Bavaria and Baden respectively have also adopted the single-phase system at 10,000 volts, 15 cycles; and short main line sections between Salzburg and Freilassing, in Bavaria, and between Basle and Zell, in Baden, are already being equipped. Plans have also been prepared by both States for the conversion of a large number of other lines. The Austrian State Railways will shortly have 29 miles of line near Trieste working on the single-phase system at 10,000 volts, 15 cycles, and plans have been prepared for a large number of main lines south of the Danube. The Austrian South Railway Co. intend to introduce three-phase traction on certain of their lines, and the same system may be employed for some of the State railways. A new main line, to be worked on the single-phase system at 10,000 volts, 15 cycles, is being constructed in the north-east of Austria to provide an additional connection between the railway systems of Bavaria and Austria. The Hungarian State railways will shortly have an important suburban system at Budapest, working electrically at 10,000 volts, 15 cycles, single-phase, and a portion of the main line between Prague and Vienna is also to be equipped shortly. Plans are also ready for a 56-mile section of the important line between Fiume and Budapest. The Swiss Federal Railways have decided to adopt the single-phase system at 15,000 volts, 15 cycles, and the St. Gothard Railway will probably be the first to be equipped. A short section of the Loetschberg Tunnel line, now under construction, is already working electrically on this system. The equipment of the Simplon line, which is worked at 3,000 volts, 16 cycles, three-phase, is to be extended at the Italian end of the line. The conversion of the 12-mile Giovi Tunnel line to 3,000 volts, 16 cycles, is practically completed, as is also the Mont Cenis Tunnel line. A number of other main line sections are shortly to be converted, but not necessarily on the three-phase system. The French State railway authorities are considering the introduction of electric traction on lines near Paris, and will assist in the conversion of the belt line just inside the fortifications. The Chemins de Fer du Midi have adopted single-phase at 12,000 volts, 16 cycles, and are already equipping a 70-mile main line section between Pau and Montrejeau, while it is probable that the whole 250 miles of line between Toulouse and Bayonne will be working electrically in a few years. The P.L.M. Co. are making experiments on an electrically equipped track at Grasse, and have in view the conversion of the main line section between Cannes and Ventimiglia. The Swedish State Railway authorities have also adopted the single-phase system at 15,000 volts, 15 cycles, and an 80-mile line in the North is being equipped. Plans have also been prepared for the conversion of the whole system of lines south of Stockholm, and the necessary water power has been secured. In Norway, a 30-mile line is being converted to single-phase working at 10,000 volts, 16 cycles. The author also referred to the proposed conversion of railways in Denmark, Russia and elsewhere, and concluded with some notes on the possibility of the introduction of electric traction upon the main lines of this country.

Cable Interruptions.	Date of Interruption.
Assab—Perim	July 8, 1909
Malta—Tripoli	April 20, 1910
Latakia—Palura	May 26, 1910
Tourane - Amoy	Sept 25, 1910
Port de France—Paramaribo	April 10, 1911
Bonny—Duala	April 16, 1911
Zanzibar—Mombasa	April 19, 1911

Current Topics.

Subjects of current interest dealt with in this issue include the following:—

Mr. G. F. C. Searle concludes his article entitled "On Resistances with Current and Potential Terminals."

We publish an article summarising the methods of protecting high-tension systems.

The Tramways and Light Railways Association have issued a report on "Speed Indicators for Tramcars." This subject is discussed in our Leading Article.

At a recent meeting of the Royal Photographic Society Messrs. J. S. Dow and V. H. Mackinney read a Paper on "Photography and the Measurement of Brightness."

We give an account of the discussion on Mr. W. B. Woodhouse's Paper on "Public Electric Supply in Country Districts."

The Tramways Committee of Manchester Corporation were able to report a satisfactory increase of income over the amount of the original estimate for 1910. £75,000 is again to be contributed to the rates from this source.

Manchester Electricity Committee have decided to hand over £19,496 (1 per cent. on the capital outlay) in relief of rates.

An interesting contract between Stockton-on-Tees Corporation and Messrs. Head, Wrightson & Co. is reported.

A list is issued of the successful candidates at the recent examination for 1st class certificates of the Association of Mining Electrical Engineers. We have received no official intimation of this examination or its result, and publish the list subject to confirmation.

The extraordinary position taken up by the Aldershot Gas Co. in regard to preferential treatment of non-users of electrical energy is recorded elsewhere.

A good demonstration of the utility of electric driving in emergencies was afforded last week at Messrs. Rennie & Co.'s mills at Stanningley. The works were rendered idle by the failure of a steam engine on Wednesday, and within 24 hours the Yorkshire Electric Power Co.'s supply was connected and the first motor set to work.

Haslingden Council propose, on the expiration of their agreement with Accrington Corporation, to supply current to their tramways from their own distributing station, for which purpose they are seeking powers to borrow £8,750.

At the meeting of Holborn (London) Council last week it was reported that a joint tender for public lighting had been received from the Metropolitan Electric Supply Co. and the Gas Light & Coke Co. After discussion, the matter was referred to the Works Committee for report to the Council in committee.

Beckenham Council have received sanction to a loan of £5,000 for free wiring, &c. An interesting return as to the number of houses wired has been made to the Council.

On the subject of the proposed Telephone Authority, the Postmaster-General (Mr. H. Samuel) made a statement at a dinner at Cardiff on Monday.

Legal.—Mr. Pollock, Official Referee, has given judgment in the action brought by Mr. H. Cruse and others against Messrs. Willans & Robinson for damages for alleged breach of contract in regard to the manufacture of superheaters, and has awarded plaintiffs £3,535 damages, with costs.

Companies' Meetings and Reports.—At the meeting of the Anglo-Argentine Tramways Co. last week the chairman gave an interesting account of the development of the tramway system of the Company and supplied some particulars of the scheme for the construction of subways in Buenos Ayres.

The directors' report of the Deutsch-Atlantische Telegraphen gesellschaft for 1910 is abstracted in another column.

The directors' report of the San Paulo Electric Tramways, Light & Power Co. gives particulars of the electric lighting and tramway undertakings of the Company.

At the recent meeting of Clayton & Shuttleworth, the chairman Col. F. Shuttleworth, said the directors had adopted electric driving throughout the works, and had secured advantageous terms from Lincoln Corporation for the supply of electrical energy.

PERSONAL NOTES.

It is officially announced that Mr. J. W. Meares, electrical adviser to the Government of India, is granted 7½ months combined leave from March 23, or any subsequent date, and Mr. R. J. Browne, electrical inspector to the Government of Bengal and Eastern Bengal an

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Assam has been appointed to officiate as electrical adviser to the Government of India during Mr. Meares' absence, or until further orders.

New Zealand Government intend to carry out large telephone construction works, and Mr. T. Buckley, chief electrician of the Post and Telegraph Department, will visit England to investigate the latest types of telephone equipment and installations.

APPOINTMENTS VACANT AND FILLED.

An electrician is required to take charge of an electric lighting installation and control of three assistants at a North of England textile factory. See an advertisement.

A young electrical engineer, with thorough college and shop training and some knowledge of the requirements of collieries and iron and steel works, is required for the mining department of a large Continental electricity works. See advertisement.

Two or three draughtsmen are wanted by a large electrical firm. See an advertisement.

The Electrical Power Storage Co., 4, Great Winchester-street, London, E.C., require a qualified sales manager. Applicants must have had experience of storage batteries, and possess a good connection. See an advertisement.

A thoroughly reliable estimator is required in a leading firm of manufacturing electrical engineers in the Midlands.

An assistant master is required to assist in teaching mathematics and science (physics and chemistry) at the South African College School, Cape Town. Salary £250 per annum. Applications to the Secretary by May 3.

A lecturer in applied mathematics is required for the Grey University College, Bloemfontein. Salary £400 per annum. Applications to the High Commissioner for South Africa, 72, Victoria-street, London, S.W., by May 19.

The Wrexham Local Higher Education Committee require a director of the technical schools. Salary £220, rising to £250 per annum. Applications to the Clerk to the Governors by May 16.

Mr. Alfred Bremner, M.I.E.E. (late of Burslem), has been appointed assistant electrical engineer of the Walsall Corporation electricity works. Mr. Bremner will act as borough electrical engineer during the absence of Mr. A. S. Barnard, who has six months' sick leave.

Mr. J. Cotton, B.Sc., has been appointed assistant lecturer in mechanical electrical engineering for the remainder of the present session at the Technical College, Huddersfield.

Mr. J. F. Tivey, of Sydney University, has been appointed assistant lecturer and demonstrator in engineering at Queensland University.

Mr. A. Goodall has been promoted to the position of chief assistant electrical engineer at Devonport electricity works, in succession to Mr. Stamp, who recently left for Canada.

INSTITUTIONS AND SOCIETIES.

Royal Institution.—The arrangements at this institution for the remainder of the session include the following courses: On Thursday, April 27th, Prof. R. W. Wood, of the Johns Hopkins University, will begin a course of three lectures on "The Optical Properties of Metallic Vapours," these being the Tyndall Lectures. The Friday evening course on April 28th will be delivered by Prof. W. M. Flinders Petrie, F.R.S., on "The Revolutions of Civilisation"; on May 5th by Prof. M. O. Forster, F.R.S., on "New Organic Compounds of Nitrogen"; and on May 12th by Prof. William Stirling, on "Physiology and the Cinematograph."

Physical Society.—ERRATUM.—We have been asked to state that the meeting of this Society on March 24th was held at the City and Guilds (Engineering) College. This is not clear from the account in our issue, as reference is only made to the Imperial College of Science.

Faraday Society.—At the meeting of the Faraday Society to be held on Tuesday, May 2nd next, Mr. A. Scott-Hansen, the well-known American engineer, will deliver a lantern lecture on "Hydro-electric Plants in Norway, and their Application to Electrochemical Industries." On the same evening a Paper is down for reading by Mr. Walter Cutts, of Sheffield, entitled, "Electrometallurgy in the Sheffield District." The Society meets at the Institution of Electrical Engineers, Victoria Embankment, W.C., and the secretary, Mr. Alfred Gradidge, 62, Victoria-street, S.W., will be glad to send cards of admission to anyone interested desirous of attending the meeting.

Glasgow Section of the Institution of Electrical Engineers.—At the meeting of the above Section on Tuesday, April 11th, the following council were nominated for the session 1911-12: *Chairman*, Mr. F. A. Newington; *vice-Chairman*, Mr. Jas. Lawson; *hon. sec.*, Mr. Jas. E. Sayers; *Committee*, Messrs. Wm. McWhirter, T. B. Murray, T. C. Parsons, Jas. Ferguson, D. A. Starr, Lee Murray, J. A. Robertson, Prof. Magnus McLean and Dr. Jas. T. Bottomley, F.R.S. The chairman intimated that the Council of the Institution had acquiesced in the Local Section's request that the Section in future be known as the "Scottish Local Section."

EDUCATIONAL NOTICE.

Crystal Palace School of Practical Engineering.—The usual term distribution of certificates to the students of this school took place on Wednesday, April 12th, when the Right Hon. Sir George Reid, High Commissioner for Australia, presided and addressed the students.

The "Wilson" premium for the best Paper read before the Engineering Society (affiliated to the Society of Engineers) during the session has been awarded to J. F. Ormsby, for his Paper on "Liquid Air." Other Papers read during the session were: "Locomotive Superheaters," by F. E. Wright: "Roads," by C. M. H. Sheridan; "Tube Railways," by G. H. Henfrey; and "Sanitation," by A. Zammar.

ARRANGEMENTS FOR THE WEEK.

SATURDAY, April 22nd.

NEWCASTLE BRANCH OF THE ASSOCIATION OF MINING ELECTRICAL ENGINEERS.

2 p.m. Visit to the Electrical Installation at Chopwell Colliery.

MONDAY, April 24th.

ILLUMINATING ENGINEERING SOCIETY.

8 p.m. Meeting at the Royal Society of Arts, John-street, Adelphi. Papers on "The Ratio of Light to Illumination," by Mr. Haydn T. Harrison, and "Some Notes on the Effect of Wall Papers upon the Illumination of Interiors," by Mr. P. J. Waldram.

TUESDAY, April 25th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Meeting at Great George-street, Westminster. Annual General Meeting.

NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION.

8 p.m. Meeting at the Institution of Electrical Engineers, Victoria Embankment, W.C. Paper on "Foreign Compared with Home Industrial Finance," by Mr. L. Joseph.

WEDNESDAY, April 26th.

ELECTRICAL TRADES BENEVOLENT INSTITUTION.

7 p.m. for 7:30 p.m. Festival Dinner at the Hotel Cecil, London.

STUDENTS' SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

7:45 p.m. Meeting at Victoria Embankment. Paper on "Single Phase Commutator Motors, especially the Latour-Winter-Eichberg Motor," by Messrs. H. Page and C. J. Scott.

BIRMINGHAM SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Meeting at the University, Edmund-street, Birmingham. Paper on "Battery Economies and Battery Discharge Arrangements," by Mr. A. M. Taylor.

THURSDAY, April 27th.

ROYAL INSTITUTION.

3 p.m. Meeting at Albemarle-street. Lecture on "Optical Properties of Metallic Vapours," by Prof. R. W. Wood. Tyndall Lecture I.

INSTITUTION OF MECHANICAL ENGINEERS.

7 p.m. for 7:15 p.m. Anniversary Dinner at the Hotel Cecil, London.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Meeting at Victoria Embankment. Paper on "Battery Economies and Discharge Arrangements," by Mr. A. M. Taylor.

FRIDAY, April 28th.

PHYSICAL SOCIETY OF LONDON.

5 p.m. Meeting at the Imperial College of Science, Imperial Institute-road, South Kensington. Agenda: "High-Tension Electrostatic Wattmeters," by Prof. E. Wilson; "Previous Magnetic History as Affected by Temperature," by Prof. E. Wilson and Mr. L. C. Budd; "Note on the Behaviour of Incandescent Lime Cathodes," by Dr. R. S. Willows and Mr. T. Picton; "On the Formation of Dust Striations by an Electric Spark," by Dr. S. Marsh and Mr. W. H. Nottage.

STUDENTS' SECTION OF THE INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Meeting at Great George-street, Westminster. Lecture on "The Commercial and Technical Relations of Engineering Design and Work," by Mr. T. Frame Thomson.

ROYAL INSTITUTION.

9 p.m. Meeting at Albemarle-street. Discourse on "The Revolutions of Civilisation," by Prof. W. M. Flinders Petrie, F.R.S.

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HIGH-TENSION CABLES.*

BY DR. PAUL HUMANN.

Ten years ago a voltage of 10,000 was considered as the outside limit for which a cable could be constructed for everyday work, and even so at this pressure there had been some unpleasant experiences of a costly nature. Lately, however, cables for a working pressure of 20,000 volts have been put in operation without any very noteworthy difficulties, and enquiries are occasionally made for cables to be used on 40,000 and even 60,000 volts. Very little, comparatively speaking, seems to have been published on the subject of the construction of cables for lighting and power work; and it may therefore be of interest to give some outlines relating to the dimensions of high-tension cables.

The purchase of a high-tension cable is a matter full of uncertainties, and this obviously ought not to be the case. For instance, if enquiries were to be made of a number of manufacturers for cables, suitable for a working pressure of 30,000 volts, the prospective buyer would make the curious discovery that some makers increase the thickness of the insulation with an increase in the diameter of the conductor, while others do the reverse. In 1908 Dr. Apt showed, as a corollary to O'Gorman's theory, that the thickness of the insulation should decrease as the diameter of the conductor increases. Considering the matter theoretically, let us take first the simple case of a cable with a single conductor and with an insulation of a uniform nature, such as is approximately the case with those constructed of impregnated paper. The insulation can then be considered to consist of a series of concentric layers of very small thickness; each layer, therefore, constitutes a condenser, a large number of which are therefore placed in series with one another. The capacity of the layer at a distance x from the centre and of a thickness dx is given by the equation

$$C_x = \frac{c \cdot L \cdot 2 \cdot \pi \cdot x}{4 \cdot \pi \cdot dx} = \frac{c \cdot L \cdot x}{2 \cdot dx},$$

where c is the dielectric constant, and L is the length of the cable. The capacity of the cable between the conductor and lead covering is, therefore,

$$C = \frac{c \cdot L}{2 \log \frac{R}{r}},$$

where R and r are the external and internal radii of the insulation. If we denote the voltage between the conductor and lead covering by E, and remember that the voltage across a layer is inversely proportional to the capacity, we get the following relations, viz.:—

$$\frac{dE}{E} = \frac{\frac{c \cdot L}{2 \log \frac{R}{r}}}{\frac{c \cdot L \cdot x}{2 \cdot dx}} = \frac{dx}{x \log \frac{R}{r}},$$

$$\frac{dE}{dx} = \frac{E}{x \log \frac{R}{r}} = \frac{E}{2{\cdot}3 \cdot x \log_{10} \frac{R}{r}}.$$

The value of $\frac{dE}{dx}$ gives the potential gradient and has a maximum value when $x = r$, and this value may be called e. The fall of voltage on the inner surface of the insulation is a factor of the first importance. If the thickness of the insulation is denoted by δ, then we can deduce from our formula the following equation, viz.:—

$$\log R = \log (r + \delta) = \frac{E}{2{\cdot}3 \cdot r \cdot e} + \log r,$$

and this enables us to determine the relation between the thickness of the insulation and the diameter of the conductor. It must be emphasised that these equations apply only to a homogeneous dielectric, and this is not necessarily the case with a cable the insulation of which has been submitted to a series of impregnations, and cases also arise where designedly a differential treatment has been adopted. Let ϵ denote the ratio between the working voltage E and the specific tension across the innermost layer, or expressing all quantities in millimetres, the ratio of E to e. Then the last equation becomes

$$\log (r + \delta) = \frac{\epsilon}{2{\cdot}3 \cdot r} + \log r,$$

and from this it is easy to calculate the thickness of the insulation δ and the overall diameter of the cable, *i.e.*, the internal diameter of the lead covering. Taking the value of e as 2,000, we can calculate the values of δ for working voltages of 10,000, 20,000 and 40,000 and for different values of the diameter of the conductor. The following table gives the resulting figures:—

* Abstract of an article in the "Elektrotechnische Zeitschrift."

Table I.

r in mm.	Thickness of insulation in mm.			Overall diameter of cable in mm.		
	$\epsilon = 5.$	$\epsilon = 10.$	$\epsilon = 20.$	$\epsilon = 5.$	$\epsilon = 10.$	$\epsilon = 20.$
1	148·0	22,400	$500 \cdot 10^6$	298·0	44,800	$1{,}000 \cdot 10^6$
3	12·9	81·5	2380·0	31·8	169·0	4,766·0
5	8·6	32·1	270·0	27·2	74·2	550 0
7	7·3	22·3	116·0	28·6	58·6	246·0
9	6·7	18·3	74·2	31·4	54·6	166·4
11	6·3	16·3	56·8	34·6	54·6	135·6
13	6·1	15·1	47·6	38·2	55·2	121·2
15	5·9	14·3	42·0	41·9	58·6	114·0
20	5·7	13·0	34·5	56·4	66·0	109·0
25	5·6	12·3	30·7	61·2	74·6	111·4
30	5·5	11·8	28·5	71 0	83·6	117 0
40	5·4	11·4	26·0	90·8	102·8	133·0

From this we see that under all circumstances, the radial thickness of the insulation decreases as the diameter of the conductor increases, the value of δ tending to approach the value of ϵ. Very small diameters of conductor are impossible with very high tensions. With low-voltage cables there is something to be said on mechanical grounds for increasing the thickness of the insulation on the bigger cables; but if several millimetres are necessary in any case on electrical grounds, mechanical considerations are of no importance. For each value of ϵ there corresponds a radius, r, which gives a minimum overall diameter to the cable, and if the values are plotted out on curves it will be found that when r is equal to ϵ the cable will have a minimum size. The same result is, of course, obtained by differentiating the last equation given above, and equating the differential quotient to zero. This does not necessarily mean that the said cable can be made for the lowest price, and probably one with a

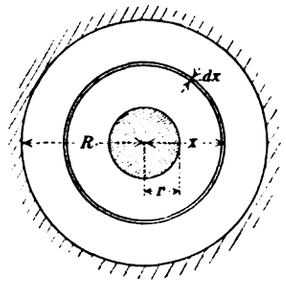

FIG. 1.

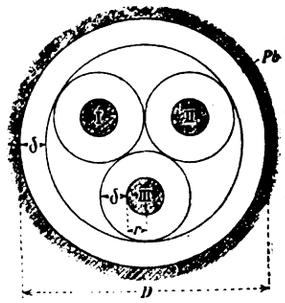

FIG. 2.

slightly smaller diameter would be better in this respect. For very high voltages the smallest overall diameter may correspond to a conductor much bigger than is actually required. In such cases the conductor can be made hollow by winding the strands of copper round a core of hemp, or aluminium may be employed, which has 1·7 times the specific resistance of copper.

The foregoing argument applies only to single cables, and for three-core cables, used with polyphase current, things are undoubtedly more complicated. In order to determine the equipotential surface in the dielectric, an elaborate theoretical investigation is necessary. Let us suppose that, as in Fig. 2, there is an equal thickness of insulation between the conductors themselves and between the conductors and the lead sheath. In this case the overall diameter under the lead is given by the equation

$$D = 4{\cdot}31 \cdot r + 6{\cdot}31 \cdot \delta.$$

The thickness δ of the insulation is given by the equation

$$\log (r + \delta) = \frac{\frac{E}{\sqrt{3}}}{2{\cdot}3 \cdot e \cdot r} + \log r,$$

where E is the line voltage and the conductors are supposed to be joined up on the star system. From the values in Table I. it is possible to draw up figures for the case of the three-core cable. The results are shown in Table II. It must be noted that here ϵ is the ratio of the voltage across the star-connected conductors to the voltage giving the specific tension on the insulating material. Therefore we have $\epsilon = \frac{E}{e\sqrt{3}}$.

If these values are inserted on a curve we see that to each value of ϵ there is a corresponding minimum overall diameter of the cable and that these minima lie on the straight line drawn through the

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Table II.

r in mm.	Overall diameter of cable. $\epsilon=5$.	$\epsilon=10$.	$\epsilon=20$.
1	938·0	141,300·0	$3,150 \cdot 10^6$
3	94·3	527·0	15,000·0
5	75·8	224·0	1,700·0
7	78·3	170·9	762·0
9	81·1	154·3	507·0
11	87·2	150·2	405·0
13	94·5	151·2	356·0
15	101·9	154·9	329·7
20	122·2	168·2	303·8
25	143·1	185·4	291·4
30	164·0	203·7	309·1
40	206·5	244·3	336·4

origin of co-ordinates. The simple relation that exists between r and ϵ is

$$r=\frac{2}{3}\epsilon \cdot \sqrt{3}=\frac{2}{3}\epsilon_1,$$

where ϵ_1 represents the ratio of E to e. The breakdown voltage of impregnated paper can be taken as 20,000 volts per millimetre, if the paper has been thoroughly dried and suitably impregnated. It should, however, be experimentally determined from short lengths of cable, and its value can then be inserted in the above formulæ. Still, a good deal depends on the nature of the surface of the conductor, on the thickness and quality of the paper and on the composition of the impregnating mass; but these factors are left out of account in the present superficial treatment of the subject.

Lately copper cores have been used that are not of a circular section; sometimes they are oval or sector-shaped, the idea being that the overall diameter of the cable is thereby reduced. Sometimes they are semicircular in shape, as in certain kinds of two-core cables. For very high voltages such methods are to be condemned, as the sharp angles have a tendency to raise the potential gradient at these points. The thickness of the insulation must, therefore, be correspondingly raised, and this makes the sector-shaped cable bigger than the round one, This has been often enough shown to be the case under test, and any deviation from the circular form is quite certain to be disadvantageous when high pressures are used. For low pressures the matter is of no importance, seeing that the factor of safety is always very high.

VOLTAGE REGULATION OF GENERATORS.*

BY H. A. LAYCOCK.

Summary.—After discussing voltage regulation generally, the author describes the method of operation and arrangement of the Tirril voltage regulator when used for alternating-current and continuous-current generators.

Various devices have been exploited with a view to obtaining voltage regulation of alternators, but most of them have been based on the principle of the automatic rheostat, which has been unsuccessful due to hunting, and also to the fact that in order for a rheostat to come into operation the voltage must first vary, and of course the moving element being slow, the voltage would vary considerably before the regulating rheostat would operate.

The alternator is a good inherent regulating machine, and is one which is designed at fairly high saturation, with a given excitation it is supposed to regulate within 8 per cent. with a constant speed. In order to obtain the best voltage regulation from an alternator without an automatic regulator the exciter is also run at a high density and is usually compound-wound so that it will either give the same voltage from no-load to full load or will be slightly over-compounded. Probably one of the best voltage-regulating machines was the inductor type alternator, which had a long magnetic path and very high density, in which the time element was six to eight times that of the present revolving-field type of generator. With a non-inductive load this alternator would probably regulate for voltage better than the revolving-field machine, but with an inductive load, which required a much broader range in excitation, the inductor alternator was not satisfactory. The reason this type of alternator was unsatisfactory in regulation was due to the fields requiring a very wide range in excitation, and with an inductive load the excitation was from two to three times that required by the revolving-field type of alternator, and with an automatic regulator, which increases the field excitation according to the variation in load, it was a difficult matter to regulate this type of generator.

* Abstract of a Paper read before the American Institute of Electrical Engineers.

In voltage regulation the exciter is also a very important factor. For example, if an exciter is designed at very high density the time element required to change the voltage from one point to another is so long that the voltage regulation may be materially affected, and, in order to have the best combination for voltage regulation, an alternator should require a range in excitation from no-load to full load (with approximately 80 per cent. power factor) of not more than one to two. The flux densities of the exciters should be fairly low, especially in the fields. The exciter should also have a time element, so that it will be responsive to changes in field excitation to the extent that the voltage will fall, by inserting an external resistance equal to about three times the resistance of the field, from 125 volts to 25 volts in from six to eight seconds. The ideal exciter designed on these lines will also readily give at full field 165 volts, and the increase in field current from 125 volts to 150 volts will not be over 50 per cent.

Before the automatic regulator was perfected the majority of exciters were designed with fairly high densities and very heavy series fields. In some cases the series field equalled 50 per cent. of the total excitation of the exciter, and with an exciter fully loaded it required a very large amount of resistance in the exciter field rheostat to vary the voltage of the exciter to any appreciable extent due to the series field supplying the large amount of excitation and holding up the voltage. In some cases where the series field excitation is about 50 per cent. of the shunt field excitation, the shunt field can be entirely broken under full-load conditions and the voltage would not fall below 60 to 70 volts on 125-volt excitation, but since the adoption of the automatic regulator these conditions have been changed until now the series field excitation does not exceed 30 per cent. of the total shunt excitation and oftentimes it is about 20 per cent., so that very good regulation is obtained by control of the shunt field rheostat.

Automatic Regulators.—The only successful automatic voltage regulator known to the author is that here described, which was

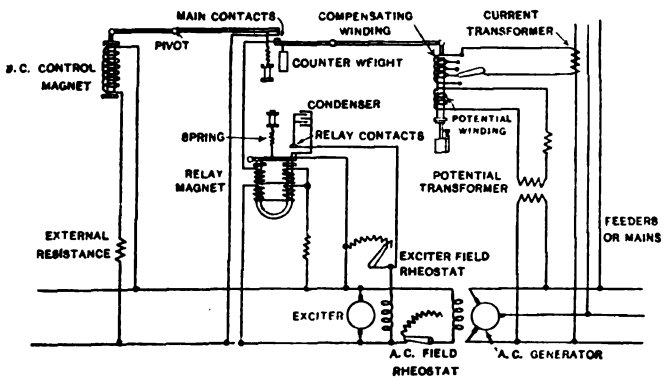

FIG. 1.—CONNECTIONS OF AUTOMATIC REGULATOR.

brought out about 10 years ago and which has been used extensively ever since. This regulator operates on the theory of floating a pair of primary contacts by connecting one coil, which is known as the direct-current control magnet, to the exciter 'bus bars, and is graduated by mounting four springs on the lever connected to this control magnet and supported by a pivot at a proper distance so that this lever operates over the 100 per cent. range in exciter voltage. These springs are so graduated as to pick up a difference of 25 per cent. in voltage; this keeps a constant pressure on the contacts. The alternating-current element of the control magnet, connected to the alternator, is also balanced practically in the same manner except that a counterweight is used instead of springs. It is pivoted in such a manner that with a given voltage—say, 110 volts—a balance is produced in which the contacts supported by the alternating-current lever and the contacts supported by the direct-current lever are at an absolute balance, and with the core of the alternating-current magnet arranged to pull in one direction and the core of the direct-current magnet arranged to pull in the opposite direction this balance is produced in such a manner that the main contacts travel less than $\frac{1}{32}$ in. to obtain a range of 100 per cent. increase in exciter voltage, and the opening at the main contacts in any condition is less than 0·01 in. In addition to the two magnets described above there are also one or more relay magnets, the latter being differentially wound, so that with both windings energised the current is neutralised and the residual is reduced to a minimum, and the operation of the relay is such that it can respond, without any time element, to changes required by the generator. The relay magnet is provided with one or more sets of contacts which are connected across the shunt circuit to the exciter field rheostat, the voltage being reduced

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first to 65 per cent. below normal, at which point the rheostat is set before the regulator is cut into service. The alternating-current control magnet is also provided with a current winding which is connected to a current transformer in some principal feeder so that the feeder can be overcompounded to take care of the drop in the copper between the central station and centre of distribution. A diagram of the small automatic regulator is shown in Fig. 1. This is a small type of voltage regulator now designed for from one to four exciters, depending upon their capacity. For exciters having larger capacity, Fig. 2 shows diagrammatically the same principle of regulation with the exception of the relay magnet, which is a magnet designed with circular type flat coils but of the differential design, of which from two to 12 sets of relay contacts are employed, depending upon the size and characteristics of the exciters. The diagram shows the connections of two exciters, one set of relay contacts being connected to one exciter, while the second exciter has its field rheostat divided up into two equal ohmic divisions having a set of contacts across each division so that the field discharge is taken up by both sets of contacts equally, and this method can be employed with the present design of voltage regulator up to 24 sets of contacts, having two sets of these relay coils in mulitple controlled by one set of main contacts.

Regulation of Transmission Lines.—The above regulators are designed either to maintain steady 'bus bar voltage or to compensate for non-inductive load through one current transformer. This arrangement does not compensate for an inductive load, and in order to accomplish this result a line drop compensator is employed. Two current transformers are cross-connected in order to deliver the

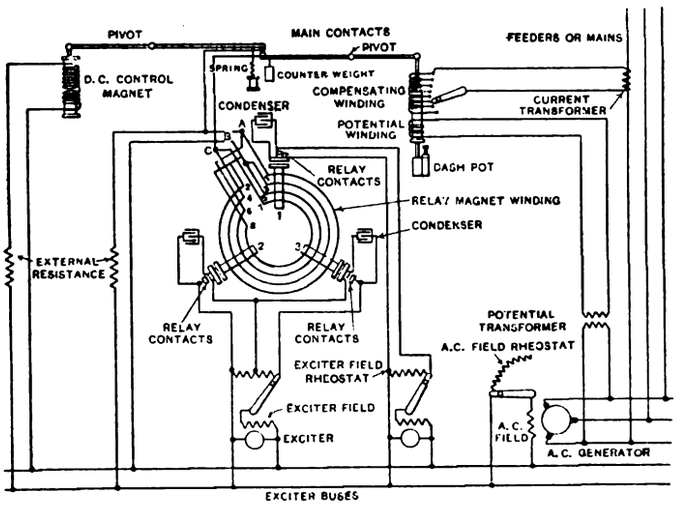

FIG. 2.—CONNECTIONS OF REGULATOR.

proper amount of current to the line drop compensator, which compensator is designed with a reactance coil and resistance coil, the resistance coil being for the non-inductive compensation, and the reactance coil being for the inductive compensation. The current coil of the regulator is omitted with this connection and the compensation is secured by the current flowing either through the reactance or resistance coil of the compensator.

On long transmission lines where a large drop in voltage is experienced from heavy inductive loads it is generally conceded that the adoption of synchronous condensers is an advantage in increasing the output of the central station, and by the application of an automatic voltage regulator with a condenser of the proper size the installation can be made in some remote place along the line where the condenser or regulator needs very little attention and the condensers can be used for automatically compensating for line drop.

The same connections as employed in the alternating-current generator are applicable to synchronous condensers.

The cycle of operation of the ordinary voltage regulator is such that when the main contacts just begin to open the shunt circuit across the exciter field rheostat is opened and the exciter field reduced to a point that without the regulator in service the voltage on the alternator would be about 65 per cent. below normal. The present type of automatic voltage regulator has been so successful because the regulator does not have to wait for the voltage to change, but is operating all the time owing to the fact that the voltage is tending to drop; but the regulator operating at a higher rate of vibration and intermittently short-circuiting and opening the shunt, circuit across the exciter field rheostat makes the time element negligible.

Installations.—As an illustration of the generator capacity for which the automatic voltage regulator is now employed the plant of the Connecticut River Power Co. is cited, in which alternating-current generators aggregating 20,000 kw. are equipped with these regulators. The two 300 kw. 125-volt exciters are driven from vertical turbines and operate in parallel on one voltage regulator. Another application is in the plant of the Ontario Power Co., which delivers 30,000 kw. and contains two 375 kw. exciters equipped with two individual regulators of the eight-relay type.

Voltage Regulation of Direct-Current Generators.—The principle of regulation of the direct-current generator is shown in Fig. 3. The voltage regulator is designed with one main control magnet which is connected permanently to the 'bus bars of the direct-current generators, and has one movable and one stationary core. These cores at a given flux are balanced by the spring, calibrated so as to float them at a certain voltage. The lever supporting the core and spring is equipped with a pair of contacts which operate a relay. For simplicity this relay is shown series wound. The main contacts open and close the winding of the relay which overpowers the spring supporting the armature that carries the relay contacts. The relay contacts are connected across the shunt field rheostat, which is first turned to give about 35 per cent. of the normal voltage that it is desired to maintain, so that when the relay contacts are closed the generator voltage tends to rise until it reaches normal value. The main contacts are opened, thus opening the relay contacts, which tends to reduce the voltage 35 per cent. below normal, but this does not actually happen, as the main contacts, being set for a given voltage and operating at a very high rate of vibration, the voltage is maintained at the predetermined value and is constant under all conditions of load and speed. This was one of the first successful voltage regulators for direct-current generators, but it was limited in capacity to one relay.

As most direct-current generator installations require two or more generators of from 100 kw. to 200 kw. capacity each, a single-relay regulator was found to be too small to handle the field discharge of these large generators. It was therefore necessary to resort to the

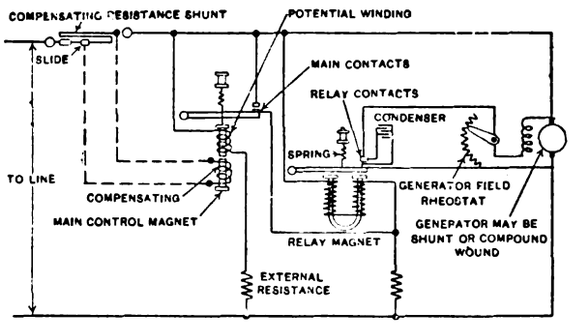

FIG. 3.—CONNECTIONS OF REGULATOR FOR DIRECT-CURRENT GENERATOR

multiple relay type of regulator, which operates on the same principles, but which has a number of relays controlled by one set of main contacts. The multiple relay type of direct-current regulator differs slightly from the alternating-current regulator in the design of the relays, which are differentially wound with parallel conductors so as to neutralise the self-induction of the coils, thus eliminating the sparking at the main contacts. It is impossible to place a condenser section across the main contacts owing to the condenser discharge causing the main contacts to stick, the break not being sufficient to allow the condenser to discharge properly; and if the break is large enough to allow this discharge the regulation will be affected. Condensers are placed across the relay contacts to absorb the arc as these contacts are usually set about $\frac{1}{32}$ in. apart. The connections to the generator field rheostat when multiple relays are used are shown in Fig. 4, in which it will be noted that there are four relays in multiple operating with one set of main contacts.

Another method of regulating direct-current generators is to employ the alternating type of floating contact regulator and separately excite the direct-current generators from an exciter. The direct-current generator in this case virtually becomes an alternating type of generator so far as the principle of regulation is concerned. For Edison three-wire systems, two regulators and two exciters are employed. For large direct-current installations the latter arrangement is very satisfactory as the current to be handled by the regulators is very small and they can also be arranged for over-compounding for line drop by the shunt described above, the current winding opposing the potential winding of each regulator. The exciters for the main generators operate in series the same as the generators themselves.

Special Regulators.—There are numerous applications of voltage regulators which no attempt will be made to describe in this Paper

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such as regulating alternating-current systems where a storage battery is floating on the exciter bus bars. The method employed is to use a booster with the voltage regulator to boost the exciter voltage to the proper amount. Special regulators are also in use for constant-current work, flywheel equalising sets, and many other special applications.

There is one special appliance in addition to voltage regulators which should be mentioned, and that is an automatic device to be used on an alternating-current system where heavy short-circuits are encountered. If the voltage regulator is employed and a short-circuit is experienced, the action of the regulator will tend to hold the voltage up and, therefore, give the exciter full field. Often in hydro-electric installations when this happens the water-wheel gates are wide open—full excitation is supplied to the exciters and generators—and if the short-circuit is suddenly relieved the voltage is likely to rise above normal value before the excitation can be reduced on the generators and exciters. The time required to reduce the excitation is the time taken by the generators and exciters to demagnetise their fields between maximum full field voltage and the voltage corresponding to the normal load excitation, which may be from two to six seconds. This is augmented by the time required for the water wheels to reduce the speed to normal. This can be overcome by placing overload and high-voltage relays in the transmission line so that should the current increase to a given value the relays will open the connections to the regulator and reduce the voltage to a certain value (to be determined by the operating engineer), and

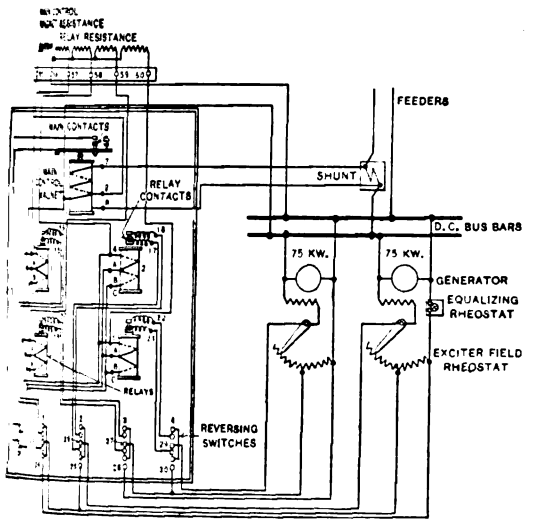

Fig. 4.—Connection of Regulator for Two Direct-Current Generators in Parallel.

when the short-circuit is burned off and the current becomes normal again the relays will close and the regulator will automatically be restored to service. While the above device is not necessary in ordinary central stations it is a very important factor in large hydro-electric installations.

PHOTOGRAPHY AND THE MEASUREMENT OF SURFACE BRIGHTNESS.

In a Paper recently read by Mr. J. S. Dow and Mr. V. H. Mackie before the Royal Photographic Society attention was called to the wide range of brightness with which a photographer has to deal. Incidentally it was also pointed out that the connection between photometry and photography is closer than might be supposed, and that each art can come to the assistance of the other.

Tables have been constructed, both by photographic experts and others interested in school lighting, showing the variation in daylight throughout the year. On this basis Hurter and Driffield, many years ago, devised exposure tables intended to enable photographers to take climatic variations into account. But the drawback to these tables is that although true "in the lump" they may be quite misleading in experience on any actual day. For example, tests by the authors of the illumination between the hours of ten and four on successive days showed that variations of several hundred per cent. were recorded in the intensity of daylight, the lowest value, that of an exceptionally dark period, being about ½ ft.-candle and the highest over 300 ft.-candles. Moreover, in these cases the character of daylight as the day proceeded was entirely different from that indicated by statistics based on long periods of time.

When it is recalled that even greater deviations in brightness are actually met with owing to the variation in daylight in different parts of a room, the varying reflecting power of different objects, &c., the difficulty of obtaining the ideal exposure is obvious. Actinometer readings, again, naturally cannot readily be applied to gain information as to the gradation of tone in an interior, the comparative brightness of near and distant objects, &c., all of which have to be allowed for by more or less rule-of-thumb methods.

The authors therefore suggested the value of actual measurements of the surface brightness of the various objects to be brought out in the field of view, as a means of determining the correct exposure. They showed a series of photographs in which this principle had been applied, the method being to measure the brightness of the chief objects in the field with the Holophane Lumeter illumination photometer.* It will be recalled that this instrument enables the brightness of distant objects to be readily determined, and the authors appear to have used it for studying even such objects as buildings, trees, &c., the brightness of which is largely dependent on the state of the intervening atmosphere.

Among the advantages claimed for such measurements are the speed with which data can be secured and the fact that the instrument enables the relative depth of tone in the different portions of the subject photographed to be studied and recorded in a few seconds. Now it is almost impossible to secure a variation in tone of more than 30 to 1 in the final print, and a record of the degree of shade in the subject thus provides valuable information as to what may be expected when development of the plate takes place, and how far it is possible to approach the actual conditions. The range of surface brightness of objects which are met with in ordinary photography is enormous. Thus, a white surface illuminated by direct bright sunlight may approach 5,000 ft.-candles, but on a dull day may be 1 ft.-candle and less, while dark parts of interiors may yield values of the order of hundredths of a foot-candle. On the other hand, the brightness of actual illuminants is enormous, the electric arc having a brightness equivalent to some millions of foot-candles.

A branch of work in which measurements of surface brightness appear to be specially serviceable is the photography of artificially lighted interiors. Engineers interested in lighting questions have frequently experienced the difficulty of securing photographs of this kind showing, in a proper manner, the distribution of illumination, the actual sources, &c. In this connection Mr. Dow mentioned that Mr. T. E. Ritchie, of the Union Electric Co., had been independently using the Lumeter instrument in this way, and a number of excellent photographs of inverted arc lighting were shown, obtained by Mr. Ritchie in the South Kensington Musuem and elsewhere. A remarkable feature was that the very bright portions of surfaces immediately above the arc were perfectly clear and yet the gradation of tone in the darker parts of the interiors, under arches, &c., was also well represented.

The authors then proceeded to throw on the screen a series of three photographs illustrating the distribution of illumination under a Holophane reflector and a bare lamp respectively. It was pointed out that, in view of the fact that a photographic print will not enable a greater contrast than 30 : 1 to be shown, it was most essential to judge exactly the desirable exposure so as to secure a faithful representation of the exact conditions. This was done by exposing primarily for the surface brightness of white material immediately below the two units compared. Other photographs were also shown of an outdoor subject, and illuminated test charts, &c., in each of which cases the exposure was based on previous experience with the holophane lumeter.

In conclusion, it was suggested that, even in the case of a really expert photographer, the instrument might be of service in affording a record of actual conditions, and that it should also be specially serviceable in teaching photographic principles in research. One question to be born in mind was, of course, the actinic value of different illuminants. It was suggested that although a measure of surface brightness will yield valuable comparative results for the same illuminant, the difference in actinic value must be allowed for when examining interiors lighted by different means. This could be done by adopting certain factors, based on experience, for each illuminant. To illustrate this point a series of photographs were taken of a white card illuminated successively by a carbon filament glow lamp, a metal filament lamp, an incandescent mantle, an arc lamp, a Bastian mercury vapour lamp, a Silica mercury vapour lamp and daylight, the surface brightness as tested by the holophane lumeter instrument being 5-foot-candles and the exposure 1 minute in each case. The negatives were then developed under identical conditions in the same dish, and also fixed in exactly the same manner. As a result it appeared that the exposure for daylight was about right, that the photographs taken by the mercury lamps and the arc lamp were over-

*See The Electrician, Oct. 28, 1910, p. 85.

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exposed, and that those secured by the light of the glow lamps and the gas mantle were under-exposed. Prints were exhibited showing the gradation of density in the various cases.

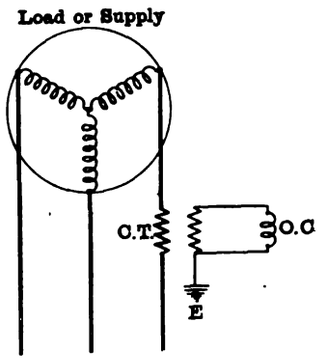
One other question of interest is the applicability of measurements of surface brightness to highly coloured objects, it being recognised that the eye sees such surfaces in a different manner from a photographic plate. This, however, is a difficulty that confronts photographers in any case; it was suggested that it might be mitigated by using a Wratten panchromatic plate and K 3 filter, intended to alter the sensitiveness of the plate in such a manner as to resemble that of the eye much more closely.

Reference was finally made to the value of the Holophane Lumeter instrument for measuring the reflecting power of different materials, stains, solutions, &c., and for studying the opacity of negatives and lantern slides.

PRESENT-DAY METHODS OF PROTECTING HIGH-TENSION SYSTEMS BY MEANS OF AUTOMATIC SWITCHGEAR.

[COMMUNICATED.]

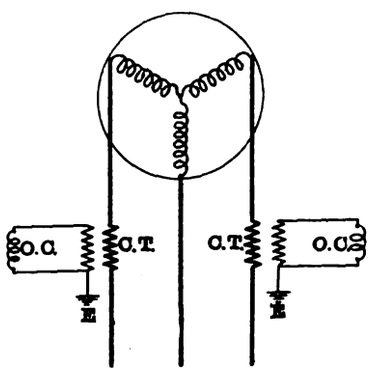
Trouble is often experienced due to the inability correctly to connect together electrically control apparatus after its purchase, and although diagrams are often provided by manufacturers of electrical gear showing the method of connecting their particular gear, the following standard arrangements, it is suggested, may be useful for reference.



C.T. Current transformer. O.C. Oil switch operating coil.

FIG. 1.—OVERLOAD PROTECTION ON BALANCED THREE-PHASE SYSTEM.

The present article is intended to show by the use of diagrams the methods of connecting automatic protective switchgear on high-tension systems of the present day, and deals with apparatus designed to operate in the event of overloads and reversals of power on the systems. The cases taken are those chiefly met with in practice in this country.



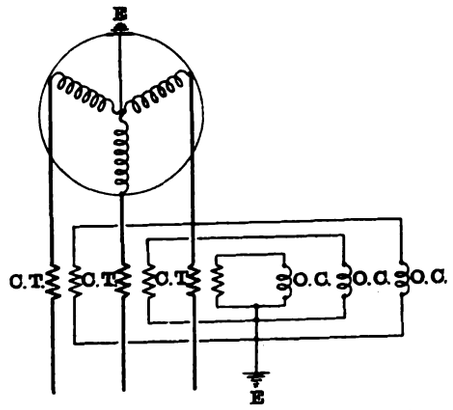
C.T. Current transformer. O.C. Oil switch operating coil.

FIG. 2.—OVERLOAD PROTECTION ON UNBALANCED THREE-PHASE SYSTEM.

Overload Gear.—In Fig. 1 is shown diagrammatically the necessary apparatus for protection against overloads on a three-phase system, where the power is equally balanced in each of the phases. The arrangement necessitates the use of one current transformer connected in one of the phases as shown, with its secondary winding connected to earth; this transformer is coupled with the operating coil of the oil switch, the latter switch not being shown in the diagram. It is immaterial which side of the current transformer secondary winding is connected with earth, although it is well to observe a definite and consistent ruling throughout the practice, and use as the earth terminal, say, the end facing the incoming supply.

Such an arrangement, it will be understood, provides protection against a balanced overload on the system.

Fig. 2 is the case usually met with in practice, viz., the protection against overloads of an unbalanced three-phase system where all the mains are insulated from the mass of our earth. Two current transformers of the same current ratio are necessary to give adequate protection to the system, and these are connected respectively to the oil-switch operating coils, as shown in this diagram. This form of protection is applicable to either the star or delta-connected system where the phases are insulated from earth.

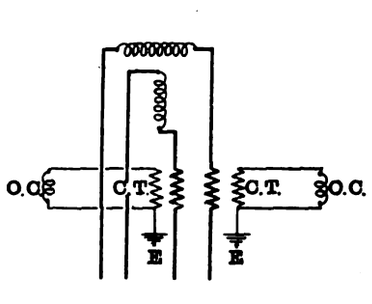


C.T. Current transformer. O.C. Oil switch operating coil.

FIG. 3.—OVERLOAD PROTECTION ON THREE-PHASE SYSTEM WITH NEUTRAL POINT EARTHED.

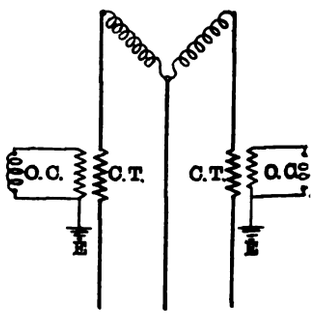
Where the middle point of a star-connected three-phase system is connected to earth, such as is usual on colliery systems, it will be understood that it becomes necessary to provide protection on each of the phases by the use of three transformers connected to three operating coils on the oil switch. Faults to earth, or between the phases, are thus provided for by means of the gear mentioned, connected as shown in Fig. 3.

Overload protection on a two-phase system with four conductors is ensured by the employment of two current transformers connected one in each of the phases, as in Fig. 4. The case can, of course, be treated as two single-phase systems entirely independent of one another.



C.T. Current transformer. O.C. Oil switch operating coil.

FIG. 4.—OVERLOAD PROTECTION ON TWO-PHASE FOUR-WIRE SYSTEM.



C.T. Current transformer. O.C. Oil switch operating coil.

FIG. 5.—OVERLOAD PROTECTION ON TWO-PHASE THREE-WIRE SYSTEM.

As in the two-phase four-wire system, overload protection is maintained on the two-phase three-wire system by means of two current transformers connected in the outer conductors as shown in Fig. 5, and coupled to two operating coils on the main oil switch. In all cases where the line currents are of equal values the current ratios of the operating transformers are the same.

As in the three-phase balanced system the single-phase system requires only one current transformer for its protection,

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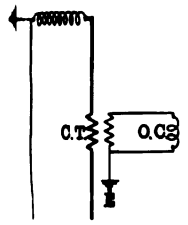
which is connected directly to the operating coil of the oil switch, as shown in Fig. 6.

The method of overload protection still holds good when one side of the system is connected to earth.

Where a relay is introduced in place of the direct-connected operating coil, the connection is as shown in Fig. 7. Such relays are often employed, so that an adjustment of the time operation of the oil switch may be readily made, and also to provide a means whereby direct current can be used for operating the oil switch if desired.

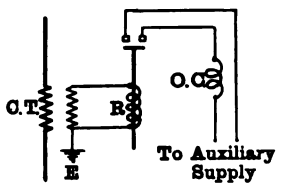
Reverse Power Relays are shown diagrammatically in Figs. 8 to 13 as connected on systems chiefly used in this country.

To protect the balanced three-phase system against a reversal of power, single element protective gear only is necessary. The relay, which consists of a double winding, is supplied by



C.T. Current transformer.
O.C. Oil switch operating coil.

FIG. 6.—OVERLOAD PROTECTION OF INSULATED OR EARTHED SINGLE-PHASE SYSTEM.



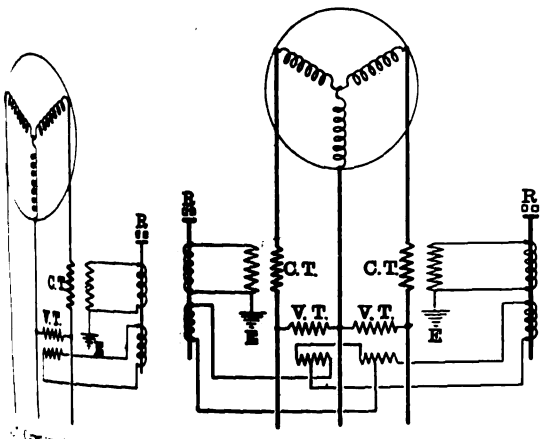
C.T. Current transformer. R Relay.
O.C. Oil switch operating coil.

FIG. 7.—OVERLOAD RELAY IN PLACE OF DIRECT-CONNECTED OPERATING COIL.

means of a current transformer and voltage transformer connected as shown (Fig. 8). Such an arrangement would protect the system against a reversal of power on the assumption that each reverse occurred in each of the phases and, as the system supplies, was balanced.

Proper adjustment of the relay is necessary so that under normal conditions any movement due to electrical influence would be prevented, and that only in the event of a reversal of power in the system would the apparatus fulfil its duties.

It is not intended here to discuss the theory of reverse relays for alternating-current systems, and for further consideration the



C.T. Current transformer. V.T. Voltage transformer. R Relay.

FIG. 8.—REVERSE POWER RELAYS FOR THREE-PHASE BALANCED SYSTEM, STAR OR MESH.

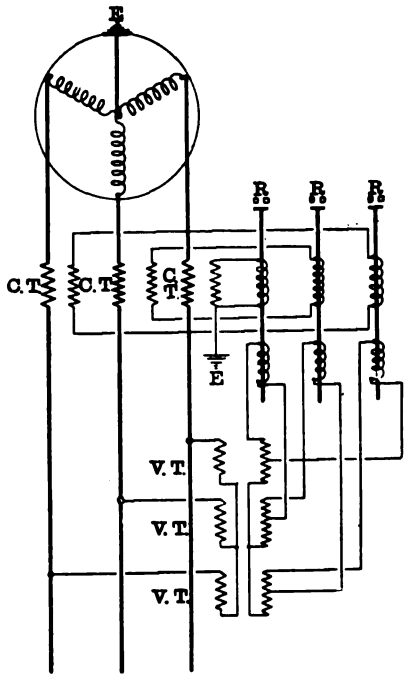
FIG. 9.—REVERSE POWER RELAYS FOR THREE-PHASE UNBALANCED SYSTEM, STAR OR MESH.

reader would refer to the text-book entitled "Electricity Control" by Leonard Andrews, where a simple explanation of the reverse relay is given.

For protecting a three-phase insulated system against independent reversal of power in any phase, it becomes necessary to employ the use of a double set of transformers connected as shown in Fig. 9.

In order to bring the potential and line currents as near as possible into phase in the relay circuit, the voltage transformers are connected to the mid points of their respective secondary windings as shown. This phase correction will be easily understood by reference to an ordinary vector diagram for the three-phase system.

On three-phase systems having the neutral connected to earth it becomes necessary to employ a triple set of gear, the connections being as shown in Fig. 10. The employment of three sets of transformers becomes necessary on account of the

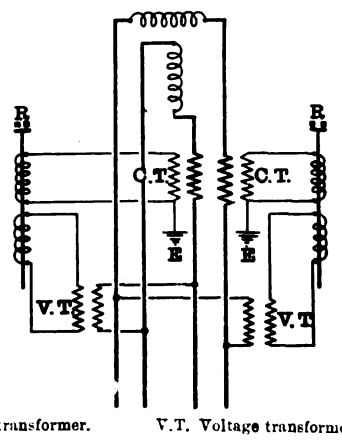


C.T. Current transformer. V.T. Voltage transformer. R Relay.

FIG. 10.—REVERSE POWER RELAYS FOR THREE-PHASE SYSTEM WITH NEUTRAL EARTHED.

possibility of the existence of a different frequency harmonic to the fundamental supply frequency (this, of course, applies when machines are running in parallel). This peculiar phenomenon, as is generally known, can produce circulating currents of considerable value between the phases and earth, which if not guarded against are liable to cause trouble.

By the employment of the transformers shown with the voltage transformers connected in star, trouble that would otherwise be experienced due to the higher frequency harmonics



C.T. Current transformer. V.T. Voltage transformer. R Relay.

FIG. 11.—REVERSE POWER RELAYS ON TWO-PHASE FOUR-WIRE SYSTEM.

is eliminated. As before, phase correction in the relay circuit is obtained by cross connecting the secondary windings of the voltage transformers.

A reference to this diagram will clearly show that a reversal of power on any of the three phases is coped with by the use of this arrangement of protective gear.

The two-phase three and four-wire systems are protected against power reversal by practically the same method, which consists of connecting in each of the phases one current

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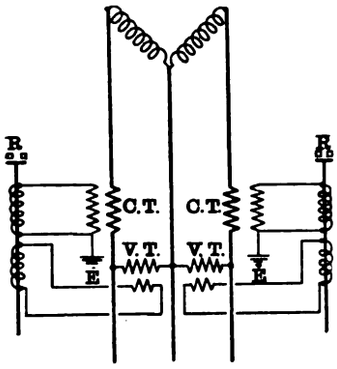
transformer, and across the phase a voltage transformer interconnected with its relay, as shown (Figs. 11 and 12). The line currents and voltage being presumably in the same phase relationship, correction becomes unnecessary.

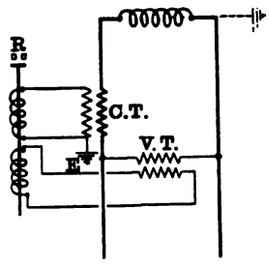
Protection is provided in the single-phase system by the use of a single set of gear as in the balanced three-phase system (Fig. 8). The connection shown in Fig. 13 applies equally well for a system where one side is connected with earth.

Conclusion.—It has been intended to show in this article the methods of connecting together the various apparatus dealt with, and not to discriminate between different types and forms of relays or other devices for operating oil switches. More than one form of reverse power relay is in use at the present time, but all types necessitate the use of the operating transformers shown, so that the diagrams will hold good for the different types of apparatus.



C.T. Current transformer.
V.T. Voltage transformer. R Relay.

FIG. 12.—REVERSE POWER RELAYS ON TWO-PHASE THREE-WIRE SYSTEM.



C.T. Current transformer.
V.T. Voltage Transformer. R Relay.

FIG. 13.—REVERSE POWER RELAY ON SINGLE-PHASE SYSTEM, INSULATED OR EARTHED.

The question as to whether alternating or direct current should be utilised for operating the oil switches is purely optional, as is also the employment of a three-phase operating transformer in place of three single-phase transformers.

THE HIORTH ELECTRIC STEEL FURNACE.*

BY J. W. RICHARDS.

In this Paper the author describes an improved form of induction furnace due to Hiorth and Söderberg. It is working at Jossingfjord, in Norway, where at least 1,000 water H.P. is available. The furnace is of double-channel induction type, with the primary consisting of four coils connected in series. Fig. 1 shows diagrammatically the electrical principles, E being the steel bath, with its two channels *dd*, *a* the magnetic circuit, *bb* the upper coils, co-extensive with the heating channels, and *cc* the lower coils. The coils *bb* are suspended from pulleys with flexible connections, and, when running, are close to the covers of the channels *dd*, but can be raised about 2 ft. when the covers are to be removed. The coils *bb* are uninsulated, bare copper bars, coiled spirally. The coils *cc* are hollow, water-cooled copper conductors, and in the actual furnace are embedded in the magnesite lining about 16 in. beneath the channels *dd*. The voltage employed on the primary is so low that no particular precautions for insulation are needed, and no one can be seriously hurt by it. The space between the magnet *a* and the furnace wall is a clear foot, which allows the magnets (which weigh several tons) being bolted, firmly fixed to the floor, while the furnace can be tilted for pouring. The central space E is 1 ft. wide in the middle, 2 ft. wide at the sides and nearly 76 in. long from front to back. It furnishes space enough to re-melt ingots or other scrap.

On the occasion of the author's visit the furnace was lined with Veitsch Styrian burnt magnesite, which had been in position for seven weeks, during which it had been occasionally repaired. Norwegian magnesite had been tried and found to crumble badly; it had not been previously properly burnt. The covers were silica slabs, not sufficiently thick, however, properly to protect the melted steel from large radiation losses.

* Abstract of a Paper read before the American Electrochemical Society.

The materials being melted were the purest obtainable Swedish Dannemora pig-iron from the middle bed of the Dannemora ore deposit, and Dannemora Walloon iron, costing, respectively, £6 and £15 per metric ton. These are the identical materials used in Sheffield for crucible melting to produce the best quality of crucible steel. Yellowish-white blast-furnace slag, vitreous and glassy, from the Dannemora furnaces, was being used as a flux, mixed with fluorspar when greater fusibility was desired. The contents of the furnace being 5 tons, 3 tons were poured at a time and 2 tons left in to start the next charge, which then consisted of 3 tons of raw materials. The analyses of the raw materials and of some steels produced from them are given as:

	C.	Si.	Mn.	S.	P.
Dannemora white pig...	3·80	0·310	1·727	0·025	0·020
,, Walloon iron	0·107	0·013	0·068	0·010	0·009
Steel	1·42	0·130	0·322	0·010	0·019
	1·20	0·107	0·269	0·009	0·019
	1·02	0·112	0·301	0·008	0·021
	0·76	0·108	0·253	0·009	0·021
	0·67	0·108	0·288	0·006	0·021

The details of the heat run off when the author was present were as follows —

12:20 p.m. In furnace, 2,775 kg. of previous steel, 1·00 per cent. carbon. Charged 1,000 kg. pig iron and 500 kg. Walloon iron. Current started.
12:30. Current 1,800 A, 273 V, 380 kw., load factor 0·77.
1:30. Current 1,840 A, 273 V, 395 kw., load factor 0·80.
2:0. Current 2,050 A, 265 V, 380 kw., load factor 0·70.
2:30. Charge melted. Average current 380 kw. for 2 hr. 10 min. = 550 kw.-hr. per ton of metal melted.
2:30. Charged 350 kg. pig iron and 1,150 kg. Walloon iron.
3:30. Current 2,275 A, 270 V, 400 kw., load factor 0·65.
4:30. Charge melted. Average current 400 kw. for 2 hours = 530 kw.-hr. per ton of metal melted.

Assuming 300 calories necessary to melt 1 kg. of steel, the thermal efficiency of this melting operation is 55 per cent. and the furnace

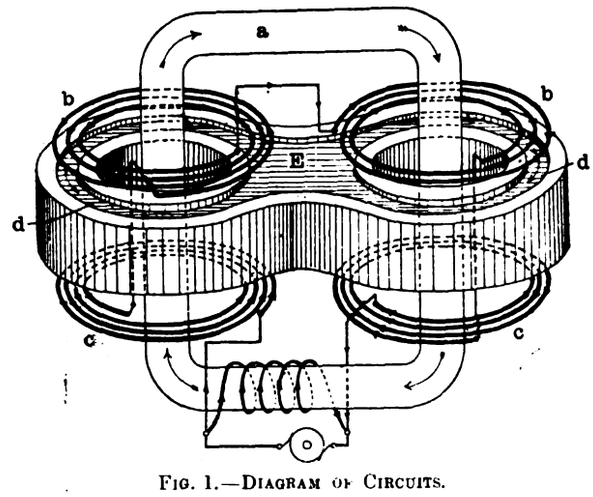


FIG. 1.—DIAGRAM OF CIRCUITS.

radiation loss works out at 180 kw. at this temperature. It was stated that it took about 170 kw. to keep the charge melted when the furnace was heated up over night.

5:30. Current 2,370 A, 265 V, 395 kw., load factor 0·63.
6:0. Current 2,425 A, 278 V, 400 kw., load factor 0·59.
6:15. Current 2,300 A, 280 V, 365 kw., load factor 0·57.

With the metal at casting temperature the current used averaged 395 kw. for six hours, or 790 kw.-hr. per ton of steel. As low a figure as 700 kw.-hr. was reached in this 5-ton furnace on cold materials. During the heat there was added to the bath 35 kg. of 30 per cent. ferro-silicon and 8·7 kg. of 80 per cent. ferro-manganese; while 0·15 kg. of pure aluminium, equal to 0·005 of 1 per cent. of the charge, was added in the ladle.

The steel was poured into 20 cm. square ingots of ½ ton each, and cast beautifully. These ingots were shipped to Sheffield for use in the steel works, and metal from this furnace has already given good service for razors, pocket knives, carvers, chisels, axes, files, reamers, taps, drills, slow-speed turning tools, rock-drills, blacksmiths' tools and engineers' hammers. It sells in competition with crucible steel made from the same materials, the selling price of which is £60 per ton. The labour required on this furnace per 24 hours was one head melter, 1 helper, 1 boy on each of two shifts and 1 ladle man and 1 helper on one shift.

The capacity of the furnace is 12 tons in 24 hours, tapping a 3-ton heat every six hours. When in regular, steady running, 700 kw.-hr. are used per ton of cold charge melted.

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The principle of the furnace is such that it may be increased almost indefinitely in size; a 50-ton furnace on this design is certainly practicable. In this 5-ton furnace the annular ring channels, 8 in. wide by 18 in. deep, are only filled 8 in. deep with steel, and the narrowness increases the difficulty of working in the slag. Larger furnaces with wider channels will certainly be more free from this arching-over of the slag, because it will fall of its own weight on to the metal.

It is distinctly worth while to remark that the temperature of the steel in the centre compartment was fully as high as in the annular spaces even just before the doors. This shows that, with proper heat-insulating covering over the steel, supplementary heating of the central bath is not a necessity. It appears to the author that the difficulty heretofore met at this point is incidental merely to the smallness of the furnaces, and will disappear as larger furnaces are built.

THE TESTING OF TRANSFORMER IRON.*

BY LANCELOT W. WILD.

When accuracy is the first consideration, transformer iron is doubtless best tested in the form of rings. For routine tests, however, ring specimens are impracticable on account of the cost of winding. For

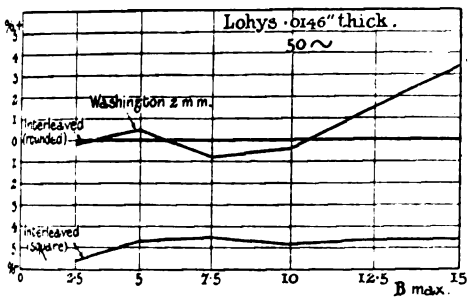

FIG. 1.

everyday testing transformer iron is generally obtained in strips, which are built up to form some form of magnetic square, the strips being threaded into coils ready wound, and fixed to a base-board.

The "interleaved butt-joint system with square corners" has been very largely employed. In this the strips are built up with butt joints differently disposed in alternate layers, so that the joint in one layer is covered by continuous iron in the next. In the system employed at the National Bureau of Standards, Washington, which may be called the Washington system,† the strips of iron are interleaved with strips of paper or other suitable insulating material of the same thickness as the iron. They are then made up into four bundles, which are wound round with tape and inserted into the coils. Corner-pieces are then cut and bent, each to a different length, and these are inserted between the ends of the strips. A

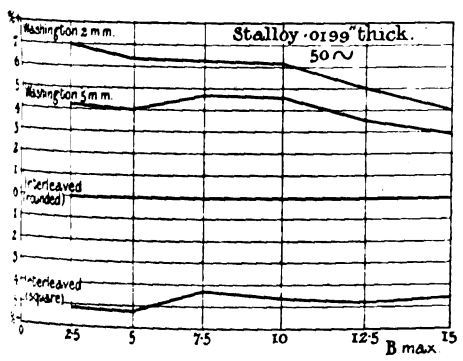

FIG. 2.

clamp is finally placed at each corner, and is tightened up so that the strips and corner-pieces are held fast together. The two chief objections to the interleaved system are, first, that the difference between the longest and shortest path presented to the flux is great; and, secondly, at the corners the cross-sectional area is increased to above the normal. At low densities the flux will tend to crowd into the shortest path, and this should increase the specific loss as a whole. At high densities the decreasing permeability will tend to cause the flux to spread out more, and at very high densities, if there is no magnetic leakage, the results obtained will tend to come out correctly.

The objection to the interleaved system can partly be overcome by rounding the corners. This renders the cross-section constant at all points of the circuit. The fault that naturally occurs to one with regard to the Washington system is that the cutting and bending of the corner-pieces is likely so to increase hysteresis locally as to vitiate the total measurement. There is also the practical consideration that the operation of making and fitting the corner-pieces takes a considerable amount of time.

In order to arrive at a general idea of the magnitude of the errors involved, the author has made comparative tests on four specimens, employing all three systems, the strips used measuring 10 × 2 in. The specimens were of Lohys and Stalloy. The results are set out in tables and diagrams in the Paper. Two diagrams showing the percentage differences are given herewith (Figs. 1 and 2).

Conclusions.—The author says there appear to be two general conclusions that may be arrived at from these tests with a considerable degree of certainty. Firstly, the Washington method is quite unsuitable for Stalloy, and is of rather doubtful utility for Lohys. Secondly, if it should be decided that the interleaved method with rounded corners is the most accurate, it is hardly necessary to trouble about cutting the corners round. If the amount of waste material at the corners is deducted from the gross weight, the results obtained will not differ by more than 1 per cent. from the results that would have been obtained had the corners been rounded.

It appears to the author that the interleaved method is still the best method of testing transformer iron available. It is generally agreed that if accurate results are to be obtained the strips must be annealed after being cut, and this can only properly be done by the manufacturer. There is no special virtue, then, in using wide strips.

* Abstract of an original communication published in the "Journal" of the Institution of Electrical Engineers.

† Described in THE ELECTRICIAN, December 3, 1909, p. 320.

MEASUREMENTS OF INTRINSIC BRIGHTNESS BY A NEW METHOD.*

BY H. E. IVES AND M. LUCKIESH.

The apparatus here described lends itself to the making of measurements of intrinsic brightness in a more direct manner than any hitherto known to the writers. The instrument used is a modification of the Holborn-Kurlbaum optical pyrometer. In this latter instrument the furnace or surface the temperature of which is to be measured is viewed directly, while between the eye and the object is placed an incandescent lamp filament. The current in the filament is varied until the filament becomes invisible—that is, until its brightness is the same as that of the background. A previous calibration of the filament makes it possible to state this intrinsic brightness in terms of "black-body temperature." A temperature measurement with this instrument might, however, be expressed in terms of brightness per unit of area by means of the data of Nernst† on the candle-power per square millimetre of a black body at various temperatures.

In attempting to apply this method of measuring intrinsic brightness to the measurement of illuminants the usual conditions are reversed. That is, instead of having a background of large extent, against which the auxiliary lamp filament may be matched, the surfaces to be measured are often of very small dimensions. For instance, an incandescent lamp filament is so small that the attempt to match one with the brightness of another filament crossing it is altogether impracticable. The difficulties have been overcome by using as background the image of a Nernst glower. In the first place, the glower happens to have a higher intrinsic brightness than any of the incandescent filaments. In the second place, since it is operated in the air, and not in a bulb, an image may be formed by a lens without distortion. In the third place, the ordinary commercial glower is large enough so that only a few-fold magnification is necessary.

A few words are necessary in regard to the use of an image as a background. It follows from geometrical optics that the intrinsic brightness of an image in space, as viewed from the side away from the lens forming it, is equal to the brightness of the original source, provided the beam of light entirely fills the pupil of the eye or the aperture of the telescope with which the image is viewed. Consequently, an image of any convenient size may be used, and it may be focussed in any plane desired, such, for instance, as that of a lamp filament in a bulb. In the latter case the relative position of filament, lens and bulb is such that no troublesome distortion is introduced by the glass of the bulb. The absorption of the lens has, of course, to be taken into account.

* Abstract of an article in the "Electrical World."

† "Phys. Zeit.," June 1, 1906.

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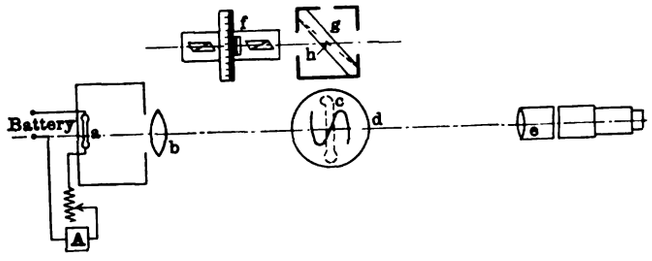
A plan of the apparatus is shown in the accompanying diagram, where *a* is the Nernst glower enclosed in a tin box to avoid draughts. For this work a direct-current 0·6 ampere glower was used, without the heating coil. Current was read by the ammeter A; *b* is the lens, *c* is the enlarged image of the glower in the plane of *d*, the incandescent lamp to be measured, and *e* is the observing telescope.

In order to make measurements it is obviously necessary to vary the brightness of the Nernst image and to know the values of this brightness. Several means of changing the candle-power of the Nernst were tried, and finally two were employed, each for a different range. In measuring the incandescent lamps it was found most satisfactory to change the Nernst by varying the current through it. Separate photometer measurements gave the relationship between current and brightness in the glower. This means of varying the brightness could not be used for low values (below 200 c.p. per square inch) owing to the failure of the glower to operate. For other illuminants of lower intrinsic brightness a pair of Nicol prisms, *f*, were inserted. Their angle of rotation relative to each other could be read; when a setting was made each side of the extinction point (θ_1 and θ_2) the brightness of the glower image was $a \sin^2 \frac{\theta_2 - \theta_1}{2}$, where *a* is the transmission of the Nicol prisms at their point of maximum transmission. This formed a very satisfactory method for varying the brightness of the background, and would have been preferable throughout were it not that the absorption of the Nicol prisms reduces the background intensity below the value necessary for matching the lamp filaments at their normal operation.

For the measurement of flames and other illuminants of an extended character it was necessary to introduce an auxiliary device. A thin, reflecting filament was made, consisting of a ½ mm. strip of silver, *h*, chemically deposited on the back of a 7 deg. prism. Against this a second prism was cemented with Canada balsam, so that the outer faces of the prisms were parallel, but at an angle with the silver strip. This compound prism was enclosed in a small box, *g*, with



PLAN OF APPARATUS FOR MEASURING BRIGHTNESS OF LIGHT.

front, back and a narrow side opening. By this means all reflections except those from the silver strip were invisible at the telescope. Portions of flames reflected in this strip appear very much like the lamp filaments and disappear very satisfactorily against the background.

Some of the values obtained in the present investigation are given in the accompanying table, together with some values given by Barrows for comparison. The incandescent lamp values given refer to the brightness inside the bulb; they will be about 10 per cent. less as ordinarily viewed.

Type of lamp.	Barrows. C.p. per sq. in.	Ives & Luckiesh. C.p. per sq. in.
Crater, carbon arc	200,000	84,000
Flaming arc	5,000	...
Nernst glower (115-volt 6-ampere d.c.)	...	3,010
Tungsten, 1·25 watts per candle-power	1,000	1,060
Tantalum, 2 watts per candle-power	750	580
Carbon, 3·5 watts per candle-power	375	400
Carbon, 4 watts per candle-power	300	325
Enclosed carbon arc (direct-current)	100–500	...
Welsbach mantle	20–25	31·0
Cooper-Hewitt mercury vapour	16·7	14·9
Candle flame	3–4	...
Gas flame (fishtail)	3–8	2·7
Frosted incandescent lamp	4–8	...
Tip of 25-watt frosted tungsten	...	1·67
Side of ditto	...	6·00
Moore carbon-dioxide tube	0·6	...

Some improvements in the apparatus might be made as a result of experience with these measurements. Chief among these would be the use of some other background. The direct-current Nernst glower proved somewhat fragile. A thick tungsten filament in a fairly flat and uniform or large diameter bulb would be preferable. In the event of using a filament of this type a purely substitution method would be advisable, referring all measurements to a filament of known brightness, itself matched against the special tungsten background.

These modifications of the procedure would be well to follow were intrinsic brightness measurements found of such use in any photometric method as to make convenience in obtaining them of practical importance. As a matter of fact, the present apparatus was devised to test the possibility of rating incandescent lamps at a uniform specific consumption by setting them at the same intrinsic brightness. The method has been found good, but unfortunately too good for commercial incandescent lamps. These vary from filament to filament and from point to point on one filament by an amount corresponding to several volts. Further difficulties might have developed due to differences in vacuum, &c.

ON RESISTANCES WITH CURRENT AND POTENTIAL TERMINALS.

(*Concluded from page 14.*)

BY G. F. C. SEARLE, M.A., F.R.S.

Summary.—Although conducting systems with current and potential terminals have been in use for many years, the general theory of conduction through such systems has received little attention. The usual proof of the important theorem that current and potential terminals may be interchanged without affecting the P.D. on the main resistance involves the condition that the whole of any one junction is at the same potential. This condition is approximately satisfied in the case of a network of fine wires, but not in a "low resistance" or "shunt." In dealing with such a system we need a proof of the reciprocal relation which shall be independent of the form of the system. Helmholtz has given such a proof, and a simple, direct one is here given due to Heaviside. Dr. Bromwich, employing Green's theorem, also gives a solution. Useful information regarding the properties of conducting systems with three and four terminals is obtained, and it is shown that a triangle of resistances may be replaced for all purposes by a three-rayed star of resistances. In the case of a four-terminal resistance we can construct even low resistance systems such that the want of infinite conductivity at the junctions can produce no sensible error. The discussion of the design of such resistances shows the great advantage of connecting each current and each potential terminal to the main resistance by a rod or wire, the length of such being at least three times its greatest width. The resistance of such a system is very definite. In the case of low resistances capable of carrying currents of the order of 1,000 amperes, slight changes in the connections at the terminal lugs have been found to produce appreciable changes in the P.D. on the main resistance. These defects are easily remedied. Potential "tongues" in sheet resistances are shown to be an advantage. For the comparison of four-terminal resistances with other resistances five methods are discussed, the most important of them being the Thomson bridge, which possesses an advantage not previously realised.

§ 25. *Comparisons of Four-terminal Resistances with Other Resistances.*—We now proceed to discuss some methods of comparing the four-terminal resistance [CD . AB] or [AB . CD] for any given system having current terminals AB and potential terminals C D with other resistances. The resistance [CD . AB] can be compared with the four-terminal resistance [C′D′ . A′B′] of a standard system by means of potentiometer methods. But these methods assume the constancy of currents of 100 amperes or more in the case of very low resistances, and thus cannot be expected to yield as accurate results as suitable Wheatstone bridge methods, in which no assumption is made as to the constancy of the current. For commercial purposes the potentiometer methods are satisfactory, but they will be passed by here in favour of the bridge methods.

The methods discussed below are applicable to *any* given system and do not require for their theoretical validity that the resistance [BD . AC] should vanish. In some cases, as, for instance, that of a mercury standard of resistance with current and potential terminals, the resistance [BD . AC] is so exceedingly small that it may be safely treated as if it were accurately zero. In these cases the system may be replaced by a five-wire model, as in § 17, and then a number of methods take simple forms. But it must not be assumed without special examination that the formulæ which are valid when [BD . AC] is zero can be applied to cases in which [BD . AC] is not zero. The methods given below are applicable to systems of any form.

§ 26. *First Method.*—The system for which the resistance [CD . AB] is to be found is associated, as in Fig. 21, with three

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resistances, P, Q, S, without potential terminals, and an additional resistance, T, is included between the points A and L. The battery is joined to N and L, and the galvanometer joins M and C or M and D. By the reciprocal relation of §23 we may, as far as theory goes, interchange the battery and the galvanometer. In practice that arrangement should be chosen which gives the greatest sensitiveness.

Let the resistance [CD . AB] be denoted by R, let [AC . AB] be denoted by X and [DB . AB] by Y. Then when a current of 1 ampere flows from L to N through B, $V_A - V_C = X$ volts, $V_C - V_D = R$ volts, and $V_D - V_B = Y$ volts.

The galvanometer is first joined to M and C, and the bridge is balanced by adjusting T or S or both. Let the balance values be T_1 and S_1. Let u_1 be the current in the branch LBN and v_1 that in LMN. Then, since C and M are at the same potential, we have

$$(T_1+X)u_1 = Pv_1,$$
$$(R+S_1+Y)u_1 = Qv_1.$$

Hence,

$$Y - \frac{QX}{P} = \frac{QT_1}{P} - R - S_1 \quad . \quad . \quad . \quad . \quad . \quad (1)$$

The galvanometer is now joined to M and D, and the bridge is again balanced by adjusting T or S or both. Let the balance

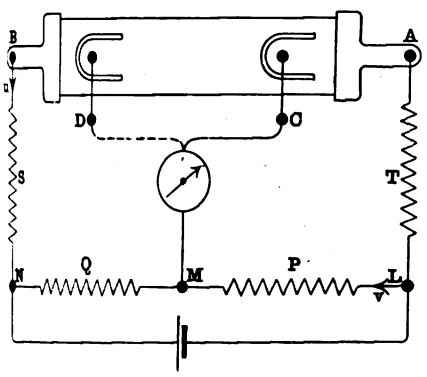

FIG. 21.

values be T_2, S_2, and let the currents now be u_2, v_2. Then, since M and D are at the same potential,

$$(T_2+X+R)u_2 = Pv_2,$$
$$(S_2+Y)u_2 = Qv_2.$$

Hence,

$$Y - \frac{QX}{P} = \frac{Q(T_2+R)}{P} - S_2 \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

By subtracting (1) from (2) we obtain

$$R = \frac{P(S_2-S_1)+Q(T_1-T_2)}{P+Q} \quad . \quad . \quad . \quad . \quad (3)$$

If T is kept constant, we have

$$R = \frac{P(S_2-S_1)}{P+Q}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

and if S is kept constant,

$$R = \frac{Q(T_1-T_2)}{P+Q} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Hence (4) or (5) we require the absolute value of $S_2 - S_1$, or of $T_1 - T_2$, and of the ratio P/Q.

If equation (4) be used, the measurements are easily made by using a resistance box furnished with proportional arms. These arms carry the resistances P and Q, and the remainder of the box carries S. The coil T may be any coil whose resistance is sufficiently great to allow a balance to be obtained when the galvanometer is connected to M and C. The fine adjustment of value BN may be made by shunting.

If the resistances P and Q be equal, we have by (4)

$$R = \tfrac{1}{2}(S_2 - S_1).$$

Hence if we make S_1 zero by making B coincide with N in the first adjustment, which is then made by varying T, the value of R is $\frac{1}{2}S_2$—i.e., R will be half the resistance which must be inserted between B and N in the second adjustment. In this way a four-terminal resistance, R, of nominally 1 ohm can be compared with a coil, S_2, of nominally 2 ohms resistance. If the 2 ohm coil be greater than 2R the exact balance can be obtained by shunting the 2-ohm coil. If, on the other hand, the 2-ohm coil be less than 2R, the two potentials C D are connected by a shunt wire of such resistance as to make the shunted value of 2R less than the 2-ohm coil; the second adjustment can then be made by shunting the 2-ohm coil. The true value of R can then be deduced from the shunted value by equation (6) of § 23. An alternative method is to use (3), and to make $S_2 - S_1$ nominally 2 ohms, while the fine adjustments are made by varying T by shunting.

The connections may be made by mercury cups formed in stout blocks of copper. For the most precise work some allowance must be made, where necessary, for the resistance between two Mercury cups in the same block; in the blocks used at the National Physical Laboratory this resistance is about 3×10^{-6} ohms.

§ 27. *Second Method.*—In the last method two adjustments of a Wheatstone bridge are necessary; in the present method

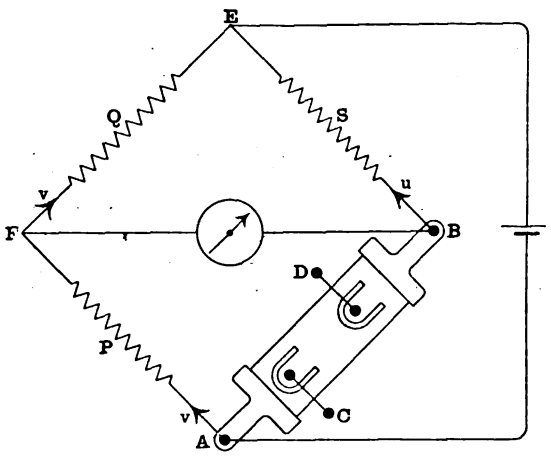

FIG. 22.

three adjustments are required. The system, having current terminals A B and potential terminals C D, is associated with three other resistances P, Q, S, as in Fig. 22. In the first adjustment the battery is joined to E and A, and the galvanometer to F and B, and P_1, Q_1, S_1 are the values required for a balance. Then

$$[AB] = P_1S_1/Q_1.$$

Let [CD . AB] be denoted by R. Then, since [AB] = [AB . AB],

$$[AB] = [AC . AB] + [CD . AB] + [DB . AB]$$
$$= R + [AC . AB] + [DB . AB].$$

For convenience we shall denote [AC . AB] by X and [DB . AB] by Y, and P_1S_1/Q_1 by R_1. Then

$$R + X + Y = R_1. \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

For the second adjustment the battery is joined to E and A and the galvanometer to F and D, and the balancing resistances are P_2, Q_2, S_2; we denote P_2S_2/Q_2 by R_2. Then, if u and v be the currents in ABE, AFE, we have

$$Q_2v = [DB . AB]u + S_2u = Yu + S_2u,$$
$$P_2v = [AD . AB]u = [CD . AB]u + [AC . AB]u = Ru + Xu.$$

Hence, by eliminating u/v,

$$R + X - YP_2/Q_2 = R_2. \quad . \quad . \quad . \quad . \quad . \quad (2)$$

For the third adjustment the battery is joined to E and C and the galvanometer to F and B. The balancing resistances are P_3, Q_3, S_3, and P_3S_3/Q_3 is denoted by R_3. Then

$$Q_3v = S_3u.$$

Equating to zero the P.D. between F and B for the branch BAF, we have

$$P_3v + [BA . CA]v + [BA . CB]u = 0,$$

or

$$P_3v + Xv = [CB . AB]u = [CD . AB]u + Yu = Ru + Yu.$$

Hence

$$R - XS_3/Q_3 + Y = R_3. \quad . \quad . \quad . \quad . \quad . \quad (3)$$

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From (1), (2) and (3) we can find R, X, and Y. From (1) and (3)

$$X=\frac{(R_1-R_3)}{1+S_3/Q_3}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

and from (1) and (2)

$$Y=\frac{R_1-R_2}{1+P_2/Q_2}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Hence, by (1),

$$R=R_1-X-Y=R_1-\frac{R_1-R_3}{1+S_3/Q_3}-\frac{R_1-R_2}{1+P_2/Q_2}. \quad . \quad . \quad (6)$$

This method is well adapted for measurements on standard 1-ohm coils having current and potential terminals. In these coils the potential and current terminals at each end of the system are close together on a thick copper conductor, and thus R_1-R_3 and R_1-R_2 will be small. The small changes which are required to produce a balance in the three positions can be very accurately made by shunting one out of P, Q and S. It will be seen that the resistances are permanently connected at A, B, E, F, and thus all variable contact resistances are eliminated.

It will be seen that equations (1), (2) and (3) are exactly those which we should have obtained if the system A, B, C, D had been of the form shown in Fig. 23; here H K are joints of perfect conductivity and AH=X, HK=R and KB=Y. But the model in Fig. 23 *cannot* replace the actual system for *all* purposes, unless it happens that [AC . BD]=0 for the system itself. In the determination of R or [AB . CD] by the present method we are, however, only concerned with the three resistances R=[AB . CD], X=[AC . AB] and Y=[DB . AB], and thus the actual system may be replaced by *any* model which has the same values of these three resistances as the system itself has.

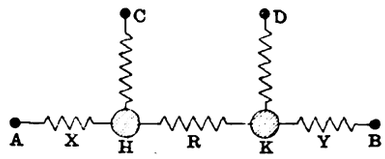

Fig. 23.

The model of Fig. 23 is not the only one which may be substituted for the actual system *for the purpose of the present measurement*. If we express R, X, Y in terms of the resistances of the eight-wire model of Fig. 7, we obtain

$$R=[AB\,.\,CD]=r_{13}-r_{23}=p^2/(p+q),$$
$$X=[AC\,.\,AB]=r_{11}-r_{13}-r_{12}+r_{23}=a+pq/(p+q),$$
$$Y=[DB\,.\,AB]=r_{22}-r_{12}=b+pq/(p+q).$$

If we select any value for q we can find from these equations the values of p, a, b in terms of R, X, Y, q, and thus we can make as many models as we please. But each of these will only serve to define [AB . CD], [AC . AB] and [DB . AB], and *cannot be used for any other purpose*.

§ 28. *Third Method.*—This method depends upon the results (8) and (9) of § 23. Let $[AB]_Q$ be the resistance between A and B when C and D are joined by a wire of resistance, Q, while [AB] is the value when Q is absent. Let $[CD]_P$ be the resistance between C and D when A and B are joined by a wire of resistance, P, which [CD] is the value when P is absent. Then,

$$[AB\,.\,CD]^2=\{[AB]-[AB]_Q\}\{Q+[CD]\}, \quad . \quad . \quad . \quad (1)$$
$$[AB\,.\,CD]^2=\{[CD]-[CD]_P\}\{P+[AB]\}. \quad . \quad . \quad . \quad (2)$$

It is convenient to attach to the four terminals A, B, C, D (Fig. 24) four connecting wires AE, BF, CG, DH, the lengths of these wires being sufficient to allow them to be connected to the proper points of the resistance box or other form of the Wheatstone bridge which may be employed. The connections at A, B, C, D must be carefully made, and must remain undisturbed during the series of measurements. If due regard has been paid to the design of the system A, B, C, D we may write

$$[AB\,.\,CD]=[EF\,.\,GH],\quad [BC\,.\,AD]=[FG\,.\,EH],$$
$$[CA\,.\,BD]=[GE\,.\,FH],$$

and hence we may substitute the points E, F, G, H for A, B, C, D as far as the three four-terminal resistances are concerned.

The points E and F are connected to the Wheatstone bridge and the resistance [EF] is found. The points G H are then connected by a good short-circuiting key, and the new resistance $[EF]_0$ is measured. If CG+DH=Q, we have

$$[AB]-[AB]_Q=[EF]-[EF]_0.$$

Since Q+[CD] is the resistance between G and H when E and F are not connected, Q+[CD] may be denoted by [GH]. Thus, by (1)

$$[AB\,.\,CD]^2=\{[EF]-[EF]_0\}[GH].$$

The *sign* to be given to [AB . CD] depends upon which of the two potential terminals is denoted by C.

If $[GH]_0$ be the resistance between G and H when E and F are connected by a short-circuiting key, we have, by (2)

$$[AB\,.\,CD]^2=\{[GH]-[GH]_0\}[EF].$$

The method is not well adapted for cases in which [AB . CD] is very small, on account of the impossibility of securing invariable contact resistances at EF and GH.

§ 29. *Fourth Method.*—This method depends upon the result obtained in § 13.

$$[AB\,.\,CD]=\tfrac{1}{2}\{[AD]+[BC]-[AC]-[BD]\}.$$

Four connecting wires AE, BF, CG, DH are joined to this system as in Fig. 24. If the system is properly designed, [EF . GH]=[AB . CD]. In this case

$$[AB\,.\,CD]=\tfrac{1}{2}\{[EH]+[FG]-[EG]-[FH]\}. \quad . \quad . \quad (1)$$

Thus, [AB . CD] can be found by measuring the four resistances on the right side of (1). If the two additional resistances

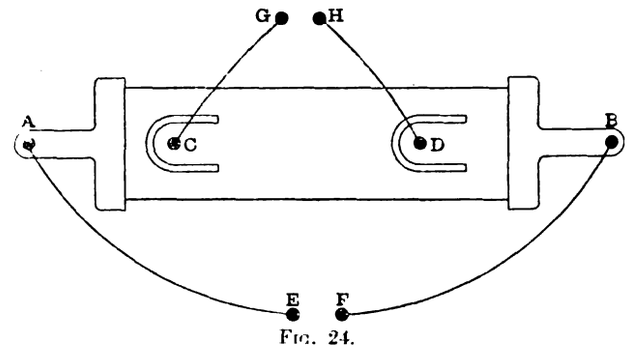

Fig. 24.

[EF] and [GH] are determined the whole of the six two-terminal resistances for the system EFGH are known, and hence [BC . AD] and [CA . BD] can be found. The resistances of the four wires AE, BF, CG, DH can be measured, and so the six resistances AB, AC, AD, BC, BD, CD can be found. All the three-terminal resistances for the system can then be calculated. Though this method gives more information than the others, the large number of variable contacts involved tends to make it less accurate, unless the six resistances AB, AC .... are large. . . .

§ 30. *The Thomson Bridge.*—In the previous methods the four-terminal resistance [AB . CD] of a system ABCD is compared with a number of two-terminal resistances. In Lord Kelvin's method a second system, EFGH, is employed, and the ratio of [AB . CD] to [EF . GH] is determined by the aid of a number of two-terminal resistances. The method has the great advantage that the inevitable contact resistances affect only coils of considerable resistance, and thus the method may be used for accurate comparisons of four-terminal resistances as low as 0·00001 ohm.

When the systems are such that [AC . BD]=0 and [EG . HF]=0 each system can be replaced by the simple five-wire model discussed in § 17, and the derivation of the necessary formulæ is very easy. It has been generally assumed that the systems occurring in practice can be replaced by these simple models, and the formulæ have been obtained on that assumption. In some cases the special condition is exceedingly nearly satisfied, but in the case of very low resistances the special condition is only approximately satisfied. Since the Thomson bridge is the best method of comparing these very low resistances it becomes essential to obtain the accurate formulæ which apply to the general case in which [AC . BD] and [EG . HF] do not vanish.

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The arrangements for carrying out the method are shown in Fig. 25. One of the systems has AB for current terminals and CD for potential terminals. Its four-terminal resistance AB (CD) or [CD . AB] will be denoted by P. The other system has EF for current terminals and GH for potential terminals, and [EF . GH] or [GH . EF] will be denoted by Q. The two systems are associated with two main resistances KD = R, KH = S, and with two auxiliary resistances LC = U, LG = V. The terminals AE are joined by a connector AOE of small resistance, the smaller the better. It is convenient to select some definite point on AE and to denote it by O.

We shall now investigate the relation which exists among the various resistances, when the galvanometer indicates no current. Let the battery current $x+y+z$ so distribute itself that x flows along DKH through R and S, y along CLG through U and V, and z along the connector AOE. Since there is a balance, the difference of potential between D and K is equal to that between D and L, and the difference of potential between K and H is equal to that between L and H. Further, the difference of potential between L and O by the path LCO is equal to that by the path LGO. Expressing these three conditions in symbols, we obtain the three equations

$$Rx=[DL\,.\,BD]x+[DL\,.\,BL]y+[DL\,.\,BO]z,$$
$$Sx=[HL\,.\,FH]x+[HL\,.\,FL]y+[HL\,.\,FO]z,$$
$$0=[LO\,.\,BD]x+[LO\,.\,BL]y+[LO\,.\,BO]z=[LO\,.\,HF]x+[LO\,.\,LF]y+[LO\,.\,OF]z.$$

When the current and potential terminals are properly selected, we may write

$$[DL\,.\,BO]=[DC\,.\,BA]=[CD\,.\,AB]=P,$$
$$[HL\,.\,FO]=[HG\,.\,FE]=[GH\,.\,EF]=Q.$$

We shall employ the following abbreviations :—

$$R=[DL\,.\,BD]=R+[CD\,.\,BD]=R',$$
$$S=[HL\,.\,FH]=S+[GH\,.\,FH]=S',$$
$$U=[DC\,.\,AC]=U',\quad V+[HG\,.\,EG]=V',$$
$$[LO\,.\,BO]+[OL\,.\,OF]=[CO\,.\,BO]+[OG\,.\,OF]=N,$$
$$[DL\,.\,BD]=[OL\,.\,BD]=W_P,\quad [EG\,.\,FH]=[OL\,.\,FH]=W_Q,$$
$$W_P+W_Q=W.$$

Then we have

$$[DL\,.\,BL]=U=[DC\,.\,BC]=U+[DC\,.\,BA]+[DC\,.\,AC]=U'+P$$
$$[HL\,.\,FL]=V=[HG\,.\,FG]=V+[HG\,.\,FE]+[HG\,.\,EG]=V'+Q,$$
$$[LO\,.\,LF]=U+[CA\,.\,CB]+V+[GE\,.\,GF],$$
$$=U+[BD\,.\,AC]+[DC\,.\,AC]+V+[EG\,.\,FH]+[HG\,.\,EG],$$
$$=U'+W_P+V'+W_Q=U'+V'+W.$$

By use of the abbreviations the three equations for x, y, z become

$$R'x-(U'+P)y-Pz=0, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$
$$S'x-(V'+Q)y-Qz=0. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$
$$Wx-(U'+V'+W)y-Nz=0. \quad . \quad . \quad . \quad . \quad (3)$$

The relation existing between the resistances when no current passes through the galvanometer is found by eliminating x, y, z from these equations. The relation can be expressed in two forms. To obtain the first form we write

$$U'-P=X,\quad V'+Q=Y,\quad U'+V'+W=M.$$

Then we have

$$PS'(M-YW)-Q(MR'+XW)+N(S'X-R'Y)=0.$$

Or

$$PS'\left\{M+YW+W\left(\frac{S'X}{R'}-Y\right)\right\}-N(S'X-R'Y),$$
$$\frac{P}{Q}=\frac{R'}{S'}-\frac{Y}{Q}\cdot\frac{N-QW/S'\left(X\quad R'\right)}{M+YW/S'\left(Y\quad S'\right)}. \quad . \quad . \quad . \quad (4)$$

The ratio X/Y can be found by a second adjustment of the resistances. The connector AOE is removed, and R and S are adjusted to the values R_0 and S_0, the corresponding values of R' and S' being R_0' and S_0'. The resistances U and V remain unchanged and thus X and Y are unchanged. Since the current now flows, zero the equations for x and y are

$$R_0'x=Xy,\quad S_0'x=Yy,$$
$$X/Y=R_0'/S_0'.$$

The general condition for a balance when the connector AOE is in place can then be written

$$\frac{P}{Q}=\frac{R'}{S'}-\frac{Y}{Q}\cdot\frac{N-QW/S'\left(R_0'\quad R'\right)}{M+YW/S'\left(S_0'\quad S'\right)}. \quad . \quad . \quad . \quad . \quad . \quad (5)$$

If the four resistances R, S, U, V can be so adjusted that the removal of the connector does not disturb the balance, then $R_0'/S_0'=R'/S'$. The equation then takes the simple form

$$P/Q=R'/S'. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

The quantity N depends upon the resistance of the connector AOE, and cannot be made to vanish. The presence of W expresses the fact that the two systems cannot be replaced by two five-wire models, since W does not vanish unless the systems can be so replaced ; we need not consider the special case in which $W_P=-W_Q$. It is remarkable that when the condition $R_0'/S_0'=R'/S'$ is secured, the whole of the correcting term involving N and W vanishes. The adjustment $R_0'/S_0'=R'/S'$ has been very generally secured in practice with a view to

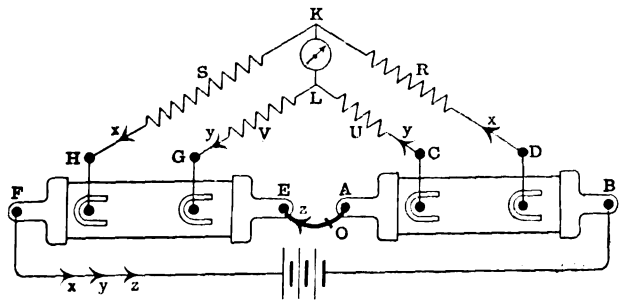

Fig. 25.

eliminate any correction for the resistance of the connector. But it appears that the undesigned advantage of eliminating the correction depending upon W has been gained at the same time.

The quantity [CD . BD] which appears in R' may be determined by sending a current from B to D, and measuring the fall of potential from C to D, and likewise for [GH . FH].

When the conditions are such that the resistances R, S, U, V can be made large, the resistances [CD . BD] and [GH . FH] can be eliminated by making a second adjustment, in which R and S have the values R_1 S_1. The resistances U and V are again adjusted so that the balance holds good whether the connector is in place or not, We then obtain

$$P/Q=R_1'/S_1'.$$

Then,
$$\frac{P}{Q}=\frac{R'}{S'}=\frac{R_1'}{S'}=\frac{R'-R_1'}{S'-S_1'}=\frac{R-R_1}{S-S_1}. \quad . \quad . \quad . \quad (7)$$

In this case P/Q is given simply by the ratio of the change in R to that in S.

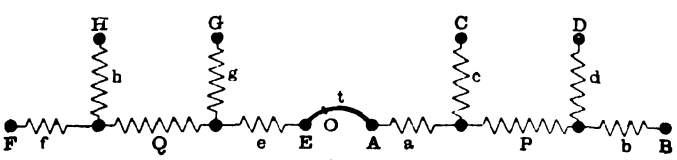

Fig. 26.

The second form of the condition for a balance is found by eliminating x, y, z from equations (1) to (3) without substituting X and Y for U' + P and V' + Q. We then obtain

$$PS'\{M+N+V'W/S'\}=QR'\{M+N+U'W/R'\}-N\{S'U'-V'R'\}.$$

Hence, since $M=U'+V'+W$,

$$\frac{P}{Q}=\frac{R'}{S'}-\frac{V'}{Q}\cdot\frac{N-QW/S'}{U'+V'+N+W(S'+V')/S'}\left(\frac{U'}{V'}-\frac{R'}{S'}\right). \quad . \quad (8)$$

This equation is useful when U'/V' can be accurately determined as well as R'/S'. This involves the determination of [DC . AC] and [HG . EG] by the fall of potential method. The equation used at the Reichsanstalt in comparing a resistance of 0·00001 ohm with one of 0·0001 ohm is derived from equation (8) by putting W = 0.

It may be useful to exhibit the values of R', S', U', V', N for the case in which each system can be replaced by a five-wire

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model. In terms of the resistances indicated in Fig. 26, we have

$$R'=R+d, \quad S'=S+h, \quad U'=U+c, \quad V'=V+g,$$
$$N=a+e+t.$$

Since W_P and W_Q are zero for the five-wire models, the latter are inadequate to represent the general case.

Conclusion. The author desires to express his sincere thanks to Mr. F. E. Smith of the National Physical Laboratory for the great labour he has bestowed upon the criticising and discussion of the paper in its various stages; his help has been invaluable. Thanks are also due to Dr. Heaviside, F.R.S., and Dr. Bromwich, F.R.S., for mathematical assistance, and to Dr. E. B. Rosa of the Bureau of Standards, and Dr. St. Lindeck of the Reichsanstalt, for information as to the methods adopted in those institutions. Mr. G. M. B. Dobson, B.A., of Caius College kindly prepared the drawings for the illustrations.

PUBLIC ELECTRIC SUPPLY IN COUNTRY DISTRICTS.

We give below an account of the discussion that took place at the meeting of the Yorkshire Local Section of the Institution of Electrical Engineers on the 5th inst., when Mr. W. B. Woodhouse read his Paper on this subject.

Mr. W. Emmott referred to the discussion that took place in 1904 on this subject, when Mr. Woodhouse urged the necessity of his power company supplying Urban District Councils, as against a supply from the boroughs. About an equal division of opinion on the matter was shown. Things had altered considerably, and the speaker was now in favour of the lack of electric supply in the out-districts being met by the Yorkshire Power Co., as the municipal authorities now realised that they had quite work enough at home without extending their borders. Many districts were now supplied by the Yorkshire Power Co., to the satisfaction of both the consumers and the Company. It was impossible to estimate the value to an out-district, where rates were considerably lower than in the boroughs, of an electricity supply, as manufacturers were realising that it would pay to put down their works outside the boroughs, thus saving considerably in rates, paying less for land, and getting current for power and lighting on the most favourable terms. This practice was bound to increase, and he foresaw a great and successful future for the Company.

Mr. A. G. Lupton thought a supply of electric power was undoubtedly required in Yorkshire, particularly in the West Riding. The development had been much slower than he anticipated. A point not always recognised was that textile mills were formerly planned and built so as to have the heavy work near the engine and the lighter work at the far end of the shafting; with electric power the mill could be planned to suit the processes that had to be carried out, and not merely to assist the mill engine to carry its load. There were other important advantages in being able to run part of the works at night time, &c. He put efficiency first and economy second, and if the electric drive gave both these to advantage there was the further consideration that the smoke which disgraced the whole community should be got rid of. The waste of national resources could be limited by such general engineering schemes as those of big power companies. He believed they were on the verge of great improvements in social conditions arising from conservation of national forces and the benefits that would accompany it.

Mr. J. W. Hame (York), as a representative of a municipal electric supply undertaking, thought municipalities were very much indebted to the pioneer work which the large supply companies had done. Before the large companies on Tyneside and elsewhere commenced to develop their undertakings, very little was done by municipalities to supply current for power purposes. This had an important bearing with municipalities in their commercial development. One of the most interesting points in the Paper to a municipal engineer was the development of cottage lighting. The only commercial way at present to supply electricity for cottage lighting was by means of overhead wires. With reference to the Barnsley installation, he asked whether the overhead wires were used solely for public lighting or partly for public lighting and partly for domestic lighting.

Mr. S. D. Schofield agreed that it was undoubtedly impossible to supply country districts from a small station with underground mains, and that if a supply of electricity was to be given in country districts, it must be by taking a bulk supply from a power company or large power station, in conjunction with a small sub-station or transformers, with overhead lines and with a minimum maintenance cost.

Mr. E. A. Barker (Barnsley) gave a few figures with reference to the street lighting on the outskirts of Barnsley. At present two approaches to the borough were served with street lighting from overhead mains. The longer of the two was 1,100 yds. and the cost worked out at £93, including three-section steel poles, wires, insulators, lamp brackets, globes and service to overhead supply; about 1s. 8d. per yard. The author had stated that the cost of 36 street lamps was £100. At Barnsley the brackets and hoods cost 15s., so that the author's figure might be easily reduced to below £40. At the end of these overhead mains the District Council had street lighting by the latest type of incandescent gas, and a considerable amount of competition had taken place with regard to the relative costs. Several photometer tests had been made between the last Corporation electric street lamp and the first incandescent gas lamp in Dodworth (the District Council area), this distance being 90 yds. The balancing point of the light was on each test at a point 39 yds. from the gas lamp and 51 yds. from the electric, showing a penetrative power, in favour of the electric, of 25 per cent. The total annual cost of the electric street lamp was something like 3s. per post less than gas. With reference to Mr. Hame's query, no provision was made for domestic lighting, there being no houses in the district. In the distance of 1,100 yds. there were 11 lamps, each giving 100 c.p.

Mr. F. Thursfield said the smoke nuisance emanated largely from the domestic fire, and if small amounts of power could be provided at anything like the price at which large amounts of power were being supplied, there was a very large load indeed to be found for domestic heating by electricity. He did not think that the difference between the cost of producing electricity by the large power company and the small local authority was so great as the author made out. A small local authority with one or two oil engines could produce power in a small area very cheaply indeed. As far as fuel costs were concerned, it could work almost as cheaply as the larger concern. The chief difference was in capital outlay and in attendance. He thought Mr. Woodhouse had omitted the chief point in favour of the power company, viz., that the small urban authority was not justified in sinking much capital in a business which might in a few years' time become more or less antiquated. He was surprised by the author's statement that the annual revenue from a business supply rarely exceeded 15 per cent. of the capital expenditure. The cost of street lighting at £2 per lamp per annum was very low. At Chester they had a large number of these lamps, in fact, nearly every street gas lamp was converted, but he could not possibly get the cost of running below £3 per lamp. The author only counted on 2,000 hours per year; the usual street lighting hours amounted to over 3,000 per annum.

Mr. Holliday (Ardsley) assured members that some prejudice existed against overhead mains. If people could only see overhead mains taken along in such a neat manner as shown on the screen that evening it would go a long way towards removing the prejudice. The author had not made the most of one of his points with regard to extinguishing and lighting lamps. By switching the lights on and off simultaneously so many lamplighters were not required, and in a small district like Ardsley the saving in this direction would be at least £60 per annum.

Mr. I. Fawcett thought that a cottager who could afford to take 160 units per annum was a very good customer, and it would be cheaper to move than pay the bill. The difficulty of supplying farms was that they were generally off the line of the main road, and possibly off the line of the mains, and it did not look as if it would pay.

Mr. H. M. Sillar said that some small local authorities were debarred from starting an electric supply because they were afraid of the cost of a Provisional Order (£150 without opposition). He asked whether the author could advise very small authorities to start a supply without an Order; also whether it would be possible for several Local Authorities to obtain a joint Provisional Order and after that to work their districts separately.

Mr. H. Dickinson (Leeds) asked the author to give his experience in approaching the various Local Authorities or Urban District Councils, and whether he found much opposition to overhead wires. The author had made out a very good case, but he might have emphasised the general position of the bulk supply much more strongly than he had done; for instance, the great advantage of combination. Some time ago he (the speaker) went into the question of tramway supply in conjunction with lighting stations, and in comparing the results in other towns and taking the maximum load for lighting and the maximum load for traction, he found that in many cases the maximum traction load came in the summer and the maximum lighting load in the winter. There was an enormous saving in capital expenditure on plant. In the case of one combined station the saving in capital at £30 per kilowatt, including land, plant and buildings, worked out at £78,000.

Mr. W. Hartnell said that electricity, like everything else, must be produced at its lowest cost. He believed when the Post Office had this question of wires before the House of Commons the cost of installing the cables underground was mentioned as being six or seven times more expensive than to place them overhead, and the Post Office declined to put them down.

Mr. H. H. Wright said nothing had been mentioned of any competitive sources of cheap power. As wind was perhaps the cheapest form of power it might have some bearing on the subject of cheap production of power.

Mr. T. Harding Churton referred to the importance of using large units and overhead mains. Like every Englishman he had a lingering affection for the fireside, and thought it would be a long time before they abandoned the coal fire. As far as cooking was concerned, however, they did not feel the same sentiment.

Mr. W. B. Woodhouse, in reply, mentioned that 95 per cent. of the power used on the banks of the Tyne was supplied by the power company and the result was that the fogs and the mists that used to hover about had been enormously reduced and the amount of sunshine increased. The collection of small accounts was difficult, and the simplest way was to include it in the rent. Mr. Thursfield had thought he did not allow sufficient return on the capital. If, however, one took the accounts of most small undertakings it would be found that the gross revenue was

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...ave than 15 per cent. on the capital, which in many cases was ... like £100 per kilowatt. As to wind power, a gentleman who had ... said the difficulty was that they had the least wind in Novem... when the foggy days were prevalent. As to cottage lighting being ... the case quoted was where they were using carbon lamps. ... pointed out in the Paper, with metal lamps the cost would be quite ... As to the farms being out of the way, the transmission ... could run across the country and miss the main roads, and with... difficulty could be made to approach most farms. Mr. Sillar ... some interesting points of cases where very small districts, of ... 4,000 inhabitants, required a supply of electric lighting for street ... Any Parish Council could adopt the Lighting Act, but without ... a Provisional Order they could not get powers to supply elec... to houses. It was an unfortunate state of the law. All these ... districts had to spend a good deal of money to get the powers. ... never got them the undertaking was so small that it could never be ... a success. That difficulty could be got over, however, as in the ... North Metropolitan Company, by Local Authorities support... power company to get a clause to allow them to supply lighting ... where a Provisional Order was not justified, giving the Local ... the option of taking over the lighting mains at a later date if ... to do so. The only case that he could remember of Local ... joining to obtain Provisional Orders was in Lanarkshire, ... number were taken out by the County Council and handed them ... the power company. As to using the telephone poles for lighting ... did not know of a case where that was done, but it seemed the ... In a number of recent tramway Acts the Postmaster-General ... to run his telegraph wires on the tramway poles, making ... for the privilege. All public supply authorities should ... one thing. In America it was common practice to join together ... of the poles. The opposition to overhead wires varied very ... In the case of Horsforth the streets were very narrow, ... good many places overhead wires would not be possible, but in ... districts the Council had been very ready to agree.

TRIALS BY THE TRAMWAYS AND LIGHT RAILWAYS ASSOCIATION ON SPEED INDICATORS FOR TRAMCARS.

In 1908 the Tramways and Light Railways Association was re... by the Board of Trade to furnish them with its observations ... subject of speed indicators for tramcars. The matter was ... discussed at several meetings of the council, and in February, ... a circular letter was addressed to every member of the Associa... asking his views upon the subject. Fifty-eight replies were ... and discussed by the council, with the result that the Board ... were informed that no indicator on the market satisfied ... conditions, and that this class of instruments was not ... to fulfil a useful function on tramcars.

As a result, however, of further correspondence with the Board an ... appeared in the technical papers in June, 1909, offer... trials for official trials of any speed indicators of merit. ... replies were received, and a committee consisting of ... R. W. Cramp (Birmingham & Midland Tramways), H. ... (West Wakefield), W. E. Ireland (L.C.C.), C. W. Mallins (Liver... A. H. Pott (Metropolitan Electric Tramways), Sir Clifton ... (London United Tramways), J. R. Salter (Lancashire ... Tramways) and S. Sellon were appointed to carry out trials ... report on the various instruments submitted.

The conditions under which the tests were carried out and the pro... which was adopted by the undertakers carrying out the tests ... indicators, together with a description of the instruments ... and transmission gears and the detailed results of the tests, ... in the April issue of the "Journal" of the Tramways ... Railways Association. Ten instruments were finally ... and each competitor had also to design and supply his ... gear.

In the general remarks with which the committee conclude their ... it is pointed out that the majority of the makers submitting ... instruments were unacquainted with the difficulties met with ... working under tramway conditions. The instruments had ... been designed (1) for experimental work on locomotives, ... and stationary engines, (2) for stationary engines alone ... motor cars. Instruments of the first of these classes are, ... remarks point out, suitable for tramway work, though they ... special adjustments and are expensive. Speed indicators ... for use in the second class are generally quite unsuited for ... work. The instruments in the third class, which are de... motor cars are usually adaptable to trams, though some ... instruments submitted were handicapped by faulty trans... gear. When it became evident that the transmission gear ... the chief difficulty it was decided that all makers' instru... should be, as far as possible, tested on the same type of car—... bogie trucks—this being the most suitable type, as it is easier to find a position in which to fix the gearing. The cheapest and easiest transmission is from indicators actuated by dynamos. This is also the cheapest form of indicator where they have to be fixed at both ends of the car. In considering the best form of transmission gear, it must be borne in mind that almost all types will be damaged on bogie cars by a derailment, unless the gear is designed to come adrift when the truck radiates too much. When only an insulated wire runs between the truck and the platform, the damage is limited to the rupture of the wire. There is no doubt that all-mechanical transmission gears must be strongly made and encased throughout, so as to be protected against mud and water. Moving parts must, however, be accessible for lubrication. There is possibly not much improvement required in the design and workmanship of instruments by leading makers. The centrifugal patteras are usually cheaper, but have the disadvantage of not recording at very low speeds. The cases should always be as weather-proof as possible.

It is pointed out by the committee that there is a strong feeling among some engineers and tramway managers that it is most undesirable to place anything on the car which may tend to withdraw the motorman's attention from the road. It is suggested that the fitting of speed indicators might act in this way, especially with young motormen, and lead to accidents which would otherwise have been avoided.

From a careful consideration of the tests of speed indicators which were specially submitted for the Tramways and Light Railways Association tests, and of others previously tested, the committee have formed the following conclusions:—

1. That there are now speed indicators on the market which, so far as the instruments themselves are concerned, have worked satisfactorily during the tests, although it is not at present possible to state what their life is likely to be when fixed on tramcars.

2. That transmission gears could be made which might stand for some time the rough conditions met with underneath a tramcar; their first cost and maintenance, however, must be considerable.

3. That in view of the first cost and the cost of maintenance of instruments and transmission gear it would be a serious burden on tramway undertakings to have to equip service cars with indicators.

4. That as the proper maintenance of the existing equipment on a car already fully occupies the attention of the staff during the short time available between cars leaving and returning to the sheds, it is most undesirable to add anything more to a car which will require attention, especially if this is not a vital part of the equipment.

5. That the electrical form of speed indicator is the cheapest and easiest to fit, but from the tests it will be seen that indicators of this type appear unable to stand the rough conditions of tramway operation.

6. That if speed indicators are required at all, they should only be fitted on cars for instruction and test purposes.

7. That except for special test purposes, no speed recording chart is necessary, and a mileage recorder is not required.

8. That no indicator showing the maximum speed attained (by ringing a bell or moving a maximum pointer) is of much value, as the authorised speed varies at different parts of the same route; and whereas it may be safe to exceed a speed of, say, 16 miles per hour on one part of a route, it may be dangerous on another part of the same route to exceed even 4 miles per hour.

9. That since the most successful form of transmission is that in which a belt or chain is driven from one of the car axles, the wear of the wheel will necessitate a constant adjustment of the instrument, otherwise there would be a considerable inaccuracy in the reading of the indicator.

Electrification of Chicago Main Lines.—According to "Engineering News" a railway electrification committee has been appointed by the Chicago Association of Commerce to investigate the problem of converting the steam railway terminal lines to electric traction. The railways are represented on the committee by the presidents of the Chicago & Western Indiana Railway, the Chicago & Northwestern Railway, the Chicago, Burlington & Quincy Railway, and by the vice-president of the New York Central Railway. The city is represented by the Chief Smoke Inspector, the Health Commissioner, the chairman of the City Smoke Commission and the chairman of the council Committee on Local Transportation. The other members are Dr. W. F. M. Goss, of the University of Illinois, the president of the Northwestern Elevated Railway, and several business men. The committee will appoint a chief engineer and engineering staff and will maintain permanent headquarters.

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SPEED INDICATORS ON TRAMCARS.

About two years ago some correspondence passed between the Board of Trade and the Tramways & Light Railways Association in regard to the employment of speed indicators on tramcars. The Board were of opinion that the evolution of an instrument for this purpose should be encouraged, and that it should be used at least for the purpose of training the drivers. Although the Association did not welcome the idea of using speed indicators to any great extent, they were quite willing to carry out tests on instruments supplied by the makers and to report generally on the results of such tests. Consequently, an advertisement was prepared asking makers to submit instruments and laying down terms on which the trials would be conducted. The Report has now been issued, and appears as the April number of the "Journal" of the Tramways and Light Railways Association.

It is, perhaps, a little unfortunate that the trial of the speed indicators was complicated by that of the transmis-

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...ion gear, and that the makers of the instruments were ...sponsible for the latter also. The design of a really satis... ...ion gear for transmitting motion from the bogie wheels ...o the indicator is by no means easy. It requires both ...me and money. Not only must any vertical oscillatory ...ovement of the car frame be taken into account, but pro... ...ision must be made for the very large angular movements ...f the bogie in regard to the frame. This necessitates a ...ear with a great deal of freedom and many working parts, ...all of which are subject to wear and require maintenance. ...It is, in fact, the sort of thing that is repellent to the de... ...igner anxious for simplicity, cheapness and certainty of a ...good result. We do not doubt that some makers felt that it ...was not worth while to spend time and money on a problem ...of this kind when there was no certainty of a return, but ...only a possibility that someone else would profit by their ...efforts.

Finally ten instruments and gears were received, and these ...were tested by running up to some thousands of miles; but, ...as might have been expected, the tests were quite as much ...tests of the transmission gear as of the instruments. On ...the whole, we think it would have been better if makers ...had, in the first instance, been asked to send in a design ...of the transmission gear they proposed to use. Since most ...instruments require the same type of drive, it would have ...been easy to select the best design, or to combine designs ...to give the best result. The number of designs used would ...then have been reduced to a minimum, most of the com... ...peting makers would have been put to the least possible ...trouble, and the different instruments would have com... ...peted on more equal terms. As it was, the Committee ...state that "some of the instruments which did not give ...very good results might have been quite satisfactory with ...more suitable transmission gear." It is also stated that ...while there is not much improvement required in the ...design and workmanship of instruments by leading ...makers. This remark applies to indicators of the class ...used on motor cars; not to those used for experimental ...work and on stationary engines as these are obviously un... ...suited for the arduous life experienced on a tramcar.

The Committee conclude that there are speed indicators ...on the market which have worked satisfactorily, but that ...it is impossible to state what their probable life would be ...on a tramcar. The position in regard to transmission gear ...is more clear. Such gears might be so made as to stand ...for some time, but the Committee are afraid that their first ...cost and maintenance would be considerable. This, it is ...said, coupled with the cost of the instrument, would be a ...serious burden on a tramway undertaking if service cars ...were to be so equipped; also, that the staff already have ...their hands fully occupied without adding further equip... ...ment requiring attention. The view is taken that if speed ...indicators are fitted at all this should only be done for ...experimental or test purposes.

There is no doubt that these conclusions can be pretty ...well supported. One of the weak points of nearly all ...instruments is that the indication depends upon the ...size of the tyre, and as this wears down, the indicator ...becomes inaccurate. By designing the gear to be correct ...for the mean diameter of the wheel the maximum error due to this cause, as stated in the Report, will not exceed 7 per cent. This is still rather a large error, but its elimination would necessitate periodical adjustments of some kind.

Some tramway engineers hold the view that a speed indicator on a car would withdraw the driver's attention from the road, on which it ought to be fixed, and that accidents would occur in consequence. We very much doubt if any such difficulty would be found to arise, because the indicator would not be the primary object in the mind of the driver; no such trouble, for example, arises in the driving of motor cars, in which quite as keen a look-out is necessary. As to whether speed indicators would prove useful from the point of view of safety, we think much must depend upon the character of the road. If the road is straightforward we do not see what would be gained, though drivers should be trained to know something of the limiting speed, for it is scarcely fair to prosecute the drivers of motor cars for exceeding the limit if drivers of tramcars can do so with impunity. On the other hand, where gradients are heavy, and special speed limits have been imposed by the Board of Trade for the sake of safety, we think speed indicators might prove a valuable safeguard. Only those who have driven and observed the speed by means of an indicator realise how very quickly the low speeds sometimes specified by the Board of Trade are reached; and yet safety, when the track is in a greasy condition, may depend upon the strict observance of these regulations.

REVIEWS.

(Copies of the undermentioned works can be had from THE ELECTRICIAN Office, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.)

Solectrics: A Theory explaining the Causes of Tempests, Seismic and Volcanic Disturbances, and How to Calculate their Time and Place. By ALFRED J. COOPER. (London: J. D. Potter.) Pp. ii. + 100 10s.

Lothar Meyer in his "Theoretical Chemistry" states that the proper method of investigating the correctness of any theory or hypothesis is, without reference to the facts, to deduce from it all logical conclusions, and then to compare these deductions with the actual facts; if the facts agree with the conclusions the theory attains a high degree of probability. The author of "Solectrics" by no means pursues this method. He supposes the sun to be the source of a universal energy, embracing all known forms of energy, and he calls this Solectric *force*; then, taking the phenomena which he wishes to explain, in turn, he endeavours to fit his theory round them. Judging by the fit, and also by the curious things it is made to do, "solectric force" would appear to be highly elastic, rather than plastic. The greater part of the book consists in calculations respecting the relative positions of the sun, moon and planets on the dates of past storms, earthquakes, &c., and on these occasions solectric force generally appears as a kind of static charge of electricity; but in the first 18 pages the general theory of solectric force is explained, and it there seems to be a continuous current of electricity. The solectric explanation of the rotation of the earth on its axis may be given as an example—it is very simple and weird. To begin with, solectric force does not behave as an ordinary decent rotor quantity, but it has, nevertheless, two components, called the vertical and horizontal respectively, but not drawn at right angles to each other. The vertical component is a continuous electric current "permanently acting on the side of the earth turned towards the sun," and also "circulating freely past it." This latter behaviour explains the obliquity of the ecliptic, the earth being analogous to a permanently deflected galvanometer needle.

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The horizontal component is also an electric current and encircles the earth a number of times. The interaction of these two components produces rotation, because wires carrying currents flowing in the same direction attract each other, and vice-versa!

The author says that the solectric theory is founded on the dynamical laws of electricity, and he explains that Newton had not the advantage of knowing these laws, but the whole thing would be much more plausible if the first 18 pages were omitted, and solectric force assumed to obey only new laws of the author's discovery. On p. 13 are two remarkable sketches, evidently a product of impressionistic art, showing "solectric power forcing a passage through the insulating atmosphere."

We are exceeding our space, but we hope the Editor will find room for one quotation, illustrating the author's graphic description: "Flaming blazes issued downwards and were returned by the earth upwards. A negro was in mortal fright, seeing great electric sparks passing from him. Can it be contended," asks the author, "that a storm is merely air in movement, after such evidence?" F.F.

Encyclopédie Électrotechnique. Part 35: Les Machines Electriques Alternatives à Collecteur. By L. Barbillion. (Paris: Librairie des Sciences et de l'Industrie.) Pp. 148. 2fr. 50c.

This booklet forms one of fifty-four parts of an encyclopædia of electrotechnics, 10 parts having now been published. The book under notice deals with alternating-current machines with commutators, one-half being devoted to rotary converters and the other to alternating-current commutator motors.

The treatment of the whole subject is of a mathematical nature, but a good knowledge of algebra and elementary calculus will cover all the mathematics used. For so cheap a book the arrangement and printing are very good, and the number of typographical errors is quite small.

The theory of rotary converters, both single phase and polyphase, is dealt with in a very clear manner. The compounding of rotaries is, however, only briefly mentioned; we think that this subject should have been treated more fully.

The greater part of the section on alternating-current commutator motors is given up to the theory of the repulsion motor. The proof that the transformer E.M.F. between the brushes is zero when the brushes are in the neutral position is, to our mind, rather laboured. The elementary mathematical theory of the single-phase commutator motor is given very fully, and compensated repulsion motors are briefly discussed. The treatment being of a theoretical nature, but little mention is made of the methods of preventing sparking at the brushes and other details of a more practical nature.

The book is so very inexpensive that it would be a good investment for the student who is of a mathematical turn of mind. To the student who is not mathematical the book will be of little use, for there is almost a complete absence of purely descriptive matter. A. E. C.

The Encyclopædia of Municipal and Sanitary Engineering. Edited by W. H. Maxwell and J. T. Brown. (London: Constable & Co.) Pp. xiv.+561. 42s. nett.

This volume is intended to provide a handy guide in all matters connected with municipal and sanitary engineering and administration. The constant addition to the duties and responsibilities of local authorities has doubtless rendered some such publication desirable, since it is obviously impossible for engineers and officials to keep themselves fully informed on all the subjects with which local authorities are now concerned. Many well-known experts have assisted in the compilation of the present work, which is of necessity very comprehensive. If, however, we are entitled to judge by those sections which deal, or ought to deal, with electrical matters, we must say that this encyclopædia leaves much to be desired as regards an impartial (or perhaps we might say modern) presentation of subjects of vital importance in municipal work. For instance, in the article on "Gas and Electric Light Testing" a table setting forth the comparative cost of illumination by various methods is given. Electrical energy is taken at 4d. per unit, and a 450 c.p. (250 watt) arc lamp, a 16 c.p. carbon glow lamp, and a 65 c.p. Nernst lamp represent electricity. It is not surprising, therefore, that the cost of 1000 c.p.-hours for these lamps, namely 2·2d., 12·5d. and 6·2d. respectively, compares unfavourably with that of the Welsbach mantle at 2·1d. (gas at 3s. per 1,000 cubic ft.), the intensified mantle (1·2d.) and the Kitson light (0·8d.) The Table is stated to be taken from the book on "Public Lighting" by the author of the article in question, Mr. W. J. Dibdin (formerly Superintending Gas Engineer to the London County Council), but attention should certainly have been drawn to the fact that these figures were in no way representative of modern practice. Again, in the article describing systems of heating, no mention is made of electrical apparatus; but under "Smoke Prevention" it is stated that electric heating can be dismissed as too costly. The solution of smokeless domestic heating is, by the way, looked for in the production of cheap gas at the coal fields, and its supply to our cities through high-pressure mains.

Turning now to the article under the heading "Electricity," we note that the subject is treated from the practical aspect, electricity being considered merely as "something which, consumed in sufficient quantities, serves to provide light and heat, and to propel tramcars and railway trains, and to drive machinery in workshops and factories." An unfortunate error occurs in the second column of the article, a quantity of electricity in kilowatt-hours being stated to be 1,000 times the product of the pressure in volts, the current in amperes and the time in hours. The error is the less pardonable since the writer proceeds: "In other words: kilowatt-hours = 1,000 × volts × amperes × hours." In dealing with power in a later paragraph the same mistake is repeatedly made, power being three times stated to be—

$$\text{kilowatts} = 1{,}000 \times \text{volts} \times \text{amperes}.$$

The brief description given of a flame arc lamp will scarcely be grasped by a non-electrical reader, since the hood of the lamp in the illustration is lettered to correspond with the reference to the carbons in the description. Both carbons are also said to be fed downwards, although the diagram illustrates one carbon vertically over the other.

Reference has already been made to the article on "Gas and Electric Light Testing." It may also be noted—to quote from the article—that "the tolerance shown by public authorities to the electrical industry by neglect to establish a severe system of tests and punishments for default in supply, as in the case of gas, has gone not a little way to encourage the growth of the newcomer in the field of luminous energy." A biased attitude is obvious throughout this article, and is to be deplored in an encyclopædia for reference by public officials.

As it is only possible here to refer to a few of the articles we may just mention that under "Thermometers" no mention is made of any for taking readings at high temperatures. Municipal tramways are briefly dismissed in some 4½ pages. In this section a Table, showing the summarised results of electric tramway operation in this country, would have been more useful if it had been brought more up-to-date than the financial year 1907-8.

A rather remarkable omission is that neither under the heading "Turbines," nor under "Steam Engines," in fact anywhere in the book, is mention made of steam turbines.

A NEW METHOD FOR THE ABSOLUTE MEASUREMENT OF ELECTRIC QUANTITY.*

BY BURTON McCOLLUM.

Summary.—The author describes a type of dynamometer of great sensibility which allows electric quantity to be measured with great accuracy. The proportional dimensions of the coils and the degree of accuracy obtainable are discussed.

In the absolute measurement of current two classes of method are available which are capable of considerable accuracy, viz. electrodynamometer methods and current balances. By the latter form of apparatus measurements of current have been made in which a higher degree of accuracy has been attained than with the first-named type. There are, however, numerous possible sources of error

* Abstract of an article in the "Bulletin of the Bureau of Standards.

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in the use of the current balance, and, although most of these can be made small individually, they may, on account of their number, introduce uncertainty in the result.

In electrodynamometers of the ordinary types the dimensions of the windings must be known with extreme accuracy, thus requiring that the coils not only be wound with great regularity and measured with great care, but permanency of both size and form must be assured. In the Gray electrodynamometer a great difficulty still is met with in measuring the torque, due to the erratic behaviour of all materials available for the torsion wire. They cannot be depended upon to remain constant with time, they vary considerably even with slight changes in temperature, and they all have a greater or less tendency to take a permanent set when twisted. Again, both electrodynamometers and current balances have a rather troublesome temperature coefficient; and although artificial cooling may alleviate this condition somewhat, a certain amount of local heating is inevitable, and the consequent change in the dimensions may give rise to considerable variation in the constants of the instruments between the time of measuring the dimensions of the coils and the time of making a measurement of current.

There is here described a type of electrodynamometer which, when used to measure the electrochemical equivalent of silver, appears to be free from the objections referred to above, without introducing other difficulties of a serious nature. The instrument consists essentially of a relatively large fixed coil, C_1, Fig. 1, with its axis in a horizontal position, at the centre of which is suspended the movable coil C_2, with its axis parallel to the axis of the fixed coil when at rest. Attached to the movable coil is a cylinder, K, of some homogeneous material placed with its axis vertical and coincident with the axis of suspension. This cylinder should be of very regular dimensions, and should have a moment of inertia as large as, or larger than, that of the movable coil. If these two coils be connected in series in proper relation, and a current sent through them, there will exist a couple tending to hold the movable coil with its axis parallel to that of the fixed coil, and if the movable coil be

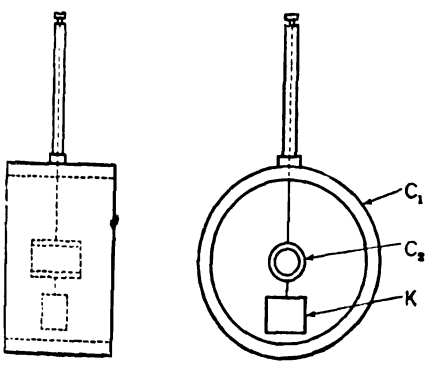

Fig. 1.

given an angular displacement and release, it will oscillate as a torsion pendulum. If now, the form of the field due to the fixed coils be such that the restoring couple is directly proportional to the angular displacement, a condition that can readily be realised, the period of the oscillation will be independent of the amplitude, and we shall have, in effect, a torsion pendulum subject to the laws of a simple harmonic oscillation.

The time of vibration of the moving system is, therefore, given by the equation $T = \frac{2\pi}{\sqrt{R\frac{K}{a^2}-\frac{a^2}{4K^2}}}$, where R is the restoring couple per unit angular displacement, a is the counter torque due to the damping forces at unit angular velocity, and K is the moment of inertia of the moving system. Since, as assumed above, the coils are so proportioned that the torque due to the current i is proportional to the deflection θ, we will have $R = Ci^2 + b$, where C is a constant of the coils, b the constant of torsion of the suspending wire, and R the total restoring couple. We have, therefore,

$$T_1 = \frac{2\pi}{\sqrt{\frac{Ci^2+b}{K}-\frac{a^2}{4K^2}}} \quad \text{and} \quad T_2 = \frac{2\pi}{\sqrt{\frac{b}{K}-\frac{a^2}{4K^2}}},$$

where T_2 is the time of vibration obtained when current is switched off. Solving for i we get

$$i = \frac{2\pi}{T_1}\sqrt{\frac{K}{C}\left(1-\frac{T_1^2}{T_2^2}\right)}.$$

This equation is exact, and shows that damping introduces no error in the calculated value of the current. If the apparatus be properly designed, the ratio $T_1^2 : T_2^2$ can be made small (not exceeding 1 per cent.), so that a very large error in determining this ratio would introduce but a very small error in the value of i. The ultimate accuracy with which i can be measured depends, therefore, on the accuracy with which the three quantities T_1, K and C can be measured. These quantities can be determined with a high degree of precision by methods indicated below. This apparatus and the above equation may be used for the absolute measurement of current, if such is desired.

The time of vibration, T_1, may be written t/n, where t is the total elapsed time and n is the number of vibrations occurring during that time. We have then

$$it = Q = 2\pi n\sqrt{\frac{K}{C}\left(1-\frac{T_1^2}{T_2^2}\right)},$$

where Q is the total quantity of electricity that has passed through the instrument while the movable system is making n vibrations. Thus the instrument may be used for the direct measurement of electric quantity. By using this equation as the working formula, a very high degree of accuracy should be possible. An inspection of the equation will show that it is not necessary that the current be maintained rigorously constant. Indeed, the current might fluctuate continuously within a range of $\frac{1}{2}$ per cent., or it might remain continuously too small or too large by as much as one part in 1,000, and the resulting error in Q would not exceed 1 part in 100,000. The ultimate accuracy with which Q can be determined depends, therefore, on the accuracy with which n, K and C can be determined. Suitable methods for determining these factors are described below.

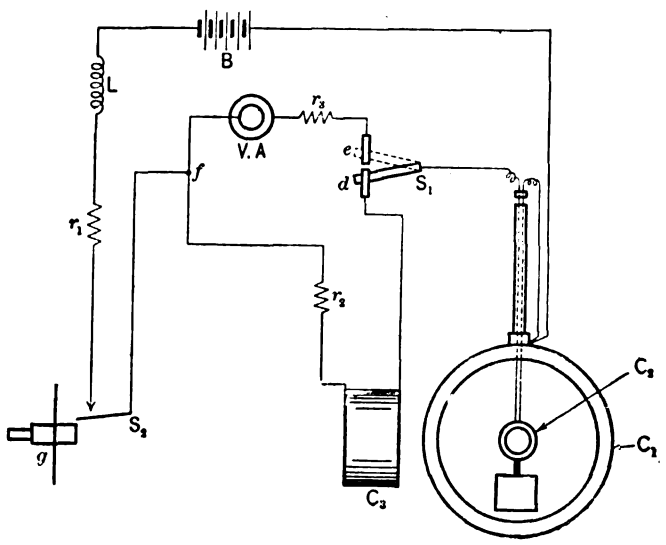

Fig. 2.

Determination of n.—A typical arrangement of the apparatus is shown in Fig. 2. B is a battery supplying current through the regulating resistance r_1, to the coils C_1 and C_2 of the electrodynamometer connected in series. S_1 is a single-pole double-throw switch which at starting is thrown over to the terminal d, so that the current is made to flow through the control coil C_3 which holds the movable coil C_2 at any suitable initial deflection (which need not be measured). The resistance of the circuit df should be previously adjusted nearly equal to that of the circuit ef, which contains the voltameter VA, and the terminals d and e adjusted so that the switch S_1, when thrown over, makes contact with e an instant before breaking the current at d. When ready to start the experiment, the switch S_1 is quickly thrown from d to e which starts the current in the voltameter circuit ef, and at the same time breaks the circuit of the control coil C_3, thus releasing the movable coil C_2, and the vibrations begin. The instrument should then be permitted to swing freely for a sufficient length of time to permit the deposition of enough silver for accurate weighing, during which time the number of complete vibrations of the movable coil is counted. When it is desired to stop the experiment, a reading should be taken of the last maximum deflection θ_0 at the end of n_0 complete vibrations, and about a quarter period later the current should be switched off, and at the same instant the position of the movable coil in its cycle and also its direction of motion should be noted. From these data, the value of n, the total number of vibrations, can be readily determined. In order to determine the position of the coil at the instant of opening the circuit, a telescope and scale, g, and reflecting mirror should be provided as in ordinary galvanometer work. Since the scale is in motion its position must be determined by obtaining

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a momentary view of it at the instant of opening the circuit. Numerous ways suggest themselves for accomplishing this, one of the simplest, perhaps, being as follows: A portion of the scale, preferably the central portion, should be somewhat heavily shaded so that its reflection in the mirror will be very faint, if not invisible. A specially designed switch, S_2, which is used to open the circuit, should be placed near the shaded portion so that the flash caused by opening the switch will illuminate the scale for a brief instant. If, then, the switch be opened when the shaded portion of the scale is being reflected into the telescope, the scale will appear stationary, and its deflection, θ, can be easily read. The brightness of the flash can be made ample by including a self-inductance, L, in series with the circuit if necessary.

The author next shows that $n = n_0 + \frac{1}{2\pi}\cos^{-1}\theta/\theta_0$, where θ is the final deflection, and that the greatest accuracy is attainable if the final reading is taken when θ is small. Assuming that the experiment has continued for at least half an hour, that the period of vibration is 15 seconds, that the final reading is taken when θ is less than $\frac{1}{10}\theta_0$, that the scale is 2 metres from the mirror and that θ_0 equals 1/25 radian, the author calculates that an error as great as 1 mm. in the final reading of the scale would introduce an error of less than 1 part in 120,000 in the value of n, and that any small error in reading θ_0 is reduced 7,536 times in the value of n. With reasonable care, therefore, the precision of the measurement of Q would depend only on the determination of K and C.

Determination of K.—In order that K may be determined accurately, the movable coil should have attached to it a cylinder of some homogeneous material suspended with its axis vertical and coincident with the line of suspension. It should be made of some material that is known to be of uniform density and should preferably be of high electrical resistance so as to avoid excessive damping. Brass and other metal castings are objectionable because of the possibility of blow-holes and other defects which cannot be detected. Glass would seem to be a suitable material. A carefully made cylinder of glass would be expensive, but it would have the great advantage that any inequalities could readily be detected by simple optical tests. It would also be free from damping effects due to induced currents. The moment of inertia of such a cylinder carefully ground to size could be determined with great precision by calculation from its mass and dimensions. The most obvious method of determining the total moment of inertia of the system would be to take readings of the time of vibration, first without the glass cylinder attached and again with this cylinder in place. There are two objections to this method, however. The chief objection is that the torsion wire is subjected to considerably greater tension in the second part of the experiment than in the first, and this would undoubtedly affect appreciably the torsion of the wire. This disturbance could be greatly reduced by using a multifilar suspension, but even then it would probably be troublesome. Further, it is practically impossible to find a torsion wire that can be depended on with certainty to remain constant even under constant stress. These errors can be almost entirely eliminated, however, by making a constant current flow through the coils while taking the period, and there would be no difficulty in making the electromagnetic couple ae least 99 per cent. of the total couple.

Determination of C.—Taking the formula given by Gray* for the mutual inductance between two coils, the author finally shows, with the ratio of length to diameter of the fixed coil $\frac{\sqrt{3}}{2}$ and of the moving coil 2.062, the radius of the fixed coil should be 5·4 times that of the movable coil and that C is given by $\frac{2}{10}M_0$, where M_0 is the maximum mutual inductance, the coils being placed in that position.

The final working formula is, therefore,

$$Q = 2\pi n\sqrt{\frac{10K}{9M_0}\left(1-\frac{T_1^2}{T_2^2}\right)}.$$

The possible sources of error are discussed in the article at some length. It may be noted that the foregoing method for the absolute measurement of electric quantity has not yet been subjected to experimental test, so that the limits of the ultimate accuracy attainable by it cannot be stated with great precision. As compared with the Gray type of electrodynamometer and some types of the current balance, this instrument possesses, in common with the Rayleigh type of current balance, the advantage that errors in the dimensions of the coils are reduced manifold. The Rayleigh balance, however, possesses this advantage in greater degree. The method here described also possesses an advantage over the Gray electrodynamometer in that the torsion of the suspending wires is eliminated. Further, the fact that the indications of the instrument are in a large degree independent of the temperature of the movable coil and of moderate variations in the strength of the working current, contributes greatly to the convenience and to some extent to the accuracy of the method. As to the sensibility of the instrument, it seems that owing to the very great apparent travel of the scale, which, as a rule, would be from 100 to 200 metres, the sensibility of the instrument may safely be said far to exceed the limits of accuracy aimed at in absolute measurements at the present time. The constant of the instrument can be redetermined at any time without disturbing the coils by simply measuring their maximum mutual inductance, and this affords a convenient and accurate check on the stability of the instrument, which would in turn increase considerably the confidence that could be placed in individual measurements. The further fact that the quantity of electricity may be obtained directly without any knowledge of the value of the current being necessary, might often be of advantage where the electrochemical equivalent of silver or other metals is being determined, or, in other cases, where the time integral of current is required.

* Gray, "Absolute Measurements in Electricity and Magnetism," Vol. II., part 1, pp. 274, 275.

BETTINGTON DUST FUEL BOILER.

At a recent meeting of the Yorkshire Local Section of the Institution of Electrical Engineers a new type of boiler was described. The following particulars are based on the remarks made:—

This boiler is of the vertical water-tube type consisting of mild steel top and bottom headers connected by straight steel tubes, the top header being fitted with doors for drawing tubes. A brick lining surrounds the innermost circle of tubes to form the furnace, an important feature being that no binding material is employed for these special fire-bricks. The tuyere or fuel pipe is surrounded by a water jacket into which the feed water is fed, thus forming at the same time a mud drum.

The coal is fed or shovelled into a hopper placed at the side of the pulveriser and from there by a revolving worm to a chute which leads directly into the pulveriser casing. The pulveriser acts also as a blower, and after the coal has been disintegrated it is delivered up into the dust chamber, the finer particles passing direct to the fuel nozzle, the coarse particles returning by gravity to the pulveriser for re-grinding. The gases, on leaving the boiler, pass through an air heater, thereby pre-heating the air prior to its being drawn into the pulverising fan. By thus pre-heating the air, coals containing up to 15 per cent. moisture, or even more, can be easily disintegrated and burned. Slides are provided in the pulverising fan intake for regulating the amount of air, and the coal feed is controlled by means of a friction wheel driven from a shaft or by an adjustable slide in the hopper. The amount of air and coal can be instantly regulated and varied between very wide limits, thus immediately increasing or decreasing the rate of firing to suit any variations in the demand for steam. The fires may be extinguished and re-lighted in a few seconds. The greatest amount of evaporation takes place in the inner row of tubes. The circulation being rapid and the tubes vertical the scale deposit is much less than what would occur in inclined tubes, where the tendency would be for the scale to settle on the lower side and, under sluggish circulation, to burn on in patches, resulting in blisters or boils. In this case it is ejected from the tubes by the rapidly circulating water, returns to the bottom header where there is less ebullition, settles, and is in due course blown out.

It is well known that practically perfect combustion of a finely pulverised fuel can be secured by the introduction of such fuel, with a proper admixture of air, into a heated furnace. Such a mixture of air and fuel dust can be considered as a coarse gas, containing all the elements necessary for complete combustion. A true gas so constituted is explosive; but in the less intimate mixture of a solid and a gas, the rate of transmission of the point of explosion is comparatively low, and under the ordinary conditions of storage, mixture and transmission to furnaces no explosions are possible. In fact, this difficulty of ignition necessitates the surrounding of the discharge of mixed fuel and air with a furnace of incandescent fire-brick.

Hitherto, although the benefits to be derived from pulverised fuel have been taken advantage of at places for burning cement in special kilns, no commercial success has been established in its use for firing boilers. The broad principle now adopted, and which, in combination with special details, has solved the difficulties met in all previous arrangements of the combustion chamber, consists in the use of a vertical gas jet inlet so constructed that a mushroom-shaped

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flame is produced within a closed ring of vertical water tubes, which are part of the steam-producing plant.

The heating up and continuous ignition of the incoming stream of dust and air is effected primarily by the enveloping sheath of products of combustion, now a true gas, or rather a mixture of gases (principally CO_2, H_2O, and N) and at a temperature of about 3,000° F. Obviously this "self-igniter" can never change its predetermined position, no matter how great a velocity is given to the incoming stream of combustible mixture. Ignition is now independent of the incandescent brickwork, which hitherto was in turn dependent upon its proximity to the point of explosion for incandescence. As an experimentally demonstrated fact, the point of explosion does not rise more than about 10 per cent. under the highest feed velocities it is practicable to employ. The tendency is for the enveloping gases to increase slightly in temperature as the velocity is increased. At the same time these returning gases always ensure incandescent brickwork around the tuyere. This has the advantage of storing heat, which is sufficient, after a temporary stop, to re-start the fire by merely turning on the fuel supply. Obviously with gravity and momentum acting in the same direction, *i.e.*, vertical stream lines, no separation can take place in a continuous stream of mixture, no matter how great a difference there may be between the specific weights of its constituents.

From the above it follows that the amount of air used can be reduced to the minimum required for the chemical reactions involved. The mixture, which it is most important should be as thorough as possible, is made before the "coarse gas" is projected into the furnace. As the solid portion forms theoretically only 1/11½th part by weight and an infinitely smaller part by volume of the mixture, it is safe to assume that owing to friction it enters the furnace through the tuyere at the same velocity as its accompanying air, which at this point is relatively high. But, owing to friction and expansion, the air very soon loses part of its initial velocity, but not to the same degree as the coarser particles of coal dust. Although these take fire immediately on entering the furnace, they take an appreciable time to become completely oxidised.

The ash of the fuel in its passage through the zone of highest temperature is converted into a liquid spray. A portion of this liquid spray strikes the brick lining of the furnace and in time trickles down to the bottom edge, being kept in a molten state by the descending hot gases, till it finally reaches the lower or "dripping" edge of the furnace proper. Being unable to adhere to the water-cooled surface it drips and falls clear to the ash pit, which, being relatively cool, chills the ash sufficiently to prevent the succeeding drop from adhering to it. The result is that the furnace automatically keeps itself perfectly clear of slag at all rates of combustion, and deposits the same in a manageable form, *i.e.*, small globules ¼ in. to ½ in. diameter, which are easily discharged to an ash conveyor or raked out periodically—an operation requiring but a few minutes, and not likely to be done at most more than once in 24 hours. This liquid spray also serves a very useful purpose. It renders it possible in running the furnace to dispense with the use of fireclay; the refractory bricks are merely stacked in position, and on firing up for the first time the gases naturally take advantage of all crevices to find their way out to the stack. As even the best coal contains some slag, this, being in the form of a liquid spray, also attempts to escape, being sucked through with the gases. But as this slag reaches at a relatively high temperature it very soon chokes up and hermetically seals all crevices and even large holes, at the same time coating the lining into one solid piece, as well as glazing the inner surface as though with a smooth enamel. Experiment has shown that even large holes several inches in diameter automatically close up, as well as any space there may be between the top edge of the brick lining and its water top, thereby entirely preventing all possibility of short-circuit of the gases.

The combustible mixture enters the furnace along its central axis, and soon after, and undergoes its most intense reaction in what is termed the "point of explosion" for want of a better name, after which it continues its path until deflected either by a layer of gas or the water-cooled metal top and in doing so is partially cooled. This partially cooled gas in which combustion, except for the coarser particles, has virtually ceased, envelopes on its forward escape the "exploding" mixture, thus actually forming a protective lining of gas between the "exploding" mixture and the brickwork lining and the water tubes of the boiler, which, in turn, keeps down the temperature of the brickwork lining within practicable limits. But the "gas" lining, while preventing "blowing" (still one of the most destructive phenomena we have to contend with in any form of combustion), does not prevent the utilisation of the most useful heat waves, popularly known as "radiant heat," which are able to pass directly through the "gas" lining and be absorbed by the brick lining and water tubes without involving their direct contact with its source of production. The boiler heating surface radiating from the central source of heat prevents unequal expansion and contraction of any of the parts, thus preventing unequal stresses being set up.

Among the many advantages of this system and construction of boiler may be mentioned the following:—Elimination of all standby losses, the possibilities of using the cheapest kinds of fine coal, the rapidity with which the output can be varied and steam raised, the perfect system of controlling the amount of air supplied for combustion, the use of hot air, the free and unrestricted circulation of the water, the ease with which all the tubes can be visually inspected throughout their entire length, the prevention of all air-leaks through the outer casing, the reduction in floor space, and the small amount of supervision required.

Messrs. Fraser & Chalmers, Ltd., 3, London Wall Buildings, E.C., are the manufacturers of the plants.

CORRESPONDENCE.

MULTIPLEX TELEPHONY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of March 17th Mr. B. S. Cohen describes a method of multiplex telephony, due to Major George Owen Squier, of the U.S. Army. Referring to this, I beg to remark that this method is neither new nor is it the invention of Major Squier. In the "Elektrotechnische Zeitschrift," for 1907, p. 484, I proved, in the article "Uber Mehrfach-Fernsprechen," mathematically that with high-frequency alternating currents multiple telephony can be pursued, in so much that every current might be the vehicle of a special speech. The currents produced must have such a high frequency that they do not produce sounds in the telephone. I showed also that the best effect is procured if an adjustment is made for resonance. In this manner the alternating currents with the respective messages are separated at both ends of the line—at both the sending and receiving ends. In the above-named article I mentioned also that I was able to transmit simultaneously five messages. I executed these experiments in the electrical laboratory of the Hungarian Post Office. A summary of this article appeared in the "Electrical World," 1907, Vol. XLIX., p. 1228, under the title "Multiple Telephony."

In the meantime I pursued my investigations relating to "multiplex telephony" with high-frequency currents. In the "Elektrotechnische Zeitschrift" of 1908, p. 1119, I published an article entitled "Uber Wechselstromtelephonie," in which I showed the advantages of alternating-current telephony, and remarked that by the tuning of the alternating current to the circuit the speech can be transferred along the circuit without distortion. I showed also that the higher the frequency the higher is the intensity of the speech, and that in this way the much-discussed problem of the telephone relay can be solved in the easiest way, advantages which with loaded lines cannot always be obtained. A summary of this article appeared in the "Electrical World," 1908, Vol. LII., p. 1307, entitled "Alternating Currents for Telephony."

In the meantime I reported my experiments to the first Conference of the European Post and Telegraph Engineers, and I communicated to the Conference the fact that I was able to transmit messages on a line 15 km. long. This communication is to be found in the "Comptes Rendus de la première conférence technique des administrations des postes et des telegraphes à Budapest," 1908, p. 31. After these publications there appeared in the "Elektrotechnische Zeitschrift," of 1909, p. 160, an article signed by Mr. Weinberg (of Washington), in which Mr. Weinberg not only verified my experiments on alternating-current telephony, but also proposed this method for trans-Atlantic telephony, a problem not yet solved to-day. A summary of this article also appeared in the "Electrical World," 1909, Vol. LIII., p. 645, under the title "Alternating Current for Telephony."

Later I worked much on the improvement of methods of multiple telephony, and in the "Elektrotechnische Zeitschrift," of 1909, p. 902, in an article entitled "Zur Mehrfachtelephonie" I described a more complete form of multiple telephony, which can be obtained by the use of electrolytic valves. In this case every alternating current is the vehicle of two messages, so that with the aid of n currents $2n$ messages can be transmitted. In the above-mentioned article I pointed out the great advantages of using high-frequency alternating currents for multiplex telegraphy, and the schemes which I found best for this purpose also appeared. A summary of this article also appeared in the "Electrical World," 1909, Vol. LIV., p. 1058, under the title "Multiplex Telephony."

It appears that the system of multiple telephony claimed by Major Squier is only a simpler form of my method published in the "Elektro-

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technische Zeitschrift " of 1907, p. 484, and described also in the American " Electrical World," Vol. XLIX., p. 1228, in which my scheme is also reproduced, from which also it can be seen that Major Squier's method is only a simpler form of mine, because he uses it only for two messages.

I not only worked it out many years ago in the laboratory of the Royal Hungarian Post Office earlier than Major Squier, but I developed it and improved it with the aid of electrolytic valves to a greater degree than has Major Squier. All these methods and experiments were published in many European and American journals. And if Major Squier has dedicated this system to public use, I beg to remark that this was already done by the above-mentioned publications.

I publish these facts only to prove my priority.—I am, &c.,

AUGUST MAIOR,
Electrical Engineer of the Hungarian Post Office.

Budapest, March 24, 1911.

THE REDUCED CURRENT METHOD FOR LOCALISING FRACTURES IN SUBMARINE CABLES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In connection with Mr. Black's test, described in THE ELECTRICIAN April 7th, there is a simple empirical formula by means of which the distance to the break may be found from each reading. Balance having been found as described in the article referred to, the result, R, is equal to the resistance to the break plus the polarisation error plus the contact resistance. Mr. Black assumes, for practical purposes, that the polarisation error is inversely proportional to the current, and it has been found in practice to be equal to $\frac{100}{c}$ ohms, where c is the unreduced current to line in milliamperes when the balance is obtained. The contact resistance may be taken as approximately equal to the CR per naut (r) of the core at the exposure.

Then $$x = R - \left(\frac{100}{c} + r\right).$$

Applying this to the example given in the article:

1st reading: R=7,109$^{\omega}$, c=6 milliamperes, r=10$^{\omega}$, x=7,083$^{\omega}$.

2nd reading: R=7,127$^{\omega}$, c=3 milliamperes, r=10$^{\omega}$, x=7,084$^{\omega}$.

Actual distance, 7,088$^{\omega}$.

This test, with the above simplified formula, has given excellent results in practice.—I am, &c.,

Electra House, London, E.C., April 15. G. WALD.

WIRELESS TELEGRAPH WORKING IN RELATION TO INTERFERENCES AND PERTURBATIONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We have read with much interest Mr. Taylor's Paper on "Wireless Telegraph Working," and shall feel greatly obliged if you will publish the following observations on the subject.

Mr. Taylor considers the case of a directive aerial of triangular shape, excited on its fundamental oscillation. Now, the triangular aerial is only a particular form of the directive aerial. The ideal form consists of two vertical antennæ oscillating in one-quarter wave-length and spaced half a wave-length apart; these being joined at their lower ends by a horizontal conductor which serves to excite them. If the two antennæ are brought nearer together, or are inclined, the range and the radiation diminish, at first slowly and then rapidly. The whole aerial does not vibrate on its fundamental oscillation, but on the *third harmonic*. There are, in fact, three current loops and four potential loops on the aerial. It is well known that the effect at a distance is due to the current. If, therefore, a directive aerial is excited on its fundamental oscillation, the most useful part of the aerial—that containing the current loop—will be found in the horizontal portion, and the radiation from the aerial is very small. The conditions are quite the same as obtain where it is desired to increase the wave-length of an ordinary aerial by introducing a self-inductance at its base. The range diminishes as the wave-length increases, for the current loop becomes more and more shut up in the coil, which is unable to radiate. If, on the contrary, the same aerial be excited on its third harmonic, in such a way that there are two current loops at the lower ends of the vertical or inclined portions, the radiation will attain its maximum value.

Mr. Taylor, who kindly refers to our studies on directive aerials, contents himself with repeating the experiments of which the results were published three years ago; but since that date we have continued our investigations and experiments, concerning which Mr. Taylor evidently knows nothing. For he arrives at the conclusion that directive aerials are advantageous for " communication over short distances," and he would not have made this statement had he tried exciting his directive aerial on the third harmonic as we have been doing for a long time now.

We have made a series of very important comparative tests between a directive aerial which, excited on the third harmonic, gave a wave-length of 300 metres, and an ordinary aerial, equivalent to the other and giving the same wave-length. The measurements were made with a Duddell thermo-galvanometer at a distance away of 10 wave-lengths, and gave a ratio of 5 : 1 for the energy radiated by the two different types of aerial respectively, for the same primary input. Dr. Kiebitz has, independently, as a result of a long series of experiments, arrived at the conclusion that the directive aerial has a range " at least equal " to that of the ordinary aerial.

It is hence evident, contrary to Mr. Taylor's assertions, that by the use of a directive aerial the same distance can " at least " be obtained as with the ordinary aerial. Mr. Taylor's other assertion, that the directive aerial is limited to use with short waves, is also inexact; for Mr. Taylor is concerned solely with a directive aerial in a fixed position. Instead of employing a triangular directive aerial supported by a single mast, he has only to use a directive aerial made up of one horizontal and two vertical parts, the latter being each supported by a mast. Mr. Taylor has then only to separate the masts the necessary amount for him to be able to reach any desired wave-length. And we may add that with a single mast supporting a triangular directive aerial of suitable dimensions, and suitably excited, Mr. Taylor could easily radiate a 600-metre wave and attain at least the distance attained by an ordinary station of 600 metres wave-length. Thus the directive aerial is at least on a par with the ordinary aerial, even from the point of view of the length of wave which it can radiate.

In summarising what Mr. Taylor has written on this subject it appears that these aerials possess—from his standpoint—only one advantage, that is to say, directivity, with all its consequences; and three faults, which are: (1) Limited range, (2) impossibility of using a large wave-length, (3) use confined to two stations communicating exclusively among themselves.

We have shown that the first two defects are non-existent. The third defect, which would exist were it necessary to turn the aerial in order to change the direction of communication, does not exist either, owing to the fact that our directive system, having an antenna composed of *several* directive aerials, fixed in position and joined to a radio-goniometer allows of communication being effected in any desired direction. And since each directive aerial composing the antenna has neither the defect of reduced range, nor that of short wave-length, our system is on an equality with other systems, with the additional advantage of dirigibility. We may further add that by employing, as we do at present, instead of two directive aerials at right angles to one another, an antenna composed of 4, 6, 8 .... &c., aerials making angles with one another of 45 deg., 30 deg., 22 deg. 30 min. .... &c., joined to a form of radio-goniometer with 4, 6, 8 .... &c., fixed windings, we are able to attain a great range with aerials of reduced dimensions because we compose the effects of *many* aerials into a single very considerable resultant radiation.—We are, &c.,

E. BELLINI.
A. TOSI.

Paris, April 15.

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THE LAYING AND MAINTENANCE OF TRANSMISSION CABLES.

Mr. C. Vernier's Paper on this subject, of which an abstract appeared in our issue of March 10th, was discussed by the Glasgow Local Section on the 11th inst. The following is a brief account of the discussion.

Mr. MITCHELL (Mains Superintendent, Glasgow) was surprised at the ... of cast-iron troughs. In Glasgow they had abandoned these ... years ago, mainly on account of electrolytic action on lead-covered ... A great objection to cast-iron formerly was that it was made ... in diameter, with resultant trouble and injury in drawing ... cables. With regard to the filling in compounds used, bitumen ... approximately 2½ times the price of pitch. They had, in ... used pitch with satisfactory results for the last eight years. ... they had been trying a mixture of pitch and ground or powdered ... stone. They found it quite plastic. One of their tests was ... in the form of a U and then reverse to ∩ without cracking. ... while being quite suitable was also very much cheaper. ... to the covering of three-phase high-tension feeder cable ... exhibited a wood model of a porcelain sleeve they were using ... joint box; the sleeve was immersed in oil or special compound. ... was bared unequally at both ends where the joint was to be made, ... porcelain clover leaf section insulator slipped on in place. The ... made with sweated thimbles and the porcelain drawn over it ... over the bare metal work. There were rings on the porcelain ... concentric with the joint box, the glands in which were of the ... type, wiped or bonded as required.

Mr. D. M. McLEOD (Clyde Valley Electrical Power Co.) preferred in ... draw-in system a duct laid direct in the earth. He instanced ... on their system where they were using cement ducts and ... subsidence the duct became severely cracked, intensifying ... injury to the cables. He wanted something that would yield like ... As to an efficient lubricant for a draw-in system, soft soap ... due to chemical action of the soap on the lead or ... petroleum jelly was quite good though more expensive. In ... experience he found flaked graphite by far the best. He considered ... system the best for continuity of supply. They had experi... electrolytic action of wood on lead referred to and were now ... steel bridges for supporting the cables. He was also ... armoured cables were the most efficient and the cheapest ... transmission purposes.

Mr. VERNIER, in reply to the various points raised, recommended the ... ducts rather than fibre conduit. He found pitch ... very readily, allowing moisture to penetrate the cracks. So ... see, the addition of whinstone would only increase this ... he could not see how the elasticity was increased in any ... the reverse, and at the same time making it more or less ... sleeve shown by Mr. Mitchell was certainly interesting, ... the absence of oil between the various phases, that is the ... in the porcelain surrounding and separating the various ... not stop the creeping so well as the insulator he had ... round each phase. With regard to concrete ducts, he would ... that these were more for protection against mechanical ... the cable and not against subsidences. His experience on the ... supply was that petroleum jelly was the best lubricant to use. ... was then adjourned to the May meeting.

DEVELOPMENTS IN THE MANUFACTURE OF ELECTRIC METERS.*

BY W. LUBACH.

... developments have been made in this department of late ... though the general principles remain much as before; but the ... increased demand for meters has reacted in such a way ... a general improvement to take place. The German ... reports that "a single factory is at the moment turning ... meters daily, and on all sides factories are being extended and ... Half the output in Germany is for the export trade. In ... itself there are 10 times as many meters in use as was the ... ago, and similar progress seems likely to take place in ... 10 years." Statistics seem to show that the life of a meter ... years.

... demand for meters is due indirectly to the metal lamp, ... exerted the greatest influence on the specifications that ... issued. A meter for 10 amperes at 220 volts is quite a ... nowadays, but the main demand is for those taking from ... amperes. A few years ago a shunt current of 0·03 or 0·04 ... allowable; but it is now sometimes found that the meter ... more than the lamps in the case of a very small in... It is, therefore, necessary that the shunt circuit should ... more than 1·5 watts on 110 volts. The metal lamp also requires greater exactness at low loads, besides the certainty of an easy start. It was usual to be satisfied if a meter read correctly on one-tenth of full load and started with one-hundredth; much lower figures are now being demanded. The conditions, indeed, are fairly stiff for a piece of apparatus that must not exceed a certain price, and in small meters it is difficult to comply with the specification, owing to the fact that the space available for the coils cannot be utilised to the best advantage. Alternate-current meters are generally made on the Ferraris principle; this works with a sort of short-circuited armature, and all the difficulties which occur in direct-current meters in passing the current through the system are non-existent. They can, therefore, easily be made to start on $\frac{1}{200}$th of full load, by increasing the torque by a suitable design for the coils. This has, in fact, been doubled without any increased cost. The no-load consumption has been reduced by providing a nearly complete iron circuit for the shunt magnetic field. With polyphase meters, which work on the two or three wattmeter method, the starting difficulties have not been altogether overcome, owing to the weight of the rotating parts, which consist generally of two discs. Electromagnetic vibrations have, however, been tried, and these act in such a way that the friction of the pivots almost disappears. By this method there is no fear of any reading on no load, because it does not depend on any arrangement for increasing the torque at light loads. A similar plan for neutralising the effect of friction magnetically has been in use in America for some time.

The effects of any fluctuation in voltage on alternate-current meters has been largely avoided by properly proportioning the leakage fields to those which act magnetically on the rotating parts; the newer types are also independent of any changes in the frequency. With small alternating-current meters for less than 3 amperes, there is the difficulty that the ohmic drop in the main circuit, added to the inductive drop, makes the total loss considerable. Very little improvement seems likely in design; many designs exist, and an equally large number have been dropped. Some improvement in the construction of the component parts may be possible, though little change is to be noticed in the recording mechanism. A meter for 5 amperes and 220 volts, with a maximum torque of 4 gr. cm., has a turning moment of only 0·1 gr. cm. with a load of one 25-watt metal lamp, and the slightest unevenness in the recording mechanism will affect it. It is probable that attention might profitably be directed to some method by which falling weights serve to drive the train through an escapement.

The watt-hour meter, constructed on dynamometric principles according to Thomson's design, is very simple and very cheap; but, owing to the fact that there is so little that is really capable of improvement, it remains much where it was. Sparking produces changes on the commutator, and the friction produced by the wear on the brushes tends to increase with each day of use. A much higher torque than is necessary with alternating-current meters might do something. It already amounts to 6 or 8 gr. cm., and on an average the loss in the main circuit amounts to 10 watts. The no-load losses have been reduced on three-wire circuits by connecting the shunt between the middle and one of the outer wires; but this is not free from objection, seeing that the voltages on the two sides of the system are not necessarily equal. There has been a good deal of difficulty in keeping the no-load loss below 1·5 watts on 110 volts. The Thomson type of meter is hard to adapt to modern demands. The auxiliary coil, used to counteract friction at the start, cannot be much increased in size without fear that the meter may read on no-load, and the friction between brushes and commutator is an ever variable quantity. It is, therefore, not possible to adjust it to start as definitely as the alternating-current type. Starting and sparking troubles have still to be completely overcome, though much work has already been done. Some makers have replaceable commutators and brushes, others move their brushes by means of a lever, so that the point of contact depends on the load. The device due to E. O'Keenan may be mentioned, by which the brushes are continually vibrated, thus neutralising friction, and allowing, as alleged, of a very easy start.

Meters constructed on the dynamometric principle are very sensitive to an external field; this has been specially noted now that accuracy at low loads has been much insisted on. Small errors have finally been traced to the magnetic effect of the earth's field, and some makers therefore provide their meters with astatic armatures. Pendulum meters with short pendulums are nearly free from outside influences, but their complicated construction seems likely to prevent their general use in small installations. Meters of the magneto-motor type have been much used of late years. They take no current at no-load, are independent of external magnetic fields, can be made even in the smallest sizes from ½ ampere to 3 amperes, and develop on the smallest loads a torque which is generally more than 10 gr. cm. Their construction has been much simplified, and the

* ... of an article in the "Electrotechnische Zeitschrift."

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price reduced. The contact-resistance between the commutator and brushes is variable, and in the newer types of meter the brushes are arranged so as to be movable along the commutator, and this movement is effected by means of a coil in series or in parallel with the brushes, which causes movement as soon as the contact resistance changes. The segments of the commutator are also shaped in a special way, so that when the brushes are displaced, the zone of commutation is similarly displaced. It is thus possible to produce an increase of torque, which is effective in the face of all kinds of likely forms of friction. To ensure a certain start the armature coils are so adapted to the shape of the permanent magnet that all the conductors on the armature contribute towards producing the torque. In the older forms, a start was not altogether certain even with 1 per cent. of full load; now it will start with half that amount, and sometimes even with less. The armature is often put in parallel with a resistance carrying the main current, and the fall of pressure amounts to 1 volt; in those meters in which the armature carries the whole current, the drop is 0·3 or 0·5 volt. These latter meters are not affected by the change of contact-resistance between commutator and brush, but if a short-circuit takes place on the installation the brushes are often destroyed and the commutator injured. For this reason such meters are often provided with very carefully adjusted fuses, or with small maximum cut-outs, which short-circuit the meter in cases of overload. Short-circuits are apt to affect meters of this type, the armature consisting only of a copper disc, which rotates in a bath of mercury. Some of the mercury may be thrown out of the bath, and often the strength of the permanent magnet is affected. The torque diminishes in proportion to the current, so that in the smaller sizes it amounts to 0·5 or 1 gr. cm. at full-load, and the instrument is apt to be very sensitive to friction of various kinds. It has, therefore, not found a large field of usefulness in small installations, but in larger sizes it has been very useful, and the voltage-drop in the mercury bath is usually less than 0·01 volt at full load.

Electrolytic meters are very correct on the smallest loads. The cells with mercury anodes have been much improved by the use of a solution containing the iodides of mercury and potassium as the electrolyte, and the formation of crystals, which affected the reading of the older types, is thus avoided. These meters have not been in use for a sufficient time for us to be able to be quite certain with regard to some points—*e.g.*, as to whether the process is always exactly reversible—and also whether traces of atmospheric gases and other slight impurities are entirely without effect in producing small disturbances. One defect is that there is no registering apparatus, and it is felt in some quarters that this is not entirely satisfactory from the point of view of the consumer.

LEGAL INTELLIGENCE.

Cruse & Others v. Willans & Robinson.

Mr. E. Pollock, Official Referee, has given judgment in this action by Mr. H. Cruse (trading as the Cruse Controllable Superheater Co.) and Messrs. E. Grether & Co. against Messrs. Willans & Robinson for the recovery of £10,000 damages for alleged breach of contract in regard to the manufacture by defendants of superheaters for plaintiffs.

The hearing of the case was commenced in Manchester on Oct. 5, 1910 (see THE ELECTRICIAN, Oct. 7, 1910, page 1082) but subsequently it was transferred to London. The case took 55 days and much technical evidence was given by both sides. By way of defence it was pleaded that the defects (if any) in the superheaters manufactured for plaintiffs were caused by faulty design, for which they were not responsible, as the machines were made to plaintiffs' own designs. Defendants also counterclaimed for £1,900, being balance of price of superheaters delivered, the cost of dies, &c.

In the course of his reserved judgment, Mr. Pollock said that the evidence of both sides proved that the superheaters did not fail by reason of faulty design, but entirely through bad workmanship, and he found for plaintiffs £3,535 damages, with costs on the higher scale.

White v. Darlington Corporation.

At Darlington County Court last week Mr. Jas. White sued Darlington Corporation for the recovery of £2. 6s. 4d. and £2. 5s. 2d., alleged to be overcharges on plaintiff's account for supply of electricity owing to defective meters installed by the Corporation.

Mr. G. TAYLOR, for the Corporation, contended that plaintiff was precluded from bringing the action in regard to the first amount as it related to the quarter from December to March, 1906, and under the Public Authorities Protection Act the action must be brought within six months of the act of default complained of.

Mr. G. F. LUCAS, for plaintiff, said his client applied to the Board of Trade for one of their inspectors to inspect the meter under the provisions of the Electric Lighting Act, 1882, but the application was refused. Considerable correspondence had taken place between the town clerk and his client with a view to a settlement, it being clear that the meter, which was not certified, had not properly registered consumption. It was not until October, 1910, that the Corporation definitely refused to refer the matter to arbitration, and that was well within the six months of the action. He submitted that he should not be stopped because he did not formally commence an action within six months of the complaint.

His HONOUR said that on the grounds submitted by Mr. Taylor he would have to give judgment for defendants in the first case, with costs. With regard to the second case, he thought the Corporation should make some concession to plaintiff, who had clearly been charged for more electricity than he had consumed.

After consultation, it was agreed that the Corporation should refund 5s. 2d. of the £2. 5s. 2d. which Mr. White had paid, each side paying their own costs.

Workmen's Compensation.

In the Manchester County Court last week Judge Mellor, K.C., was asked to confirm an agreement under which Manchester Corporation would pay £50 as compensation and costs to Mrs. E. Wood (a widow) for the death of her son.

Mr. FARRINGTON, for applicant, explained that Wood was employed as a cleaner of machines, but was expressly instructed not to touch any switchboard until it was certified safe by a superior officer. On Dec. 11 last he was sent to a sub-station at the works of the Metropolitan Amalgamated Railway Carriage & Waggon Co., Openshaw, to clean a machine. An hour after entering the sub-station he was seen to be enveloped in flames, and had received a severe electric shock. He died a few days later. Counsel was, however, unable to bring evidence to prove that the accident arose "out of and in the course of the man's employment." The Corporation had, however, offered to pay £43 and £7 for legal costs.

The JUDGE: But if the man went into the place in the course of his employment and came out in flames, surely that raises a presumption that he met his death in the course of his employment.

Mr. DEHN (for the Corporation) contended that this was not so, because the sum was in the nature of a gratuity, not a lump-sum settlement for an admitted liability. As the case had aroused public interest he wished to explain that the man was only sent to clean a rotary converter which was "dead" at the time. Instead of being content with that, he must have gone into a telephone box, obtained keys, opened a cubicle fastened by two padlocks, and unscrewed the front of the switchboard before coming into contact with the machinery.

The Judge accepted this explanation and confirmed the agreement.

Charges for Parcels on Tramcars.

At the Hastings County Court recently the Hastings & District Tramways Co. sued a passenger for 2d. for the carriage of a parcel. Mr. Pearson appeared for the company, and defendant (in person) argued that the parcel (a roll of felt) was personal luggage, and that as such he was entitled to carry it on the car, under the regulations.

The JUDGE, however, while declining to give a hard and fast definition, held that personal luggage consisted of "wearing apparel and things a person takes about."

Judgment was given for plaintiffs with costs.

PARLIAMENTARY INTELLIGENCE.

Rotherham, Maltby & District Rail-less Electric Traction Bill.—The promoters have decided not to proceed further with this Bill.

The Freight Tunnels of Chicago.—In a Paper read by Mr. W. E. Worth before the Electric Club of Chicago, the author gave some interesting information with regard to these tunnels, which are considered to be unique. The work done in them consists principally in removals of earth from the excavations of new buildings, the delivery of coal, the removal of ashes, and parcel traffic. Five different kinds of electric locomotives are used. A train consists of a locomotive and ten cars, each 12·5 ft. long and 4 ft. wide over all. The motorman constitutes the entire train crew. Ordinarily one man can handle eight train movements a day, or the equivalent of 80 carloads. One carload is about equal to the load on a one-horse dray. The largest locomotives are equipped with two 25 H.P. motors. An overhead trolley is used, and direct current at 250 volts is employed. It is asserted that the public freight-receiving stations receive freight packages which would otherwise require the daily employment of 1,200 waggons in the Loop district. The bottoms of the tunnels are about 42 ft. to 45 ft. below the street, though where the lines pass under the river, which they do at 12 places, the depth is increased to 65 ft. Electrically-operated pumps are used to pump the sewage into the sewers, which are on a higher level than the tunnels, and electrically-operated points are being installed. The average speed of the trains is about 8 miles an hour.

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PATENT RECORD.

APPLICATIONS FOR PATENTS.

*Note.—The undermentioned Applications (except those marked †) are not open to [illegible] until after acceptance of Complete Specifications. Those marked * are [illegible] 12 months after the date attached to them, if they have not been published [illegible] ordinary course. Names within parentheses are those of communicators [illegible]. When complete Specification accompanies application, an asterisk is affixed.*

February 6, 1911.

[illegible] Electric resistances.
[illegible] & B[illegible]. Manufacture of electric resistances.
[illegible] & Cl[illegible]. Lamp holders for incandescent electric lamps.
[illegible] M[illegible] Kohn. Electric heaters.*
[illegible] Constructing the conduit and track for a slot system of electric [illegible] (Convention date, 5/2/10, France.)*
[illegible] B.T.-H. Co. (G.E. Co., U.S.) Mounting electric conductors.*

February 7, 1911.

[illegible] Transmitting electric impulses.*
[illegible] Electrical resistances.
[illegible] Current collecting device for rapidly moving vehicles.
[illegible] Time control of electric circuits.
[illegible] Driving mechanism for electrically propelled vehicles.*

February 8, 1911.

[illegible] Electric battery.
[illegible] Electrically-operated crossing-barriers.
[illegible] and Ordnance Accessories Co., Langley & Price. Electric lighting [illegible]
[illegible] S[illegible] water by means of ozone. (Convention date, 9/2/10, France.)*
[illegible] Electric furnace for treating gases.*
[illegible] Lift Co., & Huggett. Controller for electric lifts and the like.
[illegible] Stevens. Petrol-electric transmission for vehicles and launches.
[illegible] B.T.-H. Co. (G.E. Co., U.S.) Vapour electric devices.*
[illegible] Ltd., & Twiss. Electric insulators.*

February 9, 1911.

[illegible] & Froude & Mortimore. Magnetic separators.
[illegible] & Imperial Lamp Works (Brimsdown). Manufacture of tungsten and [illegible] metal filaments for incandescent electric lamps.
[illegible] & Adams Watkin Co. Regulating and controlling the pressure in an [illegible]
[illegible] B[illegible]thby & Paterson. Combined magneto-ignition gear for internal-[illegible] engines and wireless telegraphy apparatus.

February 10, 1911.

[illegible] Magnetic compasses.
[illegible] Underground electric cable troughing.
[illegible] Elektricitats-Zahler fabrik G.m.b.H. Prepayment electric meters. [illegible] date, 6/4/10, Germany.)*
[illegible] Automatic telephonic system selectors. (Convention date, 10/2/10, United States.)*
[illegible] & Parkinson. Electric lighting of motor-cars, railway vehicles and the [illegible]
[illegible] Rheostats or the like.*
[illegible] Intercommunicating telephone systems and apparatus.
[illegible] & Phillips. Supporting electrical incandescent lamps or the like.*
[illegible] Schatzl. Electric furnaces.*
[illegible] Electric incandescent lamps. (Convention date, 12/2/10, France.)*

February 13, 1911.

[illegible] & Co. & Metz. Switches.
[illegible] & Heap. Continuously and automatically indicating and recording the [illegible] of the insulation of electrical conductors.
[illegible] Smelting and refining metals and the like in crucibles by means of [illegible] heating.
[illegible] Receiving and transmitting telegraphic and telephonic messages.
[illegible] Brown, Boverie et Cie. Marine turbine installation with two shafts. [illegible] date, 11/2/10, France.)*
[illegible] Control of high-frequency oscillations for use in wireless telegraphy.
[illegible] transmission apparatus.
[illegible] Weintraub. Electrolytic meters. (Convention date, 14/2/10, U.S.)*

February 14, 1911.

[illegible] & Lister, Morris & Watson. Electrical influence machines.
[illegible] Voltage regulators.*
[illegible] Electrical Co., Rawlings & Sweetser. Switches.*
[illegible] United States Light and Heating Co., U.S.) Mounting dynamos on [illegible] the like vehicles.*
[illegible] & T[illegible]wood. Single-wire telephone systems.*
[illegible] Wireless Telegraph Co., & Sankey. Couplings for rotating [illegible]
[illegible] Resistances for electrical heating and cooking apparatus.
[illegible] Oesterreichische Daimler-Motoren-Ges. Akt.-Ges., Austria.) [illegible] trackway with above-ground current conductors. (Divided [illegible] 27,798/10. 29/11/10.)*
[illegible] Electric welding or soldering.
[illegible] & Wedmore. Electric circuit controlling and protecting devices.

February 15, 1911.

[illegible] Electrical fuse boxes.
[illegible]
[illegible] points and point-actuating mechanism.
[illegible] & Walker, Horrocks & Co. Electrical connector.
[illegible] heat from sparking-plugs of internal-combustion engines.
[illegible] Spark plug. (Addition to 7,617/10. Convention date, 8/10/10, [illegible]
[illegible] apparatus for the manufacture and welding of metal articles.
[illegible] and discharging electric accumulators or secondary batteries. [illegible] 22,818/09.)
[illegible] Electric sparking-plug. (Convention date, 17/2/10, France.)*
[illegible] of alternating electric discharges.
[illegible] Alternating current induction motor.
[illegible] clutches.
[illegible] & Wedmore. Switches.
[illegible] Electrical heating and cooking devices.*

February 16, 1911.

[illegible] & Mathiesen Akt.-Ges. Enclosed arc lamps. (Convention date, [illegible])*
[illegible] Electric fans.
[illegible]communication telephone systems.
[illegible] for radiotelegraphic plants with indirect excitation. [illegible] 19, Belgium.)*
[illegible] Radiotelegraphic plant. (Convention date, 1/12/10, [illegible]
[illegible] High-frequency alternator for radiotelegraphic and radio-[illegible] (Convention date, 9/5/10, France.)*

3,949 Emile Girardeau. Sender with direct excitation for radiotelegraphic plants (Convention date, 30/7/10, Belgium.)*
3,969 Smith. Incandescent vapor lamps. (Divided Application on 19,608/10. 22/8/10.)
3,970 Clark. Overground telegraph, telephone and other electric conductors.
3,971 Cooper. Recording instruments.
3,996 Evans & St. Helens Cable & Rubber Co. Electric conductors.
4,000 Leete. Attachment or cover for telephone mouth-pieces.
4,002 Warwick Machinery Co. (1908). (G.E. Co., U.S.) Governing mechanisms for elastic fluid turbines.
4,004 Merz & Hunter. Electric current distributing systems.

February 17, 1911.

4,019 Joel. Electric connections and switch control.
4,050 Judd, Fraser & Eastern Telegraph Co. Perforating the signal-controlling tape to be used with automatic telegraph transmitters.
4,054 Whitehorn. Dynamo-electric generators and motors.
4,056 Claremont. Hygienic interceptors for telephones.
4,085 Unionwerk Mea G.m.b.H. Elektrotechnische Fabrik Eisenwerk. Magneto-electric ignition apparatus. (Convention date, 17/2/10, Germany.)*

February 18, 1911.

4,118 Railing & Krause. Connector for electric conductors.
4,124 Hatfield & Dean. Automatically-timing the magneto-ignition of internal-combustion engines.
4,190 Barnard & Edwards. Motor controllers.*
4,191 Barnard & Edwards. Push button circuits for electric controllers.*

February 20, 1911.

4,256 Akt-Ges. Brown, Boverie et Cie. Compounding commutator machinery. (Convention date, 19/2/10 Germany.)*
4,266 Leblanc. Vapour electric apparatus.
4,232 Rickets. Telephone Systems.
4,286 & 4,287 Macdonald. Electric motors and pumps.
4,300 Murray. Plough for the conduit tramway system.
4,332 Fournier d'Albe. Selenium cells.
4,346 Poyser & Brameld. Hydraulic transmission of power.

SPECIFICATIONS PUBLISHED.

1910 Specifications.

869 Milch. Alternating electric current regulators of the induction type.
3,098 Childs & Hill. Electric controllers.
3,185 Joel. Portable electric battery lamps.
3,199 Compagnie de Signaux Electriques pour Chemins de Fer. Apparatus for controlling railway points and signals. (11/2/09.)
3,294 Handcock & Dykes. Electric meter systems.
3,336 B.T.-H. Co. (G.E. Co., U.S.) Manufacture of brushes for dynamo-electric machines and other carbon articles.
3,361 Williams & Stevenson. Automatically, electrically, and mechanically connecting and suspending an arc lamp, electrolier or other weight.
3,518 Ashton. Employment or running of electric lamps on alternating current circuits.
3,582 Wall. Calling apparatus for telephones and the like. (Cognate Application, 14,009/10.)
4,190 Gibbs & Sandycroft Foundry Co. Electrical controllers.
4,230 Cunliffe, Cunliffe & Dewhurst. Electric contacts for operating signal and other apparatus.
4,299 Cunnington. Twin electric incandescent lamp holder.
4,885 Johnson & Phillips, Ltd., & Brockie. Magazine arc lamps.
4,910 Marconi's Wireless Telegraph Co., & Franklin. Wireless telegraph receiving stations.
4,950 Maschinenfabrik Oerlikon. Governing mechanism of electrically or mechanically driven machines with variable numbers of revolutions. (28/6/09.)
5,054 Dean. Protected or armoured electric switch fuses. (Cognate Application, 13,843/10.)
5,119 Siemens Bros. Dynamo Works. (Siemens Schuckertwerke Ges.) Regulation of the speed of polyphase electric motors.
5,416 Railing & Angold. Arc lamps.
5,934 Johnson. (Chemische Fabrik Griesheim Elektron). Production and maintenance of long electric arcs. (Patent of Addition not granted.)
6,256 Landi. Electrical speed indicator for measuring the speed of rotating-shafts.
6,535 Barnard & Edwards. Controlling devices for electric motors.
6,704 Charlton. Operating electric switches.
7,593 Smith. Electric coupling device for use in charging accumulators.
8,225 Adams Mfg. Co. (Cutler Hammer Mfg. Co.) Electro-magnetic circuit-breakers and means for resetting the same from a distance, and signalling-devices combined therewith.
8,977 Davis, & Siebe, Gorman & Co. Electrical plug connections.
10,913 Siemens Bros. Dynamo Works (Siemens-Schuckertwerke). Regulation of the power factor in the external circuit of polyphase electric machines.
11,184 Adams Mfg. Co. (Cutler Hammer Mfg., Co.) Motor-controllers and like electric switches.
11,359 Marconi's Wireless Telegraph Co., Bangay & Prince. Portable apparatus for wireless telegraphy.
11,360 Marconi's Wireless Telegraph Co., Bangay & Prince. Carrying portable motors and dynamos on horseback.
11,978 Vandervell. Armouring for electric wires or cables.
12,149 Bisson & Berges. Arc lamps.
12,594 Blathy. Dynamo-electric machines. (27/5/09.)
12,862 Fixler & Burgess. Trolley stands for electrically-propelled vehicles.
12,889 Brush Electrical Engineering Co., & Jones. Cooling the commutator and slip rings of dynamo-electric machines.
14,004 Laureys. Cathode and Röntgen tubes.
14,859 Presser. Electric welding process. (20/9/09.)
15,167 and 15,168 Thomson. Electric furnaces. (1/9/09.)
15,426 Allgemeine Elektricitats-Ges. Control of electric motors. (28/6/09.)
16,342 Siemens & Halske Akt.-Ges. Frequency meters. (24/7/09.)
16,419 Von Cramer. Inductive wireless telephone installations. (Cognate Applications; 18,054/10 and 18,333/10.)
18,742 Gilliatt. & Excess Indicator Co. Electric overload indicators.
17,787 Siemens Bros. & Co. (Siemens & Halske Akt.-Ges.) Purifying water by ozonised air.
19,625 Gravdahl. Reversing internal-combustion engines with electric ignition (2/9/09.)
19,930 Druseidt. Combined fuse box and switch for electric circuits.
19,962 Siemens & Halske Akt.-Ges. Manufacture of tubes of tantalum metal. (7/10/09.)
20,446 Allgemeine Elektricitats-Ges. Electricity meter for registering maximum consumption. (3/9/09.)
21,031 Ruthenburg. Magnetic separators.
21,174 Sidler. Electric switches.
22,394 Forsberg. Electromagnets in telephone call indicators. (29/9/09.)
24,688 Bosch. Guiding electric cables for internal-combustion engines. (12/10/10.)
25,401 Johnson. Treatment of ores, particularly the ores of tungsten and like metal. (31/1/10.)
26,120 B.T.-H. Co. (G.E. Co., U.S.) Electric heaters.
26,737 Denny & Flood. Automatic electric tumbler switches. (Addition to 26,570/09.)
27,168 Bosch. Magneto-electric ignition machines for internal-combustion engines. (29/10/10.)
27,248 Kalambra. Electric plug couplings. (7/3/10.)
27,375 Kalamba. Electric plug couplings. (18/5/10. Addition to 27,248/10.)
27,710 Lichtwerke Ges. Filament supports for electric glow lamps. (27/11/09.)

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COMMERCIAL AND INDUSTRIAL SECTION.

MUNICIPAL, FOREIGN & GENERAL NOTES.

BRITISH NOTES.

Aldershot.—Application has been made for sanction to a loan of £2,500 for additional plant at the electricity works.

At the last meeting of the Council the chairman of the Lighting Committee (Mr. Calvert) called attention to the action of the local gas company in giving what he termed preferential treatment by making an offer of reduction to people who did not use electric light. He heard that there was a reduction to users of gas stoves, and he applied for the reduction, and thought he should have the same benefit as other users, especially as his consumption of gas and electric light was about equal. He was informed that because he used electric light in the house the reduction could not be made. It seemed to be a boycott of the electric light users.

The Clerk is to report upon the matter.

Association of Mining Electrical Engineers.—It is announced that the successful candidates at the recent examination for 1st class certificates of competency of electricians in charge of colliery installations include the following: Mr. F. Smith, electrician, Pinxton Collieries; Mr. E. Bearsdmore, engineer, Tibshelf Collieries; Mr. F. Church, electrician, Tibshelf Collieries; Mr. F. Cusworth, electrician, Summit Colliery, Kirkby; and Mr. E. Wilbraham, electrician, Ripley Collieries.

Beckenham.—The following return as to the use of electricity for lighting has been prepared for the Council:—

Ward.	No. of houses.	Free wiring.	Private wiring.	Per cent.
Copers Cope	563	128	94	39·43
Eden Park	735	115	93	28·30
Langley Park	400	85	126	52·75
Shortlands	370	73	148	59·73
Manor House	2,057	285	156	21·44
Kent House	1,472	171	56	15·42
Lawrie Park	1,388	99	43	10·23
	6,985	956	716	23·94

The L.G. Board have sanctioned a loan of £5,000 for "free" wiring, &c., on the understanding that the cost of lamps is not charged to loan account. The term of the loan is 10 years, as before.

Belfast.—The accounts of the tramways department for the year ended March 31 have been issued and show total receipts of £218,301, an increase of £14,426 over 1909-10.

The working expenses amounted to £112,959. 9s. 7d., an increase of £5,624. 8s.; and the working profit was £105,341. 8s. 11d., an increase of £8,801. 13s. 8d. Capital charges, including interest on loans, income tax, &c., amount to £51,290. 12s. 4d. The net profit amounted to £54,050. 16s. 7d., an increase of £7,754. 18s. 4d. The net balance is to be appropriated as follows:—Sinking fund, £24,025; depreciation fund, £13,000; reserve fund, £16,730. 1s. 1d.; general purposes fund, £295. 10s. 11d.

The estimated receipts for year ending March 31, 1912, are £235,000; working expenses, £125,000; working profit, £110,000; net revenue charges, £45,;000 net revenue, £65,000.

Customs Duties.—Supplements to the Australian Customs Tariff Guide state that the following duties upon imports will be leviable in future:—

Electrical appliances and materials and fittings: Adaptors, arc lamp automatic couplings, ceiling roses, wall rosettes with hooks for taking wires, electric terminals, wall plugs and ball fittings for electroliers, 30 per cent. ad val. (British goods 25 per cent.) if brass or gunmetal, and 17½ per cent. (British 10 per cent.) if of other material. Axles for steel-rimmed railway and tramway wheels of over 18 in. diameter 5 per cent. (British free), and steel-tyred wheels of over 18 in. diameter 35 per cent. (British 30 per cent.).

The Netherlands Minister of Finance has decreed that copper wire covered with varnished tape or tape prepared with paraffin is subject to an import duty of 5 per cent. ad val. Copper bands similarly covered and bright double-grooved copper wire for tramway overhead lines can be imported duty free.

Darwen.—Consumers who take 5,000 units of electric energy per quarter for power are to be supplied at ¾d. per unit.

Electric Driving of Mills.—A notable illustration of the value of public electric power supply has just occurred at Messrs. Rennie & Co.'s Providence Mills, Stanningley, where but for its aid the machinery would now be standing idle. On Wednesday last the main engine gave way, and the machinery brought to a standstill. Fortunately, the Yorkshire Electric Power Co.'s supply is available in Stanningley, and in 24 hours the supply was connected and the first motor set to work. By Sunday night the whole of the machinery was converted to electrical driving, and now over 400 H.P. is taken from the public mains. This is claimed to be a record.

Golborne.—The Board of Trade have decided to extend the period of the provisional electric lighting order (1905) for another year.

Greenock.—In moving the adoption of the minutes of the Electricity Committee on Tuesday, Bailie Williamson said that the demand for electricity had been so great that they had doubled their output at Dellingburn works during the past two years, and he believed that soon they would have to instal another additional turbine.

Haslingden.—An inquiry was held last week into the Council's application for sanction to borrow £8,750 for electricity supply.

At present the Council take electric current in bulk from Accrington, but the agreement with Accrington terminates in December, 1912, and Haslingden will then supply current to their tramcars from their own distributing station.

Holborn (London).—The matter of the improved lighting of the borough came before the Council last week, when the Town Clerk reported that he had received a sealed packet endorsed by both the Metropolitan Electric Supply and the Gas Light & Coke Companies, and thought it best to bring the matter before the Council before proceeding further.

The Town Clerk opened the package and read a letter dated from the Gas Light & Coke Co.'s offices. This was to the effect that the decision of the Council to request both the gas and the electric light companies to again tender for the lighting of the borough, after the figures of the previous tenders had been made public, and the fact that certain clauses in the new specification were onerous, had made it necessary for the companies concerned to confer together. After careful consideration they had decided not to quote in competition, but to submit a joint tender for the lighting of the borough partly by gas and partly by electricity for an inclusive annual sum of £6,950, a sum less than the amount of the tender recommended for acceptance in February last. A schedule and map were enclosed. The tender was to be based on a 10 years' contract terminable at shorter periods on payment of certain specified capital charges. The Council's requirement that the lamps should be maintained at the highest degree of efficiency was not to be complied with under the tender, but if it was desired that such an efficiency should be maintained the amount of the tender would be increased by 10 per cent nor could improved burners, lamps or appliances be adopted unless the Council agreed to pay the extra cost entailed. It was pointed out that the amount of the tender was only slightly in excess of what the Council were at present paying, while the candle-power would be increased 17 per cent., and the borough would be provided with the best and latest improvements in both forms of illuminant. The letter was signed by Mr. E. Cunliffe Owen on behalf of the Metropolitan Electric Supply Co. (acting in conjunction with the Charing Cross, West End & City Electricity Supply Co. and the County of London Electric Supply Co.), and by Mr. H. Rayner on behalf of the Gas Light & Coke Co.

Mr. MAX CLARKE, chairman of the Works Committee, said the tender was quite out of order, as it did not carry out the specifications.

Mr. FITZROY DOLL moved that the tender be referred to the Works Committee for consideration and report.

Mr. E. ANGEL supported this on condition that the report from the Works Committee should come before the whole Council in committee, and not in open meeting.

Mr. J. S. MOTION said the tender they now had was only the natural result of the Council trying to ring the changes on the gas and the electric light companies.

After further discussion the motion to refer to the Works Committee the report to come up to a committee of the whole Council, was agreed to.

Holyrood Palace.—In preparation for the visit of the King and Queen in July this Palace is being improved and renovated, and the electric light is being installed.

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Inquest.—An inquest was held at Blackpool on Wednesday last on the death of Thos. Geo. Sidney, who was employed at the municipal electricity works, and who was killed on the 10th inst. while working on some repairs.

Jas. Appleton, outside foreman of the electricity department (who was working with Sidney), said the latter asked if there should be any danger, and he (the witness) replied, "No. If you get anything, it will be the high-tension pressure." Sidney replied, "Well, I've got it, and it is making me sweat." Witness replied, "For God's sake don't touch it. I will telephone the works and get it cleared." He thought there was leakage, and warned Sidney not to touch the wires unless he put gloves on. He then telephoned the works to take the current off, and on return found Sidney stretched on the flags unconscious. He tried artificial respiration and sent for a doctor, but Sidney was dead before the doctor arrived. The pressure would be 2,000 to 3,000 volts.

W. E. Dagger, public lighting superintendent, said he started the job, and as he did not expect that it would keep them until after ordinary working hours he gave no notice at the works for the arc lamps to be kept clear. When men worked overtime it was usual to give notice at the works to that effect. He did not dream that there would be any overtime. Such an accident had not previously occurred in his experience.

The jury returned a verdict of death from misadventure.

The Coroner expressed sympathy with Dagger, and said he hoped no ill consequences to himself would result from the sad occurrence. The work was carefully conducted, and he hoped the Corporation would not take severely upon the accident.

Kingswood.—The Council have informed Kingswood Electric Light Co. that they cannot permit the use of overhead wires for the electric current.

Lowestoft.—Application has been made to the L.G. Board for sanction to a loan of £3,000 for new mains.

New Crompton arc lamps are to be substituted for the lamps in use on main thoroughfares.

Malvern.—At a recent meeting of ratepayers a resolution was passed expressing approval of the proposal to establish a system of trolley cars in Malvern, and calling upon the Council to support the preamble of the bill now before Parliament.

Manchester.—At Tuesday's meeting of the Tramways Committee it was reported that the income for the past year was estimated at ... against the earlier estimate of £809,688), of which it is calculated £2,700 will come from the parcels department.

The Committee decided to hand over in relief of rates £75,000, the same as was contributed last year, and to apportion £4,100 to the ... site purchase interest.

The City Committee have decided to start a new system of contribution to the city fund, and the payments now and in future years will be equal to 1 per cent. on the outstanding indebtedness of the undertaking. The amount to be allocated this year is £19,496, against £15,000 ...

It was reported that the Easter week-end tramway traffic results were ... The week's receipts were £16,603, against £14,843. Passengers carried 3,330,893, against 3,108,675.

Post Office and Telephone Control.—At the annual Conference of the National Federation of Sub-postmasters at Cardiff on ... the Postmaster-General (Mr. H. Samuel) said :—

There was bound to be in the future further development in the work of ... when the National Telephone Co.'s system was taken over. ... as that business developed in the future, many of the Post Office staff would find their activities enlarged and ... almost proportionately increased. He had observed that ... of Commerce had suggested as a matter of inquiry ... telephones instead of being transferred to the Post Office ... transferred to a Telephone Authority created for the purpose ... of representatives of the local authorities, of commerce ... If some such scheme were in the public interest he ... support it, for although it was detrimental to some hopes ... raised in the Post Office, the public interest must be ... the Telephone Authority which had lately been discussed ... to his mind every possible disadvantage, and could offer ... compared with the direct control of the system by ... Department. It would involve the loss of millions of ... the Post Office system of poles and underground ... used jointly for telegraphs and telephones. It would ... outlay for new buildings, and a more unbusinesslike ... have been put forward by those who claimed to represent ... interest. That authority would not be under any control ... of its own. Complaints might be attended to or ... to him that a great national service could not be ... than the direct supervision of the House of Commons ... had lately been collecting information regarding the ... in the United States, Sweden and other countries ... system had been widely developed, and he had every ... that the present system of telephones in this country ... the best in any other country. Many improvements ... made in the system in recent years and others would follow. He had no doubt that the telephone system of the United Kingdom under the able supervision of the Post Office would be equal to any to be found in any quarter of the world.

At the annual conference of the Amalgamated Society of Telephone Employés, which was held at Leeds last week, many questions affecting the status of telephone workers, &c., were discussed.

The Society are to take steps to safeguard their continued existence after the transfer, and the Post Office authorities are to be asked to give information relative to the proposed conditions of service, also as to the grades into which the various ranks will be placed. The executive of the Society are to seek to secure the removal of educational, technical and theoretical examinations as a condition of promotion subsequent to the transfer. Questions of classification, pay, &c., were debated and resolutions passed.

Rawtenstall.—An unopposed inquiry was held last week into the Council's application for sanction to borrow £15,000 for extensions of the electricity undertaking.

Rubber Exhibition.—An International Rubber and Allied Trades Exhibition will be held at the Agricultural Hall (Islington, London, N.) from June 26 to July 14 inclusive. The Exhibition is being organised by the International Rubber and Allied Trades Exhibition, 75, Chancery-lane, W.C.

St. Pancras (London).—The chief electrical engineer (Mr. S. W. Baynes) recently reported on the working of the generating stations, and made certain recommendations, which have been approved by the Electricity Committee.

In future the whole of the load during 10 hours of the day is to be taken by the King's-road station, and three-phase mains are to be laid between the two stations. Only one main is to be laid now, but a four-main capacity duct will be provided, so that additional mains can be drawn in as required in future. The cost of the main and ducts is put at £3,100, and it is calculated that a saving of at least £1,300 per annum will be effected.

Shoreditch (London).—The town clerk (Dr. H. Mansfield Robinson) has resigned, in order to take up the position of clerk to the Income Tax and Land Tax Commissioners for the Tower Division. Dr. Robinson has been 20 years at Shoreditch, and during this period many improvements have been effected in the borough, including the introduction of electricity supply. He took a keen interest in the development of electricity supply in London, and he was joint secretary (with Mr. H. B. Renwick) of the Consultative Committee of the Joint Conference of the London Electric Supply Authorities which is dealing with the linking-up of electricity supply undertakings.

Stockton-on-Tees.—The Council have agreed to supply electricity to Messrs. Head, Wrightson & Co. for the Stockton Forge for five years at $\frac{11}{16}$d. per unit for the first two years, and at $\frac{5}{8}$d. per unit for the remaining three years, with a minimum payment of £500 per annum.

It was reported to the Council that the continuance of the supply of current to the firm would entail an expenditure of £5,000, and the firm have the option of increasing the amount of electricity to be supplied from 200 kw. to 250 kw.

Swanage.—The Council have refused the offer of Mr. F. Swarbrick to prepare an electricity supply scheme for the district.

Swindon.—The Council have applied for sanction to a loan of £3,510 for a new storage battery, &c.

Truro.—The General Purposes Committee are considering communications from Messrs. J. B. Saunders & Co. and Mr. F. Swarbrick in regard to electricity supply schemes.

West Ham.—The Council are recommended to carry out the following works, at a cost of £8,925 :—

(*a*) Extension of the d.c. cables and installation of rotary converters. (*b*) Extension of feeder cable at a cost of £1,400, and extension of return cable at a cost of £1,425.

Whitehaven.—An honorarium of £50 has been granted to the borough electrical engineer (Mr. P. B. Sankey) for services in connection with the extension of the plant at the electricity works.

Will.—Mr. James Graves, Atlantic Villa, Valencia Island, co. Kerry, Ireland, who was one of the oldest members of the submarine cable service, and until recently in the service of the Anglo-American Co., left personal estate amounting to £8,557.

Wireless Telegraph Notes.—The Canadian Minister of Marine has again introduced into the Dominion Parliament a bill for the compulsory carrying of wireless telegraph installations by all passenger ships trading from Canadian ports and carrying 50 or more passengers.

When the British Imperial Conference meets next month in London the New Zealand representative will, it is stated, move a resolution certifying the great importance of radio-telegraphy "for social, commercial and defensive purposes," and propose that a chain of State-owned wireless telegraph stations be established throughout the British Empire.

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"Electra" Musical Society.—This Society will give a ladies' bohemian concert in the Small Queen's Hall, Langham-place, London, W., on Monday next (April 24), when the chair will be taken at 7:45 by Mr. J. C. Denison-Pender, L.C.C. Tickets and all further particulars can be obtained from the hon. sec., Mr. G. H. Goldsbrough, Electra House, Finsbury-pavement. E.C.

COLONIAL AND FOREIGN NOTES.

Argentina.—Señor M. Tourville has secured a concession for the erection and working of a telephone line from Misioneros (Santa Cruz) and Paso (on the Santa Cruz river).

Australasia.—The "Australian Mining Standard" says Kyneton (Victoria) Shire Council have referred to a committee a report and estimate on a proposal that the Council should establish an electricity supply undertaking. Two water-power schemes have been rejected, and a third, which is still under consideration, includes the use of a suction gas plant and overhead mains, the initial capital expenditure being put at £4,011.

Mr. G. B. Lincolne has also recommended Gea (Victoria) Council to adopt an electric lighting and pumping scheme.

Mortlake (Victoria) Butter Factory Co. recently applied to the Supreme Court for an alteration of their articles of association to enable them to supply electricity to private consumers and for public lighting. The application was adjourned.

Petersburg (S. Australia) Council recently interviewed Mr. Moncrieff (Railways Commissioner) upon a proposal that the Council should take a supply of electrical energy for lighting the town from plant which is being installed in the locomotive workshops.

Yarrawanga (Victoria) Shire Council recently issued £3,500 debentures to finance their proposed electricity undertaking.

The conference of representatives of Australian tramway employés has completed its log of wages and working conditions. It is proposed that eight hours shall constitute a day's work, that all employés shall be guaranteed 48 hours work per week, every motorman and conductor to have one day off in seven. Not more than 10 per cent. of the men to be employed on broken shifts, and these must not extend over 10 hours, the pay per day to be as follows: Motormen and conductors 11s., ditto, probationers 9s., ticket examiners 12s., shed foremen, 13s., ditto assistant 10s., electrical foreman 16s. 6d., electrical fitter foreman, 15s., electrical mechanics 12s. 6d., controller men 10s., switchboard attendants 10s., car and motor cleaners 9s., overhead wiremen 12s., and 12s. 6d., engine drivers in power house 15s., firemen 11s., coal conveyor attendants 11s., general labourers 10s., truck cleaners 9s. Sundays and statutory and proclaimed holidays, if worked, are to be paid for at double rates, and all employés with over 12 months' service are to have 21 days' leave per annum on full pay. The following resolution of the conference has been accepted by a majority of the men's association: "That no member of the association be compelled to work on or about any road upon or in connection with which a non-member of the association is employed, and he shall not be expected to handle any power that has been generated, produced or handled by a non-member. No employé shall be requested to mount any car that has been repaired or examined by a non-member."

It is stated that Mr. Reginald P. Wilson, who is associated with Mr. Merz, arrived in Melbourne recently and discussed with the Victorian Railway Commissioners the report submitted to them by Mr. Merz some time ago on the proposed electrification of the Melbourne suburban railways. Mr. Wilson said the report was unduly conservative in comparing the d.c. and a.c. systems on account of improvements likely to be made in the latter, but the improvements since made had been in favour of the former. However, they recommended the direct current not on the ground of greater efficiency but because the interest and sinking fund charges would be less.

Shepparton (Victoria) Shire Council have joined the Urban Water Works Trust in defraying the cost of a report on a scheme for electricity supply in Shepparton.

Gawler (S. Australia) Council recently decided to submit to the Minister for approval a scheme prepared by Mr. Lincolne for the erection and equipment of electricity works for the town, at a cost of about £4,000.

Hastings (N.Z.) Council are recommended to invite offers for the construction of a tramway and then to take a poll of the ratepayers as to whether any offer be accepted, or whether the line be constructed by the municipality.

Palmerston (N.Z.) Council are to obtain a report on Mr. Edison's traction battery to enable them to decide whether such battery cars can be advantageously used on the electric tramways which it is proposed to construct in the borough as a cost of £61,000.

Wanganui (N.Z.) Council, who supply electrical energy for the Castlecliff tramways, recently decided to extend their power station plant and to invite tenders. Motors for the new cars are of 40 H.P.

Daylesford (Victoria) Council are having plans and estimate of cost of electric lighting plant prepared. The Daylesford Gas Co. is being wound up.

The "Mining and Engineering Review" (Sydney and Melbourne) says that Annandale Council, who have been paying the Australian Gaslight Co. £672 a year for street lighting (300 nights per annum) by 158 gas lamps, have now entered into an agreement for the electric lighting of the streets by Sydney City Council (every night in the year) by 173 lamps at £654. 7s. 6d. per annum.

The inauguartion of the Ballina (N.S.W.) electric lighting system took place recently. There are 64 street lamps varying from 32 to 200 c.p.

Plans and specifications were recently prepared for electric lighting and pumping plant for Swan Hill (Victoria). Mr. A. H. Wood is consulting engineer.

Bolivia.—A German Consul suggests that a good opportunity exists for the provision of electricity works at the town of Riveralta, the population of which has doubled in the last three years and is still growing.

Canada.—At the offices of the High Commissioner for the Dominion of Canada, 17, Victoria-street, London, S.W., the names can be obtained of Vancouver and Ottawa correspondents who wish to get into communication with British manufacturers of electrical fittings, carbon and tungsten lamps, porcelain goods, electric generators, motors, instruments, small transformers and watt-hour meters.

The Toronto Electric Light Co. have declined the offer of the City Council to purchase their undertaking, but they have agreed to sell to Sir Wm. Mackenzie.

Cuba.—A Canadian company has secured a concession for the erection of an electric light and power station at Cienfuegos.

Holland.—It is proposed to establish electricity works for the province of Groningen, and one scheme, estimated to cost about £104,000, includes the erection of a power station at the town of Groningen. New electric tramways in the province are projected and also the electrification of the line from Groningen to Zuidbroek and, subsequently, the continuation of the electrification to Wildervank.

Street Lighting in Budapest.—Mr. Etienne de Fodor, general manager of the Budapest General Electric Co., has received a further order from the Municipal Council of Budapest to erect and install additional street arc lamps. In 1909 Mr. De Fodor put up a trial plant with flame Alba arcs in one of the principal streets at the company's expense, the object being to show what modern lighting was. The results were so gratifying that the Council not only took over the entire trial plant but ordered some 160 further arcs to be placed in other thoroughfares in 1910. Since that time the city authorities have taken over the whole company, and have been trying experiments with high-pressure gas lights but the results obtained (we are informed by a correspondent) have by no means proved so favourable as those given by the flame arc, consequently the municipality has decided to erect 380 more this year, all the principal thoroughfares of Budapest being illuminated by electric arc lights. The arc lamps are of the Siemens Schuckert "Alba" type with vertical carbons, and are connected three in series on a 110-volt circuit, taking 15 amperes. The lamps are mounted on ornamental iron posts which are placed at about 50-metre distances from one another on one side of the street, the diagonal distance between lamps on the opposite side of the street being about 35 metres. The distance of the arc to the level of the street is about 9 metres. A typical Budapest thoroughfare is shown in the illustration above.

A BUDAPEST THOROUGHFARE, SHOWING TYPE OF ARC LAMP USED.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

The COMMISSIONERS OF H.M. WORKS AND PUBLIC BUILDINGS invite tenders (from manufacturers) for supply of opal lamp shades during three years. Forms of tender, conditions of contract and particulars from the Storekeeper, H.M. Office of Works' Stores, Lambeth Palace-road, London, S.E. Tenders by 11 a.m. on Wednesday, May 10, to the Secretary, H.M. Office of Works, Storey's Gate, S.W. See also an advertisement.

The COMMISSIONERS OF H.M. WORKS AND PUBLIC BUILDINGS want tenders (from manufacturers) by 11 a.m., Friday, May 5 for supply of electric gas torches during one year. Forms of tender from the Storekeeper, 12, Lambeth Palace-road, London, S.E. See also an advertisement.

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"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1911 Edition of the Big Blue Book is READY, price 15s., post free in the United Kingdom, 15s. 9d. The volume brings a great mass of very valuable statistical and technical data quite up to date, and the Directorial Division has been thoroughly revised and amplified up to February 24th.

All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters receive every attention in the new volume, which aggregates more than 2,000 pages. The Directory Division is complete and thoroughly accurate, and has been completely revised. The Big Blue Book contains more names of live electrical firms and persons than any other Directory published, and this notwithstanding that all mere lists of members of Societies and Institutions (so easily and cheaply available) are excluded, as unreliable and of little value for Manufacturers' and Dealers' purposes. The full set of valuable Statistical and Engineering Tables, &c., have been very carefully revised and extended, and are now issued in a handy form. These are included in the 1910 Big Blue Book, making it the most complete work of the kind ever published.

The Corporation of HASLINGDEN invite tenders for supply and laying of extra high pressure trunk mains, with medium pressure feeder and distribution cables. Specification, drawings, form of tender, &c., from the engineer, Mr. S. J. Watson, M.I.E.E., Electricity Works, Bury. Tenders to Mr. W. Musgrave, town clerk, Haslingden, by noon Friday, May 5. See also advertisement.

Tenders will be received at the Town Clerk's office, AUCKLAND, N.Z. until 4 p.m. of Thursday, June 15, for supply and erection of machinery for the new power station, including water-tube boilers, feed pumps, economisers, conveyor and steam pipes, and induced draught plant; d.c. steam generators, condensers, auxiliary machinery, engine-room crane, circulating pumps and pipes and switchboard. Specifications and drawings at the offices of the High Commissioner for the Dominion of New Zealand, 13, Victoria-street, London, S.W. See also an advertisement.

The COMMISSIONERS of H.M. WORKS AND PUBLIC BUILDINGS also invite tenders (from manufacturers) by 11 a.m. of April 28, for the supply of carbon and metal filament lamps for one year from May 1911. Form of tender, conditions of contract, &c., from the Storekeeper, 12, Lambeth Palace-road, London, S.E. See also an advertisement.

Tenders are invited up to May 30 for the supply of one portable steam-driven desiccating plant to the Postmaster-General's department in Victoria, and up to May 31 for the supply of 7,000 insulators and spindles and line material to the Postmaster-General's department in SOUTH AUSTRALIA. Tender forms and specifications from the Commonwealth Office, 72, Victoria-street, London, S.W. See also advertisements.

The EGHAM & DISTRICT ELECTRIC LIGHT CO. (LTD.) invite tenders for supply of two high-speed Diesel oil engines, coupled to two 100 kw. three-phase alternators, with direct-coupled exciters, piping, tanks and accessories; one 4-ton overhead traveller and main h.t. switchgear. Tenders to the secretary (Mr. H. T. Manwaring), 53, Cannon-street, London, E.C., by noon, April 24.

The PANCRAS (London) Borough Council invite tenders for three-core h.t. cable and for stoneware ducts. Copies of specification, conditions of contract and form of tender from the Electricity Department, Offices, 57, Pratt-street, Camden Town, N.W. Tenders to the town clerk, Mr. C. H. F. Barrett, Town Hall, Pancras-road, N.W., by noon, May 15.

The DERBY Corporation invite tenders for supply of inverted rotary converters, h.t. cable and switchgear. Specifications and forms of tender from the borough electrical engineer, Mr. T. P. Wilmshurst, St. Mary's-gate, Derby.

The FULHAM (London) Borough Council invite tenders for the supply, delivery and erection of a 1,500 kw. turbo-alternator with condensing plant. Tenders by noon, April 26, to the town clerk, Mr. J. Percy Boulton, Town Hall, Fulham, S.W.

The GLASGOW Corporation invite tenders for supply and erection of a 5,000 kw. turbo-alternator, with condensing plant for Pinkston generating station. Tenders to town clerk, Mr. A. W. Myles, City-chambers, Glasgow, by 10 a.m. April 24.

HORNSEY Town Council require tenders by 4 p.m. April 24 for supply and erection of flame arc lamps. Forms of tender, &c., from the Borough Electrical Engineer.

WALTHAMSTOW Council want tenders by 5 p.m. April 28 for a cooling tower and switchboard extension (two panels). Specifications &c., from Mr. G. R. Spurr, Electricity Works, Walthamstow.

SALFORD Corporation require tenders by 10 a.m. April 24 for the supply and erection of fire and police alarm street boxes and switchboard. Particulars from the Chief Constable.

WORTHING Corporation require tenders by noon April 24 for replating storage battery. Specifications, &c., from the Borough Electrical Engineer.

ILFORD Council require tenders by noon May 9 for the supply of distributing switchboard, feeder cable and stoneware conduits. Specifications, &c., from Mr. A. H. Shaw, Electricity Works, Ley-street, Ilford.

BARNES Council require tenders by noon May 9 for the supply and erection of combination de-oiling, softening and feed heating plant. Specification, &c., from the Engineer, Electricity Works, Mortlake.

ALDERSHOT Council require tenders by May 2 for replating batteries. Particulars from the Electrical Engineer, Laburnum-road, Aldershot.

COLWYN BAY and COLWYN COUNCIL require tenders by May 3 for one year's supply of cables and accessories, engine room stores and prepayment and ordinary meters. Forms of tender from the Clerk.

SOUTH SHIELDS Corporation want tenders by May 24 for supply and erection of 1,500 kw. high-pressure steam turbine (with surface condenser and pumps) coupled to 1,000 kw. d.c. generator (with switch panel, &c.) and 1,100 kw. a.c. generator (with switch panel, &c.). Specification, &c., from the Borough Electrical Engineer.

LUTON Corporation want tenders by 7 p.m. April 24 for supply and erection of turbine generators, condensing plant, and cooling tower. Specifications, &c., from the Borough Electrical Engineer.

Tenders are also invited by the MELBOURNE City Council for the supply, delivery and erection of a battery of accumulators with boosters and switchboards. The battery is to be capable of daily maintaining a normal capacity of 4,000 amperes for one hour, during which discharge the voltage of each cell shall not be lower than 1·7, the number of cells to be sufficient to maintain a total voltage across the whole battery of 475 volts at any time during discharge at the one-hour rate. Tenders are also invited for three years' maintenance. Tender forms, &c., from Messrs. McIlwraith, McEacharn & Co. Proprietary (Ltd.), Billiter Square-buildings, London, E.C., to whom tenders by noon May 8.

Tenders are invited up to May 16 for the supply of 10,000 protectors for use at subscribers' telephone stations; up to July 25 for the supply of 12 sections of a branching multiple magneto lamp signalling switchboard, &c., or one automatic or semi-automatic switchboard, &c.; and up to June 14 for supply of a branching multiple magneto lamp signalling switchboard at Ballarat, for the Postmaster-General's Department in VICTORIA; and up to June 14 for supply of a c.b. multiple switchboard to the Postmaster-General's Department, SOUTH AUSTRALIA. Tender forms, &c., from 72, Victoria-street London, S.W.

The Director of the Municipal electricity works, NAGYVÁRAD (Hungary), will receive tenders until April 29 for supply of a 1,800 H.P. steam turbine, a three-phase 3,000-volt generator, with condenser, switchboard, &c., and two boilers. The amount provided to cover the expenditure is £17,000.

Extension of Time.—The date for receiving tenders for the erection and equipment of electricity works at VARNA (Bulgaria) (see p. 35 of our last issue) is extended to May 18.

TENDERS RECEIVED AND ACCEPTED.

Colchester Corporation have accepted the following tenders for annual stores:—

Joslins (Ltd.), ironmongery car fittings, oils and grease; Brackett & Co., castings, &c.; Cammell, Laird & Co., wheel tyres; and Watlington & Co., overhead equipment for the tramways department, Stanford & Co., castings; A. E. Diss & Son, joiner's work; Joslins (Ltd.), prepayment meter installations, ironmongery and tools, oilman's and sundries and castor oil; W. Lucy & Co., fuse boxes; and Venner & Co., prepayment and ordinary meters, for the electricity department.

Wrexham Corporation have accepted the following tenders for annual stores:—

British Insulated & Helsby Cables, service cutouts; General Electric Co., arc lamp carbons; Dussek Bitumen Co., bitumen and box compound; James Light & Sons, crank chamber oil; Henry Wells Oil Co., cylinder oil, lubricating oils; Barton & Co., coal; E. Wade Wilton, boiler

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solution; no tenders have been accepted for cables, meters or incandescent lamps.

Sydney City Council (N.S.W.) have accepted the following tenders:—

Siemens Bros. Dynamo Works, arc lamp carbons, £3,909. 9s. 8d.; W. T. Glover & Co., cable suspenders, £117. 10s., and insulators, £125; Wm. Adams & Co., Nobel's turbine oil, 3s. 3d. per gallon; and Noyes Bros., Haes & Eggers, Siemens Bros. & Co., India Rubber, Gutta Percha & Telegraph Works Co., Australian General Electric Co., Lawrence & Hanson, Paton & Co. and W. G. Watson & Co., for annual supplies of electrical accessories.

Partick Council have accepted the following tenders for stores:—

W. C. Yuille & Co., engine room stores, tools and ironmongery; General Electric Co., cable jointing requirements, service cutouts and lamps; W. T. Henley's Telegraph Works Co., service cutouts; Chamberlain & Hookham and Ferranti Limited, meters; Sloan Electrical Co., arc lamp carbons; Valvoline Oil Co., oils (six months); and Robinson, Dunn & Co., wood troughing.

Southampton Council have accepted the following tenders for annual supplies to the tramways department:—

British Thomson-Houston Co., lamps; Lankester & Son, screws and files; Ralph Harris, iron and steel; Armstrong, Stevens & Son, bolts and nuts; McWhirter, Roberts & Co., nails, &c.; Flack, Ellis & Co., castings; Edk. Bird & Co., tools.

Stoke Corporation have accepted the tender of Jas. Howden & Co., at £8,905, for supply and erection of two three-phase 1,500-1,750 kw. steam turbo-alternators, 6,600 volts, 50 cycles (Siemens' alternators and exciters), regulating resistances, Tirrill regulator, Mirrlees Watson condensers and motors.

Norwich Corporation have accepted the following tenders:—

Premier Accumulator Co., supply and erection of a storage battery at £3,415, and for maintaining same for 10 years at £205 per annum; Lancashire Dynamo & Motor Co., battery booster, regulator and switchboard at £704; and Crompton & Co., balancer with switchgear, mounted on an iron kiosk at £155.

Walsall Council have placed an order with the Equipment & Engineering Co. for ½ mile of single trolley wire, at 9d. per pound. The tender of Alfred Hall for supplying and fixing an armature drying stove, together with armature trolley to carry two armatures, at £18, has been accepted.

Kensington (London) Council have accepted the tender of J. Defries & Son (at £425) for the illumination and decoration of the public buildings at the Coronation.

Westminster City Council have accepted the tender of Speedy, Enyon & Co. for the electrical illumination of portions of Piccadilly at the Coronation, for £1,000 including supply of current.

Gravesend Council have accepted the tender of the Electrical Apparatus Co. for small meters, and those of Ferranti Limited and the British Thomson-Houston Co. for large meters.

The Chloride Electrical Storage Co. have obtained the contract for 270 1,200-ampere-hour cells and 270 2,400-ampere-hour cells for the Darlinghurst and Burwood (Sydney) tramways sub-stations.

West Ham Corporation have accepted the tender of Hadfield's Steel Foundry Co. for 200 steel tramcar wheels.

Cheltenham Council have placed an order with the Phœnix Dynamo Mfg. Co. for a motor generator, at £537. 10s.

Southend Council have placed an order with the North Eastern Steel Co. for 650 to 750 tons of Sandberg tram rails, at £6. 10s. per ton.

Newport (Mon.) Council have accepted the tender of R. Alger & Sons for wiring the higher elementary schools for £488.

Wakefield Council have placed an order with McPhail & Simpson for three superheaters, at £360.

Commonwealth Contracts.—The Australian Postmaster-General's Department have accepted the following tenders:—

New South Wales.—R. Johnson, Clapham & Morris, h.d. copper wire and copper tapers; T. Zwicker & Co., jointing sleeves and porcelain insulators; Lawrence & Hanson Electrical Co., iron spindles for cross arms; F. Lassetter & Co., bolts.

Victoria.—Western Electric Co., two and five-conductor cords iron-clad indicators, listening and ringing keys, polechangers, plugs, magneto switchboards, &c.; British Insulated & Helsby Cables, three-conductor cords, induction coils, micro-telephones, watch pattern receivers and relays; R. Johnson, Clapham & Morris, g.i. wire; Gibbs, Bright & Co., lead-covered paper insulated telephone cable.

South Australia.—Western Electric Co., silk and cotton insulated and light lead covered switchboard cable; Gibbs, Bright & Co., paper insulated lead covered cable; India Rubber, Gutta Percha & Telegraph Works Co., copper binders and insulators; W. G. Watson & Co., porcelain insulators.

Queensland.—J. F. Lambert, supply and erection of copper wires on existing poles from Cairns to Marsuba.

Western Australia.—J. Bartram & Son, magneto bells, micro-telephones, switches, handles and portable telephones; British General Electric Co., oiled paper condensers, microphone mouthpieces, Leclanche zincs and insulated tinned copper; British Insulated & HelsbyCables, v.i.r. copper conductor lead-covered cable, switchboard cable, two-twisted conductor rubber insulated braided wire and h.d. copper wire; India Rubber, Gutta Percha & Telegraph Works Co., condensers, Varley galvanometers, detectors, lightning arresters, P.O. pattern polar relays, rheostats, sounders, transmitters, keys, pole changers, switches, &c.; Western Electric Co., coin attachments, twisted pair outside wire, insulators, &c.; Siemens Bros. Dynamo Works, tubular iron poles; W. T. Henley's Telegraph Works Co., lead-covered paper-insulated cable and tinned copper r.i. cotton covered and braided wire; R. Johnson, Clapham & Morris, g.i. wire; T. Zwicker & Co., sulp. of magnesia; Unbehaun & Johnston, desicating apparatus with motor-driven air pump; Noyes Bros., tinned copper v.i.r. insulated taped and braided wire and gal. steel wire; General Electric Eng. Co., single bridle wire; Wright & Gibbs, manhole covers and frames; Tomlinson Bros., manhole plates; Saunders & Stuart, rolled steel beams; Geo. Wills & Co., bronze wire.

New South Wales.—The Harbours and Water Supply Branch have accepted the tender of Noyes Bros. for a hydro-electric generator, transmission line and pumps for water supply of towns north of Wollongong, at £1,820. 6s. 8d.

The Victoria Minister for Mines (the Hon. P. McBride) has accepted the tender of Thompson & Co., of Castlemaine (Victoria) for boilers for the electric plant for Wonthaggi (Victoria) States Coal Mine. Eight tenders were received, five for Australian made Lancashire boilers and three for imported boilers. The latter were for Babcock & Wilcox, Bettington, and Wolf boilers. The amount of the accepted tender, which includes the supply of five new Lancashire boilers and the erection of three boilers for the Government and fitting the whole eight boilers with superheaters and underfeed stokers, is £9,492. 17s. The total cost of installing the steam raising plant, including boiler room, smoke stacks, steam piping, feed piping, feed pumps, &c., will be £14,792. 17s. Imported boilers could have been installed at a total cost of £11,061.

Turbine Contracts.—During the past three weeks Messrs. Jens Orten-Böving & Co. have received a number of orders, including:—

Ushino Kubi, two Francis turbines, each of 1,300 H.P. under a head of 80 ft. Two Francis turbines each of 90 H.P. under a head of 30 ft. for Council of Taihape (N.Z.); one Francis turbine of 60 H.P. under a head of 4½ ft., for Messrs. Christy Bros. (Chelmsford); one Böving patent water turbine governor, for Shibaura Engineering Works, Japan; one Francis turbine of 14·4 H.P., under a head of 61 ft. 6 in., at 900 revs. per min., complete with governor, for University of Liverpool. Also one Victoria turbo-pump, to deliver 450 gallons per minute against a head of 205 ft., for Furukawa Ani Mines, Japan; and one pump to deliver 350 gallons per minute, against 555 ft. head for the Johnsonville (N.Z.), &c.

BUSINESS NOTICES.

Messrs. Donovan & Co. have removed to 47, Cornwall-street, Birmingham, where they have started a special conduit and fittings department. Telephone numbers 5,703 and 5,704.

The Midland Electric Mfg. Co. are removing their factory to Stafford Works, Rea-street South, Birmingham.

Sale by Auction.—Messrs. Fuller, Horsey, Sons & Cassell will include in their sale by auction at H.M. Dockyard, Chatham, on Tuesday, May 9, and following days, 210 tons scrap brass and mixed metal, 27 tons white metal, 28 tons manganese and phosphor bronze, 800 tons mild scrap steel, 500 tons wrought and c.i. scrap, 100 tons steel wire rope, 76 tons lead and zinc ashes and bottoms, 30 tons electric cable, electrical gear and stores, two dynamos, 12 old engines, machine tools, &c. May be viewed three days prior to and on mornings of sale, and catalogues (6d. each) had at the Dockyard, or of the Auctioneers, 11, Billiter-square, London, E.C. Further particulars are given in an advertisement.

Patents Development.—The proprietor of letters patent No. 5,187.1907, relating to "The distance transmission of photographs, &c.," desires to licence British manufacturers to work same in Great Britain. Applications to messrs. Boult, Wade & Tennant, patent agents, 111 and 112, Hatton-garden, London, E.C.

The proprietor of letters patent No. 12,326/1908, for "Dynamo electric machines," desires to license British manufacturers to work the invention in Great Britain. Applications to Messrs. Boult, Wade & Tennant, Patent Agents, 111 and 112, Hatton-garden, London, E.C.

Plant for Sale.—Elektron Limited (in liq.), Gothenburg, offer for sale triple expansion engines, c.c. dynamos, &c. Further particulars are given in advertisements.

Correction.—In the page advertisement of Messrs. Siemens Bros. Dynamo Works last week our readers were referred to the "Electrical Times" for "reason 3." In a number of copies the figure 3

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was dropped in error, the type having fallen below printing level. Readers with imperfect copies will note that it was the figure 3 which should have appeared.

Reid's Colliery Guide.—Any publication which enables members of the electrical industry to come into contact with mining interests is welcome, and the "Handy Colliery Guide and Directory," for the counties of Northumberland, Durham and Yorkshire, for which Messrs. Andrew Reid & Co., of Newcastle-on-Tyne and London, are responsible, is a serviceable publication in this connection. Besides containing a useful map of the districts with which the guide is chiefly concerned, there are lists of collieries, colliery owners, agents, managers and engineers in all three counties; lists of associations and institutions connected with these counties, names and addresses of the inspectors of mines for the districts, and, in addition, an extended list of mine inspectors covering the entire United Kingdom. The various Acts of Parliament and Home Office and other orders affecting mining operations are also given, together with numerous items which one would expect to find in such a work. The price of the guide is 2s. 6d., and it is strongly bound and of a size that can be carried in the coat pocket.

BANKRUPTCIES, LIQUIDATIONS, &c.

A dividend is to be paid to creditors of Ernest F. Jones, electrical engineer, &c., 132, York-road, West Hartlepool. Claims to Mr. J. S. Britain, North Eastern Bank Chambers, Stockton-on-Tees, by May 1.

An application for the discharge of Wm. H. Steed, electrical engineer, &c., 13, Stamford-street, Altrincham, will be heard at the Court House, Quay-street, Manchester, on May 22.

Claims against the Rosario Electric Co. (Ltd.) can be sent to Mr. H. E. Flatthell, 52, Moorgate-street, London, E.C., by May 30.

BOOKS RECEIVED.

Copies of the undermentioned works can be had from *The Electrician* office, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published at 6s., and 5 per cent. for books published nett. Add 10 per cent. for abroad or for foreign books.

"Mathematical and Physical Papers," Vol. V.: "Thermody Namics, Cosmical and Geological Physics, Molecular and Crystalline Theory, Electrodynamics." By Sir W. Thomson, Baron Kelvin. Arranged and revised by Sir J. Larmor. (Cambridge: University Press.) 18s.

"A Dictionary of Electrical Engineering." Edited by H. M. Hobart. (London, 1910: The Gresham Publishing Co.) 35s. net.

"Transactions of the South African Institute of Electrical Engineers." Vol. I., part 14, and vol. II., part 1. 2s. each.

"Transactions of the Royal Society of Edinburgh." Vol. XLVII. Session 1910-11. £1. 0s. 10d.

COMPANIES' MEETINGS AND REPORTS.

ANGLO ARGENTINE TRAMWAYS CO. (LTD.)—Mr. J. B. Concanon, who presided at the meeting last week, stated that the company carried 21 passengers in 1910. Gross receipts were £2,419,185, and ... (including £110,000 credited to depreciation renewals funds) ..., showing a profit of £855,092. An interim dividend of ... had been paid on the ordinary shares, and the directors ... a final dividend of 4¼ per cent., leaving £13,044 to be carried forward. Mr. Concanon also gave particulars of the present ... scheme for the construction of subways in the city.

BABCOCK & WILCOX (LTD.)—The directors' report for the year ended ... states that the net profit during the year amounted to ... 10d., and with balance brought forward (£63,082. 14s. 9d.) ... 42. 17s. 7d. Interim dividends of 3 per cent. on the preference and ... per cent. on the ordinary shares amounted to £86,000, ... 42. 17s. 7d. The directors recommend the following dividends, viz.: 3 per cent. on the preference, less tax (£3,000), ... on the ordinary shares, tax free (£66,400); also a bonus ... on the ordinary shares, tax free (£66,400). £100,000 has ... to reserve (bringing this fund to £700,000), £25,000 to the ... equalisation fund, and £10,000 to staff pension fund, leaving ... 7d. to be carried forward. The volume of business during ... showed an increase, but competition and increased cost of materials reduced the ratio of profit. The turnover is, however, ... to give a good return on the capital, notwithstanding ... rates of profit on orders. The demand for the firm's ... for naval work has been satisfactory, and their use in the ... continues to show progress, several important orders ... In view of the application of crude oil engines for marine propulsion, the directors have acquired a general licence for the British Empire to use the patents and experience of the Maschinenfabrik Augsburg Nurnberg, a firm which has made the greatest advance so far in this direction. The firm are consequently in a position to take advantage of this development should the future require it.

BROMLEY (KENT) ELECTRIC LIGHT & POWER CO. (LTD.)—Mr. F. E. Gripper stated at the recent meeting last the lamp connections had increased from 98,282 to 95,307 8 c.p. In spite of the introduction of metal filament lamps, the sale of current showed a slight increase. Including £172. 7s. 1d. brought forward the profit was £12,201. 18s. 3d. A final dividend at the rate of 8 per cent. (making 6 per cent. for the year) was declared.

CALCUTTA TRAMWAYS CO. (LTD.)—At the meeting on Wednesday the chairman (Mr. E. C. Morgan) said that they had run 40,000 car-miles and carried about 1,500,000 more passengers, producing an increase in traffic receipts of over £10,500. They had actually spent less money than in 1909. The savings had been effected by more careful supervision of expenditure. One of the most encouraging features in the report was the justification of the policy of the directors in carrying out extensions. It was agreeable to notice that the result of the last year's working showed a considerable increase in the profit, and he ventured to think that Howrah would soon be a welcome addition to their business, the ferry competition notwithstanding.

CHISWICK ELECTRICITY SUPPLY CORPN. (LTD.)—The directors' report for 1910 states that the undertakings at Chiswick and Aberystwyth continue to expand. £3,969 was spent on capital account for machinery, mains, free wiring, &c., while £263 was written off for depreciation. The number of consumers was 2,081, against 1,875 in 1909, and the revenue was £15,404, against £15,129, the profit for the year being £7,534, compared with £7,592. The results of the year's working enable payment of a dividend on the ordinary shares of 6 per cent., the same as paid for the previous four years. (The shares of the Chiswick Co. are held by the West London & Provincial Electric Supply Co., Ltd.)

CLAYTON & SHUTTLEWORTH (LTD.)—At the meeting last week Col. Frank Shuttleworth said that the question of their power supply had recently engaged the directors' attention. They were taking a considerable amount of electric power from the Lincoln city mains for general purposes, and for the sake of uniformity, and also because of the convenience and efficiency of the system, the board determined to adopt electric driving throughout the works. When they approached the Lincoln Electricity Committee on the matter they received an offer for an increased supply of power at rates sufficiently advantageous to warrant them entering into a new agreement with the Corporation. It was a tribute to the exceptional efficiency of that department of the Corporation that they had been placed in as favourable a position for obtaining cheap power as that enjoyed by concerns situated in the larger industrial centres of the country. It would be seen, therefore, that they were carrying out a well-ordered scheme of progress. Trade prospects continued to be favourable, and their engineering works were employed up to the limit of their capacity.

DEUTSCH-ATLANTISCHE TELEGRAPHENGESELLSCHAFT.—The directors' report for 1910 states that the profit, after meeting working expenses, is M.3,353,318 (£167,666), compared with M.2,966,311 (£148,316) in the previous year. Of this amount £7,195 has been placed to reserve, £20,000 to special reserve and repairs fund, £5,000 to insurance fund and £3,775 to pension and benevolent funds; £90,000 is devoted to payment of 7½ per cent. dividend, £6,476 for fees, &c., for directors and officials, and £25,222 is carried forward. The Atlantic traffic shows a steady upward tendency. The Vigo cable is so fully occupied that its duplication must be considered. With regard to the effect of wireless telegraph competition, the report states that since the opening of the Marconi Company's trans-Atlantic service the cable business has further increased. The spread of wireless telegraphy on ships and in out of the way islands has provided a new source of traffic for the cables.

GRASSINGTON ELECTRIC SUPPLY CO. (LTD.)—At a special meeting of shareholders last week it was decided to issue the remainder of the ordinary shares.

KIDDERMINSTER & DISTRICT ELECTRIC LIGHTING & TRACTION CO. (LTD.)—The report for 1910 states that the total capital expenditure to Dec. 31, 1910, on buildings and plant for electric supply amounted to £51,480. The gross receipts (including dividend on shares held in the Kidderminster and Stourport Electric Tramway Co.) amounted to £9,599, which, with £87 brought forward, made a total of £9,686, compared with £9,252 for 1909. After deducting expenses (including debenture stock and other interest), the available balance was £4,222. The directors propose to place £1,175 to depreciation and renewals fund, and £250 to debenture and loan redemption reserve. The cumulative preference dividend for the year absorbed £1,500, and it is proposed to pay a dividend at the rate of 2s per cent. per annum on the ordinary shares, leaving £122 to be carried forward.

LECHLADE ELECTRIC LIGHT & POWER CO. (LTD.)—The first annual meeting was held last week, when the chairman (Mr. B. F. Innocent) gave a resumé of the company's work since its inception, and said that in the face of difficulties it could now be said to be in a state of stability. The area of its usefulness was being slowly but surely extended.

ORIENTAL TELEPHONE & ELECTRIC CO. (LTD.)—Including £10,528. 12s. brought forward, and after deducting interim preference

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and ordinary dividends of 3 per cent., and making provision for redemption of debenture stock and other charges, the amount to be dealt with is £37,065. 9s. 3d. The directors recommend payment of final preference dividend of 3 per cent. (less tax), and of 5 per cent. (tax free) on the ordinary shares (making 8 per cent. for the year). After making provision for reserve and for contemplated staff pension scheme, £18,099. 16s. 3d. is carried forward.

The Bombay Telephone Co. increased its dividend from 7 to 8 per cent., but the Telephone Co. of Egypt, the Bengal Telephone Co. and the China & Japan Telephone & Electric Co. continue to pay their previous rates (10, 5 and 5 per cent. respectively).

A 30 years' concession to extend the telephone service over the whole of the island of Mauritius where practicable has been granted to the company by the Government of Mauritius. The construction of the lines inland will commence as soon as the document is completed.

SAO PAULO TRAMWAY, LIGHT & POWER CO. (LTD.)—The gross earnings for 1910 were $2,949,292.90, operation expenses were $962,357.63 and net earnings $1,986,955.27. Deducting bond interest, taxes, &c., the net surplus was $1,003,093.19. $999,992.50 has been appropriated for dividends, $200,000 provided for renewals, &c., and $403,100.69 transferred to profit and loss. The gross earnings of the tramways amounted to $1,999,778.25, against $1,677,907.41. The gross earnings of the lighting department were $949,514.65, compared with $761,578.36. In addition to the regular expenditure for maintenance of property, there was expended in the renewal of different sections of track and overhead system, &c., $164,791.69. Expenditure on capital account during the year amounted to $1,051,819.17. The greater portion of this expenditure was incurred in installing for the hydraulic plant the third feeder pipe (12 ft. in diameter, 2,300 ft. in length), another 2,000 kw. generator, transformers and switchgear, a turbine, pen-stock, &c., and alterations and additions to plant for increasing the transmission-line voltage from 22,000 to 41,000 volts. The track mileage was increased by 2 miles, and additional feeders were laid for the light and power systems. In the company's shops 25 motor-cars were constructed and a sub-station was erected at Ypiranga. At Dec. 31 the equivalent of 75,900 8 c.p. lamps were connected, an increase of 12,031, or 18·8 per cent. Lighting customers were 5,343, increase 615, and power customers were 535, increase 107. Motors installed 1,159 (16,172 H.P.), increase 252 (4,384 H.P.).

SIR W. G. ARMSTRONG, WHITWORTH & CO. (LTD.)—At the recent meeting the Chairman (Sir Andrew Noble) said that although the results, both at Elswick and Openshaw, had been exceptionally good, the board did not think it desirable to increase the dividend beyond 10 per cent. They had carried forward sufficient to pay an additional 5 per cent., because they had found it necessary to remove their yard for the construction of war vessels from Elswick to a site below the bridge at Walker. The work in progress was considerably larger than at the corresponding period last year, and the position and outlook were satisfactory.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

DRY GLASS ELECTRIC FIRE EXTINGUISHER CO. (LTD.) (115,216.)—Reg. on April 11, capital £1,000 in £1 shares, to carry on the business indicated by the title. Private company. Reg. office, 39, Corporation-street, Birmingham.

ELECTRICAL ENGINEERING & AGENCY CO. (LTD.) (115,089.)—Reg. April 4, capital £10,000 in £1 shares, to carry on the business of electricians, electrical and mechanical engineers, manufacturers of and dealers in electrical appliances, &c. Private company.

GEORGE BAILEY & SONS (LTD.) (114,974.)—Reg. March 29, capital £1,000 in £1 shares, to take over the business of an electrical, gas and general engineer, fitter and brass founder, carried on at Wolverhampton as G. Bailey & Sons. Private company. First directors: G. W. Bailey and Mrs. E. E. Bailey. Reg. office: 2, Berry-street, Wolverhampton.

INDESTRUCTIBLE ACCUMULATORS (LTD.) (115,259)—Reg. April 12, capital £12,000 in £1 shares, to carry on the business of engineers, manufacturers of accumulators, apparatus and engines, &c., and to adopt an agreement with the Vacuum Engineering Co. Private company.

PLAYER & MITCHELL (LTD.) (115,270.)—Reg. April 12, capital £15,000 in £1 shares, to take over the business of naval and railway brass-founders, lamp manufacturers, and electric lighting contractors carried on as Player & Mitchell, and to adopt an agreement with S. W. Mitchell. Private company. First directors, S. Sheppard and W. Dampier (both permanent). Reg. office, Attwood-passage, Cambridge-street, Birmingham.

STAIRWAYS (LTD.) (115,307)—Reg. April 13, capital £15 in 1s. shares, to carry on the business of makers, proprietors and conductors of electric and other lifts, stairways, elevators, escalators, moving stairways, tramways, railways and other mechanical appliances, &c. Private company. First directors, T. Kipping, S. Boyd and H. Hill (all permanent). Reg. office, 17, Gracechurch-street, London, E.C.

STANIAR, CLEGG & CO. (LTD.) (114,935.)—Reg. March 27, capital £1,000 in 500 10 per cent. preference shares of £1 each and 10,000 ordinary shares of 1s. each, to carry on the business of electrical engineers, dealers in electrical goods, cables, wires, dynamos, controllers, arc lamps, &c., and to adopt an agreement with H. D. Staniar and A. E. Clegg. Private company. First directors, H. D. Staniar and A. E. Clegg. Reg. office: 112, Portland-street, Manchester.

STATUTORY RETURNS.

CENTRAL ELECTRIC SUPPLY CO. (LTD.)—According to return to Feb. 4 capital is £100,000 in £5 shares. All shares taken up. £100,000 aid. Mortgages and charges, £450,000 guaranteed debenture stock.

COWPER-COLES INVENTIONS DEVELOPMENT CO. (LTD.)—Return to Dec. 31 gives capital £50,000 in £1 shares (25,000 A and 25,000 B, 1,582 A and 10,000 B shares taken up). £1 per share called up on 1,582 A and £1,582 paid. £10,000 considered as paid on 10,000 B. Mortgages and charges, £190 debentures.

DIRECT UNITED STATES CABLE CO. (LTD.)—In return dated Feb. 7 capital is £1,300,000 in £20 shares. 60,710 shares taken up. £1,214,200 paid. Mortgages and charges, nil.

KENT ELECTRIC POWER SYND. (LTD.)—According to return to Jan. 5 the capital is £15,030 in 1,500 ordinary shares of £10 each and 600 deferred shares of 1s. each. All shares taken up. £15,021. 14s. paid, leaving £8. 6s. in arrears. Mortgages and charges, £1,033.

MORTGAGES AND CHARGES.

HINDHEAD & DISTRICT ELECTRIC LIGHT CO. (LTD.)—Issue on June 11 of £50 debentures, part of a series of which particulars have already been filed.

NORTHAMPTON ELECTRIC LIGHT & POWER CO. (LTD.)—Memorandum of satisfaction in full on Jan. 13 of debentures dated March. 8, 1901, and March 29, 1906, securing £5,000 and £1,400 respectively, has been filed.

A. REYROLLE & CO. (LTD.)—Issue on March 30 of £600 debentures, part of a series of which particulars have already been filed.

RECEIVERSHIP.

J. C. CHILDS & CO. (LTD.)—Notice of appointment of H. W. Fresh water, 7-8, Railway-approach, London Bridge, S.E., as receiver, on March 31, under powers contained in debentures dated 1908, has been filed.

CITY NOTES.

MEMORANDA (April 20).—**Bank rate 3 per cent.** (March 9, 191 **Price of silver, 24⅛d. per oz. Consols 81⅞—82 for money; 81⅞—82⅛ fc account. Consols Pay Day, May 4; Stock and Shares Continuatio Days, April 25 and May 10; Ticket Days, April 26 and May 11; Pa Days, April 27 and May 12; Mining Shares Carry Over Day, April 2(**

PRICES OF METALS (London).—*Copper*, cash, 53⅝; three month 54¼. *Lead*, English, 13⅜—13¾; foreign, 12⅝—13 cash, 13—13 three months. *Spelter*, 23¾. *Tin*, English, 190—192; foreign, 191¼ cas 187 three months. *Iron*, Cleveland, cash, 46/4, three months, 47/0.

BRITISH COLUMBIA ELECTRIC RAILWAY CO. (LTD.)—The direct have declared an interim dividend at the rate of 8 per cent. on deferred stock in respect of the half-year ended Dec. 31.

CITY OF SANTOS IMPROVEMENTS CO. (LTD.)—The directors h declared a final dividend for 1910 of 4½ per cent. (making 7 per cent. the year) on the ordinary shares. The net profit showed an incre of £6,200 over 1909.

HINDHEAD & DISTRICT ELECTRIC LIGHT CO. (LTD.)—The direct recommend a dividend of 3½ per cent. for the half-year to Dec. 31 (mak 6 per cent. for the year).

KAMINISTIQUIA POWER CO. (LTD.)—A quarterly dividend at rate of 3 per cent. has been declared.

MONTE VIDEO TELEPHONE CO. (LTD.)—The directors have decl an interim dividend at the rate of 6 per cent. per annum on the ordi shares for the past half-year.

MONTREAL LIGHT, HEAT & POWER CO.—A dividend of 2 per c has been declared for the quarter ended April 30th.

PERGAMINO (ARGENTINA) ELECTRIC LIGHT CO.—This company declared a dividend of 10 per cent.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee granted quotations to a further issue of £20,000 5 per cent. second m gage debentures of the *Bombay Electric Supply & Tramways Co.* (L and a further issue of £50,000 6 per cent. first debenture stock o *Buenos Ayres Port & City Tramways (Ltd.)*. The Committee have asked to appoint a special settling day in and grant a quotation to paid scrip for £300,000 5 per cent. first mortgage convertible bonds o *Cuban Telephone Co.*, and to allow £1,188,300 5½ per cent. first mor debentures (in lieu of scrip) of the *Lima Light, Power & Tramway (Las Empresas Electricas Asociadas)* to be quoted.

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ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

LINE	Week ended.	Amount	Inc. or Dec. (a)	Aggregate: No. of weeks.	Aggregate: Amount.	Aggregate: Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	April 12	1,278	+ 26	45	62,585	+ 1,629
[illegible]	,, 7	201	− 5	14	2,920	− 34
Anglo-Argentine	,, 15	47,478	+ 950	15	744,067	+ 93,511
[illegible]-Lyne	,, 8	366	+ 41	2	754	− 39
Ayr Corporation	,, 15	236	+ 29	48	13,739	+ 351
Barnsley	,, 7	175	+ 28	14	2,361	+ 11
Barrow	,, 7	241	+ 41	14	3,185	+ 49
Bath Electric Trams, Ltd.	,, 12	681	− 42	15	9,771	− 720
Birmingham Corporation	,, 15	7,043	+ 400	2	15,455	+ 363
Birmingham & Midland	,, 7	857	+ 94	14	11,879	+ 712
Blackburn Corporation	,, 12	1,016	+ 52	†3	2,510	− 502
Blackpool and Fleetwood	,, 15	709	+ 420	..	..	..
Bolton Corporation	,, 16	3,235	+ 892	3	6,292	+ 854
Bombay	March 17	2,941	+ 140	11	31,066	+ 1,676
Bournemouth Corporation	April 12	1,399	− 112	‡2	2,355	− 461
Bradford Corporation	,, 8	4,847	+ 336	1	4,847	+ 336
Brighton Corporation	,, 16	1,063	+ 229	¶2	2,000	+ 10
Bristol Trams & Carriage	,, 14	5,882	+ 346	2	11,279	+ 407
Burnley Corporation	,, 15	1,732	+ 536	2	2,968	+ 590
Bury Corporation	,, 16	272	+ 18	§2	578	+ 6
[illegible] Corporation	,, 16	1,591	+ 433	¶2	3,146	+ 431
Calcutta Tramways Co.	,, 15	R53,518	+ R1,532	15	R831,542	+ R6,342
Camborne-Redruth	,, 15	119	+ 8	15	1,678	− 58
Cardiff Corporation	,, 8	2,091	+ 129	1	2,091	+ 129
[illegible]	,, 7	80	+ 18	14	863	− 143
Central London Railway	,, 15	4,381	− 1,139	15	79,972	− 2,586
Chatham & Dist. Lt. Rys.	..	..	..	..	..	..
City & South London Rly.	,, 16	3,189	+ 99	15	51,497	+ 1,991
[illegible] Birmingham	,, 7	2,782	+ 193	14	38,692	− 301
[illegible] Corporation	,, 12	154	− 8	..	..	..
Cork Electric Trams Co.	,, 13	473	+ 1	15	6,350	− 168
[illegible] & Dist. Trams	,, 7	434	+ 25	14	5,849	+ 291
[illegible] Corporation	,, 8	186	+ 7	1	186	+ 7
[illegible] & Lucan Railway	,, 14	135	+ 10	15	1,611	− 95
[illegible] United	,, 14	5,163	− 100	15	74,249	− 599
[illegible]-Stourbridge	,, 7	716	+ 75	14	10,040	+ 352
[illegible] Corporation	,, 12	1,163	− 26	§47	56,052	+ 211
[illegible] Council	,, 15	1,061	+ 96	2	2,194	+ 134
[illegible] Corporation	,, 14	298	− 7	2	560	− 19
[illegible] & Dist. Trams	,, 7	993	+ 71	14	13,684	+ 536
[illegible] Corporation	,, 15	18,121	+ 1,113	46	816,964	+ 43,927
[illegible] Trams	,, 15	140	+ 32	15	1,708	+ 75
[illegible] Corpn.	,, 12	257	− 4	2	517	+ 12
[illegible]-Northfleet	,, 7	182	+ 2	13	2,439	− 155
[illegible] & City Rly.	,, 15	1,394	− 53	15	23,671	+ 1,004
[illegible] & Port Glasgow	,, 7	678	+ 80	14	8,364	+ 1,180
[illegible]	,, 11	1,562	+ 47	†2	2,646	+ 24
[illegible] Tramways	,, 7	218	+ 21	14	2,919	+ 75
[illegible] Elec. Trams Co.	,, 13	769	− 77	16	10,553	− 1,263
[illegible]	,, 15	$7,713	− $622	16	$119,057	− $110
[illegible] Corpn.	,, 15	1,864	+ 124	2	3,733	+ 416
[illegible]	,, 15	2,833	+ 261	2	6,274	+ 209
[illegible] Council	,, 15	586	+ 100	2	1,168	+ 49
[illegible] Council	,, 12	116	+ 7	2	239	+ 27
[illegible] Corporation	,, 15	445	+ 79	2	843	+ 103
[illegible] Co.	..	..	..	..	..	..
[illegible]	,, 7	118	+ 8	14	1,543	+ 18
[illegible] Corporation	,, 13	163	..	2	308	− 4
[illegible] & District	,, 7	83	+ 8	14	1,141	− 53
[illegible] Corporation	,, 16	153	+ 12	48	7,218	+ 277
[illegible] Corporation	,, 12	293	+ 50	2	565	+ 50
[illegible] Trams Co.	..	..	..	..	..	..
[illegible] United	,, 12	1,168	− 4	15	17,643	− 492
[illegible]	,, 7	134	− 36	14	1,802	− 204
[illegible] Corporation	,, 15	7,354	+ 658	2	15,924	+ 2,127
[illegible] Corporation	,, 15	2,550	+ 359	2	4,834	+ 418
[illegible] Corporation	,, 15	587	+ 30	48	28,217	+ 28
[illegible] Corporation	,, 15	140	+ 25	2	259	+ 31
[illegible] Rly.	,, 16	1,457	+ 143	15	20,744	+ 1,315
[illegible] Bay Ry.	,, 14	195	+ 34	§19	2,473	− 235
[illegible] County Council	,, 5	41,315	+ 2,470	¶1	41,345	+ 2,470
[illegible] Ry. Co.	,, 15	12,665	− 340	15	211,600	+ 11,855
[illegible] United	,, 15	6,740	− 1,025	15	80,615	− 3,128
[illegible] Corporation	,, 15	172	+ 29	28	4,362	+ 190
[illegible] Corporation	,, 15	16,608	+ 1,814	2	34,757	+ 4,312
[illegible] Railway	,, 15	2,018	+ 82	15	30,659	+ 835
[illegible]	,, 7	187	+ 11	14	2,528	− 105
[illegible] Dist. Railway	,, 15	11,040	+ 54	15	176,354	+ 13,612
[illegible] Elec. Trams	,, 7	7,664	+ 800	14	105,110	+ 11,694
[illegible]	,, 7	385	+ 30	14	3,884	+ 58
[illegible] Corporation	..	..	..	..	..	..
[illegible]-Tyne Corp.	,, 15	4,130	+ 391	2	8,967	+ 400
[illegible]	,, 15	721	+ 99	2	1,533	+ 69
[illegible] Corporation	,, 14	463	+ 21	2	896	+ 28
[illegible] & Hyde	,, 7	530	+ 50	14	7,149	− 133
[illegible] Corporation	,, 16	2,158	+ 410	3	6,361	− 56
[illegible] Corporation	,, 12	152	− 11	47	7,723	+ 349
[illegible] Elec. Trams	,, 14	1,635	− 1	15	24,595	+ 852
[illegible]	,, 7	100	+ 10	14	1,371	+ 16
[illegible] Corporation	,, 15	2,104	+ 304	2	3,683	− 497
[illegible]	,, 7	1,926	+ 344	14	25,925	+ 2,500
[illegible] Corporation	,, 12	660	− 3	2	1,348	+ 30
[illegible]	..	..	..	..	..	..
[illegible] Corporation	,, 7	66	− 41	14	628	− 326
[illegible]	,, 17	5,755	+ 1,259	‡2	12,218	+ 1,720
[illegible] Corporation	,, 7	42	− 2	14	577	− 8
[illegible]	,, 16	6,377	+ 513	3	19,287	+ 97
[illegible]	,, 16	$10,807	+ $267	11	$103,843	+ $2,699
[illegible]	,, 7	643	− 50	14	9,341	− 701
[illegible]	,, 7	842	+ 110	14	11,624	+ 573
[illegible] Corporation	,, 12	1,004	+ 15	2	1,715	+ 36
[illegible]	,, 12	393	− 24	2	667	− 113
[illegible]	,, 7	238	+ 1	14	3,124	− 205
[illegible] Corporation	,, 15	1,125	+ 484	2	1,985	+ 513
[illegible]	,, 16	1,200	+ 180	2	2,666	+ 220
[illegible]	,, 12	403	+ 55	24	10,357	+ 628
[illegible] Corporation	,, 7	1,045	+ 120	14	14,249	+ 788
[illegible]	,, 12	132	+ 7	2	228	− 2
[illegible] Council	,, 7	39	..	14	506	− 32
[illegible]	,, 7	157	− 8	14	2,022	− 121
[illegible]	,, 12	398	+ 32	15	5,653	− 51
[illegible]	,, 15	1,063	+ 198	2	2,177	+ 241
[illegible] Corporation	,, 15	554	+ 44	14	7,941	+ 5
[illegible]	..	..	..	..	..	..
[illegible]	,, 6	2,350	+ 107	1	2,360	+ 107
[illegible] Co.	,, 7	25	− 34	14	252	− 279
[illegible]	,, 7	398	+ 49	14	5,706	+ 138
[illegible] Corpn.	,, 12	812	+ 30	2	1,725	+ 57

ELECTRICAL COMPANIES' SHARE [LIST]

Shares	Last Dividend	NAME	Price Wed., April 19.	Rate per cent. Yielded (£ s. d.)	Dividends Due
		Electricity Supply.			
10	6/0	Bournemouth & Poole Elec. Sup. Ord.	8¼—8¾	6 0 0	Mar, S[illegible]
10	4/6	Do. 4½ per Cent. Cum. Pref.	9¼—9¾	4 12 3	Feb, A[illegible]
10	6/0	Do. 6 per Cent. Cum. Second Pref.	10—10½	5 13 0	Feb, A[illegible]
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101—103	4 7 6	Jan, J[illegible]
5	5/6	Brompton & Kensington Elec. Sup. Ord.	7⅛—7⅝	6 11 3	March,
5	3/6	Do. 7 per Cent. Pref.	7⅛—7⅝	4 11 6	Mar, S[illegible]
St.	4%	Central Elec. Sup. Co. 4% Guar. Deb. Stock	99—103	3 17 6	June,
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	4—4½	5 11 0	Feb, A[illegible]
5	2/3	Do. 4½ per Cent. Pref.	4⅛—4⅝	4 17 0	Feb., A[illegible]
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	96—98	4 1 6	Jan, J[illegible]
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	100½—102½	4 8 0	..
5	2/3	Do. City Undertaking 4½% Cum. Pref.	3⅞—4⅜	5 3 0	Jan, J[illegible]
5	3/0	Chelsea Electric Supply Ord.	4—4½	5 11 0	March
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	100—102	4 8 6	June,
10	8/0	City of London Electric Lighting Ord.	11½—12	5 15 9	Feb, A[illegible]
10	6/0	Do. 6 per Cent. Cum. Pref.	12—13	4 12 3	Jan, J[illegible]
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	119—123	4 1 0	June,
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	101—104	4 6 6	Jan, J[illegible]
5	..	County of Durham Elec. P. D. Ord.	1⅝—2	..	April,
5	1/3	†Do. 5 per Cent. non Cum. Pref.	2¼—3	8 6 9	April,
10	6/0	County of London Elec. Supply Ord.	7⅞—8⅜	6 3 0	Feb, A[illegible]
10	6/0	Do. 6 per Cent. Cum. Pref.	10¾—11¼	5 5 6	Mar, S[illegible]
St.	4½%	Do. 4½ per Cent. Deb Stock (red.)	108½—111½	4 0 9	Jan, J[illegible]
St.	4½%	Do. Second Deb. Stock	101—104	4 6 6	May, N[illegible]
5	2/0	†Folkestone Electricity Supply Co. Ord.	4¼—4¾	5 19 0	April,
5	2/6	†Do. 5 per Cent. Cum. Pref.	4¾—5¼	4 15 3	Mar, Se[illegible]
St.	4½%	Do. 4½ 1st Deb. Stock (red)	97—100	4 10 0	Feb, A[illegible]
5	5/0	†Hove Electric Lighting Ord.	6⅞—7¼	6 6 0	April,
St.	4½%	Isle of Wight E. L. & P. Co. Deb. Stk.	90—93	4 16 9	..
5	5/0	Kensington & Knightsbridge Ord.	7—7½	5 16 0	Feb, A[illegible]
5	6%	Do. 6 per Cent. 1st Pref.	5¾—6	5 0 0	Jan, J[illegible]
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	93—95	4 4 0	..
St.	4%	Kensington & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	96—99	4 1 0	April,
St.	4½%	Kent Elec. Power Co. Irred Deb. Stk.	80—84	5 7 0	Jan, J[illegible]
3	1/2⅖	London Electric Supply Ord.	1⅞—2	3 0 0	Mar, S[illegible]
5	3/0	Do. 6 per Cent. Pref.	4¾—5¼	5 17 0	Mar, S[illegible]
St.	4%	Do. 4 per Cent. 1st Mort. Deb	91—94	4 5 0	Jan, J[illegible]
5	3/0	Metropolitan Electric Sup. Ord.	3⅞—4⅜	5 12 6	April,
5	2/3	Do. 4½ per Cent. Cum. Pref.	4¼—4¾	4 17 6	Jan, J[illegible]
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	101—104	4 6 6	June, [illegible]
St.	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	86—89	3 18 6	Jan, J[illegible]
..	4½%	Midiand Elec. Corp. for Power Dist, 4½ 1st Mort. Debs.	97—99	4 11 0	..
5	2/6	†Newcastle Elec. Supply Ord.	3¾—4¼	4 14 0	Feb, A[illegible]
5	2/6	†Do. 5 per Cent. non Cum. Pref.	4¼—4¾	5 5 0	Feb, A[illegible]
100	4½%	Do. 4½ per Cent. 1st Mort. Deb.	98—100	4 10 0	Jan, J[illegible]
100	5%	†North Metro. Elec. Power Sup. 5 Morts.	95—97	5 3 0	..
1	6%	Northampton Elec. Lt. & P. Ord.	1 1/16—1 3/16	4 13 9	Feb. A[illegible]
1	5%	Do. 5% Pref.	1 1/16—1 3/16	4 6 0	Feb, A[illegible]
St.	4%	Do. 4% Debs.	99—101	3 19 0	June, [illegible]
10	10/0	Notting Hill Electric Ord.	12—12½	5 17 6	March
5	4/3	Oxford Electric Ord.	6—6½	5 11 6	March
St.	4%	Do. 4% Deb. Stk.	93—96	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	8½—9	5 11 0	Feb, A[illegible]
5	3/6	Do. 7 per Cent. Pref.	6¾—7¼	4 16 6	Feb, A[illegible]
St.	3½%	Do 3½ per Cent. Deb. Stock (red.)	85—88	3 19 6	Jan, Ju[illegible]
5	..	Smithfield Markets Electric Sup. Ord.	1⅛—1⅞	..	Feb.
5	4/0	South London Electric Supply Ord.	3—3½	6 3 0	April
St.	5%	Do 5% 1st Mort. Stock (red.)	101—104	4 16 0	..
1	..	South Metrop'n Elec. Lt. & Power Ord.	[illegible]	..	..
1	0/8⅘	Do. 7 per Cent. Cum. Pref.	1 1/16—1 3/16	5 18 0	Feb, A[illegible]
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	95—98	4 11 6	April, C[illegible]
5	1/3	Urban Electric Supply Ord.	¾—1¼	..	April, C[illegible]
5	1/3	Do. 5 per Cent. Cum. Pref.	2¼—2¾	9 2 0	April, C[illegible]
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	85—87	5 3 6	April, C[illegible]
5	5/0	Westminster Elec. Sup. Ord.	7¾—8¼	5 19 6	Mar, Se[illegible]
5	2/3	Do. 4½ per Cent. Cum. Pref.	5—5½	4 3 6	Jan, Ju[illegible]
		Electric Railways and Tramways.			
1	..	Bath Elec. Trams Pref. Ord.	[illegible]	..	April ..
1	0/6	Do. 5 per Cent. Cum. Pref.	[illegible]	6 13 6	Jan, Jul
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	79—83	5 8 6	April, O[illegible]
St.	4½%	B'ham & Midland Trams 4½ 1st Deb. Stock.	92—94	4 16 0	Jan, Jul
10	4%	Bristol Tramways & Carriage Ord.	7¼—7¾	5 3 0	Feb, Au
10	4%	Do Cum. Pref.	7¾—8	5 0 0	..
St.	4%	Do. 4 per Cent. Debs.	101—102	3 18 3	Feb, Au
10	..	British Electric Traction Ord.	1¾—2	..	June, D[illegible]
10	..	Do. 6 per Cent. Cum. Pref.	4¾—5¼	..	Feb, Au
St.	5%	Do. 5 per Cent. Perpetual Debs.	94—98	5 2 0	April, O[illegible]
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	79—81	5 6 3	May, No
St.	3%	Central London Ordinary Stock	74—76	3 19 0	Feb, Au[illegible]
St.	4%	Do. 4 per Cent. Pref. Stock	88—90	4 9 0	Feb, Au[illegible]
St.	2%	Do. Deferred Stock	61—65	3 0 6	Feb. ..
100	4%	Do. 4 per Cent. Debs.	102—104	3 17 0	Jan, July
5	2/6	†City of Birmingham Trams, 5% Cum. Pref.	4⅝—4⅞	5 2 6	April, O[illegible]
100	4%	†Do 4 per Cent. 1st Mort. Debs.	97—101	3 19 3	April, O[illegible]
St.	1½%	City & South London Rly. Con. Ord.	35½—36½	4 2 0	Feb, Au[illegible]
St.	5%	Do. 5 per cent. Perp. Pref. (1891)	108—110	4 11 0	Feb, Au
St.	5%	Do. (1896)	104—106	4 12 6	Feb, Au
St.	5%	Do. (1901)	101—104	4 16 0	Feb, Au
St.	5%	Do. (1903)	101—104	4 16 0	Feb, Au
St.	4%	Do. 4 per Cent. Perpetual Debs.	101—103	4 16 9	May, N[illegible]
10	6/0	Dublin United Trams, 6 per Cent. Pref.	12½—13½	4 10 6	Feb, Au
10	12/0	†Gateshead and District Trams Ord.	8⅝—9¼	6 19 6	..
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	1¼—1½	..	Feb, A[illegible]
5	..	Hastings & District Elec. Trams, 6% C. P.	1⅛—1⅞	..	Mar. Se[illegible]
St.	4½%	Do. 4½ Deb. Stock	73—78	5 14 6	April, C[illegible]
10	..	Imperial Tramways Ord.	3—3½	..	Mar, Se[illegible]
10	..	‡Do. 6 per Cent. Pref.	4¼—4¾	..	Mar, S[illegible]
St.	4½%	Do. 4½ per Cent. Debs.	70—72	6 5 0	Jan, Ju[illegible]
..	2/6	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	2—2½	5 5 0	Mar, Se[illegible]
St.	4%	Do. 4 per Cent. Deb. Stock	79—84	4 15 0	Jan, Ju[illegible]
10	6/0	Lanarkshire Tramways	9¾—10½	5 12 3	Feb, A[illegible]
St.	5%	Lancs Utd. Trams, 5% Prior Lien Deb. Stk.	82—84	5 19 0	Jan. Ju[illegible]
St.	4%	London Electric 4% Deb. St.	97—99	4 1 0	..
St.	4%	Do. 4% Pref.	82—84	4 15 3	..
10	..	London United Trams, 5% Cum. Pref.	2¾—3¼	..	Jan, J[illegible]
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	74—77	5 3 6	Jan, J[illegible]
St.	..	Mersey Con. Ord. Stock	6—8	..	Feb, A[illegible]
1	1/1½	†Metropolitan Elec. Tramways Ord.	1⅜—1⅝	6 0 0	..
1	..	Do. Deferred	[illegible]	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	[illegible]	5 7 0	April
St.	4½%	Do. 4½ per Cent. Deb. Stock	102—104	4 6 6	Feb, [illegible]
St.	5%	Do 5 per Cent. Db. Stk	99½—101½	4 18 6	Jan, [illegible]
St.	1½%	Metropolitan Railway Consolidated	53½—53¾	2 11 6	Feb,
St.	2½%	Do. Surplus Lands Stocks	66—68	4 1 0	Feb,
St.	3½%	Do. 3½ per Cent. Preference	90—92	3 16 0	Feb,
St.	3½%	Do. 3½ per Cent. "A" Preference	89—91	3 17 0	Feb,

* In calculating the yield allowance has been made for accrued int[illegible] for red[emption]. † Ex Dividend. ‡ The London Stock Exchange Committee have [illegible]

†Do. $1,000 4½% Fdg. & Rl. Est. Cd. Bnds 98—101 | Victoria Falls Power Co. Pref. (1 to 805,000) | Do. (803,081 to 1,700,000)

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ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

NAME.	Price Wed., April 19.	Rate per cent. Yielded.	Dividend Due.	Business 8 Days to April 19. High- est.	Low- est.	Sh're	Last Divi- dend
c Railways and Tramways—*Continued.*		£ s. d.					
ly. 3½ per Cent. "A" Deb. Stock..	92 —94	3 14 6	Jan, July	93½	93	100	2$
olitan District Railway Ord.....	33½—34	..	Feb, Aug	34¾	32½	..	4%
4½% First Pref.	88 —90	5 0 0	Feb, Aug	89	88½	St.	4%
Assented Ext. Pref. (Int. Guar. by						St.	5%
d. Elec. Rlys. Co. of London, Ltd.)	74 —76	4 12 0	Feb, Aug	75½	..	5	3/0
3 per Cent. Consoltd. Rent-charge	76 —78	3 13 0	Jan, July	..	..	1	0/7½
4 per Cent. Midland Rent-charge	103 —105	3 16 0	Jan, July	..	..	1	0/6
6 per Cent. Perp. Deb. Stock.....	148 —150	4 0 0	Jan, July	149	148½	St.	6%
4 per Cent. Ditto.....	97 —99	4 1 6	Jan, July	..	..	St.	6%
es Electric Traction Ord.	⅝—¾	..	April, Oct	—	..	10	6/0
5 per Cent. Cum. Pref.....	⅝—¾	7 5 0	Feb, Aug	..	..	10	6/0
4½ per Cent, Deb. Stock.....	87 —90	5 0 0	May, Nov	90	..	5	6/0
Elec. Trams. & Ltg. 6% Cm. Pref.	⅝—¾	..		—	..	1	2/6
4 per Cent. Deb. Stock.....	75 —80	5 0 0	Jan, July	..	..	St.	3½%
land Dist. Elec. Trms. 5% 1stMtDb.	..	8 4 0	Jan, July	..	..	St.	4%
dE. Rys. Lon. 6% In. bds with coup 7	55 —57	1 15 0	June, Dec	56½	55½	..	4½%
5% Prior Lien Bonds.....	102 —103	4 17 0	..	..	..	1	7/d.
4½% Bonds with coup. 7	98 —100	4 10 0	..	99½	98½	1	0/7½
4 per Cent. 1st Power Ho. Dbs. ..	99 —101	3 19 3	..	..	..	St.	4%
ire (W.R.) Elec. Trams. Ord.....	⅛ ⅛	..	March ..	..	..	..	4%
6 per Cent. Cum. Pref.....	2⅞—2¾	..	..	..	..	5	3/0
4½ per Cent. 1st Debs.....	81 —84	5 7 0	Jan, July	..	..	5	4½%
						St.	2/6
ctric Manufacturing, &c.							4½%
Cable Co. 4½ % Deb. Stock	99 —101	4 9 0	—	..	..	5	3/0
Electricity Meter Ord.....	⅛—¼	..	..	⅛	..	10	2/0
6% Cum. Pf.	⅝—¾	7 4 0	April, Oct	⅝	..	10	3/0
k & Wilcox Ord.....	5⅛—5⅛	4 7 9	April, Oct	5⅛	5¼	10	6%
Pref.....	1⅛—1⅛	4 0 0	..	..	..		
Insulated & Helsby Cables Ord...	6¾—7⅛	6 15 6	July, Feb	7⅛	..		
6 per Cent. Pref.....	5⅛—6⅛	4 16 0	Jan, July	5⅛	—	5	2/6
4½ per Cent. 1st Mort. Deb. (red.)..	101 —103	4 7 6	Jan, July	..	..	5	2/6
Thoms'n-Houst'n 4½% 1st Mt. Db.	96 —99	4 11 0	Mar, Sept	..	..	St.	4%
Westinghouse 6 per Cent. Pref.....	⅛—⅛	..	Feb, Aug	..	..	St.	4½%
6 per Cent. Prior Lien Dbs. (rd.)..	102 —103	5 16 3	..	..	..	St.	21/9
4 per Cent. Mort. Deb. Stock.....	59 —62	6 9 0	Jan, July	..	—	St.	5%
E. Eng. Co. 4½% Perp. 1st Deb. Stock	58 —63	7 3 0	Mar, Sept	..	..	5	4/0
Perpetual 2nd Deb. Stock.....	40 —45	10 0 0	Jan, July	..	..	5	2/6
ler's Cable Con. Ord.....	9½—9¾	7 12 0	Jan, July	9⅝	..	St.	4½%
5 per Cent. Cum. Pref.....	4⅝—5⅛	4 17 6	Jan, July	..	..	St.	8%
4½ per Cent. 1st Mort Debs. (red.)..	102 —104	4 6 6	Nov, May	..	..	St.	6%
r-Kellner Alkali Co.....	3⅛—3⅜	4 18 3	May, Nov	3⅜	3⅛	St.	5%
4½ per Cent. 1st Mort. Deb. (red.)..	105 —106	4 3 6	Feb, Aug	..	..	40	4½%
urn's (Ship) Telegraph Ord.	1⅛—1⅛	5 19 0	March ..	..	..	100	4½%
dated Electrical Co.....	⅛—¼	10 0 0	August ..	—	..	St.	4½%
dated Signal Co.....	⅛—⅛	5 7 0	April, Oct	..	..	St.	5%
6 per cent. Cum. Pref.	⅛—1	6 0 0	April, Oct	..	..	St.	6%
ton & Co (Nos. 1 to 85,000)	⅛—¼	..	Jan, July	..	..		
5 per Cent. 1st Mort. Debs. (red.)..	70 —80	6 5 0	Jan, July	..	..	5	2/6
& Timmins	⅛—1¼	..	Mar, Sept	..	..	100	2/6
Kerr & Co. Ord.....	⅛—1	5 0 0	Sept.	..	..	1	4½%
6 per Cent. Cum. Pref.....	1 —1⅛	5 6 6	Sept	..	..	St.	
4½ per Cent. Deb. Stock.....	97 —100	4 10 0	Jan, July	..	..	5	1/3
& Swan United ("A" Sh.) (£3 pd.)	⅛—⅜	..	Feb, Aug	⅛	⅜	St.	4%
(£5 paid)	1⅛—2⅛	9 3 0	Feb, Aug	..	..	..	5%
4 per Cent. Mort. Deb. Stock (red.)	67 —73	5 9 9	June, Dec	..	..	1	5%
5 per Cent. 2nd Deb. Stock.....	73 —81	6 3 6	Mar, Sept	..	..		
idson's Elec. Corp. Ord.....	⅛—¼	..	Jan, July	⅛	..	100	5%
6 per Cent. Cum. Pref.	3 —3½	..	May, Nov	..	..		
4½ per cent. 1st Mort. Deb. (red.)..	86 —88	5 2 3	Jan, July	..	..	1	..
c Construction Co.....	⅛—¼	..	Jan, July	⅛	..	100	5%
7 per Cent. Cum. Pref.....	1¼—2	7 0 0	July	..	..	5	6%
4 per Cent. Perp. 1st Mort. Debs..	69 —72	5 11 0	Jan, July	..	..	5	0/7½
l Electric (1900) 5% Cum. Pref..	8 —8½	5 18 0	June, Dec	..	..	100	0/7½
4 per Cent. 1st Mort. Debs.....	83 —88	4 11 0	Mar, Sept	..	..	St.	5%
's Telegraph Works Ord.....	12 —12½	5 17 9	Feb, Aug	12⅛	..	St.	5%
4½ per Cent. Pref.	4⅛—5⅛	4 7 0	Feb, Aug	5⅛	..	100	5%
4½ per Cent. 1st Mort. Deb. Stock	105 —110	4 2 0	Mar, Sept	..	..	100	5%
Rubber, Gut. Per., &c., Works....	16¼—17	5 17 9	Feb, Aug	16½	16¼	100	$1¼
5 per Cent. Cum. Pref.	101 —103	4 14 0	..	..	..	St.	5%
4 per Cent. Debs. (red.)	96 —98	4 1 6	April, Oct	..	..	St.	6%
al Elec. Construction Co.	⅛—⅛	..	April	..	..	St.	4½%
dsons, Westgarth & Co., Ltd. Ord.	⅛—⅛	..	Nov	..	..		
6 per Cent. Cum. Pref.	⅝—1⅛	..	May, Nov	..	..	St.	4½%
4½ per Cent. Perp. Deb. Stock....	78 —82	5 10 0	Jan, July	..	..	1	0/6
x Conduits 6 per Cent. Cum. Pref.	4½—5	..	..	..	..	St.	5%
aph Construction & Maintenance..	30 —33	5 15 0	Mar, July	36½	..	5	3/0
4 per Cent. Deb. Bonds (1909)	100 —102	3 18 6	Jan, July	..	..		
s, Sons & Maxim, Ltd., Ord.....	2⅛—2⅜	4 14 0	..	..	2⅛	St.	4½%
5 per Cent. non-Cum. Preference..	1⅛—1⅛	4 3 0	..	..	..	100	$1¼
5 per Cent. non-Cum. Preferred ..	107 —112	4 9 3	..	109½	..	..	5%
4 per Cent. 1st Mort. Db. Sk. (red)	102 —104	3 17 0	June, Dec	103	..	100	5%
4½ per Cent. 2nd Mort. Deb. (red.)	104 —106	4 5 0	June, Dec	..	—	..	$2½
5 per Cent. 3rd Mort. Debs Scrip...	105 —107	4 13 6	..	105½	..		
White & Co. 6% Cum. Pref.	13¾—14¼	6 14 6	..	..	..	..	5%
s & Robinson Ord.....	⅛—⅜	..	Apr, Oct	..	..	100	4½%
6 per Cent. Cum. Pref.....	½—1	..	Apr, Oct	..	..		
4 per Cent. 1st Mort. Debs.....	55 —55	6 3 0	May, Nov	..	—		
Telegraphs.						5	3/0
						10	6/0
n Telegraph	6¾—7⅛	..	June, Dec	..	..	St.	4½%
5 per Cent. Debs. (red.)	97 —99	5 1 0	Jan, July	93	97½	..	5%
American	71 —73	5 1 6	F,My,Ag,N	..	..	5	3/6
Preferred	115½—116½	5 2 6	F,My,Ag,N	118½	114	5	2/6
Deferred	27⅜—27⅝	5 6 0	F,My,Ag,N	28	27⅜	100	5%
ercial Cable 4 per Cent. Deb. Stk...	88 —90	4 9 0	Jn,Ap,Jy,O	89	88¾	100	7/2½
Submarine Ord.....	9½—10½	5 17 0	Feb, Aug	..	..	100	$3½
Preference 10 per Cent.	17½—18½	5 10 0	Feb, Aug	..	..	100	5%
Spanish Ord.....	3½—4	5 0 0	April, Oct	..	..		
10 per Cent. Cum. Pref.....	8½—8¾	5 14 6	April, Oct	..	..	500	5%
4½ per Cent. Deb.	100 —102	4 8 0	Jan, July	..	..	St.	5%
United States Cable.....	7⅜—8½	5 13 0	Ja,Ap,Jy,O	7¾	..	5	..
West India Cable 4½%Rg.Db.(rd.).	100 —102	4 8 3	June, Dec	..	..	10s	..
n Ordinary	136 —139	5 0 9	Ja,My,Jy,O	138½	137½	1	0/7½
3½ per Cent. Pref. Stock.....	84 —86	4 1 6	Ja,My,Jy,O	85½	85½	..	5%
4 per Cent. Mort. Deb. Stk. (red.)..	102 —104	3 17 0	May, Nov	102	101	5	..
n Extension	13⅜—13⅝	5 1 0	Ja, Ap,Jy,O	13¾	13⅞	St.	..
4 per Cent. Deb. Stock	100 —102	3 18 3	Feb, Aug	101½	101	St.	5%
n and S. Af., 4% Mauritius Sub. Debs	101½—103½	3 17 3	May, Nov	..	..	500	5%
of Copenhagen), with Coupon 81 ..	32¼—33¼	6 0 0	Jan, July	..	..		
European	58½—60½	5 8 0	May, Nov	59¾	..	St.	$1
y Companies Common	93 —96	5 4 0	Ja,Ap,Jy,O	..	..	St.	$3½
Preference	78 —80	5 0 0	Ja,Ap,Jy,O	..	..	500	5%
ni's Wireless Teleg. Co.	1⅜—1⅝	..	April	1⅜	1	St	5%
e & Europe'n Tel. 4% Guar. Dbs. (red.)	100 —102	3 18 3	June, Dec	..	..	100	8/2½
Coast of America	1¼—1½	4 3 0	May	..	..	100	5%
4 per Cent. Debs.	99½—101½	3 18 9	Jan, July	..	..	St.	£9
India & Panama	2½—3½	2 0 0	May, Nov	3½	2½	St.	6%
6 per Cent. 1st Pref.	10¼—10½	5 11 6	May, Nov	10⅝	..	St.	5%
6% 2nd Pref.	9¼—9⅝	6 5 0	May, Nov	..	..	100	$1¼
5 per Cent. Debs.	102 —104	4 16 0	Jan, July	..	..	..	5%
rn Telegraph	13½—14	5 0 0	Mr,Jn,O,D	13⅝	13⅜	St.	4½%
per Cent. Deb. Stock (red.)	101 —103	3 17 6	June, Dec	102	101½	St.	4½%
ra Union Telegraph, $1,000 4% Bds	103 —106	3 15 6					

NAME.	Price Wed., April 19.	Rate per cent. Yielded.	Dividend Due.	Business 8 Days to April 19. High- est.	Low- est.
Telephones.		£ s. d.			
†Amer. Telephn. & Telegh. Cap. St.	150 —152	5 5 3	..	..	..
Do. Coll. Trust $1,000 4 per Cent. Bds.	93 —95	4 4 0	Jan. July	..	..
Do. 4% Cons. Bonds 1936	111½—113½	3 10 3	..	..	..
Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	100 —102	4 18 0	Mar, Sept	..	..
Chili Telephone	7⅛—7⅜	5 11 6	August ..	..	..
Monte Video Telephone Ord.....	⅛—1⅛	5 13 0	Nov	..	..
Do. 5 per Cent. Pref.	⅛—⅜	5 12 0	May, Nov	—	..
National Co. Pref. Stock.....	104 —105	5 14 3	Feb, Aug	104½	10
Do. Def. Stock	137 —139	4 6 3	Feb, Aug	137½	13
Do. 6 per Cent. Cum. 1st Pref.....	10 —10½	5 11 6	Feb, Aug	..	..
Do. 6 per Cent. Cum. 2nd Pref.....	10½—11	5 9 0	Feb, Aug	..	..
Do. 5 per Cent. non-Cum. 3rd Pref....	5⅝—6⅛	4 1 9	Feb, Aug	6⅛	..
Do Deb. Stock 3½ per Cent. (red.)....	99 —101	3 9 3	June, Dec	—	..
Do. 4 per Cent. Deb. Stock (red.).....	99 —101	3 19 3	Jan, July	99½	10
New York Telephone Co. 30 yr. Bnds.....	100½—101½	4 8 6	..	101½	10
Oriental	1⅛—1¼	4 11 6	April, Oct	..	..
Do 6 per Cent Cum. Pref.	1⅛—1⅜	4 11 6	April, Oct	..	..
Do. 4 per Cent. Red. Deb. Stock.....	87½—89½	4 9 6	Jan, July	88½	8
Telephone Co. of Egypt 4½%Db.Stk.(red.)	99 —101	4 9 0	Jan, July	..	..
United River Plate Ord. (1—150,000) ...	7½—7¾	5 3 0	July	..	..
Do. (150,001—190,000).....	⅞—7⅞	..	..	7½	..
Do. 5 per Cent. Cum. Pref.	5⅛—5⅜	4 9 0	June, Dec	..	..
Do. 4½ Deb. St. Red.....	103 —105	4 5 9	Jan. July	..	..
Financial, Investment, &c.					
Elec. & Gen. Investment 6% Cum. Pref...	3¼—4¼	7 1 0	Jan, July	4	..
Globe Telegraph & Trust	10½—11½	5 5 6	Sp,DcMrJu	10⅛	..
Do. 6 per Cent. Pref.	13 —13½	4 9 0	Sp,DcMrJu	13¼	..
†Submarine Cables Trust (Cert.)	131 —134	4 9 6	April, Oct	..	..
Colonial and Foreign Electric Railways, Tramways, &c.					
Anglo-Argentine 5% Cum. 1st Pref.	5 —5½	4 15 3	Aprll, Oct	5⅛	..
Do. 5% Cum. 2nd Pref.....	4½—5	5 0 0	Jan, July	4⅞	..
Do 4% Deb. Stock	92 —93½	4 5 6	June, Dec	93⅜	..
Do. 4½% Deb. Stock	98 —100	4 10 0	..	99⅛	..
Do. 5% Deb'Stock	101¼—103½	4 16 6	..	103	..
Auckland Elec. Trams. 5% Deb. (red.)....	104½—105½	4 14 6	Jan, July	..	..
Brisbane Electric Trams. Invest. Ord	6¾—7¼	5 17 3	May	6⅛	..
Do. 5 per Cent. Cum. Pref.	4¾—5¼	4 16 6	May, Nov	..	..
Do. 4½ per Cent. Db. Prov. Certs.....	102 —105	4 6 0	Jan, July	103	..
British Columbia El. Rly. Df. Ord.	150 —154	5 4 0	Mar, Sept	..	..
Do. Pref. Ord. Stock	124 —127	4 14 6	May, Nov	126½	..
Do. 5% Cum. Perp. Pref. Stock.....	107½—110½	4 10 6	Jan, July	108½	..
†Do. 4½ per Cent. 1st Mort. Debs.....	100 —103	4 7 6	April, Oct	..	..
Do. Vancouver Power Debs.	102 —105	4 5 9	Jan, July	..	..
Do. 4½% Perp. Con. Deb. St.	100½—102½	4 2 6	..	101½	..
Buenos Ayres Lacroze Trams 1st Mt. Db.	99½—101½	4 18 6	Mar, Sept	..	..
Buenos Ayres Port & City Tram, 1st Mt. Deb. Stock	93 —98	6 2 6	Feb, Aug	..	..
Calcutta Tramways (1 to 137,610).....	5½—6	4 3 3	Mar, Sept	..	..
Do. 5 per Cent. Cum. Pref.	5 —5¼	4 15 3	Jan, July	..	..
Do 4½% 1st Deb. Stock (red).....	93 —101	4 9 0	Jan, July	..	..
Cape Electric Tram Shares	⅛—¼	..	..	5⅜	..
City of Buenos Ayres Trams Co. (1904) Sh.	5⅜—5⅝	4 5 0	F,My,A,N	..	..
Do 4 per Cent. Deb. Stock.....	99 —101	3 19 3	June, Dec	..	..
Colombo Tr. & Ltg. 5% 1st Mt. Db.....	97 —100	5 0 0	May, Nov	..	..
Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	99½—101½	4 18 6	Feb, Aug	100⅜	..
Hong Kong Tramways Co. 5 per Cent. 1st Mort. Debs.	78 —82	6 1 6	June, Dec	..	..
Kalgoorlie Elec. Trams Sh.	⅛—⅜	..	..	..	..
Do. 5 per Cent. "A" Deb. Stock.....	97 —97	5 3 3	Jan, July	..	..
Do. 6 per Cent. "B" Ditto	69 —70	4 5 9	Jan, July	..	..
Lisbon Elec. Trams. Ord.	1 —1⅛	4 15 0	July	1⅛	..
Do. 6 per Cent. Cum. Pref.	1 —1¼	4 16 0	Jan, July	..	..
Do. 5 per Cent. Reg. Mort. Debs.	93 —102	4 18 0	Jan, July	..	..
Madras Elec. Trams. 5% Deb. Stk.	95 —98	5 2 0	Jan, July	..	..
Manaos Trams and Lt. Co. 5% Debs	92½—94½	5 6 0	..	92½	..
Manila Elec. Ry. $1,000 Gold Bonds.....	99 —101	4 19 0	Feb, Aug	..	..
†Mexico Trams Co. Com. St.	124 —126	5 11 0	..	125	..
Do. Gen. Con. 1st Mort. 5% Gold Bds.	95 —97	5 2 6	..	96½	..
Do. 6% 50 yr. Mort. Bds	101¼—102½	5 17 6	—	102½	..
Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922) (Nos. 601 to 2,000)	101 —103	4 7 6	Feb, Aug	..	..
Do. do. (Nos. 1 to 4,600)	103 —106	4 5 0	..	104⅞	..
Perth Elec. Trams Ord.	⅛—¼	2 13 6	May	..	..
Do 1st Mt. Db. Stock	103 —105	4 16 0	Jan, July	—	..
Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	5¼—5½	5 4 6	..	5½	..
Do. 4½% 1st Mort. Deb. Stk.	99 —102	4 8 0	..	..	..
†Rio Janeiro Tram. Lt. & P. Co.....	110 —111	4 10 0	..	110½	..
Do. 30 yr. Gold Bnds.	101½—102½	4 17 6	..	102½	..
Do. 50 yr. Mt. Bnds	94½—95½	5 4 6	..	95⅜	..
Sao Paulo Tramway, Light & Power Co. $100 Stock	168 —170	5 17 9	..	170½	..
Do. 5 per Cent. 1st Mt. $500 Db.	103½—104½	4 16 0	June, Dec	103½	..
Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	99 —100	4 10 0	Feb, Aug	..	..
Colonial and Foreign Electricity Supply, &c.					
Adelaide Elec. Sply Co. 6% Cu. Pr.....	5½—5¾	5 2 0	Mar, Sept	..	..
Bombay E.S. & T. 6% Cm. Pf.	10¼—11¼	5 5 6	..	..	..
Do. 4½ per Cent. Deb. Stk. (red).....	96 —98	4 11 3	Jan, July	..	..
Do. 5 per Cent. 2nd Mort. Deb. Stock..	97 —99	5 1 0	..	..	..
Calcutta Elec. Supply Ord.	6½—7	5 0 0	April, Oct	..	..
Do. 5% Cum. Pref	4¾—5¼	4 13 0	..	..	..
Kaministiquia Power Co. 5% Gold Bnds...	102 —104	4 16 0	..	..	..
Madras E. S. Corp. Ord.....	2½—3½	..	..	..	..
Melbourne E. S. Co. 6% Cum. Pref.	36 —41	..	..	..	..
Do. 5% 1st Mortg Deb. Stock.....	93½—95½	5 5 0	..	94½	..
Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	83½—89½	5 11 9	..	90	..
†Mexican Lt. & Power Co. Com. St.	85 —88	4 11 0	..	88½	..
†Do. 7% Cum. Pref. St.	106½—108½	6 9 0	..	108½	..
Do 5% 1st Mort. Gold Bnds.	94½—95½	5 4 9	..	95⅛	..
Monterey Rly. L. & P. Co. 1st Mort. Db. Sk.	90 —92	5 8 6	..	90⅛	..
Montreal Lt. Ht. & Power Co. Cap. St.....	155 —159	4 8 0	F,My,A,N	..	..
Northern Lt. Power & Coal 5% Gd. Bds ..	73 —75	6 13 6	..	73⅛	..
River Plate Electricity Co. Ord. Stk.	225 —235	3 16 6	April	..	..
Do. 6 per Cent. non-Cum. Pref. Stk. ..	103 —113	5 6 0	May	..	..
Do. 5 per Cent. Deb. Stock	102 —104	4 16 0	Jan, July	..	..
Shawinigan Water & Power Co. Ca.....	115 —118	4 4 9	..	117⅛	..
Do. 5 per Cent. Bds.	107½—109½	4 11 3	Jan, July	108	..
Do. 4½ Per Con. Mt. Db. St.	103 —105	4 5 6	—	105	..
Toronto Power Co. 4½% Db. St.	101 —103	4 7 6	—	..	..

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NOTES.

The Institution of Electrical Engineers.

The following nominations for the new Council of the Institution of Electrical Engineers were announced at the meeting last night :—

President.
S. Z. de Ferranti.

Vice-Presidents.
Mr. W. A. J. O'Meara, C.M.G. W. Duddell, F.R.S.
J. F. Snell. W. H. Patchell.

Members of Council.
J. S. Highfield. G. K. B. Elphinstone.
[illegible] W. Judd.
E. T. Jenkin. P. V. McMahon.
[illegible] Kingsbury. R. K. Morcom.
[illegible] Sparks. W. M. Morrison.
W. A. Cook. S. L. Pearce.
[illegible] Dickinson. H. Faraday Proctor.
C. H. Wordingham.

Associate Members of Council.
H. F. Wimperis. E. Russell Clarke. S. Morse.

Honorary Treasurer.
Robert Hammond.

The names printed in italics are new nominations. The hon. treasurer retires annually, and is eligible for immediate re-election.

We are sure that our readers will note with sincere satisfaction the nomination of Mr. Ferranti to serve a second year as President of the Institution. So far as we are aware this is the first time that a President has served two consecutive years, and in setting such a precedent we think the Council have done well. The fact ought to have been realised ere this that the electrical industry is not sufficiently large to produce Presidents of the Institution at the average rate of one per annum. Even in the Institution of Civil Engineers, whose membership covers the whole field of engineering and is therefore much larger, it has been found desirable that the President should fill his office for two years, rather than for one. Election to the Presidency of the Institution of Electrical Engineers is the highest honour that the electrical industry can offer, and nothing will be lost by bestowing this honour less widely than has been the case in the past. We need say nothing of the claims of Mr. Ferranti to the position he now holds, for they are universally acknowledged.

As regard the new members of the Council, Mr. Highfield, Mr. Hirst, Mr. Kingsbury and Mr. Sparks have already been members at one time or another. Mr. Jenkin who is so well known in association with Sir Alexander Kennedy, has not previously served on the Council, and we are sure his assistance will be of value. New blood is always desirable on such bodies. Mr. Wimperis, the new associate member of the Council, is chiefly known to our readers for his work in connection with acceleration, gas engines and kindred problems. The name of Mr. Kingsbury will remind our readers of the controversy, marked by some unfortunate features, which took place when his election last year was opposed by an outside nomination. Although we are fully in accord with the view that the membership of the Institution in the provinces should be properly represented on the Council, we hope that any such contest will not occur on the present occasion. The Local Sections are at present exceedingly well represented, both by members elected to the Council and by *ex officio* members, and therefore we feel that the present nominations should be accepted as being in every way satisfactory.

Rail Corrugations.

Longer experience appears to assist but little in the solution of the problem of rail corrugation, which, for

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several years now, has baffled tramway engineers. At one time it was hoped that a comparison of the experiences of different undertakings would provide a satisfactory explanation of the phenomenon, but the trouble has now become so widespread that this method of investigation seems likely to fail. Statistics of this nature have been collected for some years, and in view of the heavy expense that the removal of corrugations is likely to involve until some means is discovered of preventing their formation it is not surprising that tramway engineers are only too ready to place their experience at the disposal of the industry. Our contemporary, the "Tramway and Railway World," has from time to time collected valuable information on the subject. These statistics show that, whereas in February, 1907, 19 out of 57 municipal tramways in this country, from which particulars had been obtained, were immune from corrugation, two years later only 11 of these systems were unaffected; whilst at the present time only two undertakings—Dundee and West Bromwich—report entire absence of corrugations. At Bradford, however, there is practically none, and at Bolton only slight evidence of their formation. As these two undertakings have been in operation 12 and 10 years respectively the freedom from corrugation is noteworthy, particularly as the two most recent undertakings—those at Darlington and Gloucester, where corrugations were practically unknown a year or two ago—now report a considerable amount. At present there is no remedy but to grind out the corrugations as they become serious.

An interesting contribution to the subject has recently appeared in the "Electric Railway Journal" by Herr K. Sieber, of Nürnberg. His observations, which extend over many years, show, among other characteristics, that corrugations only appear when the speed exceeds a certain limit (depending on the track foundation), and their average length varies with the speed of the car; also that they do not appear on the treads of rails on short-radius curves, and that on curves of large radius the corrugations are deep and short on the outer rail and, if present on the inner rail, long and shallow. Although a short-radius curve is not defined, we believe that Herr Sieber's experience as to the absence of corrugations is not universal; but of more interest is his observation that, contrary to the statements of other engineers, corrugations appear (with the above exceptions) under all conditions of track, on up grades and down grades, on low rails and on high rails, on tight and loose gauges, on braking and on coasting sections, on T-rails and on grooved rails. The means which he recommends for their prevention are: (1) to construct the track so that the rail will give at least $\frac{1}{16}$ in. under a normal load; (2) the tensile strength of the rail and ties should not exceed 41 tons per square inch; (3) concrete should not be allowed to come into contact with the rails; and (4) the joints should be as light as is consistent with strength. As experience is the best—in fact, the only—guide in such cases, it is by trial that engineers will have to ascertain the value of Herr Sieber's suggestions; but that corrugations are not unknown in Nürnberg is evident from his statement that they are ground off at intervals of from one to three years, the average annual cost of removal being about £24 per mile of track.

Contributions in Relief of Rates.

At this time of year, although the results of the past 12 months' operation of municipal tramways and electricity undertakings may not yet be available, it becomes necessary for the various Committees to present estimates of their accounts for the past year, so that the Finance Committee may prepare a "budget" for the ensuing year. On such occasions efforts are not infrequently made, in view of a possible increase in the rates, to obtain considerable contributions from the prosperous undertakings owned by a municipality, and a Committee's recommendations are liable to be "amended" by the Council. In one or two recent instances where this has been done, the Chairman of the Committee in question has, and we think quite rightly, tendered his resignation in protest. Although we do not by any means approve of the principle of paying any portion of the profits of a municipal undertaking to the "common fund," any basis for a systematic contribution is perhaps to be welcomed. We may, therefore, draw attention to the fact that, at a meeting of the Electricity Committee of the Manchester Corporation last week it was decided to recommend that in future a contribution reckoned at 1 per cent. on the outstanding indebtedness of the electricity undertaking should be paid to the city fund. On this basis the amount to be contributed this year is £19,496, a considerable increase on the contribution last year. As the Tramways Committee have decided to hand over in relief of rates £75,000, a similar sum to that contributed last year, it is evident that the ratepayers will benefit considerably at the expense of the electricity consumers and tramway users.

Electricity Meter Approved by the Board of Trade.—On April 24 approval was given to the construction and pattern and means of fixing the Hookham Patent C. C. Meter, combined with Lackie's Patent Demand Indicator, provided the meter be constructed as described in specifications and drawings H. 4617 and in accordance with the pattern meter 243,093, deposited by Chamberlain & Hookham (Ltd.)

"Rational" Cooking Stove.—The "Electrical Review and Western Electrician" gives an account of a stove invented by Mr. D. Curle and known by the above name. It is constructed with a double iron casing, between the two walls of which asbestos packing is placed in order to prevent all heat radiation. The interior of the stove is divided into three compartments, the middle one of which is heated both above and below, while in the others only the lower part is heated. There are three heating resistances, each consisting of three separate units placed under perforated sheet-metal covers, which allow the heat to radiate freely within the oven. These resistances may be very easily replaced when necessary. The quantity of heat is regulated by means of switches mounted on the oven.

Cable Interruptions.	Date of Interruption.
Assab—Perim	July 8, 1909
Malta—Tripoli	April 20, 1910
Latakia—Palura	May 26, 1910
Tourane-Amoy	Sept 25, 1910
Port de France—Paramaribo	April 10, 1911
Bonny—Duala	April 16, 1911
Zanzibar—Mombasa	April 19, 1911
Kwandang—Menado	April 25, 1911

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University of Glasgow.—It is announced that Lady Kelvin has sent the Principal of this University a cheque for £500 for the foundation of a Kelvin prize. The prize is to be awarded every three years to the Doctor of Science who, during the preceding period, has offered for the degree the most meritorious thesis embodying the results of original research in physical science. A gold medal will accompany the prize.

Long Distance Wireless Telegraphy.—According to the "Railway and Engineering Review" the wireless operator in San Francisco communicated for an hour on the night of February 6 with the operator at Ghosi Shimosa, on the coast of Japan, 5,700 miles away. The messages were passed across the Pacific with one relay. It is said that the performance establishes a new record for wireless work in that quarter of the globe.

Large Central Station Battery.—According to the "Electrical Review and Western Electrician" the Minneapolis General Electric Co. has recently contracted for a large emergency battery to be installed on its system. It will consist of 260 cells of the H-67 "Exide" type and will have a capacity of 1,000 ampères at the twenty-minute rate. This will be the first battery of its kind installed by the Electric Storage Battery Co. for the Minneapolis General Electric Co.

Temporary Installations and the Coronation Decorations.—As will be seen from an advertisement elsewhere in this issue, the Corporation of London have issued a notice dealing with temporary electric light installations in connection with the Coronation decorations. In addition to regulations as to the position and size of illuminated signs, mention is made of the earthing of conduits, connecting up of wiring, &c. We notice that no bare conductors or celluloid shades and reflectors are allowed.

Electric Traction in Budapesth.—It is announced from Budapesth that the Budapesth-Czinkota-Gödöllö section of the suburban lines has recently been converted to electric traction, this being the preliminary to the conversion of all the lines in the country. The length of this section is about 20 miles long, and is double tracked throughout. Three-phase current at 10,000 volts is generated in a station at Czinkota where two 2,000 H.P. steam turbines are at present installed. The three-phase current is converted in sub-stations to direct current at 1,000 volts, while in these sub-stations batteries are also installed. The cars are fitted with 160 H.P. motors, and have been designed to run at rather over 30 miles an hour.

Automobile Line-Trucks.—The "Electric Railway Journal" gives an interesting account of a 2-ton tower automobile line truck which has recently been placed in service by the Oakland Traction Co. It has been found that in case of accidents, this type of auto-truck can be depended upon to reach the scene of trouble in one-half the time required by a horse-drawn wagon. The direct maintenance cost is small. The gasoline consumption is about ½ gallon per mile, and about a gallon of lubricating oil will serve this machine for about 1,000 miles. The dimensions of the auto-truck are as follows: length over all; width, 42 in.; height from ground to top (unloaded), 40 in.; wheelbase, 120 in. The four-cylinder vertical engine is located under the driver's seat; the cylinders are cooled by a blower. The motor control is from the throttle levers on the steering wheel. A single-lever brake is at the right of the driver's seat. The transmission is through a sliding gear of the selective type which gives four forward speeds and one reverse. The rear or driving axle is of hickory. Two brakes are provided. The gasoline tank has a capacity of 13 gallons, and the normal speed of the truck is about 18 miles an hour.

New Science Museum.—The report of the Departmental Committee which was recently appointed, with Sir Hugh Bell as chairman, to consider certain questions with regard to the Science collections at South Kensington and Jermyn-street, has been issued as a Parliamentary White Paper (Cd. 5625). The Committee find that the present exhibits are now so much crowded together that it is impossible properly to classify or utilise them. Buildings twice the size of the present would, in fact, scarcely suffice. The Committee state that this particularly applies to the Physics Section, while as regards the Mechanical Engineering Collection additional apparatus is very generally required. The Electrical Engineering Section requires to be increased to five or six times its present size. In no section is there, indeed, more urgent need of early action to secure for the Museum examples of instruments and appliances that have marked the opening of a new era in invention and industry. In the Naval Architecture and Marine Engineering Section the representation of modern types is also too limited. The Committee further suggest that it would be of advantage to establish an advisory committee to deal with all these questions, and they consider that the new buildings should include provision for an enlarged suite of workshops. A conference room, where scientific or technical societies might meet, a large lecture theatre, public demonstrations in the galleries, and the exhibition of temporary collections are also suggested.

International Competition in Practical Telegraphy.—The Italian Ministry of Posts and Telegraphs again draws the attention of British Telegraph Engineers to the forthcoming competition in practical telegraphy which will take place at Turin during the Exhibition to be opened shortly in that city. Up to the present the following countries have given notice that they are sending in teams for the contest: Germany, Austria, Argentine Republic, Belgium, Brazil, Spain, France, Greece, Hungary, Roumania, Servia, Turkey, Sweden, Switzerland, French Indo-China, New Caledonia and Madagascar; but no British team has yet been entered. It will be a pity if British telegraph engineers lose this opportunity of showing their prowess, and some effort should therefore be made to overcome the difficulties ere it is too late. The list of prizes is a long and valuable one, and includes rewards from the King of Italy, the Queen of Italy, and all the principal public administrations and cities in the kingdom. There should be little doubt that a British team could gain sufficient recompense not only to warrant its visit, but also to confer honour on the country and the telegraphic profession. All communications on the subject should be addressed to the Secretary, International Competition in Telegraphy, Ministry of Posts and Telegraphs, Rome.

Electric Train Service to the Crystal Palace.—It is announced in "The Times" that the London, Brighton & South Coast Railway will inaugurate the electric train service from Victoria Station to the Crystal Palace on May 12, the opening day of the Festival of Empire and Imperial Exhibition. It is also stated that the work of electrification is practically completed. The Company in several ways have utilised the experience gained by the working of the South London electric line from Victoria to London Bridge. For instance, the trains will be composed of six coaches instead of three or four, and the corridor, not having served the purpose of inducing people to entrain quickly, will be abolished, the extra space being devoted to increased seating accommodation. There will be first and third class compartments only. Most of the cars have already been delivered, and are at the new workshops of the Company at Norwood Junction. The route from Victoria is *viâ* Battersea Park, Clapham Junction, Balham, Streatham-hill, West Norwood, and Gipsy-hill, and this 12-mile journey will be covered in 15 minutes. The electrification of the London Bridge section from Peckham-rye, where a junction is made with the South London line, through East and North Dulwich and Tulse-hill to a junction with the line from Victoria at West Norwood, and thus to the Crystal Palace, will not be ready until after the opening day of the Festival, but there will be an accelerated service of ordinary trains *viâ* New Cross, Forest-hill and Sydenham, special through trains being timed to do the journey in 15 minutes.

"Railophone" Demonstration.—The isolation of the traveller on a railway when he is actually moving has often been the subject of comment, especially in connection with such accidents as those at Hawes Junction and Pontypridd, which might have been prevented had it been possible to commu-

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nicate with the engine driver otherwise than by semaphore. To obtain such continuous communication provides a problem not easy of solution, but nevertheless it has been attacked; and on Thursday in last week Mr. Otto von Kramer gave a demonstration at Stratford-on-Avon of his instrument, known as the "Railophone," whereby continuous communication with trains is, it is claimed, rendered possible. From the point of view of the technical press the demonstration was none too satisfactory, principally owing to the fact that the inventor showed a decided reluctance, doubtless due to commercial reasons, to go into details. From the point of view of our lay contemporaries matters were apparently more satisfactory, for they were able to obtain some photographs, which duly appeared next day, of Miss Marie Corelli, who attended formally to open the installation, doing various interesting things, such as speaking on the telephone and getting out of her motor car. Mr. von Kramer in asking Miss Corelli to send the first message explained that his system was not "wireless" in the true sense of the word. Wireless methods, he said, would be affected by the rails and telegraph wires, and would give rise to difficulties from the tuning point of view. The system he employs is briefly the following. Two horizontal coils of wire are wrapped longitudinally round the frame of each railway carriage; one of these coils is of low resistance and is connected to a specially sensitive transmitter; the other of higher resistance is connected to the receiver. The source of electrical energy is 8 or 10 dry cells. We are informed that the connections are exactly the same as in an ordinary telephone installation, the above-mentioned coil taking the place of one of the ordinary transformer coils. On "land" an insulated wire is laid alongside the track and an earth return is used, this being equivalent to the other coil of the transformer. It will be seen that the apparatus is really an induction coil with the primary and secondary some distance apart. We understand that this distance has been increased up to as much as 40 ft. without speaking becoming impossible. At present the system is being tried on the Kineton and Stratford-on-Avon section of the Stratford-on-Avon and Midland Junction Railway with satisfactory results. Arrangements have also been made to establish communications between two moving trains, and even for the brakes of one or other of the trains to be applied through a sensitive relay, but no details showing how this is done were available on Thursday. We cannot help thinking that from the inventor's point of view it is a mistake to invite members of the technical press to such demonstrations before full working details of the system are ready for publication. Such reticence creates an uneasy feeling. It may be mentioned that though communication was established between a call box and a train, the latter was not moving at the time.

Current Topics.

Subjects of current interest dealt with in this issue include the following:—

Dr. C. V. Drysdale contributes an article on "The Propagation of Magnetic Waves in an Iron Bar."

A description is given of the electrical installation of the new home of the Royal Automobile Club in Pall Mall.

In our Leading Article we discuss the requirements of the Inland Revenue authorities that agreements for the sale of electricity where a minimum payment per annum is guaranteed must be impressed with an *ad valorem* stamp.

At the meeting of the Institution of Electrical Engineers last night Mr. A. M. Taylor read a Paper on "Battery Economics and Discharge Arrangements."

We give particulars of the official tests of a 3,000 kw. turbo-alternator recently installed by the Bristol Corporation Electricity Department.

At a meeting of the National Electrical Manufacturers' Association on Tuesday last Mr. L. Joseph read a Paper on "Foreign Compared with Home Industrial Finance," and an interesting discussion took place.

A new process of producing alternating-current vector diagrams experimentally was described by Messrs. A. E. Kennelly, H. G. Crane and J. W. Davis in a recent issue of the "Electrical World."

An abstract of the report for 1910 of the proceedings of the Board of Trade and the Light Railway Commissioners under the Light Railways Act appears in another column.

Islington (London) Borough Council is discussing the extension of the electricity undertaking, as well as an agreement with the Great Northern & City Railway Co. to provide a bulk supply.

At Bradford Mr. C. J. Spencer's new tramway brake has been inspected by the Tramways Committee.

Mr. Charles Bright read a Paper on "Imperial Telegraphs", at a meeting of the Royal Colonial Institute on Tuesday.

An inquiry was held on Monday and Tuesday into the application of Dublin City Council for permission to borrow £128,129 for extension of the electricity undertaking.

The joint lessees of the East London Railway have decided to convert the line to electric traction.

The Miners' Federation have requested the Executive Committee to draft an amendment to the clause of the Mines Bill relating to the use of electricity in mines.

Legal.—A Divisional Court on Tuesday dismissed the appeal of a Leeds tramcar passenger from a decision of the local stipendiary magistrate inflicting a fine of 5s. for refusing to show his ticket.

Companies' Meetings and Reports.—The report of the British Westinghouse Co. for 1910 states that the year's trading shows a credit balance to profit and loss account of £12,436. 12s. 8d. (after providing £5,642 for prior lien redemption fund and £660 towards expenses of issue of such debentures), compared with a debit balance of £7,319. 12s. in the 1909 report.

The reports of the City of Birmingham Tramways Co. and the Oldham, Ashton & Hyde Electric Tramways (Ltd.) are abstracted.

In the report of the Rio de Janeiro Tramway, Light & Power Co. particulars are given of the progress during the past year of the tramway, electric light and power and telephone undertakings of the Company.

PERSONAL NOTE.

Mr. Vincent Walker Hill, who retired as from March 31 from the position of general manager of the South-Eastern & Chatham Railway, has been elected a director of the Company, and also a member of the Managing Committee.

APPOINTMENTS VACANT.

An electrical engineer is required for iron and steel works in India See advertisement.

A switchboard attendant is wanted by the Newcastle & District Electric Lighting Co. (Ltd.) to work plant in a battery sub-station Applications to 38, Grainger-street West, Newcastle-on-Tyne. See advertisement.

Belfast Tramways & Electricity Committee require a sub-station attendant. Wages £2 per week of seven days. Applications to the city electrical engineer, Mr. T. W. Bloxam, M.I.E.E., electricity works, East Bridge-street, Belfast, by May 9. See advertisement.

A lecturer in applied mathematics is required for the Grey University College, Bloemfontein. Salary £400 per annum. Application to the High Commissioner for South Africa, 72, Victoria-street London, S.W., by May 19.

Cheltenham Local Higher Education Committee require a director for their technical schools. Salary £220, rising to £250 per annum Applications to the Clerk to the Governors by May 16.

An experienced electrician is required for a gold mine in West Africa. See advertisement.

Kilmarnock Corporation want a mains assistant engineer. Salary £2. 7s. 6d. rising to £2. 15s. per week. Applications to the Burgh Electrical Engineer by May 3.

Barnes Council require a shift engineer at their electricity works Commencing salary £120. Applications to the Engineer and Manager, Electricity Works, Mortlake, by May 4.

A mains engineer is required by an electric lighting company Commencing salary £180 per annum. See advertisement.

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INSTITUTIONS AND SOCIETIES.

British Association.—The preliminary programme of this Association's meeting, which will take place at Portsmouth on August 30th and the following days, has now been issued. Sir Wm. Ramsay, F.R.S., will deliver his presidential address on the evening of the 30th, and other public discourses will be delivered on September 1st and 4th by Dr. Leonard Hill and Prof. A. C. Seward. The reception room administrative offices will be established at the Connaught Drill Hall, which is centrally situated, close to the Town Hall and meeting places. The President will have the assistance of a strong body of representatives of the administrative, ecclesiastical, naval and military interests, headed by Princess Henry of Battenberg and the Mayor of Portsmouth.

Illuminating Engineering Society.—The annual general meeting is to be held at the Royal Society of Arts on May 9th.

Electrical Trades' Benevolent Institution.—The annual dinner of the Institution was held at the Hotel Cecil on Wednesday last, the Right Hon. Lord Justice Fletcher Moulton, F.R.S., presiding. Those present included Messrs. H. Bevis, Justus Eck, E. Garcke, Hugo Hirst, J. E. Kingsbury, W. Maurice, A. J. Walter, K.C., and Major W. A. J. O'Meara, C.M.G.

The CHAIRMAN, in proposing the toast of "The Electrical Trades' Benevolent Institution," said that he was but a bad substitute for Sir William Preece, their president, though in one way at least he was a most suitable person for the position, as he was more than ordinarily ready to sing the praises of one who was his first sponsor in electrical work. One of the first occasions on which he, the speaker, consulted Sir Wm. Preece was when it had to be decided whether a particular wire was or was not a telegraph. After much experiment with a Wheatstone sounder and phonograph they were at last able to obtain vowel and consonant sounds from a telegraph, thus conclusively proving their case. He had been connected, too, with the Electric Lighting Bill of 1882, one of the greatest industrial mistakes that had ever been made, and one, too, which had stunted electrical work in this country for six precious years, during which Germany and America had shot ahead. He had watched the development of the electrical industry then from the time when it was only capable of bell-hanging and fine work, like telegraphy, to the present day when it seemed as if it were going to do the whole of the higher class work of the world. It was a trade in which there were as many officers as men. Their Society had started work on the right lines, and was being conducted on lines on which alone benevolence could be successful. The personal element wedded to self-help was present, and the management was in the hands of the trade itself. He warned them that the time had come when demands upon their accumulated funds might be made, and that it was now more than ever necessary for them to support the Institution.

Mr. H. HIRST supported the toast. He said the capital of the Institution was now £2,400, an increase of £400 over last year, while pensions to the amount of £30 had been paid out. Further, employment or temporary relief had been arranged in a large number of cases. Most of the expenses had been incurred in making the Institution more generally known in the trade. He suggested that much more might be done in this way, and that a series of prizes should be given to those members or firms who brought in the largest amounts. In early days, to belong to the electrical industry was to belong to a society like that of Masonry. There seemed to be no reason why such should not be the case at present.

Mr. A. J. WALTER, K.C., who also supported the toast, said that there were misfortunates in every industry and profession, not necessarily through any fault of their own. Rainy days might come to anybody, and sometimes it was impossible to provide adequately for them beforehand. Such a Society enabled them not only to help themselves, but to help others at the same time, and therefore wholehearted support should be forthcoming.

Mr. C. WALLIS-JONES proposed the health of the President, and Mr. FLETCHER MOULTON, in reply, announced that the subscriptions for 1911 amounted to £520, as against £320 in 1910, while £372 had been received from the funds of the Electrical Exhibition held at Olympia in 1905. Moreover, £240 had been collected in the room that evening.

Institution of Electrical Engineers.—The Students' Committee are arranging for a tour to Sweden during the third and fourth weeks in July, to visit large engineering works and hydro-electric power stations. It is proposed that the party should leave Hull on Thursday evening, July 20, and travel via Gottenburg, Trollhättan, Falkoping, Ludvika, Grangesberg, Westeras and possibly Stockholm. It is estimated that the tour will not cost more than £15. Further particulars can be obtained from Mr. D. Betts, hon. secretary of the Students' Section.

Institution of Civil Engineers.—At the annual general meeting of this Institution, held on Tuesday evening last, the result of the ballot for the election of officers was declared as follows:—*President*, Dr. W. C. Unwin, F.R.S.; *Vice-Presidents*, Messrs. R. Elliott-Cooper, A. G. Lyster, B. Hall-Blyth and J. Strain; *Members of Council*, Messrs. J. A. F. Aspinall, J. A. Brodie, W. B. Bryan, Col. R. E. B. Crompton, C.B., Messrs. Wm. Davidson, J. M. Dobson, H. F. Donaldson, C.B., E. B. Ellington, M. Fitzmaurice, C.M.G., J. P. Griffith, Dr. C. A. Harrison, Messrs. W. Hunter, G. R. Jebb, H. E. Jones, E. H. Keating, Sir Wm. Thos. Lewis, Bart., K.C.V.O., Sir Thomas Matthews, Mr. Wm. Henry Maw, Hon. C. A. Parsons, C.B., Messrs. F. E. Robertson, C.I.E., Alex. Ross, J. W. Shores, C.M.G., Hon. F. J. E. Spring, C.I.E., Sir Philip Watts, K.C.B., Mr. W. B. Worthington and Mr. A. F. Yarrow. This Council will take office on the first Tuesday in November, 1911.

The Council have made the following awards for Papers read and discussed during the session 1910-1911:—Telford Gold Medals to Mr. W. J. Wilgus and Mr. J. Walker Smith; a George Stephenson Gold Medal to Mr. Philip Dawson; Telford Premiums to Messrs. G. W. Humphreys, H. K. G. Bamber, A. E. Carey, William Dawson, and C. S. R. Palmer; and the Trevithick Premium to Mr. A. T. Blackall. The awards for Papers published in the "Proceedings" without discussion and for Students' Papers will be announced later.

EDUCATIONAL NOTICE.

Faraday House.—At a recent examination for entrance scholarships the following awards were made:—Harry Ellis Smith, Dulwich College, to Faraday scholarship of 50 guineas per annum tenable for three years. Special prizes of 25 guineas each were also awarded to Alex. Bell, Royal School, Dungannon, and W. H. Chaplin, Christ's College, London.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, April 28th (to-day).

PHYSICAL SOCIETY OF LONDON.

5 p.m. Meeting at the Imperial College of Science, Imperial Institute-road, South Kensington. Agenda: "High-Tension Electrostatic Wattmeters," by Prof. E. Wilson; "Previous Magnetic History as Affected by Temperature," by Prof. E. Wilson and Mr. L. C. Budd; "Note on the Behaviour of Incandescent Lime Cathodes," by Dr. R. S. Willows and Mr. T. Picton; "On the Formation of Dust Striations by an Electric Spark," by Dr. S. Marsh and Mr. W. H. Nottage.

STUDENTS' SECTION OF THE INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Meeting at Great George-street, Westminster. Lecture on "The Commercial and Technical Relations of Engineering Design and Work," by Mr. T. Frame Thomson.

ROYAL INSTITUTION.

9 p.m. Meeting at Albemarle-street. Discourse on "The Revolutions of Civilisation," by Prof. W. M. Flinders Petrie, F.R.S.

MONDAY, May 1st.

SOCIETY OF ENGINEERS.

7:30 p.m. Meeting at the Institution of Electrical Engineers, Victoria Embankment, W.C. Paper on "The Protection of Water Supplies," by Mr. H. C. H. Shenton.

TUESDAY, May 2nd.

FARADAY SOCIETY.

8 p.m. Meeting at the Institution of Electrical Engineers, Victoria Embankment, W.C. Papers on "Hydro-Electric Plants in Norway and their Application to Electro-Chemical Industry," by Mr. A. Scott-Hansen; on "Electro-Metallurgy in the Steel Foundry," by Mr. Verdon Cutts; and on "Two Simple Forms of Gas Pressure Regulators," by Mr. E. Stansfield.

WEDNESDAY, May 3rd.

ROYAL SOCIETY OF ARTS.

8 p.m. Meeting at John-street, Adelphi, W.C. Paper on "Improvements in the Transport and Distribution of Goods in London," by Mr. A. W. Gattie.

THURSDAY, May 4th.

ROYAL INSTITUTION.

3 p.m. Meeting at Albemarle-street. Lecture on "The Optical Properties of Metallic Vapours," by Prof. R. W. Wood. Tyndall Lecture II.

FRIDAY, May 5th.

DERBY SOCIETY OF ENGINEERS.

7:30 p.m. Meeting at the Mechanics' Institute, Wardwick. Paper on "Electric Steel Furnaces," by Mr. Joh. Härden.

ROYAL INSTITUTION.

9 p.m. Meeting at Albemarle-street. Discourse on "New Organic Compounds of Nitrogen," by Prof. M. O. Forster, F.R.S.

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BATTERY ECONOMICS AND BATTERY DISCHARGE ARRANGEMENTS.*

BY A. M. TAYLOR.

Summary.—The author first deals with the effect of rapid discharge rates on the ampere-hour capacities and terminal E.M.F.s of batteries. Methods of discharge by regulating cells alone and by boosters are discussed, and suggestions are offered for materially diminishing the cost and inefficiency of booster methods. Batteries are next considered as a standby to steam plant, and for extensions in alternating-current substations distributing direct current. The use of rectifiers for charging batteries off extra-high-tension alternating-current mains, on the premises of large consumers is also considered. An alternative proposal to batteries as a means of dealing with peak loads is finally discussed.

Rapid Discharge Rates.—The author knows of no results published in this country dealing with discharges at considerably higher values than the 1-hour rate, and though he gives some curves representing the recommendations of the Tudor Accumulator Co. in this direction, he bases his conclusions upon results actually obtained with Exide cells in New York, in which the discharge is carried to a considerably further degree than has hitherto obtained in English practice. Fig. 1 shows a curve connecting ampere-hours with hours of discharge, the values of which between the 10-hour rate and the 1-hour rate are taken from English practice, and those between the 1-hour rate and the 5-minute rate are estimated values, which, however, are very closely confirmed by the values obtained with the Exide cells given on the right-hand side of Fig. 1. In Fig. 2 are given the initial and final discharge voltages for different periods of discharge. Here, again, the English figures below the 1-hour rate are merely estimated, but it will be seen that they follow the same tendency as the actual values obtained on the Exide cells. In Fig. 3 a series of curves is given, showing the result that might be obtained on a cell of a given type and size if charged and discharged at different rates. The values of the terminal voltage on discharges below the 1-hour rate are calculated to agree with the curve given in Fig. 1. On the same sheet are shown the performances of the Tudor cells under similar conditions.

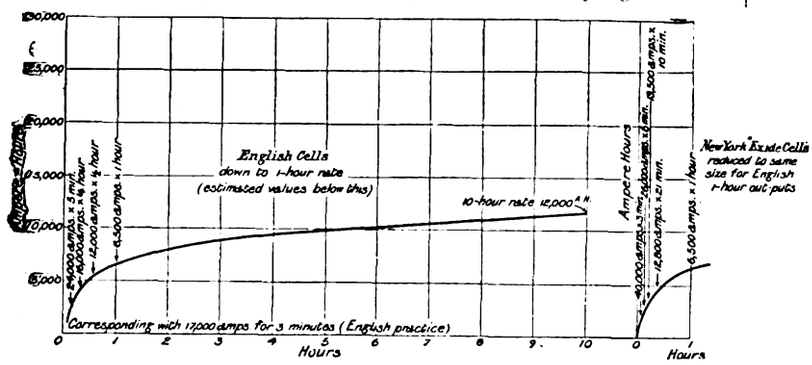

FIG. 1.

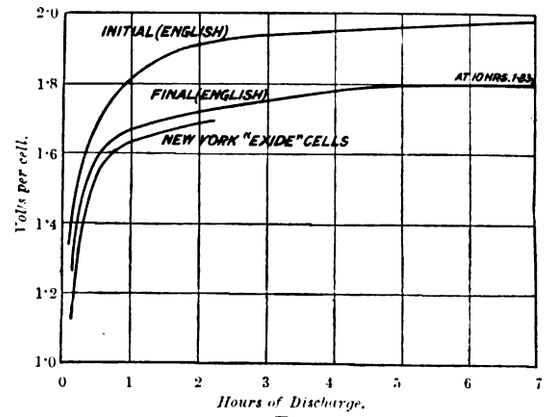

FIG. 2.

Regulating Cells.—The method of discharging large batteries by means of regulating cells has been employed on a considerable scale both in America and on the Continent, whereas in Great Britain, owing no doubt to J. S. Highfield's activities in 1901, the tendency has rather been to employ boosters for the discharge. Taking the case of a 'bus bar pressure of 510 volts, the author explains by a diagram the distribution of the charge left in the end cells of a battery where a sufficient number of regulating cells are employed to permit the battery to be discharged if necessary at the 5-minute rate. If it were never intended to use the battery at over the 1-hour rate, only 303 cells would be required (190 cells in the main battery and 113 regulating cells), and it is noted that the last 57 cells do not become properly charged unless the battery be charged at exceedingly low rates, taking a correspondingly long time, also that some of the cells are practically never discharged. This is accentuated considerably if the full number of cells (365) be installed in order to meet the extremely rapid rate of discharge (5 minutes), a larger proportion of the cells being then virtually useless except as a standby. These cells have to be fitted with regulating switch contacts, and the cost of the regulating switches becomes very considerable, besides the difficulty of maintaining cells in a healthy condition which are hardly ever called upon to give a discharge. It appears to the author that though this method of working batteries is very simple and reliable, yet it has many disadvantages, especially where rapid rates of discharge are likely to be required.

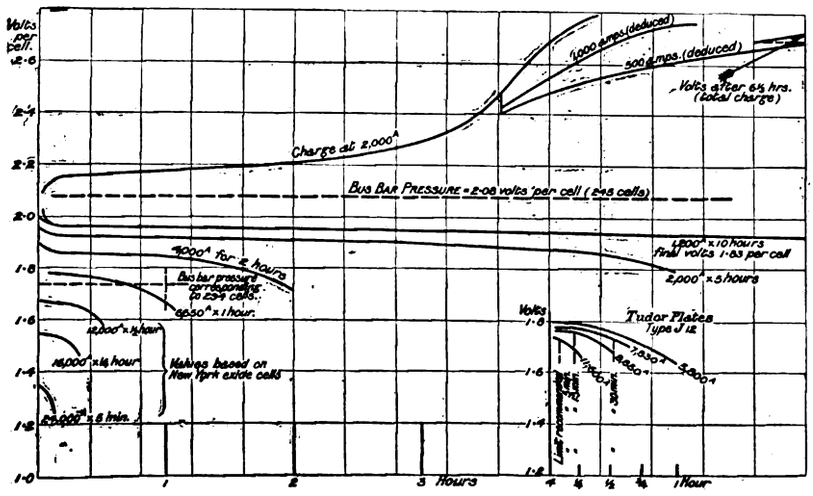

FIG. 3.

Boosters.—Up to the present time it has been very costly to obtain from boosters the necessary boost to get the discharges indicated in Fig. 1 out of the batteries. The voltage of the boosters has to be increased to such a degree that, combined with the high-current rate the resulting kilowatt capacity becomes very expensive to provide for. Virtually this has, in the author's opinion, resulted in an insufficient provision being made in boosters for discharging the battery at emergency rates, and it seems to be considered good enough either to throw the battery direct on to the 'bus bars on emergency conditions or to draw upon reserves (as, for instance, at Manchester). This, of course, means either that the batteries will never give the discharge they are capable of giving, or that, in order to obtain the discharge, the 'bus bars pressure at the station must fall tremendously. For example, in Fig. 4 the 'bus bar pressure would have to fall from 510 to 350 volts to get the discharge indicated. This is, of course, a serious matter for a central station to face. The author

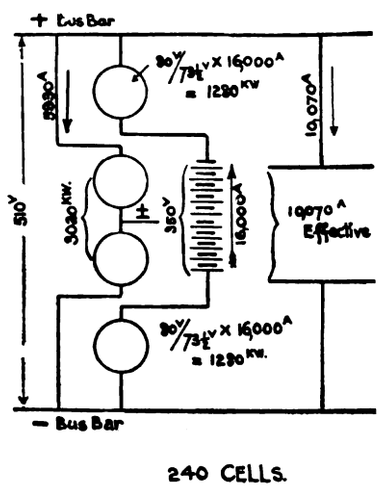

FIG. 4.

* Abstract of a Paper read before the Institution of Electrical Engineers.

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Table A.

	Period of discharge.	(Gross) kw. of discharge (at 510 v.).	Effective kw. of discharge.	Battery amperes discharge.	No. of cells.	No. of regulating cells.	Booster discharge kw. (at machine).	Motor current (at 510 volts).	Effective line current.	Final discharge E.M.F. per cell.	Final charge E.M.F. per cell.	Output of auxiliary booster (kw.)	Estim'd cost of battery (alone) per effective kw.	Estim'd cost of main booster per effective kw.	Cost of auxiliary booster per effect. kw.	Total cost per effective kw.	Highfield's costs in 1901.
	Hr.													Reg. switches.			
	Hr.												£	£	£	£	£
Regulating cells	1	2,530	2,530	4,960	303	113	...	...	4,960	1·67	2·7	...	5·36	1·50	...	6·86	...
	½	5,140	5,140	10,070	332	144	...	...	10,070	1·46	2·7	...	3·18	1·00	...	4·18	...
	½	6,370	6,370	12,500	365	176	...	...	12,500	1·26	2·7	...	2·34	0·70	...	3·04	...
Ordinary booster with motor balancer	1	3,390	2,530	6,650	240	Nil.	730	1,690	4,960	1·67	2·7	...	5·70	1·44	...	7·14	14
	½	8,150	5,140	16,000	240	Nil.	2,560	5,930	10,070	1·46	2·7	...	2·80	2·08	...	4·88	...
	½	12,200	6,370	24,000	240	Nil.	4,980	11,500	12,500	1·26	2·7	...	2·26	2·45	...	4·71	...
						For balancing.											
Triple series parallel booster with static balancer	1	2,810	2,530	5,500	280	10	236	546	4,954	1·67	2·7	58½	5·49	0·46	0·14	6·11	14
	½	6,700	5,140	13,110	280	10	1,314	3,040	10,070	1·46	2·7	58½	2·71	1·06	0·07	3·84	...
	½	9,970	6,370	19,550	280	10	3,039	7,050	12,500	1·26	2·7	58½	2·19	1·49	0·06	3·74	...

...ages to show that it is practicable to put in boosters to deal with a quarter-hour discharge at a cost not exceeding what is at present spent in obtaining a 1-hour rate of discharge, and that the cost for boosters in the case of the 1-hour rate, may be reduced to less than half the sum now spent upon them, with an all-round gain in efficiency.

With a view to emphasing the extent to which the cost of the boosters may be reduced by a suitable arrangement of boosters and batteries, the author gives, in some detail, an investigation into a particular case in which it is desired to deliver an effective discharge on the bus bars of 2,530 kw. (at 510 volts) for one hour or 5,140 kw. for a quarter of an hour, or 6,370 kw. for 5 minutes. Three different methods of obtaining this result are by a battery with regulating cells, the ordinary booster arrangement of Fig. 4 and the triple series arrangement shown in Fig. 5. The waste of battery current with the ordinary booster arrangement is very considerable, and in the case of

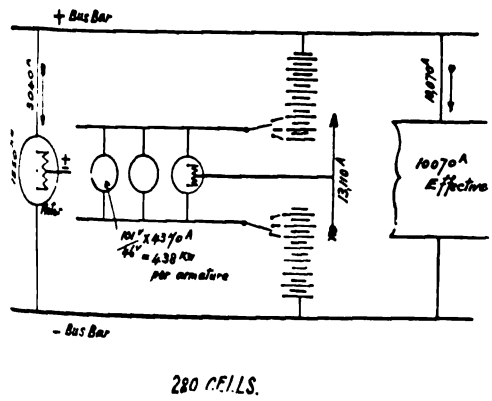

Fig. 5.

...ur rating the author shows that the output of the booster by ...s arrangement is reduced by nearly 500 kw. A summary of the conditions obtaining in the three different methods is given in ...le A, which also gives an approximate estimate of the cost of the ...ells and of the boosters.

...ig. 6 is shown a diagram of connections for obtaining the ...-series" arrangement of boosters. As shown in the right-...om corner of this diagram, a motor can be employed to ... double-wound booster armatures, each having two com-..., giving four booster armature windings, which can be ... in series or parallel; the fourth winding, however, would be ...-spare. A preferable arrangement, where cost is not a prime ...ration, would be to have two separate motors and four single-... armatures, each under its own field.

...Fig. 7 the author shows an arrangement which it appears to ... with advantage be employed in cases where the battery ... used with a regular load of known amount daily, and more ...ularly where the cells can be either charged from traction bus ..., preferably where rotary converters of the split-pole type (or ...alternating-current booster type), having a large range in their ..., are available. Where desired, existing rotary converters ... adapted for this purpose quite easily and at a low cost.

...this scheme the number of cells is so chosen that the maxi-... peak, output occurs at such a period of the discharge of the battery that practically no boost is at that time required for the latter (*see* central point of the 510-volt bus bar line of Fig. 7). For, say, one-quarter of an hour on either side of this point the boosters are worked with their armatures in parallel and are thus able to deal easily with the 6,650 amperes. During the earlier and later portion of the peak, however, the current being then much less, the booster armatures are put in series with each other. A few regulating cells, as indicated, may be employed if desired, and these could be cut out, as shown in Fig. 7, should the discharge rate require to be reduced in the early part of the discharge beyond that shown by the curve.

If traction bus bars were available, or a rotary converter could be modified to give sufficient voltage range for the charging of the cells (assisted by the battery boosters), the output of the battery boosters

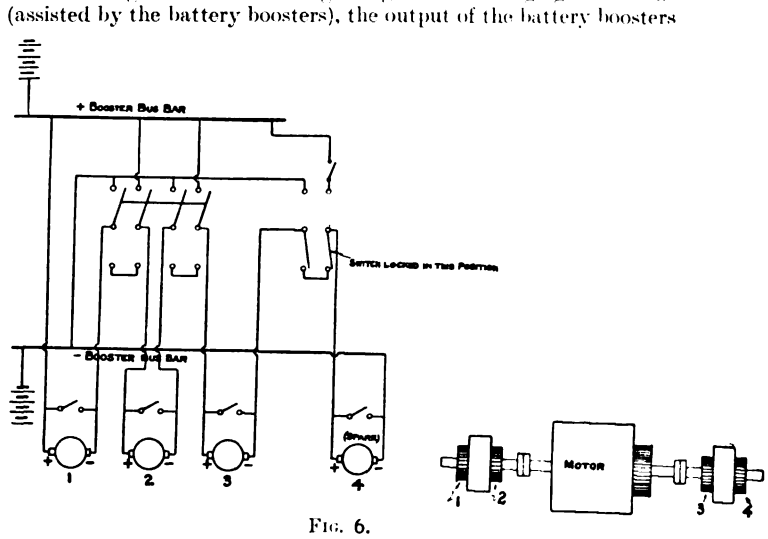

Fig. 6.

could, in the latter case, be reduced to as small a value as 66½ kw. (10 volts × 6,650 amperes). If, however, neither a suitable rotary converter nor traction bus bars were available, it would be necessary to put in boosters, if with the triple-series method, for at least 30 volts apiece, making a total booster-rating capacity on a 1-hour discharge equal to 198 kw. (30 volts × 6,650 amperes). Even this would be a distinct saving over the arrangement shown in Fig. 5, and a still greater gain over the arrangement shown in Fig. 4. In Fig. 7, however, it would be necessary to draw upon the fourth or reserve booster armature during charging (*see* Fig. 6), and it would be further necessary to arrange that the fields of all the boosters could, for short periods, be put under double the normal pressure, and also that, by speeding up the motor armature by some 30 per cent., the requisite volts on charging could be obtained.

It will be obvious that the arrangement in Fig. 7 would not be practicable if it were not feasible to make the change from series to parallel without interrupting the circuit. The author does not know of any arrangement actually on the market for performing this operation, but he sees no reason why it should not be quite practicable to combine with the double-throw switches shown in Fig. 6 certain auxiliary contacts which will perform the requisite sequence of operations.

Cells as a Standby.—The employment of accumulators as a standby against failure of the generating plant has made considerable pro-

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gress in the United States during the last year or two. The cells are worked without any boosters, there being a large number of regulating cells employed.

By the courtesy of the Chloride Company, the author is able to give the following particulars, which relate to the installation of 150 cells at the Sixteenth-street sub-station of the New York Edison Company. These cells are capable of giving 10,790 amperes for 1 hour, or 21,580 amperes for 21 minutes, or 32,370 amperes for 10 minutes, or 43,160 amperes for 6 minutes. It will be noted that the 6-minute rate is four times the 1-hour rate. The battery simply floats on the 'bus bars, and the regulating switches are automatically operated in such a manner that when a sudden discharge is required they will travel along rapidly to the contact required to give the prearranged 'bus bar voltage at the prearranged discharge.

Of the total number of 150 cells the author understands that no less than 68 are regulating cells. The switches are designed to travel along from contact to contact under any current up to 40,000 amperes. The floor space required for a battery of 280 cells works out at about 0·3 sq. ft. per kilowatt for a 'bus bar pressure of, say, 460 volts. It will be readily seen that such an arrangement compares very favourably as regards floor space with boilers, engines, and alternators; and, as regards capital cost, the cost of cells alone is probably not much over £3 per kilowatt for a 6-minute rate, and

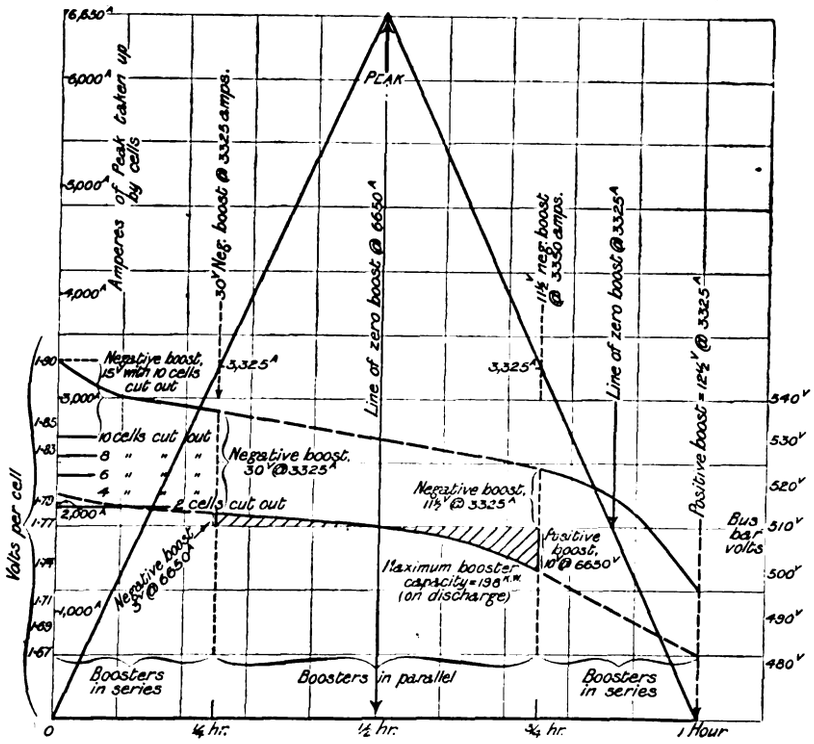

FIG. 7.—BOOST ARRANGEMENTS FOR A SPECIAL CASE.
288 cells. 'Bus bar volts = 510 (with max. number of cells).

compares very favourably indeed with any form of steam plant. Moreover, every central station engineer knows the extreme value of having standby plant which is absolutely ready to give instantaneously any discharge required from it. The battery is normally arranged to float on the 'bus bars and receive a slight charge, so that at the commencement of any emergency demand the battery is giving its full voltage, and the number of cells to be installed is thus reduced somewhat below that given in Table A.

The extent to which this method of employing batteries has obtained favour in the United States will be understood when it is stated that in the year between June, 1909, and June, 1910, batteries have been installed in New York, Chicago, Brooklyn, Boston and Washington, aggregating some 49,000 kw. at the 6-minute rate. The author, however, thinks that, valuable as this special class of battery may be as a stand-by, the savings to be introduced by working the battery in a regular way as a substitute for the use of steam plant, where the load is of a peaky nature, are so great that it will not be found advisable to put in batteries exclusively for the one class of work.

The author suggests that where batteries are put in on a large scale for lighting purposes, it will generally be found preferable to put in those batteries which deal with what may be called "time" peak (as distinct from "instantaneous" peaks) arranged to be operated by hand-regulated boosters; but, since the voltage of a battery alters very considerably with its rate of discharge, it would also seem

Table B.—*Annual Charges for 1,450 kw. (additional) Maximum Demand on Sub-station 'Bus Bars.*

Peak hours per day.	Equiv. load factor	Steam plant (coal at 12s.) Fixed charges per kw.	Running charges per unit.	Total annual sum.	Battery (coal at 12s.). Fixed charges per kw.	Running charges per unit.	Total annual sum.
	p.c.	£	d.	£	£	d.	£
1	4	3·89	0·221	6,141	1·54	0·330	2,796
2	8	3·89	0·221	6,638	2·21	0·330	4,691
5	20	3·89	0·221	8,129	3·89	0·330	9,360
		Gas plant (coal at 12s.).			Battery (coal at 12s.).		
1	4	3·82	0·082	5,717	1·54	0·120	2,507
2	8	3·82	0·082	5,902	2·21	0·120	3,753
5	20	3·82	0·082	6,457	3·89	0·120	7,025
		Steam plant (coal at 8s.).			Battery (coal at 8s.).		
1	4	3·89	0·150	5,992	1·54	0·220	2,752
2	8	3·89	0·150	6,340	2·21	0·220	4,243
5	20	3·89	0·150	7,384	3·89	0·220	8,250

desirable to have a smaller battery, which might be of the nature of a buffer battery, to take up the "instantaneous" peaks by means of an automatic booster, and so keep the 'bus bar pressure constant, while the main battery would be regulated by hand in such a manner as to enable boilers and engines to be shut down to the maximum possible extent.

Economy of Accumulator Working.—The case chosen is one involving the delivery of an additional peak load of 1,450 kw. on the direct-current 'bus bars in a sub-station at a distance of 1 mile from the main generating station, representing a load at the generating station of, say, 1,540 kw., the transmission being by high-tension alternating current and rotary converters. A number of tables are given showing the capital cost and the annual cost of delivering this additional amount of power for one, two and five hours daily by means of extra steam plant, extra gas plant and by accumulators. Table B herewith summarises the above tables.

It will be seen that on a 1-hour basis and with coal at 8s. per ton the total annual cost with the batteries is only £2,752 as against £5,576 when delivering the power direct to the 'bus bars without cells by means of rotary converters. The higher the fixed charges and the lower the running cost of the generating plant, the better does the battery show up as a substitute for it. It would seem, therefore, that where the average duration of the load supplied by the accumulators is from one to two hours and coal is moderately cheap, there is undoubtedly a good case for accumulators. Even, however, where coal is dear there is generally a sufficient saving in standby losses to make the value of the coal so saved fully equal to that lost in the inefficiency of the battery. This is exemplified in the case of Manchester, where the coal consumed per unit delivered to 'bus bars at Dickinson street, for a particular period of the year, is stated to have been reduced by 25 per cent., this taking account of the losses in the accumulators and boosters.

Accumulators with Alternating Current.—The introduction of the split-pole rotary converter, as developed in the United States, has given an incentive to the use of batteries on alternating-current systems as equalisers of the load. No doubt the employment of accumulators on alternating-current systems would be greatly extended if some less expensive and more flexible means could be introduced for charging and discharging them than that employing rotary converters. The author has devised a rectifier which he anticipates will permit of momentary overloads being passed through it many times larger (proportionately) than those which would cause the commutator of a rotary converter to flash over, and which should also be capable of dealing with large currents and of commutating direct currents into alternating currents.

The author thinks, however, that if it can be shown that, even in pure alternating-current distribution, the employment of battery substations will not only reduce the amount of generating plant as well as the aggregate section of the extra-high-tension feeders by some 20 to 30 per cent., but will also reduce the amount of wattless current to an insignificant amount, engineers will think twice before they dismiss the double advantage on the sole objection that to introduce substations with rotating machinery requiring skilled attention, in place of feeders, would be a retrograde step. As regards reliability of supply, it certainly would not be this, even if no pecuniary saving were obtained.

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The cost of entirely new sub-stations, rotaries, &c., will not be materially different from the figures given in the tables referred to above (except that rotaries and switchgear have to be added); and, if a good case has been made out for putting in accumulator plant in existing rotary converter sub-stations to save the first 20 to 30 per cent. of the generating station plant and feeders above alluded to, it should be pretty clear that the additional conversion losses in re-transforming back to alternating current are more than compensated by the additional 10 to 20 per cent. of generating plant and feeders saved on account of improved power factor.

The author states here his proposals for improving the power factor in a pure (or mixed) alternating-current system. Referring to Fig. 8, the rotary converter or motor-generator (A) and its battery (C) are used for taking up the peaks of the load in a manner well understood. The second rotary converter, motor-converter or motor-generator (B) is a synchronous machine and is over-excited in such a manner that it runs as motor, fed from the alternating-current line, and draws a leading wattless current therefrom sufficient in value to compensate for the lagging wattless currents taken by the consumers' motors. The special feature of the author's proposal is that the rotary converter (B) is enabled to find a useful load for itself by charging the battery (D), and thus a given kilovolt-ampere motor load can be dealt with with a much smaller expenditure in synchronous machines than would otherwise be the case. When the evening peak load comes on, the charge in the battery (D) is available for assisting the rotary (A) to deal with the load; and the motor-generator B may be either used to perform phase-changing by itself or, if not needed for that, is available to assist the motor-generator A in dealing with the peak.

Alternative to Batteries.—An abstract has recently appeared in the "Electrical World" of a Paper read before the American Street and Urban Engineering Association by Mr. H. G. Stott, in which the use

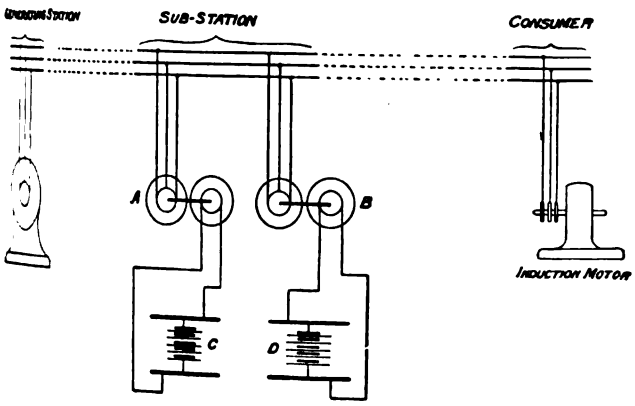

FIG. 8.

of batteries for peak loads is unfavourably compared with a scheme put forward for providing the extra power for extensions (in stations using reciprocating engines) by adding exhaust turbines to carry the load, by adding grate surface to the existing boilers, and by forcing the boilers during the time of peak load. The disadvantage which Mr. Stott's proposal labours is that the stand-by coal required to keep the boilers going through the night will still be required much as before. Moreover, the steam units cannot be so economically loaded up at all times of the day and night as by the use of batteries. Another point apparently overlooked is that the battery introduces the extra capacity at the wrong point; it should be essentially introduced at the sub-station.

The author of the present Paper deals in detail with Mr. Stott's proposals and believes that for peaks of short duration, say, up to two hours, batteries will be found decidedly the cheaper, and, moreover, little additional staff will be required than with the turbo-exciters. The question of power factor also has to be considered, and is a further inducement towards the use of batteries.

Conclusions.—The fact that batteries can now be constructed, and are being made, which will give outputs up to 40,000 amperes, shows that the Tudor plate type of accumulator has passed the experimental stage from the point of view of reliability, and central station engineers need no longer be afraid that if they put in a battery they may have to scrap it at the end of two or three years. Battery makers of repute are now to be found who will undertake the maintenance of cells for periods of 10 to 20 years. Even if this were not so, the new Tudor cell appears to have wonderful characteristics, as may be seen from tests recently published in THE ELECTRICIAN. The author is, unfortunately, unable to give an idea of its cost; but, as things are at present, it would seem to be quite safe to instal large batteries of the lead-plate type, and even if, in a few years' time, the long-expected ideal battery should make its appearance, no particular loss would be involved, provided a life of some seven years had already been obtained out of the lead-plate battery.

Three appendixes are attached to the Paper. The first gives a list of Tudor batteries having an output of over 500 kw. supplied by the German Tudor Co.; the second, a few particulars of some batteries installed in large U.S.A. central stations; and the third deals further with Mr. Stott's proposals.

A NEW AND DIRECT PROCESS OF PRODUCING ALTERNATING-CURRENT VECTOR DIAGRAMS EXPERIMENTALLY.*

BY A. E. KENNELLY, H. G. CRANE AND J. W. DAVIS.

The properties of the rotating magnetic field and their relation to two component quarter-phase magnetic fluxes are well understood. It seemed that analogous properties should be developed by a rotating electric field. Such a field should be capable of being produced either in a dielectric medium by two quarter-phase displacement currents or in a conducting medium by two quarter-phase conduction currents. Attempts to produce the latter, or voltaic, form of rotating electric field in a reliable manner were commenced in the electric engineering laboratories at Harvard University in April, 1910, using a thin sheet of acidulated water in a flat insulating tray as the conducting medium and a telephone receiver as the detecting instrument. Recently, however, very successful results have been produced with thin metallic sheets as the conducting media and a vibration galvanometer as the detecting instrument.

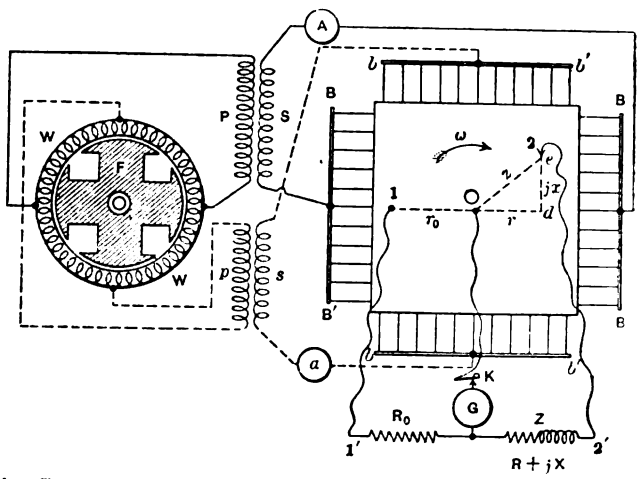

FIG 1.—GENERAL CONNECTIONS OF METALLIC SHEET, INDICATING THE PRODUCTION OF A VECTOR DIAGRAM OF IMPEDANCE.

The metallic sheets used have been composed at different times of tinned iron and of zinc. The results have been essentially the same with both substances, and only the zinc sheet will be here considered. The sheet was of commercial zinc 81·5 cm. square and 0·46 mm. thick. Its surface was marked off into centimetre squares—*i.e.*, into a system of rectangular co-ordinates. Connections were made with the edges of this plate through a fringe of high-resistivity wires, some high-resistivity fringing for the sheet being necessary in order to keep the electric current flow lines parallel to the edges. As shown in Fig. 1, 11 wires, each 29·5 cm. long, were soldered to each edge of the sheet at uniform intervals of 7 cm. The resistance of each wire was 0·836 ohm. The joint resistance of all the 11 wires in one fringe was thus 0·076 ohm. The entire flat arrangement of sheet and fringes was mounted on a wooden frame about 150 cm. square. This frame was supported conveniently in a vertical plane against a wall.

In order to produce a rotating electric field in the sheet two single-phase currents of equal strength, differing 90 deg. in time-phase, were supplied to it, with one component single-phase current along each axis. The general connections are illustrated in Fig. 2. The current density at any point in the sheet thus becomes a plane vector, rotating with the angular velocity of the alternating current. The frequency used was between 50 cycles and 60 cycles per second. Since the current-density rotated, the electric intensity, or volts per centimetre, at any point in the sheet, due to IR drop, was also a rotating vector. If appreciable harmonics existed in the currents supplied to the sheet, the resultant rotation would be non-uniform in radius vector as well as in angular velocity. The actual complex rotation

* Abstract of an article in the "Electrical World."

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would, however, in all cases be reducible to a pure uniform rotation of fundamental frequency, together with superposed pure uniform rotations of harmonic frequencies at harmonically increased angular speeds.

The instrument used to detect the rotating field was a Campbell bifilar vibration galvanometer, constructed by Mr. R. W. Paul, of London. A flexible conductor was soldered to the centre of the sheet at O, and led to a contact key K and the vibration galvanometer G. Another flexible conductor was permanently soldered to the point 1 on the reference axis, at the distance ·35 cm. from O. This wire led to a substantially non-inductive standard rheostat, R_0. For convenience in the measurement of low impedances, this rheostat was plugged for 3·5 ohms; for moderate impedances 35 ohms and for still higher impedances 350 ohms. In this way each centimetre of distance along either axis of the plate represented either 0·1 ohm, 1 ohm or 10 ohms respectively.

With the connections as shown and the impedance Z to be measured there is found to be only one point on the plate at which a roaming wire from Z can touch and show no current in the vibration galvanometer with the latter in tune and the key K closed. If the measured impedance Z happens to be reactanceless, the roaming contact must be made along the line 1O*d* of the reference axis, and the length O*d* of this line then measures to scale the resistance of Z. But with magnetic reactance in the coil, as shown, the roaming contact must be moved to a certain point *e* off the reference axis, and such that O*d* reads, to centimetre scale, the effective resistance of the coil Z, *de* reads to the same scale its effective reactance, and O*e* to the same scale its impedance, all to fundamental frequency. This may be called the simple harmonic impedance of the coil Z. If the coil has no iron core, there will usually be no appreciable difference between the ordinary complex harmonic impedance and this simple harmonic impedance. With an iron core present hysteresis tends to establish some difference between these quantities.

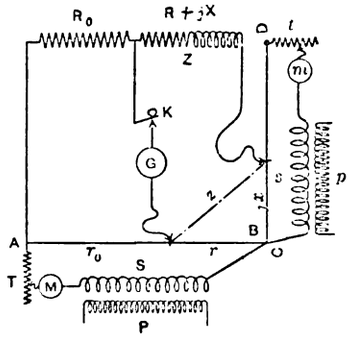

FIG. 2.—TWO-DIMENSIONAL POTENTIOMETER.

In all cases, whatever be the resistance represented by 1 cm. on the sheet, the relation is $Z/R_0 = z/r_0$.

If the direction of rotation of the electric field is as shown by the arrow in Fig. 1, then a magnetic impedance will lie on the $+j$ side of the reference axis, as shown, and a condenser impedance on the $-j$ side. But if the direction of field rotation be reversed, by reversing either of the main switches, the sign of the j-component, or reactive component, of the impedance will be reversed upon the sheet.

The action in Fig. 1 may be explained as follows: With the electric intensity rotating clockwise, as shown by the arrow at ω, the P.D. along the line O*e* on the sheet will be ahead in phase of the P.D. along O*d*, the reference axis. The current in R_0 is in time-phase with the P.D. 1O, or along r_0, if there is no reactance in the path $1'R_0$. The current in Z is delayed in time-phase by the reactance of the coil. The P.D. impressed on Z must, therefore, be advanced in time-phase by the angle *e*O*d* in order that the current in Z shall be in time-phase with the current in R_0. The identity of these two currents, both as to magnitude and time-phase, is disclosed by the absence of current in the galvanometer G when the key K is closed.

A difficulty which soon presented itself in these experiments produced discrepancies that evaded analysis for some time. Unless care be taken to remove all stray magnetic flux from the galvanometer circuit, the voltage induced by a stray field may mask or dominate the P.D. rotating in the sheet. It was found necessary to bind the wires 11′, O, K, 22′ tightly into a queue from the centre of the plate, to use twisted pairs for the supply wires, and to take other like precautions. An ideal arrangement, with this difficulty in view, would be to use a return current sheet side by side with and of the same dimensions as the working sheet, the two being separated only by a thin layer of insulating cloth so that the two exciting circuits could be kept almost completely non-magnetic. No such compensating return sheet was used, but even after all precautions were taken it was found desirable to take two readings at each measurement, the current being reversed in both supply circuits at each alternate reading.

A number of interesting alternating-current phenomena of impedance can be demonstrated with the revolving electric sheet of current and potential. Thus, if the impedance Z (Fig. 1) consists of the primary winding of a small induction coil, the effect of short-circuiting the secondary winding is to increase the resistance component O*d* of the resulting impedance and to diminish the reactance component *de*. Again, the increase of reactance in a reactive coil with increase of frequency is readily shown.

As may be easily demonstrated, the mesaurement is made with greater sensitiveness and precision as the standard R_0 and the unknown Z are reduced in impedance. The best results to begin with are obtained with a standard resistance R_0 of only a few ohms, a measured impedance of Z about the same magnitude, and with the galvanometer carefully tuned.

There are various other ways of obtaining measurements and vector diagrams with the rotating-current sheet. Thus, the test circuit may be connected to two points along the reference axis, and a balance obtained by a roaming contact leading to the galvanometer. Some beautiful geometrical relations and figures present themselves in the different tests and connections.

The vector diagrams obtained from the rotating current sheet, particularly with the arrangement shown in Fig. 1, are concrete experimental realities, very different from the geometrical abstractions which vector diagrams have hitherto appeared to consist of in alternating-current literature, and any observer who with such an apparatus, actually experiences a vector diagram will probably carry away with him a lasting and a different impression of such a diagram from that set up in the mind merely from the perusal of text-books. The rotating-current sheet is an ideal source of instruction in this respect.

Whether the rotating-current sheet can be made into an accurate piece of measuring apparatus, or two-dimensional potentiometer, is, however, an open question. It is swift to work with in measuring impedances, but in the form above described its precision is limited. Large sheets supplied with powerful currents using anti-induction precautionary devices may improve the precision, but since the currents are distributed broadcast over the whole sheet surface, the degree of precision per ampere of supply current must necessarily be small. Moreover, it may be difficult to secure a sufficient degree of mechanical uniformity in the thickness of large-surface metallic sheets, although corrections could be found, with sufficient care in the use of continuous currents and with a direct-current potentiometer.

A more promising method of obtaining a two-dimensional or vector diagram alternating-current potentiometer, which has recently been tried by the authors, is shown in Fig. 2. The quarter-phase currents are supplied, of adjusted equal strength, to the two slide wires AB and CD, which are connected together at B. Using the standard reactanceless resistance R_0 in series with the impedance Z to be measured, balance at the two sliding contacts can be secured with no current in the vibration galvanometer, when $R_0/R = r_0/r = jX/jx$.

The supply currents required in the slide wires are now comparatively small, and the precision of the apparatus as a measuring device is much greater. The balance adjustment is thrown on two sliders, which must be moved successively to a joint balance, whereas in the case of the rotating-current sheet there is only one roaming contact point, although the direction of motion for securing balance at any instant is uncertain, being of two degrees of freedom. In the non-rotating current two-dimensional potentiometer of Fig. 2 it seems possible to secure the required two-phase voltages from a single-phase source by using a small transformer with no iron core. Experiments are being made in this direction.

When the current is rotating at full speed in the sheet it is not an easy matter to reveal its presence except with the aid of a vibration galvanometer, but if the quarter-phase alternator supplying the currents is slowed down to a frequency of only one or two cycles per second, a small compass needle supported over the sheet can be brought into synchronous rotation with the current and so make the rotation evident to the eye.

Tram Car Indicator.—A new method of facilitating the tramway traffic on the Embankment has just been introduced in the shelter at Blackfriars Bridge. A megaphone is suspended from the roof of the shelter, and as each car approaches its destination is announced as well as the number of vacant places that are available both inside and out. Behind the megaphone instrument is a loud speaking telephone of the Graham type through which the information is given by an official stationed on a refuge opposite H.M.S. "Buzzard."

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ELECTRICAL EQUIPMENT OF THE NEW BUILDING OF THE ROYAL AUTOMOBILE CLUB, PALL MALL, LONDON.

In one way, at any rate, the Royal Automobile Club may be said to be unique among clubs. Not only does it, as do all other clubs, provide food, rest and entertainment for its members, but it also concerns itself with the advance of the science of automobilism, and by means of standing committees helps to obtain information which shall be of general use. For these reasons it requires more extensive accommodation than would an ordinary Club. It must provide offices for a more than usually large secretarial staff as well as suitable meeting places for the members of its various committees. With all these various operations, it was soon found that the Club's premises in Piccadilly were too restricted and the inevitable leakage into adjoining buildings occurred. To avoid the inconveniencies thus caused it was decided to obtain a site on which a new building, capable of containing everything under one roof, could be erected. Finally, the land in Pall Mall on which part of the old War Office used to stand was obtained on lease from the Office of Works. As regards position, nothing could be more central, while the building that has been erected is quite worthy of the district.

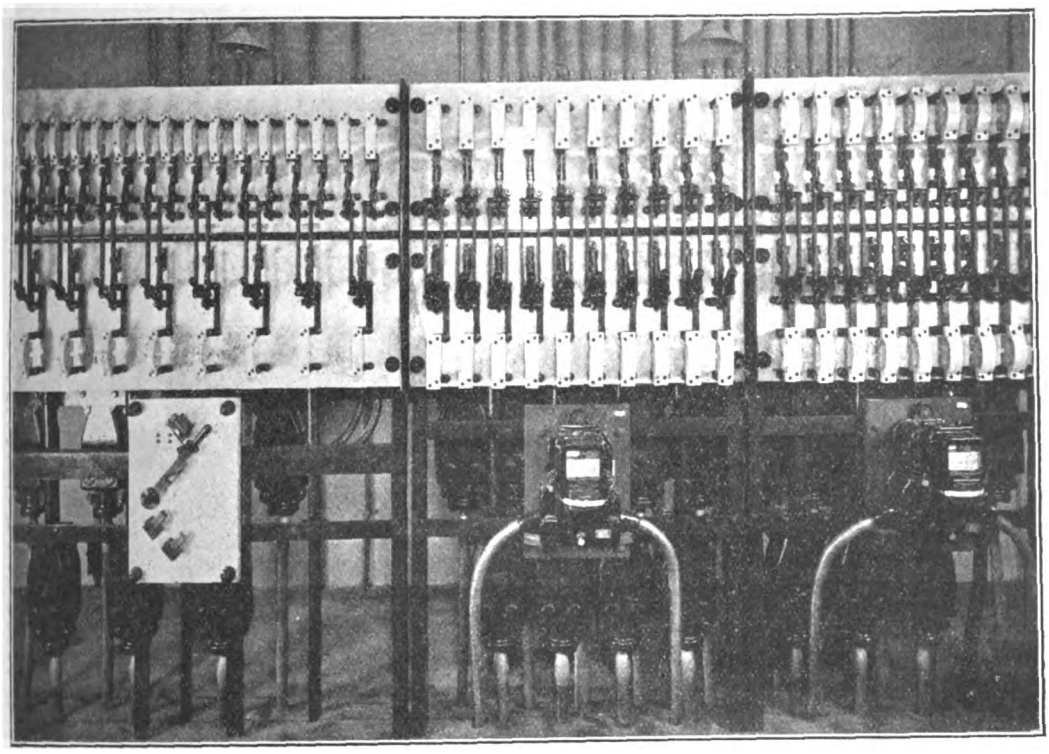

FIG. 1.—VIEW OF ONE OF THE MAIN SWITCHBOARDS.

The site has a frontage of 225 ft. to Pall Mall, with an average depth of 148 ft. The rooms at the back look directly out over St. James' Park. Great attention has been paid to the interior architectural effects and the results in general have been very successful. From the main entrance hall, a reception room and strangers' room open out to the right and left respectively. A flight of stairs leads up from the hall to a two-storey elliptical vestibule, beyond which is the Great Gallery,

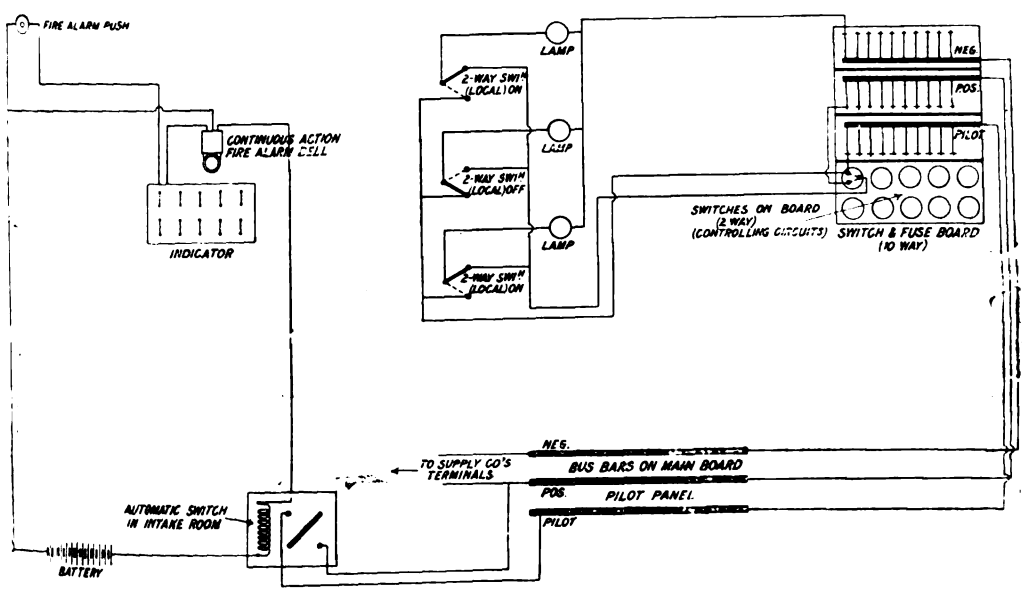

FIG. 2.—DIAGRAM SHOWING CONNECTIONS OF THE FIRE ALARM SYSTEM.

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also built in two storeys, with a balcony and a platform. To the right of the vestibule is the club room, and to the left a dining room and restaurant. On the first floor is the members' dining room which is decorated in the William Chambers style, a billard room with three tables, card room, committee room and library. The chief feature of the second floor is a fine room in the Georgian style which opens on to the terrace formed by the roof of the Great Gallery. On this floor there are also a few bedrooms. The third and fourth floors are fully occupied by bedrooms, while on the fifth floor are the servants' quarters and a photographic studio. The lower ground floor contains the kitchen and cloak rooms. In the basement are a swimming bath, Turkish bath, fencing room, shooting range, racquets courts and dressing rooms.

The building is made up of nearly 2,000 tons of structural steel work which forms the main frame of the building, the columns being supported on separate foundations.

Messrs. Mewes and Davis, and E. Keynes Purchase were the joint architects; the consulting engineer for the electrical work

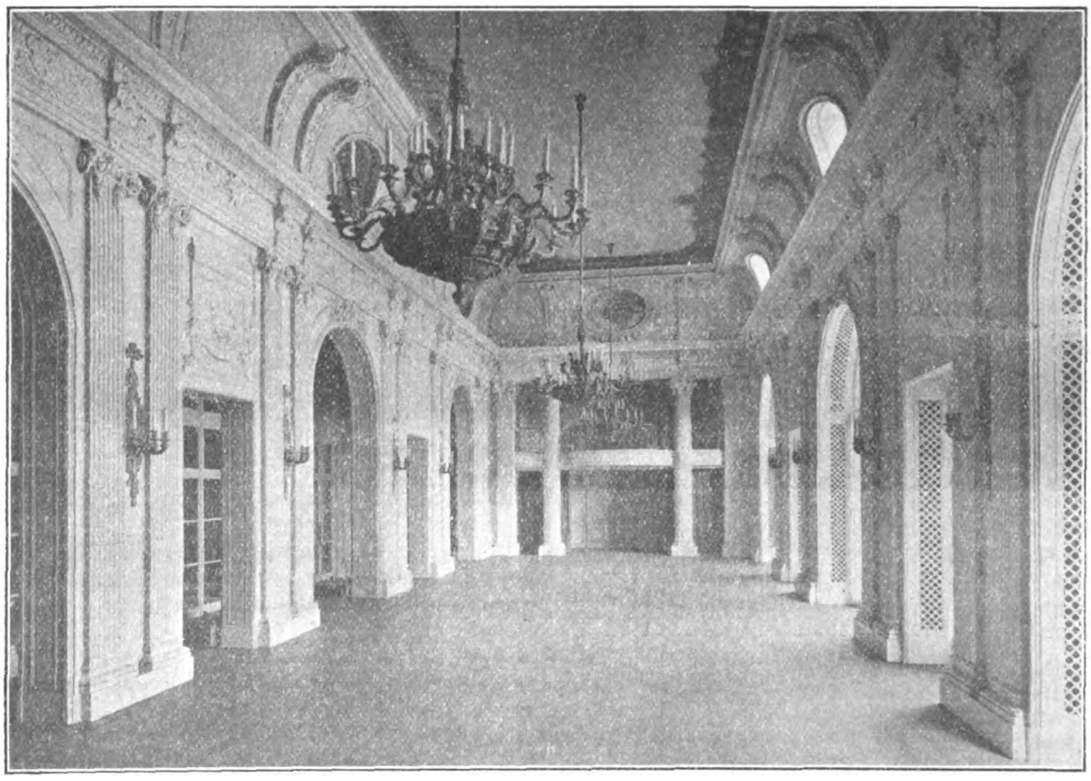

Fig. 3.—The Great Hall from the Platform.

was Mr. E. Wingfield Bowles, and the general contractors were the Building Construction Co. The entire electric light, power, bell and fire alarm installations as well as the conduit for the G.P.O. telephones, was carried out by the well-known firm of Higgins & Griffiths, on the most up-to-date lines.

The actual building was finished in 15 months at a cost of £240,000. As regards the electrical equipment, great care has been in the first place taken to prevent all the lights being extinguished at one and the same time. For this reason the lighting and power is supplied from two separate mains of the St. James' and Pall Mall Electric Light Co. The supply company's mains enter the building at two separate places, each cable being fed from an entirely distinct source of supply; in one case direct from Carnaby-street, and in the other through a sub-station from the Central Electric Supply Co.'s station at St. John's Wood. The supply is at a pressure of 110 volts direct current for lighting and 220 volts for power.

The supply mains come into a special chamber where switches and fuses are fitted, and thence pass to the intake chambers. One of these is provided for each of the two supplies. They consist of a good-sized fireproof room (securely locked) and contain the double-pole switches and fuses controlling the sub-main circuits. These are fixed on marble boards fastened to iron framing to which are also fitted integrating meters for determining the energy consumption in various parts of the building. A view of one of these boards is shown in Fig. 1.

The general arrangement of the supply is as follows:—The building is divided approximately into two halves, each half having an entirely separate intake chamber. Each room is lighted from both mains so that should one of the supply company's mains break down, the whole of the building would still be lighted. Further, all the corridors and halls are lighted from a special fire alarm circuit, details of which are given below. The mains from the intake chamber to the main boards, and from the main boards to the sub-boards are paper insulated lead-covered and armoured, and are run up special shafts along adjacent staircases. These shafts are easily accessible should it be necessary to inspect the cables.

At each intake point the St. James' Company come in with a three-wire service for lighting, and a two-wire service for power. The arrangement employed for controlling the pilot lighting is exceedingly ingenious. The mains on one pole are split and pass in parallel through a two-way switch. One side of this switch supplies the various lamps through sub-distribution boards and special local switches in the ordinary way, and the other supplies the lamps direct through sub-distribution boards and the other portion of the local switches. The pilot circuits on one side are further controlled by a single-pole switch, which, in its normal position, is held off by a catch. When the fire alarm is sounded by means of pushes in any part of the building, the coil on this switch is energised and the catch pulled off. The switch then falls by gravity and switches on the pilot lights throughout the staircases, corridors, &c., of the building. There are in all eight pilot circuits controlled as explained above by a 50-ampere triple-pole switch.

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and fuses. Fig. 2 gives a diagram of the cut-in switch arrangement.

There are altogether 52 general lighting circuits controlled from these boards, some of which are fed from the Carnaby-street mains and some from the sub-station. All these circuits have a capacity of 100 amperes; 12 of them supply the basement and are metered separately, being charged on a special tariff. There are also 12 power circuits supplied at 220 volts for working the lifts and fans, and two 110-volt circuits, one for supplying the cinematograph in the lecture theatre and the other supplying apparatus in the photograph room.

From the sub-boards the wires are run in steel screwed conduit placed under the floors. Where the conduit enters the draw-in boxes it is fitted with brass bushes. The draw-in boxes are easily accessible through traps in the floor and are provided with flush lids. All the conduit has been laid down to be electrically continuous throughout. The conduit is earthed at each intake room and distribution board by a 7/16 cable connected to the nearest water pipe. It was tested for continuity by ringing an electric bell through it. All the conduit is of ample size for the wires it carries, and to ensure that repairs could easily be made if necessary every wire was drawn into the conduit.

The distribution boards are contained in cast-iron cases painted with uralite, and are sunk in the walls. The fuses are carried on marble panels, the two poles being carefully insulated. Tubular fuses of 10 ampere capacity are used on the lighting boards. Front connections are employed throughout, and great care has been taken to keep the circuits fed from different sources of supply entirely separate. The various runs of conduit are placed quite apart under the floor, so that no switch or fitting on one circuit is within 6 ft. of any switch or fitting on the other circuit. The distribution boards for the general lighting and of the pilot lighting are placed so far apart that no man working on one can, even intentionally, touch the other. Further, they are divided into two halves, so that while the fuses can only be replaced by the electrician, the switches can be turned on or off by the ordinary attendants.

To make further separation the two sets of circuits fed from the two supplies are wired with different coloured wires, red and black being used on one circuit, and blue and yellow covered wires on the other.

The switches throughout the building are of the flush type, with the exception of those on the service and fifth floors; Lundberg plugs are used throughout, and where heating circuits are employed, a device is employed to prevent the heating plug being inserted in the lighting socket and vice versa.

A complete bell installation is provided on each floor, and is fed from batteries in the ordinary way.

In the main club rooms special attention has been paid to the lighting. This will be obvious by referring to Fig. 3, which shows a view of the Great Gallery. This chamber is decorated throughout in the style of Louis XV., and for lighting both candelabra and brackets are used, the place of the candles being, of course, taken by electric candle lamps. The same idea is followed out in the other main rooms with excellent results. In the swimming bath, for instance, which is decorated in an early Italian or Roman style, massive Greek bronze pendants of triangular shape with a lamp at each corner are used, the effect being very striking, while standards, also of Greek pattern, are placed near the edge of the bath. For lighting the bath itself, that is the water, metal filament lamps sunk in the cornice are used, the result of which arrangement can be seen in Fig. 4. The racquets courts too presented an interesting problem from the lighting point of view. It is, of course, necessary, in order that play be possible, that the ball shall cast no shadow. This condition was at last obtained after some trouble by using lamps suspended from the ceiling and placed in a reflecting trough inverted so that all the light is thrown downward. The most suitable height of these troughs was determined by experiment, and it was only after several heights had been tried that the one at last reached was chosen.

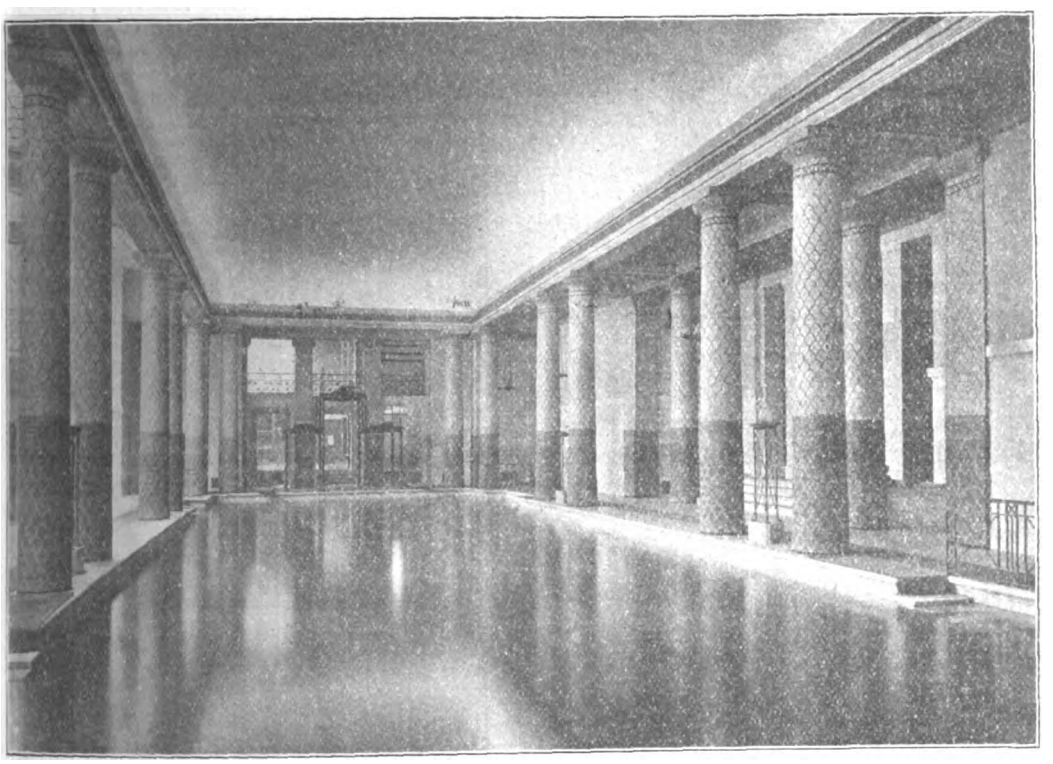

FIG. 4.—THE SWIMMING BATH.
Photographed by artificial light. The effect of the concealed lighting near the ceiling is noticeable.

In conclusion, we have to express our indebtedness to Mr. J. W. Orde, secretary of the Royal Automobile Club, for allowing our representative to inspect this most interesting building.

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LOSSES ON HIGH-TENSION LINES.*

BY G. FACCIOLI.

This Paper gives the results of tests on corona losses taken on the lines of the Central Colorado Power Co. The three conductors of the three-phase line are situated in a horizontal plane, with a distance of 124 in. between centres of adjacent conductors. Each conductor between the power house at Shoshone and Denver consists of a hemp centre six-strand copper cable No. 0 B. & S. gauge, with the exception of a section between Leadville and Dillon, where the conductors are of smaller size. From Denver to the power plant at Boulder three six-strand copper cables, No. 1 B. & S., are used (*see* Fig. 1). The insulators are all of the suspension type, and have four insulating discs each. The altitude and the climatic conditions of the country

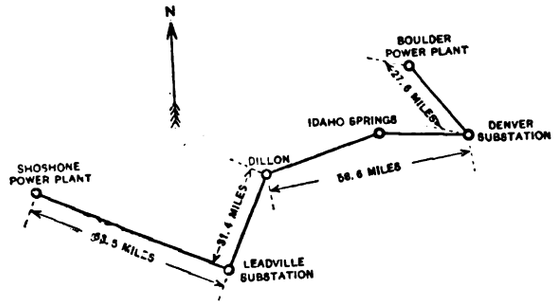

FIG. 1.

traversed by the transmission line are unusual. The line crosses the continental divide at three points, one between Shoshone and Leadville at an altitude of 12,000 ft., another between Leadville and Dillon at 12,500 ft., and the third between Dillon and Denver (Argentine Pass) at 13,700 ft. These exceptional conditions magnify the importance of the problem of line losses, as it is well known that the atmospheric losses increase with the altitude.

The generating system at Shoshone consisted of a 5,000 kw. 4,000-volt 60-cycle three-phase alternator, connected to the low-tension side of three 3,333 kw. transformers, whose ratio of transformation was 4,200 to 100,000 volts. The generator windings were Y-connected, the three transformers being delta-connected on both

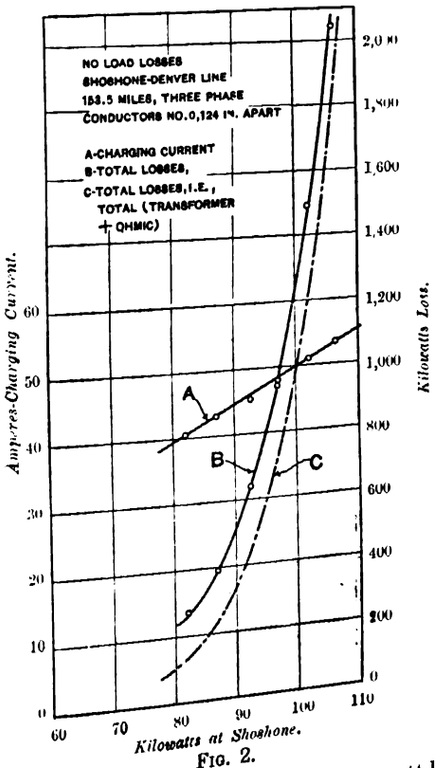

FIG. 2.

primary and secondary sides. Fig. 2 gives the kilowatt losses of this three-phase line (153·5 miles long). The voltage was varied by regulating the excitation of the alternator, and the measurements were taken on the low-tension side of the step-up transformers as follows: First, the transformers alone were connected to the generator, and the transformer losses recorded at a certain voltage; second, the line was connected to the high-tension terminals of the transformers and the loss measured at the same low-tension voltage. The difference between the two readings gave the total line losses —*i.e.*, the sum of ohmic, corona and insulator losses.

In Fig. 2, curve A shows the charging current of the line, and curve B gives the total losses measured at different voltages, that is to say, the line losses plus the transformer losses. Curve C gives the corona and insulator losses—*i.e.*, the losses remaining after the ohmic and the transformer losses have been subtracted from the total measured losses.

At 100 kv., which is about the operating voltage of the system, the transformer losses are 52 kw. and the corona and insulator losses 1,003 kw. Thus the operation of this system at 100 kv. would appear impracticable. However, when the system is loaded and in normal operation the line losses fall to small values, well within the limits of economical operation. The explanation of this phenomenon is obvious.

When the line is unloaded the voltage increases along the line, until at the far end of the line, at Denver, it is more than 10 per cent. higher than at Shoshone. With two 2,500 kw. transformers connected at Denver in open delta it was found that with 90 kv. at Shoshone the voltage at Denver was 100 kv. Hence the majority of the 1,000 kw. measured when 100 kv. were held at Shoshone was concentrated at the far end of the line, where the voltage was above 110 kv.

The above tests cannot be used to determine the critical voltage or the law which connects losses to kilovolts, because the voltage at the far end of the line is higher than the voltage at the power house, and because of the different altitudes through which the transmission line runs. For this reason some experiments were conducted on the Denver-Boulder section of the system.

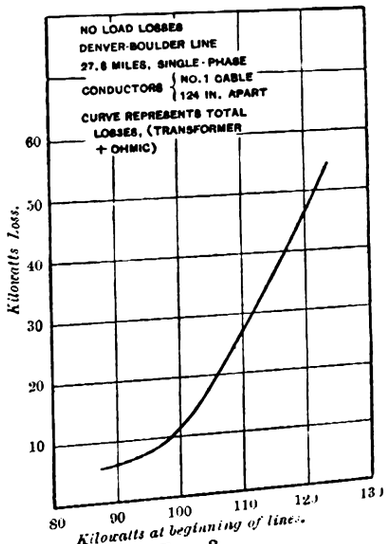

FIG. 3.

The distance between Denver and Boulder is 27·6 miles, and the line runs at an average altitude of 5,300 ft. The conditions of the majority of the tests were as follows: The main line from Shoshone to Denver was energised under normal conditions. The voltage at Denver was stepped down from 100,000 volts to 13,200 volts, and power was delivered at this voltage to the 13,200-volt 'bus bars at Denver. The low-tension winding of a 2,500 kw. single-phase step-up transformer was connected to these 'bus bars, and the high-tension winding energised two of the conductors of the three-phase line from Denver to Boulder. Different voltages were obtained by using different ratios of transformation or different combinations of step-down and step-up transformers.

The measurements were taken for a period of two weeks during which the barometric pressure varied from a minimum of 24·1 in. to a maximum of 24·7 in.; the temperature varied from 49°F. to 74°F. and the relative humidity from 21 to 35 per cent. with an average of 29 per cent. These values were measured at Denver. It was found that readings taken on different days were not affected by humidity for which, therefore, no correction was made. Also no correction was made for the slight difference in barometric pressure and temperature. The results regarding humidity obtained in Colorado corroborate the tests taken in Pittsfield, where an apparatus, consisting of a rod parallel to a plate, was tested for corona during the period of a month. The voltage at which luminous corona appeared remained constant although the vapour product varied from 0·36 to 1 and the relative humidity from 43·5 per cent. to 78 per cent. The barometric pressure varied between 28·7 in. and 29·2 in.

* Abstract of a Paper read before the American Institute of Electrical Engineers.

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Fig. 3 shows the result of the measurements. An attempt was made to separate insulator losses from corona losses, but the insulator losses (which were measured in dry weather only) were so small that no definite measurement of their value could be obtained, and these are neglected in the following decision. The voltage at the lower end of the line was measured by using a step-down transformer, and was 2 per cent. higher than at Denver.

The measurements were taken as follows: The transformer only was connected to the system and readings taken, then the line was connected to the transformer and readings taken at the same voltages as before. The difference between the kilowatts in the two cases gives the total losses of the line.

The author then proceeds to discuss an equation representing the power losses and also the term "critical voltage."

THE EFFICIENCY OF METAL FILAMENT LAMPS.*

BY R. A. HOUSTOUN, M.A., D.SC.

Abstract.—The author, after discussing previous methods, describes a method of measuring the radiant efficiency of lamps, *i.e.*, the ratio of the luminous energy to the total energy radiated. Results are given for carbon, tantalum, tungsten and osmium filaments.

Engineers are accustomed to measure the efficiency of a glow-lamp in watts per candle; on the other hand, we may regard the lamp as an energy-transforming device and measure its efficiency by the percentage of electrical energy it transforms into light. Let Q be the electrical energy consumed per second, R the total energy radiated per second and L the total luminious energy radiated per second. Then we make the following definitions:—L/Q = luminous efficiency, L R=radiant efficiency of the lamp. R is always less than Q, as all the energy is not lost by radiation, but some by conduction and convection. This proportion is, however, so small that it is usually neglected (Dr. C. V. Drysdale has found the convection loss to be not more than 2 or 3 per cent. of the total energy consumed).

For the purpose of defining L, it is usual to take 760 $\mu\mu$ as the upper limit of the visible spectrum. The lower limit is immaterial; there is little energy in the violet and ultra-violet spectrum of glow-lamps. The luminous efficiency does not measure the commercial value of a lamp because the eye is very much more sensitive to green than to violet, and it is possible for one lamp to have much more energy in the spectrum than a second one, but yet to have that energy so disadvantageously distributed that the second produces a stronger effect on the eye. The luminous efficiency is of more theoretical interest. It tells us how much of our energy is wasted in dark heat and how far we can with advantage hope to improve our lamps. This paper describes some measurements made on the radiant efficiency of carbon, osmium, tantalum and tungsten glow-lamps.

The usual method of measuring the efficiency was the calorimetric one. The lamp was placed in a glass calorimeter and then in a similar vessel of oil, and from the difference in the rise of temperature, with the proper corrections, the percentage of light radiated could be calculated. The method is in principle bad; the whole energy and the dark heat are measured, and the light is obtained as the difference between two much larger quantities, both subject to considerable error of observation. Another method was to measure the total radiation by the thermopile. A water filter was then placed in front of the thermopile, and the radiation that penetrated through the filter measured. This was supposed to be light, and if we made a correction for the light absorbed in, or reflected by, the filter—which could easily be measured photometrically—the radiant efficiency could be obtained. The objection to this method is that the water filter does not absorb all the heat. A solution of alum is no better than water, as is popularly supposed to be.† Hence corrections were made for the dark heat transmitted by the water by means of solutions of iodine in carbon disulphide, which were supposed to absorb all the dark heat that did pass. The utter untrustworthiness of all such methods, however, been demonstrated by E. L. Nichols and W. W. Coblentz. They have shown that they give a value much too large. Of these methods, one consists in determining the energy radiated at different wave-lengths by means of the spectroscope and thermo-pile or bolometer and plotting it as a function of the wave-length, a method which was introduced by K. Angström.‡ This latter has been used with modifications to the case of the carbon glow-lamp by C. E. Mendenhall.* who obtained 2·8 as the radiant efficiency of the latter at its normal brilliancy. This, I think, is the only previous determination of the radiant efficiency of a glow-lamp to which exception cannot be taken on the point of method.

The method I have applied is, as far as I am aware, original, though it almost follows from the article of Nichols and Coblentz. It seems preferable to both the above methods. The radiation was first measured in the usual way by a thermopile and galvanometer with and without a 1 cm. thick water filter, and the percentage of total radiation transmitted through the filter determined. In this case the radiation from the whole lamp was received by the thermopile. A straight part of the filament of average brightness was then focussed by an achromatic glass lens on the slit of a spectrometer with glass prism which was furnished with a Rubens linear thermopile in place of the cross wires. The same water filter was placed in front of the slit and an energy curve of the filament taken through the filter. For the region of the spectrum for which water transmits, the absorption of light in the glass and the loss of light by reflection at the glass surfaces may be taken as independent of the colour. If the prismatic energy curve thus determined be taken and an ordinate set up at the point 760 $\mu\mu$, the area on the side of shorter wave-lengths divided by the whole area gives the fraction of the radiation transmitted by the filter, which is light. It is only necessary now to find what fraction of the incident light is transmitted by the water cell. This was done by measuring the transmission coefficient of the latter when filled with water with a spectrophotometer for four different points in the spectrum. The value found was 0·84. It is somewhat low, as the glass sides of the cell absorbed rather more than usual; it did not vary with the colour.

The following table gives some results obtained:—

Radiant Efficiencies in per Cent.

Volts.	250-volt. carbon (1).	250-volt. carbon (2).	250-volt. tungsten (3).	250-volt. tungsten (4).
184	1·40	0·72	4·96	5·98
216	1·97	1·48	7·42	9·02
250	3·42	2·42	7·60	9·39
270	3·95	3·43	8·06	9·59
	130-volt. tungsten (5).	130-volt. tungsten (6).	125-volt. tantalum (7).	125-volt. tantalum (8).
75	1·61	1·69	2·06	3·00
125	6·61	6·43	6·66	6·35
146·5	9·04	8·83	...	...
150	...	...	7·70	9·25

All the lamps except the osmium (see below) are well-known makes much in use at present. Lamps (1) and (2) were of different makes, the filament in (2) having a metallic lustre; (3) and (4) were the same make, (5) and (6) the same make, and (7) and (8) the same make. A 50-volt osmium lamp was also tested and gave a percentage efficiency of 2·17 at 30 volts, 3·84 at 45 volts, and 6·52 at 55 volts.

The figures in the table are probably accurate to 5 or 6 per cent. The difference in the behaviour of the 250-volt and 130-volt tungsten lamps is probably due to a different method of manufacture. If we calculate the radiant efficiencies of the different filaments at their marked voltage and take the mean, we obtain:—

Carbon	2·9 per cent.
Osmium	5·2 ,,
Tantalum	6·5 ,,
Tungsten	7·5 ,,

My value, 2·9, for carbon, agrees well with Mendenhall's 2·8.

RAIL-LESS ELECTRIC TRACTION IN BREMEN.†

At the present time there are two electric omnibus routes worked on the overhead system in Bremen. One of these is nearly 3 miles long, and forms an extension of a municipal tramway route, while the other crosses the Bremen tramway and railway systems at one or two points. They both, therefore, act as feeders to other means of transport, though in somewhat different ways.

Both lines are supplied from the Bremen tramways station, and are worked on the continuous-current system, the pressure being 550 volts. The price charged is 1·6d. per kilowatt-hour. The overhead lines on these omnibus routes are different from those on other systems, in that the wires are placed one above the other, 11 in. apart, the positive being underneath and the negative above. In

* Paper read before the Royal Society of Edinburgh.

‡ Angström has shown recently by R. A. Houstoun and J. Logie, "Phys. Soc. Proc.," 1902, that an aqueous solution of ferrous ammonium sulphate absorbs dark heat much more effectively than water alone while allowing light to pass. Nevertheless, it is not satisfactory enough as a means of separating the dark heat from the visible radiation.

* "Physical Review," XVII., 1903, p. 302.

* "Physical Review," XX., 1905, p. 160.

† Based on an article by E. Kindler in the "Elektrotechnische Zeitschrift."

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this way the points of suspension, points, crossings and collectors are all simplified. The upper negative wire, which is earthed, acts as a protection against broken telephone or other wires. While the installation is agreeable to the eye in that the cars moving in either direction use the same source of supply, and only two wires in all are therefore needed. Cars meeting have, of necessity, to stop and change over the collectors, an operation which, however, takes only 12 to 15 seconds.

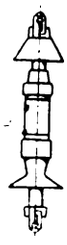
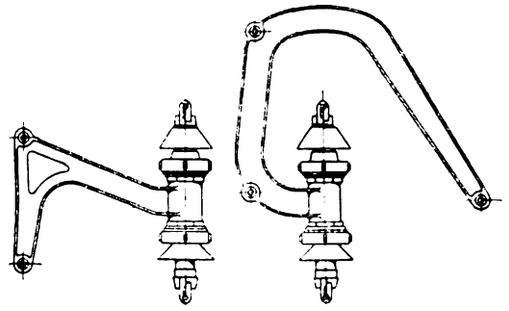


FIG. 1. DISTANCE PIECE FOR TROLLEY WIRES.



FIGS. 2 AND 3.—SUPPORTING ARRANGEMENTS ON CURVES.

The trolley wire is grooved, and is of 0·1 sq. in. in section. The supporting masts are placed 85 ft. to 100 ft. apart. Between the wires are placed separators (Fig. 1) in orde that they may be kept the proper distance apart. These separators consist of two insulator bolts fitted with terminals for the wires. The supports on the straight stretches consist of iron bows *b* (Fig. 4) with three fixing contacts for the wires. The two trolley insulator bolts, *u*, are placed upright in a coupling. They are e ch provided with a screwed cap, *v*. Each

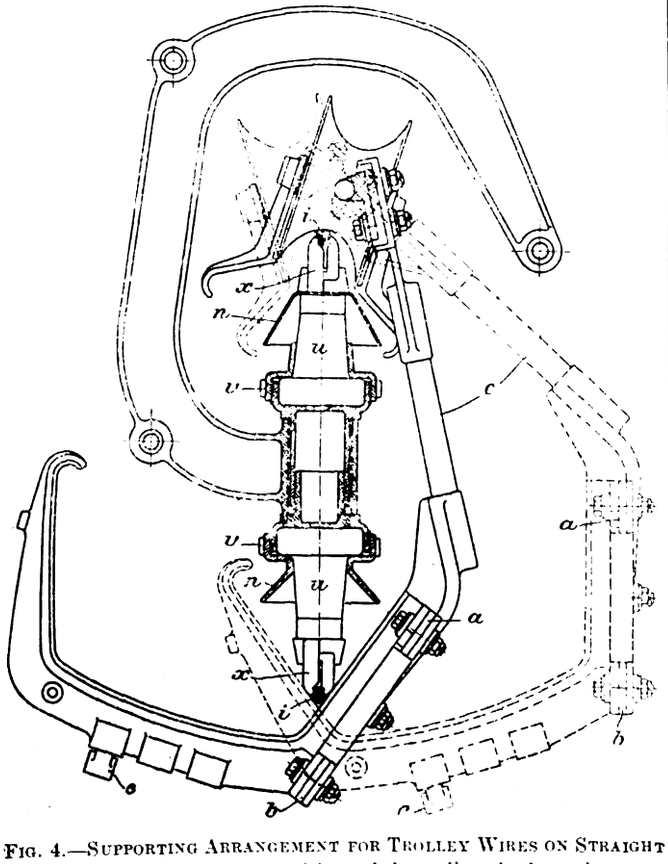


FIG. 4.—SUPPORTING ARRANGEMENT FOR TROLLEY WIRES ON STRAIGHT STRETCHES. The extreme positions of the trolley wheel are shown.

insulator bolt is protected by a covering, *w*. At the end of these bolts are fixed terminals, *x*, into which the trolley wire, *i*, is screwed. Between each span wire and the pole is placed an insulator, so that double insulation is provided between the positive and earth. Figs. 2 and 3 show the suspensions used on curves. Lightning arresters are placed in the positive wire every 1,000 yds., while the negative is earthed at equal intervals. Fig. 6 shows the arrangement employed on the overhead work where the omnibus route crosses the tram system. For a distance of 12 ft. on each side the crossing point both systems are rendered dead by the insertion of section insulators in the case of the tramways, and by breaking the trolley wires of the omnibus routes by means of several insulating buckles. As shown in Fig. 6 the trolley on the tramway has to pass over an open space of about 1¼ in. at *c*, where the wire is broken. This space has to be left for the trolley arm of the omnibus to pass through. The trolley arm employed on the omnibus routes is of the combined bow and wheel type, and its construction is shown in Fig. 5. The springs allow it to move up and down, as the height of the trolley wire varies. In order that the trolley can be quickly removed when necessary, a vertical pole is arranged at the front of the car near the driver's platform. This is movable round a horizontal axis, and supports the cable on its way to a drum, which drum is placed near

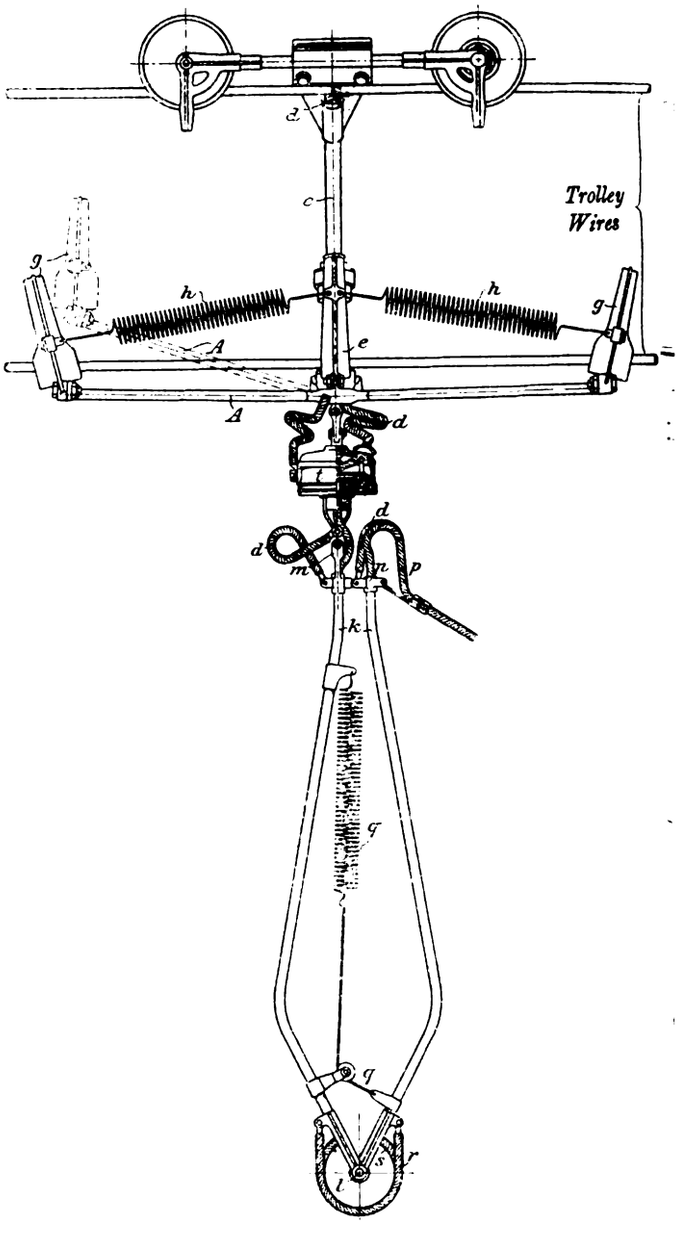


FIG. 5.—CONSTRUCTION OF THE COLLECTOR.

the front part of the car and winds the cable in or out automatically by means of a special spring arrangement. The current is then conveyed to the motors through two rubbing contacts. When two cars meet each driver, by means of a handle, can draw down the cable loop so that the cable can be uncoupled from one and coupled up to the other collector.

The cars used are about 20 ft. long, 10 ft. high and 8 ft. broad. They have seating accommodation for 20 passengers, and for standing; they weigh 3·2 tons empty.

The electrical equipment consists of an 18 H.P. interpole motor which can exert 35 H.P. if required. It runs at 650 revs. per min. and drives the rear axle through a cardan link and differential gear. The controller has five working and two braking positions. A foot-brake is also provided. For trailer working a special contact is fitted to the

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foot-brake lever, whereby current from the overhead line can be supplied to the trailer brakes. The lighting of the car is carried out by glow lamps.

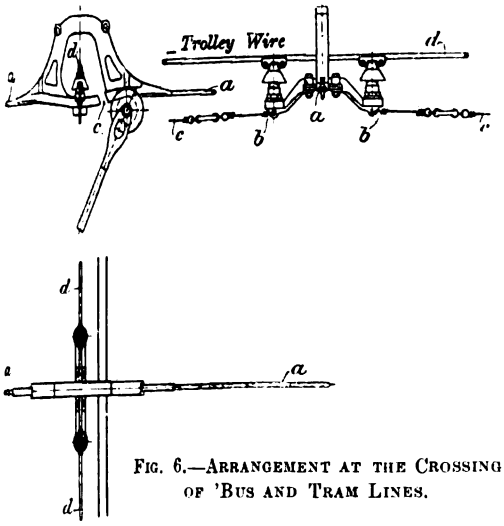

FIG. 6.—ARRANGEMENT AT THE CROSSING OF 'BUS AND TRAM LINES.

The energy consumption per car-mile including car, waiting room and shed lighting, as well as shunting, works out at about 560 watt-hours or at from 88 to 112 watt-hours per ton-mile.

THE PROPAGATION OF MAGNETIC WAVES IN AN IRON BAR.

BY C. V. DRYSDALE, D.SC.

Summary.—It is pointed out that there is a close analogy between the propagation of alternating magnetism along an iron bar and that of alternating current along a cable. Experimental results are given confirming this analogy, the measurements being made with a search coil and the author's alternate-current potentiometer.

In a series of articles published in THE ELECTRICIAN about three years ago* the writer gave a summary of the elementary theory of alternate-current transmission in electrical circuits, with diagrams showing the theoretical variation of P.D. and current along lines of different characteristics. Later, when the alternate-current potentiometer was developed,† it was pointed out that these results could be easily checked by experiment, and experiments are in progress with this object. But one of the most useful applications of the potentiometer is to the exploration of alternating magnetic fields by the aid of a search coil, and a simple illustration of this is given by the distribution of magnetic flux in a long iron bar magnetised at one end by a coil fed with alternating current. The result is that magnetic waves are propagated along the bar according to a law resembling that of the transmission of electrical waves in cables, and the variation of the flux vector from point to point can be easily determined by a search coil enclosing the bar and connected to the potentiometer.

The theory of this transmission is as follows: In Fig. 1 let PQ be the iron bar and C the magnetising coil. If we consider two sections of the bar at distances of x and $x+\delta x$ from the further or receiving end, we have $\delta V = \frac{1}{\mu} B \delta x$, where B is the induction density and δV the increment of magnetic potential. This is on the assumption that there are no eddy currents in the bar; but, if there are, their magnitude may be taken as proportional to the induced E.M.F. or to $\dot{B}$,* and also their demagnetising effect. Hence we must write $\delta V = \frac{1}{\mu} B \delta x + K \dot{B} \delta x$, where K is a coefficient depending upon the section of the bar and the conductivity of its material, or $\frac{\partial V}{\partial x} = \frac{1}{\mu} B + K \dot{B}$. At the same time there is a magnetic leakage or dispersion from the sides of the bar which we may take as being proportional to the magnetic potential V, and hence $\delta B = K' V \delta x$, or, $\frac{\partial B}{\partial x} = K' V$, where K′ is a coefficient depending on the reluctance of the return path of the flux through the air.

We may now compare the equations for the bar and cable as follows:—

Magnetised bar.		Cable.
$\frac{\partial V}{\partial x} = \frac{1}{\mu} B + K \dot{B}$	.....	$\frac{\partial V}{\partial x} = rC + L\dot{C}$
$\frac{\partial B}{\partial x} = K' V$	.....	$\frac{\partial C}{\partial x} = gV + K\dot{V}$

By comparison it will be seen that the magnetised bar is the analogue of a current carrying cable in which the resistance corresponds to the recipocal of the permeability, the inductance to the eddy-current coefficient, the leakance to the dispersion coefficient; and having no capacity.

FIG. 1.—ARRANGEMENTS FOR TEST.

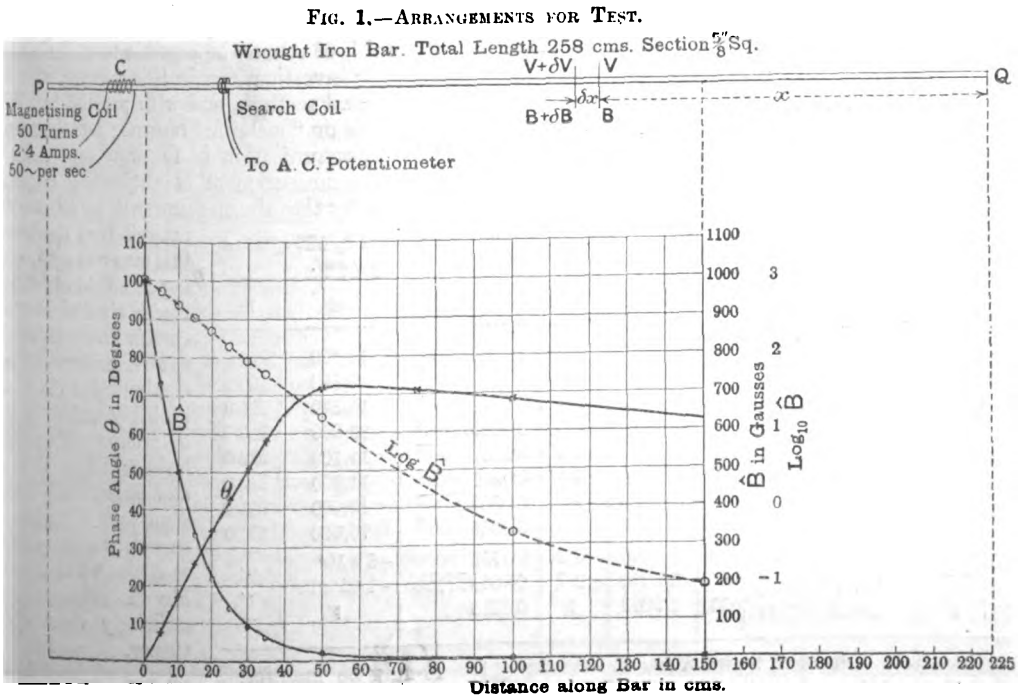

FIG. 2.—CURVES OF FLUX DISTRIBUTION.

* This is not rigidly true, owing to inductance, but is probably sufficiently close at ordinary frequencies. The effect of hysteresis would also be to cause a lag of the flux.

* "The Theory of Alternate-current Transmission in Cables," Dec. 6, 1907—Jan. 10, 1908.

† "The Use of the Potentiometer on Alternate-current Circuits," Phil. Mag., March, 1909.

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It will further be noticed that if we consider a cable with negligible inductance, the two sets of equations correspond exactly in form, if we take the magnetic induction as corresponding to the electric potential, instead of to the current.

It is of little use attempting to establish an accurate formula suitable for numerical calculation, as the permeability and dispersion are both very indeterminate; but we may expect the flux vector to vary in somewhat the same way as the P.D. vector in the case of an ordinary cable, except that the attenuation constant must be extremely large, owing to the low magnetic "insulation resistance." If the bar is sufficiently long the flux in the portion near the exciting coil should vary approximately according to the law $B = B_0 e^{-ax}$, where x is the distance measured in the direction of propagation from the point at which the induction is B_0 and a is the attenuation constant, which may be written either in the form $a\,\alpha$, or $b + jc$.

Experiments.—The bar used for this experiment was an ordinary length of square wrought iron, $\frac{3}{8}$ in. square and about 8 ft. 6 in. long. This was magnetised by a coil of about 50 turns, through which a current of 2·4 effective amperes at 50 ~ was steadily passed. Search coils of 100 or of 1,000 turns were connected directly to the potentiometer, and the bar was marked off in equal intervals, at which the search coil was successively placed. The potentiometer reading gave the effective E.M.F. vector at each position directly, from which the vector of maximum induction $\hat{B}$ was calculated by the relation $\hat{B} = \frac{\sqrt{2} \times 10^8 E}{Apt}$, where E is the effective E.M.F., A the area of section of the bar in square centimetres, $p = 2\pi n$, and t the number of turns in the search coil. In order to obtain the real attenuation constant b, we have $\hat{B} = \hat{B}_0 e^{-bx}$ from which $\log_e B = \log_e B_0 - bx$, and $b = 2{\cdot}3026 \frac{\log_{10} B_1 - \log_{10} B_2}{x_2 - x_1}$, while $\alpha = \frac{\partial\theta}{\partial x} = \frac{\theta_2 - \theta_1}{x_2 - x_1}$, and $a = \frac{b}{\cos \alpha}$, the attenuation constant thus being given in the form $a = a\angle\alpha$. Lastly, the velocity of transmission of the magnetic waves is easily calculated, for since there are 360 degrees of phase angle to each period, and n periods per second, the angle phase changes by $360n$ degrees per second, and as α is the number of degrees of phase lag for 1 cm. displacement along the bar, the velocity of propagation in centimetres per second is $v = \frac{360n}{\alpha}$. Similarly the wave-length in centimetres is $\lambda = \frac{360}{\alpha}$.

The following table gives the results of an experiment, the first three columns being observations, the remainder being calculated from them as above:—

Wrought Iron Bar 258 *cm. long,* $\frac{3}{8}$ *in. sq. Area of cross section* = 2·52 *sq. cm. Magnetised by* 120 *effective ampere-turns at* 50 ~ *per second. Distances measured from end of magnetising coil.*

t.	x.	$\bar{E}$.	$\hat{B}$	$\log_{10} \hat{B}$.	Δx.	$\Delta \log \hat{B}$.	$\Delta\theta$.	$\hat{a}$.	v.	λ.
100	0	0·5615	1000·3	3·0014	5	0·1383	7·9	0·0637/1·58°	11,400	223·0
100	5	0·4083/7·9°	729·6	2·8631	5	0·1643	9·1	0·0757/1·82°	9,880	196·5
100	10	0·2797/17°	499·8	2·6988	5	0·1760	8·7	0·0810/1·74°	10,340	205·8
100	15	0·1865/25·7°	333·3	2·5228	5	0·1826	9·0	0·0840/1·80°	10,000	200·0
100	20	0·1225/34·7°	218·9	2·3402	5	0·1861	8·1	0·0857/1·62°	11,100	222·0
100	25	0·0798/42·8°	142·6	2·1541	5	0·2048	8·1	0·0945/1·62°	11,100	222·0
100	30	0·0498/50·9°	89·0	1·9493	5	0·1754	7·1	0·0808/1·42°	12,700	254·0
1,000	35	0·3325/58°	60·1	1·7739	15	0·5604	3·6	0·0860/0·24°	75,000	1500·0
1,000	50	0·0915/71·6°	16·4	1·2135	25	0·8645	−0·9	0·0795/0·036°	-5×10^5	...
1,000	75	0·0125/70·7°	2·23	0·3490	25	0·6990	−2·7	0·0643/0·108°	$-1{\cdot}66 \times 10^5$	...
1,000	100	0·0025/68°	0·417	1·6600	50	0·6889	?	0·0318	?	...
1,000	150	0·0005/ ?	0·089	2·9511						

It will be seen that the values of $\hat{a}$, v and λ are at first fairly constant, and the mean values for the second to the sixth reading are $\hat{a} = 0{\cdot}0842\angle 1{\cdot}72°$, $v = 10{,}460$ cm. per second, and $\lambda = 210$ cm. As the angle α is so small, cos α is practically unity, and the values of the vector and real attenuation constants are sensibly equal. Beyond 35 cm. from the coil the phase angle ceases to increase at the same rate, and it afterwards actually decreases. This might be ascribed to reflections from the further end of the bar, but in view of the heavy attenuation and the distance of the free end, this can hardly be the case. In an earlier experiment, under nearly the same conditions, the same effect was found to an even greater extent, but in this case a large iron stanchion was near to the bar about half-way along its length.

In Fig. 2 the values of $\hat{B}$, log $\hat{B}$ and the phase angle θ are plotted along the bar, and it will be seen how the values of log B and of θ lie almost exactly on a straight line at first, in accordance with theory, while the phase angle at first increases in proportion to the distance, becomes a maximum at about 6·0 cm. and then diminishes.

Fig. 3 is a polar or vector diagram of the flux vectors, which should be compared with the theoretical curves given for cables in the Paper above referred to. It should be pointed out that the *vector differences* between successive flux vectors represents the magnitude and phase of the total leakage flux in the interval, and the dotted polar diagram or the "hodograph" of the longitudinal flux represents the leakage flux obtained in this manner. It also, probably, represents approximately the distribution of magnetic potential along the bar, which could also have been directly measured by winding a second search coil on a long iron rod held close to and perpendicular to the bar under test. This rod would, however, have disturbed the magnetic distribution in the test bar, in the same way as a low resistance voltmeter would disturb the distribution of potential in a cable.

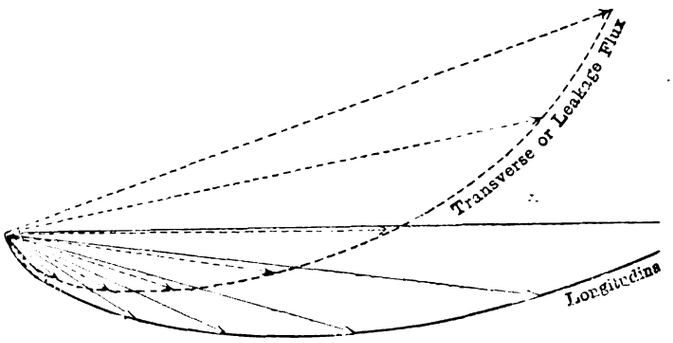

FIG. 3.—VECTOR DIAGRAM OF FLUXES.

It would, of course, be possible to make a number of most interesting investigations in this manner, with bars of various materials and sections, and with parallel bars laid by the side as magnetic or "metallic" returns; but the main object of the present communication is to show how easily problems involving the measurement of alternating magnetic fields may be solved by the alternate-current potentiometer. It will be noticed that the lowest reading in this case was $\frac{5}{10000}$ volt, corresponding to a field of 0·089 gauss, or half the horizontal component of the earth's field. In the case of alternators, motors and transformers, a single loop of the finest wire would probably suffice in most cases to determine either the working or leakage fluxes both in magnitude and phase. It is hoped to publish some tests of this kind very shortly, as well as some tests on propagation in cables, which have been made by Mr. H. Tinsley, and which are in strikingly close agreement with theory.

It may be mentioned that the whole of the arrangements for the above tests, with the observations, were made in about three hours. Some of the measurements were made by the writer and some by Mr. Tinsley with perfect agreement. The values given in the table are from a set of readings by Mr. Tinsley, to whom the writer is indebted, not only for facilities and help in the tests, but for the excellent manner in which he has constructed the alternate-current potentiometer and its accessories.

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CAST COPPER OF HIGH ELECTRICAL CONDUCTIVITY.*

BY E. WEINTRAUB.

The production in the foundry of pure copper castings mechanically sound and possessing an electrical conductivity comparable with that of pure forged copper has been an important problem ever since the development of electrical machinery and apparatus. The cause of the difficulty has been sufficiently well understood for a long time. Molten copper has the property of dissolving gases and of giving a part of these gases free on cooling. This produces pinholes and even big cavities. The casting obtained is therefore mechanically unsound, and has naturally a low electrical conductivity.

The elimination of these dissolved gases presents but little difficulty. It is sufficient to add one of the well-known deoxidisers, but the electrical conductivity of the copper thus produced is, however, as a rule, low, because all the *deoxidisers used have also the property of combining with copper*, and the remarkable rate in which the conductivity of copper drops when small amounts of impurities are alloyed with it is well known. The amount of the gaseous oxygen occurring dissolved in copper during the process of melting is a negligible quantity and is distributed throughout the whole mass. It is therefore practically impossible to add the deoxidiser in such a way as to eliminate oxygen completely without, at the same time, alloying it to a certain degree, with the copper. Accordingly, the conductivity of the resultant product was a matter of accident. In the laboratory sometimes good results were obtained, but they were hard to duplicate, and the transfer to the foundry was always a disastrous experiment.

While carrying on the work of the isolation of the pure element, boron, and its fusion, the lack of affinity of this element for copper forcibly impressed itself on my mind. Boron has, at the melting point of copper, a great affinity for oxygen, nitrogen, &c., and it occurred to the author, therefore, that boron ought to be the ideal substance for deoxidising copper.

The boron as prepared by methods described by me in paragraphs 3 and 4 of my article* can, by this time, be produced in large quantities, and is rather inexpensive for uses based on its electrical properties. For casting copper, however, its price would probably be too high. In the course of the investigation mentioned the author had prepared, as we saw, an amorphous powder which contained as essential impurity only a certain percentage of oxygen, and which was termed "boron suboxide." This substance is prepared by a modification of the reduction process of boric anhydride by magnesium. Obviously for the purpose of eliminating oxygen from copper without introducing any impurity capable of alloying with copper, this boron suboxide would be as good as pure boron, or perhaps better, on account of its being obtained in form of a very fine powder.

This substance was used in the first experiment. The very first heat was successful. A perfectly sound bar was obtained with a conductivity of 94 per cent.; 0·1 per cent. of the weight of the copper was added. Further experiments showed that the amount of boron suboxide could be reduced to 1·30 of 1 per cent., and also that the presence of a large excess, say, of 1 per cent., did not diminish the conductivity or change in any way the mechanical properties of the cast copper.

A further simplification could, however, be introduced into the process. The reduction of boric anhydride by magnesium, the first being in excess, gives a product containing magnesium borate, boric anhydride and boron suboxide. While the last one is the active agent, the first two are harmless. In fact, the presence of boric anhydride and magnesium borate is even an advantage, as the addition of a larger mass of material makes the operation easier; and as boric anhydride would probably dissolve the copper oxide and bring it to the surface as copper borate. It is therefore unnecessary to submit the direct product of the reaction to chemical treatment for the purpose of isolating the boron suboxide. It is sufficient to grind up the mixture into coarse grains and use an aliquot part of it which contains the necessary amount of boron suboxide. The foundry practice at present is to add 1 per cent. to 1½ per cent. of this material, which is equivalent to 0·08 of 1 per cent. to 0·1 per cent. of boron suboxide.

The properties of the material obtained are as follows: The electrical conductivity obtained can be as high as 97½ per cent. if the copper melted down is perfectly pure. In the foundry, where the scrap copper which is melted down cannot always be very carefully selected, a conductivity of 91 to 95 per cent. is obtained, and a conductivity of 90 per cent. is at present given. The resultant casting can be easily machined; fears which were entertained on this subject did not materialise, and the engineers using the material have not complained on this account. The mechanical properties are as follows:—

Tensile strength.	Elastic limit.	Elongation.	Red. in area
24,350 lb. per sq. in.	11,450 lb. per sq. in.	48·5%	74·49%

Castings are being made of all shapes and sizes with no more difficulty than in the case of brass. Sand and iron moulds can be used, and for standard articles the latter are preferred.

The use of cast copper is spreading as engineers get better acquainted with it, and is already of very considerable magnitude. It is interesting to note that, in spite of the fact that cast copper has lower conductivity than forged copper, in many cases, as, for instance, in case of current transformers, the effect of higher conductivity is obtained by substituting it for forged copper. This is due to the fact that in casting a chance is given to eliminate riveted, screwed or soldered joints, whereby a number of poor contacts are avoided. Not only this, but the elimination of joints often ensures a better operation.

The cost of the boron added is small; at the present prices of magnesium and boric anhydride, the cost per pound of copper is rather over ¼d.

* Abstract of a Paper read before the American Electrochemical Society.

† "Transactions," American Electrochemical Society. 16, 165 (1909).

BREAKING HIGH AND LOW POTENTIAL CIRCUITS.

At the annual general meeting of the South Wales Institute of Engineers, held at Cardiff on the 20th inst., the discussion on Mr. A. G. Collis's Paper on the above subject was concluded. An abstract of the Paper and the earlier portion of the discussion were given in our issues of March 10th and 17th.

At the meeting last week a communication was received from Mr. A. M. TAYLOR (Birmingham Corporation Electricity Department) in which he pointed out that the operation of the switch designed by him was so rapid that, when it operated on alternating currents, the period over which it acted was so short that the current could be considered uni-directional over the period considered, and therefore the action of the magnetic blow-out was as effective in quenching the arc as on a direct-current circuit. Reference had been made to the effect of the arc from the magnetic blow-out upon the oil. Whatever this might be, it was more than counter-balanced by the rapid displacement of the oil effected by the movement of the switch block in the oil. Diagram 33 of Mr. Collis's Paper showed the effect of opening on 200 amperes. If the current had been 2,000 amperes the contacts would have had to open more widely before the circuit was interrupted. He had found that in two leading makes of oil switch gaps of 1 in. and 1½ in. were attained before circuit was broken, the switches moving at a velocity of 4½ ft. per second and 2 ft. per second respectively. Without considering the damping effect of the oil and the friction of the parts, which would extend the time of opening, the times taken would be 0·036 and 0·042 seconds respectively and he therefore doubted if Mr. Collis's figure of 0·01 second was accurate. If it was, he thought he must have had special means of opening. The time would be extended if the switch were operated with the long rods and cranks necessary for medium-distance control. Mr. Collis had disagreed with him in his previous reply to the discussion, instancing a circuit-rupture on a 6,000-volt cable with 500 amperes, the length of the feeder being about 200 yds., where a rise of 9,300 volts was obtained. He did not know whether the switch had only to deal with the self-induction of the cable or whether a motor was in circuit. But if a pure short-circuit occurred across a cable a rise of volts could be produced on the generator greater than the voltage of supply, the voltage of the generator at the instant of rupture being dependent on the rise of current at that instant. If, by inserting resistance in the switch at that time, the rate of current rise could be lowered, it was obvious that the reactance voltage of the generator would be correspondingly reduced.

Mr Collis being prevented from attending the meeting, the discussion was closed, subject to a written communication from Mr. Collis being incorporated in the "Proceedings" of the Institute.

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"La Télégraphie sans fil." By G. E. Petit and L. Bouthillon. (Paris: Ch. Delagrave.) Fr.5.

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STAMPING OF ELECTRICITY SUPPLY AGREEMENTS.

The extraordinary development in the application o electrical energy to power purposes during recent years particularly since the commencement of supply by electric power companies over large areas, has brought in its train the necessity for some change in the terms and condition under which a supply is given. In the earlier days of the industry, when electricity was almost entirely used fo lighting, a supply was usually given by the undertakers upon receipt of a form of application signed by the intending consumer, who undertook to pay at a certain rate (usually a flat rate per unit) for the energy supplied. The cost o service mains, with the necessary meter and service equipment, for a lighting supply is not, as a rule, an expensiv matter once the general system of distribution mains ha been laid, and the supply authorities usually do not conside it necessary to enter into a formal agreement, as they ar practically assured of the continuance of the demand for supply so long as the premises are tenanted.

The supply of electricity in large quantities to textil manufacturers, to collieries, and to other large users of power

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however, is another matter, as a considerable capital expenditure is usually entailed, and the simple form of application for supply no longer meets the case. The supply authority must be assured of a reasonable return on the capital expended, and the practice is becoming general of entering into formal agreements under which the consumer agrees to guarantee a minimum revenue per annum for a period of years, a condition which is readily agreed to by power users. Under these circumstances the stamping or non-stamping of such documents is of considerable importance to the industry. The Stamp Act of 1891 provides that agreements in writing not specifically charged with any duty shall be subject to a stamp duty of 6d. each, but agreements relating to the sale of "goods, wares or merchandise" are exempt from duty, unless the agreement is under seal when the duty is 10s. It will be noted that this exemption only applies to agreements relating to the sale of "goods, wares or merchandise," and it may be somewhat of a surprise to find that until 1909 the Commissioners of Inland Revenue held that, whilst agreements for the sale of gas and water were within the exemption, stamp duty was held to be payable on agreements for the sale of electricity, the latter *not* being considered as either goods, wares or merchandise. By sec. 19 of the Electric Lighting Act, 1909, electrical energy is now to be deemed "goods, wares or merchandise" for the purposes of sec. 59 of the Stamp Act 1891, though the better legal opinion is that sec. 19 merely stated in set terms the law as it existed. The point, whether "electrical energy" is goods is, therefore, no longer of importance.

However, the payment of a duty of 6d. or 10s. is now considered sufficient by the Inland Revenue authorities in the case of agreements for the sale of energy where a minimum payment per annum is guaranteed, or where a minimum quantity of electricity must be taken, such agreements being held to come under the heading of "bond, covenant or other instrument being the only or principal or primary security for an annuity or for any sum or sums of money payable at stated periods," and a stamp duty of 2s. 6d. is exacted for every £5 or fractional part of £5 of the annual payment guaranteed; that is to say, if an agreement is made for the supply of electrical energy for a minimum payment of £1,000 per annum (an unreasonable or unusual guarantee in these days of cheap power supply) such an agreement must be impressed with an *ad valorem* stamp of £25, an amount equivalent to 2½ per cent. on the revenue guaranteed for the first year. Agreements of this character came before the Courts for consideration in February, 1909, when Mr. JUSTICE CHANNELL decided in his judgment in the case of the "County Durham Electrical Power Distribution Co. *v.* The Commissioners of Inland Revenue" that, although he had a strong impression that such a document as the one before him was not of the kind contemplated by the Legislature when it inserted the clause in the Stamp Act, and although the question of the Crown was a far-reaching one, he considered he was bound by judgments of the House of Lords and Court of Appeal in other cases and, therefore, he must find for the Crown. At the conclusion of the case it was stated by the Solicitor-General that "it is not the practice of the Inland Revenue officials to insist upon the *ad valorem* duty in the case of ordinary commercial documents," a statement which makes it difficult to understand why agreements for the sale of gas or water should have been exempted whilst agreements of a similar kind for the sale of electricity were charged with stamp duty.

In the course of the delivery of legal arguments, the question was raised whether electricity was "goods, wares or merchandise," and the Solicitor-General, who appeared for the Crown, expressed himself ready to admit that it was, but he contended that, nevertheless the form of agreement used by the County of Durham Co. was such that it would come under another section of the Stamp Act, and that it would fall under the category of "bond, covenant or instrument of any kind, &c.," and was, therefore, liable to duty as set out in the first schedule to the Stamp Act, 1891. The Company appealed, but the Court of Appeal upheld Mr. JUSTICE CHANNELL's decision, being bound by judgments of the House of Lords in the case of the "Sweetmeat Automatic Delivery Co. *v.* The Commissioners of Inland Revenue," a case of an agreement with a railway company to allow automatic machines at railway stations for an annual payment of £3,000; and the "National Telephone Co. *v.* the Commissioners of Inland Revenue," an agreement in writing (not under seal) whereby the Company, in consideration of an annual payment of £12, undertook to maintain a private telephone service. These cases differ widely from the Durham case, and we are not surprised that Mr. JUSTICE CHANNELL, who is without doubt one of the ablest and most impartial judges on the Bench, should be reluctant to treat as a bond, covenant, or security, an agreement (not under seal) for the supply of electricity, containing what is known as a "minimum clause." In law the Durham agreement was certainly not a bond or covenant, and it is difficult to see where the security comes in. There is no analogy between an agreement for the sale of electricity and a lease of railway premises or an agreement for the maintenance of a telephone service. Moreover, no rational distinction can be made between the cases where a flat rate and a differential rate of charging for energy is adopted. Supposing A and B, two intending consumers of electrical energy, desire the local electricity undertakers to give a supply up to a maximum of, say, 50 kw. By the Electric Lighting Acts, 1882 to 1909, each is bound to declare his probable maximum demand, and to supply other information to the undertakers. It is found that the demand of A, which is mainly for lighting, can be anticipated, and therefore, he is charged at the rate of 4d. per unit; but B requires energy for power and heating, and, as the load may vary a good deal and the demand be intermittent, the undertakers, wishing to make a safe, commercial bargain, charge him £150 per annum, and ½d. per unit for all energy consumed. Further, we cannot see any difference in principle between the case of B and, say, an agreement for the sale of goods to be paid for by instalments, or a contract by one man with another for the purchase of future goods, *i.e.*, goods to be manufactured. The purchaser agrees, say, to buy a quantity of cloth at a certain rate per yard, but he

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has the option of taking a larger quantity at a discount of 10 per cent. off the stated price. In the two last mentioned cases there would be no need to stamp the agreements, but the agreement with B would require a stamp of £3. 15s. Apart from the trouble and inconvenience of stamping agreements that are entered into daily, it is quite a tax—and an unfair tax—on a comparatively new but rapidly developing industry, which is hampered in other respects by restrictive legislation. The demand for electrical energy for power, heating and domestic purposes is increasing at a rapid rate, and it is necessary that electricity undertakers should have freedom as to the terms upon which they are to give a supply. In many agreements it is usual to insist upon a minimum clause, and it is immaterial whether this takes the form of a minimum payment of money, or a minimum quantity of energy (at a certain rate per unit) to be taken by the consumer, for in the latter case the amount of the periodical payment can be calculated.

It is, therefore, an important matter for the electric supply industry, and every effort should be made to get all agreements for the supply of electricity placed in the same position as agreements for the sale of goods. A remedy could be provided by the insertion of a clause in the annual Finance Act, and we hope that the Municipal Electrical Association, the Electrical and Allied Trades Section of the Chamber of Commerce, the Association of Electric Power Companies, and others interested in electricity supply, will take up the question with energy and cause representations to be made to the Chancellor of the Exchequer in order to induce him to remove a tax which is a serious restraint on trade.

LARGE POWER FITTING-OUT CRANES, WITH SPECIAL REFERENCE TO ELECTRIC REVOLVING CANTILEVER CRANES.*

BY ROBERT BOYLE, B.SC.

One of the chief features which have marked the early years of the twentieth century is the rapid increase in the size and capacity of ships, and, consequently, in the appliances for their equipment. This has necessitated cranes capable of handling much heavier loads, and shop cranes are now in hand by British firms with a lifting capacity of 200 tons. Fitting-out cranes of similar capacity are also required to transfer such a load to the ship itself. It behoves the engineer and shipbuilder to be well in advance with schemes for dealing with the largest loads. Such design must necessarily be in advance of the ship itself.

It is a significant fact that the Admiralty have at present under consideration tenders for a new crane of the revolving cantilever type for Portsmouth dockyard, capable of lifting a working load of 240 tons at 105 ft., with a test load of 300 tons at the same radius, and a minimum clearance of 140 ft. from quay level to underside of jib. Two floating cranes of 150 tons capacity are likewise under consideration.

The author proceeds to discuss fitting-out cranes of large capacity for shipyards, wharves and quays. After giving particulars of installations of derrick cranes, fixed portal jib cranes, Fairbairn cranes and sheer legs, he considers floating cranes and mentions that steam as a motive motor is almost universally used for these. Increased efficiency would accrue from the use of electrical instead of mechanical power, but it is difficult to apply in practice, and the working of these cranes is largely intermittent. After discussing the advantages and disadvantages of floating cranes as compared with giant cantilever cranes, large tower cranes are next dealt with.

Tower cranes of large capacity may be divided into three main types:—(*a*) Hammerhead cranes (mostly German designs); (*b*) giant electric revolving cantilever cranes (British designs); (*c*) hammerhead derricking cranes. These are all of the cantilever type. The first large cranes erected in this country were of the German hammerhead type, but at the present time the large cantilever crane is the most popular. A list of most of those already erected by British firms and by German firms in Britain is given in an appendix to the Paper. When fitted with propelling and revolving machinery the cost of a floating crane is almost double the price of a cantilever crane of equal capacity, but each case must be considered on its merits in choosing any particular type of crane.

The hammerhead cranes consist essentially of a double-armed, horizontal, revolving, cantilever jib, supported by a revolving latticed crane post, the whole resembling in shape a hammer. The crane spindle usually turns in a cylindrical bearing or foot-step, set in solid masonry, and is supported by a framework either trilateral or quadrilateral.

The form of tower which seems to commend itself most where there are no special reasons for the contrary, is the truncated trilateral pyramid, first applied by Messrs. Bechem & Keetman to a 150-ton crane at the Krupp "Germania" yard, near Kiel. By placing two of the legs at the edge of the quay the traffic can be led on both sides of the centre post, under the framework.

The British type of giant cantilever crane consists essentially of a long horizontal slewing jib, with unequal cantilever arms tied in position by a centre pivot, and capable of rotating in either direction through 360 deg. on a ring of live conical steel rollers, which rest on four strong platform box or lattice girders at the top of a square steel latticed tower. The machinery house containing the hoisting gear and brakes is placed over the counterweight box at the extreme back end of the cantilever, and a crab, or trolley, which may be self-propelling or driven from the machinery house by racking ropes led to the jib-head, travels along the long arm.

The efficiency of the modern cantilever crane is largely due to the adoption of electric power. The introduction of the electric motor has made it a success, which steam and hydraulic power could never have done. The various units in the power system may now be quite separate and disconnected, and may be placed in the position of greatest advantage. The work required from a motor for crane work is of a very intermittent nature. The controlling element is the ratio between the period during which power is given out and the period for which the motor is stationary. A motor is required which will work under the given conditions without overheating or sparking, and this determines the size. For the smaller types of wharf crane this ratio may be an average of about 1 to 8. With large cranes, however, the length of run is a very important consideration affecting the size of the machine. The period of work may be so long that a motor has more than time to heat up before there is an opportunity, however long, for it to cool down. The rise in temperature should not be greater than about 75°F. The rating should be based on the load-factor to which the motors are subjected. In general, a one-hour rating will be found ample for motors and electromagnets for brake-releasing. In hoisting with a cantilever crane, from 20 to 30 minutes may be spent in continuous running before the motor has a period of rest, when slewing or racking would commence. There are, therefore, two main considerations in selecting a motor—(*a*) the maximum period of full work without stoppage, (*b*) the intermittency of the working. All motors, especially those used for slewing, should be capable of standing very heavy starting torques.

The complete cycle of operations necessary in a giant cantilever crane are:—(*a*) adjusting and slinging the load; (*b*) hoisting; (*c*) racking; (*d*) slewing; (*e*) lowering; (*f*) releasing the slings; (*g*) hoisting the empty hook; (*h*) racking back, if necessary, and slewing the jib into the housed position. The controllers for slewing and racking are sometimes made with the same number of points of control on each side, while those for hoisting have a larger number on the lifting side than on the lowering side. The regulating resistances may be of the grid type, or a special form such as Messrs. Siemens brick type, which is used for all except the main hoist motors for the 100-ton electric crane of the Port and Docks Board, Dublin. The operator's cabin in most of the British cranes is placed at the level of the drum girder, and between the main girders of the long arm of the jib at its inner extremity. In the Admiralty crane for H.M. Dockyard, Devonport, however, the operator's cabin is placed at a height of only 25 ft. above ground level within hearing distance, where a nearer view is obtained of the slinging of the load. The cabin rotates with the jib, and is cantilevered out from a central revolving steel latticed mast which is connected to and turns with the centre pin, which is rigidly attached to the jib. A simple switchboard is provided with an iron frame, and a double-pole switch and two single-pole fuses for each motor. Each motor circuit and all electrical devices are better safeguarded against short-circuits and overloads by enclosed fuses or circuit-breakers.

*Abstract of a Paper read before the Institution of Engineers and Shipbuilders in Scotland.

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Electrically-controlled brakes, worked automatically by a solenoid, are usually provided on each motion. They are designed to hold the load should the current at any time be accidentally cut off. The greatest care should be taken to ensure that the braking appliances on all motions are good, and two independent brakes at least should be fitted on the hoisting machinery. The four types mostly used for the main hoist are:—(*a*) Electro-mechanical or solenoid; (*b*) mechanical or band; (*c*) rheostatic; (*d*) hydraulic. Brakes of these four types have been fitted by Messrs. Stothert & Pitt on two cranes on the Clyde, and two on the Tyne, built in conjunction with Sir William Arrol & Co., the designers of the structure. The mechanical or hand brakes, which can be worked by the foot in the driver's cabin, are capable of being used for any load. The electric brakes may be used for any load. The hydraulic brakes are used generally for the heavier loads from about 80 tons upwards. They are out of operation when lifting, but come into operation the moment the load tries to run back. Electric brakes depend for their action on the principle that when short-circuited by a variable resistance a mechanically-driven motor under certain conditions will generate current. The braking effort depends on the speed and resistance. The electric brakes are comparatively cheap, and give full control over the speed. An electric brake, however, can only act as long as the armature is in motion. The braking torque is applied directly to the armature of the motor. It therefore follows that should the gearing at any time give way, there would be nothing to keep the load from dropping. The same objection applies to the electro-mechanical brake provided with an electromagnetic release, as it is usually applied to the second motion shaft, or the shaft of the motor itself. These are essentially mechanical brakes of the band type, and are so arranged that the brake acts when the current is cut off accidentally or intentionally.

A typical equipment for a 150 or 200-ton crane would be as follows:—

Main Hoist.—Two motors with reversing switch. Nine points of control on both lifting and lowering sides, consisting of five series steps and four parallel steps. Overwinding switch operated by a cam on the main barrel shaft, giving an adjustable minimum distance of about 4 ft. between the two blocks. Rheostatic, hydraulic and band brakes.

Auxiliary Hoist.—One motor. Seven steps on hoisting side, and three for lowering on power. One free position, one "off" position, and four braking steps. Rheostatic and band brakes.

Main Rack.—One motor. Seven resistance steps out or in, one free position between power and braking, and three braking steps on both sides of barrel. The controller in this case is only fitted with a "dead man's handle." A switch is provided at minimum and maximum radius which operates a radius light, also a no-volt on the same switch. Rheostatic and band brakes on both sides.

Slewing.—One motor. Seven power steps and three braking steps on both sides, with a free position between power and braking. Rheostatic and band brakes on both sides.

Upper Hoist.—One motor. Five power steps on the hoisting side and two on the lowering side. Four braking steps with an intermediate position and a free position. Overwinding switch with an adjustable minimum of about 4 ft. between the two blocks. Rheostatic brake and "off" band brake.

Upper Rack.—One motor. Five points of resistance out or in. One free position and two braking steps.

The foundations, erection and testing of a cantilever crane are described in the Paper.

The author next considers hammerhead derricking cranes, which consist essentially of a pedestal derrick crane resting on a high tower, and combine some of the advantages of both the derrick and tower cranes. One of these cranes has been constructed by Messrs. Bechem & Keetman, for the Tranmere Bay Development Co., of Birkenhead. It is provided with electrically-driven hoisting, derricking, and slewing gear. It will lift 150 tons at 46 ft. on the large hook at 3 ft. per min., 50 tons at 82 ft. on the small hook at 19½ ft. per min., and makes a complete revolution in from 5 to 7 minutes. The total weight of structural steelwork is 305 tons, and the counterweight is 170 tons.

As in the case of the cantilever crane, the British type of the hammerhead derricking crane would be provided with a roller path at the top of the tower, and have no central revolving mast. A 150-ton electric pedestal derricking crane with revolving jib could be constructed for about the same price as a cantilever crane. It is believed that this type of crane will become more common, and it has many advantages.

The general principles of design of cranes are finally considered, and a design is given for a crane capable of dealing with a working load of 300 tons at 100 ft. and having a test load of 375 tons.

TEST ON 3,000 KW. TURBO-ALTERNATOR AT BRISTOL.

As the question of steam turbine efficiencies is very much to the fore, the results of the official tests of the first of the two new 3,000 kw. impulse type three-phase turbines built by the British Westinghouse Co. for the Bristol Corporation Electricity Department, may prove of interest as showing the efficiencies obtained on turbines of this type and size.

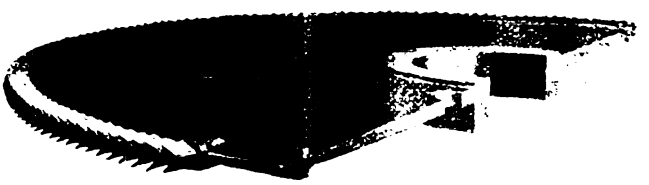

FIG. 1.—ARRANGEMENT OF BLADING.

The specified conditions of test were as follows:—

Normal output.—3,000 kw., three-phase, 50 periods, 6,000–6,600 volts. (The sets are designed for an overload of 25 per cent. for two hours, or 50 per cent. for short periods.)

Steam pressure.—200 lb. above atmosphere.

Superheat.—200° F.

Vacuum.—28 in. in relation to 30 in. barometer.

Speed.—1,500 revs. per min.

It will be seen from Fig. 3 herewith, illustrating the turbine in section, that it consists of a number of wheels mounted on a shaft revolving inside a number of cells in the casing. The first wheel carries two rows of moving blades and this wheel is compounded for velocity. The following wheels have only one row of blades and the velocity of the steam by expanding through the diaphragm nozzles is completely used up on the moving wheel at each stage. The clearance over the tips of any of the blades is not less than 3/16 in., so that fouling or stripping is entirely obviated.

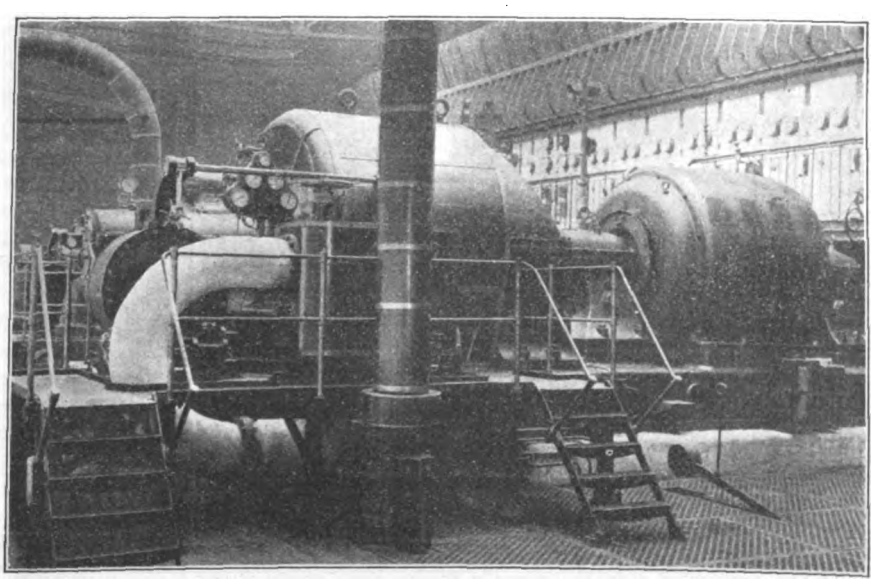

FIG. 2.—3,000 KW. TURBO-ALTERNATOR INSTALLED AT BRISTOL.

This type of turbine enables the use of very high steam pressures and temperatures without risk of injury to either

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blading or casing, as only the nozzle boxes—which are two in number—are subjected to maximum pressure and temperature. The steam expands in the nozzles from 200 lb. per square inch (total temperature, 590°F.) to about 45 lb. per square inch gauge (the temperature being reduced to 350°F.) pressure, the superheat and pressure being converted into kinetic energy which is absorbed efficiently in the velocity wheel. The casing is thus subjected to comparatively low pressures and temperatures, so that no trouble is experienced due to distortion and expansion of the casing of the shaft.

The Westinghouse water glands are used at each end of the turbine and provide a perfectly air tight seal under all conditions of running. The complete machine as installed is shown in Fig. 2.

The official tests were carried out at Avonbank Electricity Works, Bristol, on March 18 and 19 by the British Westinghouse Co., in the presence of Mr. H. Faraday Proctor and other officials of the Bristol Corporation.

Steam consumption tests were taken at ½ load, ¾ load, full load, and 25 per cent. overload—each for a duration of one hour—all instruments used being calibrated immediately before and after the test.

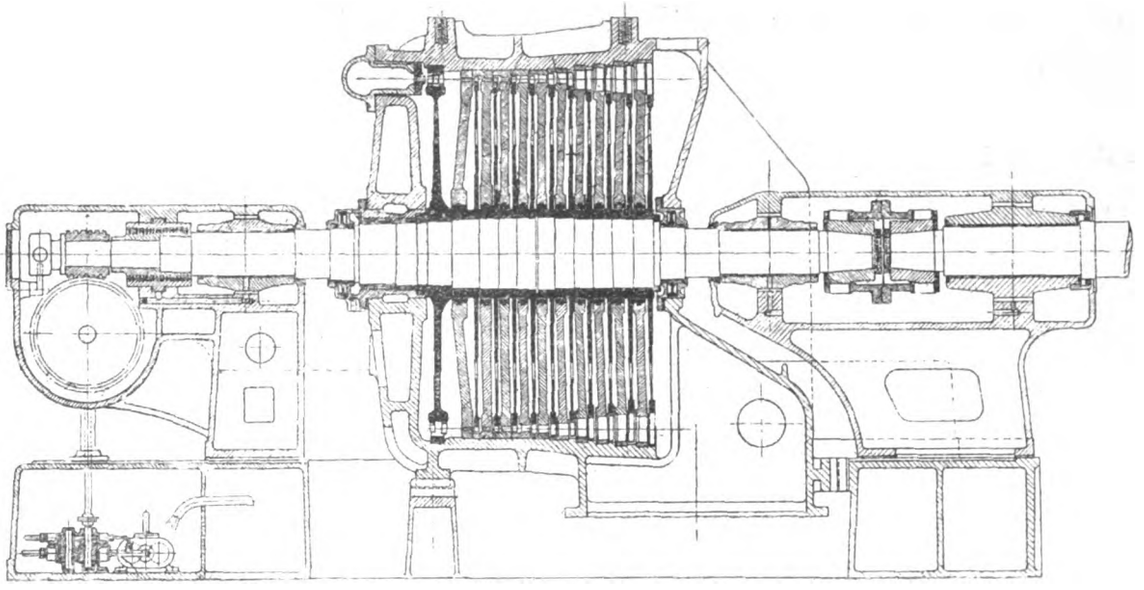

FIG. 3.—SECTION OF WESTINGHOUSE IMPULSE TURBINE.

In addition to the nozzles capable of carrying full load, separate nozzles are provided for 25 per cent. overload and full load non-condensing. Thus the consumption at 25 per cent. overload is even slightly better than at full load, since no steam is by-passed into a lower stage of the turbine.

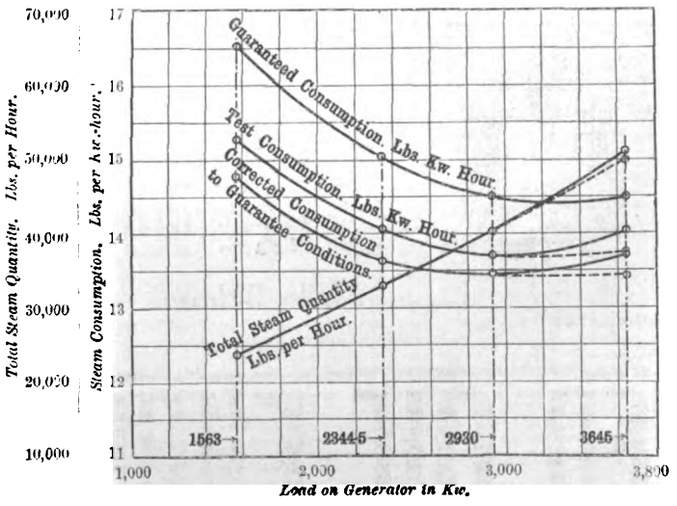

FIG. 4.—RESULTS OF TESTS ON A 3,000 KW. STEAM TURBO-ALTERNATOR AT BRISTOL.

The diaphragms splitting up the cylinder into a number of cells are provided on their outer periphery with guide blades, and in these the expansion of the steam is carried down to the condenser pressure. No expansion takes place in the moving blades, consequently there is no tendency for the steam to leak past the tips of the blades, and it is due to this that fine clearances are not necessary. The blades are cut out of the solid and secured by rivets to the periphery of the wheels. This arrangement of blading is clearly shown in Fig. 1.

Approximate Load.....	½	¾	Ffull	1¼
Output, kilowatts	1563·0 ...	2344·5 ...	2930·0 ...	3645·0
Speed, revs. per min.	1505·0 ...	1490·0 ...	1500·0 ...	1501·0
Steam pressures, lb. per sq. in.	192·5 ...	189·2 ...	195·4 ...	193·6
Steam temperature, deg. Fahr.	556·0 ...	560·0 ...	568·1 ...	565·0
Steam superheat, deg. Fahr.	171·2 ...	176·6 ...	182·1 ...	179·7
Vacuum (30 in. barometer) in.	28·42...	28·47 ...	28·18...	27·7
Circulating water inlet temp. deg. Fahr.	41 ...	41 ...	43 ...	41
Circulating water outlet, temp. deg. Fahr.	59 ...	61 ...	64 ...	66
Energy for air and circulating pumps, kilowatts	45 ...	46 ...	48 ...	46
Steam consumption. Total lb.	23,887 ...	33,015 ...	40,200 ...	51,171
Steam consumption, lb. per kilowatt-hour	15·28...	14·08...	13·72...	14·0
Ditto, corrected for 200 lb.... pressure 200°F. super-... heat. (Vacuum as during test)	14·78...	13·64...	13·47...	13·7

The corrections allowed for variations in the steam pressu and temperature as from the specified conditions are 1 per cen for 10 lb. pressure and 0·9 per cent. for 10°F. superheat. N corrections have been made for vacuum, as the contractor ha the benefit of more than 28 in. with barometer 30 in. Th curves in Fig. 4 show the results of the tests in diagrammati form.

Due to an error when the overload test was made, the by pass valve for running the turbine non-condensing was ope instead of the valve provided for 25 per cent. overload. Th dotted lines in the diagram show the results which would hav resulted under proper conditions.

We may also mention that the generator is separately excite from a 100-volt system, the energy required varying fro 276 amperes at 51 volts at half-load to 291 amperes at 55 vol at 25 per cent. overload.

We are indebted to Mr. H. Faraday Proctor, engineer a manager of the Bristol Corporation Eletcricity Departmen for the particulars of the tests given above.

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CORRESPONDENCE.

WIRELESS TELEGRAPHY IN RELATION TO INTERFERENCES AND PERTURBATIONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR,—With reference to the letter by Messrs. Bellini and Tosi on the above subject in last week's issue, much more has been read into my remarks on triangular directive aerials than, in my opinion, is justified by the brief reference made to them in the Paper. Had I been concerned in expounding the capabilities, or summarising the pros and cons of directive aerials, I would have entered into the matter in much greater detail. Far from contending that the use of such directive aerials limits the range of signalling, I would at least say that it ought not.

In the Paper I have considered a particular case—viz., a suitable type of installation to afford communication between two fixed points separated by a relatively short distance. For such a purpose the triangular aerial (which involves the use of a single mast only) set in oscillation with its fundamental frequency has certain stated advantages. That is all. If into this statement the meaning is read that the system is unsuited for long distances, I must disavow any intention of conveying such an idea. It is, perhaps, a little unfortunate from Messrs. Bellini and Tosi's points of view that short distances were mentioned, but I am unable as yet to speak with authority as to the efficacy of the method over long distances in relation to its capabilities of eliminating disturbances of all kinds. I see no reason, however, why suitably arranged directive aerials should not retain their advantages, in this and other respects, over long distances.

It may be that in the reference made in my Paper I was not sufficiently explicit, but I feel that Messrs. Bellini and Tosi are "crying before they are hurt." I am sorry they should consider I am so little interested in the developments of wireless telegraphy as not to have read their more recent accounts of investigations, but it may reassure them somewhat to know that the only part of their letter which conveys anything new to me is the last paragraph.—I am, &c.,

G.P.O., London, April 22. J. E. TAYLOR.

CRUSE *v.* WILLANS & ROBINSON, LTD.

TO THE EDITOR OF THE ELECTRICIAN.

SIR,—Mention is made in your columns this week of this law-suit in which we as defendants have been unsuccessful. As enquiries have reached us regarding same, may we point out, to prevent misconception, that the action arose solely on account of work done as far back as 1906-1908 at the Company's Queensferry works, and is in no sense connected with the main works at Rugby.

The Queensferry works, it may be remembered, were built for the manufacture of boiler and kindred work, and were closed in 1908.—We are, &c.,

Victoria Works, Rugby, April 22. For Willans & Robinson, Ltd.
C. S. ESSEX, Secretary.

FOREIGN COMPARED WITH HOME INDUSTRIAL FINANCE.*

BY L. JOSEPH.

The author does not here deal with all the aspects of industrial development and industrial organisation, but confines himself to an enquiry into the financial problems relating to industries here and abroad in order to show to what degree the organisation of industries is dependent upon the supply and organisation of capital and credit.

For large enterprises the financier has always been a necessity, but since the introduction of machinery, power plants, and modern production on a large scale have revolutionised business and industry, has the financial element played such an important part in our economic system. It seems to me that the difference in the initiation and financial construction of industrial enterprise on the one hand, and the relations between industry and the financial element on the other, are largely responsible for the course which the development of industries has taken in different countries.

The relations between English industry and English banks are only of a very loose and superficial character; beyond keeping a regular cheque account and the occasional discounting of bills with the bank, there seems to be very little intercourse. Therefore, when an iron manufacturer, say, wishes to convert his business into a limited liability company, recourse is taken to the financial agent or promoter, to whom the business may be an unknown quantity, and when the prospectus is issued inviting subscriptions there is no indication that any financial firm standing sponsor to the company is making itself responsible legally or morally for the issue; the prospectus is not signed by anybody. The promotor then approaches certain financial circles in order to get the issue guaranteed by means of underwriting or otherwise at a commission. This being accomplished, an issue is made, a special settlement on the London Stock Exchange applied for and the official quotation obtained if possible. There the function of the promoter and his interest in the concern generally ceases, unless he has taken his profit in shares, which he usually wishes to turn into cash at the earliest opportunity. The brokers of the company, as a rule, are in the same way not further concerned about the subsequent market developments. Necessarily, also, the company starts with capital inflated as a result of the capitalisation of the goodwill and by the promoting expenses, &c.

Great Britain possesses enormous wealth, the savings of centuries derived from trade and industrial activities. Wealthy people usually invest part of their fortunes in industrial undertakings if they have originated from a family engaged in industry. The medium capitalist in England is disposed to put a substantial portion of his capital into industrial enterprises in which he takes an active part. In case he chooses to make temporary or speculative investment, he directs his attention to Government stocks, mining shares, &c., which have an active market on the London Stock Exchange. The small capitalist also selects this class of securities for his investments. Almost invariably securities of manufacturing concerns attract his attention only if he believes he knows everything or something about the business.

You will realise then that not only are the relations between banks, credit institutions and industry of an indifferent nature, but also, no doubt indirectly owing to these circumstances, the connection contact between industry and the stock markets are by no means close; at all events not so intimate as is desirable and as is the case in other industrial countries. There is hardly any occasion for English clearing banks to undertake transactions which may involve a shadow of risk. They invest their funds in discounting high-class bills, making advances on so-called floaters, gilt-edged stocks and on other securities at ample margin. Credit facilities in its wider application for financing trade and industry are, generally speaking, outside their sphere. Being able to earn dividends of up to or over 20 per cent. on their paid-up capital, they can afford to leave other departures alone. True, the branch offices of the clearing banks in industrial centres grant overdrafts in some measure, but they are not of great importance, and cannot be relied upon at all times. Depositors in England, by reason of traditional custom, more than by their own thought and conviction, take it for granted that credits to industrial enterprises, in the form and measure granted by banks on the Continent, for instance, involve undue risks, and, therefore, at any period of uneasiness, severe reaction or collapse in industry, they would naturally take alarm and withdraw their deposits momentarily. In surveying the influences inimical to industrial developments we have to take these circumstances into account, but I propose to show later that such notions do not prevail among Continental depositors; at all events, not to such a degree as here. As for the other banks—merchant bankers and credit institutions—they almost exclusively devote themselves to financing regular commercial transactions which are being liquidated within short periods, and are not generally concerned in industries.

In referring to the American industry one is in the first place impressed by the swift pace of development. One hundred years ago America had but little capital, and it was for this reason that industrial enterprises were established on the basis of associated capital in the company form. These were one and all more or less local enterprises for purely speculative ventures, such as mines, oil-springs, &c., the interest of wider circles even in Europe was always invited. Industrial stocks, though being quoted on provincial exchanges, have been, until recent years, excluded from the official listing on the New York Stock Exchange. Only since the formation of the larger trusts have the authorities of the Stock Exchange recognised the desirability to alter their attitude in according a welcome to this

* Paper read last Tuesday at a meeting of the National Business Men's Association.

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class of securities, and American financiers have taken a keen interest in industrial developments for a considerable time past.

For some time back the reformation of the complicated banking system in America has been under careful consideration, but thus far without result. The different classes of banks, National banks, State banks and Trust companies, like the English banks, also administrate the available funds of the public. By the regulations of the Government they are strictly forbidden to engage in any speculative business and to grant credit facilities above one-tenth of their own capital to one and the same party. Only the National banks, about 7,000 in number, enjoy the privilege of issuing notes, whilst the establishment of branch offices is prohibited to all of them. This explains the large number of banks all over the country, most of which have only a very small capital. The capital of individual banks being very insignificant, industrial enterprises are bound to have access to the resources of a number of banks and credit institutions.

Commercial transactions in the States are based on three or six months' credit or even for longer periods. It has, therefore become customary for commercial and industrial concerns to issue and discount their own promissory notes through so-called note brokers in the market (who, however, do not take any responsibility in the way of endorsement), or direct with the banks all over the country. This single-hand paper in America forms the basis of the currency for the note issue of the National banks. You quite see the danger of that system in the event of the banks simply withdrawing or curtailing their investments in promissory notes with a view to increasing their cash resources in times of uneasiness or crisis. Nevertheless, this is the usual way in which American trade and industry, even very large firms, finance themselves.

American industry is still in need of large amounts of capital. The big companies and trusts are in a better position to raise the necessary funds than smaller concerns, whether in the form of credit or by the issue of capital. The banking community, in co-operation with capitalists, who partly have themselves made their huge fortunes in industry, take an active interest in promoting industrial developments and flotations, whilst the confidence of the general public in these gigantic organisations is obviously increasing with their successes. The result is that the progress of amalgamating, combining and establishing community of interests will continue, unless action is taken to enforce the act which is directed against the trusts. Whatever the outcome of the important decisions expected daily the principles underlying the industrial development and the close relations now prevailing between finance and industry cannot become seriously affected.

Much tighter than in England and *much more* interwoven than in America are the relations between industry and banks and credit institutions in Continental countries as Germany, Switzerland and Austria, except, perhaps, France. The termination of the war of 1871 and the inflow of the war indemnity gave a great stimulus to German enterprise. A number of new banks, classified as "Credit Mobilier," were established, largely in the provinces; and a concession was granted for the erection of the Deutsche Bank, in Berlin, with a capital of £750,000. However, the spirit of enterprise soon transgressed the limits of solid developments, and a severe reaction set in, resulting in 1873 in a crisis, the result of which was that not less than 73 banks, with a capital of 21¼ millions sterling, were forced to liquidation within the following six years. In 1875 the Imperial Reichsbank, succeeding the Prussian Bank, a Government institution, was founded. The Reichsbank is also under the control of the Government, though its capital is privately held. It has the privilege of note issue, and its constitution and functions are, upon the whole, identical with those of the Bank of England; with the distinction, however, that its power of issuing notes is elastic to a certain degree, whilst its regulations in respect to discounting bills are not so discretionary. The Riechsbank is managed by the President, in conjunction with a committee, the members of which are appointed for life, and controlled by a board of five members, the president of which is the Imperial Chancellor. The development of the Reichsbank, its able policy and operations, its co-operation with the credit banks, have undoubtedly exercised a beneficial influence upon the whole industrial and banking system in Germany.

You must bear in mind that in Germany and on the Continent generally, it is a recognised privilege of the banks, it is their *raison d'être*, to cultivate all branches of banking transactions. German wealth has not yet assumed such proportions—at any rate the loanable capital has not yet increased to such an extent—as to encourage the establishment of deposit banks pure and simple. Besides, neither the German capitalists nor the small saving classes are used to leave their money on deposit for any length of time; they are much more eager to invest it in securities. Moreover, in view of the recognised activities of banks, the public at large does not find anything disquieting or unsafe in the manner in which banks seek employment for funds entrusted to them. Confidence in the administration of the bank has, in the course of years, been so fortified, that only a serious catastrophe could seriously shake it. Can such a calamity happen? It seems almost impossible, considering the enormous amount of share capital and reserves of the big banks, of the solidarity of interests amongst them, the efficient control exercised by the board of directors, and the influence and assistance of the Reichsbank in the last resort.

The process of concentration that has been going on for years in Germany, and is still going on, and the growing responsibility of the enlarged boards of directors, make no doubt for still greater circumspection and care in the future without necessarily affecting the policy of encouraging industrial development.

Although the industrial activity which set in after 1871 was overdone, it received an intense and lasting stimulus by the nationalisation of the railways. The leading financial circles commenced immediately to direct the flow of capital towards industrial enterprises of all descriptions, especially ironworks, collieries, machinery manufacturers, engineering and electrical establishments, &c., by way of promoting and floating companies, &c. Meanwhile the company law has been greatly reformed and improved, protecting the public in every possible way from being deceived or misled by misstatements in the prospectus in respect of goodwill or otherwise. Under all circumstances two annual balance-sheets of the company after its registration have to be submitted before the securities can be introduced in the market. Most stringent regulations as to the responsibility of directors have been formulated. The prospectuses have to be signed by the issuing firms, who thereby make themselves responsible for the correctness of statements, and at the same time place their prestige and credit as issuing houses at stake. A committee of able bankers and merchants appointed by the Government, after most careful and searching investigation into the facts and figures in the prospectus, being authorised to demand any necessary explanations, has to express its opinion as to the desirability of allowing the security in question to be introduced and quoted on the Stock Exchange. All these precautions are most beneficial in creating an atmosphere of confidence and trust for industrial stocks, the more so as the banks themselves are invariably represented on the board of directors, exercising considerable influence in the management of affairs, not only in its financial but also in its general aspects. The experience of bankers being connected with a vast number of different concerns, and gaining inside knowledge of different industries, is often very valuable, even in technical matters, in questions of amalgamations, combinations, cartels, &c.

It is, I believe, safe to contend that the constant shifting and changing, adding and adopting in the industrial development is due as much to the banking influence as to the leaders of industry themselves. Being so conversant with all the affairs of industries, and keeping in constant intimate touch, it is quite logical that the banks are ever ready to assist industries even in times of stress. They make advances to them for extensions, for new equipment, for acquiring discreetly, if necessary, competing works, &c. These transactions, which naturally in themselves are profitable to them, will finally result in further issues of capital and placing and marketing of shares, &c., by which they again secure fresh revenues. They do not, and cannot, consider their function at an end with the issue of the capital; they recommend the security to their own clientèle, and they regulate the market if there is need. Important transactions in industrial securities take place on the Berlin and other German Bourses daily. The public knows that not only are these investments of intrinsic merit, but also that they can easily dispose of them, even in times of great reaction.

Under the banking influence it has become more and more the policy of industrial companies to build up such reserves as to be able to avoid too sharp fluctuations in the dividend distributions. The balance-sheets of some companies give unmistakable evidence. I have got here the figures of Siemens & Halske, showing that since 1901 the capital has been increased from £2,700,000 to £3,150,000; the open reserve from £460,000 to £740,000; permanent investments, £560,000 to £3,200,000; buildings are unchanged at £500,000; tools, machinery, lighting plant, &c., are written down from £480,000 to 1s.; raw material is reduced from £300,000 to £100,000; manufactured and half-manufactured goods from £1,200,000 to £450,000; power station from £160,000 to £40,000; interests in other enterprises from £250,000 to £35,000. These figures tell a great tale. The permanent investments alone, as a result of the arrangement with Schuckert & Co., exceed the whole share capital. On the other hand, buildings stand at the same amount, regardless of the enormous extension of the works; tools, machinery, lighting plant, &c., have been written down to the extent of £480,000; stocks of raw material are valued at one-third of their book price of nine years ago; manufactured and half-manufactured

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goods are £700,000 less, in spite of the great increase in the business. Anybody that can read a balance-sheet will recognise the enormous reserves which are hidden in these figures. The dividends since 1901 have been as follows: 8, 4, 5, 7, 9, 10, twice 11, twice 12 per cent.

Much more imposing still are the figures of the General Electric Co., that remarkable institution founded in 1833 as an offshoot of Siemens & Halske, with a capital of £250,000, which has since gradually risen to £6,500,000 with probably not much less reserves. Machinery, tools, models and patents of each single factory controlled by the company have been written down to 1s. The last balance-sheet, when the capital was still £5,000,000, shows credit balances at banks amounting to £2,200,000. Needless to say that this institution is not any more dependent on banking credit, nor would it find great difficulties in placing its securities without the assistance of bankers. The intimate relations between the banks and the A.E.G., however, still exist; representatives of all the leading banks are on its board, evidently because their co-operation is of direct and indirect benefit and not because they are representing large shareholders.

It is generally acknowledged that the progress made in the electric industries in Germany has been most striking. Without disregarding the other factors conducive to this remarkable development, it seems to me that it was in large measure due to the intelligent and the liberal assistance by the financial circles that have quickly grasped the importance of this new industry. They have enabled electrical undertakings to secure work in both hemispheres by financing them through all the different stages; they were instrumental in affiliating to the electric companies their own financial trusts and holding companies, and they have distributed the securities of all their enterprises, debentures and shares into the investing public. Without such faithful and powerful support, the electrical industries would never have forged ahead with such speed and secured the commanding position which they hold.

In conclusion, I believe to have shown that industrial credit does not necessarily involve banks in undue risks; that the organisation of the Continental banks, which are essentially credit institutions, are sufficiently equipped both financially and intellectually to cope with industrial requirements; that the co-operation between banks and financial institutions and industries has proved upon the whole satisfactory to both; that the assistance of well organised stock markets is needed for placing and popularising industrial stocks as investments. It seems to me that for practical purposes it is more essential to give attention to these points than to fiscal problems which have been under discussion for a considerable time.

DISCUSSION.

Mr. Theodore Rich said we were inclined to be insular and to think that our institutions were better than those of other people. Notes in the Press frequently stated that we had lost business from lack of genius and energy. Was it not rather due to lack of facilities to use our enterprise to the best advantage? Many would agree that it was to lack of proper financial facilities that we owed much of the trouble in the electrical industry to-day. Our industry was more allied to that of Germany than that of America. Germany, like this country, was not able to use all the capital it had. The question which naturally arose was "Could existing banking institutions take on industrial business?" We could not blame the bankers. They had grown up with the existing conditions. The banker was nothing but a bill broker in this country. He said "We have the money market of the world, and there cannot be anything very wrong," and his business was so organised that it was impossible for him to touch anything in the nature of a lock-up of capital. The German banker traded largely on his own capital, and the English banker on that of his depositors, not of his own shareholders. The result was he could not do anything which tended to lock up his capital. The German banker would lend money for many things which one could not get money for here, and he wanted to see his money was properly used. The English banker said, "Look at the record of the last 30 years. We have had practically no smashes." But millions of pounds had been lost in industrial promotions because there were no responsible people to look after them. One thing that could be laid at the door of the bankers was the appalling waste of industrial capital that had gone on for many years. The German banker took an interest in the industrial welfare of his country. The leading financiers of London had practically no interest in British industrial undertakings, and many of them had large interests in the industries of other countries. We wanted a system in which industrial capital was more spread amongst the people and not so largely in the hands of individuals. Everybody would then be interested to push the industries. The company promoter had no interest. The banking interests took no heed of the matter. In Germany the big financial concerns kept the money in the right lines so as to benefit the country. We could not shut our eyes to the fact that it was a question of national economics. Germany said it was the duty of every man to do something for his country, and if our financial interests were bound up more with industry we should get on better than we did.

Mr. M. S. Myers said the function of bankers here seemed to be to have a knowledge of the distinction between a mortgage and a bill. It was not the nature of the security they looked at so much as its realisability. That was due to the nature of the business in which they were employed. Some sort of organised authority was almost a necessity for us under present circumstances. Germany, and the large institutions in the electrical industry particularly, had the advantage not only of organised capital in a superlative degree, but of organised experts. Germany was the largest competitor of England not only in South America, where the field for electrical energy was being rapidly filled up, but in our own colonies. The Victoria Falls Power Co. was an undertaking known to a large number of people in England, but it was found difficult to raise the capital here, and while the British financial houses were considering the matter the Germans had been approached and had made a proposition that if they had all the orders for the machinery and other privileges they would pay £100 of debenture money to every £100 of preference money behind those debentures. The result was they had found three millions sterling in debentures and England had three millions in preference shares behind those debentures. The Germans had also received orders amounting to six millions sterling, and would receive orders for another two or three millions. If we had had some organised industrial bank which had given the capitalist in London the assurance which the A.E.G. gave to the German capitalists none of that money would have gone out of English hands. Directly the German institutions and experts set their hall-mark upon the enterprise the English capitalists came forward and said it was good enough for them. He could give similar instances in South America.

Mr. G. H. J. Hooghwinkel said he was in complete agreement with the last two speakers. There were many similar examples in South and Central America and the Far East. While we were negotiating for 10 years' options, &c., the German power of attorney was on the spot and clinched the matter, as a rule at a lower price than we could have offered. The ideal course of altering our system, which he supposed occurred to nearly everybody there, would be to establish an industrial bank similar to three or four which existed in Germany. There had been a lot of talk about this during the last two or three years, but they had not got much further. He suggested that the Association should take up the question officially, and have a meeting to discuss a resolution in favour of the formation of a committee to consult with some bankers. He did not suggest the Bankers' Institution, which was too high above them, but some selected bankers.

Mr. Hugo Hirst dwelt on the question whether the introduction of influential people to an industrial concern was more possible under the German than under the English system. We could get money by the means the author so ably described—by prospectuses—but the shareholders had no interest in the business; they only desired dividends, while the "industrial" who had got the assistance of the capital was really in a dangerous position. The latter knew nothing of finance. When he got more than enough money for his requirements his troubles commenced. He either got careless or schemed how to invest his surplus capital, and for the latter purpose he wanted just that advice which the German banks and financiers gave, which the English private banker gave the "industrials" in the olden days, and which they were unable to obtain under the present system. It was announced in the Press recently that Germany had decided to send technical men as attachés to its Embassies abroad, and it was suggested that England should do the same. But what could a technical expert do in our Embassies. He might report to the Board of Trade, who might send notices regarding the matter to a few private people, who would all be turned at once into applicants to the bankers; but for the big schemes now looming ahead in foreign countries great technical, financial and commercial power was wanted, and they could not be dealt with by individual firms even backed up by money, if they were not backed up by experience such as foreign competitors had at their disposal.

Mr. H. Oppenheimer said the result of the negotiations with regard to the Victoria Falls Power scheme was the general outcome of the natural disposition prevailing in this country—slow and sure—and that absolute surety, so far as the bank's business was concerned, had its advantage. A crisis would not affect an English bank, and whether that was certain to be the case on the Continent it was not for him to discuss. It had been said by the previous speakers that our ill-success from an industrial point of view resulted from lack of machinery for getting capital. The cotton industry, cited by Mr. Joseph, was not created by the joint stock banks, but by the support of the private banker, and the same thing had happened in Germany. It was a mistake to think that the industrial progress there took its rise from the large banking institutions. The German bankers took a leaf out of the Lancashire private bankers' book, and nursed the local industry where there was some industry. With the rise and progress, financially, of Germany, it was easy for the gentlemen at the head of the banking business to pick up the growths that had been nursed and matured, and they were now supported by unlimited capital. The private banker was the first to support local industries, and the same would be the case to-day if our banking institutions were not exclusively controlled by a large trust of joint stock brokers. An ordinary "industrial" going to his bank and desiring to discount a bill would not get it discounted unless his balance was sufficiently large. The gentlemen controlling the large financial interests were ready to advance unlimited sums to gentlemen connected with the Stock Exchange who required daily accommodation, but when an industrial concern, ever so sound, appeared on the scene the coffers were locked.

Mr. Donovan said the author was wrong in stating that the change came about through the introduction of machinery. It commenced by the Bank Charter Act of 1844, when gold was made the legal standard for payment of debts, &c. It gradually shut out the private banks and prevented them issuing paper money. Agricultural industry declined from the passing of that Act.

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Mr. W. L. MADGEN said he felt there was still something good in our institutions and in our methods. The only statement of fact from which he was inclined to differ was the method of formation of what the author appeared to regard as a typical company in this country. He did not think it a fair description. There was a large number of companies which were very well managed and very successful. The author had not referred to the large number of financial houses, wealthy and responsible firms, in all our large centres who devoted themselves to the support and control of different classes of business, and who fulfilled all the functions of the German banks, and he thought more efficiently than the latter. It appeared to him that the German and American banks did not exist so much for the industries as the industries existed for the banks.

The CHAIRMAN (Mr. H. W. Butler) said the English banks did not seem so much to blame. While they could return their shareholders 20 per cent. dividends they could well be content and consider they were doing good business. This being so it was no good trying to reform those banks. The speaker who suggested industrial banks for the special purposes of industrial enterprises appeared to him to have hit the nail on the head. He took it the enterprise of the German banks was chiefly due to the fact that they had not ready means of turning over their capital sufficiently often to produce the necessary dividends.

The AUTHOR said, in reply to the discussion, with regard to the creation of industrial banks, it was of no use to go on with any such project before an atmosphere of confidence in industrial enterprises could be created, and this could only be done by safeguarding the promotions and management of the affairs of the undertakings. In spite of the modifications that had been made in the Company law, there were still many methods of getting around it. Companies and shares of companies were introduced on the London Stock Exchange with no prospectus and no responsibility, and the bigger the profit made out of the promotion the bigger were the ultimate losses. So long as such methods prevailed he was afraid no industrial bank would be sufficiently attractive for capitalists to put their money into. The first alteration should be by the Government safeguarding the capital of the public. He had not said the change of the banking methods was caused by the introduction of machinery, but that the whole economic structure was changed at that time. The change in the banking methods was the result of the wealth of the English nation. With regard to Mr. Madgen's remarks, if it could be shown that the German industries had suffered by being intimately connected with the banks or the banks through intimacy with the industries, Mr. Madgen would be right. The object of his Paper was to find means of enabling English industrial concerns to alter as the German industries had done. The banks were not to blame for having made large profits. They had given their time, intelligence and capital to the industries, and they should have the benefit.

IMPERIAL TELEGRAPHS.

At a meeting of the Royal Colonial Institute at the Hotel Metropole, London, on Tuesday, Mr. Charles Bright, F.R.S.E., read a Paper on this subject.

Sir FREDK. YOUNG occupied the chair, and referred to the practical engineering attainments of Mr. Bright, the services he had rendered to telegraphy, and the various expeditions he had been engaged in. He supported Mr. Bright's view that cheap cable communication of an Imperial character should be provided.

In his Paper Mr. BRIGHT said: The forthcoming Imperial Conference serves to revive in many people's minds the need for more direct and less costly telegraphic communication between the different sections of the British Empire. That we are already provided with a highly efficient—if expensive—international cable service no one can reasonably deny. There is, however, a growing feeling that the Mother Country and her oversea dominions should be in closer and more easy commune with one another—partly with a view to increasing the scope of inter-Imperial trade. So far, however, they had not really got much beyond the idea. He would ask his hearers to recognise that just as, in order to ensure peace, we must—in the matter of armaments—be abundantly prepared for war, so equally it was essential that we should be telegraphically equipped in such a way that we can at all times rely upon talking freely, yet secretly, with the rest of the Empire.

For our cable service we are mainly indebted to private enterprise. Less than a sixth of the total of our submarine cables belong to the Governments. This is, however, a distinctly rising proportion, for foreign Governments are adopting a policy of State-owned and State-administered cables to their outlying possessions. A fair number of the cables laid by private companies have been entirely provided for by capital raised by themselves. On the other hand, large subsidies have been obtained from the Home and Colonial Governments for several important lines to the British Dominions. It would seem on the face of it that where private companies sought, and availed themselves of, subsidies from the State, they could not rightly object to either Government supervision or Government competition, or, alternatively, the subsidising of some rival enterprise, such as they had not been willing to undertake themselves on satisfactory terms.

It seemed to him that a great advance would be made in inter-Imperial communications if an all-round Imperial cable tariff—say, of 1s., 9d., or even 6d.—could be put into operation. The actual figure might be made a subject for investigation by a Government enquiry. There were, doubtless, difficulties in realising a uniform Imperial rate, but really useful work would be accomplished by any Government that took steps towards its realisation. The companies are, in the main, in a very strong financial position. Their reserve funds are largely based on what was once the accredited life of a cable—20 years—rather than double that period, such as is now known to be nearer the mark. In these circumstances, he imagined they would be prepared to meet Government suggestions in the matter if negotiations were pursued on right lines and in a suitable spirit. Some of the comparisons that had been made with railway traffics were altogether beside the mark; though, on the other hand, there appeared to be quite as strong reasons for Imperial cable tariffs being regulated by the State as for the 1d. a mile Parliamentary fare in force on the railways. He realised, of course, that the companies had reduced their rates considerably from time to time without incurring the disastrous results that had sometimes been feared. It had, however, always been admitted that if the Government took over our Imperial cables the rates could be substantially reduced.*

While increased overhead charges and additional cables constituted a real objection to tariff reductions, even with companies possessed of immense reserve funds, this difficulty had of late been met to a great extent by a recent invention—the cable relay—which permitted of a cheaper type of cable for a given volume of traffic, and, correspondingly, by its adoption at intervening points the same type of cable had a greater earning capacity. Hitherto, when once long continuous spans of cable had been satisfactorily dealt with, the elimination of intermediate stations—unless of a remunerative nature—was always aimed at, in order to dispense with manual re-transmission. Now, however, this re-transmission being effected far more efficiently and economically by machinery, it is usually considered good policy to take the line to as many intermediate points as are reasonably on the route.

The question of reduced rates for messages to be held back for any time up to 24 hours has been once more under "close observation." The cable companies, perhaps naturally, cater almost exclusively for business messages, which form at present 96 per cent. of the whole. In this way 17 Atlantic cables are kept well employed during the four or five business hours in common on each side of the ocean. By the introduction of lower rates for deferred messages the remaining hours could be turned to more profitable account by the cable, in the same way that certain railway companies fill their trains with ladies in the middle of the day. It is understood that the Eastern and its Associated Companies were now favourable to the reform, though they were certainly not so when he, for one, advocated it before the Cable Communications Committee in 1900.†

The present Postmaster-General (Mr. Samuel) appeared to favour the deferred-rate proposal, recognising that "too heavy a burden falls on individuals desiring to send messages by cable." An official conference was still considering this subject at intervals. Various suggestions had been made as to the exact form the deferred-rate system should take, and no definite decision had yet been arrived at. The most generally approved form appeared to be on a plain English non-code basis, the message being sent within 24 hours, the tariff charged being half that by ordinary rate. Both the German and French Governments were in favour of this reform being universally adopted, but the reform was still deferred. If the cables at present serving the Colonies were left in the hands of private enterprise, either fresh cables must be laid for the purposes of a cheaper new service or Government should endeavour to secure a more favourable tariff.

The strategic aspect of the cables was a more important feature than any other they had to consider. The necessity of being in constant communication with our outlying tributaries could scarcely be over estimated. An agreement had recently been entered into between the French and German Governments, the object of which was to render those countries independent of British cables—more especially for communication with Africa. The agreement provided for the common use of their respective submarine telegraph lines at any time that "accidents of a technical or other nature" interfered with the normal working of the individual services. But perhaps the most striking feature of this agreement was the laying of a Franco-German State cable between Brest and Emden with German extensions to Monrovia (West Coast of Africa) and Pernambuco (South America). If telegraphic communication with our colonies were needed only for individual purposes, there would, he considered, be no justification for the Government embarking on the expenditure of public money for State-owned cables. But such communication was highly necessary for the nation—(1) strategically, (2) politically and (3) for developing inter-Imperial trade. While there were objections to State-trading, there were more sound reasons in favour of Government-owned strategic cables to our distant possessions than would apply in the instance of State railways or the Government land telegraph system.

He trusted he had set forth sufficient grounds for a liberal expenditure in State-owned or State-subsidised and controlled cables to the various points in the Empire on a variety of routes, so that where one cable was

* Sir James Anderson (the late distinguished managing director of the Eastern and Associated Telegraph Companies) once remarked that if Government in taking over the telegraphs (meaning apparently the British cable system) could reduce the tariff one-half and still make a profit. "Private companies," he added, "could not do that." ("Proc. Roy. Col. Inst., Vol. XIX., p. 212).

† On that occasion the companies proposed as a substitute that three rates should be adopted for "preferential" messages marked "urgent" which were to be given priority. In other words, no reduction on the ordinary messages was agreed to under any pretext, but instead an increased tariff was suggested for messages of an extra-urgent character. His suggestion was made mainly with a view to developing priority messages, but also for obviating the necessity of coding and de-coding in the case of many business cablegrams of a non-urgent character.

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...peration another would be available at any moment. That cables ... foreign countries were best left in the hands of private enterprise there ... be no gainsaying.* Whether, however, the same applied in ... of Imperial lines depended upon conditions; and, in any event, ... convinced that Government control should be brought into effect. ... would be less reason for several important State lines if the com... had been prepared reasonably to undertake these. The Imperial ... cable was a case in point. The Imperial Pacific Cable had never ... interruption since it was laid. This line would, of course, ... time to be duplicated, but a reserve fund, amounting to a ... of a million, had been put aside towards that object. With ... Atlantic Ocean lines, from the commencement, "pooling," and ... of tariff between the different Atlantic cable companies had ... He might add that he had nothing but admiration for ... enterprise; his objection to the outlook was only on national ... grounds.

... proposal for a State Atlantic cable in consort with the State Pacific ... had lately been brought forward in a somewhat new form. In ... of the all-British idea was sunk on technical and commercial ... and the route for the line is from Scotland via Orkney, Shetland ... Faroe Isles to Iceland; thence to the southern point of Green... Farewell), and from there to Hamilton Inlet, Labrador. The ... for this route was that by breaking up the line into sections with ... landing stages, for the insertion of automatic cable relays, ... working speed could be achieved with the same type of cable as ... on the ordinary trans-Atlantic spans. In this case a lower ... could be charged—possibly 6d. a word ordinary rate instead of 1s. ... the line into a number of sections with intervening stations, ... effects of earth currents could be successfully over... by a complete metallic loop in each section, instead of using the earth ... This was not practicable on the ordinary trans-Atlantic ... owing to the great length of cable involved being unfavourable ... working. Another advantage in this northern route was ... from trawlers, so common a cause of trouble on the present ... cable routes. He was, however, opposed to Hamilton ... terminus for the cable, if only because there was *no* prospect ... being taken there. So considerable a departure from the ... condition would *require* substantial justification. In his ... were also technical and administrative advantages in taking ... from the west coast of Ireland rather than from Scotland. An ... to all extreme northern routes was that they are subject to ice ... eight months in the year, and on this account alone wireless ... would have actual points of advantage over a cable which ... be readily repaired at seasons of the year more or less free from ... For this reason a wireless station should be established at Cape ... Greenland), whether as an auxiliary to the cable or as a sub... of it.

... to communication with South Africa, the present *means* ... cables landing on foreign territory in more than one instance. ... to the desirability of a cable between Gibraltar and Bathurst, ... filling a gap in the all-British chain. Another useful link would ... by a cable between Bathurst and Barbados with an extension ... Particulars as to the unsatisfactory position of cable tele... with West Indies would be found in the recently published report ... Commission on Trade Relations between Canada and the ... The rates were high—3s. a word in the case of Jamaica, ... to British Guiana—and the traffic was naturally very small. ... the West Indian cable system (worked by different com... under Government control, steps could be taken to improve the ... by a process of unification, whilst the tariff could be brought ... more favourable figure. An additional cable might well be ... between British Guiana and Bermuda, touching at Barbados if not ... as recommended by the aforesaid Commissioners. From ... this line should also, in course of time, be extended to Ascen... Wireless telegraphy would be peculiarly well adapted for a news ... between the various islands. A wireless system between Port ... North Australia) and Labuan (North Borneo) would form a ... connecting link with the Eastern route. Wireless telegraphy ... recently proved the utility of its application to be recommended ... as auxiliary or reserve means of communication to the different ... of the empire, and for establishing communication where, owing ... conditions, communication by cable was impossible or ... uncertain. He did not propose on that occasion to go into ... that had been suggested would cost if put into effect, but he ... that for a subject of so much importance the fullest possible ... should be given.

DISCUSSION.

H. E. Rawson, R.E.C.B., approved the author's contention that ... Government should make certain conditions when granting landing ... for cables, and especially when it came to another Power taking ... over. He thought an Imperial Board should be appointed to ... the subject.

Sir Thos. Troubridge said the Atlantic cables seemed to be on the ... of coming into the hands of our friends the Americans, and cir... might arise in which they would have to be neutral—say, in ... war. As the Government were to subsidise a line of steamers to communicate between Great Britain and her colonies through Canada, perhaps they would subsidise a cable also.

Capt. Thomson, C.B., expressed surprise that so many more cables had been laid since he was engaged in cable laying some years ago. He thought it was a question whether wireless was not likely to supersede cables.

Mr. G. R. Neilson said Mr. Bright had referred to a uniform rate throughout the Empire. That would be very desirable, but one had to see that one did not get below the prime cost of the article which was to be provided. Communication with the other side of the world must be an expensive matter. The net cost of a message would be considerably more than one shilling. With regard to the cable relay cheapening the cost of telegraphing, it did so to some extent, but not to any very marked extent compared with the cost of the cable and its depreciation. The relay had been working for some time, and had undoubtedly afforded a benefit in rapidity of transmission. The uniform rate for inland telegrams in this country had resulted in a considerable annual loss. If traffics were greatly increased by reduced rates the number of cables would have to be increased. These had a certain carrying capacity, and if the messages to pass through these cables could be spread over the whole of the 24 hours there would be a considerable margin; but messages, for a variety of reasons, had to be forwarded (and possibly answered) in a short time. The concurrent working time between England and New York was only about three hours daily. The cables would require to have a very much larger carrying capacity than now if the traffic was to grow to any great extent. He thought the idea that wireless was on the eve of taking the place of cables was a little previous. Hitherto wireless had played the part rather of a feeder than that of a foe to the cables. The greatest desire of the Government was for the security of communication; that took first place, and was far beyond cheapness. Obviously it was for the interest of this country to encourage cables. Wherever they might be laid some benefit almost always accrued to the British Empire. At all events, the cables provided so many alternatives that it would be hardly worth the while of foreign Governments to cut some of them. If the Atlantic cable were cut, we should not be cut off from our colonies, as we could go another way round. He did not imagine that the Atlantic cables would pass into the hands of the American Government. He thought they would remain in the possession of the British companies. He did not think Mr. Bright allowed sufficiently for the danger of ice, and especially icebergs, in the northern regions, and he certainly did not think any responsible engineer would lay a cable up the St. Lawrence, for during a considerable part of the year it would be impossible to repair it. The carrying out of Mr. Bright's large views would involve the expenditure of a sum which perhaps even a wealthy country like ours might not care to face.

Mr. Bright, in reply to the discussion, said he thought that when Sir Thos. Troubridge mentioned the serious position which might be created in the event of an American combine obtaining possession of the cables he was forgetting for the moment that we had the eastern route to Australia. He felt sure Sir Thomas was correct when he said ice was no difficulty at Halifax, but he felt, with Mr. Neilson, that it was a difficulty which must always be borne in mind in the St. Lawrence. He also agreed, more or less, with Mr. Neilson with regard to wireless telegraphy, but we did not know what science had in store for us. He did not know whether Mr. Neilson went so far as to say that wireless telegraphy would never take the place of cables. He (Mr. Bright) would be sorry to say that. They knew at present that wireless was a very different thing from cable telegraphy, and he would be sorry to rely upon it entirely. He thought they required both systems. With regard to a uniform rate, he quoted what Sir James Anderson had said: "That the Government, in taking over the telegraphs, could reduce the tariff by one-half and still make a profit," and, further, that "public companies could not do that." Mr. Neilson said he (Mr. Bright) was quite wrong about cable relays.

Mr. Neilson: I did not say you were wrong. I said it was already in use and we had derived benefit from it.

Mr. Bright: I know people who are authorities on the subject who agree with my views as to what can be done on an Atlantic cable with cable relays. Continuing, he said they could either use a cheaper cable on account of the cable relay, or send a greater number of messages with the use of the relay on the existing type of cable. The daily common period for working between England and America was four or five hours. It was a matter of degree. Five hours were in common use and three hours were more general. Sir Samuel Griffin, a former Premier of Queensland, had said that, prior to the laying of the Government's Pacific cable, Australia's means of communication was a source of anxiety, because the Eastern and Eastern Extension Companies' cables ran through foreign countries and through seas which were full of the ships of foreign countries. Mr. Neilson had credited him (Mr. Bright) with large views, and he would remind him that the splendid work done by the cable companies would not have been effected but for their large views.

On the motion of the Chairman, a hearty vote of thanks was accorded to Mr. Bright for his paper.

Electricity in Mines.—At the conference of the Miners' Federation on Wednesday the Mines Bill was further considered, and it was decided unanimously to refer the whole question of the use of electricity in mines to the Executive Committee, with a request to draft an amending clause to be submitted to a subsequent conference, so as to increase the safeguards in the bill as to the use of electricity.

*As a matter of fact, no other course is open; for, just as no foreign ... would grant landing rights for a *British Government* cable on ... so, similarly, the moment a private-owned cable was taken ... Government the landing rights would be abrogated.

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PARLIAMENTARY INTELLIGENCE.

HALIFAX CORPORATION BILL.

This bill came before the Local Legislation Committee of the House of Commons on Monday, Sir W. E. B. Priestley presiding. The bill authorised the construction of additional tramways, &c.

Mr. TALBOT, K.C., for the Corporation, said the tramway system now consisted of 37 route miles, and the traffic was heavy and increasing. The list of proposed tramways appeared formidable, but they were very largely proposals for doubling existing lines. One of the portions of the route to be doubled was Waterhouse-street, and to this there was opposition.

Mr. W. M. ROGERSON, borough electrical engineer, gave detailed evidence as to the desirability of the improvements.

After hearing Mr. Rogerson, and his cross-examination on behalf of the objectors (by Mr. Charteris), the CHAIRMAN said the Committee were unanimously against the doubling of the line in Waterhouse-street.

Counsel for the promoters, however, begged the Committee to hear the evidence of the Borough Engineer before coming to a definite decision, and the Committee consented.

Mr. C. F. SPENCER, chairman of the Tramway Committee, said they had paid great attention to the proposals to set right their system on which there had, owing to an accident, been a loss of £12,000. The only part of the system which was not a commercial success was the Waterhouse-street section. After four years' consideration they decided that their present proposal was the only practical one.

Mr. S. SELLON, who has called in to advise the Corporation, considered it absolutely essential to the successful working of the undertaking that that particular section should be doubled.

Mr. JAMES LORD, borough engineer, quoted instances at Halifax, where there were roads equally narrow where they had double lines already without any interference with ordinary traffic.

The Committee then decided that they would permit the double lines for one portion of the route suggested, but not through Waterhouse-street itself.

The Standing Orders Committee have authorised the insertion of a clause permitting the construction of a new tramway along Park-street, in place of the existing line in Northgate and North Bridge-street.

Mechanical Appliances on Railways.—In reply to a question, the President of the Board of Trade (Mr. S. Buxton) said, in the House of Commons on the 20th inst., he had asked the railway companies to consider the desirability of providing mechanical or electrical appliances at places where detentions were frequent, or where trains were liable to stand out of sight of the signal cabin.

Brighton and District Tramways Bill.—The promoters have decided to withdraw this bill.

Greater London Railway Bill.—This bill will come before a Select Committee of the House of Commons on May 4, unless the Government accede to a request which will be made to refer it to a Joint Committee.

Macclesfield & District Railless Traction & Electricity Supply Bill.—Application is to be made for leave to introduce in this bill provisions to enable the company proposed to be incorporated to acquire lands, erect and equip generating station and work trolley vehicles on an additional route.

Pontefract Provisional Order.—The Standing Orders Committee of the House of Commons have declined to allow Pontefract Corporation to introduce a bill confirming an agreement for the transfer of their Provisional Electric Lighting Order, 1907, to Yorkshire (West Riding) Electric Tramways Co.

Norwegian Telegraph Service.—In the House of Commons on Wednesday the Postmaster-General, Mr. H. Samuel, stated, in reply to a question, that the telegraph service between the United Kingdom and Norway had been acquired by the Government from the Great Northern Telegraph Co. Under the agreement between the two countries, the working of the cables would be entrusted to the Great Northern Telegraph Co., in whose hands the Scandinavian service still remained.

LEGAL INTELLIGENCE.

Tramway Bye-Laws.

On Tuesday a Divisional Court (the Lord Chief Justice and Justices Pickford and Lush) heard an appeal in the case of Smith *v.* Woodhead, from a decision of the stipendiary magistrate of Leeds. From the special case stated for the opinion of the High Court it appeared that on Sept. 15, 1910, an information was laid against Mr. Woodhead charging him with having, on Sept. 7, while a passenger on a tramcar in Leeds, unlawfully refused to show his ticket to Bentley Smith, an inspector in the Corporation's employ. Appellant had paid his fare (2d.), and had been offered two 1d. tickets by the conductor, which he refused to accept. The tickets were, however, placed upon the seat beside him. The inspector subsequently entered the car and requested to see appellant's ticket. The two tickets which had been placed upon the seat had fallen to the floor, but appellant made no reference to them, stating that he had no ticket. The inspector demanded the fare which could be legally demanded from a passenger who refused to show his ticket, but appellant refused to pay it. After hearing the facts the magistrate convicted Mr. Woodhead, fining him 5s., without costs, over-ruling an objection that the bye-law which said that a passenger who had paid his fare should be required to show his ticket was ultra vires and unreasonable.

After hearing counsel for appellant, and without calling upon counsel for respondent, the Court dismissed the appeal. The LORD CHIEF JUSTICE, who delivered judgment, said that before convicting Mr. Woodhead for not showing his ticket, the magistrate came to the conclusion that the passenger knew where the ticket was, and could have produced it had he liked. In these circumstances the Court thought that the magistrate was right in his decision, and the conviction would be affirmed.

Evans v. General Electric Co.

A Divisional Court (the Lord Chief Justice, Mr. Justice Pickford and Mr. Justice Lush) had before them yesterday (Thursday) this special case, stated by the magistrates of Aston. At the Petty Sessions at Aston on Nov. 23, 1910, an information was preferred by Wm. Evans, an official of the Midland Railway Co., against the General Electric Co., charging them with having attempted to evade the payment of certain tolls to the company, by describing 10 electric stators, consigned in two parts, as "two cases bearers."

Defendants obtained a contract to supply to Bedford Corporation certain electrical machinery, including an alternator. This was consigned from Witton to Bedford via the Lawley-street station of the Midland Railway. A portion of the goods was an electric stator with laminations and coils, which was placed in two cases, the description being "bearers." According to the general classification of goods "bearers" were chargeable at a lower rate than electrical appliances, the charge for the former being 9s. 2d. a ton and for the latter 22s. 9d. per ton. Defendants contended that they were entitled to consign the goods as "bearers," and submitted that as there was no rate fixed in respect of the consignment of a generator in parts between Birmingham and Witton at owner's risk, there was no evidence in law of an offence under sec. 99 of the Railways Clauses Act, 1845.

For the Railway Company it was argued that even if the casting of the stator itself was accurately described as a bearer, when it was filled with coils it would be part of a generator, and that the description "bearer" was a false one. They contended that defendants had falsely put the description on the stator, with the intent of obtaining a lower rate of carriage.

The magistrates held that defendants had given a false description of the goods consigned with the hope of avoiding payment of certain tolls, and imposed a penalty of £10. 10s., and costs.

For appellants, Mr. DISTURNAL argued that there was no special toll applicable to these goods.

Mr. MACASSEY (with whom was Sir Alfred Cripps) argued that the goods should have been consigned under the sections X, Y or Z, which were at owner's risk.

The LORD CHIEF JUSTICE, in giving judgment, said in his opinion the judgment of the magistrates was quite right.

The appeal was therefore dismissed, with costs.

Notting Hill Electric Lighting Co. (Ltd.)—On Tuesday Mr. Justice Neville heard a petition by this company to sanction a scheme of arrangement for the purpose of wiping out the founders' shares. Counsel for the Company said these shares formed a barrier to certain negotiations. The basis of the present proposal was to get rid of the founders' shares and bring them into the class of ordinary shares. The company would issue 27,050 shares of 1s. each, which would be issued to the existing shareholders on the footing that the ordinary preference shareholders and the ordinary shareholders should be allowed to subscribe for one 1s. share in respect of each share held, and the holders of the founders' shares should be allowed to subscribe for 24 1s. shares in respect of each share. The special voting power attached to the founders' shares would go, and each share would carry with it one vote. The scheme would do away with the present division of profits. They would have 6 per cent. cumulative and non-cumulative preference shares and ordinary shares, and the new 1s. shares would be called ordinary shares. From Jan. 1, 1911, the profits of the company would be applied in paying a 6 per cent. cumulative dividend on the cumulative preference, a non-cumulative dividend on the non-cumulative preference of a like amount, and, subject thereto, would be distributed equally amongst the ordinary shareholders *pari passu* to the amount paid up on those shares. The scheme also provided for the payment of a bonus to the preference shareholders in the event of an amalgamation, on a sliding scale ranging from £1. 19s. 4d. at the end of the present year to 2s. 11d. in 1930, which was the year fixed, as in 1931 the local authority would have power to buy the company out. The scheme had had the approval of all the shareholders with the exception of the holder of one founders' share, and he declined to vote. There was no opposition, and his lordship sanctioned the arrangement as proposed.

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COMMERCIAL AND INDUSTRIAL SECTION.

MUNICIPAL, FOREIGN & GENERAL NOTES.

BRITISH NOTES.

Alloa.—The Council recently took over the administration of the electricity works from the British Electric Plant Co., and it is now proposed to duplicate the plant at an estimated cost of £3,400.

Barnstaple.—As Mr. Albert Gay has reported that the present storage battery at the electricity works is quite inadequate, the electrical engineer (Mr. J. W. Hadfield) has been requested to prepare a specification for a new battery.

Bath.—At the Council meeting on Tuesday next the Electric Lighting Committee will recommend an expenditure of £7,500 on the electricity undertaking, including the substitution of 800 H.P. Diesel engine and a 450 kw. dynamo for some of the present steam plant. The new machinery will run the summer load, and in the winter the steam plant will supplement it. The electrical engineer (Mr. F. Teague) considers that this will effect a gross saving of £2,228, and after allowing £675 for capital charges the net saving will be £1,553.

Birmingham.—The Tramways Committee have approved heads of agreement for the through running of electric cars on the cable route between July 1 and Nov. 9, when Handsworth becomes part of the city.

Bispham.—The Board of Trade have consented to overhead line being used for the Council's electric lighting scheme. Sanction to a loan has been applied for.

Blackburn.—There was a profit of £697 on the past year's working of the electricity department, against £1,387 in 1909-10. On the tramways department there was a deficit of £181, against a profit of £453.

Blackpool.—The borough electrical engineer (Mr. Chas. Furness) has reported that the receipts on the Corporation tramways for the year ended March were £56,633. 18s. 8d., compared with £57,489. 1s. 1d. in 1909-10.

The number of passengers carried was 8,999,565. The net profit is £500. In the electricity department it is expected that the net profit will exceed £5,000.

The new promenade is to be illuminated by 10 yellow flame arcs and 40 100-c.p. Osram lamps.

Bradford.—On Monday the members of the Tramways Committee inspected a new tramcar brake which has been invented by the general manager of the tramways (Mr. C. J. Spencer). No details have yet been published.

Bridgwater.—The local electric light company has been entrusted with the electric lighting of Blake Gardens.

Coronation Illuminations.—Messrs. Pigott Bros. are to illuminate the Bank of England, London, on Coronation day (June 22), using over 5,000 electric lamps.

The Public Health Department of the Corporation of the *City of London* have issued a notice addressed to electric lighting contractors and others (a copy of which is given in an advertisement on another page) setting out the conditions with which temporary installations of electric lighting for Coronation illuminations and decorations must comply.

The Yorkshire Electric Power Co. will from June 12 to 24 inclusive supply current for Coronation illuminations to any of their customers in *Guiseley, Yeadon, Otley, Farsley, Gomersal, Horsforth, Hipperholme, Liversedge, Ossett* and *Shipley Bridge* at 1½d. per unit, plus cost of additional service mains, if required.

The Sheffield Corporation will supply at 2*d.* per unit, plus 2/6 for connection &c., from June 22 to 25.

Dublin.—An enquiry was opened on Monday into the Council's application for sanction to borrow £128,129 for extensions of the electricity undertaking.

Sergeant O'Brien, K.C. (for the Corporation) said the electricity department of the Corporation was now in charge of a Special Committee. Objections to the present proposal had been made by the Tramways Co. and others, but the Corporation courted enquiry. Up to the present £965,742 had been sanctioned in connection with contracts at the Pigeon House station, the sub-stations and other matters necessary to the supply of electricity. £137,525 had been repaid, leaving £483,217. The main question was whether the station should be scrapped and new experiments made. The total capacity of the Pigeon House station was at present 6,000 kw., and of that 1,500 kw. must be kept in reserve, leaving 4,500 kw. In December last demands requiring 4,600 kw. were made. The proposed extension would involve no loss to the city, but a very substantial gain, because up to the year ending March 31 a surplus of £7,000 could be shown. Applications for new consumers were coming in more rapidly than during the corresponding period of last year. Counsel proceeded to quote from reports by the Committee and the city electrical engineer (Mr. M. Ruddle), and stated that the extension was necessary not only on statutory, but on common-sense grounds.

Mr. Fred Allan, secretary of the Electric Lighting Committee, stated that they had 3,398 consumers last year. During the present year they were having the Richmond Asylum, South Dublin Union and the new College of Science, and they expected a considerable supply from the main drainage electric pumping station. He proceeded to supply formal evidence as to accounts, &c.

The Inspector (Mr. Cowan) commented on the fact that the Corporation had exceeded by thousands of pounds the sanction of the L.G. Board.

Mr. Allan said when the Board suggested that expenditure should not be incurred without sanction, the Corporation took the practical view that they would go on with the work which they were bound to carry out, but that would curtail speculative work.

Mr. S. L. Pearce said that he had inspected the Pigeon House and Fleet-street stations, and several of the transformer sub-stations. He had been furnished with statistical records and data relating to the general working of the undertaking. As to the general condition of the undertaking, the system in use at Dublin—three-phase generation at extra high tension and distribution through static transformer sub-stations to low-tension alternating-current networks—was quite a modern and standard one, and the general lines on which that system had been applied to the city were fairly up-to-date. Whilst being quite flexible and suitable for future extensions, it would at the same time permit of many modern improvements in plant design and economies being taken advantage of. The plant at Pigeon House generating station appeared to be in good running condition and the units up-to-date. Having regard to the output, load factor and other local conditions he did not consider the works costs unreasonably high. The distributing system generally was in a thoroughly satisfactory condition. Both the high tension and low tension networks had been well laid. It would be advisable to have fewer sub-stations, with larger transformer units installed, and that, he understood, was being done. On the advisability of extending at Pigeon House or seeking another and more central site, the present question to be decided was whether the Corporation, having acquired the site, and having spent some £160,000 on the generating station were now justified in abandoning it for some more centrally situated station. He compared the figures which the alternative plans would involve, and he held that the evidence was largely in favour of the retention of the existing site. In his opinion it was clear that the proposal to shut down the Pigeon House station would involve an additional expenditure of £150,000, on which the annual charges would amount to £11,200. On a favourable estimate the Corporation could not hope to give more than £1,000 per annum, and in face of the estimates he was unable to see that any sound financial gain could accrue to the electricity department by adopting such a radical alteration as would be involved in the shutting down of the Pigeon House station and Fleet-street and the building of a new station on another site. He had come to the conclusion that there was no reason why future extensions should not be carried out there, at any rate up to the capacity of 12,000 kw. As long as the Dublin load was what it was, viz., one made up of short-hour consumers with a very accentuated evening peak, in short, with a bad load factor, low working costs were out of the question. That condition of affairs would not be improved by shifting the generating station. The remedy or partial remedy for a poor load factor was to be sought for in other directions. The present proposals of the City Electrical Engineer were a step in the right direction for the utilisation of more efficient plant. He did not, however, advise the Committee at the present time to consider scrapping any of the Pigeon House plant. The new turbine unit to be installed this year would carry the day load more than adequately, and the reciprocating units would be held in reserve largely. He did not consider the tariff high, having regard to all local circumstances, and particularly in comparison with gas at 3s. 4d. per thousand. The bulk of the street lighting was now done by 500-watt Verity a.c. open-type arc lamps, and for the most part was a fairly typical example of commercial lighting, as originally carried out by electricity undertakings. He had noted the good results obtained from the new flame arcs in the North Circular-road and elsewhere. It would be well if the Electricity Committee were to take into early consideration the advisability of either changing the existing arcs or supplementing by new flame arcs the lighting in important thoroughfares. The illumination in the centre of these roadways did not appear to be sufficient, nor on the one side where the lighting was all done from the opposite side of the road. The street lighting of Dublin was up to the standard of other similar cities.

The inquiry was adjourned.

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East London Railway.—It is announced that the Joint Committee of the East London Railway have decided to adopt electric traction. The cost is estimated at £50,000. The work will be commenced immediately, and it is hoped that it will be completed in eight months. The line consists of 5 miles 54½ chains of double track.

Festival of Empire.—In connection with the Festival of Empire at the Crystal Palace, Messrs. R. Waygood & Co. have been instructed to construct a special electric passenger lift for the use of His Majesty upon the occasions of his visits during the summer. The lift will travel from the Terrace of the Palace to the King's Pavilion, and the control will be similar to that in vogue on the London Underground Railways.

Fire.—A fire broke out on the 21st inst. at the Leyton works of the London Electric Wire Co. & Smith's (Ltd.), but the outbreak was confined entirely to a detached building in which part of the company's enamel-insulating process was carried on.

No personal injuries were sustained, and no one will be thrown out of employment. The remainder of the factory has not been affected in the slightest degree, and all other manufactures of the company are, therefore, being carried on without any interruption whatever.

Grimsby.—From the 26th inst. to May 3 demonstrations of cooking by electricity are being given by Miss G. A. Paget, on behalf of the electricity department, at the Municipal buildings.

Harbour Lighting.—Aberdeen Harbour Board have accepted the following terms of the municipal electricity department for a supply of electrical energy for five years:—

All public lighting by arc lamps to be charged at £14. 10s. per lamp per annum. Current for incandescent lighting to be at the flat rate of 2·75d. per unit. All power and heating to be at current power and heating rates. The Harbour Commissioners guarantee a total consumption of not less than 160,000 units per annum. These terms mean a reduction in the cost of electric lighting by about £150 per annum.

Heywood (Lancs.).—The accounts of the electricity and tramway undertakings show deficits for the year ended March of £2,044 and £1,403 respectively. The total income of the electricity department was £4,962, and the expenditure £3,713; while the gross receipts from the tramways was £10,964, and the expenditure £7,575. Interest and sinking fund requirements have led to the deficits.

Inquest.—An inquest was recently held at St. Helens into the death of a labourer named Bridge.

Deceased died of consumption, which it is supposed was set up by lead poisoning. He had been employed at the Corporation electricity works for several years and for some time had been engaged in painting in the subway, &c. He was taken ill last October, and had not been able to work since Christmas. The doctor who attended him diagnosed the disease as lead poisoning.

The CORONER (Mr. S. Brighouse) gave the jury a sketch of the history of the case. The coroner ordered a post mortem examination to be made by an independent practitioner, and the inquiry was adjourned until the following day.

GEORGE ERNEST GREEN, mains foreman of the Corporation electricity department, said deceased had to examine and clean the street boxes in connection with the distribution of electricity. There was a big box (2 ft. 6 in. square) and an inner box (15 in. square) and at certain times he would have to scrape the inner box and re-paint it. He did not know whether lead was a constituent of the paint. He would have to dust the lead cables before he started painting.

By Mr. HUTCHES (for the relatives): They did not use any white lead in their work. Deceased had not to scrape any lead. Deceased had complained to him of the smell of the lead getting on his chest. They were working in the sub-station, and witness, who had been painting for about an hour, said the paint had got into his stomach, and deceased said, "Yes, it gets on mine." That would be some time before Christmas.

In reply to the Coroner, Witness said several men were painting the boxes, and there was no doubt that when a man had not been painting and he went to paint for three or four hours he would feel the effects of it. With witness it was momentary, as he was all right after a bit.

By Mr. CHAPMAN (for the insurance company): Deceased had been on this work for about two years, and the only complaint he made was shortly before Christmas.

In answer to the Coroner, Mr. CHAPMAN said before an employer was liable for lead poisoning the person suffering had to produce a certificate from the certifying surgeon, but that certificate had never been produced, and the Corporation were not liable to pay anything. They paid a weekly allowance quite voluntarily. His evidence was that Bridge was suffering from lead poisoning, but that he did not die from it, and that the lead poisoning had nothing to do with the death.

Mr. J. W. WARR, chief outside assistant superintendent of the electricity department, gave evidence that there was no lead used in the paint. The only lead the man would come in contact with was the lead from the cables. In many cases there would be as many as 12 lead cables coming into one box, and they would be bonded together with another strip of lead. There might be what he would describe as an oxide of lead snuff in the boxes and he would come in contact with it by brushing the boxes.

Dr. LATHAM stated that deceased came to see him in the last week in December, when he described his symptoms, and he made a provisional diagnosis of paint colic. He saw him again at home, and came to the definite conclusion that he was suffering from acute lead poisoning. About a month later the symptoms had fairly well disappeared. The immediate cause of death was pulmonary tuberculosis, but it was certainly accelerated by the lead poisoning.

Dr. UNSWORTH, who conducted the post mortem examination, said that, in his opinion, the cause of death was pulmonary phthisis. He thought death was accelerated by the lead poisoning. But the tuberculosis was of such a character that he would have died from it sooner or later.

The jury returned a verdict that the cause of death was consumption, accelerated by lead poisoning; that while he was employed by the Corporation he suffered from lead poisoning; that the lead poisoning hastened or accelerated his death, and that the lead poisoning was acquired while he was in the employment of the Corporation.

Leeds.—The accounts of the tramways department for the year ended March 31 were presented to the Tramways Committee on Monday.

The total receipts were £370,402 (10·699d. per car-mile), traffic revenue being £364,927. 5s. 7d. (10·541d. per car-mile), against £353,860 (10·41d.). The number of car-miles was 8,308,439, and the total number of passengers carried was 80,806,270. The revenue from advertisements was £3,462, and from haulage of sand and gravel £1,659. The traffic expenses were £99,672. 2s. 6d., and included wages to drivers and conductors £71,138. 9s. 4d. Superintendence cost £1,840, cleaning and oiling cars £11,254, and uniforms and badges £2,592. General expenses (£33,239) show an increase of about £1,000, and local rates represented £21,123, compared with £18,528. General repairs and maintenance increased by £5,409, the total being £40,290, of which £8,735 was for repairs to permanent way, and £24,586 for repairs to cars. Power expenses were £22,101. The total expenditure was £195,303, which left a balance of £175,099, to which is added £1,204 for bank interest, and £4,032 for dividends on redemption fund investments, making a total of £180,335. Deducting £35,888. 17s. 6d. spent on permanent way renewals and other small sums £144,231 was left as gross profit for the year. Contributions to sinking fund came to £45,121, interest to £42,511, and income-tax £4,711, so that the net surplus is £51,886, which is to be handed over to relief of rates.

Light Railways.—The report of the proceedings of the Board of Trade and of the proceedings of the Light Railway Commissioners up to Dec. 31, 1910, have been issued.

On Dec. 31, 1909, six orders were before the Board of Trade awaiting confirmation; four of these were confirmed during 1910, and two are still held over. During 1910, 12 fresh orders were submitted to the Board by the Light Railway Commissioners for confirmation. 11 of the orders submitted, in addition to the four above referred to (making 15 orders in all) were confirmed in the course of the year, and the remaining order is still under consideration. In no case did the Board refuse to confirm an order. The orders confirmed in 1910 authorise 13½ miles of line, at an estimated cost of £76,680.

In their fourteenth annual report to the Board of Trade the Light Railway Commissioners state that 613 applications for orders to authorise light railways (including 102 applications for amending orders) have been made since the commencement of the Light Railways Act, 1896. In respect of 391 applications (including 12 in 1910) orders were submitted to the Board of Trade. Five orders are being settled; 204 applications were rejected or withdrawn; five were deferred, and nine new applications for Nov., 1910, remain to be considered. At present about 750 miles of light railways have been constructed under the Act; nearly 1,200 miles in addition have been authorised, but are not yet constructed. The main reason which accounts, in our opinion (say the Commissioners), for failure to construct lines in country districts, and also for the notable reduction in the number of proposals for new lines which followed on the equally remarkable activity of the early years is to be found in the fact that in its present form the Act does not adequately secure certain essential conditions—namely, cheap capital, cheap construction and cheap working. So far as the financial assistance of the State is extended under the present statute to light railways, it should be observed that out of £250,000 provided in 1896 to cover free grants and other "special" advances over five years, in 1910 (after 14 years) only about £140,000 had been actually advanced to seven lines with a total mileage of 68½ miles, and out of £750,000 assigned in 1896 for loans, up to and including this year only about £35,000 has been actually issued.

When it is remembered (continues the report) that the chief difficulty in all light railway schemes has been to find capital, it will be seen that the financial assistance of the State under the terms of the Act has not greatly contributed towards the construction of light railways, for the reason that the extent of such assistance, and the conditions under which it may be given, have not been found such as to enable the remainder of the capital to be raised on reasonable terms. Under the Development and Road Improvement Funds Act, 1909, advances may be made for light railways to or through a Government department, without reference to the conditions in force under the Light Railways Act; but such advances are not available for undertakings trading for profit, and, further, are we advised that we do not constitute a Government Department within the meaning of this provision. In our report of last year we referred to a point relating particularly to lines on public roads mostly worked by electric power. Under the Act it is provided that special consideration shall be given to the question whether proposals brought before us should not, under certain circumstances, be submitted to Parliament; but no provision was made in the event of the question being so determined, and

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... is prescribed for such submission. The result is that pro... taken under the Act in any such case become abortive, and the ... becomes, to that extent, less effectual and less certain ... this being, in our opinion, one of the chief causes which ... bring applications for lines of this class (in many cases lines ... public usefulness) practically to an end. We think it advisable ... to the fact that no less than 16 private bills have been ... the coming session of Parliament to authorise the use on ... of the "trackless trolley system." We have been asked to ... applications of this kind under the Light Railways Act, but are ... technically, under the terms of the Act, they are beyond our ... This system has been put forward as an economical, and ... circumstances convenient, form of transport for light ... we recognise that schemes of the kind might appropriately, ... with advantage, be brought within our powers.

Llandilo-Lampeter Light Railway.—At their meeting on Wednesday ... County Council passed a resolution in favour of this light ... scheme, which involves the construction of about 16 miles of ...

Manchester.—Sir David Harrel has issued his award in the ... the Tramways department and its employés. ... having duly weighed and considered the evidence (oral ...), is of opinion that a case has not been made out for ... of the working hours per day from nine to eight, and that ... is not necessary in the interests of the health of the men ... of the public. He declares that the tramway employes ... referred to him for decision are not reasonably entitled ... working hours reduced from 54 to 48 per week without any ... the weekly wages now paid, or the curtailment of any of ... which the men now enjoy.

Morecambe.—At the Council meeting on Tuesday the chairman of ... Committee (Ald. Brown) said that they were able to ... out of the past year's profits to relief of rates.

National Electrical Manufacturers' Association.—The next meet... Council will be held at Balfour House, Finsbury-pave... on May 4, at 2:30 p.m.

...—The electricity department shows a net profit of £826 for ... March 31, compared with an estimated deficit of £898. ... the deficit was £784, compared with the estimate of ...

...—As the Council cannot undertake to carry out the terms ... Order within the next 12 months, the Board of ... that they cannot renew it.

...Lanterns.—The night constables in several towns in Scotland ... supplied with electric in substitution for the old oil ...

... Report states that a better light is obtained, clothes are not ... chills, hitherto produced by the heating of the body ... oil lamp under the cape in wet weather, will be avoided.

...ional Order Revocation.—The Board of Trade have revoked ... Lighting Order, 1904.

...—It is reported that there was a profit of £1,944 on the ... working of the tramways, against a deficit of £357 in ...

... department there was a net profit of £5,409, an ... £231 over the previous year.

...-on-the-Sea.—The Chairman of the Council (Mr. Hodg... re-elected chairman of the Electric Lightig Com...

...Tramway Managers' Association.—A meeting of the mem... Association was held in Dunfermline on Friday, when ... were present from Glasgow, Paisley, Kilmarnock, ... Falkirk, Dumbarton, Musselburgh, &c.

...London.—The Lighting Committee have been in com... the Great Northern & City Railway Co. with re... interchangeable supply of electricity to be taken from, ... Council, as circumstances require.

... supply has been in operation for some months to ... it is possible to secure economies by taking a supply of ... company at times of heavy load, &c.

... applications for power and lighting received during the alst ... to over 1,100 kw., and the maximum load on the ... more than it was last year. As other supplies are in ... consider it necessary to enlarge the present sta... addition to the bulk supply from the G.N. & C. Co.) a ... The committee is to be authorised to obtain ...

...—The profit on the past year's working of the electricity ... and on the tramways £1,000. Electric light... substituted for gas on the pier.

...—On Thursday last the Council considered a report by ... on the acquisition of the local tramways. ... as the result of a conference with Mr. Tegetmeier ... the local tramways company) and Mr. D. James ... that the company was prepared to fix a date for the purchase by the Corporation of the whole of the lines 32½ years hence, the company in the meantime to have possession of the whole of the tramways, including the Corporation lines.

The Committee adopted a recommendation to appoint Mr. J. M. McElroy (at a fee of 50 guineas, plus reasonable travelling expenses) to advise them on the subject.

Willesden.—On the past year's working of the electric supply department the net profit was £1,600.

Wireless Telegraph Notes.—The Bolivian Government has obtained powers to raise a loan of £50,000 for the erection and equipment of radio-telegraphic stations at La Paz, Riberalta, Cobija, Trinidad, Santa Cruz, Puerto Suarez and Gran Chaco.

It was decided some time back to establish a wireless station near Hammerfest (Norway), and it has now been resolved to open a station at Spitzbergen (probably at Green Harbour). The work will probably be completed this year. The stations, which are distant 750 miles, are to be kept open all the year round. It is anticipated that the exploitation of the Arctic circle will be greatly facilitated by the new arrangements.

It is announced that an arrangement has been come to between the Marconi interests and the French Government which will overcome the former want of agreement between the parties as to the interchange of communication between ships equipped with Marconi apparatus and ships and certain shore stations equipped with other systems of wireless telegraphy.

Wrexham.—An L.G. Board inquiry will be held here on Wednesday next into the application of the Corporation for sanction to borrow £3,345 for various works for the electricity department, including (amongst other things) the fitting out and supplying of machine tools, the erection of a coal elevator, new switchboards, public lighting, the erection of stores and offices, feed pumps and forced draught apparatus for one of the boilers. An application to borrow £800 for a battery will also be dealt with.

COLONIAL AND FOREIGN NOTES.

Australasia.—The "Australian Mining Standard" says Hobart Council (Tasmania) have referred to a committee of the whole Council a proposal that steps should be taken for the acquisition of the Hobart Electric Tramway Co.'s undertaking.

Statistics prepared by Mr. G. H. Knibbs, the Commonwealth statistician, show that the total length of tramways in the Commonwealth at June 30, 1910, was 442 miles, compared with 389¾ at the end of 1909, 275 miles are worked electrically, an increase of 23¾ miles. New South Wales has 112 miles of electric tramway and 58 miles of steam lines; Victoria is the only State where the cable system is employed, the cable lines being 46 miles, in addition to 40 miles of electric, 1 mile of steam and 13 miles of horse tramways. All the Queensland and Tasmania tramways are electric, the former having 30 miles and the latter 9 miles. South Australia has 30 miles electric, 3 miles steam and 23 miles horse. Western Australia, 53 miles electric and 23 miles horse. The Commonwealth has 213 miles under Government control (viz., 165 New South Wales, 5 Victoria, 20 South Australia, and 23 Western Australia; municipally-owned tramways are peculiar to South Australia, which has 30 miles so controlled. The total of privately-worked lines comprises 199 miles, of which New South Wales has 5, Victoria 95, Queensland 31, South Australia 6, Western Australia 53, and Tasmania 9 miles.

At Gawler (S. Australia) recently a meeting of ratepayers passed a resolution approving the Corporation borrowing £4,000 for electricity works. It was stated that the scheme proposed provided for 100 private installations. It was decided that a poll should be taken.

Giving evidence before the New South Wales Public Works Committee recently as to the expediency of constructing a railway from Wagga Wagga to Tumberumba, Mr. J. Arnot said there was plenty of water power in the district to successfully work the line by electricity. The system would cost about £127,000, including rolling stock, overhead gear and power house.

Mr. W. G. Crossle (F. A. McCarty & Co., Melbourne) has been engaged to prepare plans and estimates of cost of the electric lighting scheme proposed by the Mortlake Butter & Cheese Factory for supplying the town of Mortlake (Victoria).

Mr. E. N. Moore who presided over the inquiry into the causes of the Richmond (Victoria) railway disaster, viewed with favour the electrical signalling device of Mr. V. Russell (Rochester) and undertook to draw the attention of the Railway Commissioners to it.

A deputation of the Ballarat employés of the Electricity Supply Co. of Victoria waited upon the new general manager (Mr. P. J. Pringle) soon after his arrival, and made certain requests relating to wages and conditions of labour. Mr. Pringle has decided to make certain increases and to deal with the men's other requests later.

At a meeting of the Australian Association of British Manufacturers and Their Representatives at Melbourne on March 7 (Mr. J. Wilson, India Rubber Co., in the chair), the following were elected members of the executive council: President, Mr. Percy Rosling (W. T. Henley's Telegraph Works Co.); vice-presidents, Messrs. B. K. Morton, G. Shrimpton and Edwin Wood; councillors, Messrs. G. M. Buchanan, G. Smith Morison (Siemens Bros. Dynamo Works, Ltd.), and Irwin Hinds (Gibson, Battle & Co.).

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Canada.—The bill for the construction of an electric railway from Port Dover to Galt (via Brantford, Ontario) has been passed.

The Scottish Ontario Synd. have secured from the Government the right to operate a power dam at Sturgeon Falls, on the Mattagami River, 30 miles to the north of Sandy Falls, where hydro-electric power is now being developed for the Porcupine camp.

It is reported that four electric lighting and railway companies, of a total capital of $19,000,000, are to be merged in one undertaking. The companies concerned are the Toronto Electric Light, the Electrical Development, the Toronto Power, and the Toronto Railway companies.

China.—A consular report states that a native company was recently formed for the installation of electric light works at Shasi and Ichang, and a contract had been made with a foreign company for the supply of plant capable of supplying current to 4,000 lamps at each place, but it is believed that the capital has not yet been fully subscribed, and that it is doubtful whether the scheme will go through at present.

Guatemala.—A consular report states that imports to Guatemala in 1909 included electrical material and apparatus valued at £7,910 (compared with £13,551 in 1908), machinery £38,337 (against £19,737) and scientific instruments £907 (£4,348).

St. Petersburg.—The Municipal Council have received another request for a tramway concession.

It is stated that the would-be concessionaire offers to supply £3,000,000 and procure as much again from Paris in return for a concession to construct the remaining tram lines and exploit all St. Petersburg trams for 39 years, paying a percentage of gross takings, not less than £300,000 annually, to the municipality, which will have the right to acquire the undertaking after 20 years on certain terms.

Switzerland.—An 80 years' concession has been granted to M. J. Cathrein, of Brigue, and M. a. Roemer, of Paris, for the construction of a narrow-gauge electric railway (partly on the rack and pinion system) from Brigue, via Riederalp and Eggishorn to the Aletsch glacier.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Tenders are wanted by May 19 for supply of six 60 kw. single-phase transformers, and by May 26 for 1,024,000 arc lamp carbons and for 6,000 metal filament incandescent lamps for the City of MELBOURNE electricity department. Tender forms, specification, conditions of tender, &c., from the Agents for the City Council, Messrs. McIlwraith, McEacharn & Co. Proprietary (Ltd.), Billiter-square Buildings, London, E.C. See also advertisements.

Tenders will be received at the Town Clerk's office, AUCKLAND, N.Z., until 4 p.m. of Thursday, June 15, for supply and erection of machinery for the new power station, including water-tube boilers, feed pumps, economisers, conveyor and steam pipes, and induced draught plant; d.c. steam generators, condensers, auxiliary machinery, engine-room crane, circulating pumps and pipes and switchboard. Specifications and drawings at the offices of the High Commissioner for the Dominion of New Zealand, 13, Victoria-street, London, S.W. See also an advertisement.

Tenders are invited up to May 30 for the supply of one portable petrol-driven desiccating plant to the Postmaster-General's department in Victoria, and up to May 31 for the supply of 7,000 insulators and wire and line material to the Postmaster-General's department in SOUTH AUSTRALIA. Tender forms and specifications from the Commonwealth Office, 72, Victoria-street, London, S.W.

Tenders will be received at the office of the Receiver-General and Director of Contracts, Valetta, MALTA, up to 11 a.m. of Thursday, May 11 for the supply of arc lamp carbons. British tenderers not having representatives in Malta must make a deposit of £10 in the office of the Crown Agents for the Colonies. Particulars, specification, &c., may be obtained at the office of the Receiver-General and Director of Contracts (Mr. C. Pace Bardon), or from the Crown Agents for the Colonies, Whitehall Gardens, London, S.W. See an advertisement.

Tenders are invited up to June 7 for the supply of 2 nauts single-core submarine cable to the Postmaster-General's Department in NEW SOUTH WALES. Tender forms and specification from the Commonwealth Offices, 72, Victoria-street, London, S.W. See also an advertisement.

The COMMISSIONERS OF H.M. WORKS AND PUBLIC BUILDINGS invite tenders (from manufacturers) for supply of opal lamp shades during three years, and also tenders (from manufacturers) for supply of electric gas torches during one year. Tenders by 11 a.m. on Wednesday, May 10, to the Secretary, H.M. Office of Works, &c., Storey's Gate, S.W.

SOUTH SHIELDS Corporation want tenders by May 24 for supply and erection of 1,500 kw. high-pressure steam turbine (with surface condenser and pumps) coupled to 1,000 kw. d.c. generator (with switch panel, &c.) and 1,100 kw. a.c. generator (with switch panel, &c.). Specification, &c., from the Borough Electrical Engineer.

The Corporation of HASLINGDEN invite tenders for supply and laying of extra high pressure trunk mains, with medium pressure feeder and distribution cables. Tenders to Mr. W. Musgrave, town clerk, Hsalingden, by noon Friday, May 5.

MARGATE Corporation require tenders by 1 p.m. May 8, for the electric lighting of concert pavilion and other buildings at the Fort. Particulars from the Borough Surveyor, 13, Grosvenor-place, Margate.

ST. PANCRAS (London) Borough Council invite tenders for three-phase h.t. cable and for stoneware ducts. Tenders to the town clerk, Mr. C. H. F. Barrett, Town Hall, Pancras-road, N.W., by noon, May 1.

ILFORD Council require tenders by noon May 9 for the supply of distributing switchboard, feeder cable and stoneware conduit. Specifications, &c., from Mr. A. H. Shaw, Electricity Works, Low-street, Ilford.

BARNES Council require tenders by noon May 9 for the supply and erection of combination de-oiling, softening and feed heating plant. Specification, &c., from the Engineer, Electricity Works, Mortlake.

COLWYN BAY and COLWYN COUNCIL require tenders by May 3 for one year's supply of cables and accessories, engine room stores, prepayment and ordinary meters. Forms of tender from the Clerk.

EDINBURGH School Board want tenders by 10 a.m. May 1 for the electric lighting of a new school in Duncan-street, Edinburgh. Specifications from Mr. J. A. Carfrae, 3, Queen-street, Edinburgh.

BARKING Council require tenders by 7 p.m. May 10 for extension of electricity works. Plans, &c., at the office of the Surveyor on and after May 1.

Tenders are invited up to July 25 for the supply of 12 sets of a branching multiple magneto lamp signalling switchboard, or one automatic or semi-automatic switchboard, &c.; and up to June 14 for supply of a branching multiple magneto lamp signalling switchboard at Ballarat, for the Postmaster-General's Department in VICTORIA; and up to June 14 for supply of a c.b. multiple switchboard to the Postmaster-General's Department, SOUTH AUSTRALIA. Tender forms, &c., from 72, Victoria-street London, S.W.

The Ministry of Public Works, Constantinople, will receive tenders until July 15 for the construction of electric tramways and for electricity supply in the town of ALEPPO. Specification from the Ministry of Public Works on payment of 9s. Local representation practically indispensable.

TENDERS RECEIVED AND ACCEPTED.

Stoke-on-Trent Electricity Committee have accepted the following tenders:—

British Westinghouse Co., two 600 kw. rotary converters, and two 300 kw. ditto, £1,310; Bruce Peebles & Co., two 500 kw converters, £2,250.

20 tenders were received (varying from £884 to £1,225) for supply of generating plant and for wiring at St. Patrick's College, the Bishop's House, Cavan, and the lowest (that of Macready & Co.) has been accepted.

The tender of Sutherland & Ashman has been accepted for supply of a dynamo, switchboard, and battery to the Tatura Factory Co. for the public lighting of Tatura (Victoria) at £1

The Chloride Electrical Storage Co. have secured the contract for a storage battery of 250 cells (1,200 ampere-hour capacity), booster and switchboard, for the Leith Docks.

Salford Corporation received four tenders for the supply and erection of fire and police alarm street boxes and switchboard; the contract has been let to the Gamewell Fire Alarm Co.

Southend Corporation have accepted the tender of the Darlington Eastern Steel Co. for supply of 750 tons of steel rails, at £6 per ton.

Southend Council have accepted the tender of Calleade Engineering and Construction Co. for 20 tons of copper cable.

Aylesbury Council have accepted the tender of E. T. Wright & Son for electrical work for a year.

Edinburgh Corporation have again accepted the tender of the Sebastian Meter Co. for a years' supply of 5 ampere meters.

Pigott Bros. have secured the contract for electric illumination at the Bank of England on Coronation day.

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The New South Wales Government received 24 tenders (from 12 firms) for coal loading plant (capable of putting 750 tons of coal per hour into vessels) for the jetties at Port Kembla (N.S.W.).
The tenderers included English, German, American and Australian firms, and, although alternative tenders were submitted, the tenderers agreed that the general lines laid down by the chief engineer of Harbours and Water Supply (Mr. E. M. de Burgh), for conveyors similar to those at the N.E.R. Co.'s Hull Docks, were the most suitable. The tender of Kelly & Lewis (about £30,000) has been approved by the Adviser in charge of the Department. The tenderers also included Armstrong, Whitworth & Co., Spencer & Co., Robins & Co., and the Jeffrey Mfg. Co. (U.S.A.). The plant will be operated electrically.

Electricity in Rolling Mills.—Messrs. Crompton & Co., London and Chelmsford, have received a contract from Messrs. Vivian & Sons, of Hafod, near Swansea, for the electrification of their copper rolling mills. The rolls, which are continuous running, are to be driven by two 300 H.P. motors running at a speed of 150 revs. per min. The contract also includes a 1,000 ampere storage battery with automatic reversible booster of the Chelmsford type. The battery is provided to deal with the peak loads of the motors and give a steady load on the generating plant. A complete set of switchgear and cable work is also included. The motors will drive the mills through ... double helical gear.

Electric Power Plant.—The Darlington Forge Co., which is extending its power plant, have placed an order with Messrs. C. A. Parsons & Co. for a 750 kw. direct-current turbo-generator.
The turbine, of the mixed pressure type, is designed to give full output at 160 lb. per square inch, vacuum 28 in., and will use with full efficiency low pressure steam at 140 lb. per square inch whenever the supply of exhaust steam is insufficient, the high and low pressure parts of the turbine being combined in one casing. The three existing Allen engines are coupled to 250 kw. generators, and will run non-condensing and supply steam to the turbine, provision being made for them to exhaust direct to the condenser in times of light load. The dynamo is of the four-pole type fitted with compensating winding and carbon brushes, and supply current at 220 volts.

BUSINESS NOTICES.

The title of Messrs. Vickers, Sons & Maxim, River Don Works, Sheffield, and at London, Barrow-in-Furness, &c., has now been changed to Vickers Limited.

Messrs. Babcock & Wilcox (Ltd.) have removed their Calcutta office into Clive Buildings, 8, Clive-street.

The Adams Mfg. Co. have concluded arrangements with Messrs. ... & Wuthrich, Technisch Bureau, Haarlem, to act as their agents for Holland and Java, for the sale of their motor starting and controlling apparatus.

Edward Lawley Pinching and Walter Hy. Walton, electrical engineers, 22, Cannon-street, London, E.C., have dissolved partnership. ... Mr. Walton, who continues as Pinching & Walton.

Messrs. Rodgers Bros. have acquired as a going concern the gear cutting business of J. B. Hamilton & Co., which they have ... their own business of gear specialists and general engineers. ... have recently erected modern works at Baker-street, ... London, S.W., and have appointed Mr. P. F. Brittain (who ... connected with Messrs. Hamilton) as their sole agent for the sale ... gears, with offices at 110, Cannon-street, London, E.C.

Patents Development.—The proprietors of the following British ... desire to license British manufacturers to work same in Great Britain:

No. 11,347/07, for "A telephonic dictating system."
No. 11,754/07, for "Telephone transmitters."
No. 11,343/02, relating to "Sound concentrating and focussing apparatus."

... in each case from Messrs. Boult, Wade & Tennant, Chartered Patent Agents, 111 and 112, Hatton-garden, London, E.C.

Garcke's Manual of Electrical Undertakings.—Each succeeding issue of the "Manual of Electrical Undertakings and Directory of Officials," which is compiled under the direction of Mr. Emile Garcke, M.I.E.E., F.S.S., shows an expansion and an increase in size, and the 1911 issue (Volume XV.) of the work is no exception to the rule, as it contains statistical and general technical ... about 3,000 undertakings. For all matters relating to the position of electric lighting and power undertakings, ... railways and tramways it is undoubtedly one of the most ... authorities we are acquainted with. The information and ... are the latest available in every case, and the whole ... evidence of careful compilation.
The information is classified into eight sections, viz., Electric Lighting and Traction, Telegraph and Telephone, Manufacturing ... Colonial and British Possessions, List of other companies registered since 1856, Directories of Officials, Members of Electric Lighting and Tramway Committees and of Electrical Contractors, Index of Undertakings and Buyers' Guide. It is impossible to do justice to the Manual in the space at our disposal, but it may be stated that sections I. to V. contain a record of all electrical companies formed under the Joint Stock Acts and of all electrical undertakings belonging to Local Authorities in Great Britain and Ireland, and of electrical undertakings in the Colonies and all British Possessions. The section devoted to "Progress of the Year" contain much interesting historical and other matter, and there are useful comparative summaries covering the financial results of electric lighting and traction undertakings, summaries of the 1911 Bills and Provisional Orders, many interesting maps of tramway systems, &c. The Manual forms a very valuable work of reference, and it is published at 21s. nett by the Electrical Press (Ltd.), 37 and 38, Strand, London, W.C.

Typewriter Progress.—One of the most popular typewriters in use in this country is the Bar Lock. In the latest form of this machine many useful and novel features have been introduced, and the machine, always in the front rank, is more than ever deserving of the position. There is no better indication of good business and good progress than the extension of business premises, and this is the gauge of the business activity of the Barlock Typewriter Co., and its indefatigable managing director, Mr. W. J. Richardson. The Company has just moved into handsome new offices and factory premises at Bar Lock Buildings, Southwark-street, London, S.E., and Prices-street, Southwark, S.E., respectively, where there are four telephone lines (6,747 City). The show rooms remain at 12 and 14, Queen Victoria-street, E.C.

BANKRUPTCIES, LIQUIDATIONS, &c.

The adjourned first meeting of creditors in the bankruptcy of Walter Wm. Crawford, consulting engineer, 22, Henrietta-street, Covent Garden, W.C., took place on Tuesday.
Liabilities were returned at £21,220 with a deficiency of £3,631. Debtor attributed his insolvency to loss and liabilities incurred in connection with companies (including the Crawford Electric Lamp Synd.) and other undertakings in which he had become financially interested, and with which he became connected in the course of his business.

Alphonse C. A. Wampach, electrical engineer, Formby Lodge, Seabrook-road, Hythe, has been adjudicated bankrupt.

A meeting of creditors of Arc Lamps (Ltd.) (in liq.) will be held at the offices of Messrs. Corfield & Cripwell, Balfour House, Finsbury-pavement, London, E.C., on May 9.

The discharge of Jas. Marshall Vaughan, electrical engineer, Three Queen's-lane, Bristol, is suspended for two years, ending March 24, 24, 1913.

The Rhondda Tramways Construction Synd. (Ltd.) is being wound up voluntarily. Mr. L. B. Schlesinger, 21, Cornhill, London, E.C., and Mr. W. B. Cowrie, Queen Anne's-chambers, London, S.W., have been appointed liquidators.

A meeting to receive an account of the winding up of the Synchronised Electric Clocks C. (Ltd.) will be held on May 31 at 11, Waterloo-place, Leamington Spa.

A meeting to receive an account of the winding-up of the Sylverlyte Electric Lamp Co. (Ltd.) will be held on May 27 at 46, Culverden-road, Balham, London, S.W.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application, an asterisk is affixed.*

February 21, 1911.

4,332 Fournier-d'Albe. Selenium cells.
4,356 Lauder. Securing shades and lamps to electric lamp sockets.
4,385 Justice. (American Automatic Switch Co., U.S.) Operating electric railway tracks, points and switches.*
4,397 Oesterreichische Daimler-Motoren-Akt.-Ges. Overhead electric trolley wire construction. (Convention date, 22/10/10, Germany.)*
4,405 Karavodine. Secondary batteries or storage cells.
4,414 Grote. Electric sounders.

February 22, 1910.

4,431 Robertson. Electric signalling system for railways and the like.
4,443 Hall. Sparking points in sparking plugs for internal combustion engines.
4,444 Bennett. Tram-rails and the like.
4,457 Electric & Ordnance Accessories Co. & Collins. Time-limit or retarding devices for use in connection with electric circuit breakers.*
4,488 Chambers. Transmitter for signalling by electromagnetic waves
4,491 Kent & Mitchell. Supporting or suspending electric lamps and the like.
4,498 Kotyra. Electromagnetically controlled perforating mechanism.*
4,521 Peto & Radford & Genese. Combined double and single pole switch.

February 23, 1911.

4,602 Timar & Presser. Closing of the seams of tubes by electrical resistance welding. (Convention date, 20/5/10, Germany.)*

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4,618 KESSELRING. Circuit connections for electric current distribution with transformers.*
4,623 ALLGEMEINE ELEKTRICITATS-GES. Suspension of electric conductors. (Convention date, 24.2.10. Germany.)*
4,627 HEYLAND. Starting and regulating the speed of alternating-current motors. (Convention date, 24.2.10. Germany.)*

February 25, 1911.

4,805 WATSON. Attachment for wires used for electrical conduction and other purposes.
4,895 PARKES. Construction of electric relays.*

February 27, 1911.

4,821 DOWDELL & HECHT. Electrically-operated signs.
4,827 COX. Curves on tram routes or light railways.
4,870 & 5,154 DORWALD. Incandescent electric lamps.
4,889 FERY. Electric clocks. (Convention date, 1.3.10, France.)*
4,911 KOOPMAN & PONTELEC WELDING PATENTS. Transformers. (Divided application on 10,964/10, April 30.
4,915 AKT.-GES. BROWN, BOVERI ET CIE. Astatic control of electric regulators.*
4,917 DAHL-JENSEN & AKT. BING & GRONDAHL'S PORCELLAENSFABRIK. Press-moulds for the manufacture of insulators with more than one petticoat.*
4,920 FAIELLA. Telegraphic systems. (Convention date, 27.2.10, Italy.)*
4,922 WEYMOUTH. Electrical contact device for mine or other signalling.*

February 28, 1911.

5,005 & 5,012 ELECTRIC & ORDNANCE ACCESSORIES CO., LANGLEY & PRICE. Electric circuit controlling apparatus for train lighting and similar systems.
5,051 "Z" ELECTRIC LAMP MFG. CO. & HOLT. Manufacture of incandescent electric lamps.

March 1, 1911.

5,111 STROHMENGER. Electric arc welding.
5,135 STREET. Screwed nuts for securing electrical wires or other purposes.
5,142 EVERSHED & VIGNOLES (LTD.) & EVERSHED. Measurement of the specific resistance of electrical conductors.
5,165 & 5,167 B.T.-H. CO. (G.E. CO., U.S.) Insulating material.*
5,166 B.T.-H. CO. (A.E.G., Germany.) Control of electrically-driven printing presses and the like.
5,177 THORNTON. Flexible electric conductors.
5,187 BALSILLIE & BRITISH RADIO-TELEGRAPH & TELEPHONE CO. Spark-dischargers for wireless telegraphy.
5,189 MERZ & HUNTER. Electric current distributing systems.
5,190 BERRY. Electrical transformers.

March 2, 1911.

5,227 ACTON LAMP CO. & LOWDEN. Incandescent electric lamps.
5,228 TURNER. Overhead conductors of electric tramways, railways and rail-less road carriages and the like.
5,247 SIEMENS-SCHUCKERT WERKE G.M.B.H. Cooling of rotors of electrical machines. (Convention date, 2.3.10, Germany.)*
5,248 EPICH F. HUTH G.M.B.H. & HIRSCH. Wireless telegraphy. (Convention date, 3.8.10, Germany.)*
5,253 SIEMENS BROS. & CO. & BRADLEY. Searchlights or projectors.
5,259 RUSING. Electrical telescopy.*
5,267 WESTON. Electrical measuring instruments. (Divided application on 17,091/10, July 18.)*
5,289 B.T.-H. CO. (A.E.G., Germany.) Control of electric motors.*

March 3, 1911.

5,309 TOPPIN. Water heating by means of electricity.

March 4, 1911.

5,418 BYNG & COLLINGS. Electric light standards.
5,442 DAY. Electrical contact-making devices.
5,457 MARS. Generation, transformation and utilisation of electric energy.†
5,458 CURTIS & ADAMS MFG. CO. Electrical resistances.
5,459 TRIER. Dynamo-electric machines for motor vehicles.
5,490 LAKE. (United States Light & Heating Co., U.S.) Automatic regulators for electric circuits.*
5,502 BLONDEL. Automatic arc lamp for light projections.*

SPECIFICATIONS PUBLISHED.

1909 SPECIFICATIONS.

30,030 VON LEFEL & BURSTYN. Production of pulsating high-frequency electric currents. (23.12.08.)
30,101 TURNER & FENWICK. Contacts for contact-breakers.
30,491 LEBEDENKO. Sockets for electric cables. (18/6/10.)

1910 SPECIFICATIONS.

2,062 HRAB. Secondary batteries.
4,273 STROMBERG & WILLIS. Electric meters.
4,320 HARDY & HUNGERBUHLER. Electrical accumulators.
4,467 ELDRED. Electrical lamps and other goods having leading-in wires sealed through them.
4,669 DRYSDALE. Electrical transmission dynamometer.
5,048 HINSKY. Insulating conduits for electric wires or conductors.
5,133 FESSENDEN. Wireless electric signalling.
5,221 MORRIS & LISTER. Electrical switches and the like. (Addition to 21,938/07.)
5,383 MURDOCH. (Robinson.) Devices for connecting telegraph, telephone and other wires or conductors to their insulators or supports.
5,388 LEDERER & WESTINGHOUSE METAL FILAMENT LAMP CO. Manufacturing metal filaments for incandescent electric lamps. (Addition to 6,936/09.)
6,719 BRIDGE. Automatic make-and-break contact devices for electric circuits.
6,065 ELY & FOSTER ARC LAMP & ENGINEERING CO. Electric water-heaters.
6,654 SIEMENS BROS. & CO. (Siemens & Halske Akt.-Ges.) Automatic telephone exchanges.
6,791 B.T.-H. CO. (A.E.G., Germany.) Regulating valves and the like.
7,361 COOPER & BRITISH INSULATED & HELSBY CABLES. Automatic cradle switches for table and wall telephone instruments and the like.
7,587 GODDARD. Prepayment electricity meters.
8,363 BATCHELDER. Electrically-driven vehicles. (7/4/09.)
9,722 WRIGHT. Name indicators for telephone users and like purposes.
10,722 BURROWES. Electrostatic voltmeter.
11,275 BAKER & LONGSTRETH'S (LTD.). Holders for electric incandescent lamps. (29/11/10.)
12,265 B.T.-H. CO. (G.E. Co., U.S.) Electric motor-control systems.
13,535 RIDINGS. Arc lamps. (Cognate application, 15,086/10.)
15,031 PRESSER. Regulation of the welding heat in electric welding. (Addition to 14,859/10.)
15,032 PRESSER. System of connection for electric welding by continuous current and the use of condensers. (Addition to 14,859/10.)
16,841 AUGUST SCHWARZ. Arc lamp for two or more pairs of electrodes. (28/7/09.)
17,165 LAKE. (Crawford.) Machines for running fish wires through electric conduits and the like.
19,465 HAWKES. Electric heating and/or cooking stoves.
19,593 GIBBS. Making wire electrolytically. (4/9/09.)
21,451 VON KRAMER. Inductive wireless telephone installations. (Cognate application, 22,156/10.)
22,412 FAIRWEATHER. (Stein.) Electric switching device.
22,888 SCHMIDT. Charging of storage batteries.
24,158 SIEMENS BROS. & CO. & FERREIRA. Signalling on single-line railways or tramways.
24,851 SOC. ANON. "PHI." Commutator switches. (6/8/10.)
25,964 SIEMENS BROS. DYNAMO WORKS. (Siemens Schuckertwerke Ges.) Starting and speed regulation of polyphase electric motors.
30,138 B.T.-H. CO. (G.E. Co., U.S.) Electric rail bonds.

COMPANIES' MEETINGS AND REPORTS.

Indo-European Telegraph Co. (Ltd.)

The forty-fourth ordinary general meeting of this Company was held yesterday under the presidency of Mr. CHARLES HOLLAND.

The SECRETARY (Mr. John I. Bethell) read the notice calling the meeting and the auditors' report.

The CHAIRMAN said: Gentlemen, the year 1910 has been an uneventful one and, a matter that probably interests you more closely, a prosperous one, as you will have seen from the accounts in your hands. We have, I am glad to say, been singularly free from interruptions. The trouble that was chiefly exercising our minds last year—namely, the breaking by trawling vessels of the cables upon which we rely for our communications across the North Sea—has not visited us this fishing season, a thing for which we must be thankful. It is, however, none the less evident to the Directors that additional accommodation is required in that direction, and we are still in communication with the General Post Office on the subject. Cables are always liable to breakage from this cause, and the trouble may recur during any fishing season, when one or more cables may be interrupted. It is then that the necessity for additional facilities is most felt. We have been free from interruptions even in the most troublesome portion of our system, in South Russia, except for a period of 10 days during February last, when our wires in the Caucasus collapsed under the weight of snow, which lay to a depth of from 5 ft. to 10 ft., the result of a succession of blizzards of unprecedented severity. Once this was made good, and thanks to the efforts of our maintenance staff it was done very quickly, our troubles came to an end, and we have, I am glad to say, had no serious recurrence. The Directors still intend, when a favourable moment arrives, to add to our carrying capacity throughout our system, and have recommended a further appropriation with this object. Our daily direct working London-Karachi continues to be a most valuable asset, and it is really wonderful how much traffic can be carried in this manner with the accommodation at our disposal. The necessary assumption is, of course, that a long line, such as ours, of 4,000 miles, must be kept in the highest state of efficiency in order to fulfil it object, and that, I am glad to say, is the case. Our esteemed friend, Mr Stratford-Andrews, the Managing Director, is continually experimentin with new methods and new instruments, and you may rely upon it tha everything he can introduce to do justice to the traffic is done.

There have been no serious reductions of tariffs during the year, but should mention that the Directors have with pleasure signified their con currence in proposals placed before us, in common with other companie by the Postmaster-General, to enable senders of telegrams in plain la guage to do so over certain routes at considerably reduced rates, subje only to deferment to the daily general class of fully-paid telegrams. Th proposal was considered by a committee appointed by those interested, which Mr. Stratford-Andrews was a member. The details still remain be worked out. The casual sender of the usually short telegram of family or social nature will have things made easier for him. The me chant, with his complex codes, is already, in our opinion, sufficient provided for. Our receipts from traffic continue to be very satisfacto not only those from what we used to regard as our mainstay—namely, t Indian and trans-Indian traffic—but from the South Russian, Turk and Persian traffic. The pronounceable-combination system of code still with us unfortunately, and adds not only to the number of offic repetitions asked for, which is an ever-increasing evil, but to the anxie of the clerks who transmit them. The Directors have recognised good work done by them and by the officers and staff generally by vot them a bonus of about £3,400. We think it is fitting that the staff sho at reasonable intervals of time receive some encouragement of this k when things are going well with the Company. I may mention that last bonus was distributed six years ago.

Turning to the accounts in general, the revenue from message rece and other sources, as shown in the revenue account, shows a satisfac increase of £9,945. 6s. 3d. The combined commercial and maintena expenses show an increase of £2,573. 3s. 4d., which, however, is expla by the inclusion of the bonus to the staff of £3,406. The balance-sheet tains no additional features calling for remark, though the item of sur credit balances shows an increase over last year of about £22,000, the item of which is the £15,000 allocated during last year towards increa the carrying capacity of the system and not yet expended. The Direc after providing £4,627. 13s. 8d. for depreciation of investments durin year, propose the usual final dividend, absorbing £14,875, and bon 20s. per share, or £17,000, and have again decided to recommend a s distribution out of interest upon certain investments and advanc counts of 15s. per share, free of tax in each case. There remains a cient surplus to enable them to propose the allocation of a sum of £2 towards the cost of increasing the carrying capacity of the system, brings the fund available for that purpose to £35,000. It has not found necessary at present to make any further grant to the retire fund, which is already represented by investments to the total va over £40,000—a result which, thanks to the generous contributions shareholders, will go far towards the object required of it. We, fore, carry forward to the credit of 1911 the sum of £11,327. 10s. is all I have to say as to 1910. The three working months of 19 which figures are available, show an increase of revenue, even figures lain before you to-day, so that, assuming that working con remain favourable during the rest of the year, you may possess you in peace.

On the subject of our Articles of Association, the Company's sol who have often directed our attention to this matter, have now mended that the entire set of articles should be re-drafted. With t

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...tors have expressed their agreement, and the work has been taken ...nd. These will be presented to you for adoption at an Extraordinary ...al Meeting, to be held at an early date. I now move the adoption ...the report and accounts, and the declaration of the dividend, bonus, and special distribution set out therein.

Sir WILLIAM R. BROOKE, K.C.I.E., seconded the resolution, which was carried unanimously.

The re-election of the retiring Directors, Mr. J. H. Tritton and Baron ... von Berenberg Gossler was then approved, and the retiring auditors ...re-appointed.

A cordial vote of thanks to the Chairman, Directors and staff, to which the Chairman returned thanks, brought the proceedings to a close.

BABCOCK & WILCOX (LTD.)—At the meeting on Friday the chairman (Mr. J. Dewrance) said that the net profits for 1910 were £362,360, compared with £360,000 in 1909, although the output had been considerably larger. After payment of a dividend of 3 per cent. on the preference shares, a dividend of 8 per cent. on the ordinary shares, and a bonus of 8 per cent. on the ordinary shares, and placing £100,000 to reserve, £25,000 to dividend equalisation fund, and £10,000 to staff pension fund, the balance (£63,642) was carried forward. During the year they had made many improvements in the works, and, in the way of carrying out the work, great improvements had been made in the ...ty of various articles and reducing the cost. All these benefits had been given to consumers of their goods, as the net profits were ...than in previous years. That was, unfortunately, the trend of ...industrial concerns, and it was what the shareholders must expect ...the future.

BRISBANE ELECTRIC TRAMWAYS INVESTMENT CO. (LTD.)—At the ...on Wednesday the Chairman (Mr. H. R. Beeston) said that they ...a dividend of 8 per cent. The number of passengers carried ...2,419,276, an increase of 2,686,938. The increase in car-miles run ...22,235, or 6·09 per cent. The increase in working expenses was 10·18 per cent., due partly to increased mileage and partly to increased cost of ...owing to the general rise in wages. Many newly-erected ...with wool stores were now taking current from them. The ...Steamship Co. was installing an electric crane and the new ...Loan & Mercantile Agency Co. and the Australian Estates Co. ...stalled electric wool conveyors and stackers, all operated from their ... The prospects for the current year were good. Their receipts ...first quarter of the current year showed a total increase of £6,061.

BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. (LTD.)—The ...report for the year ended Dec. 31, 1910, states that there has ...considerable improvement in the volume of business obtained ...year, and though, owing to severe competition, the prices ...have not been higher, the results of the year's trading show a ...advance on previous years. The trading, &c., profits amount to ...8. 11d., from which fall to be deducted depreciation on ...plant, &c., £24,423. 11s. 6d. (in addition to £5,550. 8s. 1d. ...general depreciation), expenses on surplus land and build... £74. 13s. 5d.), interest on 6 per cent. prior lien debentures ...and on 4 per cent. mortgage debenture stock (£49,654. 2s. 4d.), ...balance of £18,738. 12s. 8d. From this balance has to be ...amount required for prior lien redemption fund (£5,642), and ...expenses of issue of prior lien debentures (£660), leaving ...12s. 8d. Deducting from this the debit balance brought for... 12s.) there is a net credit balance of £5,117. 0s. 8d., which ...should be carried forward. A substantial sum has been ...out of revenue during the year for maintenance of build...ry and plant, and £24,423. 11s. 6d. further has been applied ...of same items. During the year the increased demand ...by the export market has continued, and has extended ...market. The orders for the current year show a consider... over those for the corresponding period of 1910. At the ...ference was made by the chairman to a pending arbitra... large sum. The award was given in March last, and has ...adverse to the company. The directors have been ...and the matter is, therefore, still sub judice. The ...have been elected to seats on the board to fill existing ...Messrs. Norman B. Dickson, C. A. Park and W. W. Blunt.

CITY OF BIRMINGHAM TRAMWAYS CO. (LTD.)—After providing ...year's interest on debentures and the dividend on the pre...shares paid and accrued up to Dec. 31 last (£10,000), the ...a surplus of £44,327. 7s. 4d.; deducting interim divi...rate of 10 per cent. per annum paid on the ordinary shares for ...months ended Sept. 30 (£6,314), the disposable balance is ...4d. The directors recommend that the surplus be applied ...dividend on the ordinary shares at rate of 10 per cent. per ...the three months ended Dec. 31 last (making, with the ...10 per cent. for the year), the balance (£36,513. 5s. 4d.) ...to reserve. £4 per share on the fully-paid ordinary ...been repaid, and the directors offered to accept the £4 ...as money paid in advance of calls, and to allow ...per cent. per annum. £7,252 has been deposited under ... The traffic receipts, compared with the previous ...increase of £3,766. 2s. 9d., while the receipts from ...interest on investments show an improvement of ... On June 30 next the company will lose several ...including the cable tramway and the tramways in ...roads, owing to the expiry of leases from the City ...and the Councils of Handsworth and King's Norton. ...Corporation have in view the construction of electric ...and in consequence of the uncertain value of the investment in the Birmingham & Midland Motor Omnibus Co., the directors recommend that it should be written down out of reserve to £5,000. Negotiations have proceeded with Handsworth Council in regard to the terms and conditions of the lease of the cable tramways, but, failing agreement, the matter was submitted to the arbitrament of the Right Hon. A. Lyttleton, K.C., and the terms of the lease for working the lines until June 30, 1911, have been settled. Negotiations have been continued with Aston Corporation to settle the terms of the lease to be taken by the company of the tramways in Aston, but the matter is not yet concluded.

CITY OF BRISBANE ELECTRIC LIGHT CO. (LTD.)—At the recent meeting it was reported that the result of the half-year's working, to Jan. 31, was a credit balance of £5,341. 19s. 5d. After payment of the preference dividend, the directors recommend a dividend at the rate of 10 per cent. on the ordinary shares and at the rate of 10 per cent. on the contributing shares. Also a bonus at rate of 2½ per cent. on the ordinary and contributing shares. The balance forward was £2,179.

ELECTRICAL DISTRIBUTION OF YORKSHIRE (LTD.)—Mr. R. W. Wickham, who presided at the meeting on Tuesday, said that there had been a considerable increase in the number of consumers during 1910. At the beginning of the year 83 applications had been received, and at the end of the year they had 201. Applications were still coming in in the same satisfactory manner, so that a further increase in the profit available for dividend might be reasonably anticipated as a result of this year's trading. There had been no increase in the number of shares allotted, but the amount owing to sundry creditors had grown from £5,363 to £9,877. That had been mainly caused through capital expenditure incurred in laying mains and in additional service mains in districts where a supply was commenced before 1910. The directors had made temporary arrangements with the Yorkshire Electric Power Co. to borrow capital sufficient to commence the development of the Distribution Company's undertakings. The Power Company had shown their confidence in the future of that company by agreeing to take ordinary shares at par in payment of the greater part of the amount owing at the end of 1910, bringing up the issued share capital to £17,000. A dividend at the rate of 2½ per cent. was declared.

WM. GRIFFITHS & CO. (LTD.)—At the meeting on Wednesday the Chairman (Mr. R. H. Burdett) regretted that the result of the year's trading had not been more favourable. The rearrangement of the capital was successfully carried out and every share in the old company had been exchanged. During the past few months they had secured a considerable amount of work, and he was hopeful that this year would result in a considerable increase in turnover and in profits.

OLDHAM, ASHTON & HYDE ELECTRIC TRAMWAY (LTD.)—The directors' report for 1910 states that the total revenue was £31,008. 15s. 2d., and the expenditure (including £1,600 for debenture interest and £1,000 placed to renewals account) amounted to £24,174. 3s. 5d., leaving a net profit of £6,834. 11s. 9d., which, added to £66. 19s. 10d. brought forward, makes an available balance of £6,901. 11s. 7d. The directors propose that £1,250 be placed to reserve, and after paying dividend at rate of 5 per cent. per annum on the cumulative preference shares (£2,500), a dividend on the ordinary shares at the rate of 7 per cent. per annum for the six months ended Dec. 31 (making with the interim dividend paid on August 15, 1910) 6 per cent. for the year) (absorbing £3,000), leaving £152 to be carried forward. The state of trade in the district during the year was unsatisfactory, and there was a decrease in traffic receipts, compared with 1909, of £56. 7s. 4d. Owing, however, to economies effected the net profit has been increased by £467. 10s. 5d.

ORIENTAL TELEPHONE & ELECTRIC CO. (LTD.)—At the meeting on Monday the chairman (Mr. B. St. John Ackers) said that the proposed dividend (8 per cent.) was a handsome one. The increase in their business continued unabated, and they could not escape further large outlays of capital. Considerable expenditure had to be incurred last year for new construction at their exchanges at Rangoon, Madras, Singapore, &c., and was continuing this year, while a further £10,000 was advanced to the Bengal Telephone Co. for their most urgent extensions. The proposal to take over the present Government telephone system in Calcutta and to supply the Government in future with all telephone accommodation required was of much importance. It was only prudent to keep in hand any funds not required for their own extensions; so that if an agreement with the Indian Government was eventually reached, the necessary funds might be fothcoming to complete the purchase. Spread over the next few years a considerable capital outlay would also be required for Mauritius, where they had secured a 30 years' concession for the whole island. The revenue to accrue from that outlay was, they considered, satisfactory. Owing to those calls on their resources a larger dividend than 8 per cent. was not at present desirable.

PEARSON FIRE ALARM (LTD.)—At an extraordinary meeting on Monday a scheme for the amalgamation of the undertaking with the May-Oatway Fire Appliances (Ltd.) and the formation of a new company to be called Automatic Fire Alarms (Ltd.) was approved. The chairman (Mr. A. D. Fairbairn) said that the two companies protected property valued at £50,000,000. It was hoped that, as a result of co-operation, they would be able to induce the tariff insurance companies to increase the inadequate rebate allowed to those who used fire alarms, and when the amalgamation was completed an application for an increased rebate would be pressed. The amalgamation would also enable them to obtain better terms from contractors and to institute considerable economies. The shareholders of the May-Oatway had approved the scheme.

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RIO DE JANEIRO TRAMWAY, LIGHT & POWER CO. (LTD.)—The net revenue for 1910 was $5,433,576 after deducting operating, maintenance and other expenses in Rio de Janeiro. The fixed and other charges of the subsidiary companies and the fixed charges, interest and general expenses of the company, amount to $3,096,434, leaving a surplus of $2,337,142, making with the amount brought forward ($1,707,935) a total of $4,045,078. The board have appropriated $250,000 as sinking fund on the first mortgage bonds, $300,000 to general reserve, two quarterly dividends of 1 per cent. each and two of 1½ per cent. each (absorbing $1,462,438) have been paid and the balance ($2,032,640) has been carried forward. As the tramway construction was completed in the first quarter of the year and the remainder of the lines operated by mule traction discontinued on March 26, 1910, construction during the period under review has consisted chiefly of the extension of the electric light and power distribution systems in the city and federal district and the erection of the new gas works. As a result of the complete electrical equipment of the entire system, the operation of the tramways department has been conducted in a much more efficient, rapid and economical manner than in previous years, with the result that the service has been very satisfactory and the gross revenue has steadily increased. The suburbs are rapidly growing, due to the increased facilities afforded by the tramways, and this should very materially increase the revenues of the suburban tramway lines in the next few years. During the year 68 13-bench motor cars were manufactured in the company's shops and put into service, and a large addition has been made to the company's equipment in its freight department. The tramways of the Jardim Botanico Co. are now consolidated with this company's system under an operating contract. By the consolidation of the two systems and the substitution of hydraulic power in place of steam on the Jardim Botanico system, a material saving in the cost of operation has been effected.

The business of the telephone department has progressed satisfactorily, there being 4,859 subscribers connected up on Dec. 31, 1910 against 3,991 in 1909. The reconstruction of the old telephone service has been continued, the greater part of the lines having been rebuilt, and a large amount of new work has been done to meet the growing demands in the suburban districts. The central sub-station in the Villa Isabel and Jardim Botanico districts have been completed, bringing up the total switchboard capacity to 8,700 lines.

The electric light and power business continues to grow in a satisfactory manner—the distribution system in the underground and overhead sections has been greatly extended with the necessary transformer equipment and low-tension lines. At present the company has installed 30,589 kw. capacity in transformers connected to its overhead and underground systems. There have also been installed 2,905 street arc lamps in accordance with the terms of the gas concession, making a total of 3,522 street arcs in operation. While the sales of gas have not increased materially during the year, owing to competition from electric light, there has been a satisfactory increase in the number of consumers.

RIVER PLATE ELECTRICITY CO. (LTD.)—After providing for administration expenses, bad debts and all necessary depreciations, the accounts for 1910 show a balance of £45,026. 9s. 7d. Interest on the 5 per cent. debenture stock requires £10,000, leaving a surplus of £35,026, which, with £5,141 brought forward, made an available balance of £40,167. The directors propose that this sum be appropriated in paying a dividend at the rate of 6 per cent. for the year upon the preference stock and shares (£7,403) and a dividend of 10 per cent. for the year upon the ordinary stock (£12,000), adding £14,000 to general reserve, paying £875 as further remuneration to the directors and carrying forward £5,889. The whole share capital of the Rosario Electric Co., in which the company, since its formation, has held a large interest, has been purchased by the Société Financière de Transports et d'Entreprises Industrielles. This company received a price for its shares in excess of the price at which they were originally acquired and stood in the books of the company, and in respect of the transaction £41,000 has been transferred to general reserve, which now amounts to £85,000. The business, both at La Plata and Tucuman, has continued to grow throughout the year, and the prospects of further business in the current year are encouraging. In addition to the contract with the La Plata Electric Tramways Co. for the supply of power, the directors have recently concluded a contract with the National Tramway Co. of La Plata for the supply to that company of all the power necessary for its system. When the electrification of the latter (now in progress) is completed, the River Plate Co. will supply the entire tramway systems of La Plata and Ensenada. The erection and equipment of the important new generating station at Ensenada is nearing completion, and it will be in service in the early autumn.

SOUTH METROPOLITAN ELECTRIC TRAMWAY & LIGHTING CO. (LTD.) Mr. C. G. Tegetmeier stated at the meeting, on Tuesday, that the result of the year's working had been a surplus of £20,245, compared with £16,113 in 1909. They had a distinctly improving property. The scope for the reduction of working expenses was limited in one direction by the fact that they were compelled to take all their current from Croydon and Beckenham Councils. The company would make a considerable saving if they could generate current for themselves.

WEMYSS & DISTRICT TRAMWAYS CO.—The traffic receipts for 1910 were £13,576, a slight decrease compared with 1910. The total income for the year was £13,843, and, after paying interest on mortgage debenture stock, providing for depreciation and writing off £350 for special expenditure, the balance was £2,573, which is increased to £2,875 by adding the balance forward. The directors have paid the 6 per cent. dividend on the preference shares (£1,800), and they propose that the ordinary shares should be paid 6 per cent., leaving £275 to be carried forward.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES, &c,

NEW COMPANIES.

MERSEY POWER CO. (LTD.) (114,319.)—Reg. April 15, capital £250,000 in £1 shares, to acquire from G. H. Cox and H. J. Falk all or part of the undertaking authorised by the Runcorn Urban and Runcorn Rural Electric Lighting Order, 1910, from Widnes Corporation all or part of the undertaking authorised by the Widnes Electric Lighting Orders, 1901-10, and the benefit of a certain agreement. First directors are G. H. Cox, W. H. Alexander and H. J. Falk. Reg. office: Colonial House, Water-street, Liverpool.

RESISTO-ELECTRICAL ENGINEERING CO. (LTD.)—Reg. April 18, capital £7,500 in £1 shares, to carry on the business of manufacturers of and dealers in electrical apparatus of all kinds. Private company. H. W. Quittenden is the first secretary.

STATUTORY RETURNS.

ELLIS & WARD (LTD.)—Return to April 3 gives capital £10,000 in £1 shares. 6,003 shares taken up. £3 paid. £6,000 considered as paid on 6,000 shares. Mortgages and charges, nil.

LONDON ELECTRIC WIRE CO. & SMITHS (LTD.)—In return to March 8 capital is £420,000 in 70,000 ordinary and 14,000 preference shares of £5 each. 64,407 ordinary and 10,000 preference shares taken up. £35 paid. £372,000 considered as paid. Mortgages and charges, nil.

MORTGAGES AND CHARGES.

ALBERT DICKINSON (LTD.)—Particulars of £300 debentures, created April 12, have been filed, the amount of present issue being £200. Property charged: company's property, present and future, including uncalled capital. No trustees.

COWPER-COLES INVENTIONS DEVELOPMENT CO. (LTD.)—Particulars of £1,000 debentures, created by resolutions of June 1, 1906, and March 29, 1911, have been filed, the amount of present issue being £320. Property charged: company's undertaking and property, present and future, including uncalled capital. No trustees.

GAVAN INRIG (LTD.)—Particulars of £500 debentures, created March 14, have been filed, amount of present issue being £150. Property charged: company's undertaking and property, present and future, including uncalled capital. No trustees.

KILOWATT PUBLISHING CO. (LTD.)—Issue on April 1 of £112. 10s. debentures, part of a series of which particulars have already been filed.

SUN ELECTRICAL CO. (LTD.)—Particulars of £7,000 debenture stock, created by resolutions of March 21 and 31, and secured by trust deed dated March 31, have been filed, the amount of present issue being £6,875. Property charged: company's undertaking and property, present and future, including uncalled capital and leasehold premises. Trustees: R. T. Smith and H. Samson.

CITY NOTES.

MEMORANDA (April 27).—**Bank rate** 3 per cent. (March 9, 1911). **Price of silver,** 24⅛d. per oz. **Consols** 80⅞—81 for money; 80⅞—81⅛ for account. **Consols Pay Day,** May 4; **Stock and Shares Continuation Days,** May 10 and 29; **Ticket Days,** May 11 and 30; **Pay Days,** May 12 and 31; **Mining Shares Carry Over Day,** May 9.

PRICES OF METALS (London).—*Copper*, cash, 54⅞; three months, 54⅜. *Lead*, English, 13½—13⅝; foreign, 12⅞—12⅜ cash, 12⅜—13⅛ three months. *Spelter*, 23⅞—24⅛. *Tin*, English, 193—194; foreign, 194¾ cash, 190½ three months. *Iron*, Cleveland, cash, 46/6½, three months, 47/3.

CITY OF BUENOS AIRES TRAMWAYS CO. (LTD.)—The directors have declared a dividend of 1s. 3d. per share for the three months ended March 31.

COLOMBO ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.)—The directors have resolved to pay a dividend of 8 per cent (tax free) for the year 1910, carrying forward £3,710. The sum of £8,300 has been transferred to reserve and renewal fund.

CUBA SUBMARINE TELEGRAPH CO. (LTD.)—A dividend is announced at the rate of 6 per cent. per annum, tax free, on the ordinary shares, for the half-year ended Dec. 31.

GENERAL ELECTROLYTIC PARENT CO. (LTD.)—For the year ended Jan. 31 the accounts show an available sum of £6,447. The directors recommended a dividend of 5 per cent., £5,017 being carried forward.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed May 4 a special settling day in 150,000 £1 fully-paid shares of *Metalite (Ltd.)* and have granted a quotation to $5,000,000 capital stock of the *Manila Electric Railroad & Lighting Corpn.* The Committee have granted a quotation to a further issue of £21,000 4½ per cent. first mortgage prior lien gold bonds of the *Montreal Water & Power Co.*

SUBMARINE CABLES TRUST.—Notice is given that 21 certificates will be redeemed from the surplus funds of the Trust by a drawing which will take place on May 4, at 34, Electra House, Finsbury-pavement, London, E.C., for payment at £120 per certificate at Messrs. Glyn, Mills & Co.

TRAMWAYS & GENERAL WORKS CO. (LTD.)—The accounts for the year ended March 31 show an available balance of £1,161. A dividend of 1s. per share is recommended and £161 carried forward.

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ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	April 19	1,349	+ 176	46	63,933	+ 1,805
Antrim	" 14	213	− 14	15	3,133	− 49
Anglo-Argentine	" 22	50,375	+ 4,842	16	794,442	+ 98,353
Ashton-under-Lyne	" 25	477	+ 136	4	1,723	+ 243
Air Corporation	" 22	292	+ 66	49	14,032	+ 418
Barnsley	" 14	186	+ 23	15	2,547	+ 35
Barrow	" 14	303	+ 81	15	3,489	+ 130
Bath Electric Trams, Ltd.	" 19	1,282	+ 542	16	11,053	− 178
Birmingham Corporation	" 22	8,272	+ 1,599	3	23,727	+ 1,961
Birmingham & Midland	" 14	833	+ 56	15	12,710	+ 769
Blackburn Corporation	" 19	1,923	+ 976	†4	4,433	+ 475
Bolton Corporation	" 23	2,466	+ 256	4	8,758	+ 1,110
Bombay	March 24	2,902	+ 56	12	33,968	+ 1,732
Bournemouth Corporation	April 19	2,510	+ 900	‡3	4,865	− 439
Bradford Corporation	" 22	6,819	+ 2,066	3	18,077	+ 2,475
Brighton Corporation	" 23	1,157	+ 375	¶3	3,156	+ 384
Bristol Trams & Carriage	" 21	7,903	+ 2,329	3	19,182	+ 2,736
Burnley Corporation	" 22	1,311	+ 149	3	4,279	+ 739
Burton Corporation	" 23	294	+ 46	§3	872	+ 52
Bury Corporation	" 23	1,209	+ 135	¶3	4,356	+ 566
Calcutta Tramways Co.	" 22	₹53,784	+ ₹1,308	16	₹885,326	+ ₹7,650
Carnarvon-Bedruth	" 22	130	+ 14	16	1,808	− 43
Cardiff Corporation	.. ..	..	.. ..	..	..	.. ..
Cardiff	" 14	79	− 1	15	942	− 144
Central London Railway	" 22	4,582	− 919	16	84,554	− 3,505
Chatham & Dist. Lt. Rys.	" 20	1,181	+ 430	16	12,135	− 39
City & South London Rly.	" 23	3,419	+ 148	16	54,916	+ 2,139
City of Birmingham	" 14	2,920	+ 172	15	41,613	− 128
Colchester Corporation	.. ..	..	.. ..	..	..	.. ..
Cork Electric Trams Co.	" 20	538	+ 77	16	6,887	− 91
Croydon & Dist. Trams	" 14	527	+ 108	15	6,376	+ 399
Dover Corporation	" 22	278	+ 102	3	754	+ 145
Dublin & Lucan Railway	" 21	190	+ 57	16	1,801	− 36
Dublin United	" 21	6,473	+ 802	16	80,722	+ 264
Dudley-Stourbridge	" 14	775	+ 66	15	10,815	+ 419
Dundee Corporation	" 19	1,185	+ 45	§48	57,237	+ 257
East Ham Council	" 22	1,187	+ 217	3	3,381	+ 357
Exeter Corporation	.. ..	..	.. ..	..	..	.. ..
Gateshead & Dist. Trams	" 14	1,059	+ 140	14	14,743	+ 676
Glasgow Corporation	" 22	18,301	+ 474	47	835,265	+ 44,492
Grimsby Trams	" 22	125	+ 17	16	1,833	+ 92
Gloucester Corpn.	" 19	411	+ 155	3	928	+ 167
Grimsby-Northfleet	" 14	205	+ 18	15	2,644	− 136
Great Northern & City Rly.	" 22	1,484	+ 25	16	25,155	+ 1,029
Greenock & Port Glasgow	" 14	745	+ 110	15	9,109	+ 1,290
Halifax Corporation	" 18	2,829	+ 1,253	†3	5,475	+ 1,277
Hastings Tramways	" 14	262	+ 58	15	3,181	+ 133
Hastings Elec. Trams Co.	" 23	1,640	+ 758	17	12,193	− 505
Hong Kong	.. ..	..	.. ..	..	..	.. ..
Huddersfield Corpn.	" 22	2,485	+ 776	3	6,218	+ 1,192
Hull Corporation	" 22	2,972	+ 400	3	9,246	+ 610
Hull District Council	" 22	686	+ 218	3	1,854	+ 267
Ilkeston District Council	" 19	171	+ 48	3	410	+ 73
Ilkeston Corporation	" 22	522	+ 179	3	1,366	+ 272
Isle of Thanet Co.	" 22	720	+ 359	29	9,159	+ 318
Jarrow	" 14	133	+ 25	15	1,677	+ 44
Keighley Corporation	" 25	252	+ 87	3	561	+ 82
Kidderminster & District	" 14	93	+ 9	15	1,235	− 44
Lancaster Corporation	" 22	155	+ 13	49	7,373	+ 290
Leamington Corporation	" 19	273	− 15	3	840	+ 35
Leamington Trams Co.	" 20	1,432	+ 34	16	21,254	+ 14
Leicester United	" 19	2,148	+ 924	16	19,792	+ 427
Lincoln Corporation	" 14	139	− 2	15	1,941	− 206
Liverpool Corporation	" 22	8,522	+ 1,831	3	24,446	+ 3,903
Llanelly Corporation	" 22	2,881	+ 653	3	7,715	+ 1,101
Llandudno Corporation	" 22	580	+ 22	49	28,798	+ 50
Llandudno Urban Corporation	" 22	144	+ 29	3	402	+ 60
Lytham Corporation	" 15	11,297	+ 437	15	162,959	+ 4,283
Maidstone & District Rly.	" 23	1,603	+ 303	16	22,347	+ 1,618
Maidstone & Mid-Kent Bay Rly.	" 21	435	+ 272	§20	2,908	+ 37
Manchester Corporation	" 12	41,322	+ 1,514	¶2	70,861	+ 2,850
Manchester United	" 22	14,340	+ 980	16	225,940	+ 12,835
Mansfield Corporation	" 22	9,109	+ 3,274	16	89,724	+ 146
Metropolitan Corporation	" 22	191	+ 65	29	4,554	+ 233
Metropolitan Railway	" 22	16,743	+ 1,939	3	51,500	+ 6,206
Middlesbrough Corporation	" 22	2,141	+ 134	16	32,800	+ 969
Middleton	" 14	214	+ 30	15	2,742	− 74
Midland Dist. Railway	" 22	11,697	+ 415	16	188,051	+ 14,027
Midland Elec. Trams	" 14	9,167	+ 2,305	15	114,277	+ 13,999
Mitcham Corporation	" 14	370	+ 96	15	4,254	+ 154
Mossley Corporation	" 22	161	+ 28	§3	605	+ 156
Newcastle-upon-Tyne Corp.	" 22	4,709	+ 1,065	3	13,676	+ 1,465
Newport (Mon.)	" 22	809	+ 165	3	2,342	+ 234
North Metropolitan Corporation	" 21	671	+ 222	3	1,570	+ 250
North Staffordshire	" 14	674	+ 159	15	7,823	+ 25
North Staffordshire Corporation	" 23	2 201	+ 515	4	8,561	+ 459
North Wales Elec. Trams	" 19	159	..	48	7,882	+ 349
Nottingham Corporation	" 21	1,830	+ 298	16	26,425	+ 1,133
Nottingham Corporation	" 14	122	+ 29	15	1,500	+ 45
Oldham Corporation	" 22	2,495	+ 745	3	6,479	+ 514
Oldham Corporation	" 14	1,953	+ 199	15	27,878	+ 2,700
Oldham Corporation	" 19	893	+ 182	3	2,238	+ 212
Oxford Corporation	" 20	831	+ 259	3	2,031	+ 316
Paisley Corporation	" 14	149	+ 65	15	777	− 262
Plymouth Corporation	" 21	4,547	+ 104	§3	16,765	+ 1,818
Pontypridd Trams	" 14	48	+ 6	15	625	+ 2
Port Talbot Corporation	" 23	6,917	+ 1,188	4	26,234	+ 1,251
Portsmouth Corporation	.. ..	..	.. ..	..	..	.. ..
Preston Corporation	" 14	870	+ 118	15	10,211	− 582
Reading Corporation	" 14	866	+ 85	15	12,491	+ 659
Rhondda Corporation	" 19	1,335	+ 320	3	3,051	+ 362
Rhondda Tramways	" 19	883	+ 436	3	1,551	+ 323
Rhyl Corporation, &c. Jt. Bd.	" 14	293	+ 38	15	3,418	− 167
Rochdale Corporation	" 22	885	+ 255	3	2,871	+ 797
Rotherham District	" 23	1,314	+ 259	3	3,980	+ 478
Rotherham Trams	" 19	634	+ 245	25	11,002	+ 873
Rotherham Corporation	" 14	1,121	+ 95	15	15,370	+ 882
Rotherham	" 19	192	+ 65	3	425	+ 63
Rotherham and District	" 14	38	− 3	15	545	− 36
Rotherham Trams Co.	" 19	192	+ 46	15	2,220	− 74
Rothwell Corporation	" 19	889	+ 512	16	6,552	− 461
Rotherham Corporation	" 22	1,270	+ 443	3	3,447	+ 684
Rotherham Corporation	" 22	731	+ 22	16	8,672	+ 227
Rotherham-Mare	" 20	441	+ 48	3	1,204	+ 93
Rotherham Co.	" 13	2,452	+ 166	2	4,812	+ 273
Rotherham Corpn.	" 14	60	+ 2	15	322	− 277
Rotherham	" 14	409	+ 20	15	6,115	+ 158
Rotherham	" 19	1,203	+ 351	3	2,928	+ 408
Rotherham W.R. Trams	" 14	284	+ 39	15	3,447	− 120
Rotherham Woollen District	" 14	138	+ 14	15	1,362	− 114
Rotherham	" 14	1,646	+ 505	17	21,183	+ 770
Rotherham	" 14	984	+ 46	15	14,509	+ 760

* These comparisons are with the corresponding period last year. • Partly electrical.
† Minus 3 days. ‡ Minus 2 days. ‖ Plus 3 days. ¶ Plus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Shrs	Last Dividend	Name.	Price Wed., April 26.	Rate per cent. Yielded. £ s. d.	Dividend Due.	Business Week to April 26. Highest.	Business Week to April 26. Lowest.
		Electricity Supply.					
10	6/0	Bournemouth & Poole Elec. Sup. Ord.	8½—8¾	6 0 0	Mar, Sep	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref.	9½—9¾	4 12 3	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Second Pref.	10 —10½	5 13 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	102 —104	4 6 6	Jan, July	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	7¼—7⅝	6 11 3	March	..	..
5	3/6	Do. 7 per Cent. Pref.	7¼—7⅝	4 11 6	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Deb. Stock	99 —103	3 17 6	June, Dec	..	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	4 —4¼	5 11 0	Feb, Aug	4	..
5	2/3	Do. 4½ per Cent. Pref.	4½—4¾	4 17 0	Feb., Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	96 —98	4 1 6	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101 —103	4 7 7	..	102	..
5	2/3	Do. City Undertaking 4½% Cum. Pref.	3⅞—4⅛	5 3 0	Jan, July	..	..
5	3/0	Chelsea Electric Supply Ord.	4 —4⅛	5 11 0	March	4 7/16	4 3/8
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	100 —102	4 8 6	June, Dec	..	..
10	8/0	City of London Electric Lighting Ord.	11½—12	5 15 9	Feb, Aug	11⅞	11
10	6/0	Do. 6 per Cent. Cum. Pref.	12 —13	4 12 3	Jan, July	12⅜	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	119 —123	4 1 0	June, Dec	—	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	101 —104	4 6 6	Jan, July	..	..
5	..	County of Durham Elec. P. D. Ord.	1½—2	..	April, Oct	..	—
5	1/3	†Do. 5 per Cent. non Cum. Pref.	2½—3	8 6 9	April, Oct	..	—
10	6/0	County of London Elec. Supply Ord.	7⅞—8⅛	6 3 0	Feb, Aug	..	—
10	6/0	Do. 6 per Cent. Cum. Pref.	10⅞—11⅛	5 5 6	Mar, Sept	11 3/16	11 1/8
St.	4½%	Do. 4½ per Cent. Deb Stock (red.)	109½—111½	4 0 9	Jan, July	110	..
St.	4½%	Do. Second Deb. Stock	101 —104	4 6 6	May, Nov	..	..
5	4/0	†Folkestone Electricity Supply Co. Ord.	4½—4⅝	5 19 0	April, Oct	..	—
5	2/6	†Do. 5 per Cent. Cum. Pref.	4¼—5⅛	4 15 3	Mar, Sept	..	—
St.	4½%	Do. 4½ 1st Deb. Stock (red)	97 —100	4 10 0	Feb, Aug	..	—
5	5/0	†Hove Electric Lighting Ord.	6⅝—7⅛	6 6 0	April, Oct	..	..
St.	4½%	Isle of Wight E. L. & P. Co. Deb. Stk.	90 —93	4 16 9	..	..	..
5	5/0	Kensington & Knightsbridge Ord.	7 —7⅛	5 16 0	Feb, Aug	..	..
5	6%	Do. 6 per Cent. 1st Pref.	5⅞—6	5 0 0	Jan, July	..	—
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	93 —95	4 4 0	..	..	—
St.	4%	Kensington & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	96 —99	4 1 0	April, Oct	..	—
St.	4½%	Kent Elec. Power Co. Irred Deb. Stk.	80 —84	5 7 0	Jan, July	..	—
3	1/2½	London Electric Supply Ord.	1⅞—2⅛	2 17 0	Mar, Sept	2	1⅞
5	3/0	Do. 6 per Cent. Pref.	4½—5⅛	5 17 0	Mar, Sept	4⅞	4½
St.	4%	Do. 4 per Cent. 1st Mort. Deb	91 —94	4 5 0	Jan, July	93	..
5	3/0	Metropolitan Electric Sup. Ord.	3⅞—4⅛	5 12 6	April, Oct	4⅛	3⅞
5	2/3	Do. 4½ per Cent. Cum. Pref.	4⅞—4⅞	4 16 0	Jan, July	4⅞	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	101 —104	4 6 6	June, Dec	..	—
St.	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	86 —89	3 18 6	Jan, July	68½	—
..	4½%	Midland Elec. Corp. for Power Dist, 4½ 1st Mort. Debs.	97 —99	4 11 0	..	..	..
5	2/6	†Newcastle Elec. Supply Ord.	3¾—4¼	4 14 0	Feb, Aug	..	—
5	2/6	†Do. 5 per Cent. non Cum. Pref.	4¼—4⅝	5 5 0	Feb, Aug	..	—
100	4½%	Do. 4½ per Cent. 1st Mort. Deb.	98 —100	4 10 0	Jan, July	..	—
100	5%	†North Metro. Elec. Power Sup. 5 Morts.	95 —97	5 3 0	..	..	—
1	6%	Northampton Elec. Lt. & P. Ord.	1⅝—1¾	4 13 9	Feb, Aug	..	—
1	5%	Do. 5% Pref.	1⅝—1¾	4 6 0	Feb, Aug	..	—
St.	4%	Do. 4% Debs.	99 —101	3 19 0	June, Dec	..	—
10	10/0	Notting Hill Electric Ord.	12 —12½	5 17 6	March	..	—
5	4/3	Oxford Electric Ord.	6 —6⅛	5 11 6	March	..	—
St.	4%	Do. 4% Deb. Stk.	93 —96	..	..	..	—
5	5/0	St. James' & Pall Mall Elec. Ord.	8⅞—9⅛	5 8 0	Feb, Aug	9	8⅞
5	3/6	Do. 7 per Cent. Pref.	6¾—7⅛	4 16 6	Feb, Aug	—	..
St.	3½%	Do 3½ per Cent. Deb. Stock (red.)	86 —88	3 19 6	Jan, July	..	—
5	4/0	Smithfield Markets Electric Sup. Ord.	1⅞—1⅞	..	Feb.	..	—
5	5%	South London Electric Supply Ord.	3 —3⅛	6 3 0	April	..	—
St.	5%	Do 5 % 1st Mort. Stock (red.)	101 —104	4 16 0	..	..	—
1	..	South Metrop'n Elec. Lt. & Power Ord.	⅞—1	..	..	..	—
1	0/8½	Do. 7 per Cent. Cum. Pref.	1 1/16—1⅛	5 18 0	Feb, Aug	..	—
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	95 —98	4 11 6	April, Oct	..	—
5	1/3	Urban Electric Supply Ord.	¾—1⅛	..	April, Oct	1	—
5	1/3	Do. 5 per Cent. Cum. Pref.	2⅛—2⅜	9 2 0	April, Oct	2⅛	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	85 —88	5 2 3	April, Oct	87	86½
5	5/0	Westminster Elec. Sup. Ord.	8 —8½	5 17 9	Mar, Sept	..	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	5 —5⅛	4 3 6	Jan, July	..	..
		Electric Railways and Tramways.					
1	..	Bath Elec. Trams Pref. Ord.	⅞—1	..	April	⅞	—
1	0/6	Do. 5 per Cent. Cum. Pref.	⅞—1	6 13 6	Jan, July	..	—
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	79 —83	5 8 6	April, Oct	..	—
St.	4½%	B'ham & Midland Trams 4½ 1st Deb. Stock	91 —93	4 16 9	Jan, July	92½	—
10	4%	Bristol Tramways & Carriage Ord.	7 —7⅛	5 6 0	Feb, Aug	..	—
10	4%	Do Cum. Pref.	7⅛—7⅞	5 1 6	..	..	—
St.	4%	Do. 4 per Cent. Debs.	101 —102	3 18 3	Feb, Aug	..	—
10	..	British Electric Traction Ord.	1⅞—2	..	June, Dec	1⅞	1⅝
10	..	Do. 6 per Cent. Cum. Pref.	4⅞—5⅛	..	Feb, Aug	5⅛	4⅝
St.	5%	Do. 5 per Cent. Perpetual Debs.	94 —98	5 2 0	April, Oct	95½	94½
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	79 —84	5 6 3	May, Nov	80	79½
St.	3%	Central London Ordinary Stock	74 —76	3 19 0	Feb, Aug	75⅛	74⅛
St.	4%	Do. 4 per Cent. Pref. Stock	87 —89	4 10 0	Feb, Aug	89⅛	88⅛
St.	2%	Do. Deferred Stock	64 —66	3 0 6	Feb.	66	64⅛
100	4%	Do. 4 per Cent. Debs.	102 —104	3 17 0	Jan, July	—	..
5	2/6	†City of Birmingham Trams, 5 % Cum. Pref.	4⅛—4⅞	5 2 6	April, Oct	..	—
100	4%	†Do 4 per Cent. 1st Mort. Debs.	99 —102	3 18 9	April, Oct	..	—
St.	1½%	City & South London Rly. Con. Ord.	34½—35½	4 4 6	Feb, Aug	35⅛	34½
St.	5%	Do. 5 per cent. Perp. Pref. (1891)	108 —110	4 11 0	Feb, Aug	..	—
St.	5%	Do. (1896)	104 —106	4 12 6	Feb, Aug	..	—
St.	5%	Do. (1901)	101 —104	4 16 0	Feb, Aug	..	—
St.	5%	Do. (1903)	101 —104	4 16 0	Feb, Aug	103½	—
St.	4%	Do. 4 per Cent. Perpetual Debs.	101 —103	4 16 9	May, Nov	..	—
10	6/0	Dublin United Trams, 6 per Cent. Pref.	12½—13½	4 10 6	Feb, Aug	..	—
10	12/0	†Gateshead and District Trams Ord.	8½—8¾	6 19 6	..	..	—
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	1¼—1⅜	..	Feb, Aug	..	—
5	..	Hastings & District Elec. Trams, 6% C. P.	1¾—2	..	Mar, Sept	..	—
St.	4½%	Do. 4½ Deb. Stock	75 —80	5 10 0	April, Oct	..	—
10	..	Imperial Tramways Ord.	3 —3½	..	Mar, Sept	..	—
10	..	‡Do. 6 per Cent. Pref.	4¼—4½	..	Mar, Sept	..	—
St.	4½%	Do. 4½ per Cent. Debs.	70 —72	6 5 0	Jan, July	..	—
..	2/5	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	2 —2⅛	5 5 0	Mar, Sept.	..	—
St.	4%	Do. 4 per Cent. Deb. Stock	79 —84	4 15 0	Jan, July	80½	—
10	6/0	Lanarkshire Tramways	9¼—10⅛	5 12 3	Feb, Aug	..	—
St.	5%	Lancs Utd. Trams, 5% Prior Lien Deb. Stk.	82 —84	5 19 0	Jan, July	..	—
St.	4%	London Electric 4% Deb. St.	97 —99	4 1 0	..	98½	98
St.	4%	Do. 4% Pref.	82 —84	4 15 3	..	83½	82½
10	..	London United Trams, 5% Cum. Pref.	2⅞—3⅛	..	Jan, July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	74 —77	5 3 6	Jan, July	76	75½
St.	..	Mersey Con. Ord. Stock	6 —8	..	Feb, Aug	..	..
1	1/1½	†Metropolitan Elec. Tramways Ord.	⅜—⅝	6 0 0	..	½	..
1	..	Do. Deferred	1/16—⅛	..	April	⅛	—
1	0/6	Do. 5 per Cent. Cum. Pref.	⅞—1	5 0 0	Feb, Aug	⅞	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	102 —104	4 6 6	Jan, July	103½	..
St.	5%	Do 5 per Cent. Db. Stk	99½—101½	4 18 6	..	101½	100½
St.	1½%	Metropolitan Railway Consolidated	50½—51	2 13 6	Feb, Aug	53⅛	50⅛
St.	2½%	Do. Surplus Lands Stocks	66 —68	4 1 0	Feb, Aug	67½	66½
St.	3½%	Do. 3½ per Cent. Preference	90 —92	3 16 0	Feb, Aug	92	90½
St.	3½%	Do. 3½ per Cent. "A" Preference	89 —91	3 17 0	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Convertible Pref.	89 —91	3 17 0	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Debenture Stock	93 —95	3 13 6	Jan, July	93½	..

* In calculating the yield allowance has been made for accrued interest, but *not* for redemption.
† Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

NAME.	Price Wed., April 26.	Rate per cent. Yielded.	Dividend Due.	Business Week to April 26. High-est.	Low-est.	Size	Last Dividend
Electric Railways and Tramways— *Continued.*		£ s. d.					
Rly. 3½ per Cent. "A" Deb. Stock	92 —94	3 14 6	Jan, July	93⅜	92⅛	100	2$
Metropolitan District Railway Ord.	31½—32	..	Feb, Aug	33⅜	31½	..	4%
" 4½% First Pref.	88 —90	5 0 0	Feb, Aug	89⅛	88½	St.	4%
" Assented Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	74 —76	4 12 0	Feb, Aug	75⅜	75⅛	St.	5%
" 3 per Cent. Consolid. Rent-charge	77 —79	3 16 0	Jan, July	78⅛	78	5	3/0
" 4 per Cent. Midland Rent-charge	103 —105	3 16 0	Jan, July	..	..	1	0/7½
" 6 per Cent. Perp. Deb. Stock	148 —150	4 0 0	Jan, July	148½	..	1	0/6
" 4 per Cent. Ditto	97 —99	4 1 6	Jan, July	99	..	St.	6%
Series Electric Traction Ord.	⅛—¼	..	April, Oct	⅜	..	St.	6%
" 5 per Cent. Cum. Pref.	⅜—½	7 5 0	Feb, Aug	⅜	⅜	10	6/0
" 4½ per Cent, Deb. Stock	87 —90	5 0 0	May, Nov	..	..	10	6/0
Met. Elec. Trams. & Ltg. 6% Cm. Pref.	⅛—¼	..	..	..	..	5	2/6
" 4 per Cent. Deb. Stock	75 —80	5 0 0	Jan, July	..	..	St.	3½%
Midderland Dist. Elec. Trms. 5% 1stMtDb.	..	8 4 0	Jan, July	..	..	St.	4%
Mersey&E.Rys.Lon.6% In. bds with coup 7	55 —57	1 15 0	June, Dec	57	56	1	4⅛%
" 5% Prior Lien Bonds	102 —103	4 17 0	..	102⅛	..	1	7½d.
" 4½% Bonds with coup. 7	97 —99	4 11 0	..	99	98	St.	0/7½
" 4 per Cent. 1st Power Ho. Dbs.	99 —101	3 19 3	..	101½	..	St.	4%
Yorkshire (W.R.) Elec. Trams. Ord.	⅛—¼	..	March ..	..	..	5	4½%
" 6 per Cent. Cum. Pref.	2⅛—2¼	..	..	..	..	3	3/0
" 4½ per Cent. 1st Debs.	84 —87	5 3 3	Jan, July	84	..	5	4⅛%
						St.	2/6
						St.	4½%
Electric Manufacturing, &c.							
Anchor Cable Co. 4½ % Deb. Stock	99 —101	4 9 0	—	..	..	5	3/0
Ediswan Electricity Meter Ord.	⅜—½	..	..	⅛	..	10	2/0
Do. 6% Cum. Pf.	⅜—½	7 4 0	April, Oct	⅛	..	10	3/0
Hopkinson & Wilcox Ord.	5½—6	4 6 9	April, Oct	5⅛	5⅛	10	6%
Do. Pref.	1⅛—1⅜	3 16 9	..	7⅛	..		
British Insulated & Helsby Cables Ord.	6½—7⅜	6 15 6	July, Feb	5⅛	—		
Do. 6 per Cent. Pref.	5½—6½	4 16 0	Jan, July	..	..	5	2/6
Do. 4½ per Cent. 1st Mort. Deb. (red.)	101 —103	4 7 6	Jan, July	..	..	5	2/6
British Thoms'n-Houst'n 4½% 1st Mt.Db.	96 —99	4 11 0	Mar, Sept	..	..	St.	4%
British Westinghouse 6 per Cent. Pref.	⅞—1	..	Feb, Aug	102	..	St.	4½%
Do. 6 per Cent. Prior Lien Dbs. (rd.)	100 —103	5 16 3	..	..	..	St.	21/9
Do. 4 per Cent. Mort. Deb. Stock	60 —64	6 7 0	Jan, July	61⅛	59½	St.	5%
Bush E. Eng. Co. 4½% Perp. 1st Deb. Stock	59 —64	7 0 6	Mar, Sept	..	..	5	4/0
Do. Perpetual 2nd Deb. Stock	41 —46	9 16 0	Jan, July	..	..	5	2/6
Callender's Cable Con. Ord.	9⅛—9¼	7 12 0	Jan, July	9⅛	9⅛	St.	4½%
Do. 5 per Cent. Cum. Pref.	4½—5⅛	4 17 6	Jan, July	..	..	St.	8%
Do. 4½ per Cent. 1st Mort Debs. (red.)	102 —104	4 6 6	Nov, May	..	..	St.	6%
Castner-Kellner Alkali Co.	3⅜—3⅝	4 18 3	May, Nov	3⅜	3⅜	St.	5%
Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 —106	4 3 6	Feb. Aug	105⅛	..	40	4½%
Chadburn's (Ship) Telegraph Ord.	1⅛—1⅜	5 19 0	March ..	..	..	100	4½%
Consolidated Electrical Co.	⅛—¼	10 0 0	August ..	..	..	St.	4½%
Consolidated Signal Co.	⅛—⅜	5 7 0	April, Oct	⅜	..	St.	5%
Do. 6 per cent. Cum. Pref.	1—1⅛	6 0 0	April, Oct	..	..	St.	6%
Crompton & Co (Nos. 1 to 85,000)	⅛—¼	..	Jan, July	..	..		
Do. 5 per Cent. 1st Mort. Debs. (red.)	70 —80	6 5 0	Jan, July	..	..	5	2/6
Davis & Timmins	⅜—1⅛	..	Mar, Sept	..	..	100	2/6
Dick, Kerr & Co. Ord.	⅛—¼	5 0 0	Sept.	..	..	1	4½%
Do. 6 per Cent. Cum. Pref.	1 —1⅛	5 6 6	Sept	100	99½	St.	..
Do. 4½ per Cent. Deb. Stock	97 —100	4 10 0	Jan, July	..	..	5	1/3
Edison & Swan United ("A" Sh.) (£3 pd.)	⅛—¼	..	Feb, Aug	⅛	⅛	St.	4%
Do. (£5 paid)	1⅛—2⅛	9 3 0	Feb. Aug	1⅛	..	..	5%
Do 4 per Cent. Mort. Deb. Stock (red.)	69 —73	5 9 9	June, Dec	..	..	1	5%
Do 5 per Cent. 2nd Deb. Stock	78 —81	6 3 6	Mar, Sept	..	..		
Edmundson's Elec. Corp. Ord.	⅜—1	..	Jan, July	1	⅞	100	5%
Do. 6 per Cent. Cum. Pref.	3⅛—3⅜	..	May, Nov	3⅛	3⅛		
Do 4½ per cent. 1st Mort. Deb. (red.)	86 —89	5 1 0	Jan, July	87¼	87⅛		
Electric Construction Co.	⅜—1	..	Jan, July	..	..	1	..
Do. 7 per Cent. Cum. Pref.	1⅜—2	7 0 0	July	..	..	100	5%
Do. 4 per Cent. Perp. 1st Mort. Debs.	69 —72	5 11 0	Jan, July	..	..	5	6%
General Electric (1900) 5% Cum. Pref.	8⅛—8⅜	5 14 6	June, Dec	..	..	5	0/7½
Do. 4 per Cent. 1st Mort. Debs.	83 —85	4 11 0	Mar, Sept	..	..	100	0/7½
Henley's Telegraph Works Ord.	12⅛—12½	5 16 6	Feb, Aug	12½	..	St.	5%
Do. 4½ per Cent. Pref.	4⅛—5⅛	4 7 0	Feb, Aug	..	..	St.	5%
Do. 4½ per Cent. 1st Mort. Deb. Stock	108 —110	4 2 0	Mar, Sept	..	..	100	5%
India Rubber, Gut. Per., &c., Works	16½—17	5 17 9	Feb, Aug	16⅝	16½	100	$1½
Do 5 per Cent. Cum. Pref.	10½—10⅝	4 14 0	..	..	..	..	5%
Do 4 per Cent. Debs. (red.)	96 —98	4 1 6	April. Oct	96¼	96¼	St.	6%
National Elec. Construction Co.	⅛—¼	..	April	..	..	St.	4½%
Richardsons, Westgarth & Co., Ltd. Ord.	⅜—½	..	Nov	..	..		
Do. 6 per Cent. Cum. Pref.	⅛—⅜	..	May, Nov	..	..	St.	4½%
Do. 4½ per Cent. Perp. Deb. Stock	78 —82	5 10 0	Jan, July	..	..	1	0/6
Simplex Conduits 6 per Cent. Cum. Pref.	4⅞—5¼	..	..	..	..	St.	5%
Telegraph Construction & Maintenance	36 —38	5 15 0	Mar, July	36⅞	36⅛	5	3/0
Do. 4 per Cent. Deb. Bonds (1909)	100 —102	3 18 6	Jan, July	..	..		
†Vickers, Sons & Maxim, Ltd., Ord.	2⅛—2⅜	4 14 0	..	2⅛	2⅛	St.	4½%
†Do. 5 per Cent. non-Cum. Preference	1⅜—1⅝	4 3 0	..	1⅝	1⅝	100	8½
†Do. 5 per Cent. non-Cum. Preferred	109 —112	4 9 3	..	109½	..	..	5%
Do. 4 per Cent. 1st Mort. Db. Sk. (red)	102 —104	3 17 0	June, Dec	102⅛	..	100	5%
Do. 4½ per Cent. 2nd Mort. Deb. (red.)	104 —106	4 5 0	June, Dec	..	—	..	$2½
Do. 5 per Cent. 3rd Mort. Debs Scrip.	105 —107	4 13 6	..	..	..		
J. G. White & Co. 6% Cum. Pref.	14⅛—15⅛	6 9 0	..	4⅜	14⅛	..	5%
Willans & Robinson Ord.	⅜—½	..	Apr, Oct	..	..	100	4½%
Do. 6 per Cent. Cum. Pref.	⅜—1	..	Apr, Oct	..	..		
Do. 4 per Cent. 1st Mort. Debs.	55 —65	6 3 0	May, Nov	..	..		
Telegraphs.							
Amazon Telegraph	7 —7⅛	..	June, Dec	7⅛	..	5	3/0
Do. 5 per Cent. Debs. (red.)	97 —99	5 1 0	Jan, July	..	..	10	5/0
†Anglo-American	71 —73	5 1 6	F,My,Ag,N	..	..	St.	4½%
†Do Preferred	115½—116½	5 2 6	F,My,Ag,N	116	115	5	2/6
Do. Deferred	27⅞—28½	5 5 6	F,My,Ag,N	28⅞	25⅜	100	5%
Commercial Cable 4 per Cent. Deb. Stk.	88 —90	4 9 0	Jn,Ap,Jy,O	89⅛	88⅛	100	7/2½
Cuba Submarine Ord.	9½—10⅛	5 17 0	Feb, Aug	9⅛	..	100	$3½
Do. Preference 10 per Cent.	17½—18½	5 10 0	Feb, Aug	..	..	100	5%
Direct Spanish Ord.	3⅜—4	5 0 0	April, Oct	..	..	500	5%
Do. 10 per Cent. Cum. Pref.	8½—8⅝	5 14 6	April, Oct	..	..	St.	5%
Do. 4½ per Cent. Deb.	100 —102	4 8 0	Jan, July	..	..		
†Direct United States Cable	7⅜—8	6 5 0	Ja,Ap,Jy,O	7⅛	..	5	..
Direct West India Cable 4½% Rg.Db.(rd.)	100 —102	4 8 3	June, Dec	..	..	10s	..
Eastern Ordinary	137½—140	5 0 0	Ja,My,Jy,O	138½	137	1	0/7½
Do. 3½ per Cent. Pref. Stock	84½—85½	4 1 0	Ja,My,Jy,O	86	85	..	5%
Do. 4 per Cent. Mort. Deb. Stk. (red.)	102 —104	3 17 0	May, Nov	103½	102½	5	..
Eastern Extension	13½—13⅝	5 2 0	Ja, Ap, Jy,O	13⅝	13½	St.	..
Do. 4 per Cent. Deb. Stock	100 —102	3 18 3	Feb, Aug	101½	..	St.	5%
Eastern and S.Af., 4% Mauritius Sub.Debs	101½—103½	3 17 3	May, Nov	..	..	500	5%
G.N. (of Copenhagen), with Coupon 81	32½—33⅜	6 0 0	Jan, July	..	..		
Indo-European	59 —61	5 6 6	May, Nov	59½	..	St.	$1
Mackay Companies Common	93 —96	5 4 0	Ja,Ap,Jy,O	..	..	St.	$3½
Do. Preference	78 —80	5 0 0	Ja,Ap,Jy,O	..	..	500	5%
Marconi's Wireless Teleg. Co.	1⅛—1⅜	..	April	1⅛	1⅛	St	5%
Pacific & Europe'n Tel. 4% Guar. Dbs. (red.)	100 —102	3 18 3	June, Dec	..	..	100	8/2½
West Coast of America	1½—1⅝	4 3 0	May	..	..	100	5%
Do. 4 per Cent. Debs.	99½—101½	3 18 9	Jan, July	..	..	St.	£9
West India & Panama	2⅜—2½	2 3 6	May, Nov	3⅛	2⅜	St.	6%
Do. 6 per Cent. 1st Pref.	10½—10⅞	5 11 6	May. Nov	10⅜	..	St.	5%

NAME.	Price Wed., April 26.	Rate per cent. Yielded.	Dividend Due.
Telephones.		£ s. d.	
Amer. Telephn. & Telegh. Cap. St.	150 —152	5 5 3	..
Do. Coll. Trust $1,000 4 per Cent. Bds.	93⅛—95⅛	4 3 9	Jan. July
Do. 4% Cons. Bonds 1936	111⅛—113⅛	3 10 3	..
Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	100 —102	4 18 0	Mar, Sept
Chili Telephone	7⅛—7⅜	5 11 6	August ..
Monte Video Telephone Ord.	⅞—1⅛	5 13 0	Nov ....
Do. 5 per Cent. Pref.	⅜—⅝	5 12 0	May, Nov
National Co. Pref. Stock	104⅛—105⅛	5 14 0	Feb, Aug
Do. Def. Stock	136 —138	4 7 0	Feb, Aug
Do. 6 per Cent. Cum. 1st Pref.	10 —10⅛	5 11 6	Feb, Aug
Do. 6 per Cent. Cum. 2nd Pref.	10⅛—11	5 9 0	Feb, Aug
Do. 5 per Cent. non-Cum. 3rd Pref.	5⅛—6⅛	4 2 6	Feb, Aug
Do Deb. Stock 3½ per Cent. (red.)	99 —101	3 9 3	June, Dec
Do. 4 per Cent. Deb. Stock (red.)	99⅛—101⅛	3 19 3	Jan, July
New York Telephone Co. 30 yr. Bnds.	100⅛—101⅛	4 8 6	..
Oriental	1⅛—1⅜	4 11 6	April, Oct
Do 6 per Cent. Cum. Pref.	1⅛—1⅜	4 11 6	April, Oct
Do. 4 per Cent. Red. Deb. Stock	87⅛—89⅛	4 9 6	Jan, July
Telephone Co. of Egypt 4½% Db. Stk. (red.)	99⅛—101⅛	4 8 9	Jan, July
United River Plate Ord. (1—150,000)	7⅛—7⅜	5 3 0	July ....
Do. (150,001—190,000)	7⅛—7⅜	..	..
Do. 5 per Cent. Cum. Pref.	5⅛—5⅜	4 9 0	June, Dec
Do. 4½ Deb. St. Red.	103 —105	4 5 9	Jan, July
Financial, Investment, &c.			
Elec. & Gen. Investment 6% Cum. Pref.	3⅛—4⅛	7 1 0	Jan, July
Globe Telegraph & Trust	10⅛—11⅛	5 4 9	Sp,DcMrJu
Do. 6 per Cent. Pref.	13 —13⅛	4 9 0	Sp,DcMrJu
†Submarine Cables Trust (Cert.)	131 —134	4 9 6	April, Oct
Colonial and Foreign Electric Railways, Tramways, &c.			
Anglo-Argentine 5% Cum. 1st Pref.	5⅛—5⅝	4 1½ 6	April, Oct
Do. 5% Cum. 2nd Pref.	⅝—5⅛	4 17 6	Jan, July
Do 4% Deb. Stock	92 —93⅛	4 5 6	June, Dec
Do. 4½% Deb. Stock	98 —100	4 10 0	..
Do. 5% Deb. Stock	101⅛—103⅛	4 16 6	..
Auckland Elec. Trams. 5% Deb. (red.)	104⅛—106⅛	4 14 6	Jan, July
Brisbane Electric Trams. Invest. Ord	6⅛—7⅛	5 17 3	May ....
Do. 5 per Cent. Cum. Pref.	4⅛—5⅛	4 16 6	May, Nov
Do. 4½ per Cent. Db. Prov. Certs.	102 —105	4 6 0	Jan, July
British Columbia El. Rly. Df. Ord.	150 —154	5 4 0	Mar, Sept
Do. Pref. Ord. Stock	124 —127	4 14 6	May, Nov
Do. 5% Cum. Perp. Pref. Stock	107⅛—110⅛	4 10 6	Jan, July
†Do. 4½ per Cent. 1st Mort. Debs.	100 —103	4 7 6	April, Oct
Do. Vancouver Power Debs.	102 —105	4 5 9	Jan, July
Do. 4½% Perp. Con. Deb. St.	100⅛—102⅛	4 2 6	..
Buenos Ayres Lacroze Trams 1st Mt. Db.	99⅛—101⅛	4 18 6	Mar, Sept
Buenos Ayres Port & City Tram. 1st Mt. Deb. Stock	93 —98	6 2 6	Feb, Aug
Calcutta Tramways (1 to 137,610)	5⅛—6	4 3 3	Mar, Sept
Do. 5 per Cent. Cum. Pref.	5⅛—5⅜	4 13 0	Jan, July
Do 4½% 1st Deb. Stock (red)	93 —101	4 9 0	Jan, July
Cape Electric Tram Shares	⅞—1	..	..
City of Buenos Ayres Trams Co. (1904) Sh.	5⅛—5⅜	4 5 0	F,My,A,N
Do 4 per Cent. Deb. Stock	98 —101	3 19 3	June, Dec
Colombo Tr. & Ltg. 5% 1st Mt. Db.	97 —100	5 0 0	May, Nov
Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	99⅛—101⅛	4 18 6	Feb, Aug
Hong Kong Tramways Co. 5 per Cent. 1st Mort. Debs.	78 —82	6 1 6	June, Dec
Kalgoorlie Elec. Trams Sh.	⅛—¼	..	..
Do. 5 per Cent. "A" Deb. Stock	94 —97	5 3 0	Jan, July
Do. 6 per Cent. "B" Ditto	66 —70	4 5 9	Jan, July
Lisbon Elec. Trams. Ord.	1 —1⅛	4 16 0	July ....
Do. 6 per Cent. Cum. Pref.	1 —1⅛	4 16 0	Jan, July
Do. 5 per Cent. Reg. Mort. Debs.	98 —102	4 18 0	Jan, July
Madras Elec. Trams. 5% Deb. Stk.	96 —98	5 2 0	Jan, July
Manaos Trams and Lt. Co. 5% Debs	92⅛—94⅛	5 6 0	..
Manila Elec. Ry. $1,000 Gold Bonds	99 —101	4 19 0	Feb, Aug
†Mexico Trams Co. Com. St.	124 —126	5 11 0	..
Do. Gen. Con. 1st Mort. 5% Gold Bds.	95⅛—97⅛	5 2 6	..
Do. 6% 50 yr. Mort. Bds.	101⅛—102⅛	5 17 6	—
Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922) (Nos. 601 to 2,000)	101 —103	4 7 6	Feb, Aug
Do. do. (Nos. 1 to 4,600)	103 —105	4 5 9	..
Perth Elec. Trams Ord.	⅛—¼	2 13 6	May ....
Do 1st Mt. Db. Stock	104 —106	4 14 3	Jan, July
Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	5⅛—5⅜	5 4 6	—
Do. 4½% 1st Mort. Deb. Stk.	99 —102	4 8 0	..
†Rio Janeiro Tram, Lt. & P. Co.	109⅛—110⅛	4 10 3	..
Do. 30 yr. Gold Bnds.	102 —103	4 17 0	..
Do. 50 yr. Mt. Bnds	94⅛—95⅛	5 5 0	—
Sao Paulo Tramway, Light & Power Co. $100 Stock	168 —170	5 17 9	..
Do. 5 per Cent. 1st Mt. $500 Db.	103⅛—104⅛	4 16 0	June, Dec
Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	99 —100	4 10 0	Feb, Aug
Colonial and Foreign Electricity Supply, &c.			
Adelaide Elec. S'ply Co. 6% Cu. Pr.	5⅛—5⅞	5 2 0	Mar, Sept
Bombay E.S. & T. 6% Cm. Pf.	10⅛—11⅛	5 5 6	..
Do. 4½ per Cent. Deb. Stk. (rsd).	96 —98	4 11 3	Jan, July
Do. 5 per Cent. 2nd Mort. Deb. Stock	97 —99	5 1 0	..
Calcutta Elec. Supply Ord.	6⅛—7⅛	4 16 6	April, Oc
Do. 5% Cum. Pref.	4⅛—5⅛	4 13 0	..
Calgary Power Co. 5% 1st Mort. Bnds.	95½—97½	5 2 6	—
Canadian Gen. Elec. Co. Com. St.	117 —120	5 17 0	..
Do. 7% Cm. Pf. Stock	119 —122	5 14 9	..
Castner Electrolytic Alkali Co. (of U.S.A.) 1st Mort. Stl. Debs.	97 —102	4 18 0	Jan, July
Elect. Development Co. of Ontario	84⅛—86⅛	5 16 0	..
Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	87 —90	5 11 0	Jan, July
Indian Elec. Sup. & Trac. Co.	1 —1⅛	..	..
Kalgoorlie Elec. Power & Ltg. Ord.	⅛—¼	..	..
Do. 6 per Cent. Cum. Pref.	⅜—½	8 0 0	April, Oc
Kaministiquia Power Co. 5% Gold Bnds.	102 —104	4 16 0	..
Madras E. S. Corp. Ord.	3 —3⅛	..	..
Melbourne E. S. Co. 6% Cum. Pref.	36 —41	..	..
Do. 5% 1st Mortg. Deb. Stock	93⅛—95⅛	5 5 0	..
Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	89 —90	5 11 0	..
†Mexican Lt. & Power Co. Com. St.	82 —83	4 11 0	..
†Do. 7% Cum. Pref. St.	107⅛—109⅛	6 8 0	..
Do 5% 1st Mort. Gold Bnds.	95 —96	5 4 0	..
Monterey Rly. L. & P. Co. 1st Mort. Db. Sk.	89⅛—91⅛	5 8 9	..
Montreal Lt. Ht. & Power Co. Cap. St.	153 —155	5 3 3	F,My,A,N
Northern Lt. Power & Coal 5% Gd. Bds.	73 —75	6 13 6	..
River Plate Electricity Co. Ord. Stk.	228 —238	3 15 6	April ....
Do. 6 per Cent. non-Cum. Pref. Stk.	110 —117	5 2 6	May ....

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NOTES.

The Wireless Telegraph Situation.

The situation in the world of commercial wireless telegraphy is changing rapidly at the present time, the latest event being the granting of a new patent to Sir Oliver Lodge extending for another seven years certain claims of his well-known patent No. 11,575 of 1897. It is quite reasonable that certain pioneer patents should be extended, for it is generally an uphill task to gain adequate reward from them in the time originally allowed; and thus it would not be surprising if a similar extension of life were given to some of the Marconi patents in due course. The judgment of Mr. Justice Parker in regard to Lodge's patent is given at length elsewhere in this issue, and may be described as a model *résumé* of the main features disclosed in the specification. This summary is of value in that it enables us quickly to seize upon the points that count to the legal mind. The claims of the new patent which appear likely to affect the wireless situation are Nos. 1 and 2, and 6 and 9 of the original patent. As regards claims 1 and 2, a great deal will depend upon how broadly these are interpreted by the courts. Claim 6 is the one which possibly presents the greatest interest at the moment. This relates to the means of charging the transmitter by impulsive rush without metallic connection with the source of supply. This impulsive rush method was recently hailed by Mr. Duddell as the anticipator of the Wien shock excitation method, and if this be so, the use of the quenched spark may turn out to be controlled by this patent.

While the object achieved is, however, to some extent the same, namely, the provision of means whereby the oscillator will continue oscillating freely, the question whether the methods of the impulsive rush and the quenched spark are identical, may require thrashing out in a court of law. For the term "shock" excitation, though it has caught on, is really a misnomer; what takes place in the quenched spark is a transfer of energy at each spark (which is an ordinary and not a B spark), through the medium of the interlinking, and the only shock really is the suddenness of the extinction of the discharge—the oscillator then continuing with its very slightly damped oscillations. With the impulsive rush method, on the other hand, the shock is in the violence of the charge; and there are various other considerations which lead one to the view that the manifestations do not make use of quite the same discharge phenomenon in the two cases. The so-called shock excitation, in fact, appears to have its mechanical analogue in the refined escapements of certain clock movements, which are designed to transmit the motion to the pendulum *without shock* and immediately to withdraw so as not to affect the further motion, this proceeding at the natural rate of oscillation. An interesting problem is also presented by claim 9, which relates to the linking of the coherer circuit through a transformer to avoid metallic connection. Now, it would appear easy to circumvent this claim by using an auto-transformer con-

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nection, which would involve metallic connection that is expressly to be avoided. But since it has already been decided that an auto-transformer and a transformer with two windings are one and the same, it would seem as though we were face to face with the conundrum, "When is a transformer not a transformer?"

London Suburban Railway Electrification.

THE Report of the Departmental Committee on Railway Agreements and Amalgamations issued this week indicates that closer combination and co-operation between railway companies is inevitable in the future, and is on the whole to be welcomed. Although the restriction of undesirable competition is, of course, the main object of the companies, the development of traffic is also one of their aims, and in this connection "through running" is likely to be considered. We do not suppose that the effect produced on "through running" by the electrification of suburban lines in London has yet received full attention, but the question must certainly be faced before long.

ALTHOUGH official confirmation is not yet forthcoming, there is no doubt that the Committee of the East London Railway have decided to electrify the 5 miles of their railway, and the opinion is generally held, as shown by articles in the daily Press, that the continuous-current third-rail system will be adopted. In view of the close connection between the lines of this Company and those of the Metropolitan District and Metropolitan Railways such a decision was to be expected, and the system employed on these last-mentioned railways may, perhaps, be a deciding factor when electrification is considered by other companies. At present the question of interconnection with the single-phase system of the London, Brighton & South Coast Railway has not arisen; but as electrification is extended to other sections of this Company's system the problem of interconnection will become more difficult and the directors of other companies may be placed in a dilemma. Thus, the proposed new electric line from Sutton to Wimbledon will of necessity be operated on the continuous-current system in view of its close connection with the lines of the Metropolitan District Railway, whilst the London & South-Western Railway Company, whose track permits of "through running" with the District Railway at several places, may have difficulty in choosing between the desirability of connecting up with this system and of adopting the single-phase system to prevent isolation from the neighbouring lines of the London, Brighton & South Coast Railway.

Trains de Luxe for an Electric Railway—According to the "Electrical Review and Western Electrician," the Illinois Traction System will shortly place in operation two-car trains composed of a motor car and trailer which will equal in every respect the parlour-car trains on the steam railways. The motor car will be of the library-buffet type and the trailer of the observation-parlour-car type. Both cars will conform to the latest practice in car building. An extra fare will be charged on these trains.

Banquet to Prof. H. E. Armstrong.—As there has been a widespread feeling among Prof. Armstrong's old students that the time is ripe for some collective expression of their indebtedness to him and their appreciation of his services to science and industry during the past quarter of a century, it has been decided to entertain him to a banquet on Saturday evening, the 13th inst. A large committee has been formed to carry out the necessary arrangements, and a number of our leading scientific men will be present as guests. The chairman will be Prof. W. J. Pope, F.R.S., and the vice-chairman Mr. Maurice Solomon. It is hoped that engineering, as well as chemical, old students will respond readily, so as to ensure a successful evening. Applications for tickets should be made not later than the 8th inst., to Mr. F. F. Renwick, Norland House, Avenue-road, Brentwood, Essex.

Electricity in a Composing Room.—According to the "Electrical Review and Western Electrician," the "New York World" is now using electricity in its press and composing rooms, not only for lighting and power but for melting the type metal in the linotype machines. This change has increased the output of the machine by about 20 per cent., while a much better "slug" is obtained. When using the old method, where the heat cannot easily be regulated, the slugs were often found to be imperfect, and had to be replaced. Since electric heating was introduced, however, this has not once been the case. The use of electric heating, too, greatly improves the conditions in the composing room. The electric melting pot is provided with a cover and spout, and is surrounded by a jacket of cast-iron lined with asbestos. A central plunger serves to force the molten metal out of the spout in the customary manner. A number of heating coils supported by insulators are placed in the air-tight space between the melting pot and the jacket. Heating coils of high resistance are placed outside and round the insulating sleeves. The coils are divided so that the heat from the inner group is applied to the main portion of the pot and from the outer group to the spout, so that the greater amount of heat energy is used for melting the metal and a less amount for keeping it in a molten condition. Heat control, which is effected by a thermostat, keeps the metal at the right temperature.

Regulating-Pole Rotary Converters.—The "Electrical World" gives an account of a rotary converter by which a variable ratio between the alternating and direct-current pressures can be obtained without the use of complicated apparatus or wiring. This machine is provided with auxiliary regulating poles, which are so set that each regulating pole adds algebraically its flux to that of a main pole, either increasing or decreasing it, and so increasing or decreasing the direct-current voltage. The current in the regulating pole circuit is varied by means of a rheostat inserted in this circuit. Five of these rotaries, each having a capacity of 1,000 kw., have been installed by the Potomac Power Co. Three of them are used in railway work for supplying current to the Washington Railway & Electric Co. They give a variation in pressure from 515 to 600 volts. By means of these machines any desired subdivision of load between the various sub-stations of the railway company can be obtained, as, by increasing the potential at which the power is supplied by a sub-station, other conditions remaining the same, its load may be increased, while by reducing the potential its load may be diminished. These machines have the usual shunt and series winding on the main poles and a shunt winding on the regulating poles. The series winding on the main pole gives the usual compounding voltage at any pressure to which the machine is adjusted by the rheostat in the regulating pole circuit. The other two converters are used for lighting at a pressure between 240 and 300 volts.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of R
Assab—Perim	July 8, 1909 ...	—
Malta—Tripoli	April 20, 1910 ...	—
Latakia—Palura	May 26, 1910 ...	—
Tourane—Amoy	Sept 25, 1910 ...	—
Port de France—Paramaribo	April 10, 1911 ...	April 27,
Bonny—Duala	April 16, 1911 ...	—
Zanzibar—Mombasa	April 19, 1911 ...	May 2,
Kwandang—Menado	April 25, 1911 ..	—

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New Wiring Rules (1911).—We have received from the Institution of Electrical Engineers a copy of the new edition of the Wiring Rules which has just been issued. We understand that these new Rules have been adopted by 49 Fire Offices and are accepted as standard practice by 232 supply authorities. The price of the Rules is 6d. per copy (7d. post free), and copies can be obtained from the Secretary of the Institution, or from Messrs. E. & F. N. Spon, 57, Haymarket, S.W. In our next issue we shall refer to the main alterations which have been made since the previous edition of the Rules was published.

A Choice of Systems for Electric Traction.—In the course of discussion on the problem of electrifying the railways in the Boston neighbourhood, Mr. W. S. Murray said, regarding systems of electrification, both the direct and alternating currents had their appropriate spheres of usefulness, but that for trunk lines, long distances and train services requiring large units of power, alternating current was fundamentally necessary. Touching further upon the advantages of alternating-current service, Mr. Murray said that the only power plant the New Haven Co. had was located at Cos Cob, 18 miles north of the Woodlawn junction with the New York Central lines. If direct-current distribution had been used it would have been necessary to instal a sub-station every 6 or 8 miles in order to enable each train to get its full quota of power. It was not clear that the saving in locomotive repairs and fuel paid for the fixed charges on electrification, unless the traffic density was very high. The savings were chiefly in fuel and locomotive repairs, combined with a decided increase in the traffic capacity of the equipment. The actual drop in voltage between Cos Cob and the Harlem River yard, 25·6 miles, at peak load gave a working potential of over 9,000 volts, which enabled the time-table to be maintained. On "Football Day" the output at Cos Cob would rise to 20,000 H.P., and the actual average loss in distribution for the entire day would be only 3 per cent., with a momentary drop of about 14 per cent. at Woodlawn. Confidence could be placed in electrification, but engineers must do what they could to check the popular clamour for it. Mr. Murray showed a large number of lantern slides exhibiting arrangements in construction within the New Haven electric zone, and concluded by briefly describing various features of the Hoosac Tunnel electrification. Two insulators were placed in series in this tunnel, the insulation being sufficient to withstand 300,000 volts. One insulator pair tested after three years' exposure to steam locomotive operation withstood 300,000 volts even when incrusted with soot and dirt, and when cleaned showed practically its initial insulating qualities.

Jubilee of Pacinotti's Machine.—To-day (May 5) is being celebrated as the jubilee of Prof. Antonio Pacinotti's toothed ring dynamo, which may be looked upon somewhat as an inversion of the Gramme ring and the forerunner of the modern toothed-core armature. The machine is described in "Il Nuovo Cimento" of June, 1864, in which Prof. Pacinotti terms the armature a "transversal electro-magnet." The reasons given by the author for adopting this form of armature are as follows:—(1) the current in the armature coils tends to flow, and the driving couple, when it is used as a motor, acts continuously; (2) the circular construction and uniform magnetisation of the parts give regularity of motion; (3) the magnetic changes in the armature core are less rapid; (4) the sparks are more numerous, but of less intensity, since the circuits remain closed. There seems to be some confusion as to when Prof. Pacinotti's article states that he constructed the model in 1860. The date of publication, as mentioned above, is 1864, though some of the reprints made for the Paris Exhibition of 1881 state that the June number of "Il Nuovo Cimento" was published in May, 1864. On the other hand Prof. Vittorio Cavassa, of Genoa, who is Hon. Secretary of the Committee for honouring Prof. Pacinotti, states that 1911, is the exact anniversary. The jubilee is to be celebrated by the issue of a special single number newspaper, containing the address of congratulation (engrossed on vellum) by the Council of the Institution of Electrical Engineers, the only one among many others. In Italy the present year, as the result of these events, is being regarded as the jubilee of the *dynamo*, which mistaken idea is doubtless the result of patriotic zeal.

The following list of Prof. Pacinotti's publications on electro-magnetism beyond the one above mentioned will be of interest to our readers:—

"Ragguagli ed esperimenti sopra una piccola macchina dinamo-elettrica." "Il Nuovo Cimento," 1870.

"Correnti indotte con un circuito magnetico chiuso." "Il Nuovo Cimento," 1872.

"Reso conto di una memoria del Sig. Gaugain sulle correnti indotte sviluppate dalla macchina costruita dal Gramme." "Il Nuovo Cimento," 1873.

"Dell' uso delle elettro-calamite trasversali per la reproduzione elettro-magnetica degleangoli." "Il Nuovo Cimento," 1873.

"Considerazioni sulla elettro-calamita trasversale adoprata come elettro-motore." "Il Nuovo Cimento," 1873.

"Descrizione del Gomitolo elettromagnetico e suo uso nelle macchine magneto-elettriche." "Il Nuovo Cimento," 1874.

Current Topics.

Subjects of current interest dealt with in this issue include the following:—

Mr. D. Owen contributes an article on "Magnetic Bodies Composed of Non-Magnetic Elements."

"An Electrodynamic Method of Investigating the Interior of the Earth" is described by Dr. H. Löwy.

We give an account of the "Thomas" transmission for motor vehicles. The transmission is partly electrical and partly mechanical. A 2,000-mile road trial of a lorry equipped with this gear is being carried out by the Royal Automobile Club.

At the meeting of the Institution of Electrical Engineers last night a Paper was read by Mr. D. Murray, entitled "Practical Aspects of Printing Telegraphy." The Institution is holding weekly meetings during the present month.

An interesting discussion took place at the meeting last week when Mr. A. M. Taylor read his Paper on "Battery Economics."

A dinner of old Ferrantians was held on Saturday last at the Trocadero Restaurant. Mr. C. P. Sparks was in the chair, and a large company were present to do honour to the guest of the evening, Mr. S. Z. de Ferranti.

Mr. Haydn T. Harrison contributed a Paper entitled "The Ratio of Light to Illumination" at a meeting of the Illuminating Engineering Society last week. A Paper on "Some Notes on the Effect of Wall Papers upon the Illumination of Interiors" was also read by Mr. P. J. Waldram.

The deputation appointed in 1910 by Birmingham Corporation to visit the continent in order to report upon town-planning, &c., has presented an interesting report, which is abstracted in another column.

The Board of Trade have refused to grant a provisional order to Bermondsey (London) Council for the St. Olave district.

Legal.—On Friday Mr. Justice Parker delivered his reserved judgment in the application for the extension of the period of patent No. 11,575/1897, granted to Sir Oliver J. Lodge for wireless telegraphy, and in the result he granted an extension of seven years for certain of the claims in the original specification.

Mr. Justice Swinfen-Eady continues this week the hearing of the action brought by the British Westinghouse Electric & Mfg. Co. against the Electrical Co. to restrain the alleged infringement of the Bremer arc lamp patent.

Companies' Meetings and Reports.—At the meeting of the British Westinghouse Electric & Mfg. Co. the chairman (Mr. J. Annan Bryce) gave an account of the progress made by the Company during the past year, and of the electrical companies in which it is interested.

At the meeting of the Santos Improvement Co., the chairman, Mr. D. M. Fox, gave a sketch of the development of the Company, and supplied particulars of the progress of their electric tramway and lighting branches.

OBITUARY.

We regret to announce the death of Mr. Stephen J. Symonds, secretary and manager of the Farnham Gas and Electricity Co., Ltd.

The death of Mr. W. G. Murrin, electrical contractor, of Wandsworth (London) and Lowestoft is also reported. Mr. Murrin was 55 years of age.

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APPOINTMENTS VACANT AND FILLED.

Belfast Tramways & Electricity Committee require a sub-station attendant. Wages £2 per week of seven days. Applications to the city electrical engineer, Mr. T. W. Bloxam, M.I.E.E., electricity works, East Bridge-street, Belfast, by May 9.

A lecturer in applied mathematics is required for the Grey University College, Bloemfontein. Salary £400 per annum. Applications to the High Commissioner for South Africa, 72, Victoria-street, London, S.W., by May 19.

An important firm of electrical engineers require for their London office a junior assistant, with technical training and knowledge of German, for publication work.

Cheltenham Local Higher Education Committee require a director for their technical schools. Salary £220, rising to £250 per annum. Applications to the Clerk to the Governors by May 16.

Mr. Patrick J. Webb, commercial instructor to the County Clare Technical Committee, has been appointed (out of 49 applicants) principal of the City of Galway Tecnhical Institute.

INSTITUTIONS AND SOCIETIES.

Royal Institution.—The annual meeting of this Institution was held on Monday last, the Duke of Northumberland in the chair. The annual report of the Committee of Visitors for the year 1910, testifying to the continued prosperity and efficient management of the Institution, was read and adopted, and the report on the Davy-Faraday Research Laboratory of the Royal Institution, which accompanied it, was also read. Thirty-nine new members were elected in 1910, and 61 lectures and 17 evening discourses were delivered. The books and pamphlets presented amounted to about 239 volumes, making with 604 volumes (including periodicals bound) purchased by the managers, a total of 843 volumes added to the library in the year. Thanks were voted to the president, treasurer and the honorary secretary, to the committees of managers and visitors, and to the professors, for their valuable services to the Institution during the past year. The following gentlemen were unanimously elected as officers for the ensuing year: *President*, the Duke of Northumberland; *Treasurer*, Sir James Crichton-Browne, F.R.S.; *Secretary*, Sir William Crookes, F.R.S.; *Managers*, Mr. J. B. Broun-Morison, Dr. J. M. Bruce, Dr. H. E. Armstrong, F.R.S.; Sir H. B. Buckley, Sir J. W. Barry, Earl Catheart, Dr. D. W. C. Hood, Mr. H. F. Makins, Sir F. Laking, Mr. Alex. C. Ionides, Mr. R. Mond, Dr. R. Messel, the Hon. C. A. Parsons, F.R.S.; Sir J. Stirling and Mr. Alex. Siemens; *Visitors*, Mr. H. Edmunds, Sir F. Fison, Mr. W. A. T. Hallowes, Dr. A. C. Hill, Mr. J. W. Gordon, Mr. H. R. Kempe, Major-Gen. Sir C. Grove, Mr. C. E. Groves, Mr. A. Kirkman Loyd, Mr. F. K. McClean, Sir C. D. Rose, Major P. A. MacMahon, F.R.S., Messrs. W. Stone, E. R. Merton and H. Swithinbank.

Institution of Electrical Engineers.—At the meeting last week the chairman, Mr. W. Duddell, who presided in the absence of Mr. S. Z. de Ferranti, read the list of nominations for the Council, which was given in our last issue. Mr. W. A. Chamen then rose and expressed the pleasure of his friends and himself at Mr. Kingsbury's name again appearing on the list of nominations. It would be remembered, he said, that last year he made an independent nomination which resulted in Mr. Kingsbury not being elected, but he was very pleased to see that Mr. Kingsbury's name was again included. As far as he and his friends were concerned, no opposition would be offered to the present nominations.

Institution of Mechanical Engineers.—The anniversary dinner of this Institution on Thursday last week brought together a distinguished gathering representative of the engineering and other professions. Mr. E. B. Ellington, president, was in the chair, and the company, which numbered about 240, included Dr. T. J. Macnamara, M.P. (Parliamentary Secretary to the Admiralty), the Marquess of Bristol, M.V.O. (President of the Institution of Naval Architects), Sir William White, K.C.B., F.R.S., Mr. F. D. Acland, M.P. (Financial Secretary to the War Office), Lt.-Col. Sir James R. Dunlop Smith, K.C.S.I., Sir William Hall-Jones, K.C.M.G. (High Commissioner of New Zealand), Sir N. J. Moore, K.C.M.G. (Agent-General of Western Australia), Sir John W. Taverner (Agent-General of Victoria), Sir Archibald Geikie, K.C.B. (President of the Royal Society), Sir Charles Owens (General Manager, London & South-Western Railway), Surgeon-Gen. Sir Alfred Keogh, K.C.B., F.R.S. (Rector of the Imperial College of Science and Technology), the Rev. Prof. T. G. Bonney, F.R.S. (President of the British Association), Mr. Alex. Siemens (President of the Institution of Civil Engineers), Mr. S. Z. de Ferranti (President of the Institution of Electrical Engineers), Mr. W. H. Patchell, Mr. F. W. Dyson, F.R.S. (Astronomer Royal), and Coun. E. L. Somers Cocks (Mayor of the City of Westminster).

After the customary loyal toasts had been duly honoured, the president mentioned that His Majesty, King George, had consented to remain, after his accession to the throne, an honorary member of the Institution.

Sir William White proposed the toast of "The Empire." In doing so he emphasised the fact that sea supremacy is vital to the stability of the British Empire, and of no other empire in the world was this the case. He by no means took a despondent view of the growing tendency for people in this country to emigrate to our colonies; in fact, he recommended members to do all they could to encourage young engineers to go to the colonies, so as to relieve the pressure in the home market.

Dr. Macnamara, in responding, gave three reasons for the unique position occupied by the British Empire; these were (1) the Britisher's genius and capacity for self-government, (2) that in the Union Jack they saw a covenant of fair play, liberty and justice, and (3) British pluck and endurance.

Sir William Hall-Jones also responded, and in a spirited speech testified to the loyalty of New Zealand and the determination of all the colonies to stand by the mother country.

The toast of "Our Guests" was then proposed by Mr. J. A. F. Aspinall, and was acknowledged by Prof. T. G. Bonney and Sir Alfred Keogh. The last mentioned speaker stated that he looked forward to the time when there would be a closer connection between the great Societies, such as the Institutions of Civil and Mechanical Engineers, and the colleges, so assisting to direct educational methods in accordance with the requirements of the country.

To the Mayor of Westminster fell the duty of proposing "The Institution of Mechanical Engineers," coupling with it the name of the President. After the latter had responded the proceedings terminated.

National Electric Light Association.—The annual general meeting of this Association will be held in New York from May 29 to June 2. A special train to be known as the "Electric Light Special" will leave Chicago for New York at 2:30 p.m. on May 28.

International Electrotechnical Commission.—The second annual report of this Commission which has just been issued in English and French gives an account of the informal conference which was held at Brussels in August last under the presidency of Mr. Eric Gerard. It is hoped that a full report of the proceedings will be ready shortly. In the present year a full meeting of the Commission is to be held at Turin, the German Committee having kindly foregone their claim to hold it in Berlin as had been originally arranged. A report on the activities of the Congress will be presented at the Pan-American Scientific Congress which is to be held in Washington in October, 1912. As regards the work of the Commission the subject of nomenclature is still being studied with the modification suggested by the German delegate at Brussels, that attention should be confined for the present to a definite and short list of terms dealing with one subject alone, thus avoiding confusion of ideas. Some advance has also been made with the subjects of symbols, rotation of vectors and rating. The Secretary (Mr. C. D. le Maistre) informs us that there are now seventeen countries in which an Electrotechnical Committee has been formed, in the majority of cases with the assistance of their respective Governments. The latest adherents are Holland and Switzerland. Mr. le Maistre has lately returned from visiting the various European Committees where, without exception, the keenest interest is being taken in the work and success of this international movement. In the near future a small international Committee, appointed at a Conference held in Brussels in August, 1910, consisting of Dr. Budde (Germany), Dr. Silvanus Thompson (Great Britain), M. Brunswick (France) and M. Eric Gerard (Belgium), is to meet and discuss the work on nomenclature. This Committee is to prepare a list of terms and definitions dealing with the one subject of electrical machinery, which list is to be ratified by the full meeting of the Commission to be held at Turin at the beginning of September next. Most of the Presidents of the European Committees have signified their intention of being present at Turin, and if the success which attended the Brussels follows the Commission at Turin, as no doubt it will, the work accomplished should certainly be of a very practical and useful nature.

Association of Mining Electrical Engineers.—At the meeting of the West of Scotland Branch of this Association on the 21st ult., at Glasgow, the discussion on Mr. Benson's Paper entitled "Compressed Air versus Electricity in Mines," was continued. (An account of the previous discussion was given in our issue of March 24th).

Mr. A. Anderson (Chairman of the Branch) thought it unfair for Mr. Benson to compare electrical plant, as it was 9 years ago, in its infancy for mining purposes with a rival which had reached manhood

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The comparison would not hold good to-day. When the only argument that could be advanced in favour of compressed air was that it was able to operate a machine of the reciprocating class, he would refer the author to the discussion on Mr. Kilburn Scott's Paper wherein it was stated that caulkers and rivetters using pneumatic tools every day undoubtedly had their lives shortened. There would always be a difference of opinion as to which system should be used, but on the point of efficiency compressed air would always have a very low efficiency. That was an incontrovertible fact. Thus, during compression 50 per cent. of the work done was carried away as heat by radiation and in the water jackets. (Mr. Anderson explained this by reference to the thermodynamic relations.) Allowing for mechanical losses, an efficiency of 30 per cent. was hardly to be expected. Two or three-stage compressors increased the efficiency of compression by something like 10 to 15 per cent., but the mechanical losses rose so that it was questionable if an overall efficiency of more than 40 to 45 per cent. would ever be obtained.

Mr. D. MARTIN instanced a test he had recently seen carried out. The engines driving the compressors developed 367 I.H.P., while at the working face the power developed by the various tools was approximately 90 H.P.

Mr. W. L. SPENCE said, as confirming the point which Mr. Martin had made, he would consider the figures given just what might be expected. In Cornwall the practice was to allow 30 H.P. at the generating end for every drill for drilling granite.

Mr. ANDERSON said he had had his attention drawn to a compressed air plant at a colliery of considerable magnitude. Immediately the owner discovered that the plant had only an overall efficiency of something like 22 per cent., he had it "scrapped."

Mr. WM. BROWN (Hamilton) said that while there always would be spheres of usefulness for both forms of power in the many intricate operations incidental to mining work, he was still of opinion that electricity was far superior. While it had not been long enough in existence in mines to furnish reliable data as to life and other maintenance charges, still it was simple to transmit electrical energy. The shaft space taken up was for the latter less than 30 per cent. of the air ducts. Then, an 8 in. air pipe in a 20 in. seam meant a lot in the roadways compared with the 1 in. or so for cable. He could recall a case where coal cutting by machinery had to be abandoned also on account of the endless worry due to leaky pipe joints owing to the continual movement of the pavement in the roadways. The use of electric cables would have meant success. They had it on the authority of H.M. Electrical Inspector of Mines that 96 per cent. of the fatal accidents due to electricity were avoidable, so that apprehension on that score could be eliminated with careful attention to installation.

Mr. ANDERSON thought Mr. Brown had opened up a good point in his reference to leaky joints. Was it not the case that the cost of repairs to pipes did not appear as such, as the roadmen looked after them, whereas with electricity the cost of cable repairs was carefully noted.

Mr. BENSON, in reply, said he felt the majority of his critics had unnecessarily laboured the superior efficiency of electrical plant. That he admitted. To ventilate by compressed air never entered his head. It was only in a troubled field, with an extraordinary number of faults and thin seams where compressed air came in useful, also for headings his experience so far proved that the "Liskol" or "Little Hardy" machines were invaluable. As to costs the boiler consumption at his colliery by the addition of air-driven coal-cutters only increased from 0·55d. to 0·75d., less than ½d. per ton of output. That was a point he would like to emphasise.

EDUCATIONAL NOTICES.

Battersea Polytechnic (London, S.W.).—The following courses will be held during the summer term, commencing May 15:—On "Electric Lamps and Illumination," Monday, 7:15 to 8:15; "Fault and Insulation Testing of Electric Mains," Monday, 8:15 to 9:15; "The Electric Railways of London," Wednesday, 7:30 to 9:30. In connection with the course visits will be arranged to sub-stations and depôts.) Fee for each course 2s. 6d. Further particulars from the secretary.

Technological Scholarships.—The West Riding (of Yorkshire) County Council offer technological scholarships, of which not more than four will be of the value of £60 per annum. Applicants must be qualified by residence within the administrative county of the West Riding (excluding the county boroughs). The scholarships will be tenable for one year (combined day and evening courses in connection with industries such as mechanical or electrical engineering, metallurgy, textile work, &c.), and are intended for young persons who have had at least three years' practical experience in workshops or their equivalent. Application forms and particulars from the Educational Department (Technical Branch), County Hall, Wakefield.

Massachusetts Institute of Technology.—The Congress of Technology, which met in Boston on April 10th and 11th, in celebration of the semi-centennial of the signing of the charter of this Institute is reported to have been a pronounced success. The opening session of the Congress commenced with an address by Dr. Maclaurin, President of the Institute, who spoke on "Some Factors in the Institute's Success." "Apart from his appreciation of the value of all sound learning," said Dr. Maclaurin, "William Barton Rogers, the founder and first president of the Institute, saw clearly that the whole controversy as to the relative merits of science and the classics in the field of education missed the mark by placing the emphasis in the wrong place. He understood that when one gets to the root of things in education, the *method* rather than the *subject* is of supreme importance, and his insistence on the value of method in teaching was the cardinal doctrine in his creed and the one that has contributed most to the success of the Institute. The idea is familiar to us all to-day, the idea of *learning by doing*." The second day was given over to the presentation of papers on various aspects of applied science. These papers, which were all given by alumni and members of the faculty, were grouped in six sections and dealt with scientific investigation and control of industrial processes, technological education in its relation to industrial development, administration and management, recent industrial development, public health and sanitation, and architecture respectively. We notice Mr. H. M. Hobart among the contributors of papers, his subject being "The progress of electric propulsion in Great Britain."

Glamorgan C.C. Summer Mining School.—Glamorganshire County Council have arranged courses of instruction to meet the requirements of the new Coal Mines Bill, and a short course of instruction will be given for three weeks during August at the University College, Cardiff.

Instruction will be given in practical surveying, electrical, mechanical and mining engineering (workshop practice), with practical mathematics, metallurgy and chemistry, courses in gas detection, &c. There will also be evening lectures in electrical engineering and a teachers' course in chemistry, geology and physics. Further particulars and forms of application may be obtained from the Chief Education Official, 35, Park-place, Cardiff.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, May 5th (to-day).

DERBY SOCIETY OF ENGINEERS.

7:30 p.m. Meeting at the Mechanics' Institute, Wardwick. Paper on "Electric Steel Furnaces," by Mr. Joh. Härdén.

ROYAL INSTITUTION.

9 p.m. Meeting at Albemarle-street. Discourse on "New Organic Compounds of Nitrogen," by Prof. M. O. Forster, F.R.S.

MONDAY, May 8th.

GRADUATES' ASSOCIATION OF THE INSTITUTION OF MECHANICAL ENGINEERS.

8 p.m. Meeting at Storey's-gate. Paper on "The Application of Liquid Fuel in Industries," by Mr. O. Wickham.

TUESDAY, May 9th.

ILLUMINATING ENGINEERING SOCIETY.

8 p.m. Meeting at the Royal Society of Arts, John-street, Adelphi. Annual General Meeting.

WEDNESDAY, May 10th.

JUNIOR INSTITUTION OF ENGINEERS.

8 p.m. Meeting at the Institution of Electrical Engineers, Victoria Embankment. Paper: "Notes on Illumination by Gas and Electricity," by Mr. F. J. Hawkins.

THURSDAY, May 11th.

ROYAL INSTITUTION.

3 p.m. Meeting at Albemarle-street. Lecture on "The Optical Properties of Metallic Vapours," by Prof. R. W. Wood. Tyndall Lecture III.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Meeting at Victoria Embankment, W.C. Paper on "The Driving of Winding Engines by Induction Motors," by Mr. H. J. S. Heather.

FRIDAY, May 12th.

PHYSICAL SOCIETY OF LONDON.

8 p.m. Meeting at the Imperial College of Science, Imperial Institute-road, South Kensington. Agenda: "Stream Lines Past the Elliptic Cylinder and Magnetic Interpretation," by Sir George Greenhill, F.R.S., and Col. R. W. Hippisley, R.E.; "The Method of Constant Rate of Change of Flux as a Standard for Determining Magnetisation Curves of Iron," by Messrs. J. T. Morris and T. H. Langford; and "Demonstration of an Electric Thermo-Regulator," by Prof. H. L. Callendar, F.R.S.

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THE VOLTAGE BETWEEN COMMUTATOR SEGMENTS.*

BY THEODORE HOOCK.

Summary.—The author shows that the maximum voltage between commutator segments depends on the saturation of the magnetic circuit, and he points out how it increases, in the case of a motor, when the speed is raised by shunt regulation.

It is very important to know the magnitude of the maximum pressure between the commutator segments, in order to design a good machine. In machines without commutating poles, a maximum voltage between segments of 30 to 35 volts will cause sparks to appear at the brushes, while if the commutator is in a bad condition, 40 volts may cause an arc or flash-over. With 500-volt traction motors without commutating poles, the pressure between segments usually reaches the upper limit (30 to 35 volts), when so-called harmless sparks are seen, but in case of sudden voltage variations due to short-circuits, &c., a flash-over occurs between the brushes and frame, due to the momentary increase in the segment-pressure. This may also happen with commutating-pole machines, on account of the small air-gap and high specific armature loading (AS).

Practical values of the pressure between segments lie between 12 and 25 volts, in any case lower than 30 to 35 volts. With a maximum voltage of 50 volts, even with sparkless running and a clean commutator, there is a tendency to flash over.

1. *Open-Circuit Field.*—The pressure between adjacent segments at any point is a function of the speed of rotation of the coils between the two segments and the resultant field at that point. If E=induced E.M.F., $2p$=number of poles, $2a$=number of parallel paths in armature, k=number of segments, the mean pressure between segments on open-circuit is (Fig. 1, curve a) :—

$$e_{mean} = E \cdot 2p/k. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

This assumes that the field-curve is rectangular, so that the pressure varies from $+e$ to $-e$ at the neutral point. Assuming the field-

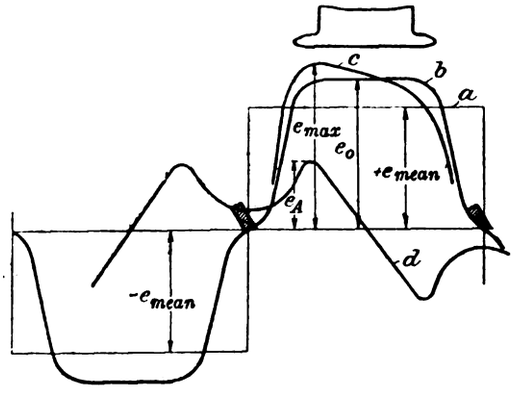

FIG. 1.

a=Ideal field curve ; b=Actual field curve on open circuit ; c=Field curve on load ; d=Armature field.

curve is sinusoidal, the value 2, in equation (1), becomes π—that is, e_0 is 1·57 times as large.† Measurements on standard machines give values about 45 per cent. higher than equation (1), and 8 per cent. smaller than by the substitution of π for 2.

Introducing a factor, which varies between 2·7 and 2·9 according to the ratio of pole-arc to pole-pitch and to the shape of the field, we obtain the more accurate equation (Fig. 1, curve b) :—

$$e_0 = \frac{(2{\cdot}7 \text{ to } 2{\cdot}9)a}{k} \cdot \frac{E\,p}{a} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

We also obtain the same result from the particulars of the machine. If B_i=density in the air-gap, l_i=ideal length of armature, w=turns per segment, we have

$$e_0 = 2\,p/a\ B_i \cdot v \cdot l_i \cdot w \cdot 10^{-8}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

By means of this equation the distribution of the density in the gap can be obtained. It must be noticed that this only gives the actual field-strength with full-pitched lap windings ; with series windings only a mean value over all the poles is obtained. This, however, has very little effect on the maximum pressure between segments.

2. *Armature Field.*—If the brushes are kept in the neutral position, a very small excitation of the main poles suffices to send full-load current through the armature at normal speed. In some cases even, remanence in the field system will be enough to supply many times the full-load current on short-circuit. If it is desired to test the machine with full-load current, either the speed must be reduced, or resistances must be connected in series with the armature, or the remanence must be eliminated. Shifting the brushes also has the same effect.

Curve d in Fig. 1 represents the armature field. Its zero value coincides with the centre of the pole. On each side it follows a straight line and reaches its maximum at the pole-tips. Since the armature field follows a straight line only with a concentric pole-arc, we will only consider this case.

We are now only interested in the maximum field strength and the pressure between segments on short-circuit, which is proportional to the field-strength.

The maximum density in the gap under the pole-tip at short-circuit is :*—

$$B_A = \frac{b_i \cdot AS}{1{\cdot}6 \cdot k_1 \cdot \delta} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

and the maximum pressure between segments at short-circuit

$$e_A = 2p/a.\ B_A \cdot l_i \cdot w \cdot v \cdot 10^{-8}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where b = ideal pole-arc,
AS = armature ampere-conductors per centimetre,
k_1 = factor taking the slot openings into account,
δ = air-gap.

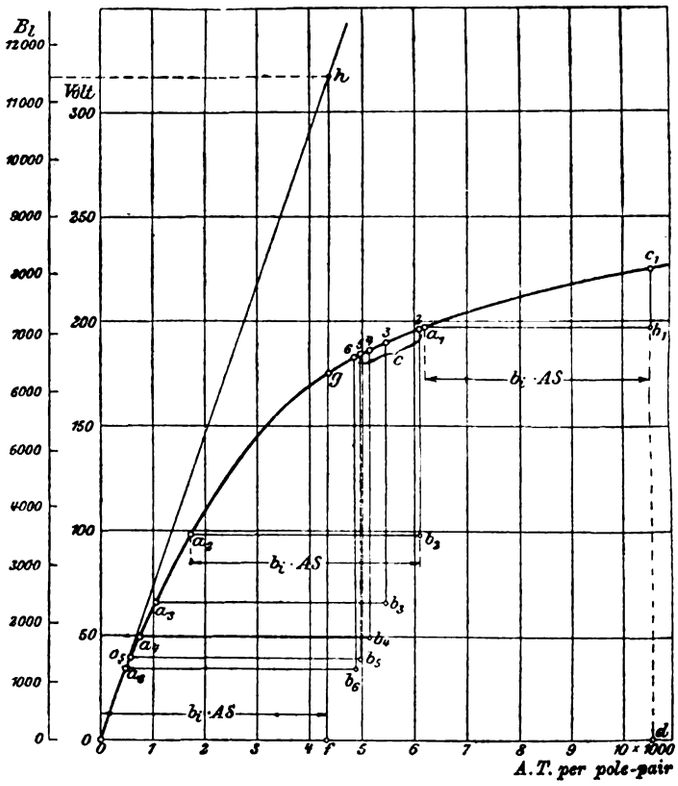

FIG. 2.—OPEN CIRCUIT CHARACTERISTIC OF A MOTOR WITH A SPEED VARIATION OF 1:6 BY SHUNT REGULATION.

The calculation of e_A is of importance for boosters, and all machines which work without excitation or with weak fields and high armature reaction. It is also useful for testing standard machines on short-circuit.

If the density in the gap is found from equation (4) to be

$$B_A < 4{,}000 \text{ to } 5{,}000,$$

so that the density in the teeth

$$B_z < 12{,}000 \text{ to } 15{,}000,$$

equation (5) can be used for e_A without correcting for saturation.

If, however, the iron is saturated, the open-circuit characteristic of the machine can be used with sufficient accuracy for calculating e_A. Assuming that we find from equation (4) that B_A=11,400, there is no longer proportionality between the density in the gap and the ampere-turns.

In Fig. 2 we find O—f ampere-turns on the main field for B=11,400, or, employing the armature field, we have, for an ideal gap-density B_A=11,400 and b_i. AS armature ampere-turns, an actual gap-density of 11,400 $\frac{gf}{hf}$; or, in other words, the pressure be-

* Abstract of an article in the "Elektrotechnische Zeitschrift."
† Arnold, "Gleichstrommaschine."

* Arnold, "Gleichstrommaschine."

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tween segments with full-load short-circuit current equals, from equation (5),

$$e_{A1/1}=2p/a\ 11{,}400\frac{gf}{hf}.\ l_i\ .\ v\ .\ w\ .\ 10^{-8}.$$

3. *The Resultant Field.*—If the machine is loaded, the resultant field-curve takes the shape shown by curve *c* in Fig. 1. Since we start with normal excitation on the main poles, we cannot neglect the effect of saturation.

The armature teeth, air-gap, pole-shoes and armature core are traversed by both the main and armature fields, and we can calculate the field-curve on load by superposing them.* As already mentioned, the open-circuit characteristic suffices for this. In Fig. 2, the point *a* represents the E.M.F. on full-load. Drawing now the armature ampere-turns b_1AS to the right from *a*, the ratio of the ordinates $\frac{cd}{ab}$ gives the increase of pressure between segments on full-load. An example will illustrate this.

In motors having a speed-variation of 1:4 or 1:6, the main ampere-turns are only a fraction of the armature ampere-turns at the higher speeds. We can, therefore, neglect the effect of the main field on the armature field and calculate the pressure between segments as for a machine on short-circuit.

Consider now a motor having a speed variation of 200 to 1,200 revs. per min., of which the open-circuit characteristic is shown in Fig. 2. We are given the following data :—

$A=205$, $b_i=21{\cdot}5$ cm., $v=0{\cdot}215\ n$, $\delta=2$ mm., $l_i=22$ cm., $k=147$ segments, E=220−23=197 volts, $w=3$ per segment.

At full-load and $n=1{,}200$, $v=25{\cdot}8$ m/sec., and we have, from equation (4), for the ideal gap-density,

$$B_A=\frac{21{\cdot}5\ .\ 205}{1{\cdot}6\ .\ 1{\cdot}2\ .\ 0{\cdot}2}=11{,}400.$$

We now find the point *h* in Fig. 2 and from it the point *g* on the curve, which gives an actual gap-density of $B_{AW}=6{,}300$. Placing this value in equation (5), we obtain the maximum pressure between segments at full-load and 1,200 revs. per min. to be

$$e_6=.\ 2\frac{2}{1}.\ 6{,}300\ .\ 25{\cdot}8\ .\ 3{\cdot}22\ .\ 10^{-8}=43\text{ volts.}$$

Hence, we have :—

At full-load and $n=1{,}000$

$$e_5=\frac{1{,}000}{1{,}200}43=35{\cdot}9\text{ volts,}$$

At full-load and $n=800$,

$$e_4=\frac{800}{1{,}200}43=28{\cdot}7\text{ volts,}$$

At full-load and $n=600$,

$$e_3=\frac{600}{1{,}200}43=21{\cdot}5\text{ volts,}$$

At full-load and $n=400$,

$$e_2=\frac{400}{1{,}200}43=14{\cdot}3\text{ volts.}$$

It is clear from this how large an increase can be obtained in the pressure between adjacent segments by weakening the field. The pressure at no-load is about 8 volts, so that we have 1·8, 2·75, 3·65, 4·55 times this value on full load.

Now we have not taken the main field into account here, but the following calculation will show that this omission introduces no appreciable error.

At full-load and $n=200$, let a_1 (Fig. 2) represent the E.M.F. Then b_1 is increased in the ratio $dc_1 : db_1$, as shown above, and we have

$$e_1=\frac{2{\cdot}9\ .\ 2\ .\ 197}{147}\frac{dc_1}{db_1}=8{\cdot}9\text{ volts.}$$

The speed is doubled, the gap-density is halved, and, therefore, from Fig. 2 we find a_2 in Fig. 2 at a point where

$$B=\tfrac{1}{2}\ .\ 7{,}100=3{,}550.$$

Setting again the armature ampere-turns, we obtain the maximum pressure between segments at 400 revs. per min. :—

$$e_2=7{\cdot}8\frac{\overline{oc_2}}{\overline{ob_2}}=15{\cdot}5\text{ volts.}$$

Similarly :—

At 600 revs. per min., $e_3=7{\cdot}8\dfrac{\overline{oc_3}}{\overline{ob_3}}=22{\cdot}6$ volts.

At 800 revs. per min., $e_4=7{\cdot}8\dfrac{\overline{oc_4}}{\overline{ob_4}}=29{\cdot}2$ volts.

At 1,000 revs. per min., $e_5=7{\cdot}8\dfrac{\overline{oc_5}}{\overline{ob_5}}=36{\cdot}3$ volts.

At 1,200 revs. per min., $e_6=7{\cdot}8\dfrac{\overline{oc_6}}{\overline{ob_6}}=43{\cdot}3$ volts.

These are practically the same values as those obtained by the previous method.

As a general rule, therefore, it is sufficient to calculate the gap-density for the top speed, correct it once for all and then put the maximum pressure between segments proportional to the speed.

For traction motors with commutating poles several firms make use of shunt regulation for varying the speed.

The use of compensating windings makes it possible to reduce the field-distortion on load to a minimum. They are, therefore, employed when high pressures between the segments are unavoidable, or when heavy rushes of current or sudden high overloads are to be expected. If it were possible to make the compensating ampere-turns exactly equal to the armature ampere-turns under the pole, no increase in the pressure between segments would take place, but since this is not possible, the distortion varies between 5 and 10 per cent. on load, either positive or negative.

It has been assumed in all the above calculations, that the brushes remained in the neutral line; shifting them increases the pressure between segments. The position of maximum pressure is affected by the dimensions of the pole-tips, the breadth of the pole and the strength of the excitation. The maximum usually occurs under one corner of the pole. Strongly saturated pole-tips are also desirable, since they considerably reduce the maximum pressure.

It is not possible to calculate the field-distortion accurately, not even with a theoretically correct method, because the magnetic reluctances can only be determined at low saturations. Even the arrangement and dimension of the field-coils affect the result. If we are given measurements for one shape of pole, good agreement with the calculations can be obtained.

* Arnold, "Gleichstrommaschine."

SURGING OF SYNCHRONOUS MACHINES.*

BY E. J. BERG.

Surging, or what is often called hunting of synchronous machines, resulting in pulsations of current and voltage, is one of the most perplexing and annoying of the phenomena with which the central station engineer meets. It is always associated with pulsation in speed and in power. The pulsations may be caused by the lack of uniformity of the speed of the prime mover, or by the electrical operation of the machines, or by both. With the limitation of speed variation of prime movers imposed by electrical manufacturers, there is little likelihood that the cause of the hunting is the prime mover if the governor mechanism and its dashpot is of good construction. It is more likely to be due to insufficient dampening of the magnetic circuit of the machines or to too much dampening, or in general to the electrical constants of the circuit. The theory of this phenomenon is fairly well understood, at least in so far as it applies to ideal machines.

The author takes the case of an alternator supplying a synchronous motor, and shows that there is a critical minimum value of reactance, corresponding to the resistance between the generators and the motor, which minimum value depends upon the amount of speed-variation of the alternator armature. It is given by $r \tan a$, a being the angular displacement. It is evident, therefore that the required reactance for stability is practically insignificant—far less than that which is found in any commercial machine. Thus, there can be no difficulties by such small speed variations.

The trouble is most often traced to defective design of the governing mechanism of the prime mover or to characteristics of the synchronous machines which do not appear in text-books or ideal machines. With sudden change in excitation the flux changes more slowly than the excitation on account of the effect of eddy-currents. Depending upon the field construction, the time required to build up the magnetism in the field may vary from a fraction of a second in laminated structures to 10 seconds or even longer in structures of solid steel, or in structures of laminated steel with embedded squirrel-cage windings. The flux produced by the armature M.M.F. would appear simultaneously with the current if the magnetic structure were perfectly laminated, and if the field-winding was open-circuited. In reality the structure is seldom so well laminated that no eddies occur, and the field-winding is always excited—that is, closed upon itself (through the exciter); thus, at the best, the flux appears later than the current causing it, and much later if the field poles have squirrel-cage winding. Thus, while two machines may have the same electrical constants, the same armature resistance and reactance, the same excitation of full load and no-load, the same armature reaction, their characteristics at the instant of change of load may be very different.

In calculations of generator characteristics, the term "synchronous reactance" is usually introduced; it means a fictitious

* Abstract of a Paper read before the Western Society of Engineers.

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reactance which gives the same effect as that of the self-induction and armature-reaction combined. This term is justified in an ideal generator having uniform magnetic reluctance in all positions of the armature, and having a magnetic structure which permits the flux to change at once with the change of M.M.F. Obviously, in a machine with good mutual induction between field and armature-winding, a machine with squirrel-cage winding, this condition is not fulfilled. The result is that if, for instance, full-load is suddenly thrown on the machines of the two types, in the first type the machine will take its load when the speed has dropped so that the angle between induced E.M.F. and terminal E.M.F. is, say, 15 deg., whereas, in the latter type it may be only 1 deg.

The same applies to the synchronous motor, but in this case the different characteristics play an important part in the stability of operation. The author considers the behaviour of the two types of motors when operated from a large generating station over a non-inductive line, and shows that for a particular case whilst the motor with excessively damped field-circuit can be loaded up to the same output as the first type if the load increases slowly, it will shut down immediately if more than about 20 per cent. of full load is suddenly thrown on. He concludes that such a motor should have some external reactance if it is to be able to carry pulsating load, and that whilst both types of motors are by theory less stable the greater the resistance, the second type is far more sensitive. A motor of the first type—that is, a motor with laminated field—while often operating satisfactorily may, however, be unstable on account of excessive reactance.

Every synchronous machine has a natural period—that is, a period at which it will oscillate when adjusting itself from one load to another. The frequency is practically proportional to the square root of the field-excitation and inversely proportional to the square root of the moment of inertia. While such oscillations always take place with changes of load, they are usually of little importance, since they cover a small phase angle only. If, however, the synchronous motor is supplied with power from an alternator whose speed for some reason or other pulsates at the same rate as the natural period of the motor, then a condition of resonance takes place and the machines cannot operate satisfactorily in parallel. In such case, the remedy is obviously to change the natural period, which can be done by increasing or decreasing the moment of inertia, or by changing the air-gap and thereby the excitation.

In general, it may be concluded, as far as the electrical side of the surging problem is concerned, it can be solved by one or more of the following alternatives: (1) Reduce the ohmic resistance between the machines. (2) Exclude all external reactances and put field-damping devices on machines of laminated fields and quick magnetic circuit, especially if the synchronous impedance is great—that is, if they, as generators, have poor regulation. (3) Add extra reactance in high-speed machines having good mutual induction between field and armature and sluggish magnetic circuit. (4) Change the natural period by change of air-gap or addition of flywheel, &c.

While thus something can be done by changing the electrical constants, it is but seldom that this is necessary. Ninety-five cases of every hundred can be traced back to some mechanical defect of the prime mover. Usually the governor is too sensitive, or there is some play in the various links connecting the governor proper with the steam-admitting valves. Sometimes, by the very nature of the drive, difficulties can be anticipated; for instance, when several generators or motors are belted to the same shafting, when it is always possible that the pulleys might be of slightly different diameters or the belts of greatly different quality.

In the case of hunting between direct-connected engine-driven units, it is easily ascertained if the governing mechanism is at fault by disconnecting it and operating by throttling. Should hunting still persist, it would seem necessary to resort to some of the three electrical remedies suggested, and, if these are impractical, to add some flywheel capacity. In conclusion, it is believed that any surging difficulty can be solved by the remedies suggested; indeed, with practical experience of a large number of cases, the writer has never met a case which could not be disposed of by them.

DISCUSSION.

Mr. P. JUNKERSFELD said some trouble occurred in Chicago with motor generators on the 25-cycle system. When the first motor generators were installed, the source of power was principally from a large double current generator, which, however, carried some elevated railway load, resulting in fluctuation of speed of the engine. The hunting troubles were minimised, although not entirely remedied, by anti-hunting devices on the pole pieces. A year or two later, by squirrel-cage windings on the motor the troubles were further reduced. They, however, had all disappeared since the advent of the steam turbine.

Mr. E. E. DUDLEY thought that in most cases much better regulation could be obtained with a sensitive governor if the sensitiveness could be regulated in such a way as to prevent the governor over-travelling. He thoroughly agreed with the author on lost motion in the governor connections. Those who had not had a great deal of experience with water-wheel and engine-driven machines could not realise how very small an amount of lost motion could be felt.

Mr. D. W. ROPER referred to early single-phase central station experience. He found that by connecting their monocyclic windings (supplementary or "teaser" windings connected to the middle point of the main winding and used for supplying three-phase motors) two machines which exhibited no tendency whatever when operating single-phase to keep in step ran in parallel very well. Again, a 1,000 kw. rotary which gave a fluctuating voltage when supplied from engine-driven units, ran very smoothly when the Fisk-street (Chicago) turbine plant was used.

Mr. W. B. JACKSON did not remember having come in contact with a case of surging of alternators where some sort of device had not been worked out to make parallel operation possible, and asked if there were any cases that had not been cured.

Mr. C. W. CRAVENS asked as to cross currents in the neutral.

Dr. BERG, in reply, said that triple frequency currents were of no consequence in connection with hunting. Experience showed that the very sensitive governor was no good as far as parallel operation was concerned; and if it were practical to operate machines on the throttle there would probably be little or no trouble in parallel operation. It was necessary to have a powerful dashpot, so that the governor was almost inoperative except in emergency. It was now relatively easy to cure hunting, but this was not the case 18 years ago.

ILLUMINATING ENGINEERING SOCIETY.

At the meeting of this Society held last week at the Royal Society of Arts, two Papers of considerable interest were read. The first was by Mr. Haydn T. Harrison, and was entitled

"The Ratio of Light to Illumination."

The author considers light as that which causes illumination, whether that illumination is visible or not. He agrees, for instance, with Mr. Trotter's definition of illumination as depending simply on the quantity of light falling upon a surface, and that it has nothing to do with the colour or reflecting value of that surface. Therefore, it would be, strictly speaking, inaccurate to state that an instrument such as the Holophane Lumeter indicated the illumination, except when it was pointed at a white screen of similar material to the screen in the instrument itself.

To demonstrate his point the author has carried out the following experiments with his "Universal" photometer, as made by Elliott Bros. By replacing the standard comparison screen in the instrument by the various tinted wall-papers which Mr. Waldram used in his experiments (referred to in the following Paper) the increased illumination necessary in order that the rays reflected from such wall-papers should have the same effect on the eye as when a white paper of similar surface to the photometer screen was used could be ascertained very accurately. The results are as follows:—

Colour.	Increased illumination necessary.
Bright red	3·5 times
Dull cardinal red	6·5 ,,
Medium blue	4·8 ,,
Light blue	3·2 ,,
Dark green	7·0 ,,
Light green	2·2 ,,

Another interesting point that these tests proved was that the angle of incidence of the light rays closely followed the cosine law over the greater part of the angular movement, despite the fact that the surfaces of these wall-papers were far from plain.

The next experiment was to ascertain the value of the light reflected from the area of these papers compared with that from white blotting paper, and though these tests were made under very different conditions and very roughly, they coroborated the figures given above, thus proving that an instrument of the Holophane Lumeter class measures correctly the irregular reflecting value of a surface.

Mr. Trotter once said: "Such terms as illumination, brilliancy brightness, intensity, and luminosity are generally employed by different writers to express different ideas, and are often used in a confused, vague way." This, unfortunately, is still true to-day, so that it is difficult to fix definitely a unit which accurately describes reflecting value. The author doubts whether a better word than "luminosity" could be chosen. Sir William Abney describes luminosity as brightness resulting from illumination, which is exactly what the Holophane Lumeter measures. But in this case are we to regard "luminosity" as denoting luminous flux per unit area so that it would be expressed, say, in lumens per square inch? Or as denoting candle-power per unit of area?

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With regard to the other terms, personally I use them in the following sense:—

Light.—The emanations from a light source.

Illumination.—The extent to which anything is illuminated; foot-candles.

Brilliancy.—Refers to primary light source and is candle-power divided by area.

Intrinsic Brilliancy.—Candle-power per unit surface (square centimetre).

Brightness and Intrinsic Brightness.—Same as brilliancy.

Luminosity or Luminous Intensity.—Same as brilliancy, but applied to secondary sources of light.

I only put the above table forward as suggestive, and would like to see the terms "brilliancy" and "brightness" always applied to primary light sources, as considerable confusion, which is now caused by their indiscriminate use, would be obviated. For example, many people talk about a bright light, and this, under the above classification, would be correct; but for an artist to talk about a bright colour would be incorrect.

Luminosity or luminous intensity is used as applied to indirect or secondary sources of light, the value of these sources could be stated in lumens instead of candle-power, which would simplify matters considerably. For example, if we could state that any given part of a room was illuminated to a certain degree in foot-candles by direct light from a source, plus so many lumens in the form of indirect illumination, we should know at once the relative reflecting value of the surroundings of the light source, and also the likely density of the shadows. This would not be a difficult thing to measure, as, excluding the direct light from the measuring surface, we get the illumination due to the lumens (indirect lighting) only.

The measurement of the illumination derived from all sources is, of course, an easy matter, such instruments as the Trotter photometer, Holophane Lumeter with subsidiary screen, and several others being available for the purpose; but to ascertain the light value of the original source of such illumination is a very different thing.

The only satisfactory method is either to eliminate all reflecting surfaces or to remove the lamps to the test-room. In either case the question presents itself as to what is the light source—is it the lamp only, or the lamp plus the globes and reflectors?

It must be borne in mind that globes and reflectors only enhance the lamp's value as a light source for the purpose of giving direct illumination, and often depreciate its value from the point of view of the reflected illumination derived from the surrounding objects. Therefore, the value of the naked lamp alone must be known, and this is, of course, easy to ascertain by the usual photometric methods. The value of such a lamp plus globes or reflectors is a more complicated matter, owing to the area of the light source being increased, and thus interfering with the square law of photometry. Under these circumstances, unless means are available for obtaining the polar curve of lighting, the only way to ascertain the illuminating value of a light source, including reflector, &c., is by ascertaining the illumination results. For this reason I would suggest that all makers of lamps who wish the apparatus supplied by them to be used to the best advantage should accurately state the candle-power developed at various angles.

This naturally leads to the consideration of the relative merits of lights with reflectors or globes which increase the illumination in the direction required, versus unprotected lights from which good illumination is obtained by using the walls or ceiling as reflectors. It is obvious that, as regards efficiency, the use of reflectors will generally have the advantage. Take, for example, a room with white ceiling and walls. The upper hemispherical rays are reflected back into the room and usefully increase the illumination, but, on the other hand, a reflector placed directly over the lamp, provided it reflects all the upper hemispherical rays, will even more efficiently project them on to the remainder of the room where illumination is required, but will leave the upper part of the room in comparative darkness. In the case of a room which has not a white ceiling and walls, while the efficiency of a reflector will be comparatively higher, what is even more important, will remain constant owing to the reflector can be cleaned more often than it is convenient to whitewash the ceiling and walls of a room. But the physiological (light effect is different, because the illumination is derived from a single source, while in the other case it emanates from all directions. A person entering a room with light-coloured ceiling and walls will often state that it is better illuminated than a similar room where the surroundings are dark coloured. Nevertheless, the illumination in the latter case may be better than in the former, and while the physiological effect would eventually prove more generally satisfactory as the high luminosity of the surroundings would tend to close the iris, thus producing a trying effect on the optic nerve, an attempt to work is made under those conditions. Nature tones down the luminosity of surroundings as the brilliancy of the sunlight increases by providing them with a covering of green which is restful to the eye.

Artists have learnt that in order to depict high illumination they must have strong contrasts, such as the deep shadows provided by Nature, and I think in this respect they teach illuminating engineers a lesson. Shadowless illumination is always depressing, just as a day when the sun is obscured by clouds is depressing; and I think it would be wise to deliberate carefully before any system of shadowless illumination is adopted, and to remember that the object of all illumination is to produce an effect by which the outlines of objects are easily seen; which result is greatly assisted by the effect of light and shade.

Mr. P. J. WALDRAM then read a Paper entitled

"Some Notes on the Effect of Wall Papers on Illumination."

When one considers the enormous development of the gas and electric lighting industries throughout the world, it seems strange that few exact rules should exist which would enable any given degree of illumination to be predetermined from illuminating units of given candle-power distribution. It is no exaggeration to say that very few experts could say whether the factor of reflection and counter-reflection in any given case will increase the total illumination by 10 per cent., by 50 per cent., or by 100 per cent. A not unusual way out of the difficulty is to calculate the direct flux only, leaving any increase due to reflection to make up for subsequent deterioration in lamps.

It is, moreover, a direct temptation, in cases where economy is of importance, to specify shades which tend to concentrate the rays of light into a given specified working plane, leaving the walls and ceilings objectionally dark, and leaving the working plane under the disadvantage of a strong undiffused light, very liable to cause shadows and glare from glazed surfaces. The secret of all successful artificial illumination is to approximate as closely as we can to those conditions of daylight under which our eyes have developed; and the property which all artificial illuminants lack is diffusionn.

Our eyes accept without protest huge differences in range of daylight because it is so perfectly diffused by the enormous depth of atmosphere through which it must pass; but a difference of even two or three foot-candles in artificial illumination will cause considerable inconvenience.

Optically, it would appear that the correct policy is to utilise as fully as possible the reflecting and diffusing properties of walls and ceilings, and to afford relief from trying uniformity by the use of coloured surfaces, in positions where they will catch the eye without unduly reducing the efficiency of the installation.

What is expected of any scheme of artificial illumination is as follows:—

(1.) That the working or table plane of the room shall receive an equable light, as much diffused as possible, sufficient for the purposes for which the room is to be used without being excessive.

(2.) That the walls and ceilings should receive and reflect such an amount of light that they appear to be neither too glaring nor too dull, with all essential architectural features brought into sufficient prominence.

Up to the present it has been customary to neglect more or less the wall and ceiling illumination and to consider the working plane illumination as being a criterion of the whole. This is not only wrong, it is injudicious. The walls are what practically every one unconsciously judges by. According as they are bright or dull, warm in tint or cold, so, rightly or wrongly, the illumination of the room is popularly classed. The light reflected by the walls and ceilings has a psychological effect upon those who use, judge, and pay for it, which neither the architect nor the lighting expert can afford to disregard. Commercially, too, the reflected light from walls and ceilings is important, and it ought to be understood that a large proportion of light which falls upon walls and ceilings of poor reflecting capacity is absorbed permanently, and represents money thrown away without any result.

A dark-walled room with a dull ceiling will not only always look dull but also will actually be decidedly more expensive to light than a similar interior possessed of better reflecting surfaces. Light walls not only impress the user, they also assist very materially to illuminate the ceilings, the table planes, and themselves. Considering that rooms can be illuminated entirely by reflected light from the ceiling and walls with an almost entire absence of shadow, it is obvious that ignorance of the value of such an important factor is almost inexcusable. There is a need for recognised standards of surface brightness which will be satisfactory for different classes of interiors, and the author ventures to suggest that the Council should take steps to establish such standards.

The predetermination of interior illumination is, at first sight, by no means an easy problem. But however complicated reflection

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may be. its total *effect* at any point can be ascertained by simply screening off any direct rays previously incident on that point from the light source. If such results were obtained, averaged, and recorded for a sufficiently large number of interiors and conditions, there would be little difficulty in determining, at least approximately, what reflected illumination might be expected from any given flux of direct light on walls and ceilings of different colours and textures.

The author suggests that the reflection co-efficient for any paper, colour, or texture can be ascertained with sufficient accuracy for all practical purposes by measuring its apparent surface brightness in a direction normal to its surface, as compared with that of white blotting paper, a Holophane Lumeter standard card, or any other suitable standard under the same illumination.

Candle-power curves of lamps and shades are not used at the present time to anything like the extent which they ought to be, and to which they would be were it possible for the lighting expert to obtain them readily for any combination of lamp and shade. It is, however, no small matter to place a lamp and its shade upon a photometer bench and test it at all angles ; and if it were possible to obtain a fully accurate curve from a lamp and shade either in actual use or fixed temporarily to a point, doubtless they would be used more largely. The author suggests the following method as being simple and sufficiently accurate for practical purposes.

To one end of a light wood lath is fixed a vertical bent plate of tin blackened and marked in degrees and carrying a plumb bob so that the angle with the horizon at which the rod is being held can be at once read off. Part of the tin plate is bent at right angles to the direction of the lath, and a plate of known whiteness—white blotting paper or a Lumeter test-plate—is attached by means of a rubber band. A blackened brown paper screen is held or hung behind the lamp and shade to be tested ; the lath is held with the point just touching the lamp. The illumination in foot-candles produced on the test-plate is then read, with the lath held at different angles. This illumination (except in a blackened room) is produced partly by the lamp and partly by reflection from surroundings, or even by other lamps. The rays coming from the lamp alone are isolated from the extraneous light, as follows: A small black screen of such a size as just to screen all the rays from the lamp and shade, but nothing else, is held in a notch in the lath, and a reading taken under these conditions represents the extraneous light only. The difference between the two represents the direct rays from the lamp and shade only. The net foot-candle readings divided by the square of the length of the lath used give the required candle-power at various angles. The method gives curves which approximate very closely to those obtained in the laboratory, and it also enables curves to be measured for gas mantles, oil lamps, wax candles, &c., which are very difficult to obtain in any other way.

A very exhaustive series of tests on the increase in flux due to reflection was carried out by Sharp and Millar in America last year in a room about 12 ft. by 12 ft. by 10 ft. high, with a powerful pendant lamp near the ceiling. The walls were "greyish-white," the ceiling white, and the floor brown linoleum. Briefly summarised the results are as follows : the lamp used directed an average flux of 1·20 foot-candles on to the ceiling, 2·50 foot-candles on to the walls, and 1·25 foot-candles on to a table plane 3 ft. from the floor. It was found that the total effect of reflection and counter-reflection from walls and ceilings *under these conditions* was equivalent to an average secondary flux of 1·90 foot-candles on the walls and 0·65 foot-candles on the ceiling, whilst the illumination on the table plane was doubled to 2·5 foot-candles.

This test gives only the results for one size of room, one scheme of colour, and one scheme of lighting. What we require are more numerous (if less detailed) results obtained in a number of rooms of different sizes with different schemes of colour and with varying proportions of light thrown upon walls, ceilings, and floor respectively by means of light units at varying heights with various shades.

The author is making a number of such tests of different rooms. The method adopted is to divide the floor, walls and ceilings into a number of equal rectangles. The candle-power distribution curves of the lamps having been measured as before described, readings were then taken with an illumination photometer of the illumination received by a detached test-plate in the centre of each rectangle. Then another series of readings was taken with a small black screen placed about half-way between the test-plate and each lamp, so as just to cut out the direct lamp rays whilst obliterating as little as possible of the light reflected from the ceiling. This second test of readings isolates the increase due to all reflections and counter-reflections, and the difference between the sets of readings should equal the direct flux as calculated from the candle-power curves.

A room about 19 ft. by 12 ft. 3 in. by 10 ft., papered with very dull red paper possessing a co-efficient of reflection of only about 11½ per cent., was temporarily fitted with two 35-watt Mazda pendant lamps and tested with different Holophane shades varying the incidence of the light rays. The walls were then altered from such an approximately worst condition to an approximately best by covering them temporarily with white lining paper with a co-efficient of reflection of 100 per cent., and similar readings were taken. It is proposed to compare the results thus obtained with a series of tests which, I understand, is now being made by Holophane, Ltd., in a smaller room hung with a series of different coloured papers. The Holophane tests should be of great value when completed.' As far as the author's results have been carried it would appear that under average conditions the increase of flux of illumination on walls by reflection tends to vary somewhere from between 50 per cent. and 70 per cent. with white wall paper down to between 20 per cent. and 30 per cent. with very dark papers. The increase of flux of illumination on white ceilings appears to be in about the same proportion as on the wall papers to which they are adjacent. The increased illumination on table planes in foot-candles appears to be about a mean between the increases in foot-candles of the flux on the walls and on the ceiling.

DISCUSSION.

Mr. A. P. TROTTER, in opening the discussion on the two papers, referred to the formula for obtaining the increase in illumination due to reflections and counter-reflections. The illumination was increased in the ratio o 1/(1—coefficient of reflection). He also suggested tests on a small model room with, say, a ½ c.p. lamp and various samples of wall paper, carpets &c.

Mr. JUSTUS ECK thought Mr Harrison's definitions were just what wa wanted. All manufacturers would supply distribution curves of candle power for their lamps, if certain that these would be put to proper use From his experience abroad he disagreed with the remark that Natur provided a green surface where needed.

Mr. V. H. MACKINNEY referred to the use of a white card with th Holophane Lumeter for ascertaining illumination, and described a num ber of tests he had made with a model room and wall papers of variou colours to ascertain the amount of energy necessary to give the sam amount of illumination in each case, and also with different distribu tions of the light.

Mr. T. E. RITCHIE did not know of any really shadowless illumination

Mr. J. G. CLARK asked whether in a room of given size the illumina tion varied inversely as the square of the linear dimensions.

Mr. W. R. RAWLINGS thought the authors had overlooked the questio of comfort, as their remarks seemed to advocate the use of white wall Again, rooms were generally not square, and pictures and curtains ha to be taken into consideration. Moreover, it was impossible to lay dow fixed rules : each room had to be considered by itself.

Mr. J. HEWITT referred to the necessary points to be considered, vi the avoidance of glare, the sudden changes from bright to dark surface and eye strain.

Mr. HAYDN HARRISON, in reply to Mr. Eck, said that the latter shou not go to countries for the conditions in which his eyes were not adapte

Mr. WALDRAM, in reply, remarked that tests on small models were n easy. His experiments showed that tests on a room 10 ft. square we not comparable with results in larger rooms. He thought that t illumination more nearly varied inversely as the linear dimensions th as the square of these. His experience was that the Holophane Compa were the only firm from whom he could obtain the desired information

After the CHAIRMAN, Mr. R. J. Wallis-Jones, had made a few remar the discussion was concluded.

AN ELECTRO-DYNAMIC METHOD OF INVESTIGATI THE INTERIOR OF THE EARTH.

BY DR. H. LÖWY.

Summary.—A brief description is given of a method of investigat the interior of the earth due to experimental researches by the Aut and Dr. G. Leimbach. This is based on the use of electric wa whose course will depend upon the character of the rocks in the st traversed. That such a method has not been used previously is p ably due to the idea that the earth is too good a conductor to measurable results.

Until recently, geological methods were the only means av able for obtaining an exhaustive or detailed knowledge of interior of the earth. The employment of these methods, has generally meant the extrapolation of known facts to the known. To seismology we are indebted for the first d method. In the present article the author gives an accou another direct method which may perhaps be suitable for tending the results obtained seismologically in certain resp While, for instance, seismology enables conclusions regar the elastic properties of the earth to be obtained, the

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methods allow the interior of the earth to be explored with regard to its electrical properties. These methods depend principally upon the fact that electric waves—as theory also shows—pass through dry earth and rock without any considerable damping. Researches on this question which have been undertaken on a large scale by the author and Dr. Gotthelf Leimbach are described below.

It is clear that when electric waves pass into the earth to a considerable distance, any buried metal surfaces which are there present must be discovered by these means. In practice, two arrangements are employed, which may be termed the reflection and absorption methods respectively.

In the first method a certain point, A, of the earth's surface is connected to a slanting antenna, AB. If the waves which this antenna transmits meet a medium, M, whose electrical conductivity or dielectric constant is very different from the corresponding constants of the surroundings, they are reflected. Then they pass to a determined point on the earth's surface, which is connected to the receiving apparatus A′B′. Both receiver and sender operate as a directive system, thus allowing the waves which are transmitted directly through the air or the earth to be separated from those which are reflected. When

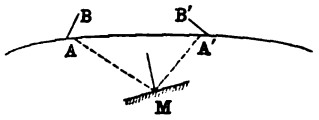

FIG. 1.

the angle of the receiver, the position of the sender being kept constant, is altered there are two maxima at the receiving end, due principally due to the direct and the other to the reflected waves.

In the absorption method bore holes some 500 ft. deep, in which the antenna is sunk, are used. If electric waves which are transmitted from the sender S (Fig. 2) are received at E_1, but not at E_2, it follows that in the path from S to E_2 lie conducting masses that, partly by absorption and partly by reflection, stop the progress of the waves.

The absorption method, in contradistinction to the reflection method, is designed for a systematic investigation of large areas. A considerable depth of bore hole is necessary, firstly, in order to be able to employ an antenna about 350 ft. long, and, secondly, in order to have the mid-surface of the antenna as far as possible in dry ground. Assuming a maximum range of 50 miles, which is certainly not too high, the area covered will be a square with a side 50 km. (31¼ miles) long. In these corners are placed the bore holes. In this way

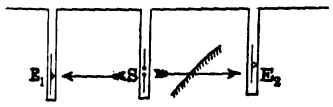

FIG. 2.

the different points at variable depths are investigated [illegible] sq. km. (1,562·5 sq. miles). For a systematic investigation of the whole lowland of Hungary 48 bore holes would be required, and were these 500 ft. deep the cost would not exceed £1,000. A great advantage of this method is, that with bore holes of known depth, it is possible to investigate points lying [illegible] deeply within the earth. On account of the curvature of the earth, for instance, waves passing between points 100 km. apart would penetrate to a depth of 3,300 ft.

Why has it come about then that so simple a means has not been used sooner? There may be two reasons for this. Firstly, everyone is accustomed, from their earliest lessons [illegible] onward, to regard the earth as a conductor,* and [illegible] over-estimate the absorption of the electric waves in the earth's crust. On the other hand, the great geological [illegible] of the earth's interior has prevented many [illegible] any clear results from relations so complicated.

* The term "to earth" shows this clearly.

In a previous discussion* of this point the author has shown that neither of these views can survive an accurate investigation. At great depths (350 ft.) the dryness of the earth is in general so great that scarcely any appreciable absorption of the waves is noticeable. The conductivity of some dry layers is less than the normal conductivity of the atmosphere. The idea of telegraphing wirelessly through the earth to great distances by means of antennæ which are sunk in bore holes has, therefore, a practical value. While the mid-surface of the antenna lies in the lower limiting surface of the ground water basin, this water itself has the advantage of giving the waves a good sending surface which is only obtained, as in ordinary wireless telegraphy, between coast stations. As regards the reflection method, in which the waves pass over the earth's surface, it can only be used in very dry places, for instance, in deserts. Lastly, it was shown that owing to the heterogeneousness of the strata, reflection does not occur as at metallic surfaces. Such illusions, which would be due wholly to geological and petrographical inhomogeneities in the earth's interior, are wholly impossible.

These results were fully confirmed by the tests undertaken by the author in conjunction with Dr. Gotthelf Leimbach at the alkali works at Vienenburg, Ronnenburg and Weetzen, as well as by the author alone at the Scharleyer Erzgruben (East Silesia). The propagation of electric waves through the earth is fully established by these researches. That the absorption, in accordance with theory, is very small is shown by the similarity of the results at the receiving end obtained with identical arrangements both over and under the earth. The tests between the alkali works at Ronnenburg and Weetzen, a distance of about 1¼ miles, with the sender and receiver about 1,500 ft. underground, in which the waves were propagated through salt and anhydrite strata, have fully confirmed the author's premises. Inhomogeneities of a petrographical nature cause no reflection of the waves. The author's tests in the Scharleyer lead mines have finally shown that a small ore content of 12 per cent. makes the earth quite impassable to the waves. In all the tests symmetrical antennæ were used which were stretched out horizontally. In the first series of tests the simple Marconi apparatus was used, while afterwards the singing spark system was employed.†

From these tests it appears that the author's method has established its utility for practical working. More extended geophysical applications, which were originally in the author's mind when he undertook the researches, are dealt with in the article to which reference has already been made.

THE CONSTRUCTION OF STANDARD CELLS AND A CONSTANT TEMPERATURE BATH.‡

BY G. A. HULETT.

Summary.—The author discusses the preparation of the materials used in standard cells and the construction of the cells; he also describes a thermostat for maintaining the temperature constant to 0·01 deg.

The one drawback of the Clark and Weston standard cells seems to be the mercury salt. It is a characteristic of mercury salts to hydrolyse, that is, to interact with water and form a basic salt and acid, and mercurous sulphate is not an exception to this rule. Sulphuric acid and sulphate solutions prevent or decrease this hydrolysis, and the hydrolysis of mercurous sulphate in a zinc sulphate solution has not been detected, but it is surely present in a cadmium sulphate solution. Such a reaction need not detract from the value of the cell, for equilibrium is established as soon as the basic salt and a definite acid concentration are present, and then the potential is again a function of the temperature only. In the Clark cell the reaction has not been detected, but in the Weston standard cell the hydrolysis takes place, although it is a very slow change which does not come to equilibrium. However, this change is generally small as well as slow, and the cell has other qualities which make it valuable.

* "Physikalische Zeitschrift," XI., 1910, p. 699.

† An account of the Veinenburg tests has appeared in the "Physikalische Zeitschrift" already quoted, while the other will be dealt with in a forthcoming issue of the same journal.

‡ Abstract of an article in the "Physical Review."

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As to the reproducibility of the cells, pure redistilled mercury may be obtained from reliable dealers and answers every purpose. In lieu of this, ordinary mercury is chemically purified and then distilled.

Mercurous Sulphate.—The depolariser is chiefly responsible for variations in the reproducibility and constancy of standard cells. The first explanation of the changes which caused the trouble was offered by Carhart and Hulett; evidence was given to show that the irregularities in the standard cells were due to the presence of a basic mercurous sulphate which had been formed in preparing the mercurous sulphate or in making the paste. It was also shown that mercurous sulphate is stable in a sulphuric acid solution when the concentration of the acid is molecular (98 grammes H_2SO_4 to a litre) or greater, but when the acid strength drops below this value the mercurous sulphate begins to hydrolyse with the formation of a basic salt, soluble with difficulty—$Hg_2(OH)_2 . Hg_2SO_2$. It was therefore found possible to suggest conditions for preparing the mercurous sulphate and making the paste so as to exclude the basic salt. The cells made under these conditions did not require the usual ageing, but showed a constant value at once, and were in exceptionally good agreement.*

It is easy to prepare mercurous sulphate chemically and with sufficient sulphuric acid present to prevent hydrolysis, but there is the inclusion and isomorphism of nitric acid, nitrates or other substances to be considered, and while the depolariser made by these chemical methods does, with the proper precautions, give correct values to the standard cells, it is our experience that the electrolytic mercurous sulphate gives on the whole the most uniform and reproducible values.

The electrolytic method has the distinct advantage that only mercury and moderately dilute sulphuric acid are used and the only

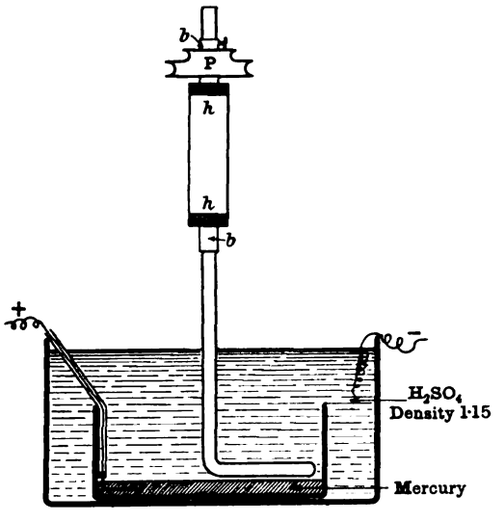

Fig. 1.

oreign substance to be looked after is sulphuric acid, which may be effectively removed as indicated below. We used an acid having a density of 1·15, made by pouring one volume of concentrated sulphuric acid into six volumes of water. When this acid is electrolysed between a mercury anode and a platinum cathode, mercurous sulphate is formed and goes into solution at the anode, but when the acid is saturated (0·2 gm. Hg_2SO_4 to the litre) the solid mercurous sulphate appears and covers the anode. At the cathode, hydrogen is liberated and a little mercury forming about 9 gm. of the salt per ampere-hour. If the mercurous sulphate is allowed to collect on the anode to any great extent, a secondary reaction may take place, but this is to be avoided, and a stirrer has been employed to keep the mercurous sulphate in suspension in the electrolyte while the current was passing, but only a limited amount of mercurous sulphate could be formed at a time.

Lately we have improved the method by using an inner dish to hold the mercury and so arranged that the mercurous sulphate passed over the rim of the inner dish and collected in the space between it and the outer dish. Fig. 1 shows the arrangement.

A motor driven stirrer was used and was made from a glass rod which was bent at a right angle and so arranged that the L part of the stirrer passed over and near to the surface of the mercury. This stirrer was held in a brass tube, *bb*, which also carried the pulley, *p*. This brass tube turned in bronze bearings in the tube, *hh*, which was firmly held by clamps (not shown). It was found to be important to have the stirrer well made so that it worked smoothly and with certainty.

* "Trans." Amer. Electrochem. Soc., 5, 71.

After the stirrer was running uniformly at the rate of some 200 revs. per min., the current was turned on. With fresh acid a skin formed on the surface of the mercury, but by breaking-and-making the current several times until the acid became saturated with the mercurous sulphate, and the solid sulphate appeared throughout the acid then there was no further trouble. The position of the stirrer was such that it did not unduly agitate the mercury. The mercury sulphate formed was carried up by rotating liquid and settled in the space between the two dishes, and much more readily when the rotation of the inner dish was retarded. This was easily accomplished by inserting glass plates edgeways down into the acid and allowing them to rest on the edge of the inner dish. With a current of from 1 to 2 amperes per 100 square cm. of mercury anode surface the product obtained was gray, due to finely divided mercury. The presence of this finely divided mercury is an advantage in checking any tendency to oxidation. Generally, 50 or 60 gm. were prepared at a run, and after the stirrer had been removed and the mercurous sulphate had settled most of the acid was removed, the contents of the inner dish were poured into the outer dish and all well stirred for some time; then the acid, with the suspended sulphate, was poured into a clean dish, and after the sulphate had settled the acid was returned to the mercury, stirred, and again decanted, and this was repeated until the mercury and mercurous sulphate were separated. The product was transferred to a glass stoppered bottle, covered with a little of the acid and kept in a dark place until needed.

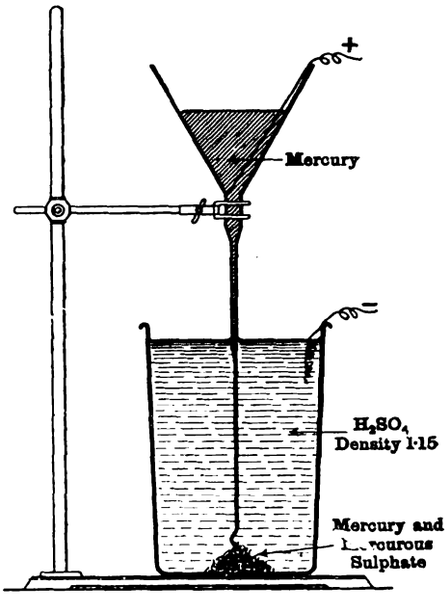

Fig. 2.

Our experience is that this gray electrolytic mercurous sulphate, prepared as just described, is the most reliable reproducible depolariser for standard cells, and that the grains are sufficiently large to avoid all effects of surface tension.

Flowing Anode Method.—Lately we have also used an interesting and very simple method for preparing electrolytic mercurous sulphate. A fine stream of mercury flowing from a funnel into the sulphuric acid is made the anode and no stirring is required. Fig. 2 illustrates the apparatus. An ordinary funnel was used, the stem was warmed in a flame and drawn down to a capillary, which was about 10 cm. in length and of such a diameter that 10 cubic cm. of mercury were delivered in about five minutes. An ordinary litre beaker glass was filled nearly full with the sulphuric acid (density 1·15) and the funnel adjusted so that the tip of the capillary was just under the surface of the acid. A short platinum spiral was hung in the acid and served as cathode, mercury was poured into the funnel, ran through the capillary and formed a spray as it entered the acid; but when contact was made with the mercury in the funnel and a current of from 2 to 3 amperes was passed, the spray changed to a cylinder of flowing mercury which extended to the bottom of the beaker and looked like a wire. It was distinctly gray save for a short distance at the top, which was bright mercury.

M. Coste and M. Etaix have used an alternating current in preparing mercurous sulphate. The flowing electrode method also permits us to use an alternating current and very simply. Two funnels were prepared with the same length of capillary stems and of the same diameter. These funnels dipped into the same beaker of sulphuric acid and the two streams of mercury were used as the electrodes.

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A 60-cycle alternating current was used and so regulated that there was no arcing between electrode and electrolyte, and thus a current of about 5 amperes was used. The efficiency here is as great as with the direct current, about 9 grammes of mercurous sulphate per ampere-hour.

With the flowing anode method the preparation is white, even with large current densities, and the sulphate is easily separated from the mercury by decanting it with the electrolyte. Cells made with these preparations as depolarisers show a slightly higher value than with the gray electrolyte previously described. The alternating current preparation seems to be the better of the two, but they have not been tested for a sufficient length of time if we are concerned with the fifth decimal place in the E.M.F. of the cells.

The Paste.—The problem is to prepare a mixture of mercurous sulphate, zinc or cadmium sulphate and saturated solution, but to avoid the presence of sulphuric acid and basic mercurous sulphate. The only impurity in the electrolytic mercurous sulphate is the sulphuric acid in which it is made and preserved, but any attempt to remove this acid by washing with water introduces the basic salt. Formerly we used alcohol, which was subsequently removed by washing with the saturated zinc or cadmium sulphate solution, for we have found that this preliminary washing with alcohol is unnecessary and that really only three washings with the saturated sulphate solution are necessary, when certain precautions are observed. (A Gooch crucible, filtering apparatus and good suction were employed.)

A large agate mortar was used in mixing the components of the paste. Zinc or cadmium sulphate crystals, about equal in volume to the mercurous sulphate, were crushed, a few cubic centimetres of the saturated solution being first added to the crystals to prevent partial dehydration by the crushing. After the crystals had been ground to a fine powder, the mercurous sulphate was added and all thoroughly mixed with enough of the saturated solution to make a thin paste and of such a consistency that it readily flowed from a 5 mm. tube. Unless the mercurous sulphate was gray a little mercury was ground up with the crystals and mixed with the paste. In all the operations of preparing the depolariser and making the paste, direct sunlight or undue exposure to light was avoided.

Zinc Sulphate.—Zinc blend, from which this salt is obtained, generally contains cadmium and manganese and often lead and tin. The salt is isomorphous with the other vitriols—iron, magnesium, cobalt, nickel and copper, but none of these metals, in the small amount usually found present in zinc sulphate, seems to affect the E.M.F. of the Clark cells. Sulphuric acid is to be excluded. Zinc sulphate as obtained in the trade generally contains less than the theoretical amount of water of crystallisation, due to efflorescence, so it is best to recrystallise the salt, and at room temperature, in order to ensure the heptahydrate.

Zinc Amalgam.—Zinc is one of the more soluble metals. With an excess of zinc we have, for each temperature, a liquid amalgam of definite composition, and in equilibrium with a solid phase which is pure zinc.

At	0	the liquid amalgam contains	1·35	per cent.	of	zinc.
	15	„ „ „	1·74	„	„	
	20	„ „ „	1·99	„	„	
	25	„ „ „	2·18	„	„	
	39	„ „ „	2·85	„	„	

There seems to be no difference between the potentials of amalgams made from "chemically pure" zinc and mercury and amalgams made from the most highly purified metals, so the "chemically pure" materials serve every purpose. Zinc dissolves but slowly in mercury and the amalgam oxidises readily when hot, but we have had no trouble with this amalgam since using the following method: A 2 cm. hole was cut in a piece of asbestos cardboard and an ordinary porcelain crucible was pushed into this hole so that it was about half way through, the board was placed on a tripod and the crucible was charged with 7 gm. of chemically pure zinc, and then 50 gms. the weight of mercury was added. A small adjustable Bunsen flame was placed under the crucible and the contents heated, without stirring, until the zinc had all dissolved. This takes a temperature near to the boiling point of mercury, and the crucible is covered with a little watch glass. The flame was now pushed 2 or 3 centimetres to one side, and when the crucible cooled down to 150 deg. the amalgam was readily transferred to the cells with a pipette.

Cadmium Sulphate.—$CdSO_4.8\,3H_2O$ is a very soluble salt, but is peculiar in that the *rate* of solution is exceptionally slow, so that considerable attention is needed to prepare a saturated solution. The solubility changes only slightly with the temperature and the hydrate is stable up to 74 deg., where it changes to the monohydrate. Cadmium sulphate does not seem to be isomorphous with the zinc salt, and consequently is obtained in a sufficiently pure state in the trade, but one may obtain such beautiful crystals that it is worth while to recrystallise the salt. Attention is to be given to the preparation of a saturated solution of cadmium sulphate on account of the slow rate of solution of these crystals; 100 cubic cm. of the saturated solution requires 75 cubic cm. of water and 86 gm. of the crystals, but a considerable excess of the crystals is to be used and stirred over night with a motor-driven stirrer.

Cadmium Amalgam.—Cadmium is the most soluble metal in mercury; the saturated amalgam contains the following percentages of cadmium:—

At	Per cent. cadmium.
0°	2·5
15°	4·4
25°	5·6
35°	7·1

With an excess of cadmium the solid phase is not cadmium but an isomorphous mixture of cadmium and mercury. In view of the great solubility of cadmium at ordinary temperatures it does not seem well to use less than 8 per cent of cadmium in the amalgam. The question of equilibrium in this amalgam needs further investigation; it is a much more complicated system than is the zinc amalgam. We have used for some time a 10 per cent. amalgam for our cells and make it quite accurately and uniformly as follows: 99 gm. of mercury were placed in a little crystallising dish, 5 cm. or 6 cm. in diameter, and 25 gm. of the clear cadmium sulphate crystals (43·82 per cent. Cd) were placed on this mercury and then about 50 cubic cm. of distilled water was carefully added and made acid with a drop of sulphuric acid. A flat platinum spiral was so adjusted that the spiral was just beneath the surface of the water and contact was made with the mercury which was cathode. When 2 or 3 amperes were used the cadmium was deposited in the mercury about as fast as the sulphate dissolved; then when the crystals had all disappeared the current was increased to 4 or 5 amperes for half an hour. This insured a complete deposition of the cadmium and also liberated enough heat to melt the amalgam. The acid was finally removed by a *pipette* or syphon and at the same time distilled water was run in. This washing continued until the current dropped to zero.

We have prepared cadmium sulphate and cadmium of the highest degree of purity, also zinc sulphate and zinc, and constructed cells with these materials, but the E.M.F. of these cells did not differ from that of the cells made with materials prepared as described above. This result is what we would expect when we consider the factors controlling the potentials at the anodes and cathodes of these standard cells.

The Glass Parts.—The "H" cell proposed by Lord Rayleigh has proved to be the most practical form of cell. It is easily filled and allows the contents of each electrode rapidly to take up the temperature of the bath. The 0·2 mm. platinum wire leads are sealed through the glass so that all but the tip end is covered with a sheath of glass. The wire is first sealed in so that the end is only just through the glass and then, while the glass is still soft, the wire is pushed in about 5 mm. and covers itself with a sheath of glass leaving only the tip exposed. Wires sealed in this way give uniform contact with the mercury or amalgams and are less liable to cause subsequent cracking of the glass, especially when a fine wire is used.

The mercury, amalgam and paste are each from 10 mm. to 15 mm. in depth. A few crystals are placed on top of the paste and on the amalgam a layer of crystals not over 10 mm. in depth. Only a small amount of the crystals are necessary for either the Clark or Weston cell, while a large excess may grow together and cause trouble. The cell is filled to the top of the cross tube with the saturated solution and then the glass parts are sealed off 2 cm. or 3 cm. above the liquid by using two small blast flames which impinge on opposite sides of the point to be sealed.

The difficulties we have encountered with these cells are the tendency of the glass parts to crack (which is most pronounced in the amalgam leg of the Clark cells), and the fact that the contents of the cell are not accessible. This difficulty was recognised by Lord Rayleigh in recommending the cork seal. The trouble with this has been that the cork was generally in contact with the liquid and so leaked sooner or later. We have used for some time a form of cell which avoids these difficulties; the glass part is the simplest possible (Fig. 3). Thin-walled tubes, 20 cm. long and 12 mm. in diameter, are closed at one end and blown out at the side about 5 cm. above the closed end. Two of these tubes are joined directly together giving the advantages of the test-tube form. No platinum wires are fused into this part of the cell. These cells are closed by corks which are 15 cm. above the liquid of the cell and are never wet and do not need to be covered with wax. These corks carry the long narrow tubes which enclose the contact wires, and these may be removed and replaced at any time. This long form of cell is found

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to have many advantages in handling in the bath; several may be bound together in a very compact form and the contents of these cells most readily take on the bath temperature while the insulation is perfect in any kind of a bath liquid.

The details of the contact wire and protecting tubes are also shown in Fig. 3. A piece of tubing 3 mm. in diameter is softened in the flame and drawn down so that the part which is to pass through the contents of the cell is not over 2 mm. in diameter. This narrow part is about 6 cm. long, while the total length is about 22 cm. A piece of 0·1 mm. platinum wire about 10 cm. long is soldered to a 20 cm. piece of silk covered copper wire (No. 32). This wire is passed into the protecting tube until the platinum wire projects one or two millimetres from the narrow end of the tube and this thin end is sealed in the flame. A bit of wax is run into the upper end to hold the wire securely. Six cells are made at one time and all bound together and then the negative or anode wires are twisted together and the exposed ends soldered so that only one contact need be made for the anodes of all six cells. The positive or cathode wires are scraped to remove the covering, and then each one is wound about a small piece of millimetre copper wire which is forced into the warmed wax in the top of the tube leaving about a centimetre exposed, and here a good contact is easily and rapidly made with a pinch connector. It is well to amalgamate the platinum tip of the contact wire just before it is inserted into the contents of the cell. This is readily done by holding it for a few minutes in boiling mercury (in a test-tube).

E.M.F. of Standard Cells.—We have made both Clark and Weston cells at intervals since 1903 and according to the preceding specifications. A dozen Weston cells, made at one time, often agree among themselves to 1 part in 100,000, but in time the agreement is not so good; in a year or so the variations may be noticeable, and when compared with a freshly made set of these cells it has been found

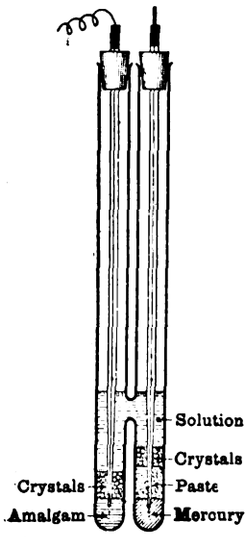

FIG. 3.

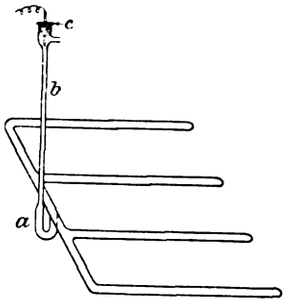

FIG. 4.

that all the older cells have decreased and some of them very noticeably. Clark cells have also been made at intervals during the last seven years and the agreement among themselves of any "set" of these cells is about the same as that of the Westons, but the Clark cells made at different times are in better agreement and none of them have shown an E.M.F. decreasing with time, such as is noticed in some of the Weston cells. It seems necessary, therefore, to make the Weston cells at intervals of about six months and reject those which fall to low values. We make both Clark and Weston cells at such intervals, and the cells are kept all in a constant temperature bath which does not vary over 0·01 deg. from 25 deg. Taken all together these two kinds of cells with the aid of a thermostat give us a standard which is independent of time and is reliable and reproducible to one or two parts in 100.000. The value in absolute units of this standard of E.M.F. is, of course, not known to anything like this degree of accuracy, but whenever the absolute value is more accurately determined, all work which has been based on this constant may be recalculated if necessary, so we are justified in giving the assumed value to the fifth decimal place. Assuming that the Clark cell gives 1·4330 volts at 15 deg. and using the customary temperature formula the Weston standard cells are found to have the value 1·01840.

The Thermostat.—The Weston cell has only about one thirtieth of the temperature coefficient of the Clark cell. This was a decided advantage before thermostats were used, but for electrical measurements which make any pretence to accuracy an automatically controlled bath is indispensable for both types of cell, so the temperature coefficient is of no consequence. It is our experience that it takes a considerable time at a given temperature for *all* the cells of a set of standards to attain their true value. We generally allow a week. It is, therefore, necessary to have an automatically controlled bath, and 25 deg. has been chosen. Our thermostat is an electrically heated and controlled kerosene bath which keeps well within 0·01 deg. for any length of time It consists of a tank made from galvanised sheet iron, 50 cm. by 65 cm. and 50 cm. deep, which rests in a box on legs. The space between the box and the tank (6 cm.) is packed with excelsior, and the top of the tank projects about 2 cm. above the top edge of the box. A cover, 100 cm. by 100 cm., was provided, and the centre (50 cm. by 65 cm.) cut out so that the top of the tank fits into this place and is flush with the top of the table part when assembled. Plate glass strips of convenient widths cover the tank proper. About 100 litres of kerosine serve as the bath liquid, and are found to be very clean and easily kept dry by a dish of calcium chloride suspended in the upper part of the tank. A motor-driven stirrer was neessary.

The regulator and heater have received most attention, the aim having been to get large surfaces well distributed in the bath liquid. Both the regulator and heater are supported by a frame about 10 cm. above the bottom of the tank. This frame was made of brass tubing, 40 cm. by 55 cm., with two cross pieces and is supported by four legs. Fastened to the under side of this frame is the glass part of the regulator (Fig. 4), which contains the toluene and mercury, and the expansion or contraction of these liquids makes or breaks a contact of the relay circuit and so controls the heating current.

Sparking between the mercury and the platinum point causes the mercury to become "dirty," changes the meniscus and thus causes a slow drift of the bath temperature. It is customary to put a condenser in parallel with this contact, but we have had much better results by arranging to use a small current of low voltage in the relay circuit. We find that our mercury contact surface remains perfect for months at a time and makes-and-breaks contact with the platinum point at exactly the same temperature.

With the arrangements we have, the heating current is made or broken by a change in the bath liquid of only one or two thousandths of a degree. For constancy, and to avoid oscillations of the bath temperature about the desired point, it was necessary to have the bath well insulated. This was accomplished with the 6 cm. of excelsior packing between the tank and containing box and the plate glass cover. Also, it was especially important to have a small amount of heat liberated in the unit of time, and well distributed in the bath liquid. Our heating coils consist of 0·25 mm. nickel wire wound on 10 mm. glass tubes shellacked to hold the wire in place. The resistance of our coil is about 120 ohms and is connected with the 110-volt alternating-current lighting circuit, but we also use an external resistance, as 0·4 ampere is sufficient to control the bath, even with very considerable variations of the room temperature.

THE "THOMAS" ELECTROMECHANICAL TRANSMISSION FOR MOTOR VEHICLES.

An interesting test of a commercial motor vehicle by the Royal Automobile Club has been taking place during the past 10 days over an exceptionally hilly route in Kent. The motor vehicle in question is a 30-40 H.P. lorry fitted with the "Thomas" electromechanical transmission, and the first section of the trial comprises a 2,000 mile constant running (day and night) test under full load between Bromley Common and Cooper's Green (one mile from Uckfield). The route, which is about 37½ miles long, passes through Sevenoaks and Tunbridge Wells. This route is traversed continuously (except for short intervals during change of observers, drivers, &c.), and the double journey of 75 miles is completed three times every 24 hours. As mentioned above, the route is of an exceptionally hilly nature, there being practically no level stretches of road, whilst the gradients are very steep. This road was chosen by the Company so as to provide a severe test of their gear, and the test is the more exacting in that the Automobile Club stipulated a 12-mile per hour speed limit.

The lorry, of which a view is given in Fig. 1 herewith, carries a net load of about 3½ tons. The weight of the Leyland chassis is 3 tons 19 cwt., and the total weight of the loaded vehicle under test is about 7 tons 18 cwt.

The "Thomas" electromechanical transmission system differs from other systems devised to give a wide speed variation by means of electrical machines, in so far that there are two distinct paths of power between the engine and the load shaft—one mechanical and

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the other electrical. This arrangement is obtained by means of planetary gear in conjunction with two small electrical machines. These units are so arranged that the greater proportion of the engine power is transmitted direct mechanically.

Fig. 2 shows the arrangement. The casing D forms the flywheel of the engine and is direct coupled to it. Inside this casing are two planet pinions P and P_1 of different diameters keyed to the same spindle; this spindle is supported in the sides of the casing and is free to rotate about its own axis. The planet pinions P and P_1 mesh with the two sun pinions W and W_1, which are rigidly connected to the independent shafts H and K. On the shaft K is mounted the armature B of an electrical machine, and on the shaft H (which is the load shaft) is mounted the second electrical machine C. These two machines, B B_1 and C C_1, have their field windings in series with their armatures, and are connected in series by the operation of the controller.

FIG. 1.—VIEW OF LORRY UNDER TEST WITH "THOMAS" TRANSMISSION.

There are thus two paths of power between the engine and the road wheels—the first, a direct mechanical path from W along the shaft H; and the second, an electrical path from W_1 through two electrical machines to the shaft H. If W is larger than W_1, then for a certain rotation of the casing W_1 will tend to rotate backwards and W forwards, at speeds depending upon their relative resistances to motion. It will be seen that if the speed of the casing D is constant, the speed of H will vary with the speed of K; and since the speed of K depends on its resistance to motion (and, therefore, on the load on the machine B B_1), the speed of H can be varied by changing the amount of power transmitted electrically.

The actual series of operations is as follows: The casing D is rotated by the engine at a constant speed. There being no electrical connection between B and C before starting, W_1 will rotate freely backwards and W remain stationary. To start the vehicle the circuit between B and C is closed; the current transmitted to C then exerts a large starting torque on H, and the load thereby impressed on B by this current decreases the speed of K, and, therefore, causes W to rotate. In this manner a large starting torque is exerted on the road wheels.

As B is gradually decreased in speed the vehicle accelerates until the armature K practically comes to rest. Up to this point B has been acting as a dynamo and C as a motor. If now K is forced to rotate in the same direction as the engine, it is evident that H can still further be increased in speed. This operation is performed by transmitting power from C to B—both machines now changing their functions. K increases in speed more rapidly than H, due to the gear ratio, until finally they are both travelling at the same speed. The coupling Q is then engaged, with the result that the current in the electric circuit falls to zero. All electrical losses are thereby eliminated, and a direct drive is obtained from the engine to the road wheels for the top speed.

In the lorry under test there are 10 forward positions of the controller, exclusive of the direct mechanical drive at top speed. In addition there are two reverse positions.

A 12-volt battery of 180 ampere-hour capacity, forms part of the equipment. This battery is used for starting the engine by running machine B as a motor. The current taken from the battery rises momentarily to a maximum of 100 amperes. The variation of the power transmitted electrically between the machines B and C is obtained by varying the field strengths of the two machines. For this purpose a resistance is connected in parallel with their field magnets, and is adjusted to obtain the various speeds. The resistances are contained in the controller, and as they are submerged in oil, efficient cooling is provided. It should be understood that the successful working of the system is not dependent on the battery, this being used solely for lighting and for starting the engine.

For running backwards electrical transmission alone is employed. The clutch Q is engaged and S disengaged; the armature B is thereby driven direct by the engine, and current is supplied to C, of which the field has been reversed. This machine then acts as an electric motor and drives the vehicle backwards. It is interesting to note that all the above operations are performed by the one control lever.

The feature of the "Thomas" system is that the electrical machines are not in use continuously, so that their rating is very high; in fact, their capacity is only about one-third the horse-power of the engine, instead of one-half, as might be expected. The weight of each electrical machine is from 5 cwt. to 6 cwt., whilst the controller weighs less than ½ cwt.

The efficiency at the lowest "running" speed is about 80 per cent. It rises from this position to a maximum of about 94 per cent. when machine B becomes stationary, and then decreases to about 86 per cent. on the tenth notch. At top speed (direct mechanical drive) the efficiency, of course, jumps to 100 per cent. It may be noted also that a higher average compression can be employed for the engine, since the latter can be run at a constant speed. As to petrol consumption, previous tests in Lancashire have shown a consumption equivalent to 9·7 miles per gallon with a three-ton load.

One of the advantages of the "Thomas" system is that electric lighting can be adopted with very satisfactory results. The question of charging the cells, which is frequently a source of trouble, is overcome by running machine B as a shunt generator when the control lever is in the top position.

The chief advantages claimed for the "Thomas" system of transmission may be summarised as follows: (1) The large proportion of power transmitted direct mechanically and therefore the high efficiency. (2) The small proportion of power transmitted electrically and therefore the low cost and weight of the electrical machines. (3) The large number of running "speeds"—the full engine power being thus always available. (4) No break in the transmission of power during the changing of speeds. (5) High and smooth acceleration. (6) Direct drive on top speed. (7) Freedom from noise and shock and reduction in wear and tear. (8) Self-starting of petrol engine. (9) Electric lighting.

We inspected the lorry on Monday last, and saw it ascend the steepest hill on the route. As we also saw the capabilities of the system from trial runs on a car fitted with the gear, we can testify to the smooth changing of speeds and to the simplicity of the control. We may mention that braking is obtained mechanically in the usual way.

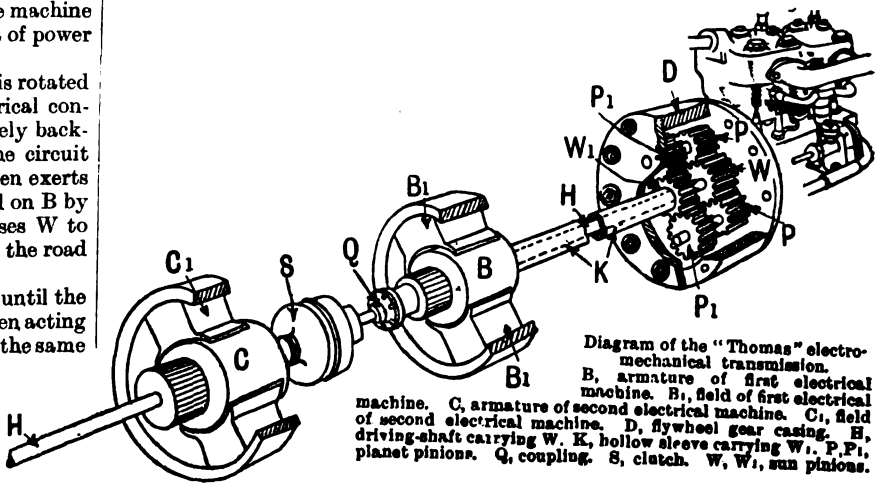

Diagram of the "Thomas" electro-mechanical transmission. B, armature of first electrical machine. B_1, field of first electrical machine. C, armature of second electrical machine. C_1, field of second electrical machine. D, flywheel gear casing. H, driving-shaft carrying W. K, hollow sleeve carrying W_1. P, P_1, planet pinions. Q, coupling. S, clutch. W, W_1, sun pinions.

FIG. 2.

In conclusion, we may say that the lorry had on Monday last completed 1,200 miles of the trial, and we understand that the gear had given absolutely no trouble whatever.

We desire to express our indebtedness to Mr. G. Thomas, the inventor of the system, and Mr. K. J. Thomson for the trouble they took in explaining all the features of the gear and in demonstrating its capabilities. We have no doubt that it will come through the present arduous test with credit, and we shall await with interest the motor omnibus fitted with this gear which is shortly to be placed in service on the London streets.

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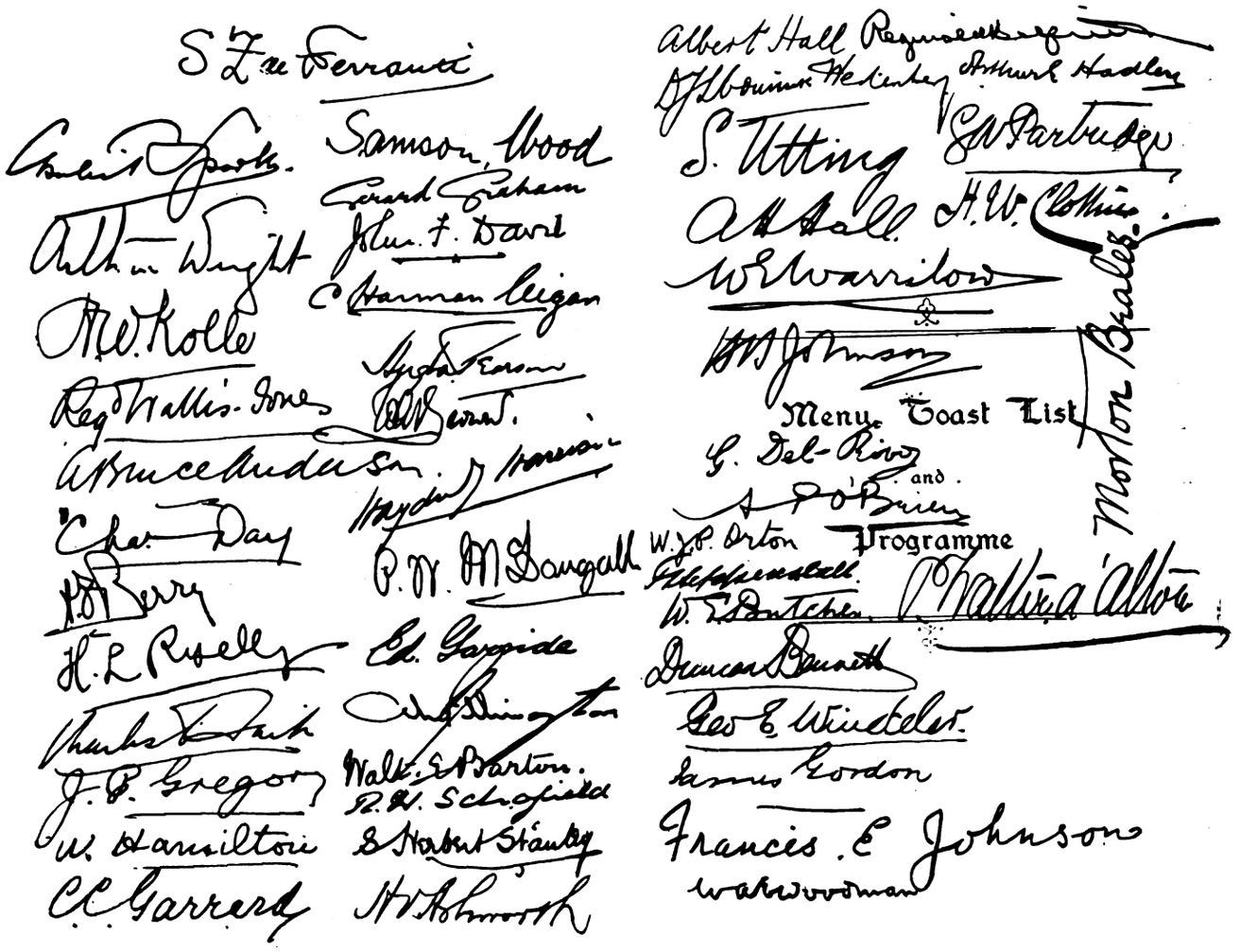
OLD FERRANTIANS DINNER.

It was a unique gathering of electrical men which assembled on Saturday last at the Trocadero to do honour to Mr. S. Z. de Ferranti. Those old Ferrantians who were able to be present comprised electrical engineers who had been associated with Mr. Ferranti in the early days of the Deptford undertaking, at his works in Charterhouse-square, London, and afterwards at Hollinwood, Lancs. The function was occasioned by the fact that Mr. Ferranti is this year President of the Institution of Electrical Engineers, an honour which had been somewhat tardily conferred upon him considering his long and prominent association with the industry. Mr. Ferranti's election as President for the second year in succession was happily coincidental with the date fixed for the dinner. The chair was taken by Mr. C. P. Sparks, and about 60 old Ferrantians were present. Upwards of 120 men were apprised of the function, but many were prevented from attending owing to business or other engagements. Among these were Mr. C. H. Wordingham, Mr. W. Cramp, Mr. C. Vesey Brown, Mr. W. L. Madgen, Mr. H. C. Sparks, Mr. W. S. Toplis, Mr. D. Martin, Mr. J. K. Stothert and Mr. A. Hobbs, who expressed their regrets at being unable to attend.



Old Ferrantians Dinner; Signatures on Mr. Ferranti's Menu Card.

The Chairman was supported by Mr. G. W. Partridge, Mr. H. W. Kolle, Col. P. W. D'Alton, Mr. A. B. Anderson, Mr. A. E. Hadley, Mr. Arthur Wright, Mr. R. Belfield, Mr. Chas. Day, Mr. M. B. Field, Mr. A. Jacob, Mr. H. W. Clothier, Mr. Haydn T. Harrison and Mr. G. Del Rivo. We reproduce Mr. Ferranti's menu card on which most of the old Ferrantians present signed their names.

Mr. C. P. Sparks, in proposing the toast of the evening, that of Mr. Ferranti, expressed the regret of Lord Crawford at being unable to take the chair. He was pleased to see so many members of the old Ferranti staff present, and was gratified to notice that practically every period of Mr. Ferranti's work was represented, from the "Old Guard" in the Deptford days to the heads at Hollinwood at the present time. He referred to the magnetic influence of Mr. Ferranti and the beneficial effect which it had had upon all the electrical men who had been associated with him, and particularly those engaged on his staff. For the past 25 years Mr. Ferranti had maintained an extraordinary enthusiasm. He had been able to look ahead, and see possibilities which had subsequently become eventualities. His work in connection with the Deptford scheme was well known, but as a permanent reminder of it, and also a memento of the evening's gathering, each guest had been presented with a small piece of the original 10,000-volt concentric main which was laid from Deptford to the Grosvenor Gallery and had been in use for 21 years. These pieces of cable had been made up by Mr. G. W. Partridge, chief engineer of the London Electric Supply Corpn., and presented by him as menu holders. That cable was an indication of Mr. Ferranti's early insistence upon simplicity in the design of everything electrical with which he was associated. Mr. Sparks then reminded his audience of the work which Mr. Ferranti had been doing as President of the Institution of Electrical Engineers during the past year. His efforts to consolidate electrical interests and his earnest wish that the Institution itself might prove more helpful to its members and to the industry generally were much appreciated. He regarded it as auspicious that the occasion coincided with the election of Mr. Ferranti as President for the second year in succession, and he felt sure that during his next term of office Mr. Ferranti would be able to carry towards practical realisation the good work he had begun. In proposing the toast Mr. Sparks presented Mr. Ferranti with a solid silver inkstand, which had been subscribed for by old Ferrantians in all parts of the country. The toast was drunk with great enthusiasm.

Mr. Ferranti, in rising to respond, was visibly moved by the ovation. He expressed his sincere thanks for the present, and said that he should value it on account of the good feeling which existed between his staff and himself. He should also prize it in remembrance of his long association with his staff from the early days of the industry to the present time. He looked upon the gathering as unique in the annals of the electrical industry. He could see men around him who had assisted at the initiation of public electricity supply in the early eighties. He also felt that the assembly typified the extraordinary progress which had been made since his first intro-

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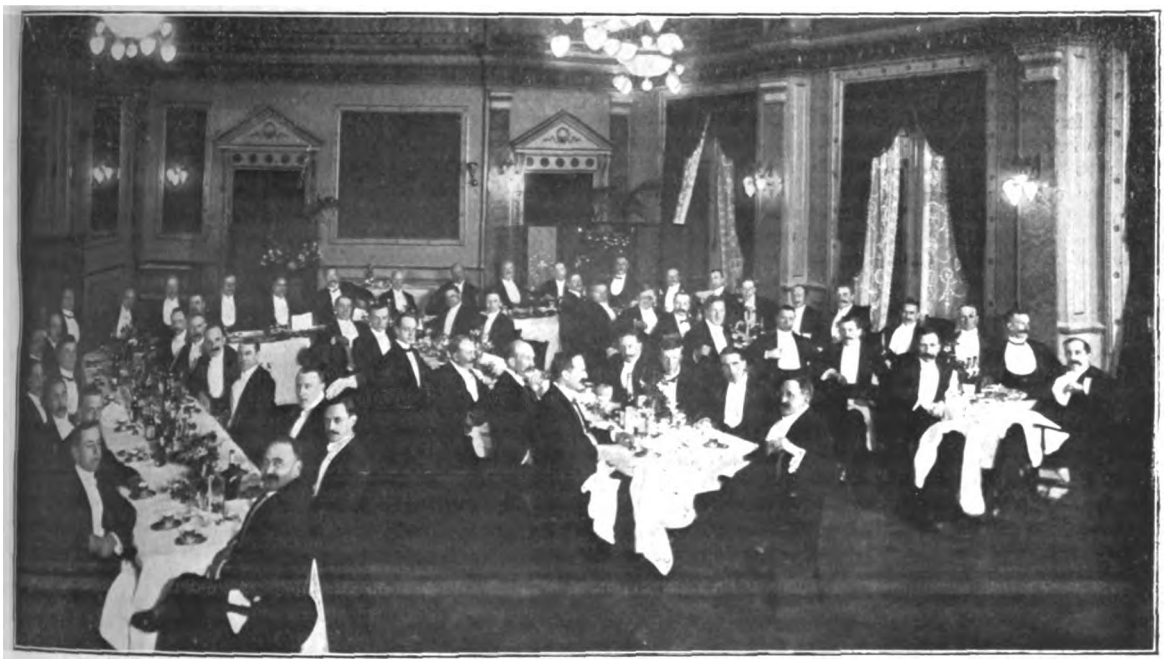
duction to the industry. He recalled his own early efforts when Grove and Daniell cells were the only known sources of practical electricity. He caused considerable amusement by referring to his boyish ambitions to insulate magnetism, and how he could not realise at the time what a tremendous revolution might be effected if such a thing were possible. He had always endeavoured to be enthusiastic, and he was not sure if his enthusiasm had been communicated to his staff, or whether he had not derived a considerable amount of it from the staff themselves. It required great faith in the Deptford days. As a practical instance of it he related how Mr. H. W. Kolle risked his life by holding a cold chisel which was driven through the first concentric main while this was alive at a tension of 10,000 volts. Mr. Ferranti reminded members of his old staff of the paucity of materials in the early days, when mica, though certainly known, was practically unworkable, and only ebonite was a reliable insulator. The pieces of cable which each man had before him on the table were practical examples of the first use of a cheap insulator, paper and the refuse of candles being employed to insulate one conductor from the other. He was glad to see round him the faces of such men as Mr. R. Belfield, Col. P. W. D'Alton, Mr. Samson Wood and Mr. W. Lawrie. In Col. D'Alton he recalled a man who was



THE OLD FERRANTIANS AT DINNER.

[illegible] to take charge at Deptford mainly on the recommendation [illegible] he had gone under the sea in a submarine boat. In those [illegible] times the man who could do such a thing was especially suited [illegible] after the Deptford station. Mr. Samson Wood was the [illegible] man to build up the zigzag armature for his early copper-type [illegible]. The armature of this machine, which he noticed was [illegible] on the front of the menu card, was not wound with a [illegible] conductor, but four separate conductors in parallel. It was the [illegible] instance of a machine from which an equal E.M.F. could be [illegible] with multiple conductors. He was now able to look back [illegible] satisfaction on the efforts of the pioneers of direct-current [illegible] to bring about the downfall of alternating-current high-[illegible] supply. The scaremongering indulged in at the time was [illegible] to impair seriously the success of the Deptford undertaking. Mr. Ferranti then expressed his pleasure at being elected to remain in [illegible] as President of the Institution for another year, and referred [illegible] to the plans he hoped to develop whereby the members might be more mutually helpful than heretofore in restricting the undue amount of competition which seriously threatened the progress of the industry. While cheap machinery and plant might be useful enough from a public point of view, at the same time, in an industry such as that of electrical engineering, large profits were required to carry on developments and research work. When these profits could be shown, then capital would be attracted to the industry, and manufacturers would get an even greater recompense for their efforts.

In conclusion, Mr. Ferranti again thanked those present for attending the dinner, and he further assured them of the immense amount of pleasure it had afforded him. He would take away the most pleasant recollections of one and all of those who in different ways and at different times had proved so helpful to him.

Mr. HAYDN T. HARRISON proposed the remaining toast, that of the chairman, Mr. C. P. Sparks, in an amusing speech, and recalled the early days at Charterhouse-square, which immediately preceded those of the "Old Guard." He remembered that Mr. Sparks had put him in the sulphur room, and that incident impressed upon him the force of Mr. Ferranti's remark that pioneer electrical engineers were hampered for lack of materials. He had painful recollections of the number of air bubbles which would get into the sulphur he had to manipulate. There was great laughter when he spoke of a Kelvin electro-static 40,000-volt voltmeter, which was a huge box with practically nothing inside it, and which had been sent to Deptford, but was ordered to be returned to the makers, because no one could get a circuit through it. The toast was received with enthusiasm, and Mr. Sparks replied in a humorous speech, in which he told an amusing story of the tightest corner he had ever been in in his life. This was an occasion on which he interviewed a Scotch town council to explain the cause of the failure of the electric light, and how his difficulties disappeared when his case was championed by a baillie who had had a long standing grudge against the convener of the electricity committee. The proceedings, which terminated at a late hour, were concluded by a vote of thanks to Mr. Warrilow, the hon. secretary.

Proposed Electrification of Chicago Termini.—According to the "Electrical Review and Western Electrician," the Committee appointed by the Chicago Chamber of Commerce to discuss this question has already begun its sittings under the chairmanship of Mr. Jesse Holdom. The scope of this Committee is indicated in the following terms which form part of the report of another Committee appointed to consider the scope of the investigation:—"Your Committee, to whom was referred for consideration and report the scope of the investigation necessary to be made in connection with the proposal for the electrification of railroad terminals, is of the opinion, and so reports, that the investigation necessary briefly may be stated to include: First, the necessity for the proposed change; second, the mechanical practicability of such change; and, third, the commercial feasibility thereof. These heads naturally subdivide into many specific subject-matters which, in the opinion of your Committee, will and should be developed by the expert in charge." It was decided that the three phases of the investigation should be taken up simultaneously, and that the progress of the work should be permitted to dictate the relationship of each to the others.

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PRACTICAL ASPECTS OF PRINTING TELEGRAPHY*

BY DONALD MURRAY, M.A.

Summary.—The author first discusses the field for printing telegraphs. Their use is chiefly in connection with land lines between centres of population, and they will assist materially the co-operation between telegraph and telephone. He next gives a detailed account of the difficulties encountered in connection with the development and practical application of printing telegraphs, and finally describes the Murray automatic system and the new Murray multiplex system.

The Paper is divided into three parts, as follows: Part I., which discusses generally the field for printing telegraphy; Part II., dealing with the practical difficulties in the way of printing telegraphy; and Part III., describing some printing telegraph apparatus designed to overcome these difficulties.

Part I. (Introduction).

No doubt in time wireless printing telegraphy will receive more or less attention, but it will not be of much importance, in this generation at any rate, because there cannot be any saving of line or line maintenance when there is no line. Any saving of labour that might be effected by wireless printing telegraphy is of trifling importance, because the wireless operator has to be in attendance in any case, and the speed of signalling is low.

For railway work printing telegraphs have hardly been employed at all up to the present, and as the telephone is gradually displacing the telegraph for most railway work in America, and therefore no doubt in time in other countries also, printing telegraphy does not appear to have any extensive possibilities in conjunction with railways. In time, printing telegraphy will probably play a considerable part in connection with ocean cables, but up to the present hardly anything has been done in this direction, because the conditions to be fulfilled are extremely complicated. There cannot at present be any line saving, because ocean cables are already utilised up to their full capacity. It will be possible to effect a slight saving of time and some saving of labour, but the apparatus will necessarily be of a very delicate and intricate character. The expenditure will necessarily be heavy, and the saving will not be more than about £300 or £400 a year on each cable at each end.

So far as the present position of printing telegraphs is concerned, the Hughes tape printer carries the bulk of the telegraphic traffic on the Continent of Europe, and it has done so for nearly half a century, about 3,000 Hughes instruments being now in use. Most of the telegraph traffic between Great Britain and the Continent is also carried by the Hughes, but this machine is only employed outside of Europe to a very slight extent. During the past 30 years the Baudot system, which may be described as a multiplied Hughes tape printer, has been developed and extended in France until all the telegraph lines of any importance are equipped with it. During recent years it has also made considerable progress in Italy, Brazil, India and Russia. In Russia it is quite extensively used, most of the leading towns in European Russia being connected by it. It has likewise secured some foothold in most other European countries, Paris being linked up by it to nearly all the capitals of Europe. Great Britain has proceeded in very leisurely fashion, and, so far, has only coquetted with printing telegraphy, more or less prolonged flirtations having been carried on by the British Post Office with the Hughes and Baudot, the Buckingham, the Murray automatic, the Siemens & Halske and several other systems. The latest arrival, the Murray multiplex, may be described as the child of the British Post Office, it having been developed with the assistance of that institution. The Murray automatic system has made most progress up to the present in Germany. It has also secured a foothold in Russia, Sweden and Norway. It is in regular commercial use between Hamburg and Berlin, Berlin and Frankfurt, Hamburg and Frankfurt, Berlin and St. Petersburg, St. Petersburg and Omsk in Siberia (about 2,400 miles, with three repeating stations), Stockholm and Gothenburg, Kristiania and Bergen. A new installation with all the latest improvements is being established between London and Dublin. For various reasons, however, the use of the Murray automatic system is limited to long lines and underground cables, and there is, consequently, not a very wide field for it, especially in comparatively small countries like Great Britain. The Murray multiplex, on the other hand, is very well adapted for moderate distances, but it has not yet had time to come into extensive use. In the United States the Buckingham system was developed under the auspices of the Western Union Telegraph Co., and some 60 circuits are now equipped with the Buckingham system as improved by Barclay.

Printing telegraph inventors are still busy increasing the height of the printing telegraph scrap pile, but the substantial results over the whole wide world are summarised in the foregoing paragraphs. These results are neither extensive nor brilliant, and it is an actual fact that less than £1,000,000 sterling would cover the value of all the printing telegraph machinery on the face of the earth to-day. This is the outcome of 50 years of constant labour by scores of inventors. We have only to compare this with the gigantic extension of telephone apparatus all over the world in only a few years to realise that there must be some hampering circumstances, some peculiar difficulties and obstacles in the way of printing telegraphy.

Before considering these difficulties the author discusses the four economies of fundamental importance in the transmission of intelligence—namely, to save time, to save labour, to save line, to save office equipment—and he emphasises the heavy labour cost and loss of time in the transmission of telegraphic communications. The vital importance of printing telegraphs lies in the fact that they can greatly reduce the present waste of line and labour in telegraphy, and that they render it possible to foster the growing co-operation between the telegraph and the telephone. The telegraph and telephone are each strong where the other is weak. We can set out the points in tabular form thus:—

——	Telegraph.	Telephone.	Telegraph-telephone.
Time	Wasteful	Extremely economical	Fairly economical
Labour	Wasteful	Extremely economical	Fairly economical
Line	Very economical	Very wasteful ...	Very economical
Office equipment	Cheap	Expensive	Expensive

If we utilise the telephone as the short-line feeder and distributor for the long-line telegraph we get the ideal co-operation shown in the last column of the table. The cost of office equipment will be increased, but this will be outweighed 10 or 20-fold by the economies of line, labour and time.

If telegraph messages were charged for like telephone messages—by time instead of by the number of words—a lot of the labour cost would fall away. A merchant would then ring up the nearest telegraph office. He would be switched on to the required circuit, and he would dictate his message direct to a telegraph operator, who would type it on a rapid keyboard tape perforator. The perforated message would run through an automatic transmitter, and would be printed automatically direct from the line signals at the distant station, from which point it would be telephoned at once to the addressee. This telephone-telegram idea is already slowly emerging into everyday use. The British and other administrations now accept and deliver telegrams by telephone, and the British Post Office has actually coined the special name of "phonograms" for such telephone-telegrams. To handle "phonograms" under ideal conditions there should be a system giving either high automatic speed of transmission or at least four simultaneous transmissions in each direction on busy lines, and the speed of each transmission should be a steady average of at least 40 words a minute. Not only would quick handling and transmission of messages be necessary, but also quick reception and printing of the messages at the other end of the line ready for transmission by telephone. Printing telegraphs are a necessity for such methods of handling telegrams.

The chief stumbling-block at present is the practice of charging for telegrams according to the number of words, which involves an incredible amount of waste time and labour in counting the number of words.

In addition to the telephone as a local collector and distributor of telegrams, there appears to be a field for the small step-by-step printing telegraphs generally known as stock-tickers. The Siemens & Halske teletyper is a good example of this class of machine. These little machines, however, are more expensive and complicated and slower than telephones, and in the nature of things can only come into very limited competition with the telephone. The same remarks apply to the telewriter.

Meanwhile we have to see what steps we can take to reduce labour cost of telegrams under present conditions. The subject is very complicated and there are many obstacles, but threepenny telegrams and quick service would lead to a wonderful growth of telegraph traffic. These depend on rational co-operation between the telegraph and telephone, upon the extension of the telephone to practically every office and home, and last, but not least, upon efficient printing telegraphs. It is practically certain that in the course of the next 10 or 15 years the British Post Office alone will have to spend not less than a quarter of a million sterling on printing and other telegraph machinery in telegraph offices.

* Abstract of a Paper read before the Institution of Electrical Engineers.]

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PART II.—(DIFFICULTIES IN GENERAL).

The printing telegraph inventor has to conform to most intricate and unexpected conditions, and although the telegraph administrations do all they can to assist in the development of printing telegraphy, they are still bound to look at the matter from the financial point of view, and to insist on a printing telegraph showing either (1) a saving of labour, or (2) a saving of line, or (3) a saving of time in transmission, or if possible all three. In fact, we may say that the difficulties in the way of introducing printing telegraphs are essentially commercial.

In Europe, excluding Russia, labour saving is most important, especially as the telephone has cut into telegraph traffic to such an extent that during the past few years the growth of telegraph traffic in most European countries has been small or nil. In giant new countries with magnificent distances, including the United States of America, Russia, Canada, South Africa, the Argentine, Brazil and Australia, the saving of wire is of the greatest importance, and some waste of labour may be tolerated if there is compensating line saving. In each case the relative advantages of line and labour saving have to be balanced to get the maximum benefit.

The difficulties in the way of labour saving in telegraphy may be roughly classed under two heads: those in connection with commercial messages and those in connection with press messages. Commercial messages are short and average about 20 words; constant stoppages of the mechanism are therefore necessary. With a page-printing telegraph the loss of time in cutting up tape and pasting it on message forms is saved, but provision has to be made and time allowed for line-feed, column-feed and page-feed. These delays take place every 20 words or oftener, thereby considerably reducing the saving possible in theory. The position is entirely different in the case of the stock-ticker and ticker news service, and practically the whole of the troubles are questions of mechanical maintenance.

Press Messages.—The conditions at the first glance are much more favourable for printing telegraphy, but actual experience shows that the obstacles are much worse than in the case of commercial messages. The British system of news distribution is divided into the Post Office "News Division" worked by the Wheatstone system, and the leased and private wires rented from the Post Office by the leading British newspapers. *London* is the great originating and distributing centre for news, and it flows out from London all over the United Kingdom. Taking first the Government service, in the British "News Division," news distribution is carried on by an elaborate arrangement of Wheatstone circuits, each message being perforated simultaneously on from one to eight tapes by pneumatic perforators, the tapes being then used to transmit press messages over as many as 30 different Wheatstone news wires, many of which have six or more towns strung on them in series. In this way news is distributed all over the United Kingdom at a very rapid rate, and with remarkable economy of labour, as one man can prepare a message for transmission to a hundred or more towns. There are very great difficulties in the way of any printing telegraph coming in and doing this work. In the first place, the news is distributed at a very high speed of from 200 to 300 words per minute. No printing telegraph can work steadily at such a speed on one wire. Also the Murray automatic system, and, indeed, any other printing telegraph using a special alphabet (not Morse), would require a piece of news to be handled in the Murray alphabet as well as in the Morse, unless the whole news service of Great Britain was handled entirely by the Murray automatic system. Apart from the speed difficulty and the cost of the apparatus, it would take years for a printing telegraph to be installed all over the country. Using it for a few circuits for news would mean double labour in perforating the messages, and although the advantages might be great enough to compensate for this extra labour the speed of the line would have to be dropped to about 150 words a minute.

In those countries where there is no highly complicated arrangement for news distribution there is no obstacle to the use of such printing telegraphs as the Murray automatic; but in countries where there is no complicated news-distributing organisation there is very little news traffic, and it can be handled easily by the Hughes and other low-speed and therefore cheap instruments.

Another difficulty about news work is that in London and other large centres of population at least 12 copies are required of press messages for the various newspapers. It puts a serious strain on any operator to make 12 copies continuously for long periods of time at high speed. Rotary mimeographs and hectographs get over the difficulty in New York, and there is no reason why they should not do equally well in London.

Newspaper Private Wires.—In the case of these wires the conditions for the most are even worse from a printing telegraph point of view. High-speed printing telegraphs are of necessity complicated, and require good mechanical skill to keep them in order. This means that a skilled mechanic with an assistant and a small workshop would have to be installed. The question of speed also is just as serious with newspapers as with the Post Office. Take, for instance, a great provincial daily paper like the "Glasgow Herald." Every night it sends from 30,000 to 40,000 words from its London office to its Glasgow office 400 miles away. The great bulk of this news is sent over the "Glasgow Herald" private wire between 5 p.m. and midnight, and the conditions are such that it is absolutely imperative to have a speed of transmission over the line of not less than 250 words a minute (1,500 letters) and preferably 300. At present the work is done by the Wheatstone system, and there is a staff of six to eight operators in London, who punch the news in the form of perforated tape, and it runs through the Wheatstone transmitter at 200 to 300 words a minute, coming out in the Glasgow office of the "Herald" as dots and dashes on a tape, which is then copied out by a staff of 8 to 10 men. It is not apparent how any printing telegraph can meet such requirements. The writer tried it with the Murray automatic system, but the utmost that he could achieve was 184 words a minute, and even this was with very fine adjustment, much too fine for practical work; 150 words a minute was practical, but it was too slow. Less serious troubles are to be found in the fact that mistakes show up badly in the type-written pages produced by printing telegraphs, and make the sub-editors uneasy about the accuracy of the messages. In the case of the Wheatstone the transcribers correct the errors as they proceed, and they write out clean "copy."

In spite of the great difficulties in the way of using printing telegraphs for news work, it would be taking too pessimistic a view to say that printing telegraphs cannot be used for press despatches. They can be and they are so used. In Germany and France, for instance, where the newspaper telegraph traffic is small, all the press messages are sent over the Hughes and Baudot printing telegraphs, and even in Great Britain printing telegraphs will in time make their way for news work; but it will be a very slow progress and very costly. The apparatus will have to be faultlessly made, and well-trained men employed to run it. There will probably be a saving of time, but the saving of labour will not be great.

The difficulties in the way of making a copy for record of telegrams delivered are explained, and the author points out that wet-press copying is the only practical method when printing telegraphs are used. The necessity for keeping copies of telegrams at all is not obvious.

When page-printing telegraphs are used a change is necessary in the telegraph forms used by various Administrations. There are two kinds of telegraph messages, those sent from city A to be delivered in city B, and those sent from city A to be re-transmitted in city B to city C. In city B nearly all telegraph administrations use two different kinds of telegraph forms to distinguish these two kinds of messages. For a page-printing telegraph only one form for both kinds of messages is possible.

Numbering messages involves a waste of about 2½ per cent. in line time and labour; and the tendency is to omit all unnecessary signals. Whether consecutive numbers on telegrams are necessary appears to be an open question. Certainly numbering is a safeguard against messages being lost—an accident that happens occasionally in all telegraph offices. Hence when the Murray automatic system was introduced into the British telegraph service it was considered desirable by the officials to resume the numbering of messages on the Murray circuit. This is a small matter, but it involved a certain amount of change of routine, and in a big department a change of routine is a matter of difficulty. The experience of the writer is that the real conservatives are not the official heads but the operators, who often show extraordinary reluctance to accept change of routine. In fact, that is one of the minor obstacles to the introduction of printing telegraphs.

Counting the number of words in telegrams is a serious matter, causing much waste of time and labour. Charging by the number of words is a very defective system, but it is difficult to say what better arrangement could be adopted. As long as word counting remains in force it will be one of the hindrances to any considerable saving of labour by printing telegraphy. The number of words in the message is sent in the preamble, and it is the duty of the receiving operator to count the number of words in the received message to see that it agrees with the number in the preamble. In case of discrepancy this involves a talking back and forward, which, with printing telegraphs, is not so quick as with the Morse key. There are also so many Siamese twin words that are neither one nor two that counting is difficult, and the labour cost is increased. Thus, "motorbus" is one word, but "motordriver" is two. If it were possible to charge for telegrams in some way by time as in the case of the telephone a lot of delay and labour would be saved.

Apart from these difficulties, the most serious trouble a printing telegraph system has to face is errors in telegrams. These, due to

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disturbances on the telegraph line, stray currents, inductive interference, men repairing the line, wind and weather, or to the human operator, involve repetition of messages and impose very serious limitations on the time and labour saving possible with printing telegraphs.

A special difficulty for printing telegraphs is also to be found in the variety and irregularity of telegraph traffic, which varies greatly in volume and in character according to the circuit and the seasons. There are also great variations in the volume and kind of traffic according to the hours of the day. Moreover, the present system of multiple address messages is impossible with a printing telegraph.

Traffic arrangements and hours of duty of operators are necessarily of a very complicated character in the case of large telegraph administrations, and the introduction of printing telegraphs leads to considerable variation of these arrangements. It is most difficult to introduce changes in the daily routine of large numbers of human beings. Of course, in the case of France, Germany and other countries on the Continent of Europe, where the Hughes has been largely employed for more than a quarter of a century, such difficulties have long since adjusted themselves. It is in the Morse key and sounder countries that the introduction of printing telegraphs necessitates some changes of routine.

International telegraph traffic presents special difficulties because of the division of authority and difference in habits and ideas and customs, and differences in language. Alphabetical troubles are not the least that printing telegraph inventors have to encounter. Each country requires some variation in the telegraphic alphabet, and it appears to be a physical impossibility to devise a printing telegraph that will suit all languages. A curious illustration of this alphabetical difficulty is the confusion that exists in Great Britain through the use of the oblique stroke both for money and fractions. 3/8 may be read as 3s. 8d. or as $\frac{3}{8}$. This confusion has led to monetary loss. Code and cipher messages also are the despair of telegraph administrations, but on the whole a good printing telegraph can handle such messages with less risk of error than the Morse key and sounder, and at least as expeditiously if proper methods are used. The essential condition is careful training of operators in working on typewriter keyboards without looking at the keys.

The use of envelopes and the addressing of telegrams present difficulties in the case of page-printing telegraphs. On the Continent of Europe envelopes are not used, and the telegrams have to be folded up in special ways, varying with each administration. The printing of the messages must suit these methods of folding. This requirement is hard to fulfil in the case of a page-printing telegraph.

Finally, there are mechanical difficulties of construction. Printing telegraph machines belong to a theoretically bad group of mechanisms, in which the majority of the actions are striking instead of liding or rolling, and it is only by close attention to details that uccess has been achieved.

(*To be concluded.*)

NEW METALLIC FILAMENT LAMPS.*

BY G. S. MERRILL.

Summary.—The author discusses the physical properties of the filaments of incandescent lamps. A description is given of the apparatus used for testing the breaking strength of metal filaments, and the effects of burning on continuous and alternating current circuits are shown for tungsten lamps.

The author deals with the lamps themselves rather than with their applications in commercial service, and discusses the following physical properties of the materials: Electrical resistance, vapour tension and melting point, emissivity, selectivity, mechanical strength.

The following figures are given for the effect of 1 per cent. increase in voltage of lamps operating at normal efficiency—

	Increases wattage.		Increases c.p.
Tungsten	1·59 per cent.	....	3·73 per cent.
Tantalum	1·72 per cent.	....	4·27 per cent.
Metallised carbon	1·77 per cent.	....	4·90 per cent.
Treated carbon	2·07 per cent.	....	5·69 per cent.
Untreated carbon	2·32 per cent.	....	7·10 per cent.

The filament of an incandescent lamp must not only meet certain requirements of an electric conductor but it must also possess certain characteristics as a luminous radiator. The latter condition greatly limits the number of materials which can be used as filaments of incandescent lamps. The light of incandescent lamps is produced by temperature radiation as distinguished from luminescence or fluorescence. It is therefore desirable to operate the incandescent filament at as high a temperature as possible in order that the proportion of the energy radiated within the visible spectrum, and hence the efficiency of light production, may be high. The maximum temperature at which it is possible commercially to operate a certain material in the high vacuum of an incandescent lamp bulb is determined by its rate of disintegration if the vapour tension is high, and by its melting point if the vapour tension is low. The high vapour tension of the carbon filament, which is shown by its tendency to evaporate at temperatures far below its melting point, makes it impossible commercially to operate carbon filaments at the normal working temperature of the tungsten filament.

Not only do the various filament materials differ in their ability to withstand high operating temperatures, but they differ also in their radiating properties. The emissivity or more ability to radiate energy does not affect the luminous efficiency, but it plays an important part in determining the lengths and diameters of filaments in commercial lamps.

The metal osmium has been shown to possess the property of selective radiation in the visible spectrum to a high degree, but the difficulty of working it and its relatively low melting point have made its commercial use impracticable. Tungsten, while not quite as selective as osmium, is more plentiful, and moreover it can be operated commercially at a higher temperature and efficiency, so that it is a more a desirable filament material than osmium, in spite of the greater selectivity of the latter substance.

The greatest problem in the production of metal filament incandescent lamps has been to produce the filament material in a high state of purity and in the proper physical form, and the ingenuity of the manufacturer has been taxed to the utmost in devising means by which this can be accomplished. It is difficult to secure a high degree of purity in tungsten metal, principally because its atomic weight is high and, in consequence thereof, a very little carbon (which is the most common impurity) is sufficient to form a considerable amount of tungsten carbide. The Paper contains a number of micro-photographs which illustrate the changes during the various processes of manufacture and during the subsequent burning. Microscopic inspection of the longitudinal surface of tungsten filaments after various periods of operation shows that a gradual wrinkling or breaking up of the surface takes place. Apparently the effect is confined almost entirely to the surface material, the filament itself suffers no serious distortion and no marked difference in appearance is produced by burning on alternating current. The appearance of the tantalum filament after burning on direct current is not very different from that of a tungsten filament, but on alternating current a gradual breaking up of the tantalum filament takes place. This can hardly be ascribed to vibration due to rapid heating and cooling, because tungsten filaments, operated under similar conditions do not show this tendency.

The study of the change in appearance of filaments throughout their life naturally leads to a consideration of the effect of burning on the strength of the filament. In order to investigate the relative strength of lamps of different types, various methods of testing them have been devised. Strength tests are made with the filaments cold, because when they are heated it is practically impossible to break them, the most serious damage that can then result from shocks and blows being a twisting together of one or more loops.

One method of testing strength consists of mounting the lamp rigidly on a block which can be bumped by a second block allowed to swing as a pendulum. The impact is regulated by the arc through which the pendulum is allowed to swing, and is increased by small increments until the filament is ruptured. The method has been modified by one investigator so that the impact is obtained through a ball rolling down an inclined plane. Another method requires the lamp to be mounted on a block which can be dropped from gradually increasing heights, the apparatus resembling somewhat a miniature pile driver. Other tests have been made by packing lamps in boxes as for shipment, and dropping the boxes from increasing heights, the lamps being frequently inspected. These methods have the advantage of breaking the lamps under conditions at least approximated in service, and moreover give some indication as to the value of the method used in supporting the filament. The results obtained are at best somewhat erratic and a large number of lamps must be averaged in order to obtain a proper appreciation of relative strengths.

In order to obtain some idea as to the strength of the filament itself, considered apart from its supporting structure, several methods of testing have been commonly used. One method consists in laying the filament on a pad of paper, smooth but not rigid, and allowing a small metal cylinder to roll lengthwise along it. Rollers of increasing weights are used until the filament breaks. In another device the filament is drawn by a hook at the centre between two converging guides until it breaks; the distance which it was drawn into the

* Abstract of a Paper read before the Franklin Institute.

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"I" before breaking gives an arbitrary measure of its elasticity. This method has been varied in another device so as to draw the filament through a spiral guide, thus giving the sample a greater and greater curvature until it breaks.

The number of ways in which filament strengths can be measured with precision is somewhat limited by the physical nature of the filaments and by their extremely small diameter. The filaments readily lend themselves to cross-bending tests, and in order to carry out certain investigations a device for making such tests with some degree of accuracy was constructed. Short pieces of filaments were supported at points 0·5 cm. apart and a load slowly applied at the middle until the filament broke, the load and deflection both being measured. By taking short pieces of filament it was possible to test from 10 to 20 samples from a given lamp, and the average load and deflection shown by these 10 or 20 samples gives a very good measure of the filament strength in that particular lamp. In addition to determining the breaking strength, the deflection under various loads could be measured and deflection load diagrams could thus be obtained.

The machine, which it is believed involves a new principle, consists essentially of a horizontal beam balanced on a knife edge (*see* fig. 1), supporting at one end a cylindrical plunger C and at the other end a cylindrical weight W of the shape shown. The weight W at one end of the beam hangs with its lower edge midway between the points of support of the filament which is laid horizontally across an opening 0·5 cm. long. The block A carrying the filament can be raised through measured distances by means of a micrometer screw.

A small concave mirror, M, on the beam reflects light from the source to form an image at I. By keeping this image on a certain point, the beam may be kept horizontal and the deflection of the filament may be read from the micrometer screw.

The plunger at the other end of the beam hangs within a vessel which may be filled slowly with water. The plunger is buoyed up by the water as the latter rises and a load proportional to the weight

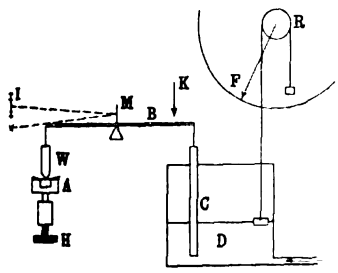


FIG. 1.—FILAMENT TESTING MACHINE.

of water displaced by the plunger is thrown upon the filament. As the plunger is uniform in section, the volume of water displaced can be most easily measured by its height upon the plunger. In testing, the beam has been kept balanced with a small part of the plunger submerged, and consequently the load upon the filament is determined by a difference in water levels. To enable the water level to be read with accuracy, a carefully balanced float rides upon the surface of the water in vessel D, and by means of a silk thread passing over the small pulley, R, its motion is magnified by the long pointer F travelling over an arbitrary scale. The water level readings can be reduced to the equivalent load in grammes on the filament by means of a calibration curve.

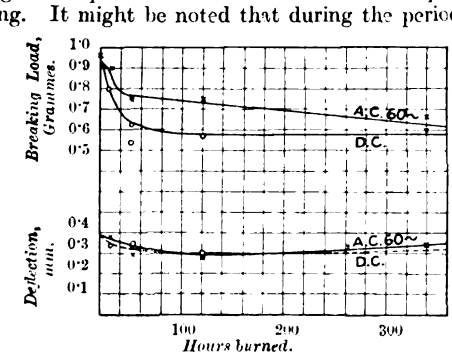
After putting the filament in place, and taking the initial reading of the pointer F and the micrometer head H, water is allowed to flow into the vessel D. As this throws a load on the filament and produces a deflection, the operator raises the filament with the micrometer screw, in order to keep the image I at a fixed point. The reading continues until the filament breaks, at which instant the water supply is automatically cut off by electrical contact of the unbalanced beam with the point K. The pointer F indicates the water level at breaking. The deflection of breaking is indicated by the difference between the initial and final readings of the micrometer head.

In order to compare strengths and deflections of filaments of varying size, it was necessary to express the results in terms of some unit length and diameter. Consequently all measurements of strength and deflection have been reduced to the equivalent load in grammes and deflection in cm. of a filament 0·5 cm. long and 0·005 cm. in diameter. In some cases filaments were found to be slightly elliptical in cross section rather than circular. (The difference between the maximum and minimum diameter, however, rarely exceeded 10 per cent.) In reducing the results of the cross-bending tests to a common basis, the diameter of the filament was therefore taken as the mean of two diameters at right angles in order to reduce the error due to possible deviation from a circular section.

Some of the most interesting tests made with the device have reference to the change in strength of the filament during its life. Three lots of 40-watt 110-volt tungsten filament lamps representing modifications in manufacturing processes were run through such comparative test. Each lot was divided into two parts, one of which was burned on 60-cycle alternating current and the other on direct current. All lamps were burned at 1·23 watts per candle-power. At certain intervals lamps of each lot were removed from the burning racks and the strength of the filaments tested. Fig. 2 shows the results of the tests for one lot, the general tendency of the curves being the same in each case.

Each point on the curves is the average of 10 determinations of strength of the filament from a single lamp. The deflection at breaking indicates that the flexibility of the filaments does not change very much with burning, especially after the first few hours.

The decrease in strength with burning could be most easily shown by either some change in the structure of the filament or by some change in the effective cross section. Although the results have all been reduced to terms of a uniform gross diameter, a microscopic inspection of the filament shows that there is a tendency for the surface to become wrinkled with burning, which would, in all probability tend to reduce the effective diameter as far as strength is concerned. In general, the surface which was originally smooth gradually becomes rough during the first 100 hours burning. Beyond this point the changes are not so marked. The strength curves indicate in a general way that the greatest reduction in strength occurs during the first 100 hours of inspection, and thereafter the change is less marked. This seems to point to the possibility that the strength is dependent at least to some extent upon the surface roughening. It might be noted that during the period covered by



Results reduced to filaments 0·5 cm. long, and 0·005 cm. in diameter.

FIG. 2.—CURVES SHOWING STRENGTH AND DEFLECTION OF TUNGSTEN FILAMENTS.

the test the gross diameter of the filaments of the several lots remain practically constant, *i.e.*, no marked reduction in diameter with burning could be noted.

In regard to changes in structure, there is a tendency for the crystalline structure to become somewhat coarser with burning. This change would naturally tend to weaken the filament due to the greater ease with which the fracture could follow the larger crystalline surfaces. A compact small-grained crystalline structure is apparently the more desirable from the standpoint of strength. The investigation, however, should be carried further before any definite conclusions are reached.

In order to give the relative idea of the strength and stiffness of a tungsten filament and a glass thread, a glass rod was drawn down to a diameter approximately equal to that of the filaments and a number of samples were tested. The ultimate strength of the threads of glass was almost three times that of the filament, but the flexibility of the glass was considerably less, giving about 60 per cent. as great a deflection as a tungsten filament under the same load.

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BATTERY ECONOMICS.

Mr. A. M. TAYLOR's persistent advocacy of accumulators as a desirable adjunct in large as distinct from small generating stations is evidently bearing fruit and causing other engineers to think more about this problem. At the last meeting of the Institution of Electrical Engineers, Mr. TAYLOR read another Paper dealing with the same subject, though more from the point of view of using a battery to the best advantage as regards its efficiency.

A battery differs from a dynamo in that the E.M.F. falls with a heavy discharge in addition to there being internal drop due to resistance. A battery therefore acts like a dynamo having a large demagnetising armature reaction; but unfortunately there is nothing to correspond with the exciting coils in a dynamo for bringing the E.M.F. back to the desired value. This feature makes efficient regulation difficult. As is well known, two methods of compensation have been used; one being by means of regulating cells, and the other by means of boosters. Leaving out of account buffer batteries, to which our remarks do not apply, regulating cells are found to give sufficiently quick regulation, but they have the well recognised disadvantage that

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these end-cells are put to very unequal use and that deterioration consequently results. The construction of sliding contact switches when the currents to be handled are heavy also presents a difficulty; but, nevertheless, this method of regulation has been used largely both on the Continent and in the United States, even when the currents have been as high as 40,000 amperes.

Practice in this country, on the other hand, has favoured the booster, which in this connection may be regarded as a home product. Here the difficulty is of another kind. If a battery is to be used for dealing with peak loads in preference to the installation of further steam plant, the question of efficiency becomes important. When a booster is used for regulating the discharge of a battery, energy is being used for this purpose just when all the energy available should be sent into the feeders. Moreover, the booster under these conditions is very often run inefficiently, being worked for a large part of the time at considerably under full load. It is for these reasons, no doubt, that very low overall efficiencies are sometimes obtained, a figure of only 54 per cent. being mentioned by Mr. A. H. Seabrook during the discussion on Mr. Taylor's Paper.

The solution proposed by Mr. Taylor in order to raise the efficiency is to run three boosters instead of one, the boosters being run three in series when the E.M.F. required is a maximum and the current a minimum, and three in parallel for the converse conditions. At first sight these may seem complicated arrangements, but there is no particular reason why they should not work out fairly simply. From an efficiency point of view the booster is certainly a weak point in this method of regulation, and anything that can be done to cut down the size of machine that must be used should materially improve the conditions. Something more might also be done on the lines pointed out by Mr. Taylor, namely, so to proportion the battery that at times of lowest load it could be run without any booster in circuit.

There is little doubt that large batteries of accumulators have certain distinct merits or they would not be used to the extent they are in other countries. This may be due partly to the fear of heavy penalties in the case of failure to supply, and this point of view seems to apply in the case of German stations. But we doubt if this is so in the United States, where, nevertheless, many very large batteries are in use and where end-cells seem to be favoured. Actual results obtained in practice are more valuable than any estimates of what may happen, and we do not doubt that the figures given by Mr. S. L. Pearce during the discussion on Mr. Taylor's Paper will produce considerable effect on those who are considering the economics of the question. The figures obtained at Manchester, namely, a commercial efficiency of 71 per cent., including losses in boosters, for a period extending over one year, is an extremely fine result, and serves to show that the efficiency obtainable depends considerably upon the conditions of working. Mr. Pearce also mentioned, as will be seen elsewhere, that the average saving in coal amounted to 13 per cent., and that the loss of energy in the battery was covered four times over by the coal saved. Having regard to these results, and to the fact that battery makers will give terms of maintenance extending up to 15 years, it is to be hoped that the Local Government Board will now take a more rational view of things and will grant longer terms than seven years for the repayment of battery loans, for these terms can only act as a deterrent to municipal engineers wishing to adopt accumulators on an extensive scale.

REVIEWS.

(Copies of the undermentioned works can be had from The Electrician Office, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.)

Die unipolare Gleichstrommaschine. By Boris von Ugrimoff. (Berlin: J. Springer.) Pp. 98.

The unipolar machine has always been a fascinating subject to the electrical engineer. Yet in scarcely any branch of his work, has his labour been less rewarded or his task more thankless. Indeed the production of a continuous current from a machine without a commutator seems ever to have been one of the alchemist's riddles in electrical engineering, and the number of untold hours—apparently wasted—on this alluring subject must be appalling. True, certain practical forms of the unipolar machine have been developed and are in use, but up to the present this type does not appear to have any market value.

The present booklet is a thesis on the unipolar, continuous-current generator, and was submitted as a "Doktorarbeit" to the Technische Hochschule, Carlsruhe-in-Baden. In the first 38 pages the author deals with the development of this machine, and gives a general historical survey of the subject from its earliest days down to the latest improvements. After describing the methods used for giving this machine practical shape, the author passes on to consider the contact made between a rotating disc and quicksilver. A long series of experiments is described with different arrangements of this liquid contact at very high peripheral speed. It is only when water-cooling is resorted to, however, that a practical solution can be found. The theory is then evolved by the aid of hydrodynamics.

On the basis of these investigations a machine was designed to give 80 kw. at 40 volts when running at a speed of 8,000 revs. per min. It is difficult to express an opinion on the results obtained from an experimental machine of this kind, but of the author's own conclusions we may mention the following:—

1. The unipolar machine with nickel-steel disc armature and good liquid contacts can be made to yield pressures sufficient for incandescent lamps.

2. The water-cooled liquid contact has proved satisfactory for collecting current at peripheral speeds up to 270 metres per second.

It is not often that the thesis for a doctorate leads to the development of a new type of machine, and we shall be glad to see with what success the author's future investigations are attended. S. P. S.

Compulsory Working and Revocation of Patents. By Ernest Lunge. (London: Stevens & Sons.) Pp. vii. + 89. 3s. 6d.

No part of the Patents and Designs Act of 1907 has been the subject of so much discussion as Sec. 27, which re-introduced into English patent law the principle of "compulsory working" the principle that an inventor who holds a British patent shall put his invention (even though it should be for a minor improvement on some existing machine or piece of apparatus) into practice in this country under pain of forfeiture. The controversy is still going on; one side lauding the section in question as being the essence of legislative wisdom, the other denouncing it as highly unjust towards inventors, a most useful and deserving section of the community. The subject is still further confused by introducing political issues into the controversy, and the only fault we can find in Mr. Lunge's excellent monograph on the compulsory working of patents is his little digression into the Free Trade and Tariff Reform

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controversy. We suppose this is pardonable, as compulsory working is, as Mr. Lunge clearly shows, a revival of a practice of the 17th century when monopolies, tariffs, &c., were hotly debated. We believe that we should have been able to make out a good case for a modification of Sec. 27 of the 1907 Act without having recourse to current political controversies. However, the blemish is a small one, and we can heartily recommend Mr. Lunge's book as being a complete and accurate guide to the law and practice relating to the compulsory working of patents in this country. Both the State (which grants the monopoly for working an invention) and the patentee have an interest in the subject-matter of the patent, and we think that Sec. 27 of the 1907 Act is too rigid, too sweeping in its character, and we believe that time and experience will prove this to be so.

The Young Electrician. By HAMMOND HALL. (London: Methuen & Co.) Pp. xvi. + 289. 5s.

The author states in his preface that this book pretends to no higher aim than that of affording instructive amusement to intelligent boys. We are afraid, however, that, except in the case of a few geniuses, the majority of boys will find much of the contents too technical. In fact, the volume savours more of an elementary treatise on electricity and magnetism, many of the diagrams (especially those relating to dynamos and motors) being more suited for a text-book. Apart from the large number of technical terms, such as "inductive capacity," which have been introduced, the author would, we think, have been better advised to have omitted such appliances as the "Prony brake" and the names of all except the best known scientists. Thus, few electrical engineers would be familiar with the name "Lesage," who, we are told, suggested a machine for spelling out words by means of pith-balls; nor would they connect the name Henley with a discharger for a Leyden jar. Again, it is scarcely necessary to mention in a book of this kind that the telautograph was invented by Elisha Gray.

The subject of electricity possesses a fascination for most boys, and no difficulty should be experienced in arranging a large number of experiments requiring very simple apparatus that would familiarise the naturally inquisitive mind of a boy with the general features of electricity. The present volume, however, errs on the side of "over-completeness," and may possibly confuse by the mere wealth of material.

RECENT PHYSICAL RESEARCH.

VII.—MAGNETIC BODIES COMPOSED OF NON-MAGNETIC ELEMENTS.

BY D. OWEN, B.A., B.SC.

§ 1. Heusler's discovery in 1903 of the magnetic alloys of copper, aluminium, and manganese opened the way to a new line of physical investigation. For the first time elements which alone are very feebly magnetic were seen to be capable of forming, when in combination, a ferro-magnetic body. The question arose as to what limits of intensity of magnetisation were possible in this new class of bodies, and whether they might not exceed the saturation value for the most magnetic of the ferro-magnetic group of elements—namely, iron. The practical consequences of such a consummation are too obvious to be enlarged upon. Whilst it cannot be said at present that these hopes are in any way realised, neither can the new facts be said to have received as yet any adequate explanation, and the experimental side of the subject appears to be far from exhausted.

Of the large number of investigations already made may be specially mentioned those of Fleming and Hadfield, of Prof. Gray and other workers in the Glasgow University Physical Laboratory, of Wedekind, and of Bruce V. Hill, as well as of Heusler and his co-workers. An account of the main results follows below.

§ 2. *Heusler's Alloys.*—Heusler succeeded in producing a number of ferro-magnetic bodies containing copper and manganese along with a third metal which might be Al, As, Zn, Sb, Sn, &c. Of these the alloy containing aluminium gave the best results. A systematic study of the effect of variation of composition led him to the conclusion that, for any given percentage content of copper, the alloy is most magnetic when the aluminium and manganese are present in the proportion of their atomic weights. Maintaining this proportion, the magnetic quality improves as the percentage of copper diminishes. This reduction cannot, however, be carried below 60 per cent., owing to the unsatisfactory mechanical qualities that the product then manifests. Alloys containing more than 60 per cent. of copper are amenable to working on the lathe, though forgings are not possible.

Confining attention to the properties of the copper-aluminium-manganese alloy, with percentages 63·5, 12·5 and 25 respectively in the order named, an examination of the results of different observers shows considerable differences, which appear to be largely attributable to differences in the thermal treatment undergone by the test specimens. For the moment let it be said that these thermal effects are very decided, as well as complicated. This alloy may, however, be broadly classed with nickel and cobalt and the medium grades of cast iron. It gives the well-known general form of **B-H** curve, with **B** = 3,000 to 5,000 for **H** = 150, with a maximum permeability of some 200 occurring at low field strengths (less than 10 C.G.S.).

The *coercive force* is rather greater than for nickel or cobalt, and consequently the hysteresis is greater. According to Fleming, the latter may be represented by a formula of the Steinmetz form—viz., $W = \eta B^{n}$, the power of **B** required being about 2·25. The value of η found for a specimen containing 60 per cent. copper was 0·000549, and for one containing 68 per cent. Cu 0·00077.

These alloys possess a critical temperature, or temperature of magnetic transformation, varying between the limits of, say, 250°C. and 450°C., according to percentage composition. Cooling curves indicate the evolution of heat in passing through that point.

The effects of *thermal treatment* are very marked, but are not capable of representation by any simple law. This is only to be expected in view of facts that are well known as to the behaviour in this respect of other magnetic compound bodies. Thus, for example, the so-called non-magnetic manganese steel containing 12 per cent. of manganese is capable under certain treatment, of becoming distinctly magnetic again, Hopkinson's nickel-steels are capable of existing in two distinct states, both stable at the same temperature, one magnetic, the other practically non-magnetic. Beginning with a Heusler alloy which has been cast and cooled down more or less slowly from the melting point (between 900°C and 1,000°C.) to ordinary temperature, it has been generally found that an improvement in magnetic quality (to the extent of an increase of some 30 per cent. or more in **B**) is obtainable by a process of "ageing," the specimen being maintained at a temperature of about 110°C. for several days, then tested at room temperature. Subjection to higher temperatures results in a deterioration to an extent greater as the temperature is higher. The experiments of Hill on this subject are especially valuable. He found a temperature of magnetic transformation of about 330°C. for the specimens investigated. As cooling took place from this point the magnetism steadily increased though on regaining room temperature the intensity of magnetisation was only 250, a distinct drop on the initial value of over 300 (field kept steady at 85 C.G.S.). A second heating this time up to 500°C., was carried out. On re-cooling the magnetisation regained was very small—namely, **I** = 27 at 17°C. Further cooling to −190°C. only increased **I** to 36. It is thus possible to obtain the alloy in two states: one strongly magnetic, the other comparatively feebly magnetic, at the same temperature. This is the phenomenon already observed in the case of the nickel steels by John Hopkinson. But in the manganese alloy the magnetic condition is not restored at a lower temperature. It therefore occcurred to Hill to observe whether a rise of temperature, to a point considerably above the temperature of magnetic transformation, would result

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the passage to the magnetic state. This he found to be the case. On heating to a dull red heat (650°C. to 700°C.) and allowing to cool slowly the value I=90 was found at 17°C. H. Sh. On then heating to bright red heat (say, 850°C.) and allowing to cool the value I=155 was obtained at room temperature. The Heusler alloy is, therefore, irreversible as regards variation of magnetism with temperature. In contrast with the 25 per cent. nickel-steel, which appears in the non-magnetic condition on cooling from melting point, the cast Heusler alloy appears in the magnetic state. The changes are not, however, of so simple or definable a character in the former case as in the latter; there is no definite cycle which can be traversed over and over again (H constant) with precise return to one of two definite values of intensity of magnetisation at any given temperature. Like the nickel-steel, the Heusler alloy shows distinct differences in density, &c., in the magnetic and non-magnetic states.

The effects of very low temperature have been investigated recently in the Glasgow laboratory. At the temperature of liquid air the magnetisation is distinctly greater than at ordinary temperature. If the alloy has been rendered but very feebly magnetic by raising to about 300°C. and quenching in water, the magnetism is largely or entirely restored on cooling to −190°C. This increase of magnetism is not, however, retained on return to ordinary room temperature. The effect of extremely low temperatures, it may be noted, is in this respect opposite in sign to the effect recorded by Dewar and Fleming in the case of annealed iron and pianoforte steel wire, though of the same order as the change in unannealed iron or in hardened iron.

§3. The copper-aluminium-manganese alloy is the most notable of the class of bodies here under consideration. Others, however, have been prepared. Mention has been made of some discovered by Heusler, in which the place of aluminium is taken by another element. Heusler also showed that certain Mn-Zn and Mn-Al alloys possess appreciable ferro-magnetism. Wedekind has added to the list a considerable number of compounds of manganese, including the sulphide and compounds with B, Sb, P, As, Bi, N, &c., respectively. All these show distinct remanent magnetism after subjection to an intense magnetic field. The boron compound is reported to have a permeability one-sixth or one-seventh that of iron, whilst a flux density approaching to within 30 per cent. of the value of iron is stated to be attainable in the case of MnSb. These results appear to require confirmation.

There is but little evidence of the existence of ferro-magnetic bodies from which manganese, as well as iron, nickel and cobalt are excluded. Wedekind reports CrB to be magnetisable to a marked extent. Ross and Gray have made experiments upon alloys of copper and aluminium which indicate the possession of a permanent, though very feeble, magnetism after subjection to a strong magnetic field. According to these experiments, the permanent magnetism is more pronounced when the material has been quenched from a high temperature. Cooling in liquid air accentuates the effect. For example, in the case of an alloy of 95 per cent. copper and 5 per cent. aluminium, the annealed material showed a remanent intensity of 0·01 C.G.S. at 15°C. and of 0·091 C.G.S. at −190°C.; the quenched material possessed an intensity 0·029 at 15°C. and 0·110 at −190°C. Experiments on practically pure copper led to similar results. The slowly-cooled material exhibited no sensible remanence after subjection to a field of 3,000 C.G.S.; the quenched metal, on the contrary, gave a remanent intensity of 0·10 C.G.S. at 15°C. and of 0·27 at −190°C. The traces of iron present were estimated to be far too small to account for these results. On the other hand, experiments with a very pure specimen of electrolytic copper showed no trace of remanence. These results can, apparently, only be reconciled by assuming that the traces of iron present in the first case form with the copper a magnetic alloy of considerably higher permeability than pure iron.

§4. In spite of these recent extensions of our knowledge of ferro-magnetic bodies, the problem of their constitution remains unexplained. Iron in the pure state is strongly ferro-magnetic; in its salts it is paramagnetic, capable only of feeble magnetisation in comparison with the amount of iron present, and devoid of retentivity; in its alloys it may become, as in Hadfield's manganese steel, only feebly ferro-magnetic; in combination with aluminium or silicon its permeability may in low fields exceed that of pure iron, but on carrying the magnetisation to saturation the aluminium appears to function only as a non-magnetic diluent. Some of the nickel-steels may in one state be practically non-magnetic, in a second state more magnetic when saturated than a mere mixture of the elements present would be. Clearly, then, the magnetisability of a body is not a function merely of the atoms present, but depends on the structure of the molecule or on the manner of grouping of the molecules.

The interesting question of the part played by manganese is still an open one. Practically all the magnetisable bodies from which iron, nickel and cobalt are excluded contain manganese. Certainly all those of marked magnetic quality do. Does, then, manganese belong fundamentally to the ferro-magnetic group of elements, as Faraday considered probable? The nearness of its atomic weight (55) to that of iron (55·9) suggests it. It is curious that the black peroxide MnO_2 was for long known as *magnesia nigra*, on account of its supposed magnetic properties, the name manganese being thence derived to distinguish this element from magnesium. Metallic manganese as normally prepared is, however, non-magnetic. This commercially pure metal is, in truth, but a crude product, containing, it may be, some 4 per cent. of impurity, chiefly copper and iron. Weiss has produced the pure metal by electrolytic reduction of $MnCl_2$, using a mercury cathode and an anode of platinum-rhodium. The grey powder which results on driving off the mercury by application of heat in presence of hydrogen behaves, when compacted into a rod, as a paramagnetic body. Melted in an electric furnace in a vessel composed of magnesia and in an atmosphere of hydrogen it acts as a ferro-magnetic body. A BH curve was obtained showing an enormous coercive force (670 C.G.S.), with a remanent intensity one-hundredth that of pure iron. Even at H=12,000 the specimen still remained unsaturated. This manganese, furthermore, appeared to have strong magneto-crystalline properties. Such appears to be the most successful effort at producing elementary manganese in a distinctly magnetic state. Cooling experiments down to liquid air temperature have long since been made, only to negative the idea of a simple explanation in terms of a low temperature of magnetic transformation. The magnetic nature of the element has to remain for the moment unexplained.

BATTERY ECONOMICS AND BATTERY DISCHARGE ARRANGEMENTS.

We give below an account of the discussion that took place at the meeting of the Institution of Electrical Engineers last week, when Mr. A. M. Taylor read his Paper on the above subject. An abstract of this Paper appeared in our last issue.

DISCUSSION.

Mr. TAYLOR, in reading the abstract of his Paper at the meeting, applied his figures (given in Tables B, C, E, F) to Fig. 19 of the Paper, showing the load at Dickinson-street. The area of the curve represented 93,800 units per day, or 33,800,000 units per annum—that is, a 35 per cent. load factor. They might compare the cost of putting in steam plant for the whole 11,200 kw. as against the cost of installing steam plant for 5,200 kw. and battery plant for 6,000 kw. (at a 1½ hour rate), which would supply a two-hour peak. The fixed charges for the 11,200 kw. plant at £3·89 per kilowatt per annum were equal to £43,500; and the "true" running costs at, say, 0·15d. per unit equalled £21,100, giving a total of £64,600 for the all-steam scheme. Considering next the battery scheme, they had as follows: 5,200 kw. of steam plant at £3·89 per kilowatt =£20,200 per annum; 6,000 kw. of battery plant at £1·58 per kilowatt, or £9,480 per annum, giving a total for fixed charges of £29,680 per annum. To this had to be added £21,100 for running charges, as for steam, and £1,200 for lost units in the battery and boosters, giving a total for the battery scheme of £51,980. But, as no margin was provided in the battery plant beyond that of the normal peak, it was desirable to provide a second battery (which might be of the Exide type), for use solely for emergency conditions, having a 6,000 kw. capacity for 1½ hours. This battery would add to the fixed charges a sum of approximately £6,300

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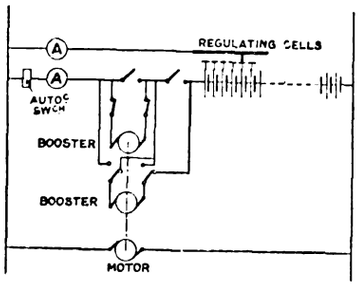
per annum (6,000 kw. at £1·05), making a total of £58,280, thus giving a saving of £6,320 per annum over that of the all-steam plant. It might be mentioned that the sum of £43,500, given in the steam scheme for fixed charges, included £3,100 on the 6,000 kw. plant, representing stand-by coal, which was entirely saved on the battery scheme.

Mr. B. M. JENKIN thought one of the most interesting points was the comparison made between the ordinary battery booster and the author's suggested arrangement. That method of working might be carried still further, since the chief object of the battery was to give the maximum possible discharge when it was most needed. So long as a booster was used to assist the battery to discharge, some energy would be used in the booster when it was of most value for the load. The question of how the boosters could be switched to run either in series or in parallel was left rather vague in the Paper. Personally, he was unable to follow the reason for the complicated proposal made, and he did not think it was really necessary. The suggestion in Fig. 14 of a double commutator and single field for booster was undesirable, because one required to have independent control of the voltage of each booster. No complicated switch was needed, so far as he could see, but it was necessary to have each armature in a separate field. He suggested that the absence of the booster during discharge was the point to be aimed at, especially if the battery discharge was to be regarded as a standby. The arrrangement shown in Fig. 4 involved a great deal of switching and depended entirely upon the boosters during the battery discharge. The author suggested in that figure the use of regulating cells in addition to the booster, but did not mention how it was possible to overcome the difficulty of properly charging the cells connected to the regulating contacts. The speaker suggested that the better plan would be to use regulating cells on a battery with a sufficient number of cells to take the discharge. He outlined the following arrangement: The booster was placed in parallel with the regulating switch circuit as indicated in the diagram herewith. During



charge the whole of the cells were equally charged through the booster. The regulating switch was adjusted to suit the 'bus bar volts, and the booster voltage was adjusted to give the required charge and at the same time keep the current through the regulating switch circuit at zero. During normal discharge the same method was followed, so that all the cells were equally discharged. During the beginning of the discharge the booster was run inverted and the motor delivered current to the 'bus bars. At the end of the discharge the switch was on the end cell and the booster shut down. In emergency the heavy discharge was taken through the regulating switch circuit, and the booster was automatically cut out as the switch was moved to the end cell. The regulating switch circuit was available for emergency discharges at all times, and was not affected by the booster connections which might be set with armatures in series or in parallel, charging or discharging.

Mr. C. E. C. STAWFIELD (Wolverhampton) could hardly agree with the advantages of using batteries for standby purposes, and more particularly with the suggestion for putting in boosters to enable a battery to be discharged at a high rate. He could scarcely imagine that in this country conditions were likely to arise which would make a 5 minutes' discharge rate necessary. Even if such circumstances did arise he thought they would last considerably longer than 5 minutes. He thought that 1 hour would be the shortest time necessary for a discharge; and if they wanted to go beyond that, the capital charges in respect of boosters &c., would be greatly increased. As to regulating cells versus boosters, he had certainly been under the impression that the booster was the best and most economical method of charging and discharging a battery; but he was very much surprised to find when he recently had an opportunity of going through the Berlin Electricity Works that the opposite opinion was held on the Continent. The regulating switches in use in those works were really wonderful in their simplicity and certainty of operation. He saw one move over several contacts when carrying 4,000 amperes, and although that particular switch had been in service seven or eight years the contacts appeared absolutely new. He was assured that they had not required any repairing or renewal during that period. In regard to the cost of regulating switches, it did not appear to be any higher than the cost of the boosters. In the case of a battery giving 1,000 kw. for 3 hours he was informed that the cost of the regulating switch and connections, delivered and erected, was £1,050. The switch was capable of discharging the battery at the 1 hour rate at, he thought, 4,000 amperes without damage and without any serious sparking. He thought that there was very little doubt that the efficiency to be obtained by the use of regulating cells was very much higher than was possible with boosters. Further, as the author said, units were wasted in the booster at the time when they were most expensive to produce, whereas the units for charging were used at the time when they cost the least. The extent to which batteries were used by the Berlin Electricity Works was rather startling, compared with English practice. The figures given in the Paper, he thought, were rather on the small side. He was informed that the capacity of the batteries installed in Berlin was 35,000 kw. on the 2-hour rate, and that in case of breakdown they were capable of maintaining the whole supply of the city for a period of 2 hours. Why it had been considered necessary to make such a large provision in the way of batteries was, he understood, that they resulted in considerable economy in coal, which was expensive in Berlin. Further, the supply company was under very heavy penalties to the local tramways, to the underground railways and to the municipality in the event of any failure of supply. The batteries installed were an insurance against the heavy liability for breakdowns. Such a state of affairs, however, did not exist in England, and he did not know of any case where supply undertakings were liable for more than nominal penalties. Therefore, he thought the use of batteries could only be justified where they reduced the cost of generation. The advantage, however, was limited to their capacity at the two or three hour rate, and arrangements should not be made for dealing with heavier currents. He wished the author had given further details of the Exide cells. He understood him to say that they were suitable only for emergency purposes and not for regular use. If that was so he could not see why their use was suggested at all. The principal use for a battery was to carry over the periods of peak load, and either the battery was to be used daily to meet the peak load demand or it was not required at all. He was not able to follow the author's figures. The standing charges for 11,200 kw. per annum were given as £43,500; surely it ought to be something like half of that amount. Then £3·89 per kilowatt per annum would represent a capital expenditure of over £30 per kilowatt, whereas with modern steam plant the cost would be as low as £12 per kilowatt. The comparison made by the author was not, therefore, quite correct.

Mr. S. L. PEARCE (Manchester) said that as the author had referred in two or three places in his Paper to the large batteries installed at Manchester, a few facts and figures relating to the first year's working might be of interest. In the first place he would like to correct the statement that the coal bill had been reduced by some 25 per cent. That was true of three months in the summer of last year, but the average for the completed 12 months was only 13 per cent. Originally, when the battery was installed, it was intended to charge entirely from the traction 'bus bars, and to discharge only on the lighting peak loads. The capacity of the battery at the one-hour rate was approximately 3,000 kw. It was quite possible, and at times was found to be of very considerable advantage, to run the booster motors from the traction 'bus bars as an alternative to the lighting 'bus bars. Although intended normally to charge the battery from the traction bars and to discharge on the lighting bars, it was so arranged that both charging and discharging if desired could be done entirely on the lighting system. The year's experience had shown that the best results were obtained by keeping the battery entirely on the lighting system. Possibly the conditions at Manchester were ideal for a battery of that capacity. As most of them knew, they had a high-tension station at Stuart-street and low-tension stations at Dickinson-street and Bloom-street; the two latter for all practical purposes might be considered as one.* That gave a very flexible arrangement. Supposing they had very dark weather in the morning and took a more or less complete discharge out of the battery, the load at Stuart-street, which supplied principally the tramways and industrial undertakings, would drop 6,000 or 7,000 kw. during the dinner hour, say, 12 to 2, and it was, therefore, quite possible to get a very good charge through the sub-station into the battery again during that interval of time. The battery charging rates were accordingly arranged to be as high as possible—viz., 4,000 amperes normal and 6,000 as a maximum. The battery was then ready to meet the peak. The conditions at Manchester for getting more than one discharge per day out of the battery were more or less ideal. With regard to the savings effected, he had estimated that during the first completed year these were as follows: Coal, a reduction from 3·33 lb. to 2·89 lb. per unit generated, or a saving of 13 per cent., which for an output of 30,550,000 units meant a saving of 6,055 tons, or £3,348 in coal alone. Other savings in the works costs had been secured. They amounted in all to 0·064d. per unit, and taking the given output of 30,550,000 units totalled £7,762. Allowing for full capital and maintenance charges on the battery, so far as he could see there had been a saving on the first year of £3,041. That took no account whatever of any saving on capital charges of plant, and if they were prepared to admit that the battery at the one-hour rate could be fairly compared with the steam plant at Stuart-street, plus high-tension mains, plus converting plant at Dickinson street, the capital cost showed £13 per kilowatt for steam plant and £8 for the complete cost of battery, switchgear, &c., a difference of £5 per kilowatt. Taking 8½ per cent. on £5 and 3,000 kw. at the one-hour rate they arrived at a saving of £1,900, or, with the above-mentioned £3,041, a total of approximately £5,000. This figure did not differ materially from that given by the author in the Paper. They estimated further that the daily steam plant load factor in the winter would be increased from 32 to 43·5 per cent., and as a matter of fact they had averaged 47 per cent., with some days as high as 60 per cent. On p. 24 the author referred to a sufficient saving in stand-by losses on boilers and engines shut down to make the value of the coal so saved equivalent to the losses in the battery and boosters. The figures at Manchester were: Total units lost in battery and boosters approximately 700,000, equivalent to £870, and this loss was covered four times over by the saving of coal. With regar

* At Dickinson-street they had installed a large sub-station, which formed the connecting link between the alternating-current and direct current supply stations.

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to the question of rapid discharge, perhaps the figures of the Tudor battery at Manchester obtained in actual practice might be of interest :—

8,400 amperes for 1 hour.
13,000 amperes for ½ hour.
17,000 amperes for 5 minutes.

On the question of switches to deal with high discharge rates for short periods, he assured them that the design and operation of the Manchester switches made him wonder how the Americans successfully dealt with a 47,000 amperes current. He agreed with the author's remarks that it was not advisable to put in batteries exclusively as a stand-by. A battery large enough to act as a substitute for peak load steam plant and to give economy of working which made it a sound commercial investment, had, in his opinion, all the "emergency" qualities necessary. He agreed with the author's suggestion that for ordinary commercial purposes it was quite good enough to put in a battery to buffer the demand in foggy weather. With regard to the booster equipment, he thought the author had done Manchester an injustice when he spoke about the booster plant being insufficient for discharging the battery at emergency rate. That was not correct. The boosters were three in number and collectively, when operated in parallel, were sufficient to give current corresponding to the five-minute maximum discharge of the battery at maximum boost. They were divided into three sets because they were partly required for the traction load, when two were operated in series, but at times of discharge on lighting the boosters were all in parallel. They experienced no difficulty in working with the "series parallel" arrangement. It was quite easily arranged; in fact, the diagram of connections of the Manchester battery which had been published showed very clearly the arrangement of the switchgear, and no complications were introduced. He did not quite appreciate where the economy of the author's booster proposals came in. Something might be saved on capital account, but the losses, especially on charge, would, he thought, be greater than with the ordinary booster arrangement. With regard to Fig. 15, it seemed to him a purely hypothetical case, and hardly likely to occur in actual practice. He suggested that the maximum discharge was always coupled with the question of maximum boost. A point interesting to engineers-in-charge of municipal stations was the question of loan periods for batteries. The Local Government Board would only grant loans on batteries for seven years, whereas the makers were prepared to give maintenance contracts for at least 15 years. He thought, therefore, the period might reasonably be extended.

Mr. A. H. SEABROOK (Marylebone) said he had considered the question of the use of batteries for some years. In going into the figures for additional steam plant for the Marylebone station the capital cost came out at £57,000 and the cost for storage batteries of 3,000 kw. capacity on the 1-hour rate £26,000, a considerable saving. He was able also to fix up a maintenance contract with the battery manufacturers for 20 years, but the Local Government Board only allowed 10 years as the loan period. The loan period for batteries ought, he contended, to be extended, especially considering the high scrap value. The efficiency of 71 per cent. mentioned by Mr. Pearce was, however, rather staggering. He found the overall efficiency, including boosters, &c., was 54 per cent.; 71 per cent. was undoubtedly exceedingly good. As to regulating cells, he did not think these could be passed over in favour of boosters quite so readily as the author thought. Regulating cells were used extensively in America and in Germany. It would be interesting to know if any one had figures relating to the working efficiency of regulating cells as compared with boosters. Battery makers during the past year or two had been prepared to include regulating cells in maintenance agreements. A point in favour of regulating cells was that they were more reliable than boosters. The booster was the weak link in the discharge arrangement. Moreover, switching was much less complicated with regulating cells.

Mr. LEONARD ANDREWS called attention to apparent discrepancies between the first items in Tables B and C. The capital cost of the extra 1,500 kw. of steam plant was given in Table A as being £19,500. Interest and sinking fund at 6½ per cent. on this sum would amount to £1,270, or £50 less than the amount Mr. Taylor had included in Table C for standing charges on the steam plant. The author made him (the speaker) responsible for the higher figure by quoting from his Paper of two years ago on gas engines, but he could find no justification in that Paper for the figure included of £1·91 per kilowatt of maximum demand, which, he agreed with Mr. Shawfield, was much too high. He concluded that the author had arrived at this figure by adding to the 6½ per cent. on the capital cost of the 1,500 kw. of plant, 25 per cent. for additional stand-by plant, and a further charge for increased labour and repairs—(Mr. Taylor: That is so). He contended that it was altogether erroneous to assume that the increased labour and repairs would be directly proportional to the maximum demand upon the generating station. If, for instance, the labour charges on an 8,000 kw. steam plant amounted to £5,600—the figure given in the speaker's Paper—and the maximum demand on the steam plant was reduced to 6,500 kw. by carrying 1,500 kw. of the peak load on batteries, he was of opinion that the maximum reduction it would be reasonable to expect on the labour and repairs item would be £350 per annum. He considered, therefore, that the standing charges on the steam plant should not be taken as being higher than

6½ per cent. on £19,500	£1,270
25 per cent. extra stand-by	318
Extra labour and repairs	350

This total being £1,938, or £1·26 per kilowatt of maximum demand instead of £1·91. With this amendment, and accepting Mr. Taylor's figures for the other items, he considered that the correct total fixed and running charges should be :—

	Fixed charge per kw. maximum demand.	Running charge per kw.-hour.
For steam plant	£3·2	..... 0·221d.
For gas plant.....	£2·98	..... 0·0825d.

These figures still showed that a very substantial saving would be effected by installing batteries to deal with the peak load, as recommended by the author.

Mr. MACGREGOR DUNCAN said, in regard to maintenance contracts for batteries, it would be interesting to know if the manufacturers were prepared to give the same terms for contracts for stations where the conditions were such that the battery could be discharged twice, or even oftener, per day as for stations where it would not be possible to discharge the battery oftener than once a day. Did they limit the number of discharges per day by the terms of the contract?

Mr. W. R. COOPER (communicated) thought that the extremely efficient result obtained at Manchester might be due partly to the conditions under which the battery was worked apart from the boosters. This view was borne out by the fact that a buffer battery worked more efficiently than a battery used under the usual lighting conditions. The higher efficiency of the buffer battery was doubtless due to the small range of the charge and discharge curves over which working mostly took place. The most efficient result was likely to be obtained by working over what might be termed the flat parts of the normal charge and discharge curves as far as possible, so as to approach buffer battery conditions.

Mr. A. M. TAYLOR, in reply, thought Mr. Jenkin's principal objection was the complication of the switchgear, but the suggestion on which Table A was prepared involved no switchgear that had to be touched while the battery was being discharged. As to the switchgear shown in Fig. 14, the two double-throw switches were mounted on a separate panel and were put up or down, as the case might be, when the discharge or charge commenced, and would remain in that position. They were independent of the panel switches that would control the boosters. A sudden overload of the boosters could be easily met by having an automatic switch which short-circuited the booster 'bus bars and at the same time wiped out the booster fields and broke the booster motor supply. The boosters could then be put in on a one-hour basis, and the supply was also left uninterrupted. The proposals in Fig. 15 were really given as applying to special cases, but even these involved nothing but turning over the selector switches at predetermined times and required no adjustments or skilled attention. Mr. Shawfield appeared to be surprised at the booster losses. The losses with ordinary boosters were undoubtedly very serious, and incidentally he was therefore not surprised at the figures quoted by Mr. Seabrook. If, however, boosters could be used of from one-third to one-tenth the size, and always fully loaded, both on charge and discharge, the losses would become unimportant. After all, the greatest loss was in the batteries. He wished the makers could give them batteries that would show an energy efficiency of over 75 per cent. They seem to stick at that percentage. With reference to Mr. Shawfield's remarks, Fig. 23 might perhaps give the impression that for every three units generated one was lost in the battery and two delivered to the 'bus bars. They had to deal, however, with a one-hour peak corresponding with a 4 per cent. load factor, and if the load factor were, for example, 80 per cent., the batttery was supplying roughly 1 unit for every 16 units generated at the station; but only one-third of that 1 unit was the actual amount wasted in the battery; the waste was, therefore, only one-third of one-sixteenth, or one-forty-eighth of the total units generated. As to the fixed charge of £3·89 per kilowatt per annum, that included stand-by charges and stand-by coal, and was divisible by the diversity factor, when applied to consumers. With reference to Mr. Shawfield's remarks as to the use of regulating cells, it would be seen, by reference to Fig. 13 of the Paper, that the effect of increasing the number of cells sufficiently to give the one-hour discharge without a booster involved the use of a booster, merely for charging purposes, whose kilowatt capacity was equal to or greater than that required for discharging purposes on the triple-parallel method. Why, then, spend a very large sum in regulator switches, and be unable to work the battery to its full extent, and involve additional risk in maintenance, when you had got the booster ready to hand for the discharge? He (Mr. Taylor) quite agreed that, with ordinary booster arrangements, it was a question as to whether the booster should be employed for the discharge: but with the triple series-parallel arrangement there should be no doubt whatever on this point. It was quite easy and cheap to protect the booster against overloads by an automatic switch which short-circuited the booster, and at the same time wiped out the booster field and cut off the power from the booster motor. This would permit of a one-hour rating being given to the boosters, and would still keep the battery solid on to the 'bus bars. The regulating switches which he showed in his diagrams were very few in number and were not really regulating switches in the ordinary sense of the term. They were merely intended to permit of the battery floating on the line during the early part of the day, when used purely for stand-by purposes, and were accordingly very cheap. He was very pleased to hear that Mr. Pearce found his battery giving such successful results, and Mr. Pearce was to be congratulated for his courage in putting in a battery instead of steam plant at a time when such a proposal was looked upon askance. The figure of £13 per kilowatt for steam plant, which Mr. Pearce quoted, was almost exactly the figure assumed in the Paper, and he thought it would be found that his figure of £3·89 for the fixed charges was justified. He could quite understand Mr. Pearce's efficiency being high, but 71 per cent. was undoubtedly very good for an overall efficiency. Mr. Pearce suggested that it was a good plan to spend plenty of money on the booster, but why put in a booster of 700 kw. capacity if the same work could be

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done with a booster of 250 kw. capacity or even 66 kw.? Money should rather be spent in spare boosters, as these were the weak links. Mr. Pearce had installed three boosters, and said they would deal with the emergency load: but he had no stand-by for a breakdown. He quite agreed on the point of longer loan periods for batteries. He thought Mr. Seabrook would find that it was his booster that was the cause of the low efficiency. If they were working the battery at the one-hour rate, which was three times the charge rate, then during the charge they were calling upon the booster to give 20 per cent. of its volts at some periods and throughout to run at one-third its discharge rate, and it was only natural that the efficiency should be low. In Fig. 13 of the Paper each booster was continuously loaded both on charge and discharge at its full current rate; and its efficiency increased in proportion. With regard to Mr. Andrew's remarks, he apologised for apparently misquoting his figures, but he thought Mr. Andrews would find on further investigation that this had not been done. He had tried to tack Mr. Shawfield's figures for rates, taxes and insurance on to Mr. Andrew's figures for other standing costs. He was glad Mr. Andrews admitted that £3·22 might be correct. As regards another speaker's inquiry as to the Manchester battery, he believed he was right in saying that the Tudor Company had faced the question of two discharges per day and yet had not raised the maintenance rates above those of other makers for the one discharge per day. One of the battery makers at the Nottingham discussion stated that about 3,000 discharges could be got out of one battery, which would cover a period of about 10 years with a single discharge per day, and perhaps that was a good basis upon which to work. With regard to Exide cells, his proposal was to instal these as a second battery, to be called upon only in case of breakdowns, or to deal with fogs, &c., in fact, only as a pure stand-by.

ENGINEERING EDUCATION.*

BY J. A. EWING, C.B., F.R.S.

There are two great professions in which the fruits of scientific study and the methods of scientific thought are directly applied for the benefit of man. These two are medicine and engineering. In both of them science is the proper basis of practice, but in both we have to recognise as a fact of primary importance that the practitioner, to be even fairly competent, requires much more than a knowledge of science or even a habit of scientific thought. He must have profited by what may be broadly described as experience, not simply the experience which he acquires at first hand in his own attempts to carry out professional work, but such of the advantages of experience as it is possible to become possessed of by association with men who have already acquired it.

The sciences which form the basis of engineering have not only grown *pari passu* with the art itself, but between the two there has been a continuous and most beneficent interaction. Physics may be said to owe to engineering as much as engineering owes to physics. Many of the greatest advances in theory, notably in electricity, are direct fruits of the demands made by practice and of the facilities for research which arose through the development of practical appliances. I believe the same is true of medicine. There is no need to labour the point, but it is important, in relation to the question of training, to recognise that whereas both arts began with nearly pure empiricism, both are now so dependent on and so closely related to science that the days of empiricism are dead. The transition has been gradual, and it has been accompanied by a corresponding, or perhaps I should say a somewhat lagging, change in the conception of how a young man should be prepared for professional life.

The successful empiric was a man who had experience and who in general had also that practical intuition which comes neither from scientific studies nor from experience, the intuition which, even in a scientific age, is still a potent factor in the highest professional efficiency. To train an empiric the natural way was to set him to assist a successful empiric, to learn his trade by helping, by watching, and by imbibing such counsel as the man of experience might communicate. Accordingly, the early system of training, both in medicine and in engineering, was a system of apprenticeship and nothing more. Sent as an apprentice or "pupil" into the office of a civil engineer or into works, the young engineer was left to pick up practical knowledge as best he could, with no foundation of scientific comprehension, without system or guidance, and in most cases without even the personal contact with a successful chief which was a redeeming feature of medical apprenticeship. Even at the present day examples may be found of young men seeking to enter the engineering profession in this haphazard manner. But it is now at least widely, though not universally, recognised that no proper education for the engineer is to be obtained by practical pupilage or apprenticeship alone, and that the ideal training is one which comprises, in addition to means of getting experience, a properly organised course of study in the relevant sciences taught with reference to their practical application. These "applied sciences" may be broadly described as the theory of engineering.

The Institution of Civil Engineers has done a good deal to foster right ideas about engineering education by requiring of candidates for admission to its membership that they should not only give evidence of practical experience, but should either pass an examination in theory or hold an exempting University degree or certificate. In some respects these regulations are unduly inelastic; on the other hand, they do not prescribe that the candidate should have had a properly organised course of scientific study. To pass an examination in certain sciences is one thing: to have had the advantage of a University or college course in which the same sciences are well taught is quite another thing. It would probably be harsh on some deserving candidates if the college course were made a *sine qua non*; but one may hope that as time goes on the candidates who have not graduated after a full course of engineering theory will become few.

One may note in passing that the sudden growth of industrial electricity, in its application to lighting and to the distribution of power, which took place about 30 years ago, gave an immense impetus to engineering education. It became obvious then that rule-of-thumb methods would not serve an engineer confronted with such novel material, so a knowledge of science became a recognised essential in his equipment, and engineering schools sprang up everywhere. As might be expected, the result of this movement has profoundly affected British engineering. It came at a critical time, when the stress of foreign competition was beginning to be felt, and we were at a disadvantage from the fact that the foreigner saw the need for scientific training sooner than we, for the most part, saw it. Even now it may be questioned whether our eyes are as open to it as are his; I do not think they are. But even as things stand, much has been accomplished. You have only to refer to the Papers that are read before our engineering societies or listen to the discussions that take place in them to be aware that a new generation of engineers has arisen whose mental outlook is different, who are familiar with the concepts and language of science, who think and speak in terms that would be unintelligible to men of the old school. And in listening to them you find that the new phrases and the new ideas are not the expression of a culture lying outside of their professional life. Science has become part of the very fabric, it helps to determine everything that the engineer does.

A striking feature of the engineering schools is their general likeness—the substantial uniformity in method which has now been evolved. This tendency is, in part, due to the similarity or identity of text-books, and also in considerable part to the very useful practice of having the professor in one institution serve as external examiner in another, in association with the professor there as internal examiner. This practice is now generally followed, and it is in every respect a sound way to conduct examinations to have collaboration between the teacher whose pupils are to be examined and some independent person possessing expert knowledge.

The most conspicuous difference, as regards organisation, is that in some schools the division of engineering into branches is carried farther than in others; specialisation begins earlier and is more pronounced. Premature specialisation means narrowness, and it is the business of the University to save the young man from that by laying foundations that are broad and deep, on which the superstructure of professional knowledge will afterwards be built. In those British Universities which first took up the teaching of engineering the ideal aimed at was to lay a general foundation; no attempt was made to give detailed information on professional subjects. From this ideal there has been in some instances a considerable departure; the American and Continental methods, in which professional detail occupies a large place, are now more closely approached in several British schools.

The differentiation of professorships tends towards this. It allows of and practically compels a more thorough treatment of each branch, but it has serious drawbacks. There is apt to be a lack of co-ordination and balance between the various parts of the engineering school, and the student who wishes a general course is not well provided for.

What, then, are the fundamental subjects which primarily require attention in the education of the engineer? First, there is mathematics of the practical sort, to be regarded as a tool and not as an end in itself. Then there is mechanics, or, as we may better describe it, applied mechanics, of all the engineer's studies surely the most important. After this, mechanism, the strength of materials and the theory of structures, prime movers and applied electricity. Mechanical drawing is also an indispensable part of his equipment because it is the very alphabet of expression on the part of the engineer. Closely connected with drawing is the art of surveying in which the student has to learn certain conventions of representa

* Abstract of a Paper read at the Imperial Education Conference last week.

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both as well as modes of measuring distances and angles and levels on the ground. Finally, there is the experimental work of the engineering laboratory; and I am a profound believer in the value of the laboratory, not only as a means of research, but as an instrument of education. Care must be taken, however, not to pay too much attention to an elaborate equipment. All teachers do not realise how much of the best laboratory work is done with the simplest apparatus; how vastly more educative it is to the student to have to rig up appliances for himself than to find everything ready to his hand. The temptation of the engineering professor is great, when funds are available, to go one better than his neighbours in other schools in the number and scale and ingeniously varied capabilities of his engines and testing machines, and so forth; but it is a temptation to be resisted. What he ought to do, however, by all means in his power, is to encourage his better senior students to undertake original research; and I am afraid this is not recognised as it should be.

The opinion used to be very general among British professors that the use of tools could not be taught in a college workshop in such a way as to have solid professional value. Experience, however, has led many to the contrary view. Personally, I have no doubt at all of the effectiveness of the college workshop as a means of professional training, provided it is set up on a fairly large scale and well provided with good machinery, and that the teaching is properly combined with skilled workmen who are at the same time competent instructors. This is borne out by our experience in the training of naval cadets.

The ordinary student of engineering must, however, look to getting his workshop experience either before or after his collegiate education. There is much to be said in favour of both plans. On the whole, the advantages incline to having the practical training follow rather than precede the other, mainly because the mental development given by the college course will make each stage of the practical training enormously more full of meaning than it can be when the pupil attacks it without preliminary knowledge of the reason of what he has to do, or sees done. Finally, the vitality of an engineering school depends largely on the professor's keeping himself in touch with engineering practice, and to this end it is very desirable that he should himself engage to a certain extent in professional engineering work. He should be not only permitted but encouraged to do so. To bar an engineering professor from outside work is to make him less efficient as a teacher, and is the way to prevent the best men from seeking or holding professorial appointments. The professor should have a free hand, subject only to an understanding that the governing body may step in if necessary to exercise a veto in cases where they find that he is abusing his freedom by undertaking work which, through its excessive amount or unsuitable character, is interfering with his duties or lowering his influence as professor.

IMPROVEMENTS IN THE TRANSPORT AND DISTRIBUTION OF GOODS IN LONDON.*

BY A. W. GATTIE.

In an address to the London Chamber of Commerce last June (*see* THE ELECTRICIAN, Vol. LXV., p. 459), I promulgated the adoption of the principle of the bankers' clearing house to the business of transport. I showed how great a benefit the clearing house had been to the banker, and I believe I succeeded in proving, by analogy, that there would be as great, or even a greater, benefit in the matter of transport.

For the present moment I only wish to invite your attention to the great economy to the railway companies which would be effected by the adoption of this bankers' clearing house system, because it would be a place where railway companies can exchange loads with one another without any shunting or marshalling, and consequently would do away with the necessity of the enormous shunting yards which they now possess. But this is not merely a question of railway economy; it is also a question, and an equally important and pressing question, of the congestion of van traffic in London streets. All traffic between goods stations would necessarily disappear, as the business could be done at the clearing house; but, more than that, it is quite clear that both in taking goods to consignees and carrying them from consignors, one vehicle instead of two would be necessary where a great number are now used. The proposed clearing house, however, would not confine itself to the mere exchange of heavy loads. It would also be equipped for the rapid handling of goods, and making up of loads, and this work could be carried out at a speed of something like 2,000 bales a minute. In the interval that has elapsed since the delivery of my speech at the London Chamber of Commerce I have been asked many questions, and one very persistently. How is it, it has been asked, if so great a benefit can be conferred on railway companies by your proposed reforms, that railway managers do not receive you with open arms? The directors of my company have been quite as puzzled on this subject as our questioners, and in order to clear the matter up and enable me to give you some definite information on the point, we last month addressed the following letter to all the General Managers and Goods Managers of the railway companies running into London:—

The General Managers of two railway companies coming into London have expressed the opinion that the project put forward by this company of establishing a central goods clearing house in London is "impracticable."

The directors of this company naturally attach considerable importance to this expression of opinion, and are therefore anxious to learn whether you endorse it?

If that is the case, may we inquire whether you claim that the alleged impracticability consists in any of the following details:—

1. The proposed electrical arrangements.
2. The proposed mechanical arrangements.
3. The proposed structural arrangements, and if so, whether in the matter of the proposed approaches or in the structure and design of the building itself.
4. The proposed system of sorting parcels, bales or heavy loads of goods by automatic conveyors.
5. The proposed clerical arrangements.
6. The proposed arrangements for elimination of shunting and marshalling.
7. The proposed arrangements for the manipulation of traffic.
8. The proposed financial arrangements, and if so, in what specific direction?

Failing the discovery of any impracticability in the foregoing features, would you so far indulge us to let us know in what shape, form or function you discover the alleged impracticability?

We should be very much indebted to you if you can see your way to do this, as we feel that the opinion expressed by the two general managers referred to must be due to a misconception or want of detailed information as to the proposals actually put forward by this company.

We shall have much pleasure in answering any question you care to put to us, or in clearing up any point of objection if made in a specific form.

Under separate cover we are sending you a copy of our Chairman's address to the London Chamber of Commerce last June.

The subject will be further discussed on the 3rd May next at the Royal Society of Arts, and any railway gentleman will be, we know, heartily welcomed by that Society.

I have received a variety of replies from the railway companies, but not one will give any endorsement to the opinion of the two General Managers, who without the remotest knowledge of any of the apparatus it is proposed to employ, expressed the opinion that the project was "impracticable." One of these general managers specifically asked how fish traffic would be dealt with under this scheme, the author therefore went into this question in detail, and showed that all the fish arriving in London would first be taken to the clearing house wharf and then unloaded into specially designed barges and taken to Billingsgate, where the usual distribution would be made.

In considering the attitude of railway managers towards the clearing house scheme, two important factors must not be lost sight of. The one is the immense force of habit of mind, and the other is the great progress which has been made in recent years in scientific apparatus. Railway managers are not scientists. The manager has been accustomed all his life to receive a goods train in London in the small hours of the morning, to have it unloaded clumsily, slowly and arduously by hand and hand truck, and having so unloaded it to allow empty trains to cumber some 50 miles of sidings for about 16 or 17 hours, when some of these trucks are again loaded and despatched from London. We are all of us creatures of habit, more so than we realise, and the railway manager is no exception to the rule. Consequently, he wants to know where we are going to store some 12,500 waggons for 17 hours in the Clearing House. So to store waggons in the Clearing House is utterly absurd and impossible, and it has never been suggested, and it is by no means necessary. The necessity only exists in the mind of the railway manager.

The second part of the Paper dealt in detail with Mr. Gattie's proposals. These have already been dealt with in the issue of THE ELECTRICIAN mentioned above.

DISCUSSION.

Mr. JAMES SWINBURNE, who occupied the chair, said one must realise that the traffic in London was largely blocked by waggons waiting and in many cases empty. In the railway yards, also, one could see the difficulty the railway companies had in loading, shunting and sorting. Their cranes seemed to be always worked endways, which appeared to be a bad system. The author had said we were all creatures of habit. He might almost say we were all savages, for everybody really opposed every-

* Abstract of a Paper read before the Royal Society of Arts.

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thing new except his own new things. Mr. Gattie was tackling the big end of the problem. He had only shown us London, and nothing, practically, about the docks, but the system was also intended to deal with the docks and with other large towns. We were faced with the difficulty that new streets had to be made, but if Mr. Gattie was *right*, that could all be saved for a good many years and it would mean enough money saved probably to carry out the clearing house scheme.

Mr. C. U. FISHER (L.C.C.) said the goods vans blocked the facilities we required for passenger locomotion and for the quick conveyance of parcels. Many influential members of the London Chamber of Commerce and many members of the L.C.C. were in favour of Mr. Gattie's scheme.

Mr. L. R. S. TOMALIN said no one had attempted to amend Mr. Gattie's figures, and if his scheme had been a wild one some statistics would have been presented to show this. The congestion of our streets was worse than ever. He, himself, endorsed the scheme, and thought that its being brought before the Royal Society of Arts would lead to its receiving increased support.

Mr. S. CHAPMAN said he fully appreciated the value of electricity for working the machinery for this scheme, but, although 200 cranes might promptly unload the trucks, he doubted whether there would be sufficient goods to fill the trucks again, and there might, consequently, be a large number of empty trucks to be conveyed to a point where they could stand until they were again required. With regard to the clerical labour, he thought this would be so considerable as to modify Mr. Gattie's figures.

Mr. H. MURRAY asked if Mr. Gattie could show that any considerable profit could be made on the basis of current rates.

Mr. W. L. MADGEN thought that, with the assistance of electricity, some scheme of the kind would sooner or later be adopted. He was doubtful, however, whether Mr. Gattie's scheme would alleviate the congestion in the streets. He thought the only solution of that question was in an organised redistribution of industries.

Mr. S. WATERS said most of the opposition came from the railway companies, which was not surprising, seeing that Mr. Gattie proposed to take away a large portion of their terminal revenue.

Mr. GUY LIDDELL said Mr. Gattie's scheme showed how an enormous improvement could be made in regard to goods traffic, and he thought a good case had been made out. It was difficult to imagine anything more unsystematic than the present arrangements, which were unprofitable, both to the public and to railway shareholders.

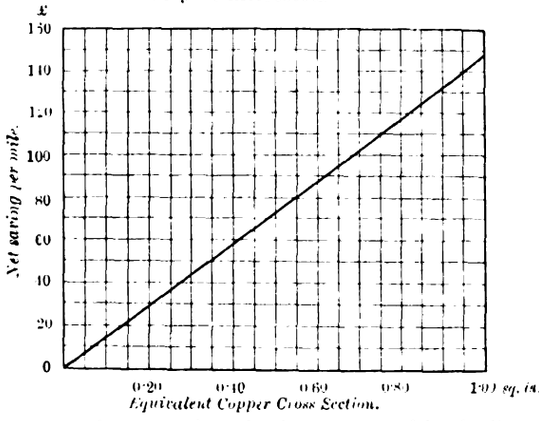
Mr. A. G. SEAMAN said the principal cost of transporting goods was not the cost of hauling but that of handling at the terminals, and people would appreciate Mr. Gattie's scheme more fully when they appreciated that fact.

Mr. GATTIE, in reply, said his calculation as to the six months' laden mobility and 17 years' life of railway wagons included the whole of the goods and mineral trucks. It showed 3 per cent. efficiency. The efficiency for the general merchandise trucks was nearly the same. With regard to the question of centralisation or decentralisation, there would be 2,000 wagons on the streets instead of between 30,000 and 40,000, and he thought enormous space economy would be arrived at by doing away with 80 or 90 per cent. of these vehicles. His 2,000 cars would make about four journeys a day, but it was the vehicles standing still that caused the congestion. They must reduce the question to van-space minutes; a car which went two miles an hour would occupy the streets twice as long and twice as much as one that went four miles an hour. With regard to the terminal charges, if the New Transport Co. could do for 3d. what the railway companies did for 1s., the railway companies and the public could both have a share of the money saved and nobody would be injured. He was substituting for the hand truck an electrical apparatus which would, he believed, do the work of 80 men, but there was no alteration involved in "documentation." The electric conveyor was absolutely honest, so that the bookkeeping need not be quite so strict as in the present system. They could handle girders or anything else in the clearing house better than it could be done in the existing goods stations. With regard to a man who used his own cart to take goods to a station which was almost next door to him, one of the New Transport Co.'s cars would call and he would not want his own cart. There would be storage accommodation in the clearing house. The cubic contents of the clearing house were 117 million cubic feet, without including the crypt. The question of profit had been gone into by chartered accountants and other people capable of dealing with the matter, and they found that, taking current rates on a revenue of £10,000,000, they would save something like £6,000,000 a year. That was a 60 per cent. proposition.

Austrian Electricity Works.—The Electrotechnische Verein will publish in July next in a collected form statistics of all the electricity supply works in Austria and Bosnia-Herzegovina (numbering about 800), and also the distributing stations taking bulk supplies serving 1,600 districts. The book is entitled "Statistik der Elektrizitätswerke in Osterreichs." Owners, populations, date of commencement of supply, systems of generation and distribution and voltage, capacity of generating plant and accumulators, numbers of incandescent and arc lamps connected, electricity meters in use and motors connected, with their capacity, prices of energy, methods of charging, capital outlay, annual output, places and works to which power is supplied, &c. The Verein announce that the work is not published for profit but with a view to serving a public need and especially the interests of the electrical industries.

INSULATED ALUMINIUM CABLES.

Although aluminium is now being used extensively for overhead conductors, it has so far been little employed for underground mains, partly on account of the increased size of cable necessary (which is, however, to some extent offset by the reduction in weight), and also due to the difficulty of making satisfactory joints on such cables. With improved methods of manufacture and the consequent reduction in price of the metal, however, the question as to the desirability of using aluminium insulated cables has become of considerable importance. We have received from the British Aluminium Co. a copy of a Table giving the aluminium equivalents of standard sizes of paper-insulated and lead-covered copper cables. This Table has been prepared in accordance with the specifications of the Engineering Standards Committee, and gives, in addition to the equivalent size of aluminium cable, the number and diameter of wires, thickness of dielectric, thickness of lead sheath, overall dimensions, weight per mile, &c. The Company will be pleased to send copies of this Table to any of our readers who may be interested.



The accompanying curve has also been prepared by the Company to illustrate the saving which can be effected by the use of lead covered paper-insulated aluminium cables, as compared with copper cables of equal carrying capacity. The saving is based on a cost of raw copper of £60 per ton and of aluminium wire at £93. 6s. 8d. per ton.

ELECTRICAL TRADES BENEVOLENT INSTITUTION.

The following is a list of the donations and subscriptions received by this Institution on the occasion of the Festival Dinner on the 26th ult. We may mention that the list is still "open" for further contributions.

DONATIONS.

	£	s.	d.
Rt. Hon. Lord Justice Fletcher Moulton	10	10	0
Bazire, A.	1	1	0
Kinnsbury, J. E.	1	1	0
Buck & Hickman, Ltd.	1	1	0
Sterling Telephone & Electric Co.	3	3	0
Webb, J. W.	1	1	0
London Electric Firm, The	2	2	0
Goddard, J. T.	1	1	0
Spicer & Pegler	1	1	0
McDougall, Ltd.	1	1	0
Thurnauer, L.	1	1	0
Tasker, W. Howard	1	1	0
Wolf, A.	1	0	0
Barfield, E. P.	1	1	0
Thomson, W. C.	1	1	0
Raworth, J. S.	2	2	0
Eck, Justus	2	0	0
Nalder, F. H.	1	1	0
Garcke, Emile	5	5	0
Hart Accumulator Co.	10	10	0
Boulton, G. & Sons	0	10	6
Lock, Lancaster & Sons	1	1	0
Spies Bros. & Co.	1	1	0
A. Hurst & Co.	1	1	0
Wallach Bros., Ltd.	1	1	0
Holmes, F. J.	1	1	0
Brundle, F. H.	0	10	6
Hay, G.	1	1	0
Worrell & Baynes	0	10	6
Esdaile & Co., Ltd.	1	1	0
Meyer, M. L.	0	10	6
Clark, E. J.	1	1	0
Tasker, W. H.	0	10	6
Blackwood, J. A.	2	2	0
Cooper, W. R.	2	2	0
"The Electrician"	2	2	0
Tucker, Geo.	1	1	0
Walter, Arthur J.	5	5	0
Howe, J. W.	0	10	6
Greene, F. A.	1	1	0
Harris, A. F.	0	10	6
Hecht, J. S.	1	1	0
Pell, W. M. D.	1	1	0
Jandus Arc Lamp & Electric Co.	2	2	0
Attwood, Reginald G.	0	5	
Benest, F. E.	1	1	
Bevan, Edward	0	5	
Raphael, F. C.	1	11	
Sanderson, C. F.	0	10	
Jacobs, C. M.	0	10	
Benjamin, H. L.	2	2	
Samuelson, F.	1	1	
Pirelli, Ltd.	2	2	
Krausse & Auerbach	1	1	
Zettel, Theo.	0	10	
Sheppard, E. G.	0	10	
New, Max	1	1	
Davenport, Walter	1	1	
Rich, Theodore	0	10	
Bright, Chas.	1	1	
Murray, Ruthven	1	1	
General Electric Co.	31	10	
Osram Lamp Works	26	5	
Robertson Electric Lamps, Ltd.	15	15	
Aron Electricity Meter, Ltd.	10	10	
Peel-Conner Telephone Works	5	5	
Hirst, Hugo	10	10	
Byng, E. G.	10	10	
British Thomson-Houston Co.	21	0	
N. J. Fenner & H. B. Alder & Co.	0	5	
Sun Electrical Co.	5	5	
"Electrical Review"	10	10	

SUBSCRIPTIONS.

	£	s.
Burney, Guy	2	2
Handcock & Dykes	1	1
Peel, C.	0	10
Wilkinson, H. D.	1	1
Steinitz, J. J.	1	1
Siddeley, H. C.	1	1
Levinger Max	1	1
Hextall, G. B.	1	1
Overlander, Otto	1	1
Armorduct Manufacturing Co.	2	2
Schmahl, W.	2	2
Gibson, J. D.	1	1
Longbottom, B.	2	2
Berry, H. H.	1	1
Hughman, R. W.	1	1

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LEGAL INTELLIGENCE.

British Westinghouse Electric & Mfg. Co. v. Electrical Co.

On Thursday last week Mr. Justice Swinfen Eady commenced the hearing of this action, which related to the alleged infringement of the Bremer arc lamp patent, No. 18,786 of 1902.

Mr. Walter, K.C., Mr. J. Hunter Gray and Mr. E. Russell Clarke were counsel for plaintiffs; and Mr. Bousfield, K.C., and Mr. Colefax were for the defence.

Mr. Walter said the patent had already been before the Courts, and its validity had been certified in the Court of Appeal. The patent related to an arc lamp of a kind suitable for burning what were known as flame arc carbons. In such lamps were fixed two carbon pencils in contact, which by a mechanism were withdrawn from each other with the result that the current flowed from the point of one carbon pole across a gaseous space to the point of the other carbon pole, with the result that what was known as the arc light was obtained. There were various means by which the carbons in arc lamps were separated. Most of the arc lamps were on the principle of vertical carbons which were brought into contact and then separated until a suitable arc was obtained. There had also been certain suggestions for lamps in which the carbons were placed at an angle to one another, the points of which approached each other and were then separated to form the arc; but none of these ever came to anything. There were other devices, too, in the early days of electric arc lighting, but eventually a time arrived when the flame arc carbons came into use. These differed from the ordinary carbons inasmuch as they contained a quantity of salts (fluorine or chlorine), mixed with the carbons, which had the effect of forming a better contact, producing a longer arc, and also changing the colour of the flame. Instead of the old white, non-permeating light, a coloured flame was produced of far greater permeating and dispersive value. Despite this, however, these carbons had their peculiar difficulties. It was very difficult to get them of such a fine texture that it was possible to depend upon the existence of the arc remaining constant for any length of time. There were variations in the resistance of the arc which rendered it impossible to keep the arc regular. Also in the longer arc any draughts to which the flame was exposed had its effect upon the flame, and interfered with the existence of the arc. A means of delicate adjustment was, therefore, required. Bremer, in his invention, went back to the suggested, though not then practically applied, form of arc lamp in which the carbons were not vertical but were inclined to one another, so that the carbons were [illegible] meeting at their lower ends. This position of the carbons had the advantage over the vertical carbons, because the light was uninterrupted in its passage from the lamp to the ground. There had been suggestions for fixing carbons in such a position, but the problem was not satisfactorily solved until Bremer brought out his invention for flame arc lamps. First of all he selected the type of lamp to be used—that with the electrodes pointing downwards—and the next [illegible] he laid down was that all downward pointing electrodes were useless for practical purposes in all cases in which the carbons depended for [illegible] the current into them on any frictional device—viz., a current [illegible] by means of a spring or by rubbing against a ring, the pressure of which was alternatively on and off. Having laid that down, Bremer said [illegible] only have carbons into which the current was fed by a rigid [illegible]—that was to say, by a wire clipped to the carbons. The [illegible] he said was he must have a device by which both carbons [illegible] together and equally for the same distance, and a further device by which the carbons should be capable of horizontal adjustment. Having made up his mind to the necessity of these things Bremer eventually put a device on the market which successfully solved the problem of flame arc lamps. The invention, which was the one plaintiffs [illegible] defendants had infringed, related to the class of arc lamps in which the electrodes were inclined to each other, and both pointed in a downward direction, the arc being formed at their lower extremities. The object of the invention was to provide an improved means for causing the points of the electrodes to approach and touch each other and then [illegible] for the purpose of striking an arc, such means being also applicable [illegible] an approach of the electrodes when the arc, by reason of [illegible] of the electrodes, became lower than its normal length. In lamps of this kind the points of the electrodes usually projected through suitable orifices in a plate at the top of the globe, or what might be called the bottom plate of the lamp, as it formed the bottom of the case [illegible]. The mechanism which controlled the carbons causing them to [illegible] simultaneously and through the same distance so as to cause the points of the electrodes to approach each other when the lamp [illegible] to the downward feed mechanism he provided a device [illegible] the points of the electrodes to directly approach each other by giving both of the electrodes a swinging movement. His invention [illegible] lamps of the type in which the current was supplied to the [illegible] electrode holders, in which the upper ends of the electrodes [illegible] clipped, and which were capable of being lowered [illegible] through the same distance and about one of which the electrode could swing under the action of a device acting [illegible] lower end. That (continued counsel) was the type of lamp defendants had infringed in practically every particular, for their lamp, with the exception of certain additions, was identical with the patent. Counsel described defendants' lamp in order to show [illegible] and produced a model. He also read the judgment given [illegible] Appeal in the other action in which the validity of plaintiffs' patent had been upheld.

Defendants denied any infringement, and declared that the original claims of the letters patent were not framed in good faith or with reasonable skill and knowledge. Further, they alleged prior user.

Mr. James Swinburne said he was familiar with what had been done in the early days of arc lamps. The first carbons used in arc lamps were not very satisfactory. Leaving out a very early form of lamp, all commercial arc lamps were fitted with vertical carbons. In the early eighties there were lamps in existence with two horizontal carbons, but they were not numerous. As time went on the carbons used in arc lamps were much improved, and a sudden change in their development took place when the impregnated carbons came into use. Various salts were used in the manufacture of the carbons which affected the resistance of the arc, and especially the colour of the light. When they were introduced they caused considerable trouble owing to the irregularity of their burning. In fact, prior to the introduction of the Bremer patent no successful flame arc lamp had been placed on the market. That invention applied to oblique carbon lamps, and the special point about them was that they had got a downward feed mechanism, whilst, unlike the old form of carbon lamp, the carbon always moved in one direction. The end of one of the carbons moved in a horizontal direction, and the two movements were so connected that an excessive horizontal movement resulted in subsequent vertical movement, and there was no pull back on the carbon. He had examined defendants' lamp, and the differences between it and plaintiffs' lamp were in the nature merely of additions, and were not alterations to the Bremer principle.

Cross-examined by Mr. Bousfield: The impregnated carbons were somewhat irregular in the way they burnt, especially in the early days. The beginning of flame arc lighting might be placed in the early part of the last decade. He did not remember any flame arc lamp carbons that were used commercially before the Bremer patent; they were looked upon as curiosities at first, but as they were improved they began to get a hold. Long before Bremer there were hundreds of arc lamps invented. The irregular burning of carbons was a common problem in the early days. It was common knowledge that the tractile strike action was the way to deal with the subject. The cure which Bremer put in his patent was the old cure known as the tractile strike, which had been applied in the early days of electric lighting. He denied that before the Bremer specification there were half a dozen oblique carbon arc lamps in existence. There might have been another such device in existence, but he had no recollection of it. There might have been inclined carbon lamps before plaintiffs' specification, but he had not heard of them. Those who experimented prior to the Bremer specification with the oblique carbons found a difficulty in keeping the arc in a straight position. He did not know that long before 1900, in Germany, France and Austria, the inclined carbon lamp was a commercial lamp. He remembered, but did not know whether it was ever made, a lamp with arc-shaped carbons turning about a centre. That was an American lamp, but he did not know whether it was ever made. He did not remember an inclined carbon lamp in Leicester-square. He thought there must have been a difficulty in making an inclined carbon lamp, otherwise he could not make out why they did not come in before. Given an inclined carbon lamp in which the carbons were fed down in the shape of a V, there would be a little more difficulty in applying a retractile strike to such a lamp than in a straight lamp, but not much. The retractile strike was apt to describe plaintiffs' arrangement as well as that of Serrin's lamp. Witness was examined at some length as to the method of striking the arc in both types of lamps, and said that if anyone were inclined to apply what he called the retractile principle to a lamp with inclined carbons and horizontal strike he might vary the details of it indefinitely, but he might vary the method. He might strike axially, instead of making the carbons horizontal, and he might have his retractile movement axial also; or, again, he might strike horizontally and have his retractile movement axial. Another way would be to strike axially and have his retractile movement horizontal. The only thing that was limited was that he must strike axially. The retractility was not necessarily combined with the striking. He agreed that if he desired to make an inclined carbon lamp with a horizontal strike retractile, one way to do it would be to utilise the horizontal strike. They might also make the retractile movement axial. It was quite common in lamps, especially the earlier ones, for one mechanism to strike the arc which practically moved the carbons ⅜ in. to ½ in., and stayed there, and the whole regulating of the feeding mechanism was done on the other carbon. In such a case the retractile movement was done by moving one carbon and striking by the other. From that one got the improved lamps with the striking movement which does both, and that is by the top carbon only generally. If they had vertical carbons the top carbon would feed, and the bottom carbon had got an electromagnet attached to it, so that when the carbon was touched it struck and held it.

Mr. Bousfield produced a copy of "The Electrician" for October, 1880, with the view, he said, of showing that the inclined carbon lamp (not plaintiffs') was, in fact, in use long before. Witness having admitted that the Jamin lamp was one with inclined carbons, counsel read the following extract from "The Electrician": "We hear that the new premises of Mr. Samuel Brogden, on Ludgate-hill, have been lighted with Jamin lamps." And in another issue of "The Electrician" of the same month there appeared a notice that the Royal Panorama, Leicester-square, London, was lighted with 30 similar lamps.

Witness replied that he only began electric work in 1881, and unless these notices happened to catch his eye he would not know about them. In the last few years a great deal of ingenuity had been devoted towards getting a retractile effect with a horizontal strike. Defendants' arrangement tended to a more gradual and better feed. The device tended to more sensitiveness, and if one had a dash-pot that made a very good arrangement. In regard to the arrangements for pivoting the electrode

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holder, he agreed that it was wrong in principle to so pivot the electrode holder that in burning up the carbon the range of movement of the lip of the carbon was doubled, while the range of movement of the armature was the same; but, while wrong in principle, it was not a fault which would prevent the lamp working. He had heard that for some two or three years the original Westinghouse lamps did not work successfully. In the commercial Westinghouse lamp of to-day he did not know whether the carbon pivoted about the electrode holder. In defendants' lamp the whole frame was pivoted, so that the pivot remained in a constant position.

COUNSEL referred to the specification of Hedges' lamp, which, he said was a lamp with carbons inclined downwards and pivotted, the arc being struck by electric magnets, and so on.

WITNESS said it was merely a paper document and would never work efficiently in practice. He had not tried it, but he knew it would not work because the carbons were held by two other electromagnets and one was always released before the other. The result was that after burning a little while one would release and the carbon would pass under the nose of the other and drop out because there was nothing to stop it.

Mr. EDWARD MARSHALL, commercial manager of the Union Electric Co., said his Company were agents for Messrs. Körting & Mathiesen, manufacturers of the "Excello" lamp. Witness's firm paid the patentees a royalty on the sale of the lamp and up to the present time had disposed of about 19,500 of them in this country. A considerable number had also been sold under the foreign patents. The lamps were made in Germany and his firm were the selling agents. His firm did not take any lamps from the British Westinghouse Company, nor had they done so during about eight years in his recollection. He could not say whether the type had remained identical throughout that period. Messrs. Körting & Mathiesen were the sole makers of this lamp and he agreed that the British Westinghouse Company made a lamp on very similar lines.

This concluded plaintiffs' case.

Mr. BOUSFIELD, K.C., in opening for the defence, said that according to his learned friend they were dealing with a specification which had to do with arc lamps the merits of which depended on its utility for flame arc lamps, whereas on the face of Bremer's specification he submitted it had no more to do with flame arc lamps than with any other lamps which had been used for the past 30 years. Electric arc lamps with downwardly-inclined carbons one of which was pivotted for the purpose of striking horizontally, were a perfectly well-known type of lamp at the date of Bremer's specification. It had been clearly demonstrated and admitted that the difficulty which arose from the irregularity of the burning of carbons was one of the earliest defects in the early days of electric lighting. That defect had been remedied. It was also admitted that the defect introduced by the impregnated carbons was precisely the same difficulty which had existed in the older form of carbon and the method of solving it was precisely the same. The one thing it was desirous to obtain was the retractile action, but Bremer's specification did not say a word about that. All Bremer dealt with was the action of gradually approximating carbons one to another as they burnt away. It was doubtful whether Bremer ever had in his mind any idea of dealing with the problem of retractile movement. None the less it was an old problem and had been thoroughly dealt with on every scientific principle. The majority of lamps had been made with the retractile action before Bremer's specification, and unless it was present it was impossible to burn anything but first-class carbons. That being so, there was no difficulty about anyone choosing to apply the principle to a type of lamp with downwardly- pointing electrodes one of which was pivotted. And it was on the ground that Bremer applied the old retractile strike principle to inclined carbon lamps (which was also an old unsolved problem) that plaintiffs now claimed an injunction against defendants' lamp. Bremer in his specification had declared: "My invention lies in the introducing of the idea. There are many types of old lamps which will provide the mechanism, &c., by which my idea might be carried out." Surely his Lordship would not hold that such a contention formed suitable subject-matter for patent rights. As a matter of fact it was in devising a mechanism for the successful application of the principle where the real ingenuity came in. Counsel pointed out that the mechanism for the simultaneous lowering of the carbons, which was the essence of the practical working of the lamp, was so shown in Bremer's specification as to be absolutely useless. He denied that defendants had been guilty of any infringement because, he submitted, that if defendants' lamp differed by so much as one factor from that of the plaintiffs' it was sufficient to avoid infringement. Counsel then dealt at great length with the minute details of the two lamps in question. Defendants' lamp (he said) was a far better lamp than that described in plaintiffs' specification and yet plaintiffs were declaring that if defendants wanted to burn impregnated carbons in their lamps they were not entitled to use a principle which was common knowledge and apply the well-known principle of the retractile strike. In Fig. 1 of plaintiffs' specification they had the very worst arrangement, namely, an armature which went flat down on the face of the magnet. His Lordship was not told that, in order to get the necessary equilibrium, not only in the two positions which every lamp must necessarily have, but also in the intermediate position, which was necessary for floating in order to get a proper adjustment of the spring and the magnet, a great deal of knowledge was required and a good deal of difficulty might be experienced. There was not a trace of how to do that in plaintiffs' specification. Bremer had said that the idea of making it retractile was where his ingenuity came in; it was just to think of it and then the ingenuity of any ordinary workman would be quite sufficient to work it out. He only drew attention to that in order to again emphasise that an invention must have utility. In plaintiffs' specification no useful combination was described. Not only did they have to add from common knowledge to make a complete specification, but they also had to alter what was not there. What became of the utility of a combination which had elements like that? In plaintiffs' lamp the inventor had chosen to limit himself to the electrodes firmly clipped, to simultaneous lowering through the same distance, and to an electrode holder which was pivotted so as to swing under the action of a device acting near the lower end, and he could not, therefore, be permitted to say that those were not essential things. His submission, therefore, was that one of those features being different in defendants' lamp that was sufficient to relieve them from the charge of infringement. Referring to Graham's American specification, counsel said that if a person were to take it with the common knowledge which they all agreed one would have to use in working out a specification, he could not fail to make a lamp which was indistinguishable from plaintiffs'. What a curious position it would be if that were not enough to destroy the validity of a patent. Plaintiffs declared that their invention really consisted of applying a retractile strike to inclined carbons, and they said they had with great ingenuity come to the conclusion that the real way to do that and solve the problem was to have a horizontal strike and make that strike retractile. That was the way in which they were approaching the matter and they were entirely giving the go-by to the fact that the lamp with a horizontal strike and inclined carbons was an old lamp. They had not invented that type of lamp. All they had done was to say: "We want an inclined carbon lamp and we will take the old lamp with horizontal strike and make it retractile." Put in that way it was not an invention. The only way plaintiffs could make it an invention was by saying: "There were various alternatives before us and it would have been quite easy for any one to go wrong when he conceived the idea of utilising the retractile strike in inclined carbon lamps. We have saved him the trouble of going wrong and have pointed out how he can go right by means of a horizontal strike, and so on. He (Counsel) submitted, however, that it would not have been so easy to go wrong. Seeing that the majority of such lamps had got a horizontal strike and that it had got to be made retractile, to do so in any other way than that suggested in plaintiffs' specification would have been going out of one's way to accomplish it. In order to entitle plaintiffs to get any monopoly of the idea of applying the retractile strike or the retractile action to the horizontal strike in inclined carbons they must have invented, at all events, one practicable way of carrying out the idea. It was clear in that case that plaintiffs had not disclosed that, and the mere fact that he does it in the claim and amending phrase did not necessarily make it a good invention.

Prof. JOHN D. CORMACK said that in 1902, the date of the Bremer specification, the problem of the retractile strike in lamps with vertical carbons had been completely solved. It was not accurate to say that in 1902 lamps with downwardly-inclined carbons were unknown; there were few inclined carbon lamps. They had not come into extensive use, but they were known. Flame arc lighting was quite well known in 1902. The whole subject was worked out in 1880 with regard to the effect of different chemicals on the carbons. So far as a lamp with downwardly inclined carbons was concerned the problem of obtaining a retractile strike was the same problem as in the case of a lamp with vertical carbons. The solution in Bremer's specification was the same electrically, but mechanically it was different from that for vertical carbon lamps. The principle of solution was the same. It was quite possible to have a retractile strike without floating. Floating was not specifically mentioned in Bremer's specification, and at first reading his own idea was that it was not intended to deal with floating at all. It was quite clear that it did deal with the horizontal swing of the carbon before downward feed. If floating were required the mechanism shown in Fig. 1 of the specification was of the very worst type with the direct approach of the armature to the magnet, and in Figs. 2 and 3 the mechanism was of the floating type so far as solenoid is applied, but inasmuch as the iron checks are placed on the solenoid that diminishes the floating effect, making it more like a magnet with a direct approach. It was evident that there was no mention of a flame arc lamp throughout Bremer's specification. Reading the specification as an engineer, he saw no reason to suppose that Bremer was especially contemplating flame arc lamps. The construction was equally applicable to an ordinary lamp as to a flame arc lamp. On page 2 the mechanism described in Bremer's specification appeared to make the carbons descend simultaneously, but in practice they did not do it very well. That was due to the see-saw action owing to friction. Witness considered that plaintiffs' patent was for an arc lamp having an arrangement of a horizontal swinging movement taking place before the downward feed. That was, in fact, a broad claim for all lamps of that description. The natural way of making the strike retractile with downwardly-pointing carbons was to make it in the direction of the arc. A man setting out the problem might try and make the strike longitudinal, but the natural way was to make it horizontal. The purpose of the retractile strike in those arc lamps was the same, in the first instance to form the arc, to bring the carbons together and separate them to the required distance. The purpose of making it retractile was to overcome irregularities in the carbons. The flame arc carbons were no more irregular than the carbons which used to obtain in the early days. Bremer pivotted the electrode holder, which electrode holder was one sliding downwards as the carbons fed downwards, but in defendants' lamp that device was absent. The frame and guides moved and not the carbon holder. If one took Bremer's specification as a whole, reading it and having the drawings, he thought that it required to be altered in a great many particulars before it could have any commercial success. A commercial lamp was certainly not described in plaintiffs' specification. The use of a dash-pot was simply the application of what was common knowledge to the means to overcome pumping, and was common knowledge at the date of Bremer's specification. Graham's specification was in most respects simi

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Bremer's. In Graham's lamp, which was prior to Bremer's, a floating action was obtained—indeed it would be difficult to prevent Graham's lamp floating. In regard to Crosby's specification witness described the working of a model in detail with a view of showing that the action was much the same in principle as that of plaintiffs' lamp. Wright's specification showed (he said) a very satisfactory device for floating. It was very sensitive, but the downward feed was bad. That arose from the method of adjusting the clutches. Bremer's specification in regard to the adjustment of the clutches was also bad; he had tested it and found that it was so in actual working. So far as floating in arc lamps was concerned Bremer's specification did not make any advance on the common knowledge obtaining in 1902. So far as sensitiveness or the means by which floating was obtained the method generally, as shown in Bremer's specification, was not so good as that in Graham's.

Mr. Justice SWINFEN EADY: Do you say that there is no advance by Bremer in common knowledge in any respect?—Quite so, not in any respect.

In cross-examination by Mr. WALTER, K.C., he said his evidence was generally with the evidence he gave at the last trial in regard to that specification. He admitted that the Graham and Crosby specifications had never been put on the markets. He could not say that he remembered any other case of inclined carbons at the time of Bremer's specification in which there was any suggestion of adjustment and movement of the armature as provided in plaintiffs' patent. Reading plaintiffs' specification, he said that an electrical engineer reading it through would arrive at the conclusion that a floating action was intended. An electrical engineer with a considerable amount of ingenuity could make a lamp from Bremer's specification of commercial value. There was nothing specifically mentioned in Graham's specification about floating, but solenoids as equivalent to magnets were mentioned and that implied a floating action. He agreed that it would be difficult to make a commercial lamp from Wright's specification. He did not agree that flame arc lamps were contemplated in Bremer's specification. There was no need, there to call attention to them. An electrical engineer with considerable knowledge might endeavour to get floating because it was desirable to get a floating action. There was nothing about flame arc lamps in Bremer's specification. He had not seen any of his work until this litigation. He should be surprised to hear that he was the man who invented flame arc carbons. He certainly did not know it. He admitted it was true that defendants had got every single element in plaintiffs' total combination; and all they had done was, instead of swinging the carbons at a certain point, they swung the rods upon which the carbons were supported.

In re-examination WITNESS said that at the date of Bremer's specification there was a known type of inclined carbon lamps, in which one carbon was pivotted so as to give a *horizontal* strike. Applying common knowledge at that day he would have no difficulty in knowing what he had to do in order to make the strike retractile.

Prof. S. P. THOMPSON, Mr. ANDREW FORBES and Mr. GEO. MILLS were subsequently called for the defence.

After counsel for the parties had addressed the Court, his Lordship reserved judgment.

Frost v. Kotyra and Another.

The action, which was brought by Mr. Tom Frost against Mr. Max Kotyra and the Count de St. Euilhem for damages for breach of contract, came before a jury at the Middlesex Sheriff's Court on Tuesday for assessment of damages. Defendants were neither present nor represented.

Mr. Gassor, for plaintiff, said Mr. Kotyra was the inventor of an improved machine called the Kotyra transmitter and perforator, an improvement on the Wheatstone instrument in use by the Post Office and the various cable companies for telegraphic purposes. The invention would, said counsel, reduce the work of telegraphic operators to a minimum. The Count de St. Euilhem was associated with Mr. Kotyra, and they proposed to start a company with a capital of £100,000, of which they were to receive £90,000 as the purchase price. In 1904 they were introduced to Mr. Frost, and he introduced the machine to the notice of many influential people, and gave practically six years' work, counsel said, to their business. The terms were that plaintiff was to have an interest of one-third in any syndicate or company that might be formed. At the end of six years Mr. Kotyra informed plaintiff that their plans were changed. They had found a wealthy partner and did not propose to proceed with the formation of a company, and they offered him £200 or £300 for his services. Plaintiff protested, and later the offer was increased to £500, but that was also declined. Plaintiff said the machine had now been installed in the G.P.O. He had made many journeys in connection with the business and had to pay all his own out-of-pocket expenses. He had never received a penny for what he had done or expended.

The jury awarded plaintiff £2,000 damages and costs.

In re Lodge's Patent.

On Friday last Mr. Justice Parker delivered his reserved judgment in the petition of Sir Oliver J. Lodge, F.R.S., and the other owners of Patent No. 11,575 of 1897, for "Improvements in Syntonized Telegraphy without Wires," under sec. 18 of the Patents and Designs Act, 1907, for an extension for a further term of the patent. The facts were reported in THE ELECTRICIAN for April 7.

In giving judgment his Lordship said that in the system of wireless telegraphy protected by the letters patent the subject of this petition full use was made for the first time of the principle of resonance or syntony. The difficulty of utilising that principle had been fully explained by the patentee himself, in 1894, in his well-known lecture before the Royal Institution. Electric oscillations in a good radiator were rapidly damped, and did not, therefore, give rise to such a long series of waves as was required for the purpose; and, on the other hand, a receiver which was a good absorber of wave energy was for that reason unable to accumulate the effect of a series of waves. The patentee solved the problem by a compromise between the radiatory and oscillatory qualities of his transmitter on the one hand, and between the absorbing and accumulating qualities of his receiver on the other. Sir Oliver Lodge was the first to realise what was now beyond dispute, that a certain diminution in the radiatory qualities of the transmitter or the absorbing qualities of the receiver would, so far as efficiency was concerned, be more than compensated by the cumulative action of a series of ether waves, and, further, that, by rendering his receiver responsive only to a train of waves, he could tune out all sending stations which were not working with the same wave length and so secure selectivity. The patentee effected his compromise by the introduction of an induction coil between the two capacity areas of his transmitter and receiver respectively, thus not only diminishing the natural frequency of his circuits but also increasing what had been referred to as their "electric inertia," and in that way enabling the transmitting circuit to create, and the receiving circuit to accumulate, the effect of a series of waves as opposed to one or two waves of great amplitude. In the practical working of this system the coherer was removed from the path of the receiving circuit in which it would hinder the accumulation of wave energy. The patentee placed it in a derivative circuit, into which there could be an overflow of the energy accumulated in the receiving circuit. Great precision of tuning being required, the patentee provided an adjustable induction coil, or two or more induction coils, which could be switched in or out of circuit as desired, the object being not only to secure precision of tuning between the transmitter and a single receiver, but to enable the operator to adjust the transmitter to various receivers at different receiving stations. The patentee disclosed means of bridging the spark-gap of the transmitter so as to enable it, when disconnected with the charging circuit of the Ruhmkorff coil or other instrument employed, and when connected up to the coherer circuit, to be used as a receiver. The patentee conceived that the oscillations in the transmitter could be adversely affected by its metallic connection with the source of supply. Therefore he provided means of charging the transmitter by impulsive rush without any such metallic connection, and he conceived that the oscillations in the receiver might be adversely affected by its metallic connection with the coherer circuit, and he therefore linked the circuits of the receiver and coherer respectively by means of an ordinary transformer. If the claims of the specification were examined it would be found that the first and second related to the compromise and covered the introduction of inductance coils between the two capacity areas of both transmitter and receiver, enabling the one to create and the other to accumulate the effect of a series of waves. The third, fourth and fifth claims relate to the means employed by the patentee for tuning the transmitter to a single receiver or to different receivers at different receiving stations, and of enabling the same instrument to be used either as a transmitter or receiver. The sixth claim related to the means employed for charging the transmitter by impulsive rush without metallic connection with the source of supply. The seventh claim was for a combination, including two capacity areas of a particular shape, means for tuning them, a coherer circuit completed through one or both of them, and means to enable the capacity areas to be used either as a transmitter or receiver. The eighth claim was for a particular sort of coherer not now in use. The ninth claim related to the linking of the coherer circuit with the receiving circuit through a transformer to avoid metallic connection. The tenth claim was for the particular arrangements at the receiving end which were disclosed by the patentee, and the eleventh claim was for the arrangements and combinations constituting the system disclosed by the patentee as a whole.

In his Lordship's opinion it was beyond dispute that the system of wireless telegraphy disclosed by the patent was one of great merit, and, so far as concerned the utilisation of the principle of resonance and the consequent possibility of securing that selectivity indispensable for practical purposes, constituted a great advance on Marconi's 1896 patent. It was equally certain that the patentee had been inadequately remunerated. There had been various causes contributing to that result. It naturally required time and money to put the system into operation on a commercial scale. Further, at the date of the patent a really satisfactory coherer had yet to be invented, and that was only done after experiments extending over several years. Lastly, the owners of the patent had been seriously embarrassed by the Post Office monopoly, and he understood had not yet been able to obtain the licence necessary for working the system in this country. The case, therefore, was one in which the Court would naturally incline towards granting some extension of the patent, and no one had appeared to oppose such extension. The Solicitor-General, on behalf of the Crown, had, however, pointed out that all systems of wireless telegraphy at present in use involved precise tuning and that such tuning was alone rendered possible by removing the coherer from the path of the receiving circuit, and was usually effected by adjustable inductances; and further, that in most cases means are employed for enabling the same instrument to be used either as transmitter or receiver. He also pointed out that the patentee had never taken any step to prevent that being done, and he suggested that any prolongation of the patent might seriously embarrass the development of wireless tele-

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graphy in this country, more especially as the patentee had no corresponding patent in other countries, with the exception of the United States of America. In his Lordship's opinion these considerations could not be disregarded, and were not entirely met by the offer of the petitioners to grant a licence to anyone who desired a licence on reasonable terms, to be settled by the Board of Trade or some expert appointed by the Board of Trade. With regard to removing the coherer from the circuit of the receiver and placing it in a derivative circuit, the patentee in his evidence laid great stress on that point, but he could not find that there was any separate claim directed to that portion of his system, although there was a separate claim for connecting the circuits of the receiver and coherer through a transformer to avoid metallic connection. He thought it probable that that omission was intentional, and was due to the patentee's experiments with syntonic Leyden jars, referred to in his provisional specification. It was true that those experiments appeared to have been operated by means of the lines of force in the magnetic field and not by ether waves. But in his lecture before the Royal Institution in 1894* the patentee showed the same experiments as illustrative of how the principle of resonance might be utilised in connection with ether waves, except for the fact that, if the circuits were opened out so as to become good radiating or absorbing circuits, there would be no train of waves on which such principle could operate at all. If, however, there was a radiating circuit which would create, and an absorbing circuit which would accumulate, the effect of a train of waves, the removal of the coherer from the path of the receiving circuit would be as necessary as it was in the case of syntonic jars. He doubted whether the adaptation of the device shown in the syntonic jars experiments to open radiating or absorbing circuits could be considered a great invention. With regard to tuning, in the sense of varying the natural frequency of a circuit, it had been long well known that this could be done by varying either the induction or the capacity, or both the capacity and the induction of the circuit. For tuning his syntonic jars the patentee had provided means for varying the induction. Under these circumstances, he could not think that tuning by means of induction coils, switched in or out as desired, or by means of adjustable induction coils, could be considered in itself a great invention. Again, he could not think that there was any great invention in bridging over the spark-gap of a transmitter so that it could be used as a receiver. The essence and merit of the patentee's invention appeared to lie in his conception of the compromise which enabled full use to be made for the first time of the principle of resonance. He had come to the conclusion that it was open to him, on the true construction of sec. 18 of the Act, to extend a patent as to one or more of its claiming clauses without extending it as to all the claiming clauses, and, under all the circumstances, he thought the justice of the case would be satisfied if he ordered the grant to the patentee of a new patent, to extend for seven years from the expiration of the existing patent, and to be confined to claims 1, 2, 6, 7, 9, 10 and 11 of the existing patent, such grant to contain a proviso or condition making it incumbent on the patentee to grant licences to all who desire to make use of the protected invention on such terms as a duly qualified arbitrator, to be nominated by the Board of Trade, shall think fit and reasonable: and he was prepared to make an order to that effect.

Re Langdon-Davies Motor Co. (Ltd.); Cree v. The Company.

On Friday Mr. Justice Neville had before him this debenture holder's action upon a motion for judgment in default of defence. It was stated that the Company in 1905 issued £5,000 debentures. The principal became payable in the event of winding up, and the company had passed extraordinary resolutions for winding up voluntarily. Plaintiff was the holder of 200 £1 debentures. There was no opposition, and his lordship made the usual debenture decree.

Wakefield v, London County Council.

This action brought by Miss F. Wakefield against the County Council for damages for injuries alleged to have been caused by the negligence of the Council's servants, came before Mr. Justice Channell and a special jury on Tuesday. Plaintiff was boarding a tramcar at Streatham, and when she had only one foot on the platform, the conductor, who was on top, gave the signal to start, with the result that she was dragged for some distance. It was alleged that although the bell was rung continuously the driver did not pull up until he reached the next stopping place. After hearing the evidence the jury awarded Miss Wakefield £1,000, and judgment was entered for this amount, with costs.

PARLIAMENTARY INTELLIGENCE.

L.C.C. TRAMWAYS AND DEVELOPMENT BILL.

A Select Committee of the House of Commons has been considering this Bill, under which authority is sought to construct a number of new tramways and to effect various street improvements.

Mr. ERSKINE POLLOCK, K.C., stated that last year the County Council owned 144½ miles of tramway on which they carried nearly 505,000,000 passengers. The proposals of the Bill with regard to reconstruction, extensions and widenings would involve an outlay of £750,000. With reference to the Cricklewood and Marble Arch line negotiations were taking place with the local authorities, and consideration of this portion of the Bill was postponed. Another of the lines mentioned in the Bill was a short one to cost £44,000, and to connect two existing tramways. It was opposed by the Brighton & South Coast Railway Co. on the ground that it would interfere with Forest Hill Station. The Committee, however, sanctioned it, subject to a point raised by the Home Office.

On Tuesday evidence was given in support of the proposed tramway (No. 11) in Lewisham to connect the existing line in Stanstead-road by way of Catford-road with the line at Rushey Green. The Committee decided to approve the line, subject to representations to be made later by the police upon the Home Office report.

Tramway No. 8, a single line in Lambeth, was withdrawn, but the Committee passed tramway No. 9, which proposes a junction with the line in Grove-lane, Camberwell, and passage along Grove-lane and Dog Kennel-hill to a junction with the existing tramway at Grove-vale.

On Wednesday the Committee approved a short junction between the County Council line and the line of the Metropolitan Electric Tramways (Ltd.) in Seven Sisters-road, thus providing a through service between the County Council system and the company's system in Middlesex. A loop line through Blackstock-road and Finsbury Park-road was also authorised.

Corporation of London Bridges Bill.—The preamble of this Bill, which authorises the construction of the proposed St. Paul's Bridge, was found proved by a Committee of the House of Commons on Tuesday, subject to certain protective clauses for interests affected. The Bill also authorises the construction of a new North to South highway to relieve the congestion of traffic in Cheapside, King William-street, &c.

Town Planning and Tramways.—An interesting report has been presented to Birmingham General Purposes Committee by the deputation which visited Germany and Austria in May and June, 1910, for studying town development.

The deputation comprised the Lord Mayor (Ald. Bowater), Councillors Harrison Barrow (chairman of Tramways Committee), Ellaway (chairman of Electric Supply Committee), Nettlefold (chairman of the Boundaries Committee), Mr. A. Baker (general manager of the tramways), Dr. J. Robertson (medical officer of health), and Mr. H. E. Stilgoe (city engineer and surveyor). The report deals with the division of towns into manufacturing and residential districts, the question of communication by road, rail and water, tramways, &c.

In regard to tramways, the members of the deputation state that from what they saw they *feel* convinced that it is unwise to run a tramway into undeveloped districts until they have been properly considered and a town-planning scheme settled, otherwise overcrowding is likely to take place. It would be a considerable advantage to the citizens of Birmingham if, when a district which is likely to develop at a reasonable rate has been town-planned, tramway communication were effected as soon as convenient, even though the tramway might be run at a small loss for a year or two. Much would, however, depend upon the character of the district and its likelihood of development. The deputation were impressed by the method adopted in Berlin and Vienna of making exclusive provision for tramways in new roads through undeveloped districts. The advantage to ordinary vehicular traffic as well as to tramway traffic, of separating those two forms of transit from each other was enormous. Much better speed could be obtained with less noise, collisions between tramcars and other vehicles obviated, and general repairs to the permanent way greatly reduced by reason of the rigid bed and paving being dispensed with. If all new main roads were made with a minimum width of 100 ft. this object could be attained. The width of carriageway required for a double line of 3 ft. 6 in.-gauge tramways, such as are laid in Birmingham and district, is 14 ft. 4 in. In some instances where the tracks were separate tracks the track was screened by trees. If trees were planted in this way on each side of the tramway, thus forming a tramway avenue, much of the objection to tramways would be removed and a charming effect produced.

In Berlin and Vienna the deputation were particularly interested in the arrangements for carrying trams over or under existing railways, and while they appreciate the difficulties presented by the narrowness of some of the main streets in the centre of the city, they feel that the Birmingham tramway system will always be more or less defective until some kind of "through" communication is afforded between one district and another. On the Continent single-deck cars with trailers are everywhere in evidence; indeed, double-deck cars are practically unknown. The system of running single-deck cars with trailers has much to recommend it. Passengers board and alight from the cars in much less time than that occupied with double-deck cars, and single-deck cars are undoubtedly less costly to work. The Board of Trade, however, have until quite recently prohibited the use of trailers in this country, but they have now permitted an experiment in London which, if successful, might induce the Board to permit trailers to be used in other places, particularly if single trailers were drawn behind single-deck cars. They are of opinion that such a system might prove of the greatest possible advantage in connection with tramways constructed in undeveloped districts.

With regard to the trackless trolley system, the uncertainty with regard to operating costs in this country, together with the high charges which must accrue for maintenance, render it impossible to make any recommendations in its favour for any of the outlying districts of Birmingham until more reliable data have been obtained. Trackless trolley cars can never deal with large masses of people like tramways can, and would, therefore, in the opinion of the deputation, be folly to install a trackless trolley system in a district which in two or three years may grow to such an extent as would render the system unequal to the traffic requirements.

* "Signalling Across Space without Wires." Published by "The Electrician" Printing & Publishing Co. (Ltd.).

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COMMERCIAL AND INDUSTRIAL SECTION.

MUNICIPAL, FOREIGN & GENERAL NOTES.

BRITISH NOTES.

Aberdeen.—The Tramways Committee are considering the question of adopting the rail-less trolley system of traction and a deputation will probably visit Leeds in order to report on the experiment which is being made there.

Ashton-under-Lyne.—The Tramways Committee report a net profit of £800 on the past year's working of the tramways.

Aston.—The total income of the electricity department for the year ended March 31 was £32,880, against £30,065 in 1909.

The income includes £4,926 in respect of Erdington, against £4,572 last year. Total expenses were £18,273, against £15,483, and the gross profit £14,607, against £14,582. The net profit was £3,742 against £4,693.

Bantry (co. Cork).—The Town Commissioners have entered into an agreement with Mr. Patrick Nugent for the erection of electricity works and for public lighting.

Bath.—The Electric Light Committee have adopted a recommendation of the city electrical engineer (Mr. F. Teague) to obtain sanction to a loan of £7,500 for purchasing a 450 kw. Diesel engine and electric generator, one 300 k.v.a. motor alternator, fuel storage tank, additions to switchgear, &c.

Bermondsey (London).—The Board of Trade have intimated to the Council that, after carefully considering all the circumstances, they cannot grant the Council a provisional order for the St. Olave district.

Blackburn.—The Corporation are recommended to apply for sanction to a loan of £45,170 for extensions of the electricity undertaking.

Brighton.—The Council have approved a recommendation of the Lighting Committee to pay Mr. Arthur Wright £1,000 in discharge of all claims.

The Committee reported that on April 11, the Chairman (Coun. Campbell), Ald. Carden, Mr. John Christie and the Town Clerk met Mr. Wright and his solicitor for the discussion of the disputed question as to the amount of compensation to which Mr. Wright was entitled under the terms of his agreement with the Corporation dated Sept. 21, 1905. Under the terms of the agreement Mr. Wright was entitled to 5 per cent. per annum upon all profit earned by the undertaking in any year in excess of £5,000, subject to the proviso that in the event of an alteration in the rates charged for the supply of electricity in force at the date of the agreement the years in which such rates were in effect increased or diminished, the £5,000 should be adjusted in accordance with certain average prices in force at the date of the agreement. In 1908 the Corporation adopted a scheme by reason of which, in Mr. Wright's opinion, the provisions of the agreement respecting the adjustment of revenue were brought into operation, in Mr. Wright's opinion, he was entitled to a commission in respect of the two years four months up to the expiration of the agreement on the 29 next, amounting approximately to £2,000. After discussion, it was agreed on both sides that, in order to avoid litigation, the question should be compromised by the payment to Mr. Wright of £1,000 in full settlement of all claims on his part for commission under the agreement.

Burnley.—An inquiry was held on Tuesday into the application of the Corporation for sanction to a loan of £9,023 for extension of the mains of the electricity works and other purposes.

Coronation Illuminations.—£100 is to be spent in illuminating and decorating the *Fulham* (London) Town Hall on the occasion of the Coronation.—Some of *Hull* Corporation's electric tramcars are to be decorated and equipped with coloured electric lamps during the festivities.—*Wigan* Electricity Committee have decided to supply free illuminations on June 22 and 23 free of charge to their consumers.—In addition to the other illuminations on the sea front the Brighton Corporation are recommended to spend £100 on the illumination of the Aquarium at Coronation time.

Derby.—The Council have applied for sanction to a loan of £8,500 for extensions of mains (£5,250), services (£500), motors (£2,000), meters and switchgear (£750).

Dublin.—The adjourned L.G. Board inquiry into the application of the Corporation for permission to borrow £128,129 for extensions of the electricity undertaking was resumed on Tuesday.

The electrical engineer, Mr. Mark Ruddle, supplied particulars of the proposition of the undertaking, and also technical details of the proposed extensions.

The inquiry was adjourned.

Dundee.—On Monday the Electricity Committee decided to accept tenders for a new sub-station at Downfield.

Eccles.—An unopposed inquiry was held on Friday into the application of the Corporation for sanction to borrow £3,783 for extensions of the Cawdor-street electricity works.

Certain streets are to be lighted electrically at an estimated cost of £666.

Edinburgh.—The Electric Lighting Committee again recommend that the surplus of £7,300 on the past year's working of the electricity undertaking be applied in reducing the capital debt.

The chairman of the Electric Lighting Committee (Mr. Stevenson), in moving the adoption of the recommendation, said that in his opinion the principle of subsidising the rates from the revenue of a municipal undertaking was unfair and inequitable, and he also thought that all such surpluses should go towards strengthening the financial position of the undertaking. He reminded them that during seven years they had contributed to the rates no less than £38,867. One of his strongest objections to municipal trading for profit was that it led to municipal extravagance. That principle was dangerous from the point of view that it was fraught with dire consequences to the ratepayers if at some future time the boot was on the other foot, and they were pledged in turn to subsidise some other purpose. When all had been said, there still remained the risk of a new type of plant superseding the old, and there was always the risk of an undertaking of that kind having in a moment thousands of pounds of machinery destroyed.

Mr. RAWSON moved, as an amendment that the surplus be applied to the rates. He would like to ask either of these gentlemen what they would do if they held a great departmental business, and one of these departments did not pay and one of them was profitable? Was it not reasonable that the profits of the successful portion of the business should be devoted to the portion which was not so successful? He maintained that the revenues of the city had a perfect right to be pooled for the benefit of the whole of the ratepayers of the city. He believed they were justified in doing anything up to theft. They were entitled to do any financial juggling they liked to prevent a rise in the rates at such a time as the present.

After an animated debate the amendment was carried by 24 votes to 15.

Electrical Fitters in the Navy.—The annual report of Prof. J. A. Ewing, C.B. (director of Naval Education), states that

It has been decided to establish tentatively for a period not exceeding six years, a scholarship in the subject of electrical engineering, which will be awarded to a specially able and deserving electrical fitter apprentice who has completed his four years' course of study in a dockyard school. The scholarship is tenable at the Royal Naval College, Greenwich, for one year, or at the discretion of the Admiralty for two years. The holder of the scholarship is placed on the establishment as an electrical fitter, and in addition to his pay as such is awarded £40 a year in respect of the scholarship. After the course at Greenwich he returns to a dockyard as supernumerary electrical draughtsman, or he may serve at the Admiralty in this capacity, and after one year's service will be eligible for appointment as first class draughtsman or inspector, or second assistant electrical engineer. Only one scholarship can be held at any one time. The first award was made as from October last to the electrical fitter apprentice who obtained the highest place on the fourth year Dockyard School list in June, 1909.

Electricity in Mining.—At the meeting of the Tronph Mines (Ltd.) last week Mr. C. V. Thomas said the company were adopting the ordinary open cast method (removing the sand) which were practically valueless, and extracting the karang. For that purpose he intended to put up a small electrical plant, which would be increased as the work required.

Fire.—A fire broke out at the generating station of the Hindhead & District Electric Light Co. early on Wednesday morning, and caused an interruption in the supply of current.

Fulham (London).—Application is to be made to the County Council for sanction to borrow £9,500 for extensions of the electricity undertaking, including £5,950 for generating plant, £1,000 for house connections and £2,000 for meters.

Hull.—The Tramways Committee have decided to obtain 24 new tramcars.

The Board of Trade have approved the plans for the extension of the tramway on the Hedon-road to Market-avenue.

Hulton Pit Disaster.—The Executive Committee of the Miners' Federation of Great Britain met on Friday to consider the report of Messrs. Smilie, C. Bunfield and W. Straker on the explosion at the Hulton Colliery, Bolton.

The report is an exhaustive one and states that the character of the electrical plant and appliances were, generally speaking, in the opinion of Prof. M. W. Thornton, of a high class but the controller switch-box could not be so classed. The contacts were made and broken under oil so as to prevent any sparking; but in case of sparking were not flame proof. Had the box been of a flame-proof kind, such as could be obtained (the report continued) there was little doubt the explosion would not have happened. We do not think there was sufficient care taken to be sure that there

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always was sufficient oil in the box or that the men who had to move it forward time after time as the coal face advanced had sufficient knowledge of the necessity of seeing that it was carried and placed level so as to prevent the oil from running out. The men who have to operate and examine electrical appliances such as that ought to be properly qualified electricians. We are also of opinion that in any district of a mine where gas is giving off electrically-driven machinery ought not to be permitted to be used.

Institute of Chemistry.—The pass list of the March April Examinations shows that of 13 candidates who presented themselves for the intermediate examination 9 passed, viz.,

L. E. Campbell, B.Sc., R. B. Croad, A. J. Hale, B.Sc., W. F. Hollely, W. G. Prescott, C. J. Regan, B.Sc., C. B. Roos, B.Sc., H. B. Stevens and A. F. Suggett. Of 19 candidates, who presented themselves for the final examination, 12 passed. In the branch of mineral chemistry: W. O. Andrews, A.R.C.S., C. D. V. Georgi, B.Sc., H. L. Lucking, Ph.D. and O. D. Roberts; in the branch of metallurgical chemistry: Gordon Wells, B.Sc., A.R.S.M.; in the branch of organic chemistry: E. de Barry Barnett, B.Sc., G. E. Pool and G. E. Slim; in the branch of chemistry of food and drugs and of water: S. W. Bridge, A. A. Eldridge, B.Sc., C. H. Hampshire, B.Sc. and H. M. Mason.

Leicester.—An inquiry was held on Tuesday into the application of the Council for sanction to borrow £17,000 for the electricity undertaking.

The Town Clerk (Mr. H. A. PRITCHARD) said that £12,000 was for increasing the capacity of the station to meet the demand for power and for cable extensions, &c. The remaining £5,000 was for two motor generators. The Corporation possessed two generating stations, one alternating and one direct-current. The order authorising them to supply electricity for lighting was managed by the gas department. They erected an a.c. station which had been supplying current for light. Recently, the Corporation decided it would be more economical to have the two stations under one management. They discussed the matter at length, and took the advice of Mr. James Swinburne as to what should be done. He advised the coupling up of the two stations by putting in motor generators to convert the current as occasion might require.

London Tube Railway Facilities.—The Lord Mayor on Wednesday opened the new subway between the Bank stations of the Central London and City & South London Railways.

Maidstone.—As from April 1 the charges for electrical energy for lighting in shops and other business premises will be as under:—

8s. per annum for each 32 watt lamp (or equivalent) and 1d. per unit; or as an alternative: Maximum demand system at 7d. per unit for first hour and 2d. after.

Sanction has been received to a loan of £4,099 for expenditure on mains during the next three years.

Manchester.—On Wednesday the City Council considered a report of the Tramways Committee, recommending that no further concessions be made in regard to workmen's fares.

The general manager (Mr. J. M. McElroy) has investigated the subject fully. In 1909 he estimated the cost of extending the time for the issues of workers' tickets at £20,000 per annum. On further considering the matter, and especially in view of the actual experience gained in Salford, his view is that this estimate is too low, and that it should be increased to at least £25,000 per annum. Salford Corporation some time ago extended the time during which workpeople's tickets are issued up to 8 a.m., and the concession had a disastrous effect on their revenue. As a result of the 12 months' working the income per car-mile fell from 10·44d. to 9·84d., equivalent to a difference of £14,463. 13s. 5d. and the average fare paid per passenger decreased from 1·25d. to 1·24d. Salford, after 12 months' experience, had to withdraw the concession. In previous reports Mr. McElroy pointed out that preferential treatment as regards fares tends to introduce difficulties, and he suggested that the wisest policy to adopt was to reduce the ordinary fares as low as possible—having regard to the financial stability of the undertaking—and to make everybody pay alike.

Manchester Smoke Abatement Exhibition.—A meeting was held in Manchester on Friday last of the supporters of the scheme for the organisation of a smoke abatement exhibition in Manchester in November next.

Ald. FILDES, chairman of Manchester Sanitary Committee, presided, and an explanatory statement was made by Coun. Kendall, hon. secretary of the Manchester & District Smoke Abatement Society, who are organising the exhibition. He said that the Society was formed as the result of a conversation which took place at the successful smoke abatement exhibition at Glasgow. The meeting was well attended by the patrons of the exhibition, amongst whom were the technical heads of the Manchester and Salford Corporations' gas and electricity departments, and several gas and electrical engineers from surrounding towns were also present.

Ald. FILDES spoke at some length on the injurious effects of the murky atmosphere of Manchester upon the inhabitants and said the Gas and Electrical Committees of the Corporation could help greatly by encouraging the use of gas and electricity for many purposes where at the present fuel is used.

A resolution, approving of the proposed exhibition, was carried unanimously and an Advisory Committee was appointed, consisting of the technical heads of the Manchester and Salford gas, electricity and sanitary departments, and also several professional gentlemen. Arrangements have been made with Mr. Walter Cawood, of the City Exhibition Hall, to undertake the management of the exhibition on behalf of the Society. All communications should be addressed to Mr. Cawood, 196, Deansgate, Manchester.

Marylebone (London).—The Electric Supply Committee report that for the year ending March 31, 1912, they estimate their total sales to private consumers at 11,050,000 units.

Sales during the past year show an increase of 10 per cent. over 1909-10. In estimating for the new year they are allowing for an increase of 7 per cent. only, giving a total estimated sale of 11,820,000 to private consumers. During the current year the average price will amount to 3·38d. per unit, and the committee are assuming a similar rate for the new year as to 11,050,000 units and an average of 1d. per unit only for the amount of the additional sales allowed for, thus giving an all-round average of 3·23d. per unit. As the public lighting scheme has now been practically completed the income and expenditure can be estimated closely. With regard to rents, rates and sundries the figures have been revised in view of the new assessment on the undertaking which involves an extra burden of £8,500 per annum. In addition a substantial amount had been allowed for income tax. The total liabilities for rents, rates, taxes, insurance, law, audit, expenses, &c., are estimated at £14,400, an increase of nearly £9,000, and averaging 0·260d. per unit against 0·107d. The committee point out that the sales and publicity department exists to increase the sale of current and not for earning a profit on the sale of apparatus or the carrying out of works for consumers, although it would be unfair to private traders when such works and sales are taken in hand to charge less than recognised market prices. It was estimated that the turnover for sales of apparatus, &c., during the year would amount to £16,000 and the gross profit would be such that it will meet the whole of the general business-getting and business-keeping expenses of the undertaking with the exception of a balance of £1,825. After reducing the capital debt by £40,274, a surplus of £1,018 was anticipated on the year's working.

Nelson.—During the year ended March 31, 920,456 units were sold including 303,581 for lighting, 73,008 for power, 254,900 for the tramways and 251,030 for the light railways. The equivalent of 37,000 8 c.p. lamps and 345 H.P. of motors are connected.

Obstacle to Electrical Enterprise.—On Tuesday evening Mr. G. Paish (of the "Statist" newspaper) read before the Sociological Society a Paper entitled "Savings and the Social Welfare."

In a discussion which followed Mr. CHIOZZA-MONEY said many obstacles were put in the way of the investment of individual savings in home enterprise. What, he asked, was the cause of the slow progress made in the applications of electricity in this country? He thought the answer was that the vested interests which it was feared electricity would displace were working against an advance so essential to the well-being of the community. Gas and kindred interests were in a position to put forward their claims, which were seldom ignored, and he regarded gas as an illuminant which was rapidly becoming obsolete.

Mr. PAISH disagreed on this point and said gas was cheaper in England than in any other part of the world, and, consequently, there was not really the same inducement here to establish electrical enterprise as there was in countries where fuel was expensive and electrical power could be produced very cheaply, especially from water power.

Oldham.—Messrs. Asa Lees & Co. have decided to adopt electric driving in one of their departments, and current will be taken from the Corporation mains. The firm will take about 150 H.P. at present, but ultimately they will require 250 H.P.

Pinner.—The Harrow Electric Light & Power Co. are applying for a provisional order to extend their area of supply to Pinner and other districts and Hendon Rural Council endeavoured to get the Board of Trade to insert a lower maximum price than 8d. per unit in the order. The Board of Trade have intimated that it is not usual to fix a lower price.

Poplar (London).—121, East India Dock-road is to be rented for showroom for the electricity department.

The rate for lighting premises of shopkeepers is to be reduced to £8 per kilowatt installed, and ½d. per unit for current consumed.

Provisional Orders Revocation.—The Board of Trade have revoked the Warmsley Electric Lighting Order, 1903, and the Litherland Electric Lighting Order, 1905, as from April 24.

South Shields.—An inquiry will be held into the application of the Corporation for sanction to borrow £8,960 for extensions of the plant at the electricity works.

Stepney (London).—With regard to the supply of current to consumers on time switches at 1d. per unit the borough electric engineer and manager (Mr. W. C. P. Tapper) has called the attention of his Committee to the fact that in each case a considerable expenditure is incurred in laying service in addition to an annual expenditure of £2 or £3 each to give the supply.

Mr. TAPPER states that these supplies can be given profitably between sunset and 7 p.m. during the winter months, provided the annual bill each consumer is sufficient to cover cost of current and service charges which include interest and sinking fund on the service lines and meters, cost of maintaining same, reading meters and rendering accounts. Taking a number of years this cost works out at slightly over £3 per account per annum. The initial cost of laying a service is about £8 including meters, &c. There are a large number of consumers already on this rate whose annual accounts for current vary from 11s. upwards and applications are coming in for new supplies at the same rate.

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the recommendation of Mr. Tapper it has been decided that restricted supplies are only to be granted in future on condition that consumers undertake to pay a minimum half-yearly bill of £3, but accounts rendered for any other supply of electricity taken by the same consumer on the same premises shall be allowed to form part of this minimum payment.

The Board of Trade have approved the proposed new agreement with Poplar as to supply of electricity, with some small alterations.

Stoke-on-Trent.—At last week's meeting of the Council Ald. Geen made an unsuccessful attempt to get the resolution passed on the 9th March relating to the erection of a new three-phase station rescinded.

Torquay.—A scheme for the electric lighting of Princess-gardens and Pier at an estimated cost of £2,000 has been prepared by the borough electrical engineer, Mr. C. W. Salt.

Wandsworth (London.)—The Borough Council are negotiating with London County Council as to the construction of tramways from Putney Bridge to High-street, Wandsworth.

Wireless Telegraph Notes.—The "Telegraph and Telephone Age" of America states that a rough calculation recently made as to the saving of wireless telegraphic assistance at sea shows that over 3,000 lives have been saved by the help rendered through this means of intercommunication.

Steps are said to have been taken for the establishment of wireless telegraphic communication between Teheran and Bushire, thence to two other places on the Persian Gulf, and finally to Kurrachee and Bombay.

It is announced that as the results of experiments which have been conducted for some time past at Marseilles it is likely that a powerful wireless telegraph station will be established at that port.

With reference to the proposal before the Norwegian Storthing the Bill making a grant of £16,500 for the erection and equipment of two wireless telegraph stations (at Hammerfest and on Spitzbergen respectively) has been adopted.

Worcester.—The City Council have agreed to supply electricity to Messrs. Heenan & Froude.

The firm will take annually for three years, and then subject to 12 months' notice, electrical energy of the minimum value of £500 per annum.

Sanction to a loan of £10,000 has been applied for by the Council in order to carry out extensions of the plant and mains.

Worthing.—Mr. J. F. C. Snell has presented his report on the proposals to extend the plant at the electricity works.

It was proposed to install a 1,260 ampere-hour battery, two 125 kw. Diesel generator sets and one 300 kw. steam turbo-generator. In his report Mr. Snell states that the output of electricity for power appears to be increasing; the figure for public lighting has been decreasing, but has now probably reached its minimum limit. Mr. Snell estimates that by next year the number of consumers will have increased to 921, and by 1915 to 1,190. The present lighting and power units sold for the past year total 400,440, and it is estimated that for 1915 the total will be 531,100. No increase is anticipated in the public lighting units. Mr. Snell considers that the present engineer has been, and is, using skill and evident painstaking attention to detail in the economical administration of the plant under the engineering circumstances. The load factor is low, and it will probably always be low, since Worthing is mainly a residential borough. The cost of coal is high, the steam plant small, and the capital charges (amounting now to no less than £119 per kilowatt installed.) Each of these items is the engineer responsible. He considers that the department has done very well, in spite of difficulties, and that the Electric Light Committee has acted wisely in the past in forming a reserve fund in addition to the sinking fund for repayment of loans. The report details the advantages of the three alternative plant extension proposals. In summing up, Mr. Snell recommends that two 125 kw. Diesel sets be obtained at an approximate cost of £4,400, and that the present battery plates be replaced by larger plates so as to increase the capacity hours from 600 to approximately 1,000 at an approximate cost of £1,000 to be paid for out of reserve.

The Committee have approved Mr. Snell's proposals and application is to be made for sanction to a loan of £4,960 for carrying out same.

Wrexham.—The L.G. Board inquiry, announced to take place on Tuesday, has been postponed owing to representations made to the Board by Messrs. Evan Morris & Co., solicitors, who are conducting opposition on behalf of the Wrexham Gas Co. and the Wrexham and East Denbighshire Water Co.

Dinner.—The seventh annual dinner of the Faraday House Old Students' Association took place on April 26th the president (Mr. H. H. Cunynghame) in the chair. Amongst the guests present were Mr. S. Z. de Ferranti, Prof. J. D. Cormack, Mr. W. Duddell, F.R.S., Mr. J. S. Highfield and Mr. Arthur Wright.

Mr. de Ferranti, proposing the toast of "Faraday House and its Old Students," referred to the good work which had been done by the Hammersmith and its successor—Faraday House.

Mr. Rogers Hammond replied, and reminded the company that although it was only the seventh annual dinner of the Old Students' Association it was actually the 26th annual dinner of the old students.

Mr. D. Watson proposed the toast of "The Chairman," and "The Visitors" was proposed by Mr. A. F. Berry, being replied to by Mr. Duddell, F.R.S.

COLONIAL AND FOREIGN NOTES.

Argentina.—The "Review of the River Plate" reports—

The destruction of the third customs warehouse (at Buenos Ayres) by fire within three months has led the Government to place the matter in the hands of the police, and our contemporary remarks "it would have been better if this had been done when the first fire occurred, instead of letting the matter drop by coming to the conclusion that the fire must have been produced by the electric installation." The insurance companies have, however, submitted recommendations as to fire extinguishing appliances, the use of steel ducts for electric wires, &c.

The Minister of Public Works has declared as lapsed the concession granted to Quesada & Co. for a tramway from the Federal Capital to San Justo, San Martin, Moron, Merlo, Moreno, Gral. Rodriguez and Lujan.

Australasia.—The "Australian Mining Standard" states that Mr. R. P. Wilson, who is associated with Mr. C. H. Merz in regard to Mr. Merz's scheme for the electrification of the Melbourne suburban railways, recently gave evidence before the (Melbourne) Metropolitan Traffic Commission.

Mr. Wilson said Mr. Merz had prepared his report in the belief that the public and Parliament had already decided that electrification was necessary; he had, therefore, not attempted to prove the desirability of that change, but had simply devised a scheme for carrying it out. With regard to Sir Thomas Tait's criticism, there would be no difficulty in running trains with one minute headway. In the London underground system they ran trains with only 40 seconds headway. It was less dangerous under electric traction, because the block sections could be so arranged that the block intervening between one train and the immediately succeeding train could be isolated, so that if the succeeding train did enter the block, it could not proceed. Its power would be cut off. While the steam express saved four minutes, the electric express saved 11 minutes. That was the only fair basis on which a comparison could be made. No doubt, quadruplication of lines would, from some points of view, give greater benefits than electrification. But it was necessary to consider what must be paid for it, and what would be lost. The chief difference between steam and electricity was that, with electricity, for a smaller capital expenditure, you could deal with very much larger traffic at a very much reduced cost. Mr. Merz's report indicated an initial loss but an eventual profit from the proposed system. The Commissioners had said that electrification would not be justified until the increase in traffic compared with 1906 was 33 per cent. That state of affairs had actually arisen. Sir Thomas Tait expressed the opinion that the estimated cost of cleaning and repairing the electrical coaches was at least £10,000 too low, but it was an approximation, based on the actual cost of such work elsewhere, with 10 per cent. added in view of Australian conditions. He knew of nothing about alternating current that made it of more advantage than direct current. The electrical equipment and plant needed for Melbourne railways would cost for the alternating current system nearly double what it would cost for the direct current and 30 per cent. more weight would be required to give the same efficiency. He would not say that the scheme proposed by Mr. Merz would admit of indefinite, but only of considerable, expansion.

The Commonwealth Postmaster-General, Mr. Thomas, has authorised the installation at Sydney G.P.O. of the Automatic Telephone Co.'s apparatus to serve 100 subscribers, with the object of testing the system.

Kalgoorlie (W. Australia) Council have lodged a protest against the new regulations of the Fire Underwriters' Association with regard to electrical installations. Coun. Boileau, who introduced the subject to the Council, said five months after he had fitted his premises, in full compliance with the Council's regulations, he was told he would have to make alterations. In a similar way the Palace Hotel would be put to an expense of about £200. The Council's electrical engineer, Mr. D. Curle Smith, said the insurance companies had now made general rules to be accepted everywhere, but there were certain portions of them which he did not think necessary for that place. It was decided to ask the insurance companies' electrical expert to discuss the subject with the Electric Light Committee and the electrical engineer.

Mortlake (Victoria) Butter Factory Co. have adopted the scheme of F. A. McCarty & Co., Melbourne, for installing an electric lighting plant for the town at an estimated cost of £2,500. It was also decided to invite tenders for a 66 H.P. suction gas engine. Metal filament lamps are to be used and the charges will be 7d. per unit for lighting and 3d. for power. The same firm have also received instructions to provide lighting and power plant for the Nagambie Shire Council at a cost of £2,600. The charges will be the same as at Mortlake. Messrs. McCarty & Co. are also to report on the feasibility of installing an electric light and power plant for Shepparton Shire Council.

Mr. P. J. Pringle, general manager of the Electric Supply Co., of Victoria (the owners of the Bendigo electric tramways), has referred to the directors the question of extending the tramways to White Hills. Mr. Pringle has also had a conference with representatives of Sebastopol Council, with regard to a proposal that the tramways should be extended to that town from Ballarat.

The concession transferred by the Complex Ores Co. to Hydro-Electric & Metals (Ltd.) includes the right to take water from the Ouse and Shannon rivers and to conserve the water of the Great Lake, which is about the centre of Tasmania, for the generation of electrical energy. Contracts have been entered into for the street lighting of Hobart, Newton, Queenborough and Glenarchy. The estimated cost of this electricity scheme and the equipment of the metallurgical works, which the company are bound to erect, is £220,000. It is proposed to instal 5,000 H.P. plant at the outset and to increase it subsequently to 20,000 H.P. and to erect works capable of accommodating plant of 100,000 H.P. in all.

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Russia.—Kharkov Municipality have applied to the Government for permission to borrow up to two million roubles (£211,112) for tramways, and 500,000 roubles (£52,778) for extension of electricity works. Tamboy Council have applied for a loan of 940,000 roubles (£99,223) for electric lighting, water supply and other works.

Turin Exhibition.—The King of Italy inaugurated this Exhibition on the 29th *ult.*

The principal British exhibitors in the electrical and engineering and scientific instrument sections include Sir W. G. Armstrong, Whitworth & Co. (Ltd.), Alley & Maclellan, Edgar Allen & Co., J. Bourne & Sons, British Ackley Brake Co., Brunner, Mond & Co., Campbell Gas Engine Co., Cambridge Scientific Instrument Co., Castner-Kellner Alkali Co., Clayton & Shuttleworth, F. Darton & Co., Crypto Electrical Co., Doulton & Co., J. J. Griffin & Sons, Holden & Brook, A. Herbert (Ltd.), R. Hornsby & Sons, Hulse & Co., Johnson, Matthey & Co., Marshall, Sons & Co., J. & H. McLaren, Merryweather & Sons, Morgan Crucible Co., Muirhead & Co., Nalder Bros. & Thompson, National Gas Engine Co., Ozonair Limited, R. W. Paul, Pulsometer Engineering Co., Reason Mfg. Co., Ruston, Proctor & Co., Simms Magneto Co., Silica Synd., W. F. Stanley & Co., Synchronome Co., E. R. & F. Turner, Underfeed Stoker Co., Thermal Synd., Venner & Co., &c.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Tenders are invited (up to June 14) for supply of cable, ironwork, c.i. pipes, iron or steel poles, phosphor bronze wire, &c., to the Postmaster-General's Department, QUEENSLAND; and (up to June 27) for supply of 1,400 protectors for use on main distributing frame at magneto exchanges to the Postmaster-General's Department, VICTORIA. Tender forms and specifications at the Commonwealth Office, 72, Victoria-street, London, S.W. See also advertisements.

Tenders are wanted by May 19 for supply of six 60 kw. single-phase transformers, and by May 26 for 1,024,000 arc lamp carbons and for 6,000 metal filament incandescent lamps for the City of MELBOURNE electricity department. Tender forms, specification, conditions of tender, &c., from the Agents for the City Council, Messrs. McIlwraith, McEacharn & Co. Proprietary (Ltd.), Billiter-square Buildings, London, E.C.

Tenders will be received at the Town Clerk's office, AUCKLAND, N.Z., until 4 p.m. of Thursday, June 15, for supply and erection of machinery for the new power station, including water-tube boilers, feed pumps, economisers, conveyor and steam pipes, and induced draught plant; d.c. steam generators, condensers, auxiliary machinery, engine-room crane, circulating pumps and pipes and switchboard. Specifications and drawings at the offices of the High Commissioner for the Dominion of New Zealand, 13, Victoria-street, London, S.W.

Tenders are invited up to May 30 for the supply of one portable petrol-driven desiccating plant to the Postmaster-General's department in Victoria, and up to May 31 for the supply of 7,000 insulators and wire and line material to the Postmaster-General's department in SOUTH AUSTRALIA. Tender forms and specifications from the Commonwealth Office, 72, Victoria-street, London, S.W.

Tenders will be received at the office of the Receiver-General and Director of Contracts, Valetta, MALTA, up to 11 a.m. of Thursday, May 11 for the supply of arc lamp carbons. British tenderers not having representatives in Malta must make a deposit of £10 in the office of the Crown Agents for the Colonies. Specification, &c., at the office of the Receiver-General and Director of Contracts, or from the Crown Agents for the Colonies, Whitehall Gardens, London, S.W.

Tenders are invited up to June 7 for the supply of 2 nauts single-core submarine cable to the Postmaster-General's Department in NEW SOUTH WALES. Tender forms and specification from the Commonwealth Offices, 72, Victoria-street, London, S.W. See also an advertisement.

The COMMISSIONERS OF H.M. WORKS AND PUBLIC BUILDINGS invite tenders (from manufacturers) for supply of opal lamp shades during three years, and also tenders (from manufacturers) for supply of electric gas torches during one year. Tenders by 11 a.m. on Wednesday, May 10, to the Secretary, H.M. Office of Works, &c., Storey's Gate, S.W

SOUTH SHIELDS Corporation want tenders by May 24 for supply and erection of 1,500 kw. high-pressure steam turbine (with surface condenser and pumps) coupled to 1,000 kw. d.c. generator (with switch panel, &c.) and 1,100 kw. a.c. generator (with switch panel, &c.). Specification, &c., from the Borough Electrical Engineer.

ILFORD Council require tenders by noon May 9 for the supply of distributing switchboard, feeder cable and stoneware conduits. Specifications, &c., from Mr. A. H. Shaw, Electricity Works, Ley-street, Ilford.

ST. PANCRAS (London) Borough Council invite tenders for three-phase h.t. cable and for stoneware ducts. Tenders to the town clerk Mr. C. H. F. Barrett, Town Hall, Pancras-road, N.W., by noon, May 15.

BARKING Council require tenders by 7 p.m. May 10 for extension of electricity works. Plans, &c., at the office of the Surveyor on and after May 1.

HULL Corporation require tenders by noon May 24 for extensions of Sculcoates-lane generating station and New George-street sub-station.

OLDHAM Surveyor's and Tramways Committee require tenders by May 10 for construction of about 270 yds. of tramways. Forms of tender, &c., from the Borough Surveyor.

FRANKFORT-ON-MAIN Corporation require tenders by May 20 for two 7,500 kw. steam generators with condensers.

The Town Clerk, WANGANUI, N.Z., will receive tenders until July 12 for supply of generating plant, gas producing plant and battery and booster for the Corporation tramways. Specification can be seen at 73, Basinghall-street, London, E.C. Local representation is necessary.

Tenders are invited up to July 25 for the supply of 12 sections of a branching multiple magneto lamp signalling switchboard, &c., or one automatic or semi-automatic switchboard, &c.; and up to June 14 for supply of a branching multiple magneto lamp signalling switchboard at Ballarat, for the Postmaster-General's Department in VICTORIA; and up to June 14 for supply of a c.b. multiple switchboard to the Postmaster-General's Department, SOUTH AUSTRALIA. Tender forms, &c., from 72, Victoria-street London, S.W.

The Prussian State Railways Department, PADERBORN, Germany, will receive tenders until May 10 for supply of an electric lift, crane, &c.

RUSTCHUK (Bulgaria) Municipal Council require tenders by May 24 for the erection and equipment of electric light and power works. Upset price £26,000.

The Ministry of Public Works, Constantinople, will receive tenders until July 15 for the construction of electric tramways and for electricity supply in the town of ALEPPO. Specification from the Ministry of Public Works on payment of 9s. Local representation is practically indispensable.

NAPLES Municipal Authorities require tenders by July 9 for supply and installation of the following plant in connection with the supply of electric power to Naples from the river Volturno:

1. Tubing and accessories for harnessing the water at rate of 7,000 litres a second and for the fall of 190 meters; upset price 702,900 lire (£28,116.)

2. Machinery and apparatus for hydro-electric power station, transmission line (about 57 miles), and transforming station; upset price 1,000,000 lir. (£40,000.)

Tenders to Presidente del Consiglio Generale dell' Ente Autonomo Volturno, Naples.

Manufacturers who are prepared to supply 600 km. (372 miles) copper wire 8 mm. dia. are invited to communicate with the Direzione dell' Ente Autonomo Volturno, Naples, who after two months from April 10 will send invitations to tender to firms whom they consider suitable.

Conditions of tender, &c. (in Italian) may be seen at 73, Basinghall-street, London, E.C.

TENDERS RECEIVED AND ACCEPTED.

Salford Corporation have accepted the following tenders for annual supplies to the tramways department:—

W. T. Henley's Telegraph Works Co., rubber strip 8s. 6d. per lb., black tarred tape, 9d. per lb.; India Rubber, Gutta Percha & Telegraph Works Co., plain white tape 2s. per lb.; Electrical Co., d.c. meters, 100, 200 and 300 ampere sizes, schedule prices; Chamberlain & Hookham, meters, 1½ to 50 amperes sizes (part contract), value of contract £230; Ferranti Limited, meters, 1½ to 50 ampere sizes (part contract), £210, a.c. meters, £290; Brush Co., carbon filament lamps, schedule prices; L. Andrew & Co., mica sheets, 5s. per lb., short rubber gloves, 7s. per pair; North British Rubber Co., rubber overshoes, 1s. 10½d. per pair.

Salford Council have accepted the estimate of the manager of the tramways (Mr. Holford) for providing and fixing the wires, &c., in connection with the new fire alarm system at £499. 1s. 7d.

£25 per annum is to be paid to the Tramways Committee for permission to attach the wires to the tramways standards, and £15 per annum for maintaining the lines and fittings.

Salford Council have accepted the tender of B. Longfield-Beasley (at £2,131. 10s.) to furnish and install the Gamewell system of fire alarm and police telegraphs in the borough.

Poplar (London) Council received three tenders for two 250 kw. converters, with auxiliary plant and switchgear for Orchard-place sub-station:—

British Westinghouse Co. (rotary converters) (*accepted*)	£1,830
British Thomson-Houston Co. (rotary converters)	£1,839
Bruce Peebles & Co. (motor converters)	£2,110

Leyton Council have accepted the tender of Bertram Thomas at £98. 5s. for a 600 kw. traction panel and at £116. 10s. for a lighting panel.

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Walthamstow Council have accepted the following tenders :—

A. Wright & Co., self-recording pressure gauge; W. T. Henley's Telegraph Works Co., annual supply of cable; W. E. Moore & Co., steam winch (£30); British Westinghouse Electric & Mfg. Co., new cylinder for gas engine, £82. 10s.

The tender of W. T. Glover & Co. has been accepted by Accrington Electricity Committee for supplying and laying an e.h.t. main to the Baxenden boundary at £4,333, and also for the annual supply of cables. The committee have let the contract for high-tension sub-station switchgear to the British Thomson-Houston Co. at £428.

Hertfordshire County Council have accepted the tender of Dick, Kerr & Co. to construct a tramway from Callow Land to the car station site in London-road, at £31,478. 9s. 3d.

Rugby Council have accepted the following tenders :—J. Young, transformer chambers and cable laying; Thos. Wragg & Sons, trenches and covers; Dussek Bitumen Co., bitumen.

Southampton Council have accepted the tender of McWhirter, Roberts & Co. for the annual supply of electric lamps to the works department.

Newport (Mon.) Electricity and Tramways Department received 22 tenders for supply of lubricating oils, and these have been referred to the electrical engineer for samples to be tested.

Worthing Town Council have accepted the tender of the Hart Accumulator Co., at £864. 11s., for replating the existing storage battery, and for maintaining same for 10 years for £715. 10s.

Torquay Corporation have placed an order with the British Thomson-Houston Co. for supply and erection of a turbo-generator, condensing plant, &c., at £4,601.

C. H. Walker & Co. (Ltd.) (of London, Rio de Janeiro and Buenos Ayres) have secured the contract for extension works at the Port of Buenos Ayres, at a total cost of about £5,500,000.

The following tenders have been accepted by Derby Corporation : British Thomson-Houston Co., inverted rotary converters; British Insulated & Helsby Cables, e.h.t. cables; Ferranti, Ltd., e.h.t. switchgear.

Stoke Corporation have placed on order with Siemens Bros. Dynamo Works for two induction motors for the Hanley works, at £285.

Heston and Isleworth Council have accepted the tender of Drake & Gorham for tantalum lamps at £7. 0s. 5d. per 100.

Bridlington Council have accepted the tender of Waring & Gillow Ltd. for lamps, &c., for electrical fountains, at £14. 15s.

Diesel Engines.—The Diesel Engine Co. states that in addition to the list of orders published in February (totalling between 3,000 and 4,000 H.P.), they have recently received a number of orders, including:—

Letchworth Garden City (repeat), one engine of 420 B.H.P.; Leek Urban, one engine of 330 B.H.P.; Reigate Council, two engines of 150 B.H.P. each; Chilian Government (per General Electric Co.), two engines of 250 B.H.P. and two engines of 200 B.H.P. each; Balfour, Williamson & Co. for Chili, one engine of 320 B.H.P.; Chichester Elec. Supply Co. (per Johnson & Phillips), (1st extension), one engine of 200 B.H.P.; G.N. Railway, one engine of 340 B.H.P.; Dick, Kerr & Co., one 525 B.H.P., one 225 B.H.P. and two 60 B.H.P. engines; Leatherhead & District Elec. Supply Co. (repeat), one engine of 60 B.H.P., and orders for about 30 other engines for London, Ireland, India, Ceylon, Brazil, &c., of about 1,950 B.H.P.

BUSINESS NOTICES.

The Newcastle-on-Tyne address of the St. Helens Cable & Rubber Co. has been removed to 8, Charlotte-square, Cross street.

Plant for Sale.—Elektron Limited (in liq.), Gothenburg, offer for sale triple expansion engines, c.c. dynamos, &c. Further particulars are given in advertisements.

BANKRUPTCIES, LIQUIDATIONS, &c.

A meeting of creditors of F. A. Glover & Co. (Ltd.) (in voluntary liquidation) was recently held.

Mr. W. B. Peet, one of the liquidators presented a statement of affairs, which disclosed liabilities to unsecured creditors £3,166 and a bank overdraft £317. There were also debentures for £5,888. The preferential claims amounted to £385 and the assets were returned at £10,013. Mr. Peet gave particulars of the history of the company, and pointed out that on forced realisation took place the assets might not be more than sufficient to pay the claims of the debenture holders. After discussion, a committee of five of the principal creditors was formed to confer with the debenture holders, with a view to forming a scheme in the interests of all concerned.

Wm. Hy. Illingworth (trading as the Yorkshire Metal Filament Lamp Co.), 30, Pellon-lane, Halifax, has been adjudicated bankrupt. First meeting of creditors May 10; public examination May 19 at County Court, Prescott-street, Halifax.

First meeting of creditors and contributories of the British Tungsten Lamp Co. (Ltd.), Huyton Quarry, near Liverpool, will be held on May 12 at 35, Victoria-street, Liverpool.

The Electric Fog Signal Co. (Ltd.) is being wound up voluntarily. Mr. A. T. Spear, 44, Myddleton-road, Uxbridge, is liquidator.

A first meeting of creditors of the Rhondda Tramways Construction Synd. (Ltd.) will be held at Queen Anne's-chambers, Westminster, S.W., on May 8. Claims to Messrs. S. B. Schlesinger and W. B. Cownie, at the same address by same date.

Mr. H. B. Clark, 3 and 5, Crown-court, Old Broad-street, E.C., and Mr. G. E. Corfield, Balfour House, Finsbury-pavement, E.C., London, have been appointed joint liquidators in the voluntary winding up of Arc Lamps (Ltd.). A meeting of the creditors of this company will be held at Balfour House, Finsbury-pavement, London, E.C., on Tuesday next at 12 noon.

The North Western Electricity & Power Gas Synd. (Ltd.) is being wound up voluntarily. Mr. C. E. Bullock (Messrs. Bourner, Bullock & Co.), Albion-street, Hanley, is liquidator, and will receive claims until May 30.

COMPANIES' MEETINGS AND REPORTS.

AUCKLAND ELECTRIC TRAMWAYS CO. (LTD.)—The total revenue for the six months ended June 30 was £96,959. 0s. 10d. Traffic receipts (£95,792. 13s. 8d.) showed a satisfactory increase of £6,463. 16s. 3d. over the previous six months. Deducting expenses chargeable to revenue (including £8,199. 12s. 1d. for debenture interest, the rental and percentage interest of profits payable to Auckland Council, £2,263. 1s. 5d., and £7,500 for depreciation) the surplus was £20,528. 11s. 4d., making, with £3,544. 8s. 9d. brought forward, £24,073. The directors recommend that £6,000 be placed to reserve; preference dividend (already paid) absorbed £1,500 and a dividend on the ordinary shares for the half-year at the rate of 6 per cent. requires £10,500, leaving £6,073. 0s. 1d. to be carried forward. Capital expenditure during the six months amounted to £15,233. 12s. 6d., largely in connection with the extension of the power-house plant and distributing system. An extension of 0·68 mile in the Grey Lynn district was opened for traffic on May 4, and eight further cars (bringing the total to 100) will be available before the end of the year.

BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. (LTD.)—The Chairman (Mr. J. Annan Bryce) at the meeting on Monday stated that the debit balance of £7,319 from 1909 had been transformed into a credit balance of £5,117, a net gain of £12,436. That represented a small proportion of the increased profits of the business during the year, as, in addition to substantial reserves for unforeseen contingencies in respect of contracts in course of completion, nearly £18,000 more than last year had been written off as depreciation. The trading profit was £112,538, compared with £84,156. The percentage of profit to output was somewhat lower than last year owing to lower prices. The directors, however, hoped that with a continuance of the improvement in trade a higher rate of profit might be realised. The works at Trafford Park and their equipment stood in the books at the close of 1909 at £1,706,516, but at the close of 1910, notwithstanding an additional expenditure of £10,898, they stood at £1,687,439, or a reduction of £19,076. In many respects their works were originally designed on too lavish a scale. When the capital was reduced in 1907 large provision was made to meet that, but since then it had been decided to close down the steel foundry, and for the present they had postponed the idea, then entertained, of building large horizontal gas engines. He mentioned that merely to indicate that before they could enter upon a dividend-paying stage some plan would have to be devised for bringing capital cost to a lower figure. Before making any proposals to that end the directors thought it well to await the result of the appeal in the Underground Railways arbitration. If the result of the appeal was to confirm the award, a very serious loss would have to be faced, and that would be the proper occasion for considering what proposals should be made for writing down capital. The contract out of which this trouble had arisen was made at the very beginning of their career, and no responsibility for it attached to the present board or staff. Shares and debentures in other companies (£286,414) were slightly less than before. The main items were their holdings in the Clyde Valley Electrical Power Co., the Traction and Power Securities Co. and the Mersey Railway Co. They had recently sold their debentures in the Mersey Co. at a profit over the price at which they stood on the books. The Clyde Valley Co. had considerably further improved its position within the past year, and there was every indication that before very long it would be in a dividend-paying condition. The Mersey Company showed year by year a steadily-increasing net revenue. The directors continued their endeavours to expand the company's existing lines of manufacture and to add new lines where it seemed that those could be developed advantageously in conjunction with their existing business. The expansion of the business in steam turbines had been particularly satisfactory. They altered the design of their turbines about two years ago, when a licence was acquired for manufacturing under the Rateau patents. They had installed, and were at present installing, large numbers of these machines both at home and abroad for important railways and corporations. The company's position in that important line of business was stronger than it had ever been, and the directors looked forward to continuous development in that direction. The volume of

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business during the current year had, so far, been satisfactory, and there was no appearance of any slackening in trade.

In the course of the discussion which ensued, Mr. H. W. BIRKS referred to the disappointing history of the company, and said that the constant changes on the board were matter for regret. Only one year since the formation of the company had passed without there having been secessions from the board of one kind or another. Those continued changes created a bad impression. He inquired what was the worst which could happen to the company in connection with the arbitration award.

The CHAIRMAN, in reply, said that Mr. Carlton when he came to this country arrived at the conclusion that it would be desirable gradually to alter the character of the directorate by having fewer American and more English directors. Accordingly the American directors had from time to time disappeared from the board. He realised that Americans coming here were at a disadvantage in not understanding the methods of conducting business in this country. With regard to the arbitration, if they lost the case it would involve the company in a sum of £100,000 and about £20,000 for costs.

The motion was agreed to.

CITY OF SANTOS IMPROVEMENTS CO. (LTD.) At the meeting last week Mr. D. M. Fox said the results for 1910 were satisfactory notwithstanding the vexatious delay in the matter of the definite contract with Camara Municipality for the complete electrification of the system of tramways in Santos. They had now signed a contract for 40 years. It was also gratifying to find that the effect of the partial electrification of the tramways (15 miles out of 34 or thereabouts), with the improved and more rapid service, had already resulted in a great impulse being given to the construction of new and more modern houses along the tramway routes. They were able to pay a final dividend of 4½ per cent., making 7 per cent. for the year, leaving £4,746 to be carried forward. The tramways had been worked during the year under abnormal conditions, partly by animal and partly by electric traction. The results of working the electrified system had been most encouraging. The number of passengers carried was 9,150,000, an increase of 770,000. £220,000 was the estimated cost of electrifying the tramways and matters incidental thereto. Mr. Dawbarn (of Messrs. Mordey & Dawbarn, the company's consulting engineers), with an assistant engineer, left for Santos on March 31 to start the works and to come to an understanding on all engineering points with their resident engineer (Mr. H. M. Sayers), under whose immediate superintendence the works would be carried out. In Mr. H. M. Sayers they had an experienced and capable engineer, to whom they entrusted the works with every confidence. He had not been long in the company's service, but he had had considerable experience in executing similar works. It was to be expected that the whole of the work would be completed well within the time stipulated.

CITY OF BIRMINGHAM TRAMWAYS CO. (LTD.)—At the meeting on Monday Mr. Emile Garcke congratulated the shareholders on the unique position occupied by the company, as it was a tramway company whose lines were gradually passing over to the local authorities, its receipts had year after year shown increases, and its net profits had improved. The gross receipts last year were £180,000, against £172,000 in 1909, and the net profits (after paying interest and preference dividends) amounted to £44,327, against £38,516. They were again paying 10 per cent. on the ordinary shares, and transferring to reserve £36,513. They were nearing the end of their prosperity as a tramway company. Out of the 18 miles which they were working in the City of Birmingham and the vicinity more than half would go out of their hands and pass over to the local authorities at June 30, and out of the remaining mileage six miles were in Aston, which were being worked by the company without profit. After June 30, therefore, their profits would undergo a heavy diminution, and their expenses would be relatively large. The present position of the company from a revenue-earning point of view, was likely to continue satisfactory.

COVENTRY ELECTRIC TRAMWAYS (LTD.)—The gross profit for 1910 was £12,469, against £9,621 in the previous year. Deducting debenture interest and London office expenses, the net profit was £9,570, or with amount brought forward £10,016. The directors recommend that £2,500 be appropriated for depreciation and £7,475 to payment of 5% per cent. dividend on the share capital. The cars carried 5,076,278 passengers, against 4,597,648. Five new cars were added.

The Corporation of Coventry have given notice to acquire the undertaking.

CRAIGPARK ELECTRIC CABLE CO. (LTD.)—The net profit for the year ended March 31 was £6,245. 6s. 1d. and £671 was brought forward. After payment of the preference dividend for the year a dividend at the rate of 6 per cent. on the ordinary shares for the year is recommended.

CUBA SUBMARINE TELEGRAPH CO. (LTD.)—For the half-year ended Dec. 31 the total receipts were £18,351. 5s. 11d., and expenses were £6,672. 15s. 4d., leaving £11,678. 10s. 7d., added to £7,397. 1s. 7d. brought forward, making £19,075. 12s. 2d. £2,000 has been placed to reserve against loss on investments, and £2,000 added to the reserve fund, which now stands at £120,000. The preference dividend absorbs £3,000, and leaves £12,075. 12s. 2d. The directors recommend a dividend at the rate of 6 per cent. on the ordinary shares (free of income tax), the balance (£7,275. 12s. 2d.) being carried forward. The cables continue in good working order. Mr. James Scott, for reasons of health, having asked to be relieved of the active duties of secretary, Mr. Albert Charles Austin, the assistant secretary, has been appointed secretary, and Mr. Scott's services have been retained in a consulting capacity.

DEUTSCH-ATLANTISCHE TELEGRAPHENGESELLSCHAFT.—In the note which appeared in THE ELECTRICIAN of April 21 (p. 75), giving the details of this company's report for the year 1910 there was an omission which should be rectified. After the words "after meeting working expenses" there should be inserted "applying M.595,954 for amortisation of cables and M.127,885 for writing off."

ELMORE'S GERMAN & AUSTRO-HUNGARIAN METAL CO. (LTD.)—The accounts for 1910 show that the debenture stock now stands at £75,845, and the loan to the Metall Co. has been reduced to £49,932. 14s. 7d. The progress made by the Metall Co. resulted in an increase in the sale of finished goods of nearly 300 tons, or 11 per cent. over 1909. M.160,198 (£7,814. 10s. 9d.) was expended during the year upon additions and extensions and it has been possible to still further reduce the cost of production. The profits of the Metall Co. were lower by M.100,180·80, in spite of reduced cost of production, owing to a price war in Germany since 1910. The Mertens printing process is being developed, and important newspapers in Germany and France have purchased licences. Rollers have already been delivered, but a regular demand will only be possible after the delivery and erection of the necessary printing machines; such delivery has now commenced, and the directors believe that a new and remunerative branch of business will be created. The profits of the Metall Co. not being sufficient to permit of payment of a dividend upon its shares, the accounts of Elmore's Co. show a loss of £5,333. 19s. 9d.

LA PLATA ELECTRIC TRAMWAYS CO. (LTD.)—The accounts for the year 1910 show, after paying debenture interest, a balance of £4,148.

The CHAIRMAN (Mr. W. F. Hamilton, K.C.) stated at the meeting on Tuesday that the total receipts in La Plata were £34,483, of which £21,691 had been derived from electric traction. That was satisfactory considering the abnormal conditions prevailing during the past year and the great interruptions to traffic caused by the construction work, &c. On the electric sections the takings had averaged 1s. per mile run, and the expenses averaged 67·5 per cent. of the receipts, which would bring the expenditure on the electric sections up to 8d. per mile run.

MERTHYR ELECTRIC TRACTION & LIGHTING CO (LTD.)—The total revenue for 1910 was £19,253, against £18,105 for the preceding year. The expenses were £11,034, compared with £10,540. After deducting expenses and charging profit and loss account with £1,500 for provision for renewals, the total surplus is £5,070. The directors recommend that £1,000 be placed to reserve, and after payment of preference dividend, a dividend of 6 per cent. on the ordinary shares for the year (£1,800) is recommended to be carried forward. The gross receipts from the electric supply section of the undertaking were £8,089, and working expenses £2,632. The total number of units supplied was 858,625, against 740,952 in 1909. The number of units sold for lighting and power was 464,865, compared with 352,782 units for 1909, an increase of over 31 per cent. Having obtained the consent of the Board of Trade to the erection of overhead mains, the company is now giving a supply for the public lighting of the whole of Dowlais, under agreement with Merthyr Corporation, and the mains are also being used for private supply. The gross receipts from the light railways were £11,042, a decrease of £21.

RIO DE JANEIRO TRAMWAYS CO. (LTD).—The revenue for 1910 was $5,433,576, and the surplus is $2,337,142, added to $1,707,935 brought forward, making $4,045,078, out of which $250,000 has been applied to sinking fund for first mortgage bonds, $300,000 transferred to reserve, two quarterly dividends of 1 per cent. each and two of 1½ per cent. each have been paid, and the balance ($2,032,640) carried forward.

CITY NOTES.

MEMORANDA (May 4).—**Bank rate 3 per cent.** (March 9, 1911). **Price of silver,** 24⅞d. per oz. **Consols** 81¼—81¼ **for money;** 81⅜—81⅝ **for account. Consols Pay Day, June 1; Stock and Shares Continuation Days, May 10 and 29; Ticket Days, May 11 and 30; Pay Days, May 12 and 31; Mining Shares Carry Over Day, May 9.**

PRICES OF METALS (London).—*Copper*, **cash,** 54⅞; three months, 54⅝. *Lead*, **English.** 13¼—13⅜; **foreign,** 12⅛—12⅝ cash, 12⅝—12⅞ three months. *Spelter*, 24¼ cash, 24⅜ three months. *Tin*, **English,** 191—192; **foreign,** 193 cash, 189¾ **three months.** *Iron*, **Cleveland, cash,** 46/0½, **three months,** 46/9.

EASTERN TELEGRAPH CO. (LTD.)—Subject to final audit, the accounts for the year ended Dec. 31, 1910, show that after making a contribution to general reserve fund, payment of interest on the 4 per cent. mortgage debenture stock, dividend on the 3½ per cent. preference stock and three interim dividends of £1. 5s. per cent. each on the ordinary stock to Sept. 30 last, there is a balance available out of which the directors recommend payment of a final dividend of £1. 5s. per cent and a bonus of £2 per cent. (both tax free) and payable on May 17 inst., making, with previous payments on account, a total distribution of 7 per cent. on the ordinary stock for the year 1910. The transfer books of the ordinary stock will be closed from 10th to 17th inst. inclusive.

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.)—Subject to confirmation by the shareholders, the directors have declared a dividend for the quarter ended Dec. 31 last of 2s. 6d. per share, together with a bonus of 4s. per share (or 2 per cent.), making a total distribution of 7 per cent. for 1910, payable 17th inst. The share register will be closed from 9th to 16th inst.

WEST INDIA & PANAMA TELEGRAPH CO. (LTD.)—Dividends are announced of 6s. per share on the first preference shares (for six months), 6s. per share on the second preference shares (for six months) and 1s. 6d. per share on the ordinary shares, tax free. For the first half of the year 1s. per share was paid, and at the same time the arrears on the second preference shares were cleared.

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ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	April 26	1,372	+ 183	47	65,306	+ 1,988
Airdrie	„ 21	211	− 1	16	3,345	− 50
Anglo-Argentine	„ 29	48,252	+ 3,062	17	842,694	+ 101,415
Ashton-under-Lyne	„ 29	360	+ 13	5	2,083	+ 256
Ayr Corporation	„ 29	253	+ 19	50	14,286	+ 438
Barnsley	„ 21	243	+ 64	16	2,791	+ 99
Barrow	„ 21	305	+ 79	16	3,794	+ 209
Bath Electric Trams, Ltd.	„ 26	765	+ 40	17	11,818	− 138
Birmingham Corporation	„ 29	7,046	+ 425	4	30,773	+ 1,386
Birmingham & Midland	„ 21	1,200	+ 394	16	13,941	+ 1,170
Blackburn Corporation	„ 26	1,090	+ 165	†5	5,524	+ 649
Blackpool and Fleetwood	„ 29	352	+ 45	..	..	..
Bolton Corporation	„ 30	2,411	+ 160	5	11,169	+ 1,270
Bombay	March 31	2,882	+ 259	13	36,850	+ 1,991
Bournemouth Corporation	April 26	1,767	+ 127	‡4	6,632	+ 565
Bradford Corporation	„ 29	5,113	+ 265	4	23,190	+ 2,740
Brighton Corporation	„ 30	875	+ 40	¶4	4,030	+ 425
Bristol Trams & Carriage	„ 28	5,738	+ 310	4	24,920	+ 3,046
Burnley Corporation	„ 29	1,243	+ 60	4	5,522	+ 799
Burton Corporation	„ 30	269	+ 15	§4	1,142	+ 63
Bury Corporation	„ 30	1,174	+ 51	¶4	5,530	+ 618
Calcutta Tramways Co.	„ 29	₹54,244	+ ₹4,020	17	₹939,570	+ ₹11,670
Cambourne-Redruth	„ 29	111	− 3	17	1,919	− 47
Cardiff Corporation	„ 29	2,219	+ 149	4	9,740	+ 823
Carnforth	„ 21	176	+ 106	16	1,119	− 38
Central London Railway	„ 29	5,104	− 543	17	89,658	− 4,048
Chatham & Dist. Lt. Rys.	„ 27	796	+ 66	17	12,931	+ 27
City & South London Rly.	„ 30	3,361	+ 135	17	58,277	+ 2,274
City of Birmingham	„ 21	3,694	+ 921	16	45,308	+ 792
Colchester Corporation	„ 26	180	+ 18	..	..	..
Cork Electric Trams Co.	„ 27	497	+ 46	17	7,385	− 45
Devonport & Dist. Trams	„ 21	528	+ 131	16	6,904	+ 530
Dover Corporation	„ 29	209	+ 29	4	963	+ 173
Dublin & Lucan Railway	„ 28	124	− 11	17	1,925	− 37
Dublin United	„ 28	5,690	+ 628	17	86,412	+ 829
Dudley-Stourbridge	„ 21	1,246	+ 549	16	12,061	+ 968
Dundee Corporation	„ 26	1,133	+ 13	§49	58,371	+ 270
East Ham Council	„ 29	1,002	+ 26	4	4,383	+ 391
Exeter Corporation	„ 28	305	+ 15	4	1,284	+ 74
Gateshead & Dist. Trams	„ 21	1,092	+ 173	16	15,836	+ 849
Glasgow Corporation	„ 29	18,683	+ 800	48	853,948	+ 45,712
Grimsby Trams	„ 29	120	+ 9	17	1,953	+ 101
Gravesend-Northfleet	„ 21	290	+ 104	16	2,935	− 32
Great Northern & City Rly.	„ 29	1,496	+ 30	17	26,651	+ 1,059
Greenock & Port Glasgow	„ 21	709	+ 119	16	9,818	+ 1,410
Halifax Corporation	„ 25	1,683	+ 171	†4	7,158	+ 1,448
Hartlepool Tramways	„ 21	292	+ 76	16	3,474	+ 209
Hastings Elec. Trams Co.	„ 27	925	+ 67	18	13,118	+ 67
Hong Kong	„ 29	$8,600	− $468	18	$136,947	− $129
Huddersfield Corpn.	„ 29	1,765	+ 64	4	7,983	+ 1,257
Hull Corporation	„ 29	2,845	+ 259	4	12,091	+ 870
Ilford District Council	„ 29	516	+ 30	4	2,370	+ 297
Ilkeston District Council	„ 26	115	+ 3	4	525	+ 76
Ipswich Corporation	„ 29	375	+ 28	4	1,741	+ 305
Isle of Thanet Co.	„ 29	408	+ 49	30	9,567	+ 367
Jarrow	„ 21	165	+ 53	16	1,841	+ 96
Keighley Corporation	„ 27	172	+ 19	4	733	+ 102
Kidderminster & District	„ 21	188	+ 99	16	1,423	+ 55
Kilmarnock Corporation	„ 29	148	+ 10	50	7,521	+ 300
Kimberley Corporation	„ 26	361	+ 128	4	1,201	+ 163
Lanarkshire Trams Co.	„ 27	1,526	+ 223	17	22,780	+ 236
Lancaster United	„ 26	1,263	+ 87	17	21,059	+ 496
Leamington	„ 21	233	+ 85	16	2,174	− 121
Leeds Corporation	„ 29	6,815	+ 170	4	31,261	+ 4,183
Leicester Corporation	„ 29	2,394	+ 190	4	10,109	+ 1,291
Leith Corporation	„ 29	600	+ 40	50	29,397	+ 89
Lerwick Corporation	„ 29	179	+ 10	4	581	+ 69
Liverpool Corporation	„ 22	11,942	+ 1,289	16	174,901	+ 5,571
Liverpool Overhead Rly.	„ 30	1,411	− 16	17	23,758	+ 1,602
Llandudno & Colwyn Bay Ry.	„ 28	211	+ 46	§21	3,119	+ 83
London County Council	„ 19	47,782	+ 7,658	¶3	118,643	+ 10,507
London Elec. Ry. Co.	„ 29	13,985	+ 565	17	239,925	+ 13,400
London United	..	..	..	..	..	..
Lowestoft Corporation	„ 29	152	+ 19	30	4,606	+ 164
Manchester Corporation	„ 29	15,773	+ 2	4	67,273	+ 7,438
Mansfield Railway	„ 29	2,159	+ 26	17	34,959	+ 995
Margate	„ 21	305	+ 123	16	3,048	+ 48
Metropolitan Dist. Railway	„ 29	11,515	+ 648	17	199,566	+ 14,675
Metropolitan Elec. Trams	„ 21	11,083	+ 4,087	16	125,361	+ 18,037
Middlesbrough	„ 21	491	+ 214	16	4,745	+ 368
Midland Corporation	„ 29	166	+ 33	§1	771	+ 189
Middleton-Tyne Corp.	„ 29	3,941	+ 101	4	17,617	+ 1,566
Newport (Mon.)	„ 29	671	+ 50	4	3,013	+ 283
Northampton Corporation	„ 28	473	+ 35	4	2,043	+ 285
North Ashton & Hyde	„ 21	792	+ 282	16	8,616	+ 307
North Staffordshire	„ 30	1,757	− 93	5	10,318	+ 360
Nottingham Corporation	..	..	..	..	..	..
Nottingham & Dist. Trams	„ 28	1,679	+ 207	17	28,104	+ 1,345
Oldham Corporation	„ 21	168	+ 63	16	1,663	+ 103
Oldham Corporation	„ 22	1,783	+ 5	4	6,479	− 1,240
Oldham Corporation	„ 21	2,173	+ 303	16	30,052	+ 3,008
Portsmouth Corporation	„ 26	704	+ 50	4	2,942	+ 262
Reading	„ 27	621	+ 12	§4	2,652	+ 358
Rhondda Corporation	„ 21	257	+ 154	16	1,035	+ 107
Rhymney	May 1	4,662	+ 194	§4	21,428	+ 2,029
Rochdale Corporation	April 21	56	+ 10	16	682	+ 12
Rotherham Trams	„ 30	6,207	+ 296	5	32,441	+ 1,637
Rotherham & Dist.	„ 29	$10,022	+ $316	..	..	..
Rotherham & South Yorkshire	„ 21	1,248	+ 486	16	11,459	− 95
Salford Corporation	„ 21	1,333	+ 506	16	13,794	+ 1,165
Sheffield Corporation	„ 26	1,087	+ 105	4	4,139	+ 472
Shrewsbury Tramways	„ 26	532	+ 96	4	2,083	+ 419
Smethwick Corporation	„ 21	430	+ 183	16	3,848	+ 16
South Lancashire Lt. & Pr.	„ 29	654	+ 22	4	3,525	+ 820
Southend-on-Sea Corporation	„ 30	1,130	+ 55	4	5,110	+ 535
Southport Corporation	„ 26	455	− 17	26	11,457	+ 857
Stockport Corporation	„ 21	1,335	+ 345	16	16,705	+ 1,228
Sunderland	„ 26	144	+ 15	4	565	+ 78
Swansea & District	„ 21	56	+ 17	16	601	− 19
Tynemouth & District	„ 21	311	+ 153	16	2,531	+ 78
Walsall Corporation	„ 25	398	+ 29	17	6,950	+ 490
Warrington Corporation	„ 29	1,020	+ 179	4	4,467	+ 864
West Ham Corporation	„ 29	523	+ 19	17	9,195	+ 246
West Hartlepool Corporation	..	..	..	..	..	..
Wigan Corporation	„ 27	2,520	+ 198	4	10,706	+ 1,544
Wolverhampton Corporation	„ 21	204	+ 144	16	526	− 133
Worcester Corporation	„ 21	624	+ 235	16	6,739	+ 393
Yarmouth Corporation	„ 26	946	+ 108	4	3,874	+ 516
Yorkshire Electric	„ 21	416	+ 164	16	3,863	+ 42
Yorkshire (W.R.) Trams	„ 21	114	+ 16	16	1,476	+ 12
Yorkshire Woollen District	„ 30	1,167	+ 18	18	22,350	+ 788
	„ 21	1,331	+ 365	16	15,840	+ 1,125

(a) These comparisons are with the corresponding period last year. * Partly electrical. † Minus 3 days. ‡ Minus 2 days. ¶ Plus 3 days. § Plus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Share	Last Dividend	Name.	Price Wed., May 3.	Rate per cent. Yielded.	Dividend Due.	Business Week to May 3. Highest.	Business Week to May 3. Lowest.
		Electricity Supply.		£ s. d.			
10	6/0	Boarnemouth & Poole Elec. Sup. Ord.	8¼—8½	6 0 0	Mar, Sep	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref.	9¼—9½	4 12 3	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Second Pref.	10 —10½	5 13 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	102 —104	4 6 6	Jan, July	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	7¼—7⅝	6 11 3	March	7⅛	..
5	3/6	Do. 7 per Cent. Pref.	7¼—7⅝	4 11 6	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Deb. Stock	99 —103	3 17 6	June, Dec	..	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	3¾—4⅛	5 2 6	Feb, Aug	4	..
5	2/3	Do. 4½ per Cent. Pref.	4¼—4¾	4 17 0	Feb., Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	96 —98	4 1 6	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101½—103½	4 7 0	..	103	..
5	2/3	Do. City Undertaking 4½% Cum. Pref.	3¾—4⅛	5 3 0	Jan, July	..	..
5	3/0	Chelsea Electric Supply Ord.	4 —4½	5 11 0	March	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	100 —102	4 8 6	June, Dec	..	..
10	8/0	City of London Electric Lighting Ord.	11½—12	5 15 9	Feb, Aug	11⅞	11½
10	6/0	Do. 6 per Cent. Cum. Pref.	12 —13	4 12 3	Jan, July	12½	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	119 —123	4 1 0	June, Dec	..	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	101 —104	4 6 6	Jan, July	102½	..
St.	5%	County of Durham Elec. P. D. 5% 1st Mort. Deb. Stk.	92 —94	5 5 3	Jan, July	..	..
10	6/0	County of London Elec. Supply Ord.	7⅛—8⅛	6 3 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	10⅞—11⅛	5 5 6	Mar, Sept	11⅛	11⅛
St.	4½%	Do. 4½ per Cent. Deb Stock (red.)	109½—111½	4 0 9	Jan, July	110½	110½
St.	4½%	†Do. Second Deb. Stock	99 —102	4 8 0	May, Nov	..	..
5	4/0	Folkestone Electricity Supply Co. Ord.	4⅛—4⅜	5 19 0	April, Oct	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅛—5⅛	4 15 3	Mar, Sept	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red)	97 —100	4 10 0	Feb, Aug	..	..
5	5/0	Hove Electric Lighting Ord.	6⅜—7⅛	6 6 0	April, Oct	..	..
St.	4½%	†Isle of Wight E. L. & P. Co. Deb. Stk.	85 —91	4 19 0	..	90½	90½
5	5/0	Kensington & Knightsbridge Ord.	7 —7⅛	5 16 0	Feb, Aug	..	..
5	6%	Do. 6 per Cent. 1st Pref.	5⅞—6	5 0 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	93 —95	4 4 0	..	..	..
St.	4%	Kensington & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	96 —99	4 1 0	April, Oct	..	..
St.	4½%	Kent Elec. Power Co. Irred Deb. Stk.	80 —84	5 7 0	Jan, July	..	..
3	1/2⅝	London Electric Supply Ord.	1⅛—2⅛	2 17 0	Mar, Sept	2	..
5	3/0	Do. 6 per Cent. Pref.	4⅛—5⅛	5 17 0	Mar, Sept	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb	91 —94	4 5 0	Jan, July	92½	91½
5	3/0	Metropolitan Electric Sup. Ord.	3¾—4⅛	5 12 6	April, Oct	3⅞	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	4⅛—4¼	4 14 9	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	101 —104	4 6 6	June, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	86 —89	3 18 6	Jan, July	..	..
..	4½%	Midland Elec. Corp. for Power Dist, 4½ 1st Mort. Debs.	97 —99	4 11 0	..	98½	97½
5	2/6	Newcastle Elec. Supply Ord.	3½—4⅛	4 14 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non Cum. Pref.	4 —4½	5 11 0	Feb, Aug	..	..
100	4½%	Do. 4½ per Cent. 1st Mort. Deb.	98 —100	4 10 0	Jan, July	..	..
100	5%	North Metro. Elec. Power Sup. 5 Morts.	95 —97	5 3 0	..	..	..
1	6%	Northampton Elec. Lt. & P. Ord.	1⅛—1⅜	4 13 9	Feb, Aug	..	..
1	5%	Do. 5% Pref.	1⅜—1⅝	4 6 0	Feb, Aug	..	..
		Do. 4% Debs.	99 —101	3 19 0	June, Dec	..	..
St.	4%	Notting Hill Electric Ord.	12 —12½	5 17 6	March	..	..
10	10/0	Oxford Electric Ord.	6 —6½	5 11 6	March	..	..
5	4/3	Do. 4% Deb. Stk.	93 —96	..	..	..	..
St.	4%	St. James' & Pall Mall Elec. Ord.	8¼—9¼	5 8 0	Feb, Aug	..	..
5	5/0	Do. 7 per Cent. Pref.	6¼—7⅛	4 16 6	Feb, Aug	..	..
5	3/6	Do 3½ per Cent. Deb. Stock (red.)	85 —88	3 19 6	Jan, July	87½	..
St.	3½%	Smithfield Markets Electric Sup. Ord.	1⅛—1⅞	..	Feb.	..	..
5	..	South London Electric Supply Ord.	3 —3½	6 3 0	April	..	..
5	4/0	Do 5 % 1st Mort. Stock (red.)	101 —104	4 16 0	..	..	..
St.	5%	South Metrop'n Elec. Lt & Power 7% 1st Pref	1⅛—1⅜	5 18 0	Feb, Aug	..	..
1	8⅛	Do. 6 per Cent. 2nd Pref.	⅝—¾	6 17 0	Feb, Aug	..	..
1	7⅛	Do. 4½ 1st Deb. Stock (red.)	95 —98	4 11 6	April, Oct	..	..
St.	4½%	Urban Electric Supply Ord.	¼—1½	..	April, Oct	..	..
5	1/3	Do. 5 per Cent. Cum. Pref.	2½—3	8½ 6 0	April, Oct	..	..
5	1/3	Do. 4½ per Cent. 1st Mort. Deb.	80 —83	5 2 3	April, Oct	..	..
St.	4½%	Westminster Elec. Sup. Ord.	8 —8½	5 17 9	Mar, Sept	8⅛	8
5	5/0	Do. 4½ per Cent. Cum. Pref.	5 —5½	4 3 6	Jan, July	5	..
5	2/3						
		Electric Railways and Tramways.					
1	..	Bath Elec. Trams Pref. Ord.	⅞ —1	..	April	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	⅞ —1	6 13 6	Jan, July	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	79 —83	5 8 6	April, Oct	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Deb. Stock	91 —93	4 16 9	Jan, July	..	..
10	4%	Bristol Tramways & Carriage Ord.	7 —7⅛	5 6 0	Feb, Aug	..	..
10	4%	Do Cum. Pref.	7⅛—7⅞	5 1 6	..	..	..
St.	4%	Do. 4 per Cent. Debs.	101 —102	3 18 3	Feb, Aug	..	..
10	..	British Electric Traction Ord.	1⅛—1⅞	..	June, Dec	1⅞	1⅛
10	..	Do. 6 per Cent. Cum. Pref.	4½—5	..	Feb, Aug	4⅝	4
St.	5%	Do. 5 per Cent. Perpetual Debs.	94 —98	5 2 0	April, Oct	95½	94
St.	4½%	†Do. 4½ per Cent. 2nd Deb. Stock	77 —82	5 10 0	May, Nov	79	..
St.	3%	Central London Ordinary Stock	75 —77	3 18 0	Feb, Aug	75	74
St.	4%	Do. 4 per Cent. Pref. Stock	87 —89	4 10 0	Feb, Aug	88½	87
St.	2%	Do. Deferred Stock	64 —65	3 0 6	Feb.	65	64
100	4%	Do. 4 per Cent. Debs.	102 —104	3 17 0	Jan, July	..	..
5	2/6	City of Birmingham Trams, 5 % Cum. Pref.	4¼—5	5 0 0	April, Oct	..	..
100	4%	Do 4 per Cent. 1st Mort. Debs.	99 —102	3 18 9	April, Oct	100½	..
St.	1½%	City & South London Rly. Con. Ord.	34½—35½	4 4 6	Feb, Aug	35	34
St.	5%	Do. 5 per cent. Perp. Pref. (1891)	109 —111	4 10 0	Feb, Aug	109½	..
St.	5%	Do. (1896)	104 —106	4 12 6	Feb, Aug	..	..
St.	5%	Do. (1901)	101 —104	4 16 0	Feb, Aug	..	..
St.	5%	Do. (1903)	102 —105	4 15 3	Feb, Aug	104½	104
St.	4%	†Do. 4 per Cent. Perpetual Debs.	100 —102	3 18 6	May, Nov	..	..
10	6/0	Dublin United Trams, 6 per Cent. Pref.	12½—13½	4 10 6	Feb, Aug	..	..
10	12/0	Gateshead and District Trams Ord.	8½—8¾	6 19 6	..	..	..
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	1⅛—1⅜	..	Feb, Aug	..	..
5	..	Hastings & District Elec. Trams, 6% C. P.	1½—2	..	Mar. Sept	..	..
St.	4½%	Do. 4½ Deb. Stock	75 —80	5 10 0	April, Oct	..	..
10	..	Imperial Tramways Ord.	3 —3½	..	Mar, Sept	..	..
10	..	‡Do. 6 per Cent. Pref.	4¼—4½	..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Debs.	70 —72	6 5 0	Jan, July	..	..
..	2/6	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	2 —2⅛	5 5 0	Mar, Sept.	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	7⅞ —8¼	4 15 0	Jan, July	..	..
10	6/0	Lanarkshire Tramways	9½—10½	5 12 3	Feb, Aug	..	..
St.	5%	Lancs Utd. Trams, 5% Prior Lien Deb. Stk.	82 —84	5 19 0	Jan. July	..	..
St.	4%	London Electric 4% Deb. St.	97 —99	4 1 0	..	99½	98½
St.	4%	Do. 4% Pref.	82 —84	4 15 3	..	83	82¼
10	..	London United Trams, 5% Cum. Pref.	2¾—3¼	..	Jan, July	2⅞	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	74 —77	5 3 6	Jan, July	74½	74¼
St.	..	Mersey Con. Ord. Stock	6 —8	..	Feb, Aug	..	..
1	1/1½	Metropolitan Elec. Tramways Ord.	⅞—1⅛	6 0 0½	..	..	..
1	..	Do. Deferred	⅝—¾	..	April	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	¾—1	5 0 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	102 —104	4 6 6	Jan, July	..	..
St.	5%	Do 5 per Cent. Db. Stk	99½—101½	4 18 6	..	103	101½
St.	1½%	Metropolitan Railway Consolidated	51¾—52¼	2 12 6	Feb, Aug	53¼	51¼
St.	2½%	Do. Surplus Lands Stocks	66 —68	4 1 0	Feb, Aug	67¼	66½
St.	3½%	Do. 3½ per Cent. Preference	90 —92	3 16 0	Feb, Aug	91½	90½
St.	3½%	Do. 3½ per Cent. "A" Preference	89 —91	3 17 0	Feb, Aug	90	89¼
St.	3½%	Do. 3½ per Cent. Convertible Pref.	89 —91	3 17 0	Feb, Aug	90½	..
St.	3½%	Do. 3½ per Cent. Debenture Stock	93 —95	3 13 6	Jan, July	94½	..

* In calculating the yield allowance has been made for accrued interest, but *not* for redemption.
† Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote the...

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ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

NAME.	Price Wed., May 3.	Rate per cent. Yielded. £ s. d.	Dividend Due.	Business Week to May 3. Highest.	Lowest.
Electric Railways and Tramways—*Continued.*					
Met. Rly. 3½ per Cent. "A" Deb. Stock..	92 —94	3 14 6	Jan, July	93½	..
Metropolitan District Railway Ord.......	31⅜—32½	..	Feb, Aug	33½	31⅜
Do. 4½% First Pref.	88 —90	5 0 0	Feb, Aug	89½	88½
Do. Assented Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	74 —76	4 12 0	Feb, Aug	75½	..
Do. 3 per Cent. Consoltd. Rent-charge	77 —79	3 16 0	Jan, July	78½	78
Do. 4 per Cent. Midland Rent-charge	103 —105	3 16 0	Jan, July	..	..
Do. 6 per Cent. Perp. Deb. Stock......	148 —150	4 0 0	Jan, July	[illegible]	..
Do. 4 per Cent. Ditto..............	97 —99	4 1 6	Jan, July	..	..
Potteries Electric Traction Ord.	¼—⅜	..	April, Oct	..	..
Do. 5 per Cent. Cum. Pref...........	[illegible]	7 5 0	Feb, Aug	—	—
Do. 4½ per Cent, Deb. Stock..........	87 —90	5 0 0	May, Nov	..	..
†S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	[illegible]	10 2 0	..	—	..
Do. 4 per Cent. Deb. Stock..........	75 —80	5 0 0	Jan, July	..	..
Sunderland Dist. Elec. Trms. 5% 1stMtDb.	..	8 4 0	Jan, July	..	..
UndergdE.Rys.Lon.6% In. bds with coup 7	57 —59	1 13 10	June, Dec	59½	57½
†Do. 5% Prior Lien Bonds...........	100 —101	4 19 0	..	..	..
Do. 4½% Bonds with coup. 7	97 —99	4 11 0	..	99	98½
Do. 4 per Cent. 1st Power Ho. Dbs. ..	99 —101	3 19 3	..	..	..
Yorkshire (W.R.) Elec. Trams. Ord.......	⅛—⅜	..	March ..	..	..
Do. 6 per Cent. Cum. Pref.........	2⅜—2⅞	..	..	..	..
Do. 4½ per Cent. 1st Debs............	84 —87	5 3 3	Jan, July	—	..
Electric Manufacturing, &c.					
Anchor Cable Co. 4½ % Deb. Stock	99 —101	4 9 0	—	..	..
Aron Electricity Meter Ord............	[illegible]	..	..	..	..
Do. 6% Cum. Pf.	[illegible]	7 4 0	April, Oct	..	..
Babcock & Wilcox Ord. xd and bonus....	5 7/16—5 11/16	4 12 0	April, Oct	5 11/16	5½
†Do. Pref.........................	1⅛—1⅜	4 0 0	..	..	..
British Insulated & Helsby Cables Ord...	6⅞—7⅛	6 15 6	July, Feb	..	..
Do. 6 per Cent. Pref................	5¾—6¼	4 16 0	Jan, July	..	—
Do. 4½ per Cent. 1st Mort. Deb. (red.)..	102 —104	4 6 6	Jan, July	..	..
British Thoms'n-Houst'n 4½% 1st Mt.Db.	96 —99	4 11 0	Mar, Sept	..	..
British Westinghouse 6 per Cent. Pref.....	[illegible]	..	Feb, Aug	7/16	7/16
Do. 6 per Cent. Prior Lien Dbs. (rd.)..	[illegible]—103	5 16 3	..	102½	101⅜
Do. 4 per Cent. Mort. Deb. Stock......	61 —64	6 5 0	Jan, July	62½	62
BrushE.Eng. Co. 4½% Perp. 1st Deb.Stock	59 —64	7 0 6	Mar, Sept	..	..
Do. Perpetual 2nd Deb. Stock........	41 —46	9 16 0	Jan, July	..	..
Callender's Cable Con. Ord............	9⅜—9⅞	7 12 0	Jan, July	..	9⅜
Do. 5 per Cent. Cum. Pref...........	4⅞—5⅛	4 17 6	Jan, July	5 1/16	..
Do. 4½ per Cent. 1st Mort Debs. (red.)..	102 —104	4 6 6	Nov, May	..	..
Castner-Kellner Alkali Co..............	3 7/16—3 9/16	4 18 3	May, Nov	3½	3 7/16
Do. 4½ per Cent. 1st Mort. Deb. (red.)..	103 —106	4 3 6	Feb, Aug	..	..
Chadburn's (Ship) Telegraph Ord.	1 1/16—1 3/16	5 19 0	March ..	..	..
Consolidated Electrical Co.............	⅞—1	10 0 0	August ..	—	..
Consolidated Signal Co................	¾—13/16	5 7 0	April, Oct	13/16	..
Do. 6 per cent. Cum. Pref.	15/16—1	6 0 0	April, Oct	—	..
Crompton & Co (Nos. 1 to 85,000)	⅝—⅞	..	Jan, July	..	..
Do. 5 per Cent. 1st Mort. Debs. (red.)..	70 —80	6 5 0	Jan, July	..	..
Davis & Timmins	⅞—1⅛	..	Mar, Sept	..	..
Dick, Kerr & Co. Ord...................	⅞—1	5 0 0	Sept	..	..
Do. 6 per Cent. Cum. Pref..........	1 —1⅛	5 6 6	Sept	1 1/32	..
Do. 4½ per Cent. Deb. Stock.........	97 —100	4 10 0	Jan, July	..	..
Edison & Swan United ("A" Sh.) (£3 pd.)	⅛—⅜	..	Feb, Aug	..	..
Do. (£5 paid)	1⅞—2⅛	9 3 0	Feb, Aug	2	[illegible]
Do 4 per Cent. Mort. Deb. Stock (red.)	69 —73	5 9 9	June, Dec	..	..
Do 5 per Cent. 2nd Deb. Stock......	78 —81	6 3 6	Mar, Sept	..	..
Edmundson's Elec. Corp. Ord............	¾—1	..	Jan, July	1	..
Do. 6 per Cent. Cum. Pref.	3⅛—3⅞	..	May, Nov	3 3/16	3⅛
Do 4½ per cent. 1st Mort. Deb. (red.)..	86 —89	5 1 0	Jan, July	83	..
Electric Construction Co..............	¾—1	..	Jan, July	⅞	[illegible]
Do. 7 per Cent. Cum. Pref...........	1¾—2	7 0 0	July	..	..
Do. 4 per Cent. Perp. 1st Mort. Debs...	69 —72	5 11 0	Jan, July	..	..
General Electric (1900) 5% Cum. Pref. ..	8½—8¾	5 14 6	June, Dec	..	..
Do. 4 per Cent. 1st Mort. Debs........	83 —88	4 11 0	Mar, Sept	..	..
Henley's Telegraph Works Ord..........	12⅛—12⅞	5 16 6	Feb, Aug	..	..
Do. 4½ per Cent. Pref.	4 15/16—5 3/16	4 7 0	Feb, Aug	—	..
Do. 4½ per Cent. 1st Mort. Deb. Stock	108 —110	4 2 0	Mar, Sept	..	..
India Rubber, Gut. Per., &c., Works....	16½—17	5 17 9	Feb, Aug	16⅜	16⅛
Do 5 per Cent. Cum. Pref.	10¼—10¾	4 14 0	..	[illegible]	10½
Do. 4 per Cent. Debs. (red.)	96 —98	4 1 6	April, Oct	..	..
National Elec. Construction Co.	1/16—3/16	..	April	..	..
Richardsons, Westgarth & Co., Ltd. Ord.	[illegible]	..	Nov	..	..
Do. 6 per Cent. Cum. Pref.	⅛—3/16	..	May, Nov	..	..
Do. 4½ per Cent. Perp. Deb. Stock....	78 —82	5 10 0	Jan, July	[illegible]	..
Simplex Conduits 6 per Cent. Cum. Pref.	4⅞—5	..	..	..	..
Telegraph Construction & Maintenance..	36⅜—38⅜	5 16 3	Mar, July	37½	36½
Do. 4 per Cent. Deb. Bonds (1909)	100 —102	3 18 6	Jan, July	..	..
Vickers, Sons & Maxim, Ltd., Ord........	2 1/16—2⅛	4 14 0	..	2⅛	2 1/16
Do. 5 per Cent. non-Cum. Preference..	1 1/16—1 3/16	4 3 0	..	1⅛	..
Do. 5 per Cent. non-Cum. Preferred ..	109 —112	4 9 3	..	..	..
Do. 4 per Cent. 1st Mort. Db. Sk. (red)	102 —104	3 17 0	June, Dec	103½	102½
Do. 4½ per Cent. 2nd Mort. Deb. (red.)	104 —106	4 5 0	June, Dec	..	—
Do. 5 per Cent. 3rd Mort. Debs Scrip...	105 —107	4 13 6	..	..	..
J. G. White & Co. 6% Cum. Pref.	14½—15½	6 11 0	..	14 11/16	14⅝
Willans & Robinson Ord...............	⅛—⅜	..	Apr, Oct	..	..
Do. 6 per Cent. Cum. Pref...........	½—1	..	Apr, Oct	..	..
Do. 4 per Cent. 1st Mort. Debs.......	55 —65	6 3 0	May, Nov	..	—
Telegraphs.					
Amazon Telegraph	7½—7¾	..	June, Dec	7⅝	7 11/16
Do. 5 per Cent. Debs. (red.)	98 —100	5 0 0	Jan, July	99	98½
Anglo-American	71 —73	5 1 6	F,My,Ag,N	71½	.
Do Preferred	116 —117	5 2 6	F,My,Ag,N	116⅞	115⅞
Do. Deferred	27⅞—28⅛	5 5 6	F,My,Ag,N	28¼	28
Commercial Cable 4 per Cent. Deb. Stk...	88 —90	4 9 0	Jn,Ap,Jy,O	89½	88½
Cuba Submarine Ord....................	9½—10½	5 14 0	Feb, Aug	..	..
Do. Preference 10 per Cent.	17½—18½	5 7 0	Feb, Aug	..	..
Direct Spanish Ord....................	3½—4	5 0 0	April, Oct	..	..
Do. 10 per Cent. Cum. Pref...........	8⅜—8⅞	5 12 6	April, Oct	..	..
Do. 4½ per Cent. Deb.	100½—102½	4 8 0	Jan, July	..	..
Direct United States Cable..............	7½—8	6 5 0	Ja,Ap,Jy,O	7 15/32	7⅜
Direct West India Cable 4½%Rg.Db.(rd.).	100 —102	4 8 3	June, Dec	..	..
Eastern Ordinary	137½—140	5 0 0	Ja,My,Jy,O	138½	137½
Do. 3½ per Cent. Pref. Stock.........	81½—85½	4 1 0	Ja,My,Jy,O	84½	..
†Do. 4 per Cent. Mort. Deb. Stk. (red.)..	100 —102	3 18 6	May, Nov	101½	..
Eastern Extension	13⅜—13⅞	5 1 0	Ja, Ap,Jy,O	13 11/16	13⅝
Do. 4 per Cent. Deb. Stock	100 —102	3 18 3	Feb, Aug	101½	101
Eastern and S.Af., 4% Mauritius Sub.Debs	99½—101½	3 19 0	May, Nov	32	31½
G.N (of Copenhagen), ex Coupon 81	31½—32½	5 13 6	Jan, July	..	..
Indo-European	59 —61	5 6 6	May, Nov	..	..
Mackay Companies Common	93 —96	5 4 0	Ja,Ap,Jy,O	..	..
Do. Preference	78 —80	5 0 0	Ja,Ap,Jy,O	..	..
Marconi's Wireless Teleg. Co.	1⅛—1¼	..	April	1 17/32	1 5/32
Pacific & Europe'n Tel.4%Guar.Dbs.(red.)	100 —102	3 18 3	June, Dec	..	..
West Coast of America	1¼—1½	4 3 0	May	..	..
Do. 4 per Cent. Debs................	99½—101½	3 18 9	Jan, July	..	..
West India & Panama	2¼—2¾	1 15 0	May, Nov	[illegible]	[illegible]
Do. 6 per Cent. 1st Pref.	10⅛—10⅞	5 10 0	May, Nov	[illegible]	[illegible]
Do. 6% 2nd Pref.	9½—10	6 0 0	May, Nov	[illegible]	[illegible]

Shares.	Last Dividend.	NAME.	Price Wed., May 3.	Rate per cent. Yielded. £ s. d.	Dividend Due.
		Telephones.			
100	2$	Amer. Telephn. & Telegh. Cap. St.	150 —152	5 5 3	..
..	4%	Do. Coll. Trust $1,000 4 per Cent. Bds.	93½—95½	4 3 9	Jan, July
St.	4%	Do. 4% Cons. Bonds 1936	111 —113	3 10 9	..
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101 —103	4 17 0	Mar, Sept
5	3/0	Chili Telephone	7 1/16—7 3/16	5 11 6	August ..
1	0/7½	†Monte Video Telephone Ord............	⅞—1	6 0 0	Nov ....
1	0/6	†Do. 5 per Cent. Pref.	¾—⅞	5 11 0	May, Nov
St.	6%	National Co. Pref. Stock................	104½—105½	5 14 0	Feb, Aug
St.	6%	Do. Def. Stock	135 —137	4 7 6	Feb, Aug
10	6/0	Do. 6 per Cent. Cum. 1st Pref.........	10 —10½	5 11 6	Feb, Aug
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.........	10½—11	5 9 0	Feb, Aug
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref....	5 15/16—6 1/16	4 2 6	Feb, Aug
St.	3½%	Do. Deb. Stock 3½ per Cent. (red.)....	99 —101	3 9 3	June, Dec
St.	4%	Do. 4 per Cent. Deb. Stock (red.)......	99 —101	3 19 3	Jan, July
..	4½%	†New York Telephone Co. 30 yr. Bnds....	98½—99½	4 10 6	..
1	1/0	†Oriental	1 1/16—1 3/16	4 15 0	April, Oct
1	0/7½	†Do 6 per Cent. Cum. Pref.	1⅛—1¼	4 16 0	April, Oct
St.	4%	Do. 4 per Cent. Red. Deb. Stock......	87½—89½	4 9 6	Jan, July
St.	4½%	Telephone Co. of Egypt 4½%Db.Stk.(red.)	99½—101½	4 8 9	Jan, July
5	3/0	United River Plate Ord. (1—150,000) ...	7⅛—7⅜	5 3 0	July ....
5	4½%	Do. (150,001—190,000)...............	7⅛—7⅜	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅛—5⅜	4 9 0	June, Dec
St.	4½%	Do. 4½ Deb. St. Red..................	103 —105	4 5 9	Jan, July
		Financial, Investment, &c.			
5	3/0	Elec. & Gen. Investment 6% Cum. Pref...	3½—4½	7 1 0	Jan, July
10	2/0	Globe Telegraph & Trust	10⅞—11⅛	5 2 6	Sp,DcMrJu
10	3/0	Do. 6 per Cent. Pref.	13 —13½	4 9 0	Sp,DcMrJu
10	6%	Submarine Cables Trust (Cert.)	131 —134	4 9 6	April, Oct
		Colonial and Foreign Electric Railways, Tramways, &c.			
5	2/6	Anglo-Argentine 5% Cum. 1st Pref.	5 1/16—5 3/16	4 14 6	April, Oct
5	2/6	Do. 5% Cum. 2nd Pref................	4⅞—5⅛	4 17 6	Jan, July
St.	4%	Do. 4% Deb. Stock	92 —93½	4 5 6	June, Dec
St.	4½%	Do. 4½% Deb. Stock	98½—100½	4 9 6	..
St.	21 9	Do. 5% Deb' Stock	102 —104	4 16 0	..
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)....	104½—105½	4 14 6	Jan, July
5	4/0	†Brisbane Electric Trams. Invest. Ord	6⅜—6⅞	5 16 0	May ....
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅞—5⅛	4 17 6	May, Nov
St.	4½%	Do. 4½ per Cent. Db. Prov. Certs.......	102 —105	4 6 0	Jan, July
St.	8%	†British Columbia El.. Rly. Df.Ord.	146 —150	5 6 9	Mar, Sept
St.	6%	Do. Pref. Ord. Stock	125 —128	4 13 9	May, Nov
St.	5%	Do. 5% Cum. Perp. Pref. Stock.......	107½—110½	4 10 6	Jan, July
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.......	100 —103	4 7 6	April, Oct
100	4½%	Do. Vancouver Power Debs.	102 —105	4 5 9	Jan, July
St.	4½%	Do. 4½% Perp. Con. Deb. St.	100½—102½	4 2 6	..
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	99½—101½	4 18 6	Mar, Sept
St.	6%	Buenos Ayres Port & City Tram, 1st Mt. Deb. Stock	93 —98	6 2 6	Feb, Aug
5	3/6	†Calcutta Tramways (1 to 137,610)........	5¼—5¾	5 4 0	Mar, Sept
100	2/6	Do. 5 per Cent. Cum. Pref.	5⅛—5⅜	4 13 0	Jan, July
1	4½%	Do 4½% 1st Deb. Stock (red).........	100 —103	4 7 6	Jan, July
St.	..	Cape Electric Tram Shares	7/16—9/16	..	..
5	1/3	City of Buenos Ayres Trams Co. (1904) Sh.	5⅛—5⅜	4 5 0	F,My,A,N
St.	4%	Do 4 per Cent. Deb. Stock............	98 —101	3 19 3	June, Dec
..	5%	†Colombo Tr. & Ltg. 5% 1st Mt. Db.......	95 —98	5 2 0	May, Nov
1	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	99½—101½	4 18 6	Feb, Aug
100	5%	Hong Kong Tramways Co. 5 per Cent. 1st Mort. Debs.	78 —82	6 1 6	June, Dec
1	..	Kalgoorlie Elec. Trams Sh.	[illegible]	..	..
100	5%	Do. 5 per Cent. "A" Deb. Stock......	91 —97	5 3 0	Jan, July
5	6%	Do. 6 per Cent. "B" Ditto	66 —70	4 5 9	Jan, July
5	0/7½	Lisbon Elec. Trams. Ord.	1 —1¼	4 16 0	July ....
100	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1¼	4 16 0	Jan, July
St.	5%	Do. 5 per Cent. Reg. Mort. Debs.	98 —102	4 18 0	Jan, July
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	96 —98	5 2 0	Jan, July
100	5%	Manaos Trams and Lt. Co. 5% Debs	92½—94½	5 6 0	..
..	5%	Manila Elec. Ry. $1,000 Gold Bonds......	99 —101	4 19 0	Feb, Aug
100	$1½	Mexico Trams Co. Com. St.	124 —126	5 11 0	..
..	5%	Do. Gen. Con. 1st Mort. 5% Gold Bds.	97 —98	5 2 0	..
St.	6%	Do. 6% 50 yr. Mort. Bds..............	102 —103	5 16 6	—
St.	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922) (Nos. 601 to 2,000)	101 —103	4 7 6	Feb, Aug
St.	4½%	†Do. do. (Nos. 1 to 4,600)	101 —103	4 7 6	..
1	0/6	Perth Elec. Trams Ord.	11/16—13/16	2 13 6	May ....
St.	5%	Do 1st Mt. Db. Stock	104 —106	4 14 3	Jan, July
5	3/0	Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	5¼—5¾	5 4 6	—
St.	4½%	Do. 4½% 1st Mort. Deb. Stk.	99 —102	4 8 0	..
100	$1½	Rio Janeiro Tram, Lt. & P. Co..........	109 —110	4 10 0	..
..	5%	Do. 30 yr. Gold Bnds.	102 —103	4 17 0	..
100	5%	Do. 50 yr. Mt. Bnds	95½—96½	5 3 6	—
..	$2½	Sao Paulo Tramway, Light & Power Co. $100 Stock	168 —170	5 17 9	..
..	5%	Do. 5 per Cent. 1st Mt. $500 Db.	103½—104½	4 16 0	June, Dec
100	4½%	Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	98 —100	4 10 0	Feb, Aug
		Colonial and Foreign Electricity Supply, &c.			
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.......	5⅜—5⅞	5 2 0	Mar, Sept
10	6/0	Bombay E.S. & T. 6% Cm. Pf.	10½—11½	5 6 6	..
St.	4½%	Do. 4½ per Cent. Deb. Stk. (red)......	96½—98½	4 12 0	Jan, July
..	5%	Do. 5 per Cent. 2nd Mort. Deb. Stock..	97 —99	5 1 0	..
5	3/6	Calcutta Elec. Supply Ord.	6⅜—7¼	4 16 6	April, Oct
5	2/6	Do. 5% Cum. Pref	4⅞—5⅛	4 13 0	..
100	5%	Calgary Power Co. 5% 1st Mort. Bnds.....	95½—97½	5 2 6	—
100	7/2½	Canadian Gen. Elec. Co. Com. St.........	114 —117	6 0 0	..
100	$3½	Do. 7% Cm. Pf. Stock	119 —122	5 14 9	..
100	5%	Castner Electrolytic Alkali Co. (of U.S.A.) 1st Mort. Stl. Debs.	97 —102	4 18 0	Jan, July
500	5%	Elect. Development Co. of Ontario......	85 —87	5 15 0	..
St.	5%	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	87 —90	5 11 0	Jan, July
5	..	Indian Elec. Sup. & Trac. Co.	1 —1⅛	..	..
10s	..	Kalgoorlie Elec. Power & Ltg. Ord.	1/16—3/16	..	..
1	0/7½	†Do. 6 per Cent. Cum. Pref.	[illegible]	8 6 6	April, Oct
..	5%	Kaministiquia Power Co. 5% Gold Bnds...	103 —105	4 15 0	..
5	..	Madras E. S. Corp. Ord...............	3 —3½	..	..
St.	..	Melbourne E. S. Co. 6% Cum. Pref.	36 —41	..	..
St.	5%	Do. 5% 1st Mortg. Deb. Stock	94 —96	5 4 0	..
500	5%	Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	90 —91	5 10 0	..
St.	$1	Mexican Lt. & Power Co. Com. St.	85 —88	4 11 0	..
St.	$3½	Do. 7% Cum. Pref. St.	108½—110½	6 6 6	..
500	5%	Do 5% 1st Mort. Gold Bnds.	95½—96½	5 3 6	..
St	5%	Monterey Rly. L. & P. Co. 1st Mort. Db. Sk.	89½—91½	5 8 9	..
100	8/2½	†Montreal Lt. Ht. & Power Co. Cap. St.	[illegible]	5 3 3	F,My,A,N
100	5%	†Northern Lt. Power & Coal 5% Gd. Bds ..	71 —[illegible]	6 17 0	..
St.	[illegible]	River Plate Electricity Co. [illegible]	[illegible]	3 15 6	April ....
[illegible]	[illegible]	Do. [illegible]	[illegible]	5 2 6	May ....
[illegible]	[illegible]	Do. [illegible]	[illegible]	4 14 3	Jan, July
[illegible]	[illegible]	[illegible]	[illegible]	4 4 0	

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NOTES.

National Insurance.

Everyone possessing a spark of humanity must deplore the fact that sickness and unemployment bring misery to those of limited means. We all welcome with open arms any well-conceived attempt to ameliorate this almost inevitable condition of things. But, however humanitarian we may be, it is essential that we should realise that unemployment and poverty are closely allied with the advance of civilisation and the progress of the world. The production of national wealth depends upon individual effort and the profitable employment of capital; and in any attempt to reduce poverty and suffering, great care must be taken that the remedy is not worse than the disease, and that the conditions we deplore are not aggravated and extended. This is the greatest danger in the present-day attempts at humanitarian legislation—that Parliament may so rob the home investor of every reasonable possibility of an adequate return upon his investment, as to take the edge off his keenness for speculation. The late Sir William Harcourt used to say that we were all "socialists." If he had lived in 1911 he would probably have said we were adding sentiment to our socialism. Therein lies the danger.

It is unfortunate that we must of necessity consider the economic dangers in front of any such proposals as those put forward by Mr. Lloyd George. The path of the employer, however, is increasingly difficult. What with the State scheme of non-contributory old age pensions and its burden upon industrial profits; the keener-than-ever competition of our oversea trade rivals; the generally increasing cost of raw material; and now the direct contribution towards the cost of sickness and insurance of employés (whether the need exists or not), it seems that the last straw has been added to the already heavy burden of the industrial employer. We are sure the employer is no less humanitarian in his feelings than Mr. George, but he has already either a difficulty in satisfying the reasonable demands of his shareholders or in making both ends meet where he himself is the man who has to "shell out." The constant drain upon trading profits must, it seems to us, in the end destroy the main object of the Parliamentarians and drive the employer to resort to every conceivable device, humane or otherwise, to minimise the effect of these constant calls upon his resources. We believe the latest contribution the employer of labour is called upon to pay will prove the most onerous.

A Conference on Education.

Of all our engineering societies the Institution of Civil Engineers has given most attention to the subject of technical education; and some few years ago, after careful deliberation, a report was issued stating broadly the lines on which such education should be completed. The Council evidently now think that sufficient time has elapsed for the subject to be given further consideration, and consequently a conference dealing with education will be held at the Institution on June 28th and 29th. It is intended to deal with the subject on broad lines and to avoid restricting the discussion to engineers only, and much less to those practising in a particular branch of engineering. This will be clear from the list of names published elsewhere of the officers of the conference. A number of subjects will be

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discussed and will be introduced by short notes submitted by persons having special qualifications. There are, no doubt, a number of educational questions about which opinions differ very considerably. The system of education at technical colleges is becoming fairly standardised, but it is difficult to know how the education which should follow the college course can be obtained to the best advantage. A natural tendency is for the student on leaving the technical college to obtain a position in which he is paid for his labours, but this is not necessarily the best course. If the conference throws light upon this part of the subject alone it will have served a useful purpose.

Traffic Developments in London.

THE recent announcement that a powerful new company is to be formed with the object of placing on the London streets a large number of motor omnibuses has doubtless come as a surprise to most people; though it is only in keeping with previous experience that, as soon as a company has fair prospects of obtaining even a small return on its capital, other interests should enter the field to compete for the supposed unlimited passenger traffic of the metropolis. After the keen competition that has prevailed during the last few years and the disheartening financial results shown, the existing companies working omnibuses, tramways, and underground railways were doubtless looking forward to less strenuous and more prosperous times, and the improvement in traffic and receipts shown in recent reports gave promise of a more adequate return on the large amount of capital sunk in these enterprises. It seems, however, that the arrival of "The Premier Motor Omnibus Co.," as the new Company is called, is destined to dispel any such hopes. This Company, it is stated, is to operate omnibuses manufactured by the Daimler Co.—who are largely interested in the new venture—and among the features claimed for these omnibuses are:—No change-speed gear, gradual and even start, comparative absence of noise and vibration, and lower floor line.

FOLLOWING the statement of the forthcoming flotation of The Premier Motor Omnibus Co. comes the announcement, on Wednesday last, of an "arrangement" between the London General Omnibus Co. and the companies representing the underground railways, whereby more harmonious working is to result. The issue of interchangeable and through tickets is also under consideration. The London United Tramways, which already work in co-operation with the underground railways, are also involved in the arrangements; so that it is evident a very extensive scheme is on foot. At present a committee, to be composed of two representatives from each of the companies concerned, is being formed to draw up a detailed scheme.

THE London traffic problem has recently assumed a new aspect, owing to the desire of the London County Council to extend their tramway system into the "West End." Although powers are at present merely being sought to extend the track along Edgware-road to Oxford-street, in the neighbourhood of the Marble Arch (a proposed extension of the Battersea lines to the Brompton Oratory having been withdrawn, though possibly only temporarily), the general policy of the Council is becoming plain, and "The Times," in a leading article entitled "The Menace of the Tramways," sees unmistakably the ultimate invasion of Park-lane in order to link up the tramways in the north and south of London. That the matter is considered to be of great importance is evident from the fact that the Home Office have presented a Report to the Parliamentary Committee which has the Council's Bill under consideration. The Report embodies the criticisms of the Commissioner of Police, who points out that the Marble Arch is a most unsuitable place for a tramway terminus. The whole question of co-ordinating the various traffic facilities provided, however, should undoubtedly be considered at once, since delay will merely accentuate the difficulties of linking up. As to the undesirability of tramways in many West End thoroughfares there can be no two opinions, but a subway, as in Kingsway, might perhaps meet the case. In this connection, though the difficulties to be overcome in their construction might render the scheme impracticable, it is interesting to notice that such subways have recently been found necessary and desirable in several American cities.

"The Electrician" Second Mining Issue.

WITH this week's ELECTRICIAN we publish the third of those special issues whose object it is to provide an accurate idea of the position of electrical engineering in its application to certain branches of national activity. Like the first of these, which appeared three years ago, our present special issue is devoted to electricity as applied to mining. In this industry the use of electrical equipment has enormously increased, even in that short period. Not only, too, has the employment of the motor and its kindred apparatus increased, but electrical engineers have, doubtless as a consequence, better knowledge of the conditions under which their machinery has to work in mines; and are now better able to design it for operating under these conditions. In a word, three years has turned theory into practice. This does not mean that there was no practice three years ago, but rather that present-day methods have become much more practical. This is proved by the fact that we are now able to publish an issue dealing with the same subject as that considered three years ago, but dealing with it from quite a different point of view. Although great progress has been made, there is still much to be done, especially in the direction of overcoming prejudice; and because a satisfactory advance has been made in a short time this is no reason for the electrical engineer to rest.

Imperial Conference.

WE learn that it is probable when, at the forthcoming Imperial Conference, the subject of Imperial telegraphic communication is reached, it will be found that the representatives of the Home Government will meet any proposal for discussing the question of submarine cable communication throughout the Empire with an expression of opinion that it would be first desirable to discuss the subject of an Imperial System of Wireless

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Telegraphy. We understand further that one of the principal members of the present Government takes a keen interest in this question, and that his views are likely to receive the fullest support.

Constantinople Telephone Contract.—The contract in connection with the telephone concession which has been granted to Mr. H. Laws Webb (on behalf of a British syndicate) was formally signed on the 6th inst by Djavid Bey and Mr. Webb, who then left for London.

Newfoundland Cable Landing Tax.—By a majority the Supreme Court have given judgment in favour of the Newfoundland Government in their action against the Commercial Cable Co. for $16,000 yearly as landing taxes. The Company, it is stated by Reuter's Agency, will probably appeal to the Privy Council.

Olympia Electrical Exhibition (1905) Trust Fund—In regard to this fund Mr. W. Davenport has written to us as follows:—

I am pleased to inform you that this Fund has now been realised, and the sum of £378. 12s. 8d. has been paid into the funds of the Electrical Trades Benevolent Institution, and £203. 17s. 7d. to the Benevolent Fund of the Institution of Electrical Engineers. The trustees for this fund were: Sir Wm. H. Preece, K.C.B., E. Cunliffe Owen, C.M.G., John E. Kingsbury, Chas. Spencer Northcote, Jas. E. Edgcome and Walter Davenport.

Fire at Hindhead Electricity Works.—In our last issue we briefly referred to the fire that damaged the electricity supply station at Hindhead early on Wednesday last week. Further particulars which have come to hand show that the station was practically burnt out. Under these circumstances, it is very gratifying to learn that the continuous-current supply was restored in Hindhead on Friday afternoon, whilst the high-tension alternating-current transmission to Haselmere was switched on again by Sunday evening. The greatest credit is due to the staff, the consulting engineers (Messrs. Handcock & Wilkes) and to the manufacturers concerned, for the way in which the supply was made available so soon after the destruction of the station. The promptitude with which the manufacturers supplied spare parts, &c., was particularly noteworthy. Leatherhead Electricity Co. also assisted by loaning a transformer, switchboard, &c. As to the cause of the disaster, it is practically certain that the fire originated from some exploded ignition cells, which appear to have been left charging overnight on a shelf in the disused boiler house (Diesel plant is now used). At any rate, when the engineer arrived on the scene soon after the outbreak, he found the fire firmly established in the roof immediately over this shelf. Although the disaster is, of course, unfortunate, it provides splendid testimony to the way in which an electricity supply can be restored after a station has been practically destroyed by fire.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair
Assab–Perim	July 8, 1909 ...	—
Malta–Tripoli.....	April 20, 1910 ...	—
Lusaka–Palura	May 26, 1910 ...	—
Tourane–Amoy	Sept 25, 1910 ...	—
Banjy–Duala	Mar. 30, 1911 ...	April 16, 1911.
Kwandang–Menado	April 25, 1911 ...	May 5, 1911.

Current Topics.

Subjects of current interest dealt with in this issue include the following:—

In our Second Mining Issue, which is incorporated with the present number of THE ELECTRICIAN, will be found a large number of articles, among the following: "Electricity in Cornish Mines," by Neil Tasker; "The Position of Electricity in Mining in South Africa," by J. Mackness; "The Elimination of Risk in the Use of electricity in Mines," by Prof. W. M. Thornton; "Special Risks in the Application of Electricity to Mining Work under South African Conditions," by H. J. S. Heather; "The Gas-tight and Flame-proof Motor Problem," by Talbot Duckitt; "Public Electric Power Supply to Collieries," by W. B. Woodhouse; "Power Supply from a Private Plant," by W. Bolton Shaw; "Centralisation of Power in Collieries," by W. E. Chappell; "Notes on Switchgear for Use Underground in Mines," by H. W. Clothier; "The Progress of Electric Winding in England," by G. Hooghwinkel; "Coal Cutting," by H. J. Fisher; "Underground Colliery Wiring," by A. B. Mallinson; "Electric Hand Lamps for Collieries," by W. Maurice; "Controllers and Resistances in Mines," by Edmund Garside; "The New Electric Mining Rules—Some practical Considerations"; "The Profitable Use of Waste Heat." A number of descriptive articles also deal with the machinery and apparatus used in mining work.

We give further particulars and illustrations of the electrified section of the suburban system of the London, Brighton & South Coast Railway, including the recently converted Crystal Palace lines. Experimental running has been carried out on the new section during the last week or two.

We conclude our abstract of Mr. D. Murray's Paper on "Practical Aspects of Printing Telegraphy," and an account is also given of the discussion on this Paper at the meeting of the Institution of Electrical Engineers last week.

At the meeting last night a Paper by Mr. H. J. S. Heather on "The Driving of Winding Engines by Induction Motors" was read.

We give an account of the chief alterations in the sixth edition of the I.E.E. Wiring Rules issued last week. The Rules are also discussed in our Leading Article.

Particulars will be found elsewhere in this issue of the "Bruston" electric-lighting plant, the operation of which is entirely automatic.

West Ham Electric Lighting Committee propose to carry out extensions of generating plant, &c., at a cost of £59,000.

The inquiry into the application of Dublin Corporation for permission to borrow £128,129 for extensions of the electricity undertaking was concluded on Saturday.

Parliamentary.—During the week Select Committees of the House of Commons considered the Greater London Railway, the L.C.C. Tramways and Improvements, and the Matlock District Railless Traction Bills.

Legal.—The Railway and Canal Commission commenced the hearing on Tuesday of an application by the National Telephone Co. against the Postmaster-General in respect of notice received under an agreement for the purchase of the Company's undertaking by the Postmaster-General.

At the Glasgow Sheriff Court on Monday arguments were heard in an interesting appeal as to the assessment of the Corporation tramways. Judgment was reserved.

OBITUARY.

MR. E. BOULNOIS.—We regret to record the death of Mr. Edmund Boulnois, who was chairman of the Calcutta Electric Supply Corpn., deputy chairman of the Central Electric Supply Co. and a director of the Westminster Electric Supply Corpn.

PERSONAL NOTES.

Mr. T. Buckley, chief electrician to the New Zealand Telegraph Department, is visiting the United States, England and the European Continent for the purpose of inspecting the telegraph and telephone systems of those countries with a view to reporting to the New Zealand Government as to the adoption of any new apparatus, &c., that he may consider of advantage. Mr. Buckley returns to New Zealand about November.

Mr. Wm. Maurice, of Huchnall Torkard, Notts., has, we learn, resigned the management of the Huchnall Collieries, and is now developing his consulting practice as an expert in the re-organisation of old mines and in the electrification of collieries. Mr. Maurice is well known as the pioneer user of exhaust steam turbines and of the application of storage batteries to three-phase colliery installations. He has also successfully pioneered the machine mining of thin seams in the Leen Valley Coalfield, and on the literary side is the author of "Electric Blasting Apparatus and Explosives" and "The Shot-Firer's Guide," two volumes in "The Electrician" series of standard works.

Mr. H. W. Butler, chief engineer of the Electrical Power Storage Company informs us that he has now resigned his position with the Company and that all future communications intended for him should be addressed to 10, Belsize Park, Hampstead, London, N.W. Mr. Butler has been connected with the E.P.S. Co. for over 26 years.

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APPOINTMENTS VACANT AND FILLED.

The Allmanna Svenska Aktienbolaget, Västerås, Sweden, require for their estimating department an electrical engineer with large experience in working out estimates for electrical schemes. See an advertisement.

A switchboard attendant is wanted for a large power station. See advertisement.

The Newcastle & District Electric Lighting Co. (38, Grainger-street West, Newcastle-on-Tyne) require a shift engineer at their Close power station. Commencing salary £2. 10s., rising to £2. 15s. per week. See an advertisement.

A first class electrical engineer is required to take charge of instrument works. See advertisement.

A sales engineer is wanted by Sunderland Corporation electricity department. Salary £156 per annum. Applications to the borough electrical engineer and manager, Mr. Alfd. S. Blackman. See also advertisement.

A London institution of technical education by correspondence require an assistant instructor in electrical engineering. See advertisement.

Manchester Electricity Committee require a shift engineer at Stuart-street generating station. Commencing salary £175. Applications to the Chairman by 10 a.m. May 16.

An electrical engineering firm in Manchester advertise for an assistant chief tester in their instrument and transformer department, also two junior testers.

The Yorkshire Electric Power Co. advertise for a superintendent to undertake the control of the department engaged in laying underground and overhead mains, equipment of sub-stations, &c. Salary £250 per annum. Applications to the Company, Thornhill, Dewsbury.

A lecturer in applied mathematics is required for the Grey University College, Bloemfontein. Salary £400 per annum. Applications to the High Commissioner for South Africa, 72, Victoria-street, London, S.W., by May 19.

The Australian Commonwealth Government require a qualified person to design and superintend the establishment of wireless telegraph stations in Australia at £600 per annum. Applications to 72, Victoria-street, London, S.W., by May 20.

An important firm of electrical engineers require for their London office a junior assistant, with technical training and knowledge of German, for publication work.

Cheltenham Local Higher Education Committee require a director for their technical schools. Salary £220, rising to £250 per annum. Applications to the Clerk to the Governors by May 16.

Sheffield Electri ity Committee have made the following rearrangements of the staff :—

Mr. J. W. Barnes, superintendent of wiring and fittings department, to be commercial assistant, at £350 a year; Mr. C. E. R. Biggin, assistant superintendent of wiring and fittings department, to be superintendent, at £225 a year; Mr. F. E. Meredith, installation inspector, to be meter and testing assistant, at £143; and Mr. J. B. Wilkeley, chief accountant is to have his salary increased to £230 a year. The position of meter superintendent vacant by resignation, is not to be filled.

Mr. C. F. Edwin (A.C.G.I.) has been appointed chief electrical engineer to the Chilian Navy. Mr. Edwin obtained his diploma in electrical engineering in the Central Technical College in 1904. Since that date he has been with Messrs. Siemens Bros. Dynamo Works, having held the position of chief of test house for nearly four years.

Messrs. W. W. Warren and R. A. S. Duncan have been appointed shift engineers at the Greenwich generating station of the London County Council at £250 each per annum.

INSTITUTIONS AND SOCIETIES.

Incorporated Municipal Electrical Association.—A detailed programme of the Convention to be held at Brighton from June 27 to 30 has now been issued. On the first day of the Convention, following a welcome of the Association by the Mayor of Brighton, Mr. J. Christie (engineer and manager, Brighton Electricity Department) will deliver his presidential address, and the following two Papers will be read and discussed: "Electricity Supply viewed from the Municipal Committee's Standpoint," by Councillor H. Leese (Stoke-on-Trent); "Modern Wiring Practice," by Mr. J. W. Beauchamp (chief electrical engineer, Tunbridge Wells). On Wednesday, June 28, the meeting is to take place at the Municipal College, Portsmouth, when a Paper on "Internal Combustion Engines in Power Stations" is to be read by Messrs. H. L. Howard (chief electrical engineer, Barking) and R. M. Carr (chief electrical engineer, Leek). No Papers are down for reading on Thursday, June 29, when the meeting will be held at Brighton, but discussions are to take place on "Purchase of Fuel" and "Street and Shop Front Lighting," the discussions being opened by Mr. C. E. C. Shawfield (chief electrical engineer, Wolverhampton) and Mr. A. H. Seabrook (chief electrical engineer, Marylebone) respectively. The annual dinner takes place the same evening. The annual general meeting is to be held on the Friday morning, also at Brighton. In addition to the above Papers and discussions, visits will be paid to the Southwick power station of the Brighton Corporation, H.M. Dockyard power house, the lighting and tramway power stations of the Portsmouth Corporation, and other works.

Royal Society.—Among the Papers read at the meeting yesterday afternoon were the following: "On a Method of Making Visible the Paths of Ionising Particles through a Gas," by Mr. C. T. R. Wilson, F.R.S.; "The Path of an Electron in Combined Radial Magnetic and Electric Fields," by Dr. H. S. Allen; and "On the Absolute Measurement of Light—a Proposal for an Ultimate Light Standard," by Dr. R. A. Houston.

Royal Institution.—It is announced that the following gentlemen have been nominated as vice-presidents for the ensuing year: The Right Hon. Sir Henry Burton Buckley, the Right Hon. Earl Cathcart, Dr. Donald W. C. Hood, Mr. H. F. Makins, Sir Francis Laking, Bart., Mr. Alexander Siemens, Sir James Crichton-Browne, F.R.S. (treasurer), and Sir William Crookes, F.R.S. (honorary secretary).

Institute of Metals.—A general meeting of this Institute is to be held at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W., to-day, when the Second May Lecture will be delivered by Dr. G. T. Beilby, F.R.S. (President of the Institute of Chemistry), on "The Hard and Soft States in Metals." The chair will be taken at 8:30 p.m. by Sir Gerard Muntz, Bart., President of the Institute.

Institution of Civil Engineers.—The "James Forrest" Lecture will be delivered on Wednesday, June 28th, at 9 p.m., by Dr. F. H. Hatch, the subject being "Gold Mining in the Transvaal."

ARRANGEMENTS FOR THE WEEK.

FRIDAY, May 12th (to-day).

PHYSICAL SOCIETY OF LONDON.

8 p.m. Meeting at the Imperial College of Science, Imperial Institute-road, South Kensington. Agenda: "Stream Lines Past the Elliptic Cylinder and Magnetic Interpretation," by Sir George Greenhill, F.R.S., and Col. R. E. Hippisley, R.E. "The Method of Constant Rate of Change of Flux as a Standard for Determining Magnetisation Curves of Iron," by Messrs. J. T. Morris and T. H. Langford; and "Demonstration of a Electric Thermo Regulator," by Prof. H. L. Callendar, F.R.S.

INSTITUTE OF METALS.

8:30 p.m. Meeting at the Institution of Mechanical Engineers Storey's Gate. Lecture on "The Hard and Soft States i Metals," by Dr. G. T. Beilby, F.R.S. Second May lecture.

SATURDAY, May 13th.

BIRMINGHAM AND DISTRICT ELECTRIC CLUB.

7 p.m. Meeting at the Colonnade Hotel, New-street, Birminghan Paper on "Exhaust Steam Utilisation for Generating Electricity," by Mr. V. E. Walters.

TUESDAY, May 16th.

SCOTTISH SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEER

7.30 p.m. Annual General Meeting at 207, Bath-street, Glasgow.

THURSDAY, May 18th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Meeting at Victoria Embankment. Paper on "Automat Telephone Exchange Systems," by Mr. W. Aitken.

FRIDAY, May 19th.

ROYAL INSTITUTION.

9 p.m. Discourse on "Recent Experiments with Invisible Light by Prof. R. W. Wood.

THE LONDON ELECTRICAL ENGINEERS.

Officer Commanding: Lieut.-Col. H. M. Leaf.

The following orders have been issued for the current week :—

Monday, 15th, "A" Company.—Infantry Drill 7 to 7:30 p.m. Techni Drill 7:30 to 10 p.m.

Tuesday, 16th, "B" Company.—Technical Drill 7:30 to 10 p.m.

Wednesday, 17th, All Companies.—Annual Course of Musketry at P fleet Ranges. A list of trains and other detail can be obtained Headquarters, also railway tickets for officers, N.C.O.s and men atter ing the shoot.

Thursday, 18th, "C" Company.—Recruits Drill (Infantry Drill) 6:45 7:30 p.m. Technical Drill 7 to 8:15 p.m. Company Drill 8:20 to 9 p. (Millbank Barracks, Drill Order).

Friday, 19th, "D" Company.—Recruits Infantry Drill 7 to 8 p Technical Drill 7 to 10 p.m.

All Companies.—Annual Course of Musketry, detail as for Wednesd the 17th.

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THE SIXTH EDITION OF THE I.E.E. WIRING RULES.

The sixth edition of the Wiring Rules of the Institution of Electrical Engineers, which was issued last week and is dated April, 1911, has been expected for some time past. In revising this new edition the Wiring Rules Committee have had the assistance of the Cable Makers' Association and the Engineering Standards Committee. An exhaustive series of tests has also been carried out at the National Physical Laboratory on the temperature rise of conductors.

We propose here to enumerate briefly the chief features of the new Rules.

In the first place reference is made to the Board of Trade Regulations (1910) for medium pressures (250–650 volts), for the additional requirements of those places which do not come within the Home Office Regulations for factories and workshops.

Two new definitions are included, "bare" and "switchboard" being defined. Among the General Regulations applying where the pressure does not exceed 250 volts, a new rule states that "where the supply for heating or power is likely to interfere with the lighting, separate main supply fuses are desirable." The maximum current to be carried by incandescent lighting sub-circuits has now been raised from 5 to 6 amperes, whilst the maximum number of points on any sub-circuit must now not exceed 10. In the case of earthing, an earth conductor of No. 14 S.W.G., or equivalent section, is specified for every 50 amperes of working current or part thereof. Earthing conductors must be protected against mechanical injury.

A new rule states that in bathrooms special precautions must be taken to prevent the possibility of personal contact with any part of the system. Similar precautions must also be taken in respect of portable lamps where danger would exist, as in damp places.

Conductors (Size and Conductivity).—In calculating the size of conductors it is no longer necessary to assume that at least 5 watts may be consumed at any point. The permissible drop in pressure for lighting circuits must now not exceed 2 per cent. *plus* a constant allowance of 1 volt, subject to the currents given in the Table not being exceeded. This determines the minimum size of conductor; whilst for power and heating circuits the rise of temperature (20 per cent. F.) is the determining factor.

The Table giving the maximum permissible currents for the various sizes of conductors has been considerably altered. In general, it may be said that a very large increase has been made in the permissible current carried by small conductors; but, on the other hand, the maximum allowable current of large rubber insulated conductors has been reduced. Thus, whilst a 7/18 S.W.G. conductor has now a minimum carrying capacity of 5·2 amperes, instead of 4·2 amperes, in the case of both rubber insulated and paper or fibre insulated cables, a conductor having a nominal sectional area of 1 sq. in. has now a maximum permissible capacity of 595 amperes in the case of rubber insulated cables and 932 amperes in the case of paper or fibre insulated cables, as against 750 amperes for both types of cable in the previous edition of the Rules. Attention may be called to the fact that the carrying capacity of rubber insulated cables is now distinguished from that of paper or fibre insulated cables, separate columns for each class of conductor being included in the Table. Up to a size of 7/22 S.W.G., however, both types of insulated conductor have the same maximum capacity, but above this size larger currents are permitted with paper and fibre cables, the difference amounting to more than 50 per cent. in the case of the largest conductor mentioned above.

As regards other features of this Table, the minimum insulation resistance per mile has been reduced, in the case of vulcanised rubber cables for 250 volts pressure, from 2,000 megohms to 1,650 megohms; but for 1/16 S.W.G. and larger conductors the minimum insulation resistance remains unchanged. Flexible conductors have been omitted from the Table.

Insulation.—It is interesting to notice that the pressure test on insulated conductors has been reduced from 2,000 to 1,000 volts, whilst no mention is made of alternating current or frequency. The test for flexible cables is unaltered.

Wiring.—More space is given in the new Rules to methods of fixing the conductors, and the various methods are treated in separate sections. Where tubes with a polished inner surface are used, braiding is stated to be optional. As most attention is likely to be paid to the section dealing with metal conduits, we give this in its revised form.

ENCLOSED WIRING—METAL CONDUITS.

49. Conductors (excepting flexibles) insulated as in Classes A and B (para. 38) may be enclosed in steel conduits with details and accessories in accordance with the British standard specification for "Steel Conduits for Electrical Wiring" or in brass or copper conduits, which must comply with the following conditions:—

a. They must be electrically and mechanically continuous throughout. Plain slip sockets do not comply with this Rule, some form of screwed or grip joint having a conductivity equal to that of the continuous tubing being necessary.

b. At the outlet points of switches, boxes and fittings the ends of the conduits must either terminate at metal outlet boxes or they must socket into blocks, preferably of incombustible material. The conductors must in all cases be mechanically protected up to the fitting.

c. They must have all free ends bushed to prevent abrasion, except where wide bell-mouths are used.

d. They must be connected to earth (paras. 26, 27 and 28). In dry places isolated single lengths of tubing need not be earthed if adequately enamelled or otherwise insulated externally.

e. In damp places they must be watertight.

f. They must be efficiently drained if liable to internal condensation.

g. Sharp bends or elbows are prohibited, but inspection elbows are permissible.

The only new Rule as regards wood casing is the provision that "where the size of the conductor is larger than that of 7/19 S.W.G. sharp bends must be avoided". Where flexible conductors are used for open wiring, they must not "be carried unprotected within 4 ft. of the floor level." They must also be firmly supported, and, unless protected by conduits, must be attached to insulators. The supports must be spaced not more than 3 ft. apart. Flexible conductors must also be without joints, except in junction boxes. The lead covering of lead-covered conductors must be connected to earth.

Earthed Concentric Systems.—The Rules now deal more fully with concentric wiring. The following are the main points to be noted:—

59. Earthed concentric wiring may only be used when connected to systems:—

a. Supplied through double-wound transformers so as not to be in metallic connection with the general system of supply; or

b. In which the use of earthed concentric wiring has been approved by the Board of Trade; or

c. Having their own independent generating plant.

60. Every system must be protected by a single-pole switch or switch-fuse under the control of the consumer, and it must be easily accessible, and placed as near the generator or point of entry of the supply as circumstances permit.

61. Subject to para. 33*a*, the drop in volts on the external conductor from the point of earthing to the farthest lamp must not exceed 7 volts when the maximum current is in use.

62. The earthing shall take place at the point where the earthed concentric system begins—that is to say, at the main switch or switchboard.

63. From the point where the system is earthed the concentric system of wiring must be employed throughout up to the fixed outlet points for fittings. Twin flexibles may be used beyond this point.

64. All joints in the external conductors must be of such a nature that the conductivity of the conductor is not reduced.

65. Transformers, motors, arc lamps and all consuming devices must be controlled and protected as in two-wire systems, but only on the internal conductor. Only single-pole switches and fuses may be used, and no switches, fuses or circuit-breakers may be placed in the external conductor.

All ceiling roses, switches, plug connectors and outlet points must be so mounted that the external conductor is interposed between the internal conductor and the surface upon which the fitting is mounted. This does not prevent the ordinary wooden block being interposed between a metal plate and the ceiling rose, switch or plug connector.

66. Ordinary connectors, lamp holders and ceiling roses may be used. If screw socket lamp-holders are used, the centre contact of the lamp-holder must be connected to the internal conductor.

67. Fittings supporting lamps may be wired with two wires, one wire being insulated and connected to the internal conductor. The metal

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work of the fitting must be electrically connected to the external conductor.

68. The fuse board must be provided with either—

a. A metal case to which the external conductors leaving the board must be connected; or

b. A metal bar or wires connected to the external conductors, the whole being connected to a sheet of metal of the same size as the board, which is to be interposed between the board and the wall or surface on which it is to be mounted.

Switches and Circuit-breakers.—The new Rules stipulate that switches and circuit-breakers "must be so constructed or arranged that they cannot accidentally fall or move into contact when left out of contact." Maximum circuit-breakers must also be arranged effectively to interrupt the current before it so exceeds the working rate as to involve danger. According to the previous edition of the Rules, metal covers of switches for more than 5 amperes, at pressures over 125 volts, had to be lined with insulating material. The limiting current has now been raised to 6 amperes.

Fuses.—The rule as to the overload to be carried by fuses has been modified and reads as follows:—

They shall effectively interrupt the current when a short-circuit occurs, and they must be so proportioned to the current to be carried that no conductor protected by them can be raised in temperature above that specified in para. 37. When the working current does not exceed 10 amperes, the fuses must be proportioned to interrupt the current before or when the current through the conductors rises to three times the working current: for working currents above 10 amperes the fuses must be proportioned to interrupt the circuit before or when the current through the conductors rises to twice the working current. The use of fuses of the enclosed type is recommended. No fuse smaller than one having a working capacity of 3 amperes, to fuse at 9 amperes, need be inserted for sub-circuits.

Plug Connectors.—A combined switch and plug connector is stated to comply with the requirements.

Lampholders.—A lampholder must not be in metallic connection with the guard or other exposed metal work of a portable hand lamp.

Incandescent Lamps.—The use of cord grips is recommended, and especially for large lamps it is advisable that the conductors be spaced apart.

Heaters.—Portable heaters must have at least one section controlled solely on the live side of the connector. Where non-luminous heaters are liable to cause danger when left in circuit, a red pilot lamp is desirable.

Motors.—The only changes are that no-volt releases are not now stipulated for alternating-current motors, and that large motors apparently need not have linked circuit-breakers on the conductors.

Accumulators.—Portable accumulators with celluloid cases must be so arranged and placed during re-charging that if they become ignited the fire cannot spread.

The Board of Trade Regulations (1910) for medium pressures, so far as they relate to conditions intended to be covered by the Wiring Rules, are reprinted, as well as the Home Office Regulations for factories and workshops.

PRACTICAL ASPECTS OF PRINTING TELEGRAPHY.*

(*Concluded from p.* 138.)

BY DONALD MURRAY, M.A.

Summary.—The author first discusses the field for printing telegraphs. Their use is chiefly in connection with land lines between centres of population, and they will assist materially the co-operation between telegraph and telephone. He next gives a detailed account of the difficulties encountered in connection with the development and practical application of printing telegraphs, and finally describes the Murray automatic system and the new Murray multiplex system.

PART III.—(THE MURRAY PRINTING TELEGRAPH SYSTEMS.)

To illustrate some methods by which the foregoing difficulties have been more or less overcome, an account is given of the Murray printing telegraph systems. Brief reference only is made to the Murray automatic system, as it has already been described in the Paper on "Setting Type by Telegraph."†

It may be explained in the first place that the Murray printing telegraph systems form a complete printing telegraph organistion, and that they comprise the Murray automatic page-printing telegraph and the Murray multiplex page-printing telegraph, which have been designed to work together as one whole, the automatic system being best suited for long lines, and the multiplex for lines of average length. Many of the instruments are the same in both systems, and are interchangeable, the same alphabet or code of signals—the 5-unit Baudot—being used in both. An important point is that the same keyboard perforator is used on both systems.

In the Murray automatic system, the messages are first perforated on a strip of paper tape in the Baudot 5-unit alphabet. The perforated tape is then used to transmit the messages by means of an automatic transmitter working on the principle of the Jacquard loom. The speed of transmission of the signals is from 100 to 180 words (600 to 1,080 letters) a minute, and at the receiving station the arriving signals are recorded at the same speed as perforations in a second paper tape, which is an exact replica of the transmitting tape. This reproduced tape at the receiving station then serves to operate an automatic typewriter somewhat on the principle of a mechanical piano. The telegraph line is worked duplex, giving one transmission in each direction simultaneously on the one wire. The received messages are printed in Roman type in page form, at speeds ranging up to about 200 words a minute (20 letters a second). The keyboard perforator, automatic transmitter and receiving perforator were described in the previous Paper, and there has been no substantial alteration in the construction of these instruments, although there have been many improvements in detail. In the automatic printer a great improvement has been made by the construction of a high-speed typewriter specially designed by the inventor of the system to suit the automatic selecting mechanism. The essential feature of this typewriter is that the typebars are very short, only 2 in. long from the pivot to the type. This ensures extremely high speed. It is the shortest typebar ever put into a typewriter, the average length of typebars in typewriters being from 3 in. to 4 in. As the moment of inertia varies as the cube of the length of the typebars, the gain in speed is from three to eight times. The typebars are provided with ball-bearings, to ensure free movement and permanent alignment. The typebars being so short, it was necessary to arrange them in a complete circle in order to get room for the required number of 51 characters. As it was very desirable that the operator should be able to see the printing as it proceeded, the circle of type had to be arranged in a vertical plane. Key levers were omitted, as the inertia of key levers interferes with high speed. There are no other special features beyond the fact that the machine is built with unusual strength to stand the strain of the high speed.

In the Murray automatic printer, the letter, line and column feeds are entirely automatic, but the page feed is manually operated, this having been found sufficient for present requirements. The maximum speed that has been reached on this printer is 250 words a minute (25 letters per second). The speed might perhaps be pushed up to 300 words a minute, but the wear and tear would probably be great.

In order to prevent interruption of traffic by any stoppage of the apparatus, it is necessary to have reserve machines. With an automatic system this means duplicating the whole of the apparatus. The result is that the Murray automatic system is very expensive, costing at present about £1,200 per circuit, exclusive of royalites. This is a very serious handicap.

Taking the four factors already referred to—namely, saving of time, labour, line and office equipment—the Murray automatic system shows to advantage only in respect of saving of line. On long lines, 1,000 miles and over, the saving of time and labour are of much less importance than increase in the carrying capacity of the line. This is the case, for instance, in Russia and other new countries. It is in such conditions that the Murray automatic has decided advantages, as follows: (1) The alphabet or code of signals that it employs, and the manner of employing it, result in less signalling time per letter than in the case of any other sytem. (The ratio is approximately 5 for the Murray automatic compared with 6 for the Murray and the Baudot multiplex systems, and 8 for the Morse alphabet.) (2) Synchronism is not employed, only isochronism. (3) Governing or control of speed is very quick. (4) The Murray automatic apparatus is simple. (5) It works very well through the simplest of all repeating stations—namely, the Wheatstone duplex. (6) It works very well and easily with the duplex balance, even on very long lines. Hardly any of these advantages are of importance on short lines.

Murray Multiplex Page-Printing Telegraph.—It is only about a year since this system passed out of the laboratory stage and arrived at practical success. The Murray automatic system may be said to be based on the Wheatstone automatic transmitter. In a multiplex system the instrument corresponding to the Wheatstone automatic

* Abstract of a Paper read before the Institution of Electrical Engineers.

† "Journal" of the I.E.E., Vol. XXIV., p. 555, 1905.

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transmitter is the distributor, and the Murray multiplex system may similarly be said to be founded on the Baudot, because it has taken the Baudot distributor as its basis. For driving the distributors, however, instead of the Baudot arrangement, the Delaney multiplex plan of using the Lacour phonic wheel motor is adopted. Apart from the distributors, the only resemblance between the Baudot and the

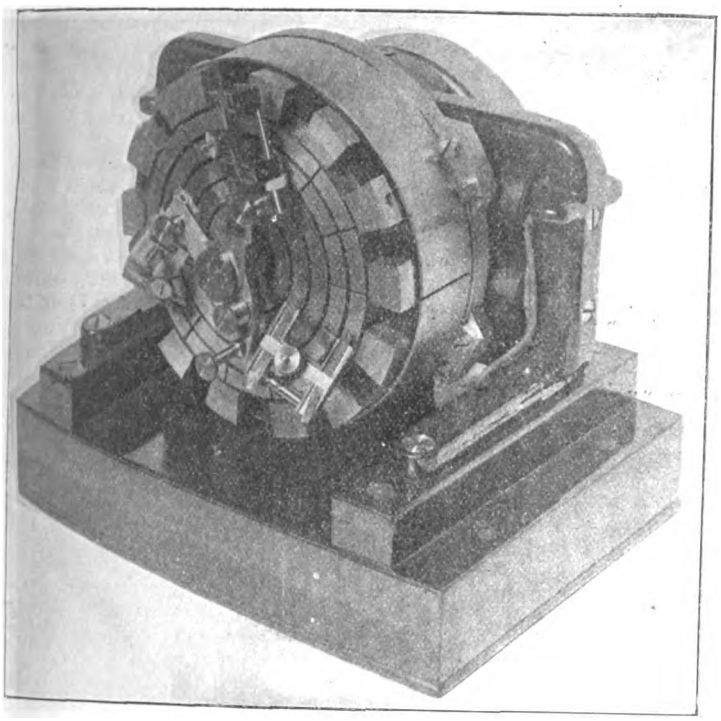

Fig. 1.—Front View of Murray Multiplex Distributor.

Murray multiplex is in general principles and in the use of the Baudot cabinet.

Like the Baudot and similar systems, the Murray multiplex printing telegraph divides up the line time so as to give several transmissions or channels on one telegraph wire, each at a comparatively low speed suitable for the work of one operator sending and one receiving. Two distributors, identical in design, are employed, one at each end of the telegraph line (station A and station B). The distributor at station A sends out a governing impulse once for each revolution of the contact arm. This impulse controls the speed and phase of the distributor at station B so as to keep it running in synchronism with the distributor at station A. The distributor used in the Murray multiplex is shown in Fig. 1. This instrument is a "double," giving two simultaneous transmissions working simplex and four when working duplex. The new system may also be worked "triple" or "quadruple," the duplex balance in these cases giving 6 or 8 transmissions simultaneously on one line.

The distributor brush arms are carried directly on the spindle of a phonic wheel motor, which is identical in all respects with the phonic wheel motor employed in the Murray automatic system, and it is driven in the same way by a vibrating reed. There are no gearwheels or governing mechanisms. The commutator and contact arms and brushes are the same as in the Baudot, and the adjustments are the same. It has the advantage over the Baudot of being simpler, cheaper and easier to construct. On the other hand, where Baudot distributors are already in use the Murray multiplex transmitting and printing mechanisms will work excellently with the Baudot distributors.

The theoretical arrangement of the electrical connections in the Murray multiplex is shown in Fig. 4. One of the transmitting channels of segments of the distributor and revolving contact brush are shown at each station. For the sake of clearness the other segments for the other transmissions on the same telegraph line are omitted, and for the sake of simplicity the Baudot five-key transmitter shown at station A. Also at station A the vibrator and the wheel that keep the contact brush of the distributor revolving are omitted. Various permutations of five positive and negative impulses are transmitted into the line as the distributor arm revolves.

A typewriter keyboard mechanism to operate these five contacts can be easily designed. In one machine made by the author for use with the Murray multiplex there is a cadence magnet which locks and unlocks the keys to enable them to be depressed at the right moment. There is also a letter-counting magnet, which rings a bell at the end of each line of about 60 letters. This is a first-class instrument of its kind, simple, strong and cheap to make; but as the result of careful practical trials by the British Post Office, automatic tape transmission was found to be so much superior to direct transmission that direct transmission was abandoned altogether, so far as the Murray multiplex is concerned.

Actual trial between London and Birmingham for several weeks showed the advantage of automatic tape transmission over direct transmission to be as follows: (1) The output of messages per operator per hour is practically doubled as compared with direct transmission. (2) There is less nerve strain on the sending operators, because there is no cadence to be observed. (3) Much more skill is required to work on the direct cadence keyboard than on the keyboard perforator. (4) Provision is made for quick and invisible correction of errors before transmission in the case of the indirect method of tape transmission in the Murray multiplex. Practical experience has shown that this is a valuable feature with page-printing. The trials were made at 40 words a minute instead of the normal Baudot speed of 30 words a minute, the increased speed being one of the advantages gained by the use of a typewriter keyboard.

The instruments used in the Murray multiplex for tape transmission are shown in Fig. 4. On the right, at A, is a keyboard perforator identical with that used in the Murray automatic system. The tape passes from the perforator into an automatic transmitter, B. This is the same as the tape-feeding mechanism of the Murray automatic printer, except that the tape-feeding mechanism is driven in this case by a magnet instead of by a cam. After running through the automatic transmitter the tape passes on to an automatic tape-winder, C. This instrument is of a very simple character and is entirely automatic. Both sides of the tape may be used, so that the cost of the tape is small. As the automatic transmitter runs steadily at 40

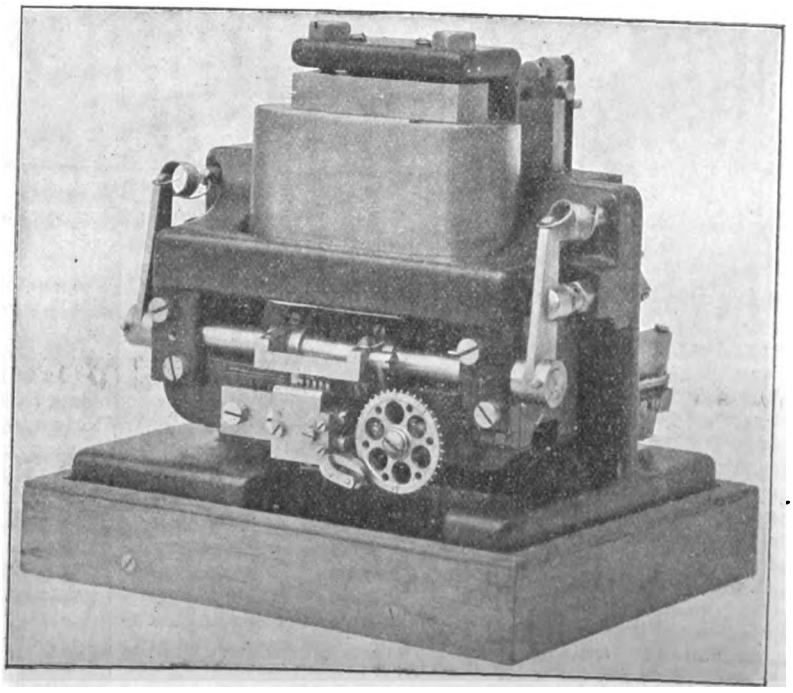

Fig. 2.—Murray Multiplex Receiving Perforator.

words per minute, it may at times overtake the operator. A starting and stopping lever is therefore provided on the automatic transmitter shown at S. This is arranged with a locking mechanism so that the operator can only start or stop the transmitter at the right

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moment. There is therefore no danger of interrrupting a letter signal in the act of transmission. In this way the operator has complete control over the tape. It is possible to make a much simpler tape transmitter than that shown in Fig. 3 if the perforations in the tape are arranged crossways, but in that case the tape would not be interchangeable on the Murray multiplex and the Murray automatic systems.

Tape transmission involves considerable increase in capital cost compared with direct transmission, and it also involves cost for paper tape, but the saving in line and labour is so great that it far outweighs the increased expenditure.

One disadvantage of tape transmission is that a rapid operator may go on perforating until he is several messages ahead of the transmitter. An inquiry may then come through from the other station, and the operator cannot transmit his answer until the messages already perforated have been transmitted. This may take two or three minutes, and it would delay delivery of a message at the other station. An arrangement has accordingly been designed, by throwing over a switch, to convert the keyboard perforator temporarily into a direct transmitter. The tape transmitter is switched out, and the punching magnet of the perforator becomes a cadence magnet. Five contacts are provided on the perforator to be operated directly by the keys. As soon as the reply is transmitted the switch is thrown over again and tape transmission is resumed. The method of governing the distributor is similar to that employed in the Murray automatic system. It will be seen in Fig. 4 that there is a local battery and a circuit passing through a local relay described as the governing relay. When the two brushes at the two stations reach the two negative contacts on the two distributors the main line relay contact will be opened, and there will be no local action at station B. If now the vibrator at station B is adjusted to run 1 or 2 per cent. faster than the vibrator at station A, then the rotating brush of the distributor at station B will run 1 or 2 per cent. faster than the brush at station A. Hence, when the brush at station A is on the plus contact, so that the main line relay contact at station B is closed, the brush of the distributor at station B will have reached the minus contact. The result will be that the local circuit through the governing relay already referred to will be closed, and consequently the governing relay contact will be momentarily opened. In this way the governing impulse from station A will repeat its retarding influence four times a second on the brush at station B. In this way the two brushes at stations A and B are kept not only at the same speed but also in phase, so that when the brush at station A touches successively contacts 1, 2, 3, 4, 5, the brush at station B will also be touching successively contacts 1, 2, 3, 4, 5, on the distributor at station B. Any permutation of signals sent out from the keyboard at station A will therefore be exactly reproduced in the five setting magnets of the printer at station B.

Fig. 5 is a sectional side elevation of the printer, which is driven by a small $\frac{1}{16}$ H.P. motor. As the printer will print correctly as long as it is driven faster than the distributor, there is no need for synchronism between the printer and distributor, the former being arranged to run anywhere about 20 to 30 per cent. faster than the latter. The Blickensderfer typewriter is employed, and the message forms are fed in automatically from a roll made up in a rather unusual way. The message forms are perforated along each side like a cinematograph film, so as to gear on to sprocket pins on each end of the typewriter platen. The message forms, in addition to being perforated along the edges, are lightly pasted together so as to overlap and at the same time form a continuous band, which is wound into a coil. The perforations ensure positive column and page-feed, and the overlap of the message forms renders it very easy to pull the messages apart after they are printed.

One argument used against page-printing by those who have been trained up in the use of tape printers like the Hughes and Baudot is that, as every correction and inquiry involves the use of a message form, there is great waste of message forms. Actual observation during the practical trial by the British Post Office showed that the loss from this source did not exceed 5 per cent. of the message forms used, and even this small loss could be halved by a little care and foresight. Also the writer has designed an arrangement by which inquiries and corrections (R Q's) can be obtained directly printed on a tape, thereby avoiding any waste of message forms, and also avoiding delay.

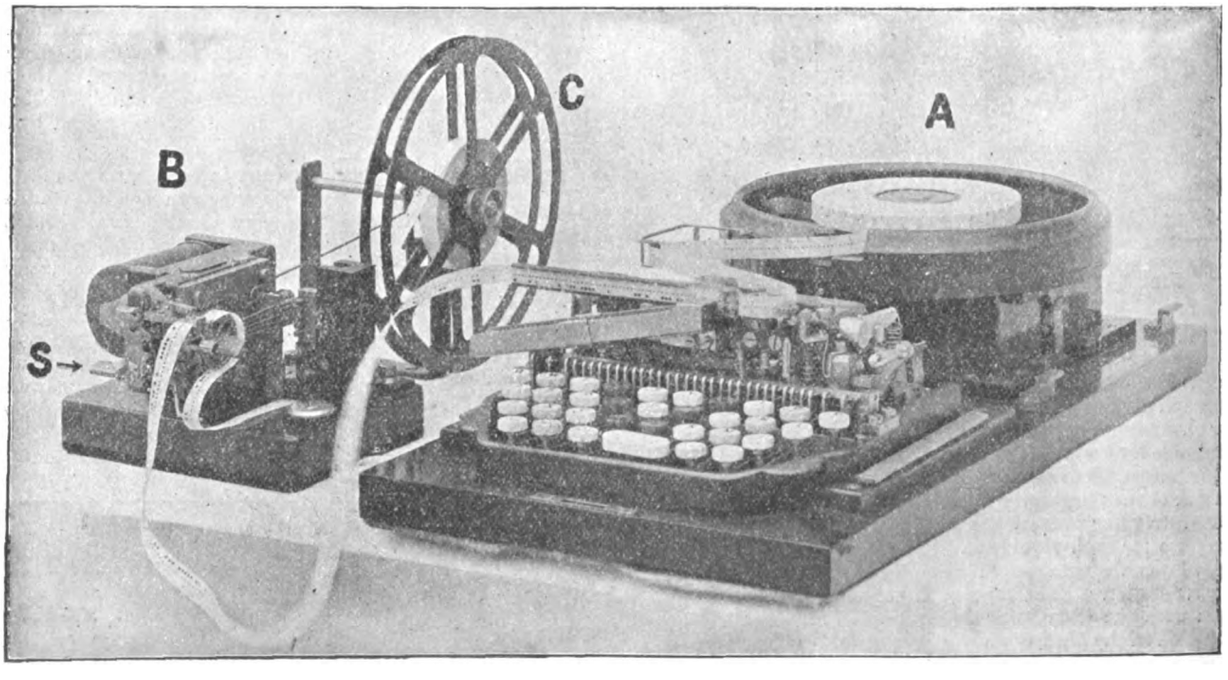

Fig. 3.—Tape Transmission Equipment of Murray Multiplex.

An important point to be noted about this multiplex printer is that the five setting magnets have very little work to do. They have merely to perform a slight releasing operation. Consequently they can be successfully operated by a very small contact on the distributor. The value of this lies in cases where a considerable number of transmissions (four to six) may be required. Under such conditions the contacts on the distributors are necessarily very small.

Receiving Perforator.—With a multiplex printing telegraph system it is a comparatively easy matter to give three towns, A, B and C, independent and simultaneous communication with each other on one telegraph wire. In the Murray automatic system all the received messages are first recorded at a high speed as perforations in paper tape, and from this perforated tape the messages are afterwards printed automatically. In the Murray multiplex a different kind of receiving perforator (Fig. 2) is provided. It is essentially a Murray keyboard perforator tilted on end and with the keys omitted. In place of the keys there are five small magnets which do the work of the keys—that is to say, they control selectively five small steel rods, which determine the holes to be punched in the paper tape. These five magnets correspond exactly with the five setting magnets of the multiplex printer (*see* Fig. 4). Each of these five setting magnets of the receiving perforator are placed in series with the correspond-

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ing one of the five setting magnets of the printer. The punching magnet of the receiving perforator is operated by the same impulse as that operating the printing magnet (Fig. 4) of the printer. On the printer there is provided a switch to throw the receiving perforator into or out of action by means of a signal from the distant station. If the sending operator at the distant station A has a message which

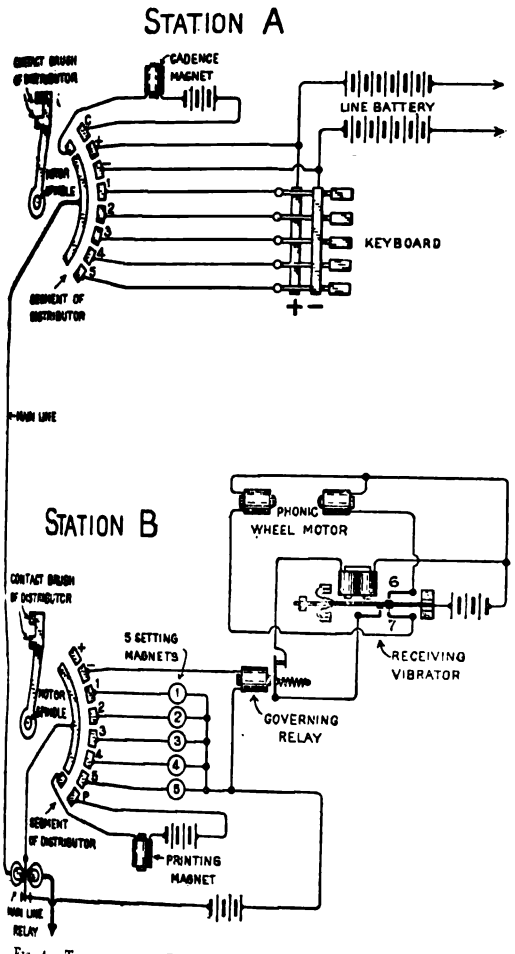

FIG. 4.—THEORETICAL DIAGRAM OF MURRAY MULTIPLEX.

requires to be transmitted at station B to, say, station F, he transmits a special signal which throws over the switch in the printer at station B. This puts the receiving perforator in action. The message is then recorded as perforations in tape by the receiving perforator at the same time as it is being printed in page form by the printer. At the end of every message the page signal, in addition to turning up a fresh telegraph form, automatically cuts out the receiving perforator.

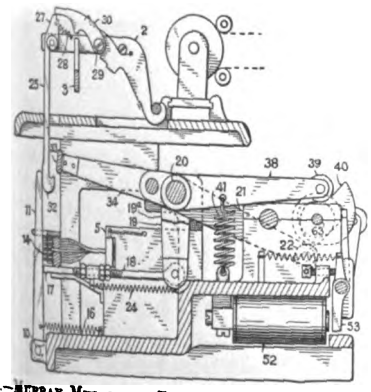

FIG. 5.—MURRAY MULTIPLEX PRINTER: SECTIONAL ELEVATION.

Consequently only messages requiring retransmission are perforated, and the sending operator has control over this operation at the distant station. As there is a printed message produced at the same time as the perforated tape, a glance at the printed message will show whether it has been correctly received. If it has been received correctly, then it can be automatically retransmitted to its destination by means of the perforated tape. If the message has not been accurately received, it can be corrected and sent in the ordinary way by manual instead of automatic retransmission.

Results with Murray Multiplex.—It is too early yet to say positively what results can be obtained with the new Murray multiplex system. A complete installation has only recently been completed for the British Post Office and is now being installed between London and Manchester. Prior to this, an experimental set, giving one transmission only, was made by the British Post Office, and tried for about six months between London and Birmingham. The results were surprisingly good. The sending operators were two girls without previous experience on typewriter keyboards, and yet within one month they were each punching from 40 to 45 messages an hour. After about three months' practice each of these two girls succeeded in perforating 100 messages in one hour. On several days during busy hours the average exceeded 100 messages an hour.

DISCUSSION.

Major W. A. J. O'MEARA congratulated the author upon having turned his attention to the Baudot principle. Many inventors of printing telegraphs had an idea that the usual telegraphic message was about 1,000 words long, and gave their attention to dealing with such long messages; but Mr. Murray was fortunate in having had some experience of British Post Office telegraph work, having been on the engineering staff for some considerable time. His invention, therefore, was based upon experience and was of a very practical kind. He (the speaker) entirely agreed that the telephone in the future would be a feature of the telegraph system. The problem of the telegraphs had, of course, to be very carefully considered, since in the future they might come to a state of affairs when there were only long-distance telegraphs. In that case all they would have to take care of would be the line, and to formulate a system which would make the best use of that "line time" in connection with messages the majority of which averaged 18 words. Mr. Murray was showing them how they could make better use of the "line time." He (Major O'Meara) personally had an opportunity recently in America of discussing that subject. Some persons thought that the use of a transmitting tape involved waste, but he thought if they considered the matter carefully they might alter their opinions. If a telegraph operator, especially with the page-printing system, made a mistake, one of two things had to be done—either repeat the whole message or make a correction. A correction, however, on the form which went to the public was a mistake, as the public were suspicious, and if they saw a correction they suspected "cooking." In America he had observed that the whole message was rejected if a mistake was made. That entailed considerable waste of the "line time." Personally, he was inclined to think that in connection with all high-speed systems the tape was the proper thing, especially if the tape could be inspected before it was put through the transmitter. In that way he thought they would have the greatest use made of their "line time."

Mr. F. HIGGINS (Exchange Telegraph Co.), in a communication sent to the meeting, said he could not endorse the references made in the Paper to the difficulty in distinguishing pounds, shillings and pence from fractions. He showed an example of a telegraph tape where the shilling mark was used for dividing pounds, shillings and pence, and the horizontal bar in fractions. As to the advantage of the telephone as a feeder to the telegraph, his Company had to handle at times as many as 500 telephone messages, and to distribute them to as many receivers. The transmission of ordinary messages and the transmission of news were, he said, absolutely different. There were many apparatus brought forward for securing high speed of working, but owing to the necessity for accuracy his Company preferred to sacrifice a little speed in order to obtain accuracy. The apparatus they had in use worked without skilled attention.

Mr. G. F. MANSBRIDGE (Postal Telegraph Factory, Holloway) agreed with Mr. Murray in regard to the telephone assisting the telegraph. He, however, gave a word of warning; the telephone could never do a great deal in assisting the telegraph because the principle on which messages were sent was fundamentally different in each case. Telegraph messages were tripped out letter by letter, but telephone messages were sent in chunks. That difficulty alone would prevent the telephone becoming a large feeder to the telegraph. In ordinary commercial messages many words and phrases would be found which offered difficulties comparable with ordinary code words. The telephone might be useful for ordinary messages, but could not be of great use, in his opinion, for commercial messages.

Mr. F. RYAN (Eastern Telegraph Co.) said, in regard to the use of the keyboard perforators, that the cable company with which he was connected experienced some difficulty in working these instruments, and were now trying to modify them so as to function with 12 keys instead of 52.

Mr. S. EVERSHED thought Mr. Murray had given an extremely clear exposition of a complicated matter both in his first Paper some five years ago and in the present case. In telegraphy the counting of the number of words seemed to be a nightmare. He suggested that the sender might be compelled, without knowing it, to count the message and also add up the cost of the telegram. That could be done by the use of squared paper telegraph forms, one letter to go in each square or compartment, and the cost to be printed at intervals of, say, six letters along each line of compartments.

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Mr. A. J. STUBBS (G.P.O.) said it was interesting to note that Mr. Murray had arranged a device for temporarily changing a perforator into a transmitter. That was done some two or three years ago by Baudot, of Paris. In regard to the latest instrument of Mr. Murray for receiving simultaneously upon the printed page and the perforated tape, he anticipated that that would be an extremely useful device under the circumstances described by the author. Supplementing Major O'Meara's remarks in regard to slip versus page printing, he believed Mr. Murray rather anticipated Major O'Meara's comments in regard to the faults made by the operator in preparing the slip. No device, however, could anticipate faults introduced by the line, and however carefully the slip might be prepared by printing devices, there would always be errors introduced by defects on the line, and it was that which made page printing so liable to come out too faulty for transmission to the public. With slip printing all the faults could easily be cut out by the operator when gumming up the slip.

Mr. WALTER JUDD did not suppose that any such apparatus as that of Mr. Murray would be adopted for long-distance cable work; but in any system adopted the International alphabet must be retained. The cable companies regarded that point as very important, as in the case of the punching or printing apparatus breaking down they wanted to have the power of reverting to the old well-tried recorder system. It would be awkward to have two different alphabets in use. He was much interested with that part of Mr. Murray's paper where the traffic aspect of the system was dealt with. There were very great difficulties in such matters, because in a page-printing telegraph it was impossible conveniently to correct mutilations and errors. In the tape system there was the trouble of getting the wet copy, but mutilations and errors could be cut out. Then as to the tape that had to be perforated at the receiving end ready for further transmission, many difficulties cropped up there from the traffic point of view. He was hoping, however, that before very long they would have a machine that would be suitable for cable work. One had been designed many years ago by Mr. S. G. Brown that worked up to a certain degree of perfection. He thought now they had got a machine of their own design that would come into use for cable working. The mechanical difficulties were far less than the traffic difficulties.

Mr. J. HUME BELL did not think the advantages to be obtained by the use of keyboard perforators would come up to expectations until they had an improvement in the handwriting of the general public. He was sorry Mr. Murray had stuck to page printing in preference to printing on tape, because it was responsible for many of the difficulties which Mr. Murray referred to, and involved considerable alterations to present practice in dealing promptly with telegrams in large offices. He agreed that the introduction of printing telegraphs would reduce the number of errors, and stated that records showed the number of errors per 100 messages to be as follows: Morse slip 0·011, Morse sounder 0·009, Hughes printer 0·004.

Mr. W. NOBLE said that Major O'Meara had referred to the fact that the author was able to deal with the subject better because of his practical experience in the British Post Office. He had always thought that it would have been in the interests of the department had Mr. Murray spent six months in the telegraph gallery seeing the operators at work immediately he took service in the Post Office. The author would then have foreseen and avoided many of the difficulties which he had experienced. Reference was made in the Paper to the Hughes tape printer which was used for inland work in France and other Continental countries, and also for telegraph traffic between Gt. Britain and the Continent. The British Post Office was now extending the use of the Hughes as well as the Baudot for inland work, and the use of the latter would be increased as more apparatus became available. The result was entirely satisfactory. Some few years ago the Hughes duplex system came into use here for inland work, and at the present time 12 circuits were equipped with that apparatus. He did not know whether it was the introduction of Mr. Murray's apparatus into the British Post Office that caused the latter to return to its old love—the Wheatstone—but, in any case, trials had been made with the automatic Wheatstone with highly satisfactory results. The present day scheme of Wheatstone working with keyboard perforators and the pasting of the Morse slip was very economical. Some 70 to 75 per cent. of messages had to be retransmitted, and for this work the Morse slip pasted on forms was equally reliable, and more economical than the printing apparatus. Furthermore, the Wheatstone was largely used by the Post Office for news, and there was always spare apparatus available in case of breakdown, whereas with the printing telegraph duplicate sets would always have to be available. He had a doubt whether Mr. Murray would get continuously out of the new multiplex machine 40 words per minute. The Baudot gave an average of 30 words per minute, and he doubted if Mr. Murray's instrument would go above that. As to the use of the telephone facilitating telegraph transmission in the future by merchants sending telegrams direct to the telegraph operator, as outlined by Mr. Murray, he did not think that was likely to happen. After all, the sending of telegrams over the telephone was a very slow process, and in London the Post Office handled many thousands of messages per day, sent through pneumatic tubes in large batches. With a larger number of messages coming over the telephone the aggregate delay would be much greater than at the present time, and many telephone circuits and many operators would be required to cope with the traffic.

Mr. DONALD MURRAY, in reply, said there was much conservatism on the part of the public and also of the Government. In all matters of the kind under discussion, however, there was a very old and highly esteemed gentleman who influenced all parties—namely, Anno Domini; and he thought that Anno Domini was on his side. He would reserve any further reply for the "Journal."

REINFORCED CONCRETE ELECTRIC LAMP POLES.*

BY L. C. SABIN.

Recent improvements in progress at St. Mary's Falls Canal, Michigan, necessitated replacing several electric light poles and adding others. The poles in use were made of timber and had to be renewed quite frequently because of decay just above the ground surface. It was decided to build an experimental pole of concrete, and this proved so satisfactory as to warrant the construction of 40 poles of the same type.

The poles are 11 in. square at the base, and 6 in. at the top, with the corners chamfered by inserting in the corners of the mould triangular strips 1in. on a side. The reinforcement consists of one ⅞ in. square, twisted bar, 34 ft. long, in each corner, extending from about a foot above the base to the top, and two similar bars ½ in. square, 25ft. long, in each side, extending to within 9 ft. of the top. The bars were tied together at intervals of 4 ft., with two turns of No. 6 soft steel wire, bent to a square, within which the rods were placed and secured at proper spacing by winding with stove wire.

In the centre of each pole is placed a standard black gas pipe, 1¼ in. diameter, in two lengths of 15 ft., to lead the wires from the cut-out box, near the base, to the top crook.

The wires are brought from the main conduits through 2 in. galvanised duct to the concrete base in which the pole is set, and up along the outside of the pole to the cut-out box, located about a foot above the base. The connection from the lamp to the top crook or goose neck is made through a high-tension insulator and outlet bell.

The poles were moulded in a horizontal position. For finishing the sides the film of neat cement was removed by rubbing with a flat piece of sandstone and water, leaving a "sand" finish. Later, carborundum blocks were found well adapted to this purpose. Some of the poles first made were painted with a neat cement grout tinted with yellow ochre, but it was later decided that the natural gray of the concrete was preferable. The poles are set in a block of mass concrete 3 ft. square by about 4 ft. deep.

The material and labour required per pole and the cost are given by the author for the following wages per eight-hour day: Foreman, $3; carpenters, $2·25 to $2.75; cement finisher, $2.25; common labour, $2. The entire cost of forms is included in the cost of 42 poles, although much of the material is good for further use. The total cost per pole may be summarised as follows:—

	£	s.
Pole as moulded	7	6
Transportation to site	0	14
Erection, including base	4	16
Wire, cut-out, &c.	4	1
Wiring and fitting up pole	1	1
Total cost	£17	18

Considering the fact that the life of a wooden pole is quite limited and that such poles must be painted annually, at a cost of about 4s., there seems to be no question that the concrete pole is more economical, especially where the wires are placed underground. As proof of this the following cost for wooden poles is given:—

	£	s.
Cost of trimmed pole	5	2
Transportation to site	0	12
Erection, including base	4	8
Wiring, &c.	5	2
Total	£15	4

The strength of the concrete pole was determined by a test of a pole moulded for the purpose, without the central pipe, top casting, and steps, but in other respects the same as the regular poles. Five feet at the butt of the pole rested on a mass of masonry, about 3 ft. above the ground, to which it was firmly secured by two pairs of fox-wedge bolts, one pair being placed 12 in. and the other 42 in. from the end of the pole. Near the top, and 29 ft. 7 in. from the edge of the masonry, was hung a platform which could be loaded with cast-iron weights. The pole developed a moment of resistance of 528,000 in.-lb. before showing any signs of failure. The yield point appears to have been reached when the bending moment was 628,000 in.-lb. The maximum moment developed was 800,000 in.-lb. At this point the measured deflection was 27·2 in., but as the loading platform touched the ground this measurement is somewhat too low.

After the load was removed the deflection decreased to 12¾ in. the small tension cracks along the pole in the upper side, extending about half the depth, remaining plainly visible.

* Abstract of an article in "Engineering News."

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ELECTRIFICATION OF THE LONDON, BRIGHTON & SOUTH COAST RAILWAY.

With the taking over of the tramways by the London County ...ncil and the electrification thereof, the Brighton Railway Com. ...an began to feel the very serious competition of the cars, and in ...0, having obtained Parliamentary powers, instructed their con...ring electrical engineer, Mr. Philip Dawson, M.Inst.C.E., to report ... the whole question ...the electrification of ...ur railways. As a ...sult of this report Mr. ...wson was instructed ... prepare specifica... which were issued ... 1905, and tenders ...ived. After careful ...sideration, the con...ct was awarded early ... 1906 to the Allge... Elektricitäts ...sellschaft, of Berlin, ...ose tender was con...dered by the railway ...mpany to be the ...ost favourable from ...l points of view. The ...ntract let was for ...hat is known as the ...uth London line, ...hich connects the two ...ntres of London ...idge and Victoria, ...d passes through ...st Brixton, Denmark ...ill and Peckham ...ye.

The decision as to ...hat system to adopt ...as not arrived at until ...fter the most careful ...amination and consideration of all that had been done hitherto, ...nd of the special problems involved in the electrification of the ...righton Railway. One of the important points which could not be overlooked was that the very heavy traffic already existing between London Bridge and Brighton rendered it likely that if electrification proved a success on the suburban system, it might afterwards have to be extended as far as Brighton. It was for this reason that the single-phase system was adopted, and results have fully justified the installation of this system.

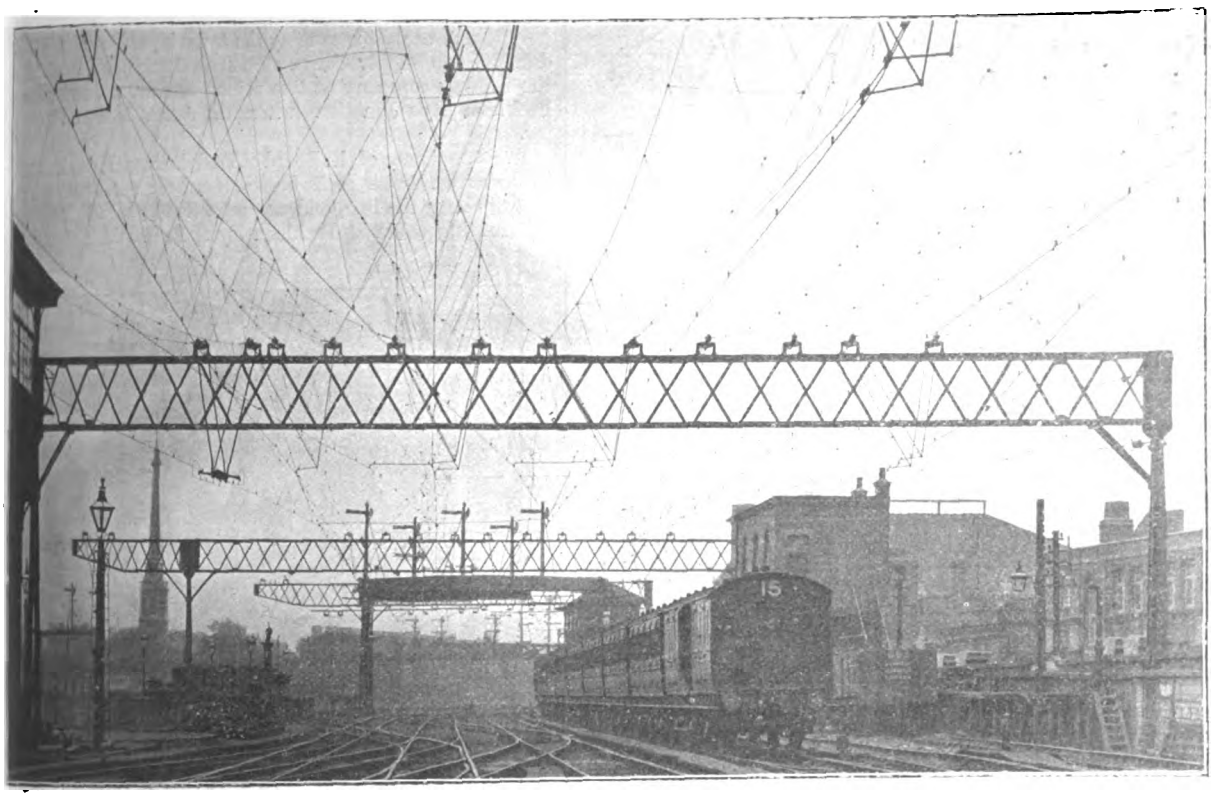

FIG. 1.—LONDON BRIDGE YARD, LOOKING FROM STATION.

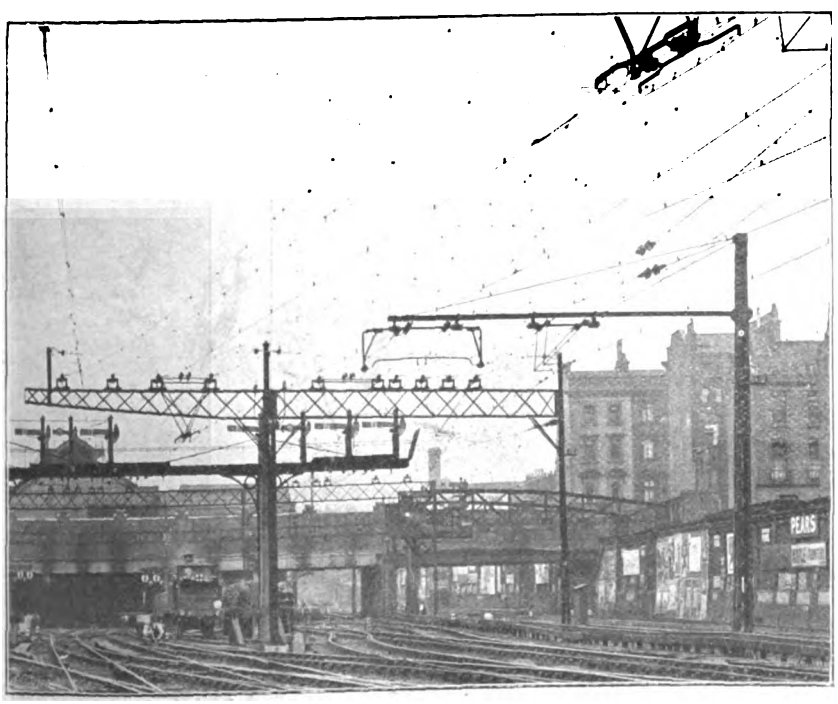

FIG. 2.—VICTORIA YARD, SHOWING LOW BRIDGE ENTERING VICTORIA STATION.

In laying out the scheme for the first electrification the fact was carefully considered that the success of this portion of the line would lead to the electrification of the whole suburban system. With this end in view the plans were so drawn up that the first portion to be electrified should form an integral part of the whole electrification, if and when completed.

Experimental trains were run on the South London line early in 1909, the full electric service being taken up in December of the same year. The length of the route is 8·7 miles, and this is equivalent to 20½ miles of electrified single line. The average distance between stations is 4,590 ft., whilst the shortest distance between any two stations is 1,386 ft. The route is very tortuous. But notwithstanding the difficulties, the journey (including 20-second stops at each station) is easily accomplished in 25 minutes. Five platforms are electrically equipped at Victoria, whilst there are six platforms equipped at London Bridge.

The success of the first experiment has been so great that in May

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of last year the directors decided to extend the electrification, the new sections being those portions between Peckham Rye and West Norwood, Victoria, West Norwood, the Crystal Palace and Selhurst;

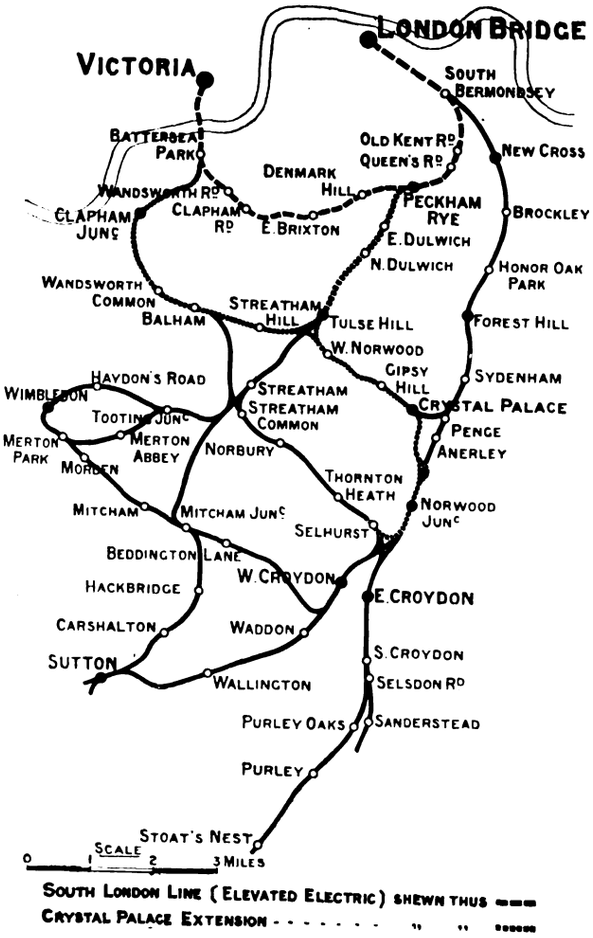

FIG. 3.—DIAGRAM MAP OF SUBURBAN SYSTEM, LONDON BRIGHTON & SOUTH COAST RAILWAY.

thus bringing up the total amount of single track electrified to 62 miles. Fig. 3 is a map of the whole suburban system.

The rolling stock on the South London line consists of 16 motor coaches, each equipped with four motors which will give an output of 115 H.P. for one hour and 57 H.P. continuously, without the temperature rise of any part exceeding 75°C. In the middle of the day the trains are made up of two coaches, one motor and one trailer, whilst in the morning and the evening two such trains are run coupled together.

The rolling stock for the extensions consists of 30 motor coaches, each equipped with four motors capable of giving 175 H.P. for one hour, and 100 H.P. continuously, during the hours of lighter traffic. One of these motor coaches will deal with two trailer coaches, thus making up a three-car train, whilst in the morning and afternoon six-car trains will be run. Side doors in the compartments have been used for all the stock, as the end door type would not have enabled the carriages to be sufficiently quickly filled and emptied at the termini. The experience of this form of stock has been entirely satisfactory.

Electric energy for running the trains is purchased from the London Electric Supply Corpn. station at Deptford, and is delivered to the railway company at two points—namely, at Queen's-road and Peckham Rye Junction—where the current is metered and paid for.

In consequence of the Board of Trade limiting the drop in potential in the return circuit, series booster transformers are located at various points along the line, and are connected by special cables to the distributing cabin at Peckham Rye. Besides this, a so-called distributing cable is run the whole length of the electrified line, the inner being in parallel with the overhead conductors and connected to them at each switch cabin, whilst the outer is bonded to the rails. Besides these cables there are a series of telephone wires run along the line connecting the various switch cabins.

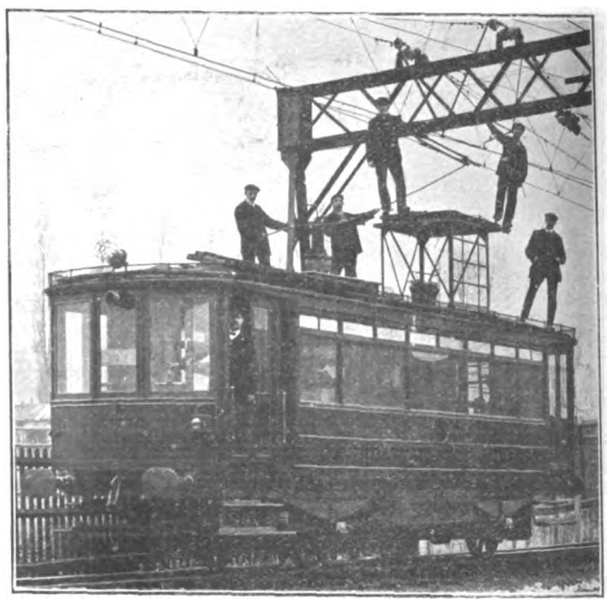

FIG. 5.—PETROL-ELECTRIC REPAIR COACH.

FIG. 4.—INTERIOR OF PECKHAM RYE REPAIR SHOPS.

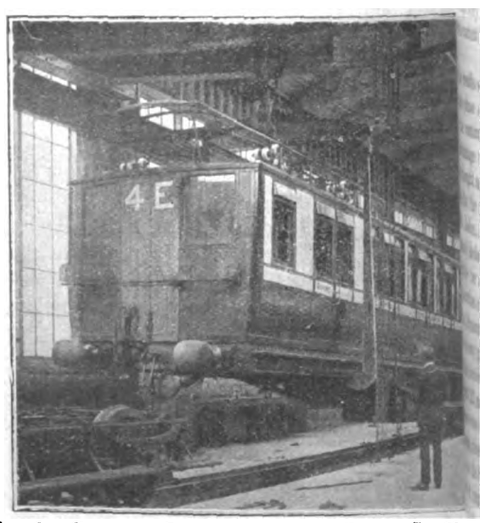

FIG. 6.—CARRIAGE LIFTING DEVICE IN REPAIR SHOPS.

Great care has been devoted to the design of the overhead work and the result of 18 months' practical working has been entirely satisfactory. The construction adopted is of the double catenary type, the contact wire being supported from the catenary every 10 ft. The contact wire itself is of copper, round in section, but with

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two sharp grooves on either side, in which the clips supporting the wire are fixed. The whole of the insulation is of porcelain, a special form of insulator being used, which has given every satisfaction. The choice of this particular size and type of insulator was the result of a large number of carefully conducted and practical tests extending over nearly 12 months. No tightening device is used for the conductor wires, and experience has shown that, at any rate in the case of the English climate, such devices are entirely unnecessary.

None of the high-tension circuits are accessible when alive. The bow collectors are of very special design, as they have to operate at varying heights, there being a difference of 6 ft. between the highest and lowest working positions. The bows are fitted with aluminium strips in which are deep grooves filled with grease. This arrangement has given excellent results. All the wear is practically taken by the strips, the wear on the copper contact lines, after nearly 18 months running, being inappreciable.

For the South London line, car sheds and repair shops were erected near Peckham Rye, and it is here that electric trains are inspected, and that overhauling and maintenance is carried out. The shop is supplied with electric cranes and capstans, which greatly facilitate operations.

Fears have been expressed in the past that any overhead line will greatly interfere with the sight of signals, but experience has not shown this to be the case.

The normal line pressure on the contact wire is 6,700 volts and the frequency 25 cycles per second. The energy consumption has been most satisfactory, and compares more than favourably with what has been done on continuous current lines. The energy consumption per ton-mile for the first eight months of 1910 as metered at Queen's Road was 75·4 watt-hours per ton-mile. In this figure nothing is included for weight of passengers, and no mileage is allowed for empty running or shunting, whilst all the energy used in the repair shops and all leakages are included. It must also be borne in mind that all trains are stopping trains, and that, therefore, the line works under unfavourable conditions when compared with other railways which have a certain number of "non-stop" trains.

The acceleration obtained is also satisfactory, being equal to that obtained on most of the continuous-current railways in Great Britain. The average acceleration as the speed rises from 0 to 30 miles an hour is at the rate of one mile per hour per second.

The total weight of a four-car train empty is 150 tons, and of this the electrical equipment, including all cables for lighting, lighting fixtures, motor compressor, and all electric gear, boosters, &c., amounts to 15 tons in the case of the South London line rolling stock. In the case of the new Crystal Palace extensions, however, the weight of a three-car train is 102 tons, and the weight of the same equipment on the same basis as above is 19 tons. The energy consumption on the trains during trial running on the South London line was 69·1 watt-hours per ton-mile measured on the train.

In consequence of the adoption of the single-phase system the transmission losses between the distributing station at Peckham Rye and the trains have been kept very low. All the losses from the distributing station where the current is paid for, up to the trains, being about 8 per cent.

understand that the results so far obtained have fully justified that the single-phase system is cheaper to instal and to work than the continuous-current system, and it possesses additional advantage that it is very suitable for extension as far as may be thought necessary by the railway company. Interesting to note that the most eminent railway authorities Prussian, Bavarian, Baden, Austrian, Swiss and Swedish State have unanimously declared in favour of the single-phase as the only suitable for main line railway electrification, the suburban, interurban or long-distance work.

Signals maintenance, 18 months' experience shows that there is to expect this to be any greater with single-phase than with current, and that notwithstanding the fact that the average during the first 12 months by every one of the motor (including all spares) was over 58,000 miles.

Regards financial results, these have been equally satisfactory; the railway company lost, on the South London line alone, in a very few years, in consequence of tramway competition, over 5,008,000 passengers. Although very little alteration was made to the fares the whole of the traffic was practically recovered within the first 12 months, and the number of passengers is increasing daily. It may be mentioned that the whole of the work was designed and carried out under the supervision of the railway company's consulting electrical engineer. In Figs. 1, 2, 4, 5 and 6 we illustrate various portions of the electrified track, and also the repair shop at Peckham Rye.

The contractors for the whole equipment of the South London electrification, excluding coaches, were the Allgemeine Elektricitäts Gesellschaft, of Berlin, the coaches being constructed by the Metropolitan Amalgamated Carriage & Waggon Co., of Saltley, Birmingham. The sub-contractors for the whole of the overhead line work, including feeders, switch cabins, &c., were Messrs. R. W. Blackwell & Co., who, in their turn, sub-contracted with the British Thomson-Houston Co. for the switchgear, and with Messrs. Siemens Bros. and Messrs. Johnson & Phillips for the cables required.

The cranes and capstans were supplied by Messrs. Stothert & Pitt. The contractors for the extensions now nearing completion are Messrs. the Allgemeine Elektricitäts Gesellschaft, of Berlin, for the electrical equipment of the trains; the Metropolitan Amalgamated Carriage & Waggon Co., for the motor coaches and part of the trailing stock (the remaining part of the trailing stock being constructed by the Brighton Company at their own works at Lancing); and for the overhead work, feeders and distributing system, Messrs. R. W. Blackwell & Co.

The repair shops and carriage sheds at Peckham Rye, as well as the switch cabin buildings and the new carriage sheds for the electrical stock at Norwood Junction, were designed and carried out under the supervision of Mr. Charles F. Morgan, the chief engineer of the Brighton Company.

THE NEW IRONCLAD-EXIDE BATTERY FOR ELECTRIC VEHICLES.*

BY L. H. FLANDERS.

In the development of the lead sulphuric acid battery for vehicle service the problem has been to secure high capacity per unit of weight consistent with durability. To meet this need the "Exide" battery was introduced in 1900, and since that time has been a most widely used battery for automobile propulsion. The author refers to the main features of this battery, and explains that if the positive active material could be prevented from being detached from the supporting grid and still be retained in a healthy and operative condition, the plates would have a very much longer life.

The manufacturers have now developed a battery with a positive plate which has even greater capacity per unit weight than the Exide positive, and which is so constructed that the loss of its active material is reduced to a minimum. On account of its remarkable durability, the new battery is called the Ironclad-Exide.

The positive plate of this new battery consists of an alloy framework, comprising top and bottom bars integrally connected by conducting cores of the same material. Surrounding these cores are the uniform pencils of active material, protected by horizontally laminated rubber tubes. Each tube is formed with two narrow vertical ribs diametrically opposite each other which take the place of the spacing ribs on the ordinary wood separator and, at the same time, give added strength and durability to the tube.

The negative plate is of the same general construction as the regular Exide negative, but it has been made somewhat thicker in order to withstand the longer life of the Ironclad positive. The outside negative plates are thinner than the inside negatives. A feature of the Ironclad-Exide battery is the flexible pillar strap connector. It consists of alloy terminals cast around lead-plated copper strips, which give great conductivity and flexibility,

The Ironclad-Exide elements are interchangeable with Exide elements. To give a concrete example: a 24-cell nine MV. Exide battery, weighing approximately 720 lb. complete, including trays, and rated at 28 amperes for four hours, will receive nine MV. Ironclad elements. It then will weigh approximately 740 lb., with an initial rating of 28 amperes for 4½ hours, or 30⅔ amperes for four hours. The rating is conservative, yet, when compared with the Exide positive, which is rated at 7 amperes for four hours, there is an increase of 12·5 per cent. in initial rating.

Using the four-hour rating of the MV Exide, at the same rate of discharge current per positive plate (that is, 7 amperes), the Ironclad-Exide battery, weighing but little more, will start with 4½ hours—*i.e.*, an initial increase of 12·5 per cent. in ampere-hours output. It will reach a capacity of from 4¾ to 5 hours within about 25 discharges, and from 5½ to 6 hours within about 200 discharges. It will then retain a capacity above its rating for practically its entire life, in some cases reaching over 1,000 cycles before dropping below its 4½-hour rating. The initial capacity at the 4½-hour rate would be about 8 watt-hours per pound of complete battery, increasing to a probable capacity of over 11 watt-hours per pound of complete battery.

For the present, the "Ironclad-Exide" batteries are being assembled and charged only by the manufacturer. Formerly, great stress was laid upon frequent and systematic cleaning; but the "Ironclad-Exide" will rarely, if ever, require cleaning, since its active material is so firmly held in place.

* Abstract of a Paper read before the Franklin Institute.

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THE NEW WIRING RULES.

In a rapidly developing industry, such as electric engineering, rules determining the methods of carrying ou certain work can, at the best of times, be based only on temporary standard to which it is desirable that all wor should at least attain, and they must of necessity be open t criticism if not frequently brought up-to-date. Althoug it is but four years since the fifth edition of the Wiring Rul of the Institution of Electrical Engineers was issued, th need for revision has been felt for some time past. Th Wiring Rules Committee being now a Standing Committe the process of revision has doubtless been much simplifie the Committee being ready at all times to receive suggestion as to any desirable amendments to the Rules. Criticism ha been raised in certain quarters as to the composition this Standing Committee, which includes representatives the Municipal Electrical Association, the Cable Make Association, the Electrical Contractors' Association, and some of the principal Fire Offices. Although the Committe which comprises 15 members, includes a considerable numb of central station engineers—past and present—this, w consider, is by no means a disadvantage, since such enginee should be in a particularly favourable position for becomi

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acquainted with the weak points of the average wiring installation. A complaint has been raised as to manufacturers being unrepresented on the Committee, although they are particularly affected by any decisions reached; we scarcely think, however, that this complaint is necessary, for the Committee would doubtless pay full regard to any representations that came from such a quarter. That members of the Committee are themselves unaffected by any change in the Wiring Rules is by no means a disadvantage.

On the present occasion, probably the most important change in the Rules is in connection with the current-carrying capacity of conductors. Until recent years, engineers have frequently adopted the 1,000 ampere per square inch rule, which enables the carrying capacity of any conductor to be at once ascertained from its cross sectional area. This "rule of thumb" method, however, has had to be abandoned in view of more careful experiments on insulated cables. As mentioned in the recent report of the National Physical Laboratory, the Electrotechnics Department of the Laboratory have carried out an exhaustive series of tests on the carrying capacity of insulated conductors, and the Table issued with the new Rules is based upon this research. The carrying capacity stated for the various cables allows a temperature rise of 20°F. in the case of rubber-insulated cables, and of 50°F. for paper or fibre insulated cables. On this basis a 1/18 S.W.G. conductor of either type may now be used for currents up to 7·2 amperes (i.e., a current density of 4,000 amperes per square inch), as against 4·2 amperes according to the Rules previously in force. The distinction between rubber insulated and paper and fibre insulated cables is certainly a step in the right direction, and is to be welcomed. In the case of small wires, the current carrying capacity of each type of insulated conductor is identical; but in the larger sizes the difference is very marked, amounting to over 60 per cent. in some cases. The maximum permissible currents with large rubber insulated conductors are less than those set out in the previous Rules, whilst the use of paper or fibre insulated cables allows the latter figures to be considerably exceeded. It must, of course be understood that the current carrying capacities given in the Table are conditional on a certain fall in pressure not being exceeded for lighting circuits. It is interesting to note that this drop in pressure, in lead and return, is not to exceed 2 per cent. of the supply pressure, *plus one volt*. The reason for this increase is not clear, since the use of lamps of higher efficiency has effected a considerable reduction in current.

It is certainly in keeping with recent practice not to stipulate for such a high insulation resistance as was once the case, and except in the case of 1/18, 1/17 and 1/16 S.W.G. conductors less than 2,000 megohms per mile are required for low pressure rubber covered cables, the figure varying from 1,250 megohms in the case of the smallest wires to 600 megohms in cables larger than 0·06 sq. in. For medium pressure cables the figures vary from 4,500 to 2,500 megohms. The pressure test applied to cables also tends to become less severe. Thus, previous to the Rules issued in 1907, a cable had to be bent six times round a cylinder before being subjected for 10 minutes to an alternating pressure of 2,000 volts at 50 cycles. In the fifth edition of the Rules, however, the bending of the cable was omitted, and the duration of the pressure test increased from 10 to 30 minutes. In the new Rules the testing pressure is reduced to 1,000 volts, and no mention is made of alternating current or any frequency. In view of the custom hitherto of specifying alternating current for the majority of pressure tests, the omission of this condition on the present occasion is noteworthy.

In connection with the clause in the 1907 edition of the Rules stating that "all conduit systems must be electrically and mechanically continuous throughout," it is now pointed out that slip sockets do not comply with this rule, some form of screwed or grip joint being necessary. As to earthing of such conduits, the omission of earthing in the case of short lengths "enamelled externally" is not rendered any clearer than in the previous Rules. In commenting four years ago on the Rules, attention was called to this clause; but we notice our suggestions for special attention to bath-room fittings and to earthing wires are dealt with in the new Rules. We are also pleased to see that the Committee have revised the Rule specifying the maximum overload to be carried by fuses before interrupting a circuit. This Rule as it stood might undoubtedly have allowed dangerous overloads in the case of large conductors; and whilst it is still permissible to protect small circuits (up to 10 amperes) by fuses so that the current is only interrupted when it exceeds the normal value by 200 per cent., an overload of 100 per cent. has been fixed for larger circuits.

Concerning other alterations little comment is necessary, except to draw attention to the prominence now given to earthed concentric systems. Although such systems cannot be connected to public supply mains except by means of double-wound transformers, they will probably be more extensively used in future where independent generating plant is installed.

Finally, we are pleased to notice that the Committee have borne in mind the Home Office Regulations for installations in factories and workshops, and these Regulations are reprinted with the Rules, whilst the Rule as to a lampholder not being in metallic connection with the guard or metal work of a portable hand lamp has evidently been taken from the Regulations. This clause, it will be remembered, gave rise to much discussion at the time, but its operation has since been made clear by Mr. RAM in an Official Memorandum.

REVIEWS.

(Copies of the undermentioned works can be had from THE ELECTRICIAN Office, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.)

A History of the Cavendish Laboratory, 1871-1910. (London, 1910: Longmans, Green & Co.) Pp. xii. + 342. 7s. 6d. net.

On December, 22, 1909, Sir J. J. Thomson completed the 25th year of his tenure of the Cavendish Professorship of Experimental Physics in the University of Cambridge. To celebrate this event, his immediate colleagues have published a volume of memoirs by various co-workers and friends dealing with the work of the Cavendish Laboratory from its institution. The result has been the production of a book of great interest to all modern physicists, and one that will undoubtedly be of great assistance to future scientific historians.

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The book naturally divides into three periods, corresponding to the three holders of the Cavendish Professorship, viz. :—James Clerk Maxwell (Cavendish Professor, 1871-1879), Lord Rayleigh (Cavendish Professor, 1879-1884), and Sir J. J. Thomson (Cavendish Professor, 1884), truly an illustrious triumvirate!

The story of the Maxwell period is told by Prof. Schuster in an extremely interesting chapter. He himself was the first research student in Cambridge. It is hard to realise that 44 years ago there was only one laboratory in the world (that of Jamin at the Sorbonne) where systematic instruction in practical physics was being given, and that Maxwell had practically no precedents to help him in arranging or equipping a laboratory. Thanks to the generosity of the seventh Duke of Devonshire, the laboratory was built and equipped so handsomely that after a few years Maxwell was able to state that the equipment comprised the whole of the "instruments required by the present state of science"—a happy condition which has never since been attained.

The question of the accuracy of electrical measurements soon engaged Maxwell's attention, and the classical research on the accuracy of Ohm's law was carried out under his direction, as was also the work of the Committee of the British Association on Electrical Standards.

In Prof. Schuster's words, "Maxwell's personality dominated the Laboratory and united those who worked in it. . . . It was the seriousness with which he discussed all ideas put before him by his students that, from the beginning, gave the laboratory its atmosphere of pure and unselfish research."

Dr. Glazebrook treats of Lord Rayleigh's tenure of the chair, a period of extreme activity. The practical classes were organised by Glazebrook and Shaw, and for some years their text-book of "Practical Physics" was the book used in the Cavendish, and in almost every other English-speaking physical laboratory. In a few concise pages Dr. Glazebrook shows the growth of the system of absolute electrical units, and one realises what a great debt the electrical industry owes to the few able men who put the electrical units on a sound scientific basis.

The period of the last 25 years has been subdivided amongst four writers, Newall, 1885-1894; Rutherford, 1895-1898; C. T. R. Wilson, 1899-1902; and N. R. Campbell, 1903-1909; with an introductory survey by Sir J. J. Thomson himself. All these chapters are of intense interest, telling of the growth of a great research organisation, concentrated (with a few brilliant exceptions) on the study of the electric discharge, and from that to the relation between electricity and matter.

Prof. Thomson in his survey, dwells on the social side of the laboratory, and it is undoubtedly the feeling of comradeship that impresses all who come into contact with the workers in the Cavendish Laboratory. Prof. Bumstead, of Yale University, in a letter to the editors, emphasises this fact:—"But your social life struck me as much richer and fuller than ours; really we seem too busy to enjoy each other's society, and yet we do not get so much done as you. I don't understand it altogether: a laboratory in this country in which nobody ever began work before 10 a.m. or worked later than 6 in the evening would serve as a terrible example of sloth and indolence. I do not see how you get so much work done and yet have time to live so pleasantly and unhurriedly. We Americans have never discovered that great secret. . . . Another thing which struck me as paradoxically fine was the relation between the professor and his students. The great admiration and reliance with which 'J. J.' was regarded by everybody was unquestionable; yet in matters of detail there was no subserviency. I saw a good many men, while I was there, following their own courses, and I remember well the frank tone prevailing at the meetings of the Cavendish Society, where the professor's theories or experiments were not spared in the general criticism."

Prof. Thomson, in his survey, is generous to all who have helped him in his work, and the many friends of the late Prof. Cassie will be grateful to Prof. Thomson for the story he tells of his high-mindedness and self-sacrifice.

Prof. Wilberforce writes on the development of the teaching in the laboratory, and gives some amusing examples of the "howlers" made by early students in the laboratory. Warm praise is given by several of the writers to the admirable teaching and research work of G. F. C. Searle.

Enough has been said to indicate what an extremely interesting book this history is, not only by reason of the scientific work therein discussed, but also from the point of view of the varied personalities taking part in it. All who read it will hope that Sir J. J. Thomson may be long spared to carry on his work. R. S. WHIPPLE.

Electric Circuit Problems in Mines and Factories. By ELLIS H. CRAPPER, B.Eng. (London: The Chichester Press) Pp. 159. 3s. 6d. net.

Attention has frequently been drawn in official reports and elsewhere to the fact that amongst those who are placed in charge of electrical plants in mines and collieries are many whose electrical knowledge is not so advanced as should be the case in view of the great responsibilities which naturally fall to them. Given an electrical system properly designed and installed, in charge of a thoroughly competent engineer, there is no method of lighting, no form of power so safe in mining work as electric. Mr. Crapper's work on "Electric Circuit Problems" has been prepared with the object of providing readily available information regarding the elementary principles, laws, and methods of testing electric circuits in mines. That such a work as this was needed is beyond dispute, and even those who consider that their knowledge is amply sufficient for all practical purposes will find much of value and interest in its pages.

The author deals with the fundamental principles of the electric circuit, and not only shows how the various problems which arise in practical work may be solved, the sizes of conductors calculated, and losses determined, but also points out how circuits should be tested, and how any faults which exist therein may be located. The opening chapter deals with the units of measurement, following which are chapters on insulation and circuit testing. A number of pages are devoted to cables and methods of testing same; and the characteristic features of both continuous and alternating-current circuits are dealt with exhaustively. The space allotted to each subject has been carefully proportioned to its relative importance, and the book can be confidently recommended to all engineers in charge of, or employed in connection with large electrical plants. G. B. B.

THE DRIVING OF WINDING ENGINES BY INDUCTION MOTORS.*

BY H. J. S. HEATHER.

Summary.—The author discusses the use of induction motors for driving winding engines, and shows that, although not so efficient in power consumption, his suggested arrangement is superior to the Ward-Leonard system as regards simplicity and safety. Emergency braking in case of failure of supply is obtained by exciting the stator from a source of continuous current.

For hoisting and winding work on a polyphase system of electric supply the direct application of the driving power of the induction motor has not hitherto been so general as its indirect application through the medium of continuous-current plant operated on the Ward-Leonard control system, with or without the Ilgner flywheel. The principal causes which have prevented the adoption of the less costly direct induction motor drive have been, first, the losses arising from the waste of energy in the rheostatic control, which losses are avoided in the Ward-Leonard system; and, secondly, the difficulties arising from the nature of the relations between torque, speed, and resistance in the secondary circuit of the induction motor.

Some tests carried out by the author on a three-phase winder for the Village Main Reef Gold Mining Co. in 1906 convinced him that the first of these two objections was more or less groundless; and some figures he obtained as to relation between the foot-pounds of useful work done in lifting rock in the shaft, and the electrical input compared on practically equal terms with the most satis-

* Abstract of a Paper read before the Institution of Electrical Engineers.

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factory results that he has seen given for a converter system. It is, therefore, with the second objection only that he proposes to deal.

In the first place he describes the Ward-Leonard control, showing its extreme simplicity and that it has the very great advantage of being regenerative in its action. With induction motors the only simple method of speed control, that of inserting resistance into the secondary circuit, is comparable when lifting, so far as wastefulness is concerned, with the rheostatic control of continuous-current motors. In each case a definite torque at a speed between full speed and zero can only be secured by using the full power that would correspond to it at full speed. Both in simplicity of operation and wastefulness, therefore, the induction motor and the rheostatically controlled continuous-current motor are on a level when lifting at speeds below full speed.

When lowering loads at speeds below full speed the continuous-current motor can be operated with rheostatic control in two ways. The more economical is to cut off the supply of current to the motor

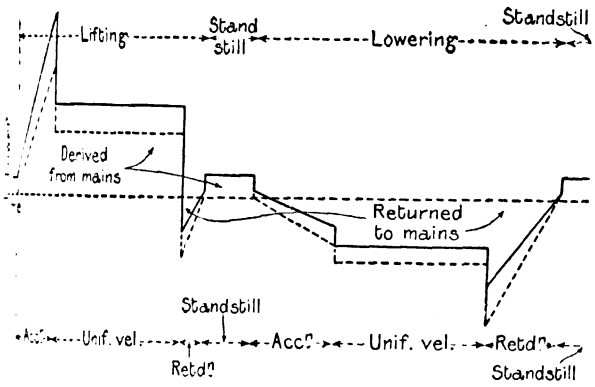

FIG. 1.

armature and allow the motor to operate as a generator, absorbing in the resistance the whole of the power generated, the power derived from the mains being only that required for excitation. The complication, however, of switching off the mains from the motor armature and short-circuiting it through the resistance is introduced, and it becomes necessary to reverse both these movements to bring the motor absolutely and steadily to rest by electrical means. The alternative method, more wasteful in power, but simpler in operation, is to leave the motor connected to the mains, to take from them the current corresponding to the desired motor torque, and to absorb in the resistance both the power represented by this current and that produced by the hoisting motor, now operating as a generator driven by the descending load. The action of the induction motor when lowering loads may be considered as almost exactly similar to the latter of the above described actions of the rheostatically controlled continuous-current motor. It is equally simple and equally wasteful.

Equally simple methods of winding engine motor control being therefore available, it follows that the direct induction motor drive must usually have by far the best over-all simplicity, as practically all heavy transmission work is done on the three-phase system, and consequently, whenever continuous-current motors are employed, some form of converter is a necessary additional complication.

In order to show that the foregoing remarks on the simplicity of induction motor control are justifiable, the author gives a few explanatory notes and diagrams to illustrate the properties of the induction motor and the requirements of winding operations. The circumstances assumed are the simplest possible—in fact, they are simpler than those that occur in practice, for although it is sometimes feasible to make the ropes balanced, this is very often not the case; acceleration and retardation are never uniform, and the problem is generally complicated to some extent by the use of conical or cylindro-conical drums, or flat rope reels. The modifications thus introduced, although they frequently involve reversing moments, are merely matters of detail. It has been shown, however, that if mechanical brakes are supposed not to be relied upon, and all control has to be effected electrically, the operation of a winding engine demands the possibility of getting any torque in either direction at any speed in either direction, subject, of course, to the limitations imposed by a maximum torque and a maximum allowable rope speed. The fulfilment of these requirements is equally possible by either the Ward-Leonard or the direct-induction motor drive.

Referring in practical work the most usual form of Ward-Leonard power-time diagram, which is also the most unfavourable to the induction motor drive, is that shown in the first half of Fig. 1, where the power given into and coming out of the winding drums is given by the dotted lines. In order to ascertain the power taken from the mains, the efficiency has to be taken into account. The result is, of course, to increase considerably the portion of the diagram above the zero line, representing power taken, and to decrease the portion below the zero line representing power returned. The power consumption diagram for a pair of trips, one up and the other down, will be somewhat similar to that shown in Fig. 1.

To get the corresponding power consumption diagram for the direct-driving induction motor, the action of the motor under reverse current and at speeds below full speed must be kept in mind. The power consumption diagram will, in consequence, be derived from the torque-time diagram, but the reversal of the direction of the torque does not mean the return of power to the mains. The power derived from the mains corresponding to any torque is now independent of the speed, and even of the direction in which that torque is exerted, and the power taken from the mains is determined by dividing, by the fraction representing the efficiency of the motor at the instantaneous speed and ampere load, the power that would be put into the winding drums at full speed, and adding thereto, for the lowering trip, the power that would be given out by the winding drums at full speed multiplied by the corresponding fractions for efficiency. The full line in Fig. 2 may be taken as showing the power taken from the mains during a lifting and a lowering trip separated by an interval, the dotted line being the power put into and taken out of the drums. It must not be forgotten that, both in Fig. 1 and in Fig. 2, the whole of the operations are supposed to be carried out electrically, no mechanical brakes at all being used. This accounts for the high power consumption of the induction motor during the period of standstill. There will be very little chance that the energy taken by the induction motor for such a pair of trips, the one raising and the other lowering a load, will be less than that taken by the Ward-Leonard arrangement to effect the same operation. If, however, the number of times that loads have to be lowered is small, and if the length of trip is long, and the interval between trips long, and mechanical brakes are allowed to hold the load at rest, it is quite possible for the direct-driving induction motor by its economy on the uniform speed portion of the trip, and when standing still, to do more than make up for its extravagance in power when starting and stopping.

It should be noted that the long duration of the acceleration peak when lifting is an important disadvantage when the supply is obtained from a small power station. Another point worthy of notice is the large amount of energy that the controlling resistance of the induction motor has to be capable of taking up. In Fig. 2 it would be represented by the area enclosed between the full line, which shows the power being taken from the mains and the dotted line which shows that being put into and taken out of the winding drums. This area would be reduced only by the losses in the winding motor whether operating as motor or generator. During the lowering

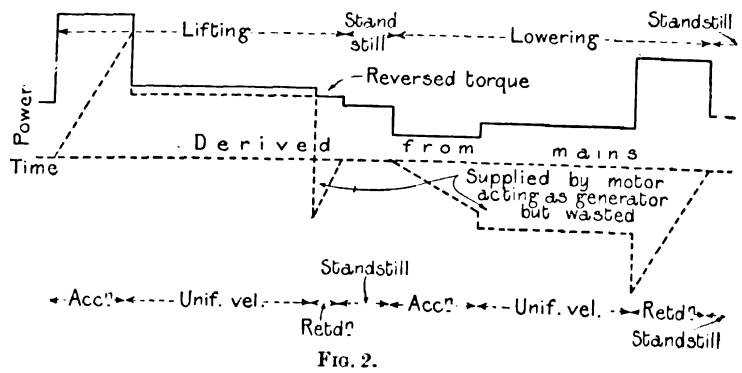

FIG. 2.

trip this energy will approach twice the value of that which the motor is capable of taking in. The dissipation of this large amount of energy in the case of a big winder need, however, present no difficulty in practice to the mechanical engineer, who is accustomed to deal with a similar problem on a similar scale when he runs his steam engines on condensers.

There are, of course, several ways of avoiding this loss in lowering. For instance, it may be permissible to allow a slightly higher speed when lowering, so that the induction motor running above synchronous speed may act as a generator returning power to the mains, or a similar result may be attained at a lower speed by using a two-speed motor. Both these methods entail complications in the manipulation of the controlling lever, and the writer prefers to pin his faith to the simpler process of using reverse current and to face the losses.

Apart from the question of economy, the chief argument that is brought forward by the advocates of the Ward-Leonard system

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against the direct induction motor drive is that it is difficult for the driver to tell at any time whether he has to increase or decrease the resistance in the secondary circuit in order, say, to increase the torque. There is, however, an extremely simple way of getting an absolutely certain guide to this. It is to use an ammeter as a torque indicator in exactly the same way as is done in the Ward-Leonard system. The author explains from the torque-slip curves why this simple method can be applied. To all possible torque-speed curves there is only one torque-ampere curve. This curve shows that the amperes go on increasing from the point of zero to que, when the ampeaes are the no-load current of the machine, to the point of maximum torque, and that even after this is reached, though the torque begins to diminish, the amperes continue to increase, reaching their maximum value (which is in the neighbourhood of $\sqrt{2}$ times the value at maximum torque) only when the slip is infinite, that is, when an infinite backward speed is reached, by which time the torque has again become zero. It can, therefore, be absolutely

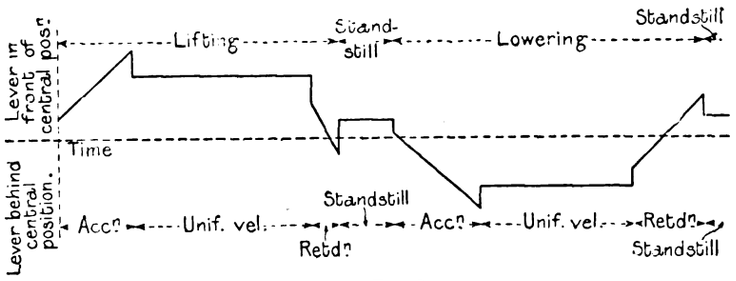

Fig. 3.

ensured that the full-line portions of the torque-slip curves are always being worked to, by making certain that the full-line portion of the torque-ampere curve is being worked to; and this simply means that the amperes must not be allowed to exceed a certain maximum value, which can readily be fixed once for all for any individual motor. In practice, a reasonable margin would be allowed to cover inequalities in the voltage of supply, &c., and the driver would be instructed never to allow the amperes to exceed the lower value so decided upon.

So far as driving in one direction is concerned, therefore, the simplicity of the control of the direct-driving induction motor is brought exactly level with that of the continuous-current motor of the Ward-Leonard system. The fact that in the latter case the torque-ampere curve is more nearly a straight line than in the former does not affect the matter in the least, as it is in both cases an indication, not of current but of torque, that is really needed, and there is no necessity for the scale to be uniform. But the polarised ammeter ordinarily used in the Ward-Leonard control goes further than merely to show the approximate value of the torque; it indicates also the direction, and this is undoubtedly useful. A similar result can be arrived at very simply and at very small cost for the induction motor drive. With this drive a reversal of the direction of the torque can only be obtained by reversing the direction of rotation of the field in the stator. This can be, and usually is, done by the movement of the same lever that inserts or cuts out resistance in the rotor circuit; and it is easy to make this lever, at the same time that it reverses the stator field, put into circuit a second ammeter coil which deflects the common needle in a direction opposite to that which the first ammeter coil gives it.

It will be seen that the guide afforded to the driver of the winding engine with the direct induction motor drive is, under the author's arrangements, almost exactly similar to that which the driver of a Ward-Leonard set has to rely on. The similarity, however, extends further than this: the necessary movements of the control lever are almost precisely similar in kind, though not in extent. If the double trip, once lifting and once lowering, be considered, the movements of the lever necessary to secure this with the Ward-Leonard may be plotted as shown in Fig. 3. The corresponding diagram for the induction motor drive is shown in Fig. 4, which corresponds to the power diagram of Fig. 2. It must not be forgotten that throughout these diagrams acceleration and retardation have been assumed to be uniform, and consequently they begin and end suddenly. In practice, all angles in the diagrams, and particularly the peaks, would be rounded off. A further modification of the last diagram, owing to the fact that all resistance is usually cut out when lifting at uniform velocity with an induction motor would result in levelling down any peaks that are shown as rising above the line of lifting at uniform velocity.

In comparing Fig. 4 with Fig. 3 there are two points to notice. The first is that exactly similar movements, so far as direction is concerned, are required under both systems at every stage of both lifting and lowering. It cannot be contended that the direct induction motor drive introduces any complication. The second point is that when lowering a load with the induction motor drive a forward position of the lever is required throughout. In this respect the duties of the driver of the induction motor agree quite closely with those for raising and lowering with steam and without using mechanical brakes, and this might properly be used as an argument in favour of the direct-driving induction motor where the problem is one of conversion from steam to electric driving. The author, however, does not attachany importance to this, as, in his experience, drivers accustomed to steam and put on to electric driving have, in a few days, invariably preferred the electric control, whether on the Ward-Leonard or the direct-driving induction motor system.

It should be pointed out that the cycle of operations depicted in the diagrams above is not the cycle that usually has to be carried out in practice. Ordinarily there is a succession of trips, all lifting loads, first with the one drum and then with the other. Such a succession of trips may be followed by a series of lowering trips.

As to an emergency safety arrangement in case of a failure of supply from the three-phase mains, ordinarily if this were to happen with the induction motor drive, the driver would be rendered helpless except for his mechanical brakes. Except for the small additional safeguard supplied by the inertia of the converter set, the same thing is true with the Ward-Leonard system, if, as is usually the case, the source of supply is three-phase. Of course, if the Ilgner flywheel is added the large flywheel inertia is a solid protection.

It was pointed out some years ago that electric braking could easily be obtained on an induction motor by exciting either stator or rotor with continuous current. The possibilities of this proposal do not, however, appear to have been recognised at that time, and nothing much appears to have been done with it owing to the failure to discover any satisfactory method of control. The suggestions thrown out by the author supply such a method. The source of continuous-current supply can be made of such a voltage that the primary field strength produced by the current it sends through the stator will be equal to that produced by the alternating current corresponding to the maximum torque. Even if applied to the stator this will only require quite a low voltage, as the opposition to the current flowing in an induction motor stator comes mainly from the inductance and not from the resistance of the circuit. The effect of the time constant, after the failure of supply, is not so great as to form an insuperable obstacle. It is possible with a moderate continuous voltage to get, within a fraction of a second, a stationary field from the stator equivalent to that required when the rotor current corresponds to maximum torque. The effect of this stationary field is to convert the induction motor into a synchronous generator capable of converting at any particular *speed* the same mechanical torque that it could deal with as a synchronous generator at the same speed above synchronism.

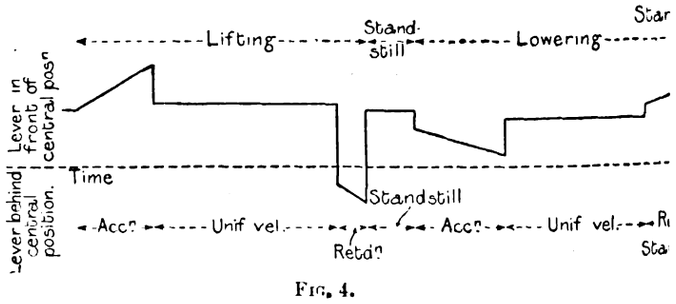

Fig. 4.

If arrangements are made so that the opening of the main circuit breaker (owing to failure of supply) automatically closes the stator circuit on to a suitable source of continuous current, and the ammeter which acts under normal circumstances as a torque indicator to the driver, is placed in the rotor circuit, the driver has, under emergency circumstances, exactly the same reliable guide as he uses for employing as a brake when working on the limiting torque principle before described. He can use for braking a torque equal to the normal full-load torque of the motor down to a speed which is the same fraction of synchronous speed as the normal slip—that is to say, down to a speed that is perhaps 5 per cent. of the synchronous speed. It is obvious that this speed is so low that any sort of mechanical brake can then safely be applied in order to complete the process of bringing a descending load to rest.

This continuous-current excitation can also be applied to the induction motor of the converter set of a Ward-Leonard system, and would certainly, as an emergency arrangement, increase its safety

(*Continued on page* 179.)

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when lowering loads. Its application to this case is not, however, so simple as its use on the direct-driving induction motor, for it would be necessary for the driver, under the emergency conditions, to pay attention to the reading of an ammeter on which he did not have to depend for normal running.

In this brief outline of a scheme for using the induction motor for driving winding engines, the author hopes that he has gone into sufficient detail to show that, although his proposals are more expensive in power consumption where much lowering has to be done, they embody arrangements which are superior to those of the Ward-Leonard system as regards simplicity and safety. Inasmuch as the cost for the simple induction motor is lower than that for a Ward-Leonard set, he considers that he can at least claim that where cheap power is obtainable from a large power plant and capital outlay is a consideration, he has made out a case for the induction motor.

CORRESPONDENCE.

ACCUMULATORS AND PORTABLE PHOTOMETERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of January 13th Mr. A. P. Trotter comes warmly to the defence of the practice, which in a previous letter I have by implication condemned, of trusting to the constancy of the voltage of an accumulator in making measurements with a portable photometer. Mr. Trotter finds it surprising that anyone with practical experience should suggest the necessity of using electrical measuring instruments as an adjunct to street photometry, and supports his contention that such instruments are superfluous by showing discharge curves of a certain accumulator.

With the data which he presents I can find no fault. The relevant fact, which no tests are required to bring out, is that the voltage of accumulators does change with time, and that the voltage of a freshly charged accumulator drops off quite rapidly during the early period of discharge so that its constancy cannot be relied upon to within 1 per cent. for more than a few minutes. Of course, I understand that an experienced man would not trust to the constancy of this portion of the discharge curve in photometric work. Unfortunately, however, not all those who use portable photometers are experienced in the handling of storage cells. Therefore, some of them at least are likely to fall into serious error on account of this peculiarity. The small change which goes on continuously in the voltage of the accumulator is also something which, in view of the sensitiveness of the candle-power of a lamp to change with current, cannot be neglected if photometric measurements are to be made with due regard for the precision which is attainable at the present day.

At the time when Mr. Trotter, in connection with Sir William Preece, was carrying out his most valuable pioneer work in street photometry, photometric apparatus and portable electrical measuring instruments had not reached their present state of perfection, and in particular the primary standards of photometry were in a deplorable condition, as far as accuracy was concerned. Under these circumstances, the practice which Mr. Trotter adopted of setting his photometer against his lamp at the voltage of his accumulator, and trusting for the same to the constancy of that voltage, was probably the best practice; and the results which were obtained were not appreciably affected by the errors introduced through the decrease in accumulator voltage. At the present time, however, the science of photometry has been raised to a different scale of accuracy. The primary standard, through incandescent lamps, has been fixed to within less than ½ per cent.; the portable electrical measuring instruments have been improved to such a point that they very nearly meet all the requirements of precision for photometric work; the photometers themselves have been refined and improved in reliability and sensitiveness. Therefore, errors which were negligible under previous conditions have become important under present conditions and cannot be neglected by anyone who wishes to do the highest grade of work.

I would call attention to another difficulty in connection with the method which Mr. Trotter so vigorously advocates. He evidently would close the circuit through his photometer lamp only for the few seconds required to make a reading, thereby conserving his storage battery's charge. This is a practice which our experiments at the Electrical Testing Laboratories have shown to be incompatible with the best results. In miniature battery lamps, such as are used in portable photometers, the filament is very short and the percentage of heat lost by conduction through the leading-in wires is relatively very large. These leading-in wires, being of copper, with a high specific heat, are capable of absorbing considerable heat from the filament, and it requires a quite appreciable time for the filament to transmit enough heat to the leading-in wires so that the whole lamp comes into a state of thermal equilibrium. During this time the average temperature, and consequently the candle-power of the filament, is changing. Such a lamp with a given current may have, at the instant the switch is closed, 10 per cent. higher candle-power than it has a minute later. Evidently photometrical measurements should not be made until the lamp has come to a stable condition, which may not be reached until a minute or two after the switch has been closed. It would evidently be impracticable to wait two minutes before making each setting; consequently the lamp must be left burning all the time that photometric measurements are being actively made, and the rate of decrease of battery voltage shown by Mr. Trotter would no longer apply.

It may be objected that such refinements are not required, or even desirable, in street photometry. I do not believe that this is so. We have entered upon a period in which the portable photometer is being used as a most important means of obtaining data bearing on the problems of illuminating engineering. Many illuminating engineers have equipped themselves with portable photometers and are industriously making and publishing measurements bearing on the very practical subject with which they have to deal. It is of very great importance that the data so collected shall be comparable in absolute values. This means that the photometers should be standardised against nothing but reliable standards and that the methods which are employed in their use should be such that the results are not subject to any systematic error which can be eliminated. To use the method which Mr. Trotter advocates, and to obtain therewith results that are at all comparable with those which are readily obtained when the electrical quantities are controlled by instruments, requires that the photometer should be checked at very frequent intervals against a reliable standard of light, in order that the change produced by the falling of the storage battery voltage may be taken account of or compensated for. Even then, the photometrist when using his photometer in outside work must trust implicitly to the constancy of his storage battery voltage and has nothing to assure him that he is not in blissful ignorance of changes which may be taking place, due perhaps, as Mr. Trotter suggests, to bad lamp sockets or faulty switches. Practically speaking, each experimenter working by this method must be equipped with a reference standard of light and must be thoroughly familiar with the use of the same.

If, on the other hand, a reliable ammeter is connected in the circuit with the photometer lamp, and the photometer is standardised at a definite lamp current, the photometrist is justified in feeling the very greatest confidence that no appreciable change will take place for quite a considerable period of time, provided, of course, that his photometer lamp has been properly seasoned before being put to use. The result is that checks against the photometric standard are not conditioned by the user's ignorance of the state of his battery voltage and are not required at anything like as frequent intervals as in the other method, since the candle-power of a seasoned lamp is a much more stable thing than the voltage of an accumulator.

The *reductio ad absurdum* of the no-instrument method has come to my attention in a pamphlet issued by the makers and sellers of the same photometer as called forth my first letter. In this pamphlet it is stated in substance that though a photometric bench in the laboratory is desirable for calibrating the

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instrument, "results which are amply accurate for practical purposes can be secured" by setting up a standard candle 1 ft. away from the test plate, waiting until a cup of molten wax has been formed and until the wick has an inclined position, and then carrying out a calibration of the instrument against this standard. When we realise that standard candles, used with the greatest care and strictly in accordance with the Parliamentary specifications, often give variations of 5 to 10 per cent., we are tempted to ask what the ideals as to accuracy of the writer of this pamphlet are. Certain it is that a recommendation of this kind will cause careful engineers to view any data obtained with the instrument in question with suspicion. It seems a pity, too, for the photometer itself, as I understand it, should be capable of yielding very good results when used by a proper method. That such a slip-shod method should be promulgated and recommended is, in view of the present state of the art, rather discouraging.

Mr. Trotter does not claim that the use of a proper electrical instrument invalidates in any way the photometrical measurements. He evidently objects to it as unnecessary and even sophomoric. My contention is that, to meet modern requirements as to accuracy and reliability, some electrical measuring device is practically indispensable in serious portable photometer work, and that it is impossible not to regard measurements made without these adjuncts as in general of an inferior order of reliability.

Mr. Trotter's long years of splendid service in maintaining the standards of the Board of Trade, a service which is known and appreciated in this country as well as in England, is a sufficient guarantee of his personal appreciation of accuracy in scientific and engineering work. I believe that he needs only to be convinced that the use of electrical measuring instruments in photometrical work tends toward an increased and not superfluous accuracy, to cause him to withdraw his opposition to this practice.—I am, &c.,

CLAYTON H. SHARP.

We have submitted Mr. Sharp's letter to Mr. Trotter, from whom we have received the following reply :—

TO THE EDITOR OF THE ELECTRICIAN.

SIR : I am in agreement with Mr. Clayton H. Sharp that the practice of photometry has been raised in precision and that an accuracy of ½ per cent. is possible under laboratory conditions. I agree, too, that high accuracy is possible under such conditions with portable photometers. But I do not consider that for street work, and other applications of portable photometers for industrial purposes, time, trouble, skill or money need be expended in securing higher accuracy than a variation of 3 per cent. from the mean of a number of measurements. One reason is that the quantity to be measured, whether illumination due to electric, gas, or daylight, is liable to vary, and another reason is that it is better in street work, &c., to obtain a number of readings of tolerable accuracy than a few readings of high precision.—I am, &c.,

London, May 9. A. P. TROTTER.

[We regret that we are compelled to hold over some correspondence.—ED. *E.*]

CONFERENCE ON THE EDUCATION AND TRAINING OF ENGINEERS.

We are asked to state that a conference on the education and training of engineers will be held at the Institution of Civil Engineers on June 28th and 29th, the Council being of opinion that the present is a desirable time to consider the methods of preparation to be adopted by those who contemplate entering the engineering profession in compliance with conditions laid down in the by-laws for election into the Institution. Questions of detail and of method involved in the realisation of the principles laid down in the report of the Committee on Engineering Education and Training in 1906 will be discussed. The subject-matter of the conference will be divided into three groups : General education, scientific training, and practical training. The subjects which will be introduced for consideration at the conference include : The extent to which mathematical and scientific subjects should share with other subjects of literate education the attention of schoolboys who intend to enter later the engineering profession ; the question of specialised entrance examinations for university or college courses of study in engineering science, with a view to the curricula to be followed, and also of the inclusion in the latter of courses in modern languages ; the relation of practical training to college study, whether, or to what extent, before, sandwiched, or after its conclusion ; the position and uses of engineering laboratories in relation to education at college ; the value of a university degree in engineering science in relation to professional competence ; the requirements of practical training in works, with the necessary complement of scientific study ; practical training in workshops or on works of construction, with special reference to training in the engineer's office ; the relation of engineering employers and colleges from the point of view of the practical training of college students ; workshop training as a preliminary to practical training in other branches of engineering. The subjects referred to will be introduced by means of quite short notes submitted by persons who have been selected on account of their experience or the attention they are known to have given to them. In this way it is hoped to secure very wide attention to the matters which are of general interest and importance. The officers are as follows :—

President : Alexander Siemens (President Inst.C.E.).

Vice-presidents : The Right Hon. Walter Runciman, M.A. (President of the Board of Education), the Right Hon. Lord Pentland (Secretary for Scotland), Sir John Wolfe Barry, K.C.B., LL.D., F.R.S. (Past-president Inst.C.E.), Sir William H. White, K.C.B., D.Sc., LL.D., D.Eng., F.R.S. (Past-president Inst.C.E.). *Honorary Secretary :* James Forrest. *General Secretary :* J. H. T. Tudsbery, D.Sc.

SECTION OF GENERAL EDUCATION.—*Chairman :* Anthony G. Lyster (Vice-president Inst.C.E.). *Vice-chairmen :* B. Hall Blyth, M.A. ; H. A. Miers, M.A., D.Sc., F.R.S. (Principal of the University of London). *Honorary Secretaries :* D. S. Capper, M.A., E. P. Hill.

SECTION OF SCIENTIFIC TRAINING.—*Chairman :* W. C. Unwin, B.Sc., LL.D., F.R.S. (Vice-president Inst.C.E.). *Vice-chairmen :* Sir Alexander B. W. Kennedy, LL.D., D.Eng., F.R.S. (Past-president Inst.C.E.) W. H. Maw, LL.D. *Honorary Secretaries :* J. D. Cormack, B.Sc., Capt H. Riall Sankey.

SECTION OF PRACTICAL TRAINING.—*Chairman :* R. Elliott-Cooper (Vice-president Inst.C.E.). *Vice-chairmen :* E. B. Ellington, James Swinburne, F.R.S., W. B. Worthington, B.Sc. *Honorary Secretaries :* J. W. Jacomb-Hood, E. W. Monkhouse, M.A., Basil Mott.

SOIRÉE OF THE ROYAL SOCIETY.

A soirée was held last Wednesday evening when a number o interesting exhibits were shown, although, generally speaking there was not a great deal that was novel from the electrica point of view. Prof. J. A. Fleming, F.R.S., showed Hemsalech' method of rendering visible the oscillatory discharge of a condense the discharge being blown by an air-blast downwards between tw copper knife edges. By this means the effect of varying the fre quency and other effects of that kind can be shown extremely wel It was interesting to notice that on the insertion of iron in the in ductance the frequency was changed to a marked extent, whereas this was not the case when a non-magnetic metal was used as a cor thus demonstrating the fact that the effect was due to magnetism an not to eddy currents. Dr. J. A. Harker, F.R.S., and Mr. C. G. Ede showed an interesting experiment in which two insulated carbon roc were maintained at various high temperatures within a carbon tub Upon connecting a battery to the two carbon rods a considerabl current is found to flow between the latter even with such a lo pressure as 1 volt. As the temperature is raised the current increas and for a given temperature the current increases as the voltage increased until a "saturation current" results. Dr. W. Rosenhai and Mr. S. W. Melsom exhibited a portable potentiometer for ten perature measurements with thermo-couples, the object being t overcome the disadvantage attached to the use of a direct deflectio millivoltmeter for measuring the E.M.F. over wide ranges of ten perature. Prof. W. M. Thornton showed the effect of electrica charges on vegetable and animal cells. It appears that when a electric current is passed through a weak aqueous emulsion of suc cells the animal cells go to the positive pole and the vegetable cells t the negative, thus giving a means of distinguishing such cells in lo

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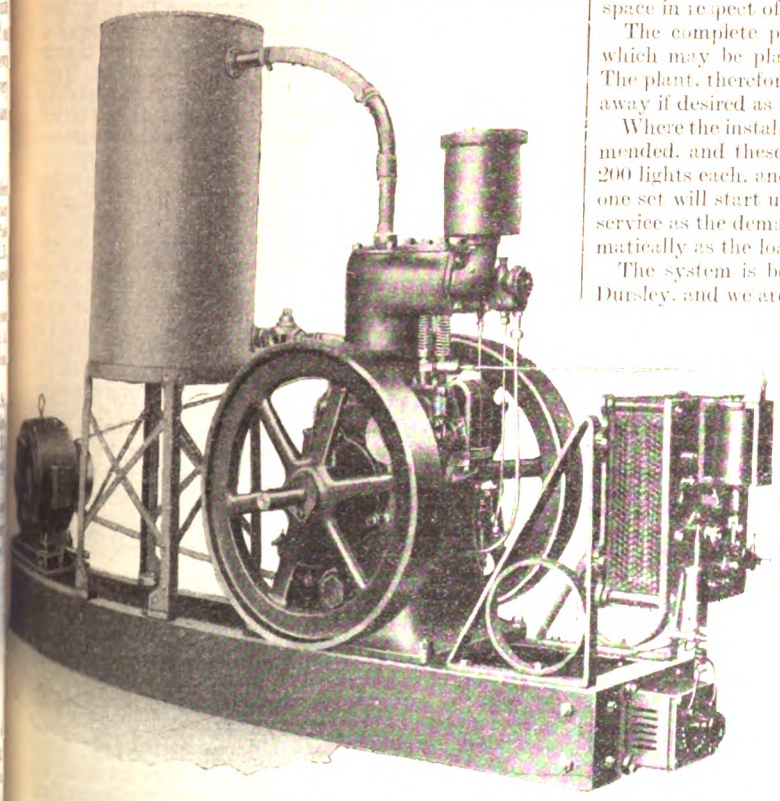
forms of life. Other electrical exhibits were shown by Prof. E. Wilson and Mr. S. G. Brown, but these have already been described in THE ELECTRICIAN. Among the non-electrical exhibits mention may be made of Sir William Ramsay's micro-balance, which is capable of registering to about 1/20,000 of a milligramme. It is mostly made of silica, and the method of varying the smallest weights involved consists in altering the apparent weight of the air in a sealed quartz valve by altering the pressure of air in the balance case. Prof. E. G. Coker showed the application of interference colours produced by transparent materials under stress, the materials being used to show the distribution of stress in engineering models, such as beams, parts of engines, &c. There were numerous other interesting exhibits of a non-electrical character, but our space will not permit of a more detailed reference to them.

THE BRUSTON AUTOMATIC LIGHTING SYSTEM.

The introduction of the petrol engine has done much of recent years to simplify the small isolated plant. It makes it possible to place equipments of this nature in the hands of unskilled labourers with a complete assurance of their operating with satisfaction. A system



BRUSTON AUTOMATIC PETROL DYNAMO PLANT.
The solenoid controller on the right starts the dynamo as a motor (with current from the battery) and the plunger of the controller when at the end of its travel lowers the exhaust valve lifter and allows the engine to commence firing.

has now been introduced whereby a practically automatic generating system is obtained. The makers claim that the introduction of this system will reduce the size of the storage batteries and materially decrease the initial cost of installation. The attendant also is only needed to keep the plant clean, lubricate the engine, and to fill up the petrol-supply tanks. When the lights are initially switched on the engine starts up, and when the last light is finally turned off it stops, both the operations being performed automatically. The generating plant is practically standard, in so far as the engine and dynamo are concerned. The only special feature is the switchboard, to which is fixed the various devices which make the plant automatic. A small battery is used in connection with the plant, and this is employed to light up the initial lamps and also to supply energy to the dynamo, which is rotated as a motor for the purpose of starting up the engine. There is a drop of 8 volts over a period of 10 seconds when the engine is being started up. The switching in of the dynamo is effected by a relay which operates after a certain number of lamps have been switched on. The engine, of course, will commence firing when rotating at a certain speed and the voltage of the dynamo will gradually be built up and current will be supplied direct to the lamps. This in time replaces the energy which was taken from the battery to start the engine. As we have said, the engine only starts after a certain number of lamps are switched on, and assuming that this limit is not reached and that the battery is called upon to supply current from the minimum of lamps for a long period, the fact that the battery voltage drops also actuates the relay and causes the plant to start up again and recharge the battery. After the lamps have been switched off and the battery charged up to its normal voltage the plant is automatically stopped. We illustrate the complete plant, to which is attached the solenoid controller for starting the dynamo as a motor. The plunger of the solenoid when at the limit of its travel lowers the exhaust valve lifter and the engine then fires. The magneto is of the oscillating high-tension type and is operated by a "flicker" on the lay shaft. We saw the plant running in London, and it never failed to start up under the conditions specified. The battery is contained in four portable cases similar to those used on motor cars, and occupies a minimum of space.

The makers claim that by the use of their system they save the 40 per cent. loss which generally applies when accumulators are used. The greatly reduced size of the battery effects a material saving on the initial cost of accumulators, and the automatic features of the plant ensure that energy will be forthcoming at any time to cope with whatever demand may be made on the plant. The saving in floor space in respect of the accumulators is also an appreciable item.

The complete plant is mounted upon two parallel steel girders which may be placed on the floor or ground without fixing bolts. The plant, therefore, needs no alignment in erection and can be taken away if desired as it is not a landlord's fixture.

Where the installation amounts to 400 lights, two units are recommended, and these can be either 100 and 300 light units, or two of 200 lights each, and they can be connected up in such a manner that one set will start up on light load and the other will be brought into service as the demand increases. It will be similarly cut down automatically as the load falls off.

The system is being developed by Messrs. R. A. Lister & Co., of Dursley, and we are informed that it has been subjected to a number of trials extending over a long period. The users of the plant speak in enthusiastic terms of its efficiency and satisfactory operation. In a pamphlet which the Company has just issued comparative estimates of the initial cost of the standard and the Bruston system are given. On a 200-light installation there is a saving in the outlay of £64 in favour of the Bruston plant, and it is claimed that if the operating economies are added to this figure the Bruston plant will pay for itself in four years. From the shipment point of view the weight figures are also of interest. For the ordinary accumulator system for a 200-light plant the weight is 35 cwt., for the Bruston system it is 15 cwt.

We understand that the automatic features of this plant place electric lighting for country houses, &c., on a competitive footing with petrol gas, which has come to the front of recent years on account of its simplicity and the fact that no attention is needed. Messrs. Lister have obtained several orders for their Bruston sets in place of petrol gas outfits, and as the plant becomes more widely known a considerable demand is almost certain to arise.

ELECTRICAL TRADES BENEVOLENT INSTITUTION.

We give below a list of further contributions received by the Institution up to Saturday 6th inst. A list of donations and subscriptions received on the occasion of the Festival Dinner was given in our last issue. We may mention that the list is still "open" for further contributions, and we hope to publish still another supplementary list next week.

DONATIONS.

	£	s.	d.
Pope's Electric Lamp Co., Ltd.	1	1	0
Icke, J. R.	0	2	6
Wild, Lancelot W.	2	2	0
Bassett, Chas.	1	1	0
Hornsby Richard & Sons, Ltd.	1	1	0
Flower, J. W.	0	10	6
Avery, J. H.	0	10	6
Plumtree, J. S.	0	10	6
"Electricity"	1	1	0
Grant from the Electrical Exhibition Olympia 1905	378	12	8

SUBSCRIPTIONS.

	£	s.	d.
Nalder Bros. & Thompson Ltd.	5	5	0
Wild, Lancelot W.	1	1	0
Hawtayne & Zeden	1	1	0
Concordia Electric Wire Co., Ltd.	3	3	0

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LEGAL INTELLIGENCE.

National Telephone Co. v. Postmaster-General.

The Railway and Canal Commission (Mr. Justice A. T. Lawrence, the Hon. A. E. Gathorne-Hardy and Sir Jas. Woodhouse) on Tuesday commenced the hearing of the application by the National Telephone Co. against the Postmaster-General in respect of certain terms of the agreement under which the Government take over the undertaking of the Company as from Dec. 31, 1911.

Sir Alfred Cripps, K.C., Mr. Danckwerts, K.C., Mr. Forbes Lankester, K.C., Mr. Edward Morten, K.C., and Mr. H. H. Gaine appeared for applicants; the Attorney-General (Sir Rufus Isaacs), the Solicitor-General (Sir John Simon) and Mr. Bramson represented the Postmaster-General.

In opening the case for the company Sir Alfred Cripps said the agreement between the Government and the Company was that the latter should be taken over on Dec. 31, 1911. The company was to be taken over on what were known as "tramway terms"—*i.e.*, as a going business as to the main part of the undertaking—and its land, plant, buildings, &c., at valuation. The private business of the company was to be taken over on business terms. The mass of the business, however, would be taken over on "tramway" principle, which involved the taking of an inventory, on which about 600 people were engaged, 400 on behalf of the company and 200 on behalf of the Post Office. Under the agreement there was a power reserved to the P.M.-G. to give notice to the company on Jan. 1, 1911, that he should decline to take over certain specified portions of the company's land, plant, buildings and equipment. Notices of that kind had been served on the company in respect of a great part of their property, but the company contended that such notices as had been served were not in accordance with the agreement, and that the P.M.-G. in other particulars misinterpreted the arrangement under which the business was being taken over. It was as to this that the Commissioners were now asked to decide. The capital of the company on Dec. 31 last was £11,483,593, and up to that date the company had actually expended £16,154,566 in the extension of its business. The gross income for the year ending Dec. 31, 1910, was £3,422,425, with a net income of £1,105,572. As an example of the great public service rendered by the company, counsel said that during its existence it had paid no less than £3,457,000 to the Post Office in royalties. In the last year £329,494 was paid in this connection, representing actually 10 per cent. of the company's gross income, exclusive of that derived from the private wire business. The staff of the company numbered 18,000 persons. Sir Alfred then gave a sketch of the history of the invention of the telephone. It was made, he said, by Prof. Graham Bell in 1876; Edison came forward with numerous improvements in the two following years. At that time the Post Office refused to buy the patent, apparently entertaining the notion that the telephone was a mere toy. The patent rights were bought in 1880 by the United Telephone Co., the predecessors of the present company. Towards the end of 1880 a decision was given in the well-known case of the Attorney-General *v.* Edison, the effect of which was that the telephone was a telegraph as regarded ordinary public business as distinct from private business, and came within the Post Office monopoly under the Telegraph Acts. In 1881, the National Telephone Co. was formed and, substantially, had carried on the telephone business of this country since that time. Some years ago the P.M.-G. bought the trunk lines of the company for £459,114. The effect of that was that the control of the trunk lines passed to the Post Office. The question was complicated by the fact that, under the Telegraph Act of 1899 certain municipalities obtained power to establish telephone services. On Nov. 18, 1901, an agreement was entered into between the Postmaster-General and the company, which was again incorporated in an agreement of Feb. 2, 1905. Under these agreements the Postmaster-General had power to give notice to the company at any time not after Jan. 18, 1911, that he might refuse to receive lands, plant, or equipment belonging to the company on the surrender date of Dec. 31, 1911. Under these agreements counsel said the P.M.-G. would also have to pay the company for their private licences running beyond Dec. 31, 1911, and any plant, buildings, &c., in use for that purpose.

Mr. Justice LAWRENCE: The scheme is, then, that you are to come to an end on Dec. 31, 1911?

Sir ALFRED CRIPPS: Yes; that we are then to be taken over by a Government department.

His LORDSHIP: Which takes your place on certain terms with regard to one branch of your business and on other terms on another?

COUNSEL: Yes, as regards certain portions of our own business in which the licences have not expired we ought to get business compensation and we also should get compensation for our private wire business. Continuing, counsel said the P.M.-G. claimed the right to refuse to take over any plant not constructed in accordance with the Government specification, and also any plant that might be found to duplicate plant laid down by the P.O. department, provided that notice was given to the company of the fact before Jan. 1, 1911. The Postmaster-General had given notice that certain lands, plant, and other equipment belonging to the company was so unsuitable, but the company contended that practically the whole of its equipment had been manufactured according to the specifications of the Government. It was also contended, on behalf of the P.M.-G. that the plant, &c., in competitive areas should not be taken over. That, said Counsel, was a contention that could not be maintained. To take, for instance, the immense London area, in which both parties were working. He pointed out what an enormous injustice the contention of the department would inflict upon the company. *Prima facie*, the arrangement was that the department should buy all the company's plant, and it lay upon the Postmaster-General to show cause why he should not do so. It was a duty of the department when it gave its notice of rejection to specify the unsuitable parts of the equipment, and say why they were unsuitable. It was quite insufficient, and wholly out of accord with the agreement between the parties, to give notice that the equipment as a whole at certain particular places was unsuitable. Such a notice gave no information to the company, and the Court would not uphold it. Counsel laid great stress on the wrong interpretation of the word "unsuitable" by the Government. They merely contended that the works of the company were unsuitable if they had enough of their own without them.

The ATTORNEY-GENERAL, interposing, said the Postmaster-General objected to taking over the lines of the company because they were worked on the obsolete magneto system instead of the automatic principle employed in the Government's lines. They were consequently quite "unsuitable" for the purposes of the Post Office Department. The department furthermore objected most strongly to the lines of the company being overhead instead of underground.

Sir ALFRED CRIPPS said that was certainly not in the mind of the Postmaster-General when the notice was given to the company that the Post Office would not be liable to take over certain plant. It was clearly then in the mind of the department that they were to refuse duplicate plant only. And counsel contended duplicate plant to be rejected must be clearly specified. Counsel drew special attention to the deed of Feb., 1906,* under which the P.M.-G. contracted to buy the undertaking of the company. "Subject to the provisions of the agreement that all land, plant and buildings of the company brought into use with the sanction of the P.M.-G. and in use by the company on Dec. 31, 1911, for the purposes of the licensed telephonic business of the company. All licensed telephonic business, any private wire business of the company with any plant, land and buildings used for that purpose. All stores which, on Dec. 31, 1911, are in the company's possession, and which are suitable for use in accordance with the methods of work of the Government. Spare plant of all descriptions in the possession of the company on Dec. 31, 1911." Plant, land and buildings, counsel said, would be held under the agreement to have been brought into use with the sanction of the P.M.-G., if such plant, land and buildings, complied with one of the following conditions, but not otherwise: (*a*) If the plant, land or buildings are not in use (or are in the process of being brought into use) for the purposes of the company's business at the date thereof, or; (*b*) In the case of plant, if such plant is, after the date of this agreement, constructed by the company in accordance with the specification; and rules set forth in the third schedule; (*c*) In the case of land and buildings, if such land and buildings are, after the date of this agreement, acquired or constructed with the consent of the Postmaster-General. Providing that the Postmaster-General, may, by notice in writing given to the company not later than Jan. 1, 1911, object to buy such plant, land or buildings as he considers will not be suitable for the actual requirements of the telephonic service of the Post Office on Dec. 31, 1911.

After dealing with other portions of the agreement treating of the private services of the company, &c., Counsel dealt with the large portion of the equipment of the company which he contended the P.M.-G. should take over unless the department had given specific objection to parts of it before Jan. 1, 1911.

Sir JAMES WOODHOUSE: Do you suggest that the Postmaster-General should have specified each wire to which he objected?

Sir ALFRED CRIPPS repeated that no general objection by the Postmaster-General should avail, but that each particular part of the company's service to which the Government took exception should have been mentioned in the notice to the company. The only object of the notices, so far as he could see, was to give the Government power to refuse to accept certain property, and so take it out of the jurisdiction of that court, by whom it would have otherwise been valued. He wanted all those matters of valuation to come before that tribunal. If the Attorney-General succeeded on the point of those notices, then, of course the matters could never come before the court. He said the decree as to the meaning of the word "suitability" for the use of the Post Office should be left entirely to the court, and should not be decided merely by the notice of the department. It was quite impossible that the notice of rejection should be given in a general form.

The Attorney-General interposed the remark, that, supposing a sufficient specification of some plant were given to which objection was raised, such a notice could not be bad. The Postmaster-General might know that there were certain lines which did not form a complete metallic circuit and which, therefore, he was bound to refuse. Where such a line occurred the Postmaster-General claimed the right to object to it as "unsuitable" under the agreement.

After Mr. DANCKWERTS, K.C., had addressed the Court for the National Company,

The ATTORNEY-GENERAL said the P.M.-G. should not raise any unreasonable objection. The Government really wanted to discover some reasonable way of dealing with what the Court must see was a very difficult matter. He understood the argument of applicants was that the notices given by the Government department was insufficient, and that they were, therefore, void. If that were so, then whether the grounds of their objections were good or bad was an entirely different matter. Of course, all the objections of the Government were not on the ground of "unsuitability." But, if the court came to the conclusion that the notice was sufficient then all they had to do was to decide whether

* This deed is set out on pp. 710 to 714 of "THE ELECTRICIAN Electrical Trades' Directory and Handbook," 1911.

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the grounds were sufficient. They objected "to accept telephone wires which did not form a complete metallic circuit. They said all overhead wires were unsuitable, and they said, further, that the court could not ask them to specify every foot of overhead cable to which they objected. That would be intolerable. They objected to all overhead cables. They said they ought never to have been used, and that they were quite unsuitable for the requirements of the Post Office business." Furthermore, the paragraph of the pleading which asked that the notices should be declared to be "insufficient and void" excepted from its operation and thereby admitted the validity of other notices or parts of notices in the same form.

Mr. ALFRED CRIPPS, interposing, asked for leave to amend the paragraph in question.

After discussion, and at the suggestion of the Court, it was arranged that the question whether the Postmaster was entitled to reject all duplicate lines as unsuitable for the actual requirements of the telephonic service of the Post Office upon the ground that he is possessed of other efficient plant or buildings suitable for his service in the area in question" should be first argued and decided. It was agreed that this was the most important point at issue, and that if this were once determined, some understanding could be come to with respect to the remainder.

In opening, the ATTORNEY-GENERAL said he read the arrangement as meaning that the Post Office was only to take over plant that would be suitable for its purposes and no other. The company could attribute any hardship to the action of the Post Office. For 30 years they had been carrying on business by the courtesy of that department. What he desired to make clear was, that all along the company knew the position. And as to taking over the wires of the company, he said that the wires of them were on the overhead system with the distributing wires coming down into the buildings they served, while the Postmaster-General held that those wires were quite unsuitable for his purpose, and the question whether they were so or not was for the consideration of the court.

The case had not concluded when we went to press.

Hartlepool Electric Tramways Co. v. Mayor and Corporation of Hartlepool.

Mr. Justice Bray commenced the hearing of this special case on Tuesday.

Mr. Atherley Jones, K.C., and Mr. Eustace Hills were for plaintiffs; Mr. W. Balfour Browne, K.C., and Mr. H. A. McCardie for defendants.

Mr. Jones said it was a special case stated under the Arbitration Act 1908. The arbitration was held in January, 1911, to decide the value of certain tramways at West Hartlepool with a view to purchase by the corporation. The parties were Hartlepool Corporation (the proposed purchasers) and Messrs. Sellon & Ashby, statutory promoters of the line, and the Hartlepool Electric Tramway Co., who were, at the time the line was given, constructing, and became proprietors of the tramway. A point raised by Mr. Balfour Browne (on behalf of the Corporation) was whether the promoters nor the company had any interest in the line at all which entitled them to payment, and he (Mr. Jones) submitted was a curious and novel point.

Mr. Justice BRAY: Did he say who had an interest in it?

Mr. Jones said the position taken up was that no one had any interest except that the tramway was a trespasser in the street, and that any one could sweep it away or indict it as a public nuisance. Messrs. Sellon & Ashby were certainly the proprietors of the line, but the other side said that Messrs. Sellon & Ashby had parted with their interest and had got their money on it, and they were not entitled to the purchase-money. The notice of the purchase was served both on the company and on the promoters, and was served through the intervention of the Board of Trade. The arbitrator (Mr. C. A. Kirby) had valued the tramways at £12,963, and the question for the decision of the Court was whether the arbitrator had jurisdiction to make the award he had done.

Mr. MCCARDIE, for the Corporation, argued that neither the Tramway Co. nor the statutory promoters had any legal right to the money, and that the Corporation paid it they would be surcharged by the Local Government Board auditor.

Mr. JUSTICE BRAY: The proper thing to do is that this arbitrator should make his award, counsel on each side should agree to be without prejudice to their contentions, and then the question ought to be tried by an action for specific performance.

Mr. ATHERLEY JONES, K.C.: The real point is: Is it competent to the original promoters or the company purporting to be assigns (not to whom, as has been pointed out, no assignment has been made although an agreement to assign has been executed and no consent obtained from the Board of Trade?

Mr. JUSTICE BRAY: I cannot (unless you gentlemen agree) try something which is not within the four corners of the special case.

Eventually, both sides agreed to accept, without prejudice, the arbitrator's figure as the value of the undertaking in question, and to try the matter as an action without pleadings before his lordship on June 13.

Glasgow Tramways Assessment.

In the Glasgow Sheriff Court on Monday Sheriff Gardner Millar heard an appeal by Glasgow Tramways Committee against the decision of the City Assessor as to the assessment of the city's tramway system. Appellants maintained that the tramways were railways and should be assessed only on one-fourth of their value as entered in the valuation roll, as, in practice, they claim, that was followed until 1908. The Assessor maintains that the tramways are not railways, and that they are rather like ordinary heritages to be taxed on their full value, except under those statutes which specifically mention them as entitled to the reduced assessment. The sum involved originally amounted to £15,223, but, as adjusted, it now stands at £12,514.

Mr. J. Avon Clyde, K.C., M.P., and Mr. A. Russell appeared for the Tramways Committee, and Mr. F. Cooper, K.C., with Mr. A. Crawford, for the City Assessor.

Mr. CLYDE submitted the schedule of the rates to which the appeal related. The total amount of rates imposed was £27,737. 18s. 2d., and the amount which appellants considered they should not be called upon to pay was £12,514. 8s. 3d., being made up by the differences on 6 out of the 19 rates on the schedule, viz.: Police, sanitary, statute labour, sewage, roads and bridges and parks. The question whether the Tramways Committee were entitled to a reduction depended on whether the expression "railway" in the clauses which provided for restriction of assessable valuation included a tramway. He quoted sec. 36 of the City of Glasgow Act. 1891, in support of his contention. For 39 years nobody ever questioned that the meaning of the statutes was that the tramway was entitled to the restriction as being within the expression "railway." But in 1909 the proposal was made, and it was carried out by the Corporation, of treating the tramway as being not a railway, but as some other form of land and heritage, and therefore liable to be rated on the full value.

The SHERIFF: Is there anything in the question, Why is this exemption given to a railway, and if the reason can be ascertained readily, does it not apply as much to a tramway as to a railway?

Mr. CLYDE said the reason was that the amount of assessable value in railways and the extent of the benefits they received from local government services, such as policing and sanitation, were out of proportion to the benefits which ordinary lands and heritages derived. Stations and depots were rated in the ordinary way, but with regard to the actual lines the benefit derived from the public services were very small. The reasons which led to exemption in the case of railways, canals, or any work which was continuous were applicable to those sort of railways which were laid down on the streets.

Mr. COOPER, K.C., said that practice could not interpret a recent Act of Parliament, and if the rating authority of Glasgow for a number of years had chosen not to exercise their powers to the full that could not be a bar to them doing so now, provided the statutes under which they operated entitled them to a larger claim than they had hitherto made. When they valued a railway they valued a heritable subject—the land that the railway owned and occupied for its purposes. In valuing a tramway they did not get at the value of the land, because it had not got any land. What they did get was the value of an undertaking which had no land, but which, because it rested upon the soil and had certain qualities, was treated as a heritable subject. A tramway would not fall within the section of the 1891 Act. The words there used did not suit the peculiar qualities of a tramway, which were very distinguishable from those of a railway. Up to 1891 there had been no fewer than four previous Acts obtained by Glasgow in which tramways as well as railways were allowed assessment upon one-fourth of valuation. If the tramways were to get a certain reduction on their assessments, the committee must be able to put their finger on the section of the statute which mentioned them.

His Lordship reserved judgment.

London Electrobus Litigation.

On Thursday last week Mr. Justice Neville had before him the action of the Re-Organisation Control Synd. (Ltd.) v. International Motor Traffic Synd. (Ltd.) and others upon a motion by defendants to vary the terms of an order of Feb. 13 last.

Mr. AUSTEN CARTMILL, in support of the motion, reminded his lordship that the action was brought against defendant syndicate and the Brighton, Hove & Preston Omnibus Co. in respect of an alleged wrongful sale of certain electric motor 'buses and spare parts, and £800 was paid to the International Synd. in respect of the purchase-money. The original judgment did not deal with the spare parts, because everybody at the time thought the spare parts delivered to the Brighton Co. were comprised in a list (now exhibited to the order). It turned out, however, that the list only included a portion of the accessories. There was also a technical objection to the minutes of the order.

His LORDSHIP said that the list of accessories was an agreed list, and the case proceeded on that basis. It was conclusive, and he thought he ought not to leave open the question of whether the sale of all the articles in the agreement was wrongful.

Mr. COLEBRIDGE pointed out that the enquiry would have to go as to what really were the things included in the list.

His LORDSHIP said that would be left open, but the enquiry was not to include any articles that were in the list. He thought also that it should be made clear that the order was made on both the claim and counterclaim.

The minutes of the order were directed to be varied accordingly.

Dead Tramway Points.

At the Westminster County Court on 4th inst. the F.I.A.T. Motor Cab Co. sued London County Council for £5. 18s. 6d. damages to a motor cab alleged to have been caused by its running into an electric tramcar. Plaintiffs' case was that the tramcar got on to a dead point at High-street, Camden Town, early on the morning of Nov. 23 last, where it would have to stop without lights until pushed forward sufficiently for the plough to pick up the current again. It was very foggy, and one of plaintiffs' cabs, containing two gentlemen, ran into the rear of the car, both passengers being injured and the cab damaged to the amount claimed. Defendants

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were negligent in not providing a permanent tail light as required by the Board of Trade.

For the defence it was said that the car was moving and lighted, and complied with the police and Board of Trade requirements. Dead points were authorised, and it was inevitable that the lights would go out when dead points were crossed.

After hearing the evidence and legal arguments, his HONOUR held that the car was stationary and unlighted, and found for plaintiffs, with costs, on the ground that if the car had been an ordinary vehicle it must, when stopped, give some warning to the traffic following it.

Trade Union Funds.

In an action brought by Mr. John Wilson against the Amalgamated Society of Engineers and its trustees to restrain them from applying their funds for Parliamentary and other purposes, Mr. Justice Parker, in the High Court, recently delivered judgment in favour of the plaintiff. His Lordship said the judgment would go substantially in the form of the Osborne case in the Court of Appeal. In the present case the rules purported to give power to levy for the purposes of elections of municipal and other local bodies. Every argument in the Osborne case seemed to apply to such elections also, and the judgment must, therefore, be framed so as to extend to elections of municipal or other local government authorities, not including boards of guardians.

PARLIAMENTARY INTELLIGENCE.

L.C.C. TRAMWAYS AND IMPROVEMENTS BILL.

A Select Committee of the House of Commons, presided over by Sir Luke White, has been considering this bill during the past week.

After hearing the chief officer of the tramways (Mr. A. L. C. Fell) the committee agreed to a clause being inserted which will enable the Council to erect tramway shelters (with the consent of the local authority) at different points on the routes.

A clause authorising the Council to run reserved tramcars for women workers and Sunday school and other parties was also passed.

In regard to the proposal to construct a tramway along Edgware-road to the Marble Arch, Mr. POLLOCK, K.C., stated that the tramway would start at a junction with the Middlesex County Council tramways at Cricklewood, and terminate at the Marble Arch end of the Edgware-road. The total length would be nearly 2½ miles and the total cost £116,500. The cost of the proposed widenings (as settled between the different authorities) was £277,000, of which £246,000 was for land. At the Marble Arch terminus there would be a single line 25 yds. long, leaving a roadway on each side 20 ft. wide.

Mr. M. FITZMAURICE, C.M.G., chief engineer to London County Council, gave evidence in support of the bill. In cross-examination witness did not agree with the report of the Home Office, which was adverse to the construction of such a tramway owing to the difficulty of regulating the traffic. According to the report, a dead-end terminus at Marble Arch would be dangerous, particularly on the occasion of great meetings in Hyde Park.

In reply to Mr. Lankester, K.C., witness said there was no intention to put forward a proposal eventually for continuing the tramway through Park-lane. He had never recommended or thought of any such extension. He had thought of a scheme for carrying a tramway under Hyde Park.

On Wednesday Mr. EDWARD WHITE, Chairman of the County Council, said that this tramway was much wanted in the public interest. Apart from the tramway, the proposed widenings would be of immense advantage. They were in negotiation with the Middlesex County Council as to the amount they would contribute to the cost of widenings. He had every reason to suppose that the widenings would cost £300,000, and then there would be the cost of laying the lines. Asked whether he thought the intended dead-end at Marble Arch was a suitable place for a terminus, Mr. White replied that it was just about the best that could be picked in London, because the space that would be occupied by the single line was not wider than the refuge which was already there.

Mr. A. L. C. FELL stated that the journey between the Marble Arch and Cricklewood would occupy about 25 minutes, and the fare for the whole distance would be 2d., with ½d. and 1d. stages. He would advocate a tramway down the Strand.

Mr. MACASSEY said that, so far as the County Council were concerned, it must be the whole scheme or nothing.

The Committee adjourned.

In a report on the above bill, by the Commissioner of Police it is stated that in streets in which tramways are laid the general traffic invariably increases. This is especially apparent in the suburbs, in the main streets of which the general traffic appears to increase pari passu with the facilities offered for transit.

When tramways are laid streets tend to change their character from residential to mercantile. The fast-moving tramcars have the effect of diverting other vehicular traffic to the sides, so that any overflow from the pavement to the road becomes impossible or dangerous. Accordingly, when tramways are laid, pavements—instead of being reduced, require rather to be widened to provide greater accommodation. It appears, therefore, desirable that when a new tramway scheme is proposed the whole effect of the scheme should be considered beforehand, and the necessary provision made for the increased traffic by maintaining or providing sufficient width of footway, and, if necessary, by the widening of the street.

The Edgware-road and other portions of the Council's scheme of tramways extension are criticised, and suggestions as to street-widening, &c., are made.

GREATER LONDON RAILWAY BILL.

A Select Committee of the House of Commons (presided over by Sir J. Compton-Rickett) commenced the hearing of this Bill.

Mr. J. D. FITZGERALD, K.C. (for the promoters) said powers were sought to construct a railway 57 miles in length to pass in a semi-circle round London north of the Thames, connecting with all the existing railways and with the Victoria and Albert and Tilbury Docks. The proposed line would begin at Feltham with a junction with the London & South-Western line, and give a connection via Clapham Junction with the lines south of the river. Passing through Southall and Northolt, connection would be made with the Great Western Railway, and the route to Birmingham, at Sudbury with the Great Central, at Wembley with the London & North-Western line and with the Metropolitan & Great Central, at Hendon with the Midland, and at Finchley with the Great Northern. Getting on to the Great Eastern there would be junctions with the Cambridge and Colchester lines, and proceeding eastwards the line would end at Tilbury Docks. Connection from Barking, through East and West Ham, would be made with the Victoria Docks. By means of these connections (said counsel) the dock traffic to and from the Midlands and the North could be transitted without entering London. The proposed line would also form a desirable route for the interchange of North and South London traffic, and for the traffic arising from the establishment of the factories and works on the line of route. A representative of the War Office would tell the Committee how advantageous the line would be for the movement of troops. The promoters thought a share capital of £4,000,000, with the usual one-third borrowing powers would suffice. That was not a novel proposal, as on three occasions a similar scheme had been before Parliament, and on two occasions had been sanctioned. The opposition to the Bill came mainly from railway companies, and was not in the public interest. The promoters were Lord Weardale, Sir Douglas F. R. Dawson, Col. Ivor Phillips, the Hon Arthur Stanley and Mr. H. Mallaby-Deeley.

Mr. W. FOXLEE, C.E., consulting engineer for the scheme put the expenditure on works and contingencies at £2,252,366, and on land at £1,453,202. The average would be £64,116 per mile of double line, or for works £38,972 per mile.

In reply to the Chairman, Mr. WEDDERBURN, K.C., said the land proposed to be taken would allow stations to be within the limits of deviation and the positions would be arranged with local authorities. The promoters had arrived at an agreement with the Port of London Authority.

Mr. BALFOUR BROWNE, K.C., called attention to the Report of the Commissioner of Police to the Home Office in which the proposed bridges over main roads were represented as too narrow and the gradients as too steep.

Mr. FOXLEE said the requirements of the report could be complied with at an increased cost of £60,000 for the bridges. There would be little difficulty in altering the gradients to 1 in 30. Negotiations were proceeding with the L. & S.W. Co. in reference to a junction at Feltham. No arrangement had been made for junction with the Great Eastern line. The tramways on the route would not be competitors for traffic, but would act as feeders for the new line.

On Tuesday Lord Ritchie, Chairman of the Parliamentary Committee and Port of London Authority, said the Authority were spending considerable sums in deepening the river, and had under consideration large extensions of the Victoria and Albert Docks. He expressed no opinion on details of the present scheme, but as it afforded additional railway facilities the Authority were in favour of it.

General G. V. KEMBALL, President of the War Railway Council and Director of Movements and Quartering for the War Office, said from a general military point of view the line would be advantageous.

Sir T. COURTENAY WARNER, M.P., said the line would be an enormous advantage to Walthamstow and the working-class population.

Mr. S. FAY, general manager of the Great Central Railway Co., said he did not see that the proposed line would be of any particular advantage to the Great Central Co., and he was not prepared to support the scheme on that ground.

Mr. W. FOXLEE, C.E., consulting engineer for the scheme, gave further evidence.

The Committee adjourned.

MIDDLESBROUGH, STOCKTON AND THORNABY TRAMWAY BILL.

On Monday a Committee of the House of Lords, presided over by Lord Sanderson, commenced the hearing of this bill.

For the promoters, Mr. BALFOUR BROWNE, K.C., said the bill would extend the time for the construction of tramways authorised in 1904 and some powers which were extended in 1907. In consequence of a series of tolls demanded along the line of route of the proposed tramways the promoters had found it impossible to proceed with the tramways, and now asked for an extension of time, the renewal of certain powers in one case where they had lapsed, and power to acquire compulsorily and extinguish the tolls on the roads.

After the Committee had heard the arguments of counsel for Middlesbrough Corporation and other petitioners against the bill, they decid

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to hear petitioners in regard to new facts which had occurred since 1907 to make revival and extension of the powers granted under the 1907 Act objectionable, and also as regards objections to new provisions contained in the bill.

Mr. SAMUEL WHITE, a director of the Imperial Tramway Co. (the promoters), gave evidence, and said they were asking that their powers might be kept alive in order that time might be given for coming to an arrangement with regard to the tolls.

In cross-examination, he said he did not think it was worth while going on with the bill if the municipal authorities declined to assist the company in extinguishing the tolls, and he declined to give any guarantee whatever that the scheme in the bill would be carried out within a certain time.

Mr. PAGE, K.C. (for Middlesbrough Corporation), said under no circumstances would Middlesbrough Corporation enter into an arrangement with the promoters for the purchase of the tolls, or contribute towards the expenses for which the company had made themselves liable under the Acts of 1904 and 1907.

The CHAIRMAN announced that the Committee had decided to allow the bill to proceed subject to certain clauses as to the completion of the works and the extinction of the tolls being adjusted.

MATLOCK DISTRICT RAIL-LESS TRACTION BILL.

A House of Lords Select Committee, presided over by the Duke of Bedford, commenced the consideration of this bill on Wednesday.

The bill proposes the incorporation of the Matlock District Rail-less Traction Co. (to which Messrs. W. H. Collier, F. Douglas Fox and Thos. Bell and others have agreed to subscribe capital) with a capital of £5,000 and £5,000 borrowing powers to equip and run electric rail-less trolley cars between Matlock and Matlock Bath and the Market Place, Cromford, about 2¼ miles.

Mr. WEDDERBURN, K.C. (who with Mr. Hutchinson, K.C., and Mr. Crundall appeared for promoters), said the cars would weigh 3¼ tons empty and 5 tons full. The promoters offered to pay Derbyshire County Council £50 per mile per annum for additional upkeep of roads which the County Council said would be necessitated by the use of the rail-less trolley cars. The County Council opposed the Bill on the ground that the roads were steep and narrow, that the promoters were strangers in the district, and that no time was proposed to be fixed by the bill for the completion of the works.

Mr. J. B. HAMILTON, general manager of Leeds Corporation tramways, gave particulars of the Leeds experimental rail-less system. He said a return overhead wire was used. This was a requirement in all cases where no rails were used. He also described the systems in use in Austria and Italy. In Vienna the operation of the cars was simplicity itself, and the public were very pleased with the system. There was a range of deviation of about 15 ft. The overhead construction cost from £1,200 to £1,500 per mile, and the vehicles from £700 to £800 each. The cost of operation at Vienna was about on a par with ordinary tramways of the same carrying capacity. He thought they had reached the same point of reliability in trackless trolley traction. It was particularly suitable for thinly populated districts. A minimum of road-wear was caused by such a system. In the case of the Leeds rail-less cars he reckoned the margin of profit at ¾d. per car-mile, and the cost of working at 12d. per car-mile, without a conductor. If a conductor were necessary that would add about 1d. per mile. He did not know that if a generating station were put up at Matlock the cost of current would be higher than at Leeds (about ¾d. per unit). There had been no accidents at Vienna where part of the system had been working about six years. There was no more risk in insulating rail-less cars than ordinary tramcars. He agreed with Mr. Hutchinson that electricity could be generated by means of a water-power engine (which it was stated the company proposed to use) at ¾d. per unit.

Mr. I. E. WINSLOW (consulting engineer for the scheme) thought the proposed system would be of benefit to the neighbourhood. He agreed with Mr. Hamilton's evidence. There was a large traffic on the road over which it was proposed to run. Two cars would give about 20-minutes service, and he estimated the receipts at about £2,500 per annum. Profit would be about 2d. per mile. Four or five extra cars should be put on at holiday time, and this would increase the revenue by £1,500 per annum. The total expenditure, including the cost of the Act, was put at £16,450. The annual profit was estimated at about £1,200 (7 per cent. on the capital). Cost of working would be 6d. per car-mile. On the narrowest roadway on the proposed route was between 12 ft. and 15 ft. wide.

Evidence in opposition to the bill was given yesterday (Thursday) by witnesses called on behalf of the Derbyshire County Council and the Matlock Bath and Scarthin Wick District Council.

Automatic Printing Telegraph Instruments.—In the House of Commons, on Tuesday, Captain NORTON, Assistant Postmaster-General, stated, in answer to a question, that the high first cost and maintenance charges of automatic printing telegraph instruments were always be a bar to their employment where the traffic was not large, but he hoped to extend their use at the more important offices. Ordinary typewriters to be worked by the receiving telegraphists were being tried at some other places, but there were difficulties in the way of their general introduction.

Telephone Employes.—In the House of Commons on Thursday last week, the Postmaster-General stated, in reply to a question, that the general conditions under which employes of the National Telephone Co. were to be transferred to the Post Office were stated in the Memorandum read in the House on Aug. 9, 1905, by the then Postmaster-General. The bill, which he hoped shortly to introduce, would contain provisions respecting pensions. The question of the value to be attached to service under the company for purposes of seniority and for other purposes was still under consideration, and he was not yet able to make any further statement.

Coal Mines Bill.—The Grand Committee of the House of Commons, presided over by Mr. Eugene Wason, has been considering this bill, but up to the present only 13 clauses have been dealt with. These clauses relate to the appointment and qualifications of managers.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

*NOTE.—The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application, an asterisk is affixed.*

March 6, 1911.

5,521 SUMNER. Current graduating devices or resistances.
5,530 MICKLEWOOD. Actuating gear for magnetos and dynamos.
5,563 MURRAY. Supplying electricity to consumers on the maximum demand system.
5,564 CROWE & BRITISH L.M. ERICSSON MFG. CO. Electric conctact keys or the like.*
5,569 GES. FUR ELEKTROTECHNISCHE INDUSTRIE M.B.H. Electric conductors. (Convention date, 28/6/10, Germany.)*
5,594 COTTAM. Holders for electric lamps.
5,596 SIEMENS BROS. & CO. (Siemens & Halske Akt.-Ges., Germany.) Railway signalling apparatus. (Addition to 19,558/07.)*
5,620 B.T.-H. Co. (G.E. Co., U.S.) Electric motor control.
5,622 BELFIELD. (Orlando M. Thowless, U.S.) Electric lamps.*

March 7, 1911.

5,632 DITCHAM. Frequency meter.
5,654 CHAMBERLAIN & HOOKHAM & JAMES. Electricity meters.
5,700 DAVIDSON. Working of electric railways.
5,714 MADALER. Arc lamps.
5,727 SMITH & GRANVILLE. Electric cables.
5,745 DICKINSON. Boxes for use with electric cables, telegraph, telephones and the like.
5,752 GARTELL. Metal filaments for electric lamps.

March 8, 1911.

5,766 BRUSH ELECTRICAL ENGINEERING CO. & KAHN. Connections of dynamos for three-wire supplies.
5,789 RAYNER. Telephone call register.
5,790 JONES. Sparking plugs for electrical ignition purposes.
5,806 GIRDLESTONE & THORKELIN. Arc lamps.*
5,812 HULTMAN. Channels or drums for underground cables. (Convention date, 7/4/10, Sweden.)*
5,813 HULTMAN. Conduits for underground cables. (Convention date, 9/4/10, Sweden.)
5,828 SCHULTZ. Switches and interrupters for electric circuits.
5,852 OZONAIR (LTD.) & JOSEPH. Process of bleaching, sterilising and other operations wherein ozone is employed.
5,856 GARSIDE. Electrical switches and controllers.
5,866 ANSCHUTZ & CO. Electric motors. (Convention date, 18/11/10, Germany.)*

March 9, 1911.

5,961 CARPENTIER. Measuring the relation of two electric currents. (Convention date, 18/3/10, France.)*
5,986 MARTYN. Electric wall plugs.
5,993 B.T.-H. Co. (G.E. Co., U.S.) Control of electrically operated switches.

March 10, 1911.

5,997 DITCHAM. High-frequency oscillation detectors.
6,009 GOVER. Metal filament electric lamps.
6,017 BEARDMORE & CO., BREMBERG & BANKS. Electric firing devices for ordnance.
6,049 WOOD & EASTERN TELEGRAPH CO. Automatic telegraph transmitters.
6,050 NICOL. Thermally-operated electric indicator.
6,066 RICHARDSON & CROWLEY. Lighting of electric incandescent lamps.
6,071 MCLEAN & MADGEN. Electricity meters.
6,089 TURNER. Electric incandescent lamp and holder and switch therefor.
6,095 B.T.-H. Co. (G.E. Co., U.S.) Control of electrically-operated switches.

March 11, 1911.

6,108 FOSTER. Dynamo electric machines.
6,129 PAGE. Auxiliary eletric light switch adaptor.
6,147 HARTMANN & BRAUN AKT.-GES. Push-button electric switches. (Convention date, 12/4/10, Germany.)*
6,158 BILLON-DAGUERRE. Electric furnace for two or three-phase currents.
6,182 WASSERZIER. Electric ignition device for gas burners.*
6,188 B.T.-H. Co. (G.E. Co., U.S.) Motor starting and protective devices.

March 13, 1911.

6,203 MORRIS. Regulating time-limit liquid controller for electric motors.
6,228 MOLLOY. Electrical generating.
6,257 JOEL, jun., & TAYLOR. Generating electricity on motor-driven vehicles and the like.
6,293 ALLGEMEINE ELEKTRICITATS-GES. Electric control systems. (Convention date, 12/3/10, Germany.)*

March 14, 1911.

6,336 KORTING & MATHIESEN AKT.-GES. Alternating-current arc lamps. (Convention date, 30/3/10, Germany.)*
6,345 FAIRWEATHER. (Sydney Stein, U.S.) Portable telephones.*
6,373 STEVENS. Variable-speed transmission for petrol-electric vehicles.
6,401 SCOTT. Regulating, or maintaining constant, the electromotive force or current in circuits in connection with electric generators or boosters.
6,435 RANDOLPH & RIVETT-CARNAC. Trolley poles for overhead tramway systems.
6,443 SCHWEITZER & CONRAD. High-voltage protective device.*
6,449 DITCHAM. Impulse excitation for wireless telegraphy and other purposes.

March 15, 1911.

6,490 BOTTOMLEY. (Eugenio Cantono, Italy.) Starting devices for motors and other machinery.
6,531 MORGAN & WOOD. Sparking plugs.
6,545 G. FULLER, L. FULLER & G. J. A. FULLER. Electric accumulators.
6,549 RUHMER. Multiple telephony. (Convention date, 16/3/10, Belgium.)*
6,557 ALLGEMEINE ELEKTRICITATS-GES. Control of electric motors. (Convention date, 15/3/10, Germany.)*

March 16, 1911.

6,577 BLACKWELL. Arc lamps.
6,611 ELECTRIC & ORDNANCE ACCESSORIES CO., ETCHELLS & PRICE. Variable speed dynamos.
6,166 DICKSON. Fuse holders.
6,626 SIEMENS BROS. & CO. (Siemens & Halske Akt.-Ges., Germany.) Signalling apparatus. (Addition to 19,684/09.)*
6,627 SIEMENS BROS. & CO. (Siemens & Halske Akt.-Ges., Germany.) Block-signalling systems.*
6,663 B.T.-H. Co. (G.E. Co., U.S.) Control of electrically operated switches.
6,664 ELEKTRIZITATS AKT.-GES. HYDRAWERK. Electric elements. (Convention date, 23/6/10, Germany.)*

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COMMERCIAL AND INDUSTRIAL SECTION.

MUNICIPAL, FOREIGN & GENERAL NOTES.

BRITISH NOTES.

Aston.—The accounts of the electricity department for the year ended March 31 were approved by the Corporation last week.

The total income was £32,880, against £30,065 in the previous year. After deduction of working expenses, interest, loan payments, &c., the net balance was £3,742. Altogether £4,068 is available, of which £3,600 is to be devoted to relief of rates.

Bampton.—The Urban Council have resolved to substitute electric lighting for the oil lamps at present used for public lighting.

Blackburn.—Last week the Council resolved to invite tenders for extensions of the electricity works to meet next winter's probable demand. Estimates amounting to £45,170 were approved and sanction to borrow this sum has been applied for.

Bognor.—The Board of Trade have notified the Council that the district has been excluded from the area scheduled in the provisional order granted to the Chichester Electric Light & Power Co.

Burnley.—The Tramways Committee recommend the expenditure of £14,650 on the construction of an additional length of tramway.

Burton-upon-Trent.—The L.G. Board have sanctioned a loan of £1,750 for house services and transformers.

Colne.—The Council have applied for sanction to a loan of £2,000 for extensions of mains.

Coronation Illuminations.—A meeting of permanent residents decided last week to illuminate the front of *Douglas Bay* (Isle of Man) by means of electric lamps during the Coronation season, at an estimated cost of £680. *Kingston-on-Thames* Corporation will supply current at 1½d. per unit for illuminations during Coronation week, with a small additional charge for a special meter, &c. Canbury Gardens, Kingston Bridge and the Queen's Promenade, Kingston, are to be illuminated by 17,000 electric lamps, at a cost of £100.

Country House Lighting.—The Marquis of Northampton is having electric lighting plant installed for the lighting of Castle Ashby.

It is stated that most of the fine old colza lamps at Castle Ashby which have been so much admired in the past are being converted to electric lamps connected to wall plugs. His Lordship has further decided to instal the electric light in the church, utilising the beautiful old Viennese bracket lamps. The work will be begun immediately.

Donaghadee (Ireland).—A Board of Trade enquiry was held last week by Mr. G. B. Deane, J.P., into the application of the Council for an electric lighting provisional order.

The town clerk (Mr. D. WALKER) gave evidence as to the financial position of the town, &c.

Dr. GEORGE GIBSON, J.P., chairman of the Council, gave evidence as to the present lighting of the district and the necessity for lighting portions of the district to which the gas mains did not extend and where the gas company would not put down mains. He thought an electricity scheme would prove a success in view of the fact that it could be used for pumping the water for the town supply

Mr. ARTHUR WILKINS (Messrs. Wilkins & Bowden) said his firm drew up a scheme for the electric lighting of the entire district, and estimated that, from results shown by other towns of a similar size, a profit of £290. 10s. could be made with their scheme after paying expenses, including interest and sinking fund.

Other evidence having been given in favour of the scheme,

Messrs. J. C. MacGowan (secretary) and R. M'Conkey and J. H. Barrett (directors of the gas company) gave evidence in opposition.

Dover.—The Council have received sanction to a loan of £2,300 for extensions of mains, services, &c.

Dublin.—The L.G. Board inquiry into the application of the Corporation for sanction to borrow £128,129 for extensions of the electricity undertaking was concluded on Saturday.

The evidence in favour of the application was given in THE ELECTRICIAN on April 29 and May 5. The Rathmines and Pembroke Drainage Board opposed the application.

Mr. W. W. Murphy gave evidence in opposition, and more particularly as to the unsuitability of the Pigeon House site, the cost of working, &c.

At this stage it was announced that the Electric Light Committee and the Drainage Board had come to terms.

Mr. MARK RUDDLE, city electrical engineer, was recalled by the inspector (Mr. Cowan) in reference to the plans for extension at the Pigeon House. He said he did not see any reason to change the plans at all, except in points of detail. An intermediate station between the Pigeon House and Fleet-street would increase the chance of a breakdown, and add to the expense, and the Corporation desired to work the station as economically as possible. He said, having made his protest against the site, he had done his best to make the scheme a success.

Dundee.—The Council have adopted a scheme of universal 1d. fares on the tramway system and the ½d. stages have been reduced to 880 yds.

Electricity in Gold Mining.—The chairman of the Balaghat Gold Mining Co. (Mr. John Taylor) stated at the meeting last week that from the beginning of last November, under the terms of their agreement with the Mysore Government, the contract rate for 181 H.P. supplied electrically under the Cauvery scheme was reduced from £24 to £10 per horse-power per annum.

Electricity in Pottery Works.—Messrs. T. G. Green & Co., Church Gresley, have recently installed electric power and lighting plant.

Previously the four factories of the firm were worked separately, a number of boilers and engines being utilised. All these have been discarded, and a central power house erected. The boiler house contains Lancashire boilers (by Ruston, Proctor & Co.) which work at a pressure of 150 lb. They are fed by forced draught, automatic-feed stokers by Belliss & Morcom, who have also supplied a 375 H.P. high-speed engine. The electrical work has been carried out by Messrs. Crompton & Co., and consists of a 250 kw. three-phase alternator, and 14 motors, from 50 H.P. to 5 H.P., are installed for various work. Difficulties were at first experienced with the milling portion, owing to the starting load being so extraordinarily heavy, but the few difficulties were successfully overcome, and at the present time all the four works are being driven electrically, and entirely to the proprietors' satisfaction. The works are electrically lighted throughout, the contract for this work having been sub-let to Mr. Richards, of Burton.

Hammersmith (London).—Tenders are to be invited for a feed-water-heater at a cost of £250. 68 further gas lamps in side streets are to be converted to electric lighting at a cost (including cost of posts) of £392. 14s.

Hastings.—An inquiry was held on Friday into the application of the Council for sanction to borrow £1,789 for extending the electric supply mains to the workhouse and to the sanatorium.

The Acting Town Clerk said the Guardians had agreed to take current for five years, and it was estimated to supply 10,000 units per annum. Deducting expenses there would be a net income of £181.

The local gas company opposed, and the assistant engineer to the company gave evidence in opposition. The witness admitted, in cross-examination, that he used electric lighting for part of his offices.

Hornsey Electrical Exhibition.—On Monday the Mayor of Hornsey (Coun. A. A. Yeatman, J.P.) and the Mayoress opened an exhibition of electrical and domestic apparatus at the Athenæum, Muswell Hill.

The exhibition is organised by the Electricity Supply Committee, and a number of local and other exhibitors displayed electric motors, cooking and heating apparatus, lamps, fittings, &c.

After declaring the exhibition open the Mayor gave a sketch of the progress of the electricity department. They started, he said, to supply current in 1903. They had in the first year 445 consumers and 26,000 8 c.p. lamps connected; in 1910 they had 1,750 consumers and 92,000 lamps; while now they had over 2,000 consumers and over 100,000 8 c.p. lamps. The number of units supplied increased every year in spite of metal filament lamps. They had £2,000 profit last year.

Light Railways.—The Board of Trade have confirmed the Doncaster Corporation Light Railways (Extension) Order, 1911.

A scheme is being prepared for the construction of a light railway from Ashton-under-Lyne to Bury.

It is intended to run the light railway across part of Ashton Moss, past Daisy Nook and over Buckley Hill to Failsworth. From Failsworth the line will go near Middleton and on to Bury.

London County Council.—On Tuesday an estimate on capital account of £1,675 was approved of for sand crushing machinery for the tramways.

Renewal of Special Trackwork.—It was reported that Hadfield's Steel Foundry Co. had agreed to supply the special trackwork required for renewals during the present financial year for £13,245. 15s.

Marble Arch Tramways.—Mr. Stuart Sankey brought up a report of the Parliamentary Committee which stated that negotiations were proceeding with Hampstead Borough and Middlesex County Councils with regard to street widening in Kilburn and Brondesbury and other matters, and these involved such large and additional obligations on the part of the Council that the scheme would be of a much more costly nature than was anticipated. If the negotiations were unsuccessful the Council would be under the necessity of withdrawing the scheme from the bill. The

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original estimate for street widenings in Hampstead was £95,000; it had now been raised to £277,000, and Hampstead Council were putting forward further requirements which would increase it to £310,000. Paddington would probably ask for widenings which would cost £150,000, and the cost of constructing the line was estimated at £120,000.—Report adopted.

Luton.—The Council have received sanction to a loan of £13,510 for additional generating plant, mains, &c.

Metropolitan Water Board.—At the meeting on Friday the Works and Stores Committee reported that proposals had been placed before them for an extension of the electric lighting at the Hampton and Surbiton stations.

The total cost of the work at Hampton Station, including plant, wiring, lamps, &c., will be £1,400, and the upkeep of the new plant, with interest upon the capital, will be £260 per annum. The cost of lighting this portion of the station by gas is over £400 per annum, so there will be a considerable saving. Surbiton Station is lighted by gas, and it it proposed to instal electric lighting plant and apparatus at a cost of about £1,675. The average annual cost of the existing gas lighting is £680, and the cost of maintenance of the proposed electric plant (with interest) will be £320. All the work is to be carried out by the Board's workmen.

Oulton Broad.—The Council have referred back to the Electric Lighting Committee a public lighting scheme prepared by Mr. J. Fennelather. The estimated cost is £2,868. Overhead cables are proposed for a portion of the district.

Penmaenmawr.—The Council have decided to complete the scheme for the lighting of the promenade by flame arc lamps.

Portrush (Ireland).—As the Council cannot come to terms with the local gas company re purchase of the gas works, it has been decided to take steps to erect electricity works. Messrs. Millar, Wilson & Pegg are consulting electrical engineers to the Council.

Portsmouth.—The L.G. Board have been asked to sanction the allocation of £700 towards the purchase of superheaters for the generating stations.

Presentations.—On his marriage Mr. T. Hall, borough electrical engineer at Burton-on-Trent, has been presented by the staff with a clock and silver butter dish.

The staff of Middlesbrough electricity works have presented a travelling trunk to Mr. H. E. Pawson, senior charge engineer, who is leaving to take up a position abroad.

St. Annes-on-the-Sea.—The Council have referred back a proposal to pay the electrical engineer (Mr. T. D. Clothier) a bonus of 5 per cent. on profits over those of last year.

South Shields.—An inquiry was held on Wednesday into the application of the Corporation for sanction to borrow £10,080 for extension of the electricity undertaking.

Of that amount it was proposed to borrow £7,580, the balance of £2,500 to be taken out of the reserve fund. The North-Eastern Railway and Smith's Dock Co. opposed on the ground that they want three-phase alternating current for power at their docks, and that the only way in which they could obtain such a supply was to induce the Corporation—who under their own scheme could not provide such current—to take supply from the County of Durham Electric Power Supply Co. The County of Durham Co. had offered to instal plant in the Corporation's works to provide twice the power the Corporation's new scheme provided at a cost of £15,500, the Corporation paying £10,080, which they had proposed to expend on their own scheme, the whole of the plant to become the immediate property of the Corporation.

Swansea.—There are now over 2,000 consumers, representing the equivalent of 154,225 8-c.p. lamps, connected to the electricity mains.

Swindon.—The Council have applied for a loan of £3,510 for extension of the electricity works.

Telegraph Communication with the Continent.—A deputation from the Liverpool Chamber of Commerce and other commercial interests waited on Tuesday upon the Postmaster-General to urge an improvement in the telegraphic communication between this country and the Continent.

In reply to the suggestions of the deputation, Mr. HERBERT SAMUEL said his attention had been drawn to the delay in the telegraphic communication between London and Liverpool, and considerable improvement had since been effected by the installation of new apparatus. The average delay now was 3½ minutes, which, he thought, could not be regarded as unsatisfactory. With regard to inland telegrams, he thought all telegrams should be all urgent. With respect to foreign telegrams, he was by no means satisfied with the service that existed between the commercial centres of England and the chief cities on the Continent. To avoid delays that took place between Liverpool and the Continent, he was proposing to divert a large part of that additional business to the wires through the Central Telegraph Office, and thereby to relieve the strain on the direct wires. After many experiments they had found what they thought was a really effective apparatus—the multiplex—enabling a much greater use to be made of the wires than

West Ham.—The Electric Lighting Committee reported on Tuesday that they had approved proposals of the borough electrical engineer (Mr. H. H. Couzens) for extensions of the generating plant, &c., at a cost of £59,000. The report is to be referred to the Finance Committee to report as to the provision of the necessary funds.

Mr. Couzens' proposals include river service pipework (£8,500), buildings (£9,500), 5,000 kw. turbo-alternator set, with condensers, &c. (£14,000), boiler plant and auxiliaries (£12,400), pumps, tanks, pipework, &c. (£3,100), coaling plant (£3,000), contingencies (£2,500) and general mains for two mains (£6,000). The coaling plant is inadequate, and it is proposed to instal a telpher scheme beside the existing runway of the Temperley transporter, such telpher to deal with 60 tons of coal per hour. Several of the items in the list of plant are most urgently needed, and the additional boiler plant should be in operation for next winter's load.

Woodbridge (Suffolk).—At the Council meeting last week Mr. Edmund Charrington's proposals for the supply of electricity for light and power in this district were referred to the Electric Committee for report.

Dinners.—On Saturday last a farewell dinner was given in London to Mr. Evan Parry, B.Sc., who is leaving England to take up an appointment as electrical adviser to the New Zealand Government, in connection with the hydro-electric developments which that Government propose to carry out.

Between 70 and 80 friends and well-wishers were present, amongst whom were Dr. H. F. Parshall (in the chair), Mr. Robert Hammond, Mr. W. M. Mordey, Mr. A. P. Trotter, Mr. Palliser, Mr. Tegetmeier, Mr. James Devonshire, and other gentlemen representing every branch of the engineering profession. Letters were received from Sir Joseph Ward, Prime Minister of New Zealand, and Sir William Hall-Jones, High Commissioner for the New Zealand Government, expressing regret at being unable to be present, and telegrams were received from Mr. S. Z. de Ferranti, Mr. C. H. Merz, Mr. T. O. Callender and others regretting unavoidable absence.

The toast of "The Guest of the Evening" was proposed by Dr. PARSHALL, who pointed out that Mr. Parry had been closely associated with him for the last 18 years, during which time schemes involving the expenditure of many millions of money had been carried out by them, extending as far as California, Mexico and Canada. He felt deeply the severance of a connection which had always been extremely cordial and friendly, and congratulated the New Zealand Government on having secured the services of a man so eminently qualified to carry through the schemes contemplated by them.

Mr. MORDEY, Mr. TROTTER, Mr. HAMMOND and Mr. DEVONSHIRE also spoke in eulogistic terms of Mr. Parry, after which a presentation was made to him of a handsome silver cup, on which was inscribed the names of the hosts.

Mr. TEGETMEIER, chairman of the Auckland Tramways, gave Mr. Parry a hearty welcome to New Zealand, and an enjoyable evening terminated with a vote of thanks to the chairman and to Mr. Edward Moss, the organiser of the dinner.

Mr. F. W. Roberts, late district manager of the National Telephone Co. at Brighton, has been entertained to a farewell dinner by the local staff of the company, on his leaving to take up the appointment of engineer-in-chief to the United River Plate Telephone Co. at Buenos Ayres.

Mr. C. F. Moorhouse, district manager of the National Co., presided, and was supported by the principal members of the staff. In proposing Mr. Roberts' health, Mr. Moorhouse referred in eulogistic terms to Mr. Roberts' work in the district.

Mr. Roberts was also presented with a gold watch and a silver tea service.

Sports.—The first annual sports of the Silvertown Rubber Works Athletic Club were held last Saturday at Canning Town in splendid weather. There was a large attendance, and the events on the programme kept spectators interested from start to finish.

The chief event was the Marathon race of 10½ miles for the Gray challenge cup and gold medal. This was the third year of this race. The result of Saturday's race was that the cup remains in the possession of G. Peters, who has been the winner on each of the three occasions of the race. There were 11 starters, six finishing, and the race proved an easy thing for Peters, who won in 64 min. 59 sec. The 100 yards sprint was won by A. Baker in 11 sec., and the 440 yards race by the same runner in 58⅖ sec. E. Cole won the three miles in 17 min. 50⅕ sec.; T. Tyrie was successful in the one mile in 5 min. 22⅖ sec; T. Willis won the one mile cycle race in splendid style by half a wheel, in 2 min. 45⅕ sec.; the tug-of-war, which produced the greatest rivalry between the various shops competing, was won by N department; FN team won the one mile relay; B. Knight the 100 yards race (under 18); D. Young the 300 yards handicap race for boys under 14, sons of employés; Miss N. McAlenon the 50 yards skipping race; and Miss L. Kerry the 50 yards thread-the-needle race.

At the close Mrs. P. M. S. Brodie, wife of the president, presented the prizes to the successful competitors. During the afternoon a capital programme of music was rendered by the Graysilver Military Band, under the conductorship of Mr. J. H. Parnum. This band, which has only been formed about a year, is coming along well.

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COLONIAL AND FOREIGN NOTES.

Brazil.—The Minister of Public Works has given orders for fresh tenders to be invited for the equipment of a telephone system between Rio de Janeiro and Sao Paulo.

The Cia Braziliera de Energia Electrica have been granted a concession for laying a double line of submarine electric power cables from Nectheray to Rio de Janeiro.

Budapest.—The Traffic and Finance Commission of the Municipal Council have agreed to acquire the bulk of the Budapest Electric City Railway shares.

French Telegraph Service.—The London "Daily Telegraph" of 6th inst. has the following interesting note on the work of M. Queinnec, a member of the telegraph staff of the French Imperial Service :—

Fifty million francs, or £2,000,000, has been saved to the French telegraph administration by a zealous subordinate, M. Queinnec. Incidentally, it also reveals the fact that subterranean telegraph lines have gone completely out of vogue with the engineers of the public telegraph lines. More than 30 years ago France had an elaborate system of subterranean lines. In 1879 Paris was connected with all the large towns by underground wires, which were *proof against* the ordinary disturbances of the elements. But other difficulties arose, and in 1880 none of the lines were working. They had been rapidly worn out, and the repairs would have entailed extraordinary expense. For 10 years the underground wires were *not used*, and in 1890 a report to the Budget Committee advised their total abandonment. It was then that M. Queinnec, a postal employee, came forward to save the lines, which had cost £1,600,000. He had read the report, and he called on the Under-Secretary for Posts and Telegraphs with a scheme for utilising the lines. He was received, listened to, and given a commission to execute some of the repairs at a small cost for the sake of a trial. He set to work, in spite of the scepticism of the engineers, and succeeding in thoroughly repairing one line after another. Better still, he discovered a way by which their working was improved, and the material saved from wearing out. As a result, Paris was again in underground telegraphic connection with all the great towns and military centres, except those of the eastern frontier, on which M. Queinnec had not yet received permission to work. He had saved £1,600,000 to the Treasury, and well deserved the rise in his salary which he received in consequence.

Last year the utility of his plan was still more clearly demonstrated. Many of the suburbs were cut off from Paris during the inundations. Paris had been endowed years ago with a system of subterranean wires, which completely encircled it. M. Queinnec had not yet touched these lines, which had cost some £400,000. He proposed to make them serviceable again without delay. They had been so long abandoned that the plans of some of them had actually been lost. He set to work, and in a short time all the lines were again fit for service. M. Queinnec had saved the Administration another £400,000 worth of wires. He suggested a very simple method for preventing deterioration. When in operation the wires were to carry the negative current, and the positive current when at rest. The opposite had been done before, and this was, it seems, bad for the wires. The model employee who had thus saved some £2,000,000 to the State received another rise in his salary and was decorated last July, and now the Budget Commission has proposed that he should be made inspector-in-chief of all the subterranean telegraph lines.

Holland.—It is stated that a proposal is on foot for the construction of an electric tramway 11 miles in length, from The Hague to Leyden via Wassenaar, power being taken from The Hague central station.

Italy.—The Societa-Anon. della Tramvie Elettriche della Provincia di Salerno have obtained a concession for an electric tramway in the Valle di Pompei.

Montenegro.—The Montenegrin Parliament has approved the concession for the erection of hydro-electric works of 12,000 H.P. capacity which are to be equipped with the aid of British, Belgian and Swiss capital.

South Africa.—"South Africa" states that there are indications that the electric tramway scheme for linking up Boksburg and Germiston will soon be proceeded with. Boksburg Council have framed a schedule of the route in their own area and the negotiations with Germiston for a joint scheme appear to be favourably received. The estimated expenditure by Boksburg Council is £110,000 for about 7½ miles of tramways, the construction of a subway between East Rand station and Vogelfontein crossing, and the widening of the subway at Boksburg North-road.

Wireless Telegraph Notes.—The Russian Ministries of Ways of Communication, Interior and Mines, have collectively submitted to the Duma a bill providing for measures to be taken for facilitating commercial communication between Western Siberia and Western Europe, via the Arctic Ocean. The scheme involves the construction of four radio-telegraphic stations on the coasts of the Kara and White Seas, the exploration of the Kara Sea coasts, and the exploration of the country from the lower course of the river Ob to the coast of the Arctic Ocean with a view to the construction of a railway line. Credits to the amount of 160,000 roubles (about £16,900) are asked for the current year, and to the amount of 180,000 roubles (about £19,000) for 1912 for the purpose of completing the radio-telegraphic stations.

What is described as the first communication between France and Switzerland by wireless telegraphy took place last week, when the station on the Eifel Tower at Paris held converse with the Chaux de Fonds on the other side of the Jura Alps, a distance of about 200 miles.

The great Durbar, which is to be held by King George at Delhi in the autumn of 1911, is to be on a grand scale, and we learn that amongst the features of the Durbar will be the erection of wireless telegraph stations at Delhi, Calcutta, Allahabad and Simla. It is announced that the Marconi Wireless Telegraph Co. have received orders for the erection and equipment of these stations at an estimated cost of £50,000.

It is announced that the Marconi wireless telegraph station at Slangkop, south of Cape Town, erected for the Government of the Union of South Africa, has been opened and that communication has been established with several of the Union Castle line steamers, the distance in one case being 1,500 miles.

TRADE NOTES AND NOTICES.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1911 Edition of the Big Blue Book is READY, price 15s., post free in the United Kingdom, 15s. 9d. The volume brings a great mass of very valuable statistical and technical data quite up to date, and the Directorial Division has been thoroughly revised and amplified up to February 24th.

All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters receive every attention in the new volume, which aggregates more than 2,000 pages. The Directory Division is complete and thoroughly accurate, and has been completely revised. The Big Blue Book contains more names of live electrical firms and persons than any other Directory published, and this notwithstanding that all mere lists of members of Societies and Institutions (so easily and cheaply available) are excluded, as unreliable and of little value for Manufacturers' and Dealers' purposes. The full set of valuable Statistical and Engineering Tables, &c., have been very carefully revised and extended, and are now issued in a handy form. These are included in the 1911 Big Blue Book, making it the most complete work of the kind ever published.

TENDERS INVITED.

Tenders are invited (up to June 14) for supply of cable, ironwork, c.i. pipes, iron or steel poles, phosphor bronze wire, &c., to the Postmaster-General's Department. QUEENSLAND; and (up to June 27) for supply of 1,400 protectors for use on main distributing frame at magneto exchanges to the Postmaster-General's Department, VICTORIA. Tender forms and specifications at the Commonwealth Office, 72, Victoria-street, London, S.W. See also advertisements.

SOUTH SHIELDS Corporation want tenders by May 24 for supply and erection of 1,500 kw. high-pressure steam turbine (with surface condenser and pumps) coupled to 1,000 kw. d.c. generator (with switch panel, &c.) and 1,100 kw. a.c. generator (with switch panel, &c.). Specification, &c., from the Borough Electrical Engineer.

HULL Corporation require tenders by noon May 24 for extension of Sculcoates-lane generating station and New George-street substation.

HACKNEY (London) Council require tenders by 7 p.m. May 25 for supply of 100,000 pairs of yellow flame carbons during the year to March 31, 1912. Specification, &c., from Town Clerk.

LEYTON Council want tenders by May 17 for Coronation illuminations at the Town Hall and two branch libraries. Particulars from the Engineer.

HORNSEY Corporation want tenders by 4 p.m. May 19 for water tube boiler, automatic stoker, &c. Forms, &c., from Borough Electrical Engineer.

PORTSMOUTH Corporation want tenders by 10 a.m. May 22 for supplying and fitting 186 Mazda lamps in the Town Hall. Forms of tender from the Borough Engineer.

Tenders are invited up to July 25 for the supply of 12 section of a branching multiple magneto lamp signalling switchboard, &c. or one automatic or semi-automatic switchboard, &c.; and up to June 14 for supply of a branching multiple magneto lamp signaling switchboard at Ballarat, up to May 30 for the supply of one portable petrol-driven desiccating plant to the Postmaster-General

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department in Victoria, and up to May 31 for the supply of 7,000 insulators and wire and line material to the Postmaster-General's department in SOUTH AUSTRALIA.; and up to June 14 for supply of a c.b. multiple switchboard to the Postmaster-General's Department, SOUTH AUSTRALIA; and up to June 7 for the supply of 2 nauts single-core submarine cable to the Postmaster-General's Department, NEW SOUTH WALES. Tender forms, &c., from 72, Victoria-street, London, S.W.

Tenders are wanted by May 19 for supply of six 60 kw. single-phase transformers, and by May 26 for 1,024,000 arc lamp carbons and for 6,000 metal filament incandescent lamps for the City of MELBOURNE electricity department. Tender forms, specification, conditions of tender, &c., from the Agents for the City Council, Messrs. McIlwraith, McEacharn & Co. Proprietary (Ltd.), Billiter-square Buildings, London, E.C.

Tenders will be received at the Town Clerk's office, AUCKLAND, N.Z. until 4 p.m. of Thursday, June 15, for supply and erection of machinery for the new power station, including water-tube boilers, feed pumps, economisers, conveyor and steam pipes, and induced draught plant; d.c. steam generators, condensers, auxiliary machinery, &c. Specifications, &c., at the offices of the High Commissioner, 13, Victoria-street, London, S.W.

The Deputy Postmaster-General, MELBOURNE (Victoria), will receive tenders until 3 p.m. June 13, for the supply of electric lighting material, 12 accumulators and 400 cable distributing boxes and chemicals and glassware for batteries.

The Town Clerk, WANGANUI, N.Z., will receive tenders until July 12 for supply of generating plant, gas producing plant and battery and booster for the Corporation tramways. Specification can be seen at 73, Basinghall-street, London, E.C. Local representation is necessary.

The Controller of Stores, Post and Telegraph Department, WELLINGTON, N.Z., will receive tenders until 5 p.m. June 6 for supply of 50 tons g.i. telephone wire. Specification, &c., at 73, Basinghall-street, London, E.C.

Tenders will be received by the chairman of the Board of Control, City Hall, TORONTO (up to noon, June 6), for pumps and electrical equipment, screening, elevating and conveying apparatus, and castings and indicating and recording apparatus for Venturi meters. Specifications, &c., from the City Engineer, Toronto, and can be seen by British manufacturers at 73, Basinghall-street, London, E.C.

FRANKFORT-ON-MAIN Corporation require tenders by May 20 for two 7,500 kw. steam generators with condensers.

BRUSSELS Municipality want tenders by May 19 for c.i. pipes for the electricity department.

NAPLES Municipal Authorities require tenders by July 9 for supply and installation of the following plant in connection with the supply of electric power to Naples from the river Volturno:

1. Turbines and accessories for harnessing the water at rate of 7,000 litres a second and for the fall of 190 meters; upset price 702,900 lire (£28,116.)

2. Machinery and apparatus for hydro-electric power station, transmission line (about 57 miles), and transforming station; upset price [illegible] lire (£40,000.)

Tenders to Presidente del Consiglio Generale dell' Ente Autonomo Volturno, Naples.

Manufacturers who are prepared to supply 600 km. (372 miles) copper [illegible] mm. dia. are invited to communicate with the Direzione dell' Ente Autonomo Volturno, Naples, who after two months from April 10 will [illegible] invitations to tender to firms whom they consider suitable.

Conditions of tender, &c. (in Italian) may be seen at 73, Basinghall-street, London, E.C.

TENDERS RECEIVED AND ACCEPTED.

The following tenders have been accepted for 12 months' supply of stores and materials to Pontypridd District Council:—

Tramway & Tramway Equipment.—British Thomson-Houston Co., [illegible] coils, mica and copper segments, field coils, pinion washers, [illegible] and commutator nuts, grease box covers, gear case covers, axle [illegible] traction motor brushes, gear and pinion wheels, gear cases, trolley [illegible] travelling contacts, controller fingers and finger guards, trolley [illegible] and insulating sleeves; Malleable Steel Castings (Ltd.), armature [illegible] clips; Anti-Attrition Co., journal axle box and motor suspension [illegible], trolley wheels and wheel bushes; Armstrong Oiler Co., oilers; [illegible] Finch & Co., trolley heads, trailing and mechanical frogs and [illegible] insulators; Brecknell, Munro & Rogers, trolley head connectors [illegible] &c.; Sykes & Sugden, connectors; Haslam & Schontheil, [illegible] and fuses, Obach cells, insulator bolts, &c.; British Insulated & Helsby Cables, service boxes and Reason cut-outs; R. W. Blackwell [illegible] hooks and brackets and galvanised steel span wire; [illegible] Hele-Shaw Co., J. & P. arc lamp cut-out coils.

Electric Light & Tramways Department.—Donovan & Co., bayonet [illegible] and glass shades; E. Dewhurst & Co., beech, teak and walnut [illegible]; Helm & Schontheil, cut-outs, Osram lamps, pear switches, [illegible] elbows, bends, tees, sockets, bushes and pipe clips, tapes, varnish [illegible] &c.; S. M. Jones, casing and capping; Cryselco (Ltd.), metal filament lamps, tumbler switches; Siemens Bros. Dynamo Works, water tight fittings, Tantalum lamps and Langham shades; General Electric Co., swan-neck brackets; Ward & Goldstone, window brackets, plugs and cut-outs; Paxton & Co., C. G. and batten holders; Economic Electric Co., insulated hooks, conduit bends, bushes, sockets and pipe-clips; British Thomson-Houston Co., carbon and Mazda metal filament lamps and tumbler switches; Electrical Co., Luna burners; Imperial lamp Works, Brimsdown, metal filament lamps; India Rubber Co., plugs; British Westinghouse Co., tumbler switches, opal and green and opal shades, enamelled iron shades and counter weights; Johnson & Phillips, shell reflectors; J. H. Tucker & Co., d.-p. switches; S. D. Roberts, plate glass and destination and ventilator glasses; D. A. Webb, dash light glasses and red and green signal glasses; City Glass Co., J. & P. arc outer and inner globes and Reason globes; W. T. Henley's Telegraph Works Co., three-core and twin paper cables (in plain lead, armoured and bitumen); R. R. Todd, v.r. insulated 600 to 2,500 megohm Association cables and v.i.r. 600 to 2,000 megohm flexibles and v.r. insulated 600 megohm non-Association installation wires; British Insulated & Helsby Cables, v.r. insulated 600 megohm non-Association installation wires; Micanite & Insulators Co., press-spahn paper, Empire cloth, thin fibre paper and fibre washers; Siemens Bros. & Co., Mansville tape; British Westinghouse Co., or F. J. Down, Okonite and Blackley tape; British Electrical & Mfg. Co., Para strip.

St. Pancras (London) Council have accepted the following tenders:—Sloan Electrical Co., 112,500 12 in. and 37,500 pairs 10 in. arc lamp carbons, £470. 15s. 7d.; Siemens Bros. Dynamo Works, 37,500 pairs 12 in. and 12,500 pairs 10 in. carbons, £265. 18s. 9d.; Wm. Giepel & Co., "Oriflamme" carbons, £34. 4s.; "Luna" carbons £13. 6s. 3d.; Union Electric Co., "Gilbert" carbons, £55; "Excello" duplex carbons, £37. 7d.; "Excello" cored carbons, £20. 6s.

Sheffield Council have accepted the following tenders:—

Ferranti Limited, supply and erection of switchboards for Chapel-lane and Princess-street sub-stations, £1,332. 11s.; W. T. Glover & Co., 100 tons of electrolytic copper wire bars and 200 tons lead (to be made up into cables as and when required within two years from placing the order) at current prices.

Luton Council have accepted the following tenders:—

Brush Co., 650 kw. exhaust steam turbo-generator, £2,495.10s., and 400 kw. ditto, £1,913. 5s.; Rees Roturbo Co., pump, £363; Babcock & Wilcox, tube clearner, £11.

Tonbridge Council have accepted the following tenders:—

Gwynnes Ltd., electric pumping plant for sewage works, £1,045; Western Electric Co., cables, &c., £1,032. 9s. 6d.; Seale, Austin & Barnes, wiring castle grounds for illuminations.

Deptford (London) Council have accepted the quotation of Wilkins & Son to fix electric light fittings at the New Cross branch library and provide lamps and shades at £32. 8s. 6d.

Wadebridge Council have accepted the tender of the local electric lighting company for public lighting on the Egloshayle side of the town.

Wolverhampton Council have accepted the tenders of Hadfield's Steel Foundry Co. for special tramway points and crossings, at £411, and that of W. Lucy & Co. for 300 street lamps and brackets.

Cheltenham Council have accepted the tender of Aiton & Co. for steam piping at £200, and that of Beattie & Co. for a Taylor-Scotson regulator at £95.

Tonbridge Council have accepted the tender of Gwynnes Ltd., for the supply of electric pumping plant at £1,045, and that of the Western Electric Co. for the supply of about 1,600 yd. electric cables at £1,032. 9s. 6d.

The Bastian Meter Co. have secured the contract for supplying Govan Corporation with 1½ and 3-ampere meters for the ensuing year.

St. Helens Council have accepted the tender of the Worthington Pump Co. for a centrifugal pump.

Gillingham Council have let the contract for wiring the fire station to A. Chapman.

The tender of H. S. Tett & Co. has been accepted by Faversham Council for wiring work at the sewage works.

Kingston-on-Thames Council have accepted the tender of Offer & Sons for Coronation illuminations, comprising 17,000 lamps, at £100.

BUSINESS NOTICES.

The new factory of the Electrical Apparatus Co. (Ltd.) at Vauxhall, London, is now completed. The new works have much greater accommodation and the new address of the company will be Vauxhall Works, South Lambeth-road, London, S.W. Telephone No. Brixton 1,975. The company state that the change has been necessitated by a large increase in their output of E.A.C. meters and motor-control gear.

Messrs. Carney & Pearn (Ltd.) announce that their Manchester telephone number has been changed from 4197 Central to 1279 Rusholme, and in order to deal with increased business they have a private branch exchange.

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Messrs. Marryat & Place have appointed Messrs. Leslie & Co., 888, Hay-street, Perth, as sole agents for their lifts in Western Australia, and Mervyn W. Stevenson & Co., 188, Hereford-street, Christchurch, (N. Z.), as sole agents in New Zealand.

The agency of the Allgemeine Electricitats Gesellschaft, formerly held by Staerker & Fischer, has been transferred to the Australian Metal Co. (Ltd.), which company will represent the A.E.G. in the whole of Australia (except Western Australia) and New Zealand, the Western Australian agents being Couche, Calder & Co.

The Australian Metal Co. have taken over Staerker & Fischer's electrical business at 172, William-street Melbourne, and arrangements are being made to effect a similar transfer at an early date of their Sydney business to the company.

The general manager of the Australian Metal Co.'s electrical business will be Mr. J. M. Jolly, who filled a similar position with Staerker & Fischer.

Plant for Sale.—Elektron Limited (in liq.), Gothenburg, offer for sale triplo expansion engines, c.c. dynamos, &c. Further particulars are given in advertisements.

Messrs. Leo Sunderland & Co., 39, Victoria-street, Westminster, London, S.W., advertise for sale a 500 H.P. two-phase motor, liquid starter and regulator, two-panel switchboard, starting switch for barring motor, two 7½ kw. transformers and one 15 B.H.P. squirrel cage motor.

"The Journal."—Part 206 of the "Journal of the Institution of Electrical Engineers" is now ready, price 5s. Particulars of contents are given in an advertisement.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during April, 1911, and (*b*) during the current year from Jan. 1 to April 30, with the increases or decreases compared with the corresponding periods of 1910:—

Electrical machinery (*a*) £114,514 (increase £70,344), (*b*) £382,198 (increase £200,609); telegraph and telephone cables (*a*) £29,774 (increase £14,031), (*b*) £121,617 (increase £68,969); telegraph and telephone apparatus (*a*) £13,087 (decrease £3,808), (*b*) £52,031 (decrease £6,765); other electrical wires and cables, rubber insulated (*a*) £6,696 (decrease £6,291), (*b*) £30,435 (decrease £18,792); with other insulations (*a*) £1,985 (decrease £840), (*b*) £13,537 (increase £4,643); carbons (*a*) £8,983 (decrease £1,562), (*b*) £45,671 (decrease £620); glow lamps (*a*) £30,999 (decrease £1,987), (*b*) £116,207 (decrease £56,747); arc lamps and electric searchlights (*a*) £135 (increase £10), (*b*) £564 (decrease £837); parts of arc lamps and searchlights (other than carbons) (*a*) £6,728 (decrease £97), (*b*) £35,949 (increase £11,750); primary and secondary batteries (*a*) £2,554 (decrease £1,830), (*b*) £15,945 (increase £2,104). Total of electrical goods and apparatus, other than machinery and telegraph and telephone wire (*a*) £110,624 (decrease £1,717), (*b*) £468,174 (increase £7,456).

Exports.—The exports of electrical machinery, material, &c., (*a*) during April, 1911, and (*b*) during the current year from Jan. 1 to April 30, and the increases and decreases compared with the corresponding periods of 1910, are as follows:—

Electrical machinery (*a*) £104,265 (increase £40,472), (*b*) £541,975 (increase £79,477); telegraph and telephone cables (*a*) £44,683 (decrease £16,211), (*b*) £239,946 (decrease £564,190); telegraph and telephone apparatus (*a*) £24,744 (increase £7,618), (*b*) £94,349 (increase £41,869); other electrical wires and cables, rubber insulated (*a*) £33,189 (decrease £6,040), (*b*) £135,936 (decrease £1,490); with other insulations (*a*) £24,157 (decrease £8,286), (*b*) £132,297 (increase £53,166); carbons (*a*) £1,228 (decrease £384), (*b*) £6,804 (increase £614); glow lamps (*a*) £10,143 (increase £166), (*b*) £52,198 (increase £10,391); arc lamps and searchlights (*a*) £1,282 (decrease £672), (*b*) £5,813 (decrease £1,109); parts of arc lamps and searchlights (other than carbons) (*a*) £1,275 (increase £113), (*b*) £4,736 (increase £56); primary and secondary batteries (*a*) £18,292 (increase £11,091), (*b*) £50,024 (increase £16,454). Total of electrical goods and apparatus, other than machinery and telegraph and telephone wire, (*a*) £205,358 (decrease £1,725), (*b*) £902,680 (decrease £415,399).

BANKRUPTCIES, LIQUIDATIONS, &c.

At a recent meeting of the creditors of Arthur Brooke, trading as Fox & Co., electrical engineers, Batley, the statement of affairs showed liabilities £917.

After deducting preferential claims £898 is expected to rank for dividend. Unsecured trade creditors represent £272, and there were two claims for money lent—£150 and £100. Assets estimated to produce £161, leaving deficiency £737. Mr. W. D. Burlinson, C.A., is trustee under a deed of arrangement, with a committee of inspection.

A meeting of creditors of the North-Western Electricity & Power Gas Synd. (Ltd.) is held to-day (May 12) at 37, Cross-street, Manchester.

First meeting of creditors of A. C. A. Wampach, electrical engineer, Formby Lodge, Seabrook-road, Hythe, May 17, at 68A, Castle-street, Canterbury; public examination on May 20 at the Guildhall, Canterbury.

A meeting to receive an account of the winding up of the Acme Patent Fire Alarm Co. (Ltd.) will be held on June 9 at Broad-street-chambers, Bristol.

A meeting to receive an account of the winding up of the British Radio-Telegraph & Telephone Co. (Ltd.) will be held on June 6 at 5, London Wall-buildings, London, E.C.

Cowans Limited is being wound up voluntarily. Claims to the liquidator, Mr. C. Cooper, 33, Princess-street, Manchester. Meeting of creditors will be held at 60, Spring-gardens, Manchester, on May 17.

COMPANIES' MEETINGS AND REPORTS.

Cuba Submarine Telegraph Co. (Ltd.)

The seventy-ninth ordinary general meeting was held on Wednesday, under the presidency of Mr. GEORGE KEITH.

The SECRETARY (Mr. A. C. Austin) read the notice calling the meeting and the report of the auditors.

The CHAIRMAN said: The accounts show an exceptionally good result for the half-year under review, which is generally the slack season of the year. The traffics for the six months compare favourably with those for the corresponding months of 1909. The improvement shown may be attributed to the increased prosperity and more active state of business in Cuba and the West Indies. Cuba suffers more or less every year from storms, which, fortunately for our business, increase the use made of our cables along the south coast of the island. The cyclone last October did immense damage in the western portion of the island. Our cable house at Batabano was entirely wrecked, and the landline connection with Havana was interrupted for several days. The loss of traffic during that time, I am glad to say, was more than made good by the large increase after the communication had been restored, with the result that October now shows an increase instead of the loss we had anticipated. November compares well with the large increase produced by the hurricane of the preceding November, and altogether the traffic for the whole half-year shows a very satisfactory increase. Now, turning to the revenue account, the traffic receipts for the half-year show an increase of £1,876. Interest on investments and the deposit at the bank is £96 more. The gross revenue, including transfer fees, amounts to £18,351, or £1,975 more than it was in 1909. On the debit side of the account the London expenses are slightly less. Station expenses are £348 more, due to an additional item for cable repairs, which does not occur every year, and to a decrease in the aggregate of other items. Income tax is less. Law charges are less, while the other charges remain unaltered. Altogether the total working expenditure amounts to £6,672, or £257 more than it was in 1909. The result of the half-year's business is a balance of profit of £11,679, out of which £2,000 has been placed to the reserve against depreciation on investments, and £2,000 to the general reserve. After providing for the dividend on the preference shares, the directors now recommend the payment of the usual dividend at the rate of 6 per cent. per annum on the ordinary shares, free of income tax, reducing the balance carried forward by £121 to £7,275. I think we may consider the result of the half-year's business as satisfactory. We are in a position to meet the additional expenditure to be incurred in re-establishing duplicate direct communication between Cienfuegos and Santiago, so as to ensure the efficient transmission of the through traffic. At our meeting last October I took occasion to call your attention to this matter, and I have now the pleasure to inform you that a contract has been entered into with Hooper's Telegraph Works for the manufacture, transport and laying of the new cable required between Cienfuegos and Cape Cruz, where it will join the present cable to Santiago, and thus complete the duplication of direct communication between Havana and Santiago. The cable will be laid about the end of this year, when the weather conditions are most suitable for successfully carrying out the work. In conclusion, you will be pleased to see by the report that Mr. Scott still remains with us in a consulting capacity. He has been connected with the Company for 35 years, 32 of which he has been its secretary. During all these years he has been working strenuously in its interests, and its success has been greatly promoted by his energy and zeal. I am quite sure you will join me in thanking him for his past services, and in expressing the wish that the Company may long have the benefit of his experience and advice in the management of its affairs. I now move the adoption of the report and accounts.

Mr. CHARLES W. PARISH seconded the resolution, which was adopted. The dividends were approved, and a vote of thanks to the chairman, directors and staff brought the proceedings to a close.

Great Northern Telegraph Co. (Ltd.)

At the meeting, which was held at Copenhagen on April 29, the Chairman (Commodore E. Suenson, D.R.N.) gave an account of the working of the Company during 1910. He said the condition of their cables had been about normal. In Europe there had been 21 interruptions on 10 cables and in the Far East 15 on six cables. Cable repairs and renewals had kept their cable steamers occupied: the "H.C. Orsted" in Europe for 112 days, and the "Store Nordiske" and the "Pacific" in the Far East for 264 days, of which 8 in Europe and 65 in the Far East were for the account of other administrations. The landline routes viâ Kiachta and viâ Wladiwostock connecting their two submarine systems had

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worked very satisfactorily, notwithstanding that on the former a number of telegraph poles were renewed last summer. The Chinese Administration took advantage of the opportunity to introduce a more effective inspection of the lines, which needed improvement. In the beginning of the year the landlines connecting the company's cables with the transmitting offices suffered considerably on account of the severe weather prevailing almost everywhere. In France the damage was due to the destructive inundations of the River Seine, whilst in England and Sweden snow-storms played great havoc with the lines, particularly during January and February, but thanks to the energetic measures taken by the respective administrations the transmission of the traffic suffered comparatively little delay. In previous reports shareholders had been advised of the decision of the Norwegian Government not to extend the company's concessions beyond 1910, and also of the desire of the Japanese Government to acquire the cable between Japan and Korea before the expiration of the concession in 1912. The past year witnessed the consummation of these decisions. The separation from Norway was solely due to the determination of the Government, whilst that from Korea was entirely voluntary on the part of the company. In fact, from the moment when Korea, on Aug. 22, 1910, was officially incorporated in the Japanese Empire under the name of Chosen, the company's Korean cable naturally became an integral link of the interior Japanese telegraph system. Without failing in their obligations or duties in other directions, the company had thus the opportunity of proving their readiness to meet the Imperial Government's desire by prematurely parting with the cable. The total payments for the cession of the three cables (the cables between Egersund, Norway, and Peterhead, Scotland, between Arendal, Norway, and Hirtshals, Denmark, and the Korean cable), with accessories (such as cable huts with furniture, instruments, &c.), and compensation for revenue of about two years on the Korean cable, amounted to approximately £32,000. This result was far from satisfactory, but they had never concealed from the shareholders that, on the expiration of the concessions, they were more or less at the mercy of the Governments, and they had, therefore, in their financial policy, always kept in mind that contingency. Whilst regretting the loss of the three cables, it had, on the other hand, given them great satisfaction that the British Government had entrusted the company with the working in the United Kingdom, on behalf of the General Post Office, not only of the Egersund–Peterhead cable, the service of which thus continued in the company's hands, but also of a new cable, laid in October and November last by the two Governments, between Newbiggin in England and Arendal in Norway. This arrangement would in no way reduce the financial losses resulting from the cession of the Egersund Peterhead cable, but it was a highly gratifying proof of the good feeling of the General Post Office towards the company and of their appreciation of the services which they had been rendering to the telegraphing public for more than 40 years. Furthermore, they were able to inform the shareholders that the British General Post Office had, jointly with the Norwegian Telegraph Administration, entrusted to the company the maintenance of the two Anglo-Norwegian Government cables mentioned, and that they had entered into a similar arrangement with the Norwegian and Danish Telegraph Administrations for repairing the Dano-Norwegian cable between Hirtshals and Arendal. We consider this a compliment to the company's engineering and cable repairing staff, who have, in fact, during a number of years, maintained the traditions of their ancient forefathers' maritime exploits—the memory of which is to be celebrated at the forthcoming festivities in Normandy—and they enjoy a well-merited reputation for their present achievements, both maritime and submarine, which happily have a more peaceful and useful object than those of their rough ancestors. The arrangements regarding the cables have been entered into provisionally for a term of five years. During the past year the company had also signed a new agreement with the General Post Office for working three of the company's other cables in Great Britain, for which the landing licences were prolonged in 1905. The old conditions had been only slightly varied, but, unfortunately, not to the company's advantage.

Unless an extraordinary increase of traffic should mitigate the loss caused by the transfer of the two Norwegian cables and the Korean cable, the company's telegraphic receipts would fall off considerably in the current year. The decrease would be further aggravated by the tariff reductions which they had had to introduce to maintain the equality of the rates working between the United Kingdom and the three Scandinavian countries before Jan. 1 last. The General Post Office and the Swedish Telegraph Administration had readily accepted the company's proposal for a similar reduction of the rates for the Anglo-Swedish and Anglo-Swiss traffic. The reduction of the first-mentioned rate had already come into force, but they were still awaiting the decision of the Danish Telegraph Administration as regards the reduction of the rate for traffic exchanged between the United Kingdom and Denmark. Reductions of rates had also been introduced between Sweden and Russia (Finland), as well as in the Far East, the company bearing a proportionate share. They had obtained the consent of the Telegraph Administrations of Russia and Sweden to lay a new cable (the fourth) between those countries which would soon be taken in hand, and they were also going to draw upon the reserve fund with the object of assisting the Chinese Telegraph Administration in their efforts to improve and extend the telegraph system of the Celestial Empire.

In spite of the inevitable decrease in traffic receipts from Jan. 1 last, they were satisfactory to report that for the past year the receipts had exceeded their expectations. Thanks to that and a small increase in revenue from other sources, and also, on the other hand, to an accidental decrease in expenses, the net revenue of 1910 had been about £23,400 higher than that of the previous year. That enabled them to maintain a total dividend of 18 per cent., and at the same time to carry forward a somewhat larger amount to meet the effects of the decrease of receipts which they anticipated during the present year. The usual amount has been transferred to reserve, while the contribution to the pension fund had been increased by one-third, in view of a corresponding increase in the number members of the fund since 1904, when the last increased contribution was granted. The board had provisionally requested His Exc. P. Lovenorn, late Danish Minister at St. Petersburg, to fill the place left vacant by the death, in February last, of Mr. P. Vedel. Traffic receipts had increased in round figures by £16,920, and interest and sundries by about £3,360, whilst expenses showed a decrease of about £3,000.

EASTERN TELEGRAPH CO. (LTD.)—The report of the directors for the half-year to Dec. 31 last states that the revenue for the period amounted to £670,147. 15s. 5d., from which are deducted £219,231. 0s. 9d. for ordinary expenses and £45,558. 10s. 7d. for expenditure relating to maintenance of cables, sundry differences in exchange, and income tax payable abroad, leaving a balance of £405,358. 4s. 1d., to which is added £59,590. 7s. 1d. brought from preceding account, making a total available balance of £464,948. 11s. 2d. After providing for income tax payable in England, interest on mortgage debenture stock and dividends on the preference stock, which in all absorb £81,186. 1s. 4d., there remains a balance of £383,762. 9s. 10d., out of which the directors have placed £180,000 to general reserve and have paid an interim dividend of 1¼ per cent. on the ordinary stock, amounting to £50,000. The directors now recommend the declaration of a final dividend on the ordinary stock of 1¼ per cent. and a bonus of 2 per cent., amounting together to £130,000, both payable on May 17, free of tax, and making, with the three previous payments on account, a total distribution of 7 per cent. for the year ended Dec. 31, 1910. It is proposed to carry forward the balance of £23,762. 9s. 10d. to next account.

The register of transfers is closed from 10th to 17th inst.

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.)—The directors' report just issued states that for the half-year ended Dec. 31 the gross receipts amounted to £336,976. 6s. 5d., against £315,034. 18s. 7d. for the corresponding half of 1909. Working expenses, including £22,607. 10s. 6d. for maintenance of cables, absorbed £154,300. 7s. 2d. against £143,674. 0s. 4d., leaving £182,675. 19s. 3d. From this is deducted £2,355. 11s. 2d. for income tax payable in England, £417. 14s. 6d. for extraordinary expenses and £15,048 for interest on debenture stock, leaving as net profit for the half-year £164,854. 13s. 7d. Adding £72,763. 5s. 11d. brought forward, the available balance is £237,617. 19s. 6d. One quarterly interim dividend of 1¼ per cent. has been paid for the half-year, and it is now proposed to distribute another of like amount on 17th inst., making, with the interim dividends paid for the first half-year, a total dividend of 5 per cent. It is also proposed to pay a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for 1910; £75,000 has been transferred to general reserve and the balance of £27,617. 19s. 6d. carried forward. An agreement has been entered into by the Imperial Chinese Government with the Eastern Extension and Great Northern Telegraph Companies for an advance to the Board of Communications of £500,000 at 5 per cent. interest on account of the monies payable by the Companies to the Imperial Chinese Telegraph Administration under their existing agreements. The advance has been obtained to enable the Board of Communications to reorganise, improve and develop the telegraph and telephone services throughout the Chinese Empire. The wireless telegraph installation referred to at the last meeting as then in course of erection at the Company's Keeling-Cocos station, to enable telegrams to be exchanged between passing ships and that remote place, was opened for public service on March 2 last. The negotiations with the British Government for extending the wireless service to the Company's Singapore, Hongkong and other stations are proceeding.

The register of transfers is closed from 9th to 16th inst.

SUBMARINE CABLES TAUST.—The revenue for the year ended April 15 amounted to £25,205.10s. and the expenses to £1,172. 6s. 7d., leaving £24,033. 3s. 5d., to which is added £175. 4s. 11d. brought forward, making £24,208. 8s. 4d. After providing £17,583 to meet payment of coupons, £6,578. 13s. has been transferred to redemption fund, leaving £46. 15s. 4d. to be carried forward. Since the last report, in accordance with the terms of the trust deed, 55 certificates (exclusive of coupons of reversion) have been redeemed, absorbing £6,578. 13s.; of these, 34 were purchased in the open market during the year, and 21 were drawn by lot on 4th inst. By a resolution of the trustees, £15,850 Anglo-American Telegraph Co.'s preferred stock has been sold and the proceeds invested in shares of the Great Northern and Western Telegraph Companies.

WEST AFRICAN TELEGRAPH CO. (LTD.)—The directors' report for the year ended Dec. 31 states that the revenue amounted to £61,797. 2s. 9d. and ordinary expenses to £15,602. 10s. 9d. £5,320. 19s. 1d. was required for expenditure on maintenance of cables and income tax abroad, leaving £40,873. 12s. 11d., with £922. 7s. 8d. brought forward, the available balance was £41,796. 0s. 7d. £1,139. 5s. 8d. has been provided for income tax, £31,000 transferred to general reserve and an interim dividend of 2 per cent. (tax free), absorbing £4,621. 16s., was paid on Dec. 1, last. The directors recommend a final dividend of 2 per cent. (tax free), making 4 per cent. for the year, £233. 2s. 11d. being carried forward.

WEST COAST OF AMERICA TELEGRAPH CO. (LTD.)—The report of the directors for the year ended Dec. 31, 1910, states that the gross receipts amounted to £51,216. 16s. 7d., against £50,416. 6s. 11d. in 1909. Working expenses were £39,356. 19s. 7d., compared with £39,204. 13s. 7d.

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After providing £6,000 for interest on the 4 per cent. debentures, £800 for interest on the 4 per cent. income bonds and £267. 2s. 10d. for income tax, there remains £4,792. 14s. 2d., added to £613. 14s. 5d. brought forward, making together £5,406. 8s. 7d. Of this £1,000 has been placed to general reserve and the directors recommend a dividend of 2½ per cent. (tax free), amounting to £2,813, leaving £1,593. 8s. 7d. to be carried forward.

WEST INDIA & PANAMA TELEGRAPH CO. (LTD.)—The directors' report for the half-year ended Dec. 31, 1910, states that the amount to credit of revenue is £40,306. 9s. 5d., against £34,678. 12s. 1d. for the corresponding half-year of 1909. Expenses have been £24,319. 0s. 6d., against £23,557. 18s. 6d. The balance is £15,987. 8s. 11d., to which is added £1,599. 1s. 4d. interest and £1,953. 5s. 10d. brought forward, making an available total of £19,539. 16s. 1d. The directors propose to pay the first and second preference dividends of 6s. per share to Dec. 30, and a dividend of 1s. 6d. per share (tax free) on the ordinary shares, carrying forward £1,146. 2s. 7d. Traffic receipts for the six months show an increase of £5,645. 1s. compared with the corresponding period. At the meeting on 17th inst Mr. Robert Jackson (a shareholder) will propose a resolution that £600 be voted to the directors in recognition of their past services to the company.

WESTERN TELEGRAPH CO. (LTD.)—The report of the directors for the half-year ended Dec. 31 states that the revenue amounted to £431,966. 16s. and working expenses to £162,753. 4s. 8d. After providing £16,373. 10s. for debenture stock interest, and £7,697. 9s. 10d. for income tax, the balance is £245,142. 11s. 6d., added to £7,512. 18s. 8d. brought forward making £252,655. 10s. 2d. First and second interim dividends (amounting to £62,379) have been paid, and after transferring £150,000 to general reserve and £10,000 to land and buildings depreciation fund, there remains £30,276. 10s. 2d., which is carried forward.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES, &c,

NEW COMPANIES.

ARON TAXIMETER (LTD.) (115,599.)—Reg. March 3, capital £5,000 in £1 shares, to carry on the business of manufacturers and contractors for the sale, erection and maintenance of taximeters, speedmeters, electricity and other meters, electric lamps, electrical switches and cut-outs, and other electrical apparatus, &c. Private company. First directors: M. Aron and Dr. J. Juttke. Reg. office: 80A, Salisbury-road, Kilburn, London, N.W.

BAXTER & CAUNTER (LTD.) (115,516.)—Reg. April 29, capital £50,000 in £1 shares, to take over the business of electrical engineers carried on as Baxter & Caunter, and to adopt an agreement with A. Baxter, L. G. Caunter and G. W. Kettlewell. Private company. First directors, A. Baxter, L. G. Caunter and G. W. Kettlewell (all permanent). Reg. office: 1, Trentishoe Mansions, Charing Cross-road, London, W.C.

BUCKMAN FOREIGN PATENTS SYND. (LTD.) (115,553.)—Reg. May 1 capital £1,000 in £25 shares, to carry on the business of engineers, manufacturers of, dealers in and contractors for all kinds of engines, motors, dynamos, machinery and mechanical, or electric or scientific appliances, &c., and to adopt an agreement with R. S. Buckman. Private company. First directors: N. B. Dickson, C. F. Leighton and F. McLure. Reg. office: 2, Clements Inn, Strand, London, W.C.

CHARLEVILLE ELECTRIC CO. (LTD.) (3678).—Reg. April 27, capital £2,000 in £1 shares, to manufacture, buy, sell and deal in electricity for light and power. First directors: J. R. Daly, J. Morrissey, W. P. Binchy, M. J. O'Mahony, J. Carroll, J. R. O'Connor and J. P. Moran.

ELECTRICAL FITTINGS CO. (1911) (LTD.) (115,433).—Reg. April 25, capital £5,000 in £1 shares, to take over the business of electric engineers and fitters, and manufacturers and sellers of electrical fittings carried on as the Electrical Fittings Co. (Ltd.), and to adopt an agreement with W. K. Sutton and A. W. Mills. Private company. First directors: A. W. Mills (permanent). W. K. Sutton, F. Rowe and W. Towell. Reg. office: 38, Conduit-street, London, W.

SOUTH EAST KENT ELECTRIC POWER CO. (LTD.) (115,633.)—Reg. May 4, capital £1,000 in £1 shares, to carry on the business of electrical engineers, electricians, contractors, manufacturers of electrical apparatus, suppliers of electricity, &c. First directors, A. Burr, M. Burr, D.Sc., and Sir W. H. Crundall, Kt., J.P. Reg. office: Castle Hill House, Dover.

TELEPHONE DEVELOPMENT CO. (LTD.) (115,661.)—Reg. May 5, capital £25,000 in £1 shares, to acquire a concession granted or to be granted by the Imperial Ottoman Government to the Consortium Anglo-Franco-American for the construction and working of a telephone system in Constantinople and suburbs, &c. First directors: G. Franklin, D. Sinclair, E. Thurnauer, H. L. Webb and F. R. Welles. Reg. office: 36, Whitefriars-street, London, E.C.

WELSBACH LIGHT CO. (LTD.) (115,681.)—Reg. May 6, capital £265,000 in £1 shares, to take over the business of the Welsbach Incandescent Gas Light Co., to carry on the business of manufacturers of and dealers in incandescent lights, gas and general engineers, suppliers of electric light and power, &c., and to adopt agreements with the Deutsche Gasglühlicht Aktiengesellschaft (Auergesellschaft), the Welsbach Incandescent Gas Light Co. and N. E. Spinney (its liquidator). First directors: R. Feuer, L. Fletcher, F. Kallmann and E. Lovinson.

STATUTORY RETURNS.

CITY OF BUENOS AYRES TRAMWAYS CO. (1904) (LTD.)—Return to March 1 gives capital as £1,240,000 in £5 shares. All shares taken up. £1,240,000 considered as paid. Mortgages and charges £174,000.

NATIONAL ELECTRICAL ENGINEERING CO. (LTD.)—In return to Dec. 31 capital is £5,000 in £1 shares. 2,659 shares taken up. £654 paid. £2,005 considered as paid. Mortgages and charges, nil.

MORTGAGES AND CHARGES.

INCREASED POWER CO. (LTD.)—Particulars of two series of debentures, created April 7, securing £300 each, have been filed, the whole amount being now issued in each case. Property charged: company's property, present and future, including uncalled capital. No trustees.

FRISTED MINERS' GAS INDICATING ELECTRIC LAMP CO. (LTD.)—Particulars of £1,000 debentures, created April 25, 1911, have been filed, amount of present issue £750. Property charged: Company's undertaking and property, present and future, including uncalled capital. No trustees.

SIMMS MAGNETO CO. (LTD.)—Issue on April 12 of £3,500 debentures, part of a series of which particulars have already been filed.

SUN ELECTRICAL CO. (LTD.)—Memorandum of satisfaction in full of debentures dated March 27, 1900, Feb. 15, 1901, Jan. 17 and March 7, 1902, securing £6,300, has been filed.

RECEIVERSHIP.

HOWE ELECTRICAL ENGINEERING CO. (LTD.)—A. Thraves, 7, Victoria-street, Liverpool, ceased to act as receiver and manager on April 27.

CITY NOTES.

MEMORANDA (May 11).—Bank rate 3 per cent. (March 9, 1911). Price of silver, 24½d. per oz. Consols 81⅛—81⅜ for money and for account. Consols Pay Day, June 1; Stock and Shares Continuation Days, May 29 and June 13; Ticket Days, May 30 and June 14; Pay Days May 12 and 31; Mining Shares Carry Over Day, May 26.

PRICES OF METALS (London).—*Copper*, cash, 53¼; three months 54¾. *Lead*, English, 13—13¼; foreign, 13—13⅛ cash, 13⅛—13¼ three months. *Spelter*, 24¼ cash, 24⅝ three months. *Tin*, English, 192—193; foreign, 193¼ cash, 188½ three months. *Iron*, Cleveland, cash, 45/11, three months, 46/7½.

ADELAIDE ELECTRIC SUPPLY CO. (LTD.)—At the meeting on Tuesday the Chairman (Mr. J. B. Braithwaite) said the company was met with the necessity of providing additional capital owing to the rapid growth of its business in Adelaide. The directors had decided to issue debentures. He moved a resolution authorising the company to borrow £150,000 by the issue of debenture stock. The motion was agreed to.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—The directors have decided, after placing £20,000 to depreciation and renewals account and £7,500 to reserve, to recommend payment of a final dividend on the ordinary shares for the half year ended Dec. 31 last, at rate of 10 per cent., making 8½ per cent. for the year, and to carry forward £5,621. The dividend is payable 25th inst.

CHLORIDE ELECTRICAL STORAGE CO. (LTD.)—A dividend is announced for the past year of 10 per cent. on the ordinary shares (tax free), £5,000 being placed to reserve and £8,543 carried forward.

HASTINGS & DISTRICT ELECTRIC TRAMWAYS CO. (LIMITED AND REDUCED.)—A petition for confirming a resolution reducing the capital from £500,000 to £372,942. 10s. will be heard by Mr. Justice Neville on May 16.

MONTREAL STREET RAILWAY CO.—A quarterly dividend of 2½ per cent. is announced.

RANGOON ELECTRIC TRAMWAY & SUPPLY CO. (LTD.)—The directors recommend a dividend of 4 per cent. on the ordinary shares for the past year.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed May 12 a special settling day in scrip (fully paid) for £300,000 5 per cent. first mortgage convertible bonds of the *Cuban Telephone Co.*, and May 30 a special settling day in £174,170 consolidated ordinary stock (in lieu partly of 6 per cent. cumulative preference stock) of the *Melbourne Electric Supply Co. (Ltd.)* and £800,000 5 per cent. first mortgage 50-year bonds of the *Pachuca Light & Power Co.* The committee have been asked to appoint special settling days in and grant quotations to a further issue of £600,000 5 per cent. 50-year mortgage bonds of the *Rio de Janeiro Tramway, Light & Power Co.*, fully-paid scrip for £3,000,000 5 per cent. perpetual consolidated debenture stock of the *Sao Paulo Tramway, Light & Power Co.* and scrip (fully and partly paid) for $4,500,000 5 per cent. first mortgage 30-year gold bonds of the *Mexican Northern Power Co. (Ltd.)*, and to grant quotations to a further issue of $600,000 7 per cent. cumulative preference stock of the same company, £100,000 5 per cent. prior lien debentures tock of the *Brush Electrical Engineering Co. (Ltd.)*, a further issue of £50,000 4½ per cent. debenture stock of the *County of London Electric Supply Co.* and 250,000 £1 fully-paid ordinary shares of the *La Plata Electric Tramways Co. (Ltd.)*.

SUBMARINE CABLES TRUST.—Notice is given that 21 certificates of this Trust were drawn on 4th inst. for payment on and after that day at Messrs. Glyn, Mills & Co.'s, 67, Lombard-street, London, E.C.

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ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount. £	Inc. or Dec. (a) £	Aggregate. No. of weeks.	Aggregate. Amount. £	Aggregate. Inc. or Dec. (a) £
Aberdeen Corporation	May 3	1,491	+ 38	40	66,796	+ 2,026
Airdrie	April 28	219	+ 10	17	3,564	— 40
Anglo-Argentine	May 6	52,646	+ 8,087	18	895,340	+ 109,493
Ashton-under-Lyne	„ 6	396	+ 28	6	2,478	+ 283
Ayr Corporation	„ 6	228	+ 10	51	14,515	+ 448
Barnsley	April 28	161	..	17	2,952	+ 98
Barrow	„ 28	271	+ 35	17	4,065	+ 244
Bath Electric Trams, Ltd.	May 3	747	+ 1	18	12,565	— 137
Birmingham Corporation	„ 6	7,096	+ 271	5	37,870	+ 2,657
Birmingham & Midland	April 28	849	+ 39	17	14,789	+ 1,209
Blackburn Corporation	May 3	987	— 21	†6	6,511	+ 623
Bolton Corporation	„ 7	2,540	+ 263	6	13,710	+ 1,533
Bombay	April 7	3,066	+ 235	14	39,916	+ 2,226
Bournemouth Corporation	May 3	1,588	— 26	‡5	8,220	+ 539
Bradford Corporation	„ 6	5,159	+ 222	5	28,349	+ 2,962
Brighton Corporation	„ 7	959	+ 17	¶5	4,991	+ 595
Bristol Trams & Carriage	„ 5	6,151	+ 465	5	31,071	+ 3,511
Burnley Corporation	„ 6	1,417	+ 149	5	6,939	+ 948
Burton Corporation	„ 7	258	+ 7	5	1,400	+ 70
Bury Corporation	„ 7	1,260	+ 157	¶5	6,791	+ 776
Calcutta Tramways Co.	„ 6	R56,024	+ R4,290	18	R995,594	+ R15,960
Camborne-Redruth	„ 6	119	+ 4	18	2,038	— 42
Cardiff Corporation	„ 6	2,246	+ 32	5	11,986	+ 856
Cavehill	April 28	68	+ 9	17	1,187	— 28
Central London Railway	May 6	5,113	— 607	18	94,771	— 4,655
Chatham & Dist. Lt. Rys.	„ 4	820	+ 49	18	13,752	+ 76
City & South London Rly.	„ 7	3,314	+ 139	18	61,591	+ 2,413
City of Birmingham	April 28	2,904	+ 138	17	45,446	+ 930
Cork Electric Trams Co.	May 4	500	+ 6	18	7,885	— 39
Devonport & Dist. Trams	April 28	441	+ 53	17	7,345	+ 583
Dover Corporation	May 6	219	+ 41	5	1,182	+ 214
Dublin & Lucan Railway	„ 5	137	— 10	18	2,062	— 47
Dublin United	„ 5	5,665	+ 179	18	92,073	+ 1,012
Dudley-Stourbridge	April 28	755	+ 53	17	12,817	+ 1,021
Dundee Corporation	May 5	1,176	— 19	§50	59,547	+ 251
East Ham Council	„ 6	1,037	+ 40	5	5,502	+ 508
Exeter Corporation	„ 5	308	+ 4	5	1,593	+ 79
Gateshead & Dist. Trams	April 28	973	+ 37	17	16,809	+ 886
Glasgow Corporation	May 6	20,224	+ 2,173	49	874,171	+ 47,605
Glossop Trams	„ 6	130	+ 10	18	2,083	+ 111
Gloucester Corpn.	„ 3	275	+ 9	..	..	..
Gravesend-Northfleet	April 28	188	+ 4	17	3,123	— 27
Great Northern & City Rly.	May 6	1,510	+ 62	18	28,161	+ 1,121
Greenock & Port Glasgow	April 28	687	+ 79	17	10,506	+ 1,488
Halifax Corporation	May 2	1,628	— 36	†5	8,786	+ 1,412
Hartlepool Tramways	April 28	224	— 6	17	3,698	+ 203
Hastings Elec. Trams Co.	May 4	929	+ 108	19	14,047	+ 175
Hong Kong	„ 6	$9,016	— $633	18	$166,818	— $1,420
Huddersfield Corpn.	„ 6	1,803	+ 105	5	9,785	+ 1,362
Hull Corporation	„ 6	2,800	+ 141	5	14,892	+ 1,011
Ilford District Council	„ 6	533	+ 46	5	2,903	+ 342
Ilkeston District Council	„ 3	124	— 2	5	650	+ 74
Ipswich Corporation	„ 6	387	+ 26	5	2,128	+ 331
Isle of Thanet Co.	„ 6	429	+ 94	31	9,996	+ 461
Jarrow	April 28	120	+ 11	17	1,962	+ 107
Keighley Corporation	May 4	176	+ 3	5	910	+ 105
Kidderminster & District	April 28	93	+ 8	17	1,516	+ 62
Kilmarnock Corporation	May 6	160	+ 15	51	7,681	+ 315
Kirkcaldy Corporation	„ 3	272	+ 30	5	1,473	+ 193
Lanarkshire Trams Co.	„ 4	1,387	— 20	18	24,167	+ 216
Lancashire United	„ 3	1,228	— 21	18	22,313	+ 468
Leamington	April 28	142	+ 14	17	2,316	— 104
Leeds Corporation	May 6	7,162	+ 161	5	38,424	+ 4,280
Leicester Corporation	„ 6	2,436	+ 80	5	12,545	+ 1,371
Leith Corporation	„ 6	603	+ 43	51	30,005	+ 43
Lincoln Corporation	„ 6	122	+ 8	5	702	+ 77
Liverpool Corporation	April 29	11,284	+ 235	17	186,185	+ 5,806
Liverpool Overhead Rly.	May 7	1,461	+ 54	18	25,219	+ 1,656
Llandudno & Colwyn Bay Ry.	„ 5	194	+ 11	§22	3,313	+ 94
London County Council	April 26	42,812	+ 1,914	¶4	161,455	+ 12,421
London Elec. Ry. Co.	May 6	14,150	+ 835	18	254,075	+ 14,235
London United	„ 6	6,424	+ 530	18	102,337	+ 1,093
Lowestoft Corporation	„ 6	148	+ 11	31	4,754	+ 178
Maidstone Corporation	April 29	166	+ 16	4	774	+ 115
Manchester Corporation	May 6	15,828	+ 588	5	83,101	+ 7,965
Mersey Railway	„ 6	2,114	+ 66	18	37,073	+ 1,051
Merthyr	April 28	180	+ 3	17	3,228	+ 52
Metropolitan Dist. Railway	May 6	11,824	+ 821	18	211,390	+ 15,496
Metropolitan Elec. Trams	April 28	8,465	+ 1,499	17	133,826	+ 19,536
Middleton	„ 28	298	+ 32	17	5,044	+ 400
Nelson Corporation	May 6	164	+ 26	§5	935	+ 215
Newcastle-on-Tyne Corp.	„ 6	4,033	+ 215	5	21,650	+ 1,811
Newport (Mon.)	„ 6	680	+ 44	5	3,694	+ 328
Northampton Corporation	„ 5	532	+ 36	5	2,575	+ 321
Oldham, Ashton & Hyde	April 23	532	+ 16	17	9,148	+ 324
Oldham Corporation	May 7	1,939	+ 245	6	12,257	+ 605
Perth (N.B.) Corporation	„ 3	163	+ 6	50	8,208	+ 378
Perth (W.A.) Elec. Trams	„ 5	1,650	+ 127	18	29,754	+ 1,472
Peterborough	April 28	105	+ 8	17	1,774	+ 116
Plymouth Corporation	May 6	1,920	+ 139	5	10,187	+ 687
Potteries	April 23	1,919	+ 129	17	31,971	+ 3,137
Preston Corporation	May 3	764	+ 55	5	3,748	+ 327
Rotherham Corporation	„ 4	641	+ 38	5	3,293	+ 395
Rothesay	April 28	132	+ 45	17	1,167	— 62
Salford Corporation	May 3	4,794	+ 324	§5	26,222	+ 2,338
Scarborough (?)	April 28	46	+ 5	17	727	+ 17
Sheffield Corporation	May 7	6,401	+ 516	6	38,842	+ 2,055
Shanghai Trams (?)	„ 6	$10,998	+ $1,154	18	$186,552	+ $7,466
South Metropolitan	April 28	817	+ 62	17	12,276	— 33
South Staffs	„ 28	815	+ 30	17	14,609	+ 1,193
Southampton	May 3	1,129	+ 115	5	5,269	+ 577
Southend Corporation	„ 3	509	+ 68	5	2,593	+ 487
Southport Tramways	April 28	268	+ 30	17	4,117	+ 46
Stalybridge, Hyde, &c., Jt. Bd.	May 6	714	+ 39	5	4,239	+ 885
Sunderland Corporation	„ 7	1,165	+ 134	5	6,276	+ 667
Sunderland District	„ 3	449	+ 31	27	11,907	+ 833
Swansea Trams	April 28	1,121	+ 52	17	17,826	+ 1,280
Swindon Corporation	May 3	133	+ 4	5	703	+ 82
Taunton	April 28	42	+ 5	17	643	— 14
Tynemouth and District	„ 23	184	+ 35	17	2,715	+ 114
Tyneside Trams Co.	May 3	413	+ 37	18	7,363	+ 527
Wallasey Corporation	„ 6	1,044	+ 160	5	5,511	+ 1,024
Walsall Corporation	„ 6	547	+ 25	18	9,742	+ 269
Warrington Corporation	„ 4	400	+ 13	5	1,946	+ 121
West Ham Corporation	..	..	..	..	..	..
Weston-super-Mare	April 28	85	+ 22	17	612	— 111
Wolverhampton Co.	„ 28	401	+ 14	17	7,140	+ 407
Wolverhampton Corpn.	May 3	917	+ 42	5	4,791	+ 553
Worcester	April 28	280	+ 33	17	4,144	+ 76
Wrexham	„ 28	85	— 6	17	1,562	+ 7
Yorkshire W.R. Trams	May 7	1,378	+ 235	19	23,729	+ 1,023
Yorkshire Woollen District	April 28	983	+ 46	17	16,823	+ 1,171

(a) These comparisons are with the corresponding period last year. * Partly electrical.
† Minus 3 days. ‡ Minus 2 days. § Plus 3 days. ¶ Plus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Shrs	Last Dividend	Name.	Price Wed., May 10.	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Week to May 10. Highest.	Lowest.
		Electricity Supply.					
10	6/0	Bournemouth & Poole Elec. Sup. Ord.	8¼—8¾	6 0 0	Mar, Sep	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref.	9¼—9¾	4 12 3	Feb, Aug	9⅛	..
10	6/0	Do. 6 per Cent. Cum. Second Pref.	10⅛—10⅝	5 6 6	Feb, Aug	10 1/16	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	102 —104	4 6 6	Jan, July	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	7⅛—7⅝	6 11 3	March....	..	..
5	3/6	Do. 7 per Cent. Pref.	7⅛—7⅝	4 11 6	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Deb. Stock	99 —103	3 17 6	June, Dec	..	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	3⅞—4⅛	5 2 6	Feb, Aug	4⅛	..
5	2/3	Do. 4½ per Cent. Pref.	4⅛—4⅜	4 17 0	Feb., Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	96 —98	4 1 6	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101½—103½	4 7 0	..	..	..
5	2/3	Do. City Undertaking 4½% Cum. Pref.	3⅞—4⅛	5 3 0	Jan, July	..	..
5	3/0	Chelsea Electric Supply Ord.	4 —4¼	5 11 0	March	4⅛	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	100 —102	4 8 6	June, Dec	..	..
10	8/0	City of London Electric Lighting Ord.	11½—12	5 15 9	Feb, Aug	11 15/16	11
10	6/0	Do. 6 per Cent. Cum. Pref.	12 —13	4 12 3	Jan, July	..	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	119 —123	4 1 0	June, Dec	..	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	101 —104	4 6 6	Jan, July	102½	..
St.	5%	County of Durham Elec. P. D. 5% 1st Mort. Deb. Stk.	92 —94	5 5 3	Jan, July	..	..
10	6/0	County of London Elec. Supply Ord.	7⅞—8⅛	6 3 0	Feb, Aug	8	7
10	6/0	Do. 6 per Cent. Cum. Pref.	10⅞—11⅜	5 5 6	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Deb Stock (red.)	109½—111½	4 0 9	Jan, July	..	..
St.	4½%	†Do. Second Deb. Stock	99 —102	4 8 0	May, Nov	..	..
5	4/0	Folkestone Electricity Supply Co. Ord.	4¼—4¾	5 19 0	April, Oct	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4¾—5¼	4 15 3	Mar, Sept	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red)	97 —100	4 10 0	Feb, Aug	98½	..
5	5/0	Hove Electric Lighting Ord.	6¾—7¼	6 4 0	April, Oct	..	..
St.	4½%	†Isle of Wight E. L. & P. Co. Deb. Stk.	88 —91	4 19 0	..	..	..
5	5/0	Kensington & Knightsbridge Ord	7 —7½	5 16 0	Feb, Aug	7¼	..
5	6%	Do. 6 per Cent. 1st Pref.	5¾—6	5 0 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	93 —95	4 4 0	..	..	..
St.	4%	Kensington & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	96 —99	4 1 0	April, Oct	..	..
St.	4½%	Kent Elec. Power Co. Irred Deb. Stk.	80 —84	5 7 0	Jan, July	80	..
3	1/2⅖	London Electric Supply Ord.	1¾—2¼	2 17 0	Mar, Sept	..	..
5	3/0	Do. 6 per Cent. Pref.	4¾—5⅛	5 17 0	Mar, Sept	4 15/16	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	91 —94	4 5 0	Jan, July	92½	..
5	3/0	Metropolitan Electric Sup. Ord.	3⅞—4⅛	5 12 6	April, Oct	3 31/32	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	4½—4¾	4 14 9	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	101 —104	4 6 6	June, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	86 —89	3 18 6	Jan, July	..	..
..	4½%	Midland Elec. Corp. for Power Dist, 4½ 1st Mort. Debs.	97 —99	4 11 0	..	98½	..
5	2/6	Newcastle Elec. Supply Ord.	3¾—4¼	4 14 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non Cum. Pref.	4 —4½	5 11 0	Feb, Aug	..	..
100	4½%	Do. 4½ per Cent. 1st Mort. Deb.	98 —100	4 10 0	Jan, July	..	..
100	5%	North Metro. Elec. Power Sup. 5 Morts.	95 —97	5 3 0	..	..	..
1	6%	Northampton Elec. Lt. & P. Ord.	1¼—1 5/16	4 11 6	Feb, Aug	..	..
1	5%	Do. 5% Pref.	1 3/32—1 5/32	4 6 0	Feb, Aug	..	..
St.	4%	Do. 4% Debs.	99 —101	3 19 0	June, Dec	..	..
10	10/0	Notting Hill Electric Ord.	12 —12½	5 17 6	March	..	..
5	4/3	Oxford Electric Ord.	6 —6½	5 11 6	March	6⅜	..
St.	4%	Do. 4% Deb. Stk.	93 —96	..	..	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	8¾—9¼	5 8 0	Feb, Aug	8⅞	..
5	3/6	Do. 7 per Cent. Pref.	6¾—7¼	4 16 6	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	85 —88	3 19 6	Jan, July	..	..
5	..	Smithfield Markets Electric Sup. Ord.	1⅛—1⅞	..	Feb.	..	..
5	4/0	South London Electric Supply Ord.	3 —3½	6 3 0	April	3	..
St.	5%	Do. 5% 1st Mort. Stock (red.)	101 —104	4 16 0	..	..	..
1	8⅗	South Metrop'n Elec. Lt & Power 7% 1st Pref	1 1/16—1 3/16	5 18 0	Feb, Aug	..	..
1	7½	Do. 6 per Cent. 2nd Pref.	⅞—1	6 17 0	Feb, Aug	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	95 —98	4 11 6	April, Oct	..	..
5	1/3	Urban Electric Supply Ord.	¾—1¼	..	April, Oct	1⅛	..
5	1/3	Do. 5 per Cent. Cum. Pref.	2½—3	8 6 0	April, Oct	2⅜	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	85 —88	5 2 3	April, Oct	..	..
5	5/0	Westminster Elec. Sup. Ord.	8 —8½	5 17 9	Mar, Sept	8¼	8
5	2/3	Do. 4½ per Cent. Cum. Pref.	5 —5½	4 3 6	Jan, July	5¼	5
		Electric Railways and Tramways.					
1	..	Bath Elec. Trams Pref. Ord.	½—9/16	..	April	7/32	7/16
1	0/6	Do. 5 per Cent. Cum. Pref.	½—¾	6 13 6	Jan, July	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	79 —83	5 8 6	April, Oct	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Deb. Stock	90½—92½	4 17 3	Jan, July	..	..
10	4%	Bristol Tramways & Carriage Ord.	7 —7½	5 10 3	Feb, Aug	..	..
10	4%	Do. Cum. Pref.	7⅛—7⅝	5 1 6	..	..	..
St.	4%	Do. 4 per Cent. Debs.	101 —102	3 18 3	Feb, Aug	..	..
10	..	British Electric Traction Ord.	1¼—1¾	..	June, Dec	1⅜	—
10	..	Do. 6 per Cent. Cum. Pref.	4⅜—4⅞	..	Feb, Aug	5 1/16	4⅞
St.	5%	Do. 5 per Cent. Perpetual Debs.	94 —98	5 2 0	April, Oct	96	95¼
St.	4½%	†Do. 4½ per Cent. 2nd Deb. Stock	75 —80	5 12 3	May, Nov	..	..
St.	3%	Central London Ordinary Stock	76 —78	3 17 0	Feb, Aug	77	75
St.	4%	Do. 4 per Cent. Pref. Stock	87 —89	4 10 0	Feb, Aug	88½	87½
St.	2%	Do. Deferred Stock	65 —68	2 19 0	Feb.	66	65
100	4%	Do. 4 per Cent. Debs.	102 —104	3 17 0	Jan, July	103¼	..
5	2/6	City of Birmingham Trams, 5% Cum. Pref.	4¾—5	5 0 0	April, Oct	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 18 9	April, Oct	..	..
St.	1½%	City & South London Rly. Con. Ord.	35½—36½	4 2 0	Feb, Aug	35 7/16	34¾
St.	5%	Do. 5 per cent. Perp. Pref. (1891)	109 —111	4 10 0	Feb, Aug	111	109¾
St.	5%	Do. (1896)	104 —106	4 12 6	Feb, Aug	..	..
St.	5%	Do. (1901)	101 —104	4 16 0	Feb, Aug	..	..
St.	5%	Do. (1903)	102 —105	4 15 3	Feb, Aug	..	..
St.	4%	†Do. 4 per Cent. Perpetual Debs.	100 —102	3 18 6	May, Nov	..	..
10	6/0	Dublin United Trams, 6 per Cent. Pref.	12½—13½	4 10 6	Feb, Aug	..	..
10	12/0	Gateshead and District Trams Ord.	8½—9½	6 19 6	..	..	..
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	1⅛—1⅝	..	Feb, Aug	..	..
5	..	Hastings & District Elec. Trams, 6% C. P.	1½—2	..	Mar. Sept	..	..
St.	4½%	Do. 4½ Deb. Stock	75 —80	5 10 0	April, Oct	..	..
10	..	Imperial Tramways Ord.	3 —3½	..	Mar, Sept	..	..
10	..	‡Do. 6 per Cent. Pref.	4¼—4¾	..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Debs.	70 —72	6 5 0	Jan, July	..	..
..	2/6	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	2 —2½	5 5 0	Mar, Sept.	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	79 —84	4 15 0	Jan, July	..	..
10	6/0	Lanarkshire Tramways	9¾—10¼	5 12 3	Feb, Aug	..	..
St.	5%	Lancs Utd. Trams, 5% Prior Lien Deb. Stk.	82 —84	5 19 0	Jan. July	..	..
St.	4%	London Electric 4% Deb. St.	97 —99	4 1 0	..	98⅜	98
St.	4%	Do. 4% Pref.	82 —84	4 15 3	..	83½	83⅛
10	..	London United Trams, 5% Cum. Pref.	3 —3½	..	Jan, July	3¼	2 15/16
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	76 —79	5 1 0	Jan, July	75¼	—
St.	..	Mersey Con. Ord. Stock	6 —8	..	Feb, Aug	—	..
1	1/1½	Metropolitan Elec. Tramways Ord.	13/16—15/16	6 0 0	..	..	..
1	..	Do. Deferred	1/32—3/32	..	April	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	⅞—1	5 0 0	Feb, Aug	⅞	⅞
St.	4½%	Do. 4½ per Cent. Deb. Stock	102 —104	4 6 6	Jan, July	104	103¼
St.	5%	Do. 5 per Cent. Db. Stk	99½—101½	4 18 6	..	101⅞	101¼
St.	1½%	Metropolitan Railway Consolidated	52¼—53¼	2 12 0	Feb, Aug	53⅛	50¾
St.	2¾%	Do. Surplus Lands Stocks	66 —68	4 1 0	Feb, Aug	67½	66⅛
St.	3½%	Do. 3½ per Cent. Preference	90 —92	3 16 0	Feb, Aug	91⅛	90⅝
St.	3½%	Do. 3½ per Cent. "A" Preference	89 —91	3 17 0	Feb, Aug	90⅞	90
St.	3½%	Do. 3½ per Cent. Convertible Pref.	89 —91	3 17 0	Feb, Aug	90⅞	90⅝
St.	3½%	Do. 3½ per Cent. Debenture Stock	93 —95	3 13 6	Jan, July	94½	94

* In calculating the yield allowance has been made for accrued interest, but *not* for redemption.
† Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

NAME.	Price Wed., May 10.	Rate per cent. Yielded.	Dividend Due.	Business Week to May 10. High-est.	Low-est.	Size	Last Dividend
Electric Railways and Tramways— *Continued.*		£ s. d.					
Met. Rly. 3½ per Cent. "A" Deb. Stock	92 —94	3 14 6	Jan, July	93⅛	93½	100	2$
Metropolitan District Railway Ord.	33 —33½	..	Feb, Aug	33⅛	31⅞	..	4%
Do. 4½% First Pref.	89 —91	4 19 0	Feb, Aug	89⅜	88⅜	St.	4%
Do. Assented Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	75 —77	4 11 0	Feb, Aug	75⅜	..	St.	5%
Do. 3 per Cent. Consoltd. Rent-charge	77 —79	3 16 0	Jan, July	..	..	5	3/0
Do. 4 per Cent. Midland Rent-charge	103 —105	3 16 0	Jan, July	..	..	1	0/7½
Do. 6 per Cent. Perp. Deb. Stock	148 —150	4 0 0	Jan, July	149½	148½	St.	0/6
Do. 4 per Cent. Ditto	97 —99	4 1 6	Jan, July	..	..	St.	6%
Potteries Electric Traction Ord.	⅛ —⅜	..	April, Oct	⅛	..	10	6%
Do. 5 per Cent. Cum. Pref.	⅜ —⅝	7 5 0	Feb, Aug	..	..	10	6/0
Do. 4½ per Cent, Deb. Stock	87 —90	5 0 0	May, Nov	90	..	5	6/0
S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	⅛ —⅜	10 2 0	..	..	..	St.	2/6
Dc. 4 per Cent. Deb. Stock	75 —80	5 0 0	Jan, July	..	..	St.	3½%
Sunderland Dist. Elec. Trms. 5% 1stMtDb.	..	8 4 0	Jan, July	..	..	St.	4%
Undergd E. Rys. Lon. 6% In. bds with coup 7	60 —62	1 12 9	June, Dec	61	58½	..	4½%
†Do. 5% Prior Lien Bonds	100 —101	4 19 0	..	..	..	1	1/0
Do. 4½% Bonds with coup. 7	97 —99	4 11 0	..	100	99	St.	0/7½
Do. 4 per Cent. 1st Power Ho. Dbs.	99 —101	3 19 3	..	100½	100	St.	4%
Yorkshire (W.R.) Elec. Trams. Ord.	⅛ —⅜	..	March ..	..	..	5	4½%
Do. 6 per Cent. Cum. Pref.	2⅛ —2½	..	..	..	..	5	3/0
Do. 4½ per Cent. 1st Debs.	84 —87	5 3 3	Jan, July	..	..	St.	4½%
Electric Manufacturing, &c.							
Anchor Cable Co. 4½ % Deb. Stock	99 —101	4 9 0	..	..	..	5	3/0
Aron Electricity Meter Ord.	⅛ —⅜	..	..	..	..	10	2/0
Do. 6% Cum. Pf.	⅝ —⅞	7 4 0	April, Oct	⅝	..	10	3/0
Babcock & Wilcox Ord. xd and bonus	5½ —5¾	4 14 6	April, Oct	5⅝	5⅝	10	6%
†Do. Pref.	1⅜ —1½	4 0 0	..	..	..		
British Insulated & Helsby Cables Ord.	6⅞ —7⅛	6 15 6	July, Feb	..	..	5	2/6
Do. 6 per Cent. Pref.	5⅞ —6⅛	4 16 0	Jan, July	..	..	5	2/6
Do. 4½ per Cent. 1st Mort. Deb. (red.)	102 —104	4 6 6	Jan, July	..	..	St.	4%
British Thoms'n-Houst'n 4½% 1st Mt. Db.	96 —99	4 11 0	Mar, Sept	..	..	St.	4½%
British Westinghouse 6 per Cent. Pref.	⅜ —½	..	Feb, Aug	⅜	⅛	St.	2/9
Do. 6 per Cent. Prior Lien Dbs. (rd.)	102 —103	5 16 3	..	102½	..	St.	5%
Do. 4 per Cent. Mort. Deb. Stock	61 —64	6 5 0	Jan, July	62⅛	..	5	4/0
BrushE.Eng. Co. 4½% Perp. 1st Deb.Stock	59 —64	7 0 6	Mar, Sept	..	..	5	2/6
Do. Perpetual 2nd Deb. Stock	41 —46	9 16 0	Jan, July	..	..	St.	4½%
Callender's Cable Con. Ord.	9⅜ —9⅝	7 12 0	Jan, July	9⅜	..	St.	8%
Do. 5 per Cent. Cum. Pref.	4⅞ —5⅛	4 17 6	Jan, July	5	..	St.	6%
Do. 4½ per Cent. 1st Mort Debs. (red.)	102 —104	4 6 6	Nov, May	..	..	St.	5%
Castner-Kellner Alkali Co.	3⅞ —3⅞	4 18 3	May, Nov	3⅞	3⅞	40	4½%
Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 —106	4 5 6	Feb, Aug	104⅛	..	100	4½%
Chadburn's (Ship) Telegraph Ord.	1⅛ —1⅜	5 19 0	March ..	..	..	St.	4½%
Consolidated Electrical Co.	⅜ —½	10 0 0	August ..	..	..	St.	5%
Consolidated Signal Co.	⅛ —¼	5 0 0	April, Oct	⅛	⅛	St.	6%
†Do. 6 per cent. Cum. Pref.	⅛ —⅛	6 8 0	April, Oct	..	..		
Crompton & Co (Nos. 1 to 85,000)	⅛ —¼	..	Jan, July	..	..	5	3/6
Do. 5 per Cent. 1st Mort. Debs. (red.)	70 —80	6 5 0	Jan, July	..	..	100	2/6
Dick, Kerr & Co. Ord.	⅞ —1	5 0 0	Sept. ..	..	..	1	4½%
Do. 6 per Cent. Cum. Pref.	1 —1⅛	5 6 6	Sept ..	..	..	St.	..
Do. 4½ per Cent. Deb. Stock	97 —100	4 10 0	Jan, July	..	..	5	1/3
Edison & Swan United ("A" Sh.) (£3 pd.)	⅜ —½	..	Feb, Aug	..	..	St.	4%
Do. (£5 paid)	1⅛ —2⅛	9 3 0	Feb, Aug	..	..	..	5%
Do 4 per Cent. Mort. Deb. Stock (red.)	67 —73	5 9 9	June, Dec	..	..	1	5%
Do 5 per Cent. 2nd Deb. Stock	78 —81	6 3 6	Mar, Sept	..	..		
Edmundson's Elec. Corp. Ord.	½ —1	..	Jan, July	1	..	100	5%
Do. 6 per Cent. Cum. Pref.	3⅛ —3½	..	May, Nov	..	..		
Do 4½ per cent. 1st Mort. Deb. (red.)	86 —89	5 1 0	Jan, July	..	..	1	..
Electric Construction Co.	¾ —1	..	Jan, July	..	..	100	5%
Do. 7 per Cent. Cum. Pref.	1⅛ —2	7 0 0	July	..	..	5	6%
Do. 4 per Cent. Perp. 1st Mort. Debs.	70 —73	5 8 0	Jan, July	71	..	5	0/7½
General Electric (1900) 5% Cum. Pref.	8⅛ —8⅞	5 14 6	June, Dec	..	..	100	0/7½
Do. 4 per Cent. 1st Mort. Debs.	83 —88	4 11 0	Mar, Sept	..	..	St.	5%
Henley's Telegraph Works Ord.	12⅛ —12⅞	5 16 6	Feb, Aug	12⅞	..	St.	5%
Do. 4½ per Cent. Pref.	4⅛ —5⅛	4 7 0	Feb, Aug	..	..	100	5%
Do. 4½ per Cent. 1st Mort. Deb. Stock	108 —110	4 2 0	Mar, Sept	..	..	..	5%
India Rubber, Gut. Per., &c., Works	16⅛ —17	5 17 9	Feb, Aug	16⅛	16⅛	100	$1¼
Do 5 per Cent. Cum. Pref.	10⅛ —10⅜	4 14 0	..	10⅜	10⅜	..	5%
Do. 4 per Cent. Debs. (red.)	96 —98	4 1 6	April, Oct	97⅛	96⅛	St.	6%
National Elec. Construction Co.	⅛ —⅜	..	April ...	..	..	St.	4½%
Richardsons, Westgarth & Co., Ltd. Ord.	⅝ —¾	..	Nov	..	..		
Do. 6 per Cent. Cum. Pref.	⅞ —⅞	..	May, Nov	..	..	St.	4½%
Do. 4½ per Cent. Perp. Deb. Stock	78 —82	5 10 0	Jan, July	..	..	1	0/6
Simplex Conduits 6 per Cent. Cum. Pref.	4½ —5	..	..	..	..	St.	5%
Telegraph Construction & Maintenance	36½ —38½	5 16 3	Mar, July	37⅛	36½	5	3/0
Do. 4 per Cent. Deb. Bonds (1909)	100 —102	3 18 6	Jan, July	..	..		
Vickers, Sons & Maxim, Ltd., Ord.	2⅜ —2⅝	4 14 0	..	2⅛	2⅛	St.	4½%
Dc. 5 per Cent. non-Cum. Preference	1⅛ —1⅜	4 3 0	..	..	..	100	$1¼
Do. 5 per Cent. non-Cum. Preferred	110 —113	4 8 6	..	112	110	..	5%
Do 4 per Cent. 1st Mort. Db. Sk. (red)	102 —104	3 17 0	June, Dec	103	102½	100	5%
Do. 4½ per Cent. 2nd Mort. Deb. (red.)	104 —106	4 5 0	June, Dec	..	..	..	$2½
Do. 5 per Cent. 3rd Mort. Debs Scrip.	105 —107	4 13 6	..	105½	106	..	
J. G. White & Co. 6% Cum. Pref.	14½ —15½	6 11 0	..	..	..	..	5%
Willans & Robinson Ord.	⅛ —⅜	..	Apr, Oct	..	..	100	4½%
Do. 6 per Cent. Cum. Pref.	½ —1	..	Apr, Oct	..	..		
Do. 4 per Cent. 1st Mort. Debs.	55 —65	6 3 0	May, Nov	..	..		
Telegraphs.							
Amazon Telegraph	7⅛ —7⅜	..	June, Dec	7⅛	..	5	3/0
Do. 5 per Cent. Debs. (red.)	98 —100	5 0 6	Jan, July	99¼	99	10	5/0
Anglo-American	69½ —71½	5 3 6	F,My,Ag,N	70	69½	5	5%
Do Preferred	114½ —115½	5 4 0	F,My,Ag,N	116½	114½	5	2/6
Do. Deferred	26½ —27½	5 10 6	F,My,Ag,N	28½	26⅛	100	5%
Commercial Cable 4 per Cent. Deb. Stk.	88 —90	4 9 0	Jn,Ap,Jy,O	88	..	100	7/2½
Cuba Submarine Ord.	9½ —10⅛	5 14 0	Feb, Aug	10⅜	10⅛	100	$3⅛
Do. Preference 10 per Cent.	17⅛ —18⅛	5 7 0	Feb, Aug	..	..	100	5%
Direct Spanish Ord.	3⅛ —4	5 0 0	April, Oct	..	..	..	
Do. 10 per Cent. Cum. Pref.	8⅛ —8⅞	5 12 6	April, Oct	8⅛	8⅛	500	5%
Do. 4½ per Cent. Deb.	100½ —102½	4 8 0	Jan, July	..	..	St.	5%
Direct United States Cable	7⅛ —7½	6 7 0	Ja,Ap,Jy,O	7⅜	7⅛	5	..
Direct West India Cable 4½%Rg.Db.(rd.)	100 —102	4 8 3	June, Dec	..	..	10s	..
Eastern Ordinary	137 —140	5 0 0	Ja,My,Jy,O	139½	137	1	0/7½
Do. 3½ per Cent. Pref. Stock	81½ —85½	4 1 0	Ja,My,Jy,O	85½	85	..	5%
Dc. 4 per Cent. Mort. Deb. Stk. (red.)	100 —102	3 18 6	May, Nov	101½	101⅛	5	..
Eastern Extension	13⅜ —13⅝	5 1 0	Ja, Ap, Jy, O	13⅜	13⅛	St.	..
Dc. 4 per Cent. Deb. Stock	100 —102	3 18 3	Feb, Aug	100⅛	..	St.	5%
Eastern and S.Af., 4% Mauritius Sub.Debs	99½ —101½	3 19 0	May, Nov	..	..	500	5%
E.N (of Copenhagen), ex Coupon 81	32 —33	5 8 6	Jan, July	32½	32⅛		
Indo-European	59 —61	5 6 6	May, Nov	61	..	St.	$1
Mackay Companies Common	93 —96	5 4 0	Ja,Ap,Jy,O	..	..	St.	83⅛
Do. Preference	78 —80	5 0 0	Ja,Ap,Jy,O	..	..	500	5%
Marconi's Wireless Teleg. Co.	1⅜ —1⅝	..	April	1½	1⅜	St	5%
Pacific & Europe'n Tel. 4% Guar. Dbs. (red.)	100 —102	3 18 3	June, Dec	..	..	100	8/2½
West Coast of America	1½ —1⅞	4 3 0	May	..	..	100	5%
Do. 4 per Cent. Debs.	99½ —101½	4 18 9	Jan, July	..	..	St.	£9
West India & Panama	2⅜ —2⅝	1 18 0	May, Nov	2½	2⅜	St.	6%
Do. 6 per Cent. 1st Pref.	10⅜ —10⅝	5 10 0	May, Nov	10⅜	..	St.	5%
Do. 6% 2nd Pref.	9⅛ —10	6 0 0	May, Nov	..	..	100	$1½
Do. 5 per Cent. Debs.	102 —104	4 16 0	Jan, July	102½	..	..	5%
Western Telegraph	13⅛ —14	5 0 0	Mr,Jn,O,D	13⅜	13⅛	St.	4½%
Do. 4 per Cent. Deb. Stock (red.)	101 —103	3 17 6	June, Dec	..	..	St.	4½%
Western Union Telegraph, $1,000 4% Bds	105 —108	3 14 0	—	—	—	—	6d.
Do. $',000 4½% Fdg. & Rl. Est. Gd. Bnds	98 —101	4 9 3	—	—	—	1	—
Telephones.							
Amer. Telephn. & Telegh. Cap. St.	151½ —153½	5 4 0	..				
Do. Coll. Trust $1,000 4 per Cent. Bds.	94 —96	4 3 3	Jan, Jul:				
Do. 4% Cons. Bonds 1936	112½ —114½	4 17 0	..				
Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101 —103	4 17 0	Mar, Sept				
Chili Telephone	7⅛ —7⅜	5 11 6	August ..				
†Monte Video Telephone Ord.	¾ —1	6 0 0	Nov				
†Do. 5 per Cent. Pref.	⅞ —⅞	5 11 0	May, Nov				
National Co. Pref. Stock	104½ —105½	5 14 0	Feb, Aug				
Do. Def. Stock	130 —132	4 11 0	Feb, Aug				
Do. 6 per Cent. Cum. 1st Pref.	10 —10½	5 11 6	Feb, Aug				
Do. 6 per Cent. Cum. 2nd Pref.	10½ —11	5 9 0	Feb, Aug				
Do. 5 per Cent. non-Cum. 3rd Pref.	5⅛ —5⅞	4 5 0	Feb, Aug				
Do Deb. Stock 3½ per Cent. (red.)	99 —101	3 9 3	June, Dec				
Do. 4 per Cent. Deb. Stock (red.)	99 —101	3 19 3	Jan, July				
†New York Telephone Co. 30 yr. Bnds.	98½ —99½	4 10 6	..				
†Oriental	1⅛ —1⅛	4 15 0	April, Oct				
†Do 6 per Cent. Cum. Pref.	1⅛ —1⅞	4 16 0	April, Oct				
Do. 4 per Cent. Red. Deb. Stock	87⅛ —89½	4 9 6	Jan, July				
Telephone Co. of Egypt 4½% Db. Stk. (red.)	99½ —101½	4 8 9	Jan, July				
United River Plate Ord. (1—150,000)	7½ —7⅞	5 3 0	July				
Do. (150,001—190,000)	7⅛ —7⅜	..	..				
Do. 5 per Cent. Cum. Pref.	5⅛ —5⅜	4 9 0	June, Dec				
Do. 4½ Deb. St. Red.	103 —105	4 5 9	Jan, July				
Financial, Investment, &c.							
Elec. & Gen. Investment 6% Cum. Pref.	3⅞ —4⅛	7 1 0	Jan, July				
Globe Telegraph & Trust	11 —11½	5 2 6	Sp,DcMrJu				
Do. 6 per Cent. Pref.	13 —13½	4 9 0	Sp,DcMrJu				
Submarine Cables Trust (Cert.)	131 —134	4 9 6	April, Oct				
Colonial and Foreign Electric Railways, Tramways, &c.							
Anglo-Argentine 5% Cum. 1st Pref.	5 —5⅛	4 15 3	April, Oct				
Do. 5% Cum. 2nd Pref.	4⅞ —5⅛	4 17 6	Jan, July				
Do. 4% Deb. Stock	92½ —94	4 5 0	June, Dec				
Do. 4½% Deb. Stock	100 —102	4 8 3	..				
Do. 5% Deb Stock	102½ —104½	4 15 6	..				
Auckland Elec. Trams. 5% Deb. (red.)	104½ —105½	4 14 6	Jan, July				
†Brisbane Electric Trams. Invest. Ord	6⅜ —6⅞	5 16 0	May				
†Do. 5 per Cent. Cum. Pref.	4⅛ —5⅛	4 14 9	May, Nov				
Do. 4½ per Cent. Db. Prov. Certs.	102 —105	4 6 0	Jan, July				
†British Columbia El. Rly. Df. Ord.	146 —150	5 6 9	Mar, Sept				
Do. Pref. Ord. Stock	125 —128	4 13 9	May, Nov				
Do. 5% Cum. Perp. Pref. Stock	107½ —110½	4 10 6	Jan, July				
Do. 4½ per Cent. 1st Mort. Debs.	100 —103	4 7 6	April, Oct				
Do. Vancouver Power Debs.	102 —105	4 5 9	Jan, July				
Do. 4½% Perp. Con. Deb. St.	101 —103	4 2 0	..				
Buenos Ayres Lacroze Trams 1st Mt. Db.	99 —101	4 19 0	Mar, Sept				
Buenos Ayres Port & City Tram, 1st Mt. Deb. Stock	93 —98	6 2 6	Feb, Aug				
†Calcutta Tramways (1 to 137,610)	5½ —6	5 0 0	Mar, Sept				
Do. 5 per Cent. Cum. Pref.	5⅜ —5⅞	4 13 0	Jan, July				
Do 4½% 1st Deb. Stock (red)	10. —104	4 6 6	Jan, July				
Cape Electric Tram Shares	⅛ —⅜	..	..				
City of Buenos Ayres Trams Co. (1904) Sh.	5⅜ —5⅞	4 5 0	F,My,A,N				
Do 4 per Cent. Deb. Stock	98 —101	3 19 3	June, Dec				
†Colombo Tr. & Ltg. 5% 1st Mt. Db.	95 —98	5 2 0	May, Nov				
Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	99½ —101½	4 18 6	Feb, Aug				
Hong Kong Tramways Co. 5 per Cent. 1st Mort. Debs.	78 —82	6 1 6	June, Dec				
Kalgoorlie Elec. Trams Sh.	½ —⅝	..	..				
Do. 5 per Cent. "A" Deb. Stock	94 —97	5 3 0	Jan, July				
Do. 6 per Cent. "B" Ditto	66 —70	4 5 9	Jan, July				
Lisbon Elec. Trams. Ord.	1 —1⅛	4 16 0	July				
Do. 6 per Cent. Cum. Pref.	1 —1⅛	4 16 0	Jan, July				
Do. 5 per Cent. Reg. Mort. Debs.	93 —102	4 18 0	Jan, July				
Madras Elec. Trams. 5% Deb. Stk.	96 —98	5 2 0	Jan, July				
Manaos Trams and Lt. Co. 5% Debs	92½ —94½	5 6 0	..				
Manila Elec. Ry. $1,000 Gold Bonds	99½ —101½	4 18 6	Feb, Aug				
Mexico Trams Co. Com. St.	123 —126	5 11 0	..				
Do. Gen. Con. 1st Mort. 5% Gold Bds.	96½ —97½	5 2 6	..				
Do. 6% 50 yr. Mort. Bds.	101¼ —102¼	5 17 0	..				
Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922) (Nos. 601 to 2,000)	101 —103	4 7 6	Feb, Aug				
†Do. do. (Nos. 1 to 4,600)	101 —103	4 7 6	..				
Perth Elec. Trams Ord.	⅛ —⅜	2 13 6	May				
Dc 1st Mt. Db. Stock	104 —106	4 14 3	Jan, July				
Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	5⅛ —5⅞	5 4 6	..				
Do. 4½% 1st Mort. Deb. Stk.	99 —102	4 8 0	..				
Rio Janeiro Tram, Lt. & P. Co.	103½ —109½	4 11 3	..				
Do. 30 yr. Gold Bnds.	102⅜ —103½	4 16 6	..				
Do. 50 yr. Mt. Bnds	95½ —96½	5 3 6	..				
Sao Paulo Tramway, Light & Power Co. $100 Stock	168 —170	5 17 9	..				
Do. 5 per Cent. 1st Mt. $500 Db.	103½ —104½	4 15 9	June, Dec				
Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	99 —100	4 10 0	Feb, Aug				
Colonial and Foreign Electricity Supply, &c.							
Adelaide Elec. S'ply Co. 6% Cu. Pr.	5⅜ —5⅞	5 2 0	Mar, Sept				
Bombay E.S. & T. 6% Cm. Pf.	10¼ —11½	5 5 6	..				
Do. 4½ per Cent. Deb. Stk. (red.)	96½ —98½	4 12 0	Jan, July				
Do. 5 per Cent. 2nd Mort. Deb. Stock	97 —99	5 1 0	..				
Calcutta Elec. Supply Ord.	6⅞ —7⅜	5 13 6	April, Oct				
Do. 5% Cum. Pref.	⅜ —⅝	4 13 0	..				
Calgary Power Co. 5% 1st Mort. Bnds.	96 —98	5 2 0	..				
Canadian Gen. Elec. Co. Com. St.	111 —114	6 3 0	..				
Do. 7% Cm. Pf. Stock	120 —123	5 14 0	..				
Castner Electrolytic Alkali Co. (of U.S.A.) 1st Mort. Stl. Debs.	97 —102	4 18 0	Jan, July				
Elect Development Co. of Ontario	84½ —86½	5 16 0	..				
Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	87 —90	5 11 0	Jan, July				
Indian Elec. Sup. & Trac. Co.	1 —1⅛	..	..				
Kalgoorlie Elec. Power & Ltg. Ord.	⅛ —⅜	..	..				
†Do. 6 per Cent. Cum. Pref.	⅜ —¾	8 6 6	April, Oct				
Kaministiquia Power Co. 5% Gold Bnds.	103 —105	4 15 0	..				
Madras E. S. Corp. Ord.	3 —3⅛	..	..				
Melbourne E. S. Co. 6% Cum. Pref.	..	..	..				
Do. 5% 1st Mortg. Deb. Stock	94 —96	5 4 0	..				
Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	87½ —90½	5 10 6	..				
Mexican Lt. & Power Co. Com. St.	81⅛ —85⅛	4 16 0	..				
Do. 7% Cum. Pref. St.	100⅛ —108½	6 9 0	..				
Do 5% 1st Mort. Gold Bnds.	91⅛ —95⅛	5 4 6	..				
Monterey Rly. L. & P. Co., 1st Mort. Db. Sk.	87½ —91⅛	5 8 9	..				
†Montreal Lt. Ht. & Power Co. Cap. St.	153 —155	5 3 3	F,My,A,N				
†Northern Lt. Power & Coal 5% Gd. Bds	71 —73	6 17 0	..				
River Plate Electricity Co. Ord. Stk.	228 —238	3 15 6	April				
Do. 6 per Cent. non-Cum. Pref. Stk.	110 —117	5 2 6	May				
Do. 5 per Cent. Deb. Stock	104 —106	4 14 3	Jan, July				
Shawinigan Water & Power Co. Ca.	115 —118	4 4 9	..				
Do. 5 per Cent. Bds.	108½ —110½	4 10 6	Jan, July				
Do. 4½ Per Con. Mt. Db. St.	104 —106	4 5 0	—				
Toronto Power Co. 4½% Db. St.	101 —103	4 7 6	—				
Victoria Falls Power Co. Pref. (1 to 805,000)	⅜ —1⅜	4 17 0	Jan, July				
Do. (805,001 to 1,700,000)	⅛ —⅜	—	—				

In calculating the yield allowance has been made for accrued interest but *not* for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote th

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NOTES.

Tramway Fares.

In the case of a municipally controlled tramway undertaking the question of fares frequently produces a considerable diversity of opinion between the various members of the Council. Indeed, it is almost inevitable that such should be the case, since the opinion of individual councillors on this question is certain to be affected to some extent by the desirability of pleasing different sections of the ratepayers. During recent years the desire to popularise their tramways has led some committees to grant exceptional facilities for cheap travelling, such as half-penny fares, which the majority of tramway managers believe are unreasonable except under very exceptional circumstances. There has also been a growing tendency to introduce still cheaper (and more unprofitable) fares for workpeople and others travelling before a certain hour in the morning, on the assumption that the ordinary passenger traffic during the remainder of the day will counteract any loss that may result from the cheaper fares. If the effect of introducing such fares were to improve the "load factor" of the system, something might be urged in their favour, but in the majority of cases passengers obtaining such cheap tickets may return at the "peak" of the evening load at the low fare. The case, therefore, is very different from that of low-priced units in electricity supply.

Mr. J. M. McElroy, general manager of the Manchester Corporation Tramways, has recently presented to his Committee a very interesting report in regard to workpeople's fares. This Report deals with a proposal to extend from 7 a.m. to 8:30 a.m. the time during which such fares are in operation, and the Committee, after considering the Report, wisely decided not to make any further concession in this direction. In previous reports Mr. McElroy has pointed out that preferential treatment as regards fares tends to introduce difficulties, and he again emphasises the fact that the wisest policy for his Committee to adopt is to reduce the ordinary fares as low as is feasible, having regard to the financial stability of the undertaking, and to make everybody pay alike. This policy will certainly find many adherents. From a comparative statement accompanying the Report we notice that of 10 municipal tramway undertakings recording an "ordinary" fare per mile of ½d. or less, six (including Sheffield, Liverpool, Glasgow, and Leicester) have no workmen's fares in operation; the benefit of low fares, therefore, is in such cases more widely distributed. Although the Manchester and other large tramway undertakings record each year a very considerable surplus, it must always be borne in mind that the excess of income over expenditure is very small when reckoned per passenger. Thus, this margin is only $\frac{1}{10}$d. at Manchester, so that it obviously behoves even large successful tramway undertakings to pay great attention to any slight tendency for the average fare per passenger to decrease. That tramway revenue has not of recent years increased in accordance with general expectations is admitted, and it is noteworthy that a word of warning as to the possible necessity of increased fares owing to the tendency for the receipts per car-

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mile to decline, was recently uttered by the Chairman of the Highways Committee of the London County Council.

Electric Supply Progress at Leeds.

In commenting in recent years on the progress made by the Leeds Corporation Electric Lighting Department we have referred to the decline in revenue from lighting consumers since the advent of the metal filament lamp, and we have expressed the opinion that the temporary decrease in the output would soon be arrested. Although that desirable position has not yet been quite reached, it is evident from a statement presented with the revenue account at the meeting of the Tramways and Electricity Committee this week, that the lowest point of the depression can now be gauged, if it has not already been passed. The sales of energy for private lighting for the 12 months ended March 31st last were, as a matter of fact, only 2·5 per cent. less than in the previous year, when a decrease of 12·7 per cent. was recorded. On the other hand, the output for power and heating shows an increase of over 30 per cent., and the total revenue from all sources an increase of £4,500. As working expenses only amounted to £795 more than last year, in spite of an increased output of about two million units, the result of the year's working is on the whole satisfactory, a surplus of almost £10,000 being shown. The gas journals can scarcely say, in the case of the Leeds electricity undertaking, that the cheap power supply is provided at the expense of the lighting consumers; indeed, as the output for power and heating is now more than twice that for private lighting, and is increasing at a rapid rate, the lighting output will soon become a comparatively unimportant factor. This result is the more gratifying in that the undertaking has not the benefit of a tramway load; and when this is borne in mind, the low cost per unit sold reflects the greatest credit on the engineer and manager, Mr. H. Dickinson. The fuel figure last year of 0·17d. per unit sold, which was one of the lowest recorded in this country, has on the present occasion been reduced to 0·15d. per unit, so that other undertakings have now a still more difficult task in attaining the high level of efficiency set them by Leeds.

Burton-upon-Trent.

We have always examined with interest the annual report and balance-sheet of the Burton-upon-Trent Electricity Department, and those which have come to hand this week show a very satisfactory state of affairs. Here the adverse effect of metal lamps has now passed, and in place of diminishing sales for lighting, it is very gratifying to record an increase of 7·4 per cent. for private lighting as compared with last year's output. As the number of units sold for power has increased by over 27 per cent., it is not surprising that the surplus shown in the accounts is the highest yet recorded. In view of this fact, the Council have probably felt justified in appropriating £1,000 for the relief of rates. It is interesting to notice that although meters were only installed on the tramcars towards the end of the year the consumption of energy has declined by 4·1 per cent., so that a much larger diminution in the output for traction is anticipated next year. The total cost per unit (excluding capital charges) of 0·92d. recorded last year (which is not high for a small undertaking) has on the present occasion been reduced to 0·81d., so that the economies introduced by Mr. P. J. Pringle are evidently being emphasised by his successor. That Mr. Pringle is no longer connected with the undertaking is apparent from the fact that neither in the report nor in the detailed statistics of the undertaking is any mention made of restricted-hour supply.

The Coronation Exhibition.

The Exhibition at Shepherd's Bush has now become an annual feature of London's entertainments. Although in the past the educational side of the Exhibition has by no means been sacrificed to the lighter forms of entertainment, the Science Section has not been as prominent as it might have been; in the Coronation Exhibition, however, which was opened yesterday by H.R.H. Prince Arthur of Connaught, this Section will certainly be a marked feature. On the present occasion an effort has been made to render the Section more attractive, and with this aim in view demonstrations are to be given. In the past, exhibits of scientific apparatus have had a tendency to become merely a collection of instruments of historic interest; but although the historical side of the present Science Section will be represented by the early apparatus used by Faraday, Wheatstone and others, modern apparatus and investigation will be much in evidence. Thus, models illustrating the application of electricity to agriculture have been loaned by the University of Bristol; whilst the indiarubber testing machine of Prof. Schwartz, electric resistance furnaces, thermo-electric and Féry radiation pyrometers, vibration galvanometers, Dr. Drysdale's polyphase wattmeter and alternating-current potentiometer, &c., and other apparatus of which mention cannot be made here, are all in evidence. An experiment is also being arranged to show the negative coefficient of expansion of invar over a certain temperature range, whilst two dark rooms will enable stroboscopic methods of measuring speed and experiments with X-ray and vacuum tubes to be demonstrated. We may also draw attention to the fact that a special effort has been made to make the telegraphic and telephonic part of the Section of particular interest. With this object a syphon recorder working on an artificial Atlantic cable is shown whereby difficulties in transmission due to the effect of capacity can be illustrated. Again, the Marconi stations placed at either end of one of the halls will doubtless prove a centre of attraction, since the public will be able to transmit from one station to the other and see the actual operation of the apparatus. As regards the Exhibition itself, this is likely to prove as attractive as ever.

The New I.E.E. Wiring Rules.—A new rule, to which we omitted to draw attention in our article last week, and which is of some importance, is Rule 51 relating to "Open Wiring Armoured Conductors." This states that conductors (except flexibles) efficiently armoured with steel armouring or covered with brass, copper, or equally hard metal, may be used without conduits or wood casing. The armouring or casing must be connected to earth. This rule has doubtless been framed to meet the extending use of unprotected armoured conductors of which "Stannos" wires are typical.

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Electricity Supply in Germany.—An article dealing with this subject by Mr. Meyer Coschütz appears in a recent issue of the "Elektrotechnische Zeitschrift." The author states that the change which has converted Germany from an agricultural into an industrial country has been accompanied by a rapid extension of the uses of electricity. Practically all towns of over 20,000 inhabitants are provided with electricity supply stations, and much attention is now being paid to various schemes for linking up rural districts. On the other hand, gas interests are very active, and the employment of gas has been considerably extended in places where the rates for electricity are high or complicated. The author considers that cheap and reliable electric cooking apparatus should be developed and the rates for energy used for this purpose reduced. To permit the electric light to be used by small consumers a flat rate should be charged.

Printing Telegraphy.—*Erratum.*—We regret that a slight error crept into our account of Major W. A. J. O'Meara's remarks on Mr. D. Murray's recent Institution Paper. On p. 168 of our last issue the word "feature" in the ninth line of Major O'Meara's remarks should be "feeder," the sentence, therefore, reading: "He (the speaker) entirely agreed that the telephone in the future would be a feeder of the telegraph system."

Entertainment by Long-Distance Telephone.—The "Electrical World" mentions that Mr. V. N. Bethell, president of the New York Telephone Co., entertained the Cliff Dwellers Club at his home in Montclair, N.J., on April 10, by means of speeches, music and recitations which came over the long-distance telephone from points in some cases thousands of miles distant. Performers were stationed at New York, Boston, Asbury Park, Washington, D. C., Detroit, Chicago and Denver. From Chicago Mr. W. D. Nesbit made a regular after-dinner speech, and from Detroit Mr. A. S. Hibbard, of the Chicago Telephone Co., sang a song. The feature by the fifteen participant was a reading which came over the wires a distance of about 2,000 miles with perfect clearness. The talking from Denver was over a phantom circuit made up of two pairs of copper No. 8 wires. The event was one of great interest to Mr. Bethell's guests, and was an exceptional demonstration of the comparative perfection now achieved by long-distance telephony.

An Interesting Generating Set.—"A rapidly increasing tendency," says the "Electrical Review and Western Electrician," towards combining auxiliary apparatus as much as possible in fewer sets of independent units is exemplified by a turbine set recently installed at the Easthampton cotton mills of the West Boylston Mfg. Co. This set consists of a 100-volt Behl generator furnishing direct current at 100 volts. The generator is direct driven by a 75 H.P. Terry steam turbine at 1,750 revs. per min. Beyond the generator, and mounted on the same bedplate with both the latter and the turbine, is an 8-in. centrifugal double-suction pump, which may be disconnected by means of a flexible coupling joining the generator and pump shafts. By operating the turbine 24 hours a day it is possible to obtain three different classes of service from this unit. Throughout the winter the pump, which has a capacity of 150 gallons per minute, furnished the hot water for heating the mill. The generator during the day is connected to the main bus bars for the main units which generate power for operation of the mill, and during the night it is switched over to the lighting circuit, so that it has approximately a 100 per cent. load factor. During the summer the pump is idle. Even the uses of the exhaust steam from the turbine vary at different seasons. During cold weather it is used for heating the water of the mill-heating system, while in warm weather it is changed over to the boiler feed-water-heater line."

Cable Interruptions.

	Date of Interruption.
Perm—Perm	July 8, 1909
[illegible]	April 20, 1910
[illegible]—Pelura	May 26, 1910
Torino-Arnoy	Sept 25, 1910

Electric Wiring and Lighting Equipment of Boston Stock Exchange.—According to the "Electrical World," a new board room is rapidly approaching completion for the Boston Stock Exchange, and electricity will play a prominent part in its service. Fifty-two telephone booths equipped with private wires have been installed, and an elaborate telautograph, telegraph, electric fan and lighting installation is also to be maintained. Although the wiring is concealed, there is to be easy access to every cable through concealed closets in the pillars which carry the principal circuits. The quotation boards are to be equipped for magnetic operation. In place of the present card racks the boards will be provided with magnetised surfaces, against which the board boys will place tin cards with iron backs. It is expected that much time will be saved by this arrangement. Elaborate provision is to be made for artificial electric ventilation and lighting, although the building is designed with a large glass dome, which will render the use of natural light much more common than in the present quarters of the Exchange.

"The Electrician"—Second Mining Issue.—*Errata.*—We regret that owing to the great pressure of work attendant on the preparation of this issue one or two errors have crept in. In the article on "Electric Winding in Collieries" Messrs. Crompton & Co. point out that the curve shown in Fig. 7 on p. 130 is likely to be misunderstood. The current and voltage curves refer to the secondary circuit of the motor generator and not to the main current. The current taken from the supply mains is not given, but it starts at a small value and assumes approximately the form of the kilowatt curve in the diagram. In the article on Messrs. Siemens' high-tension telephone on p. 181, Fig. 1 is a watertight mining telephone, the high-tension telephone with the protective apparatus being shown in Fig. 2. Fig. 4 is a diagram of the protective devices only and not of the telephone. We also regret that owing to extreme pressure on our space some interesting illustrations had to be omitted from the article on "The Phœnix Flame-Proof Motor." In the article on "Liquid Starters and Controllers," on p. 161 it should have been stated that Mr. T. R. H. Tetley's works are at Salford, not Leeds.

The Reliability of Tramway Service.—An indication of the efficiency of the tramcar operation in the New York metropolitan district is afforded by the monthly comparative reports of car defects, published by the Public Service Commission of First District and abstracted in the "Electrical World." The report for February shows that not one of the seven systems compared suffered through defects in car equipment more than 0·85 times per 1,000 car-miles operated, while one of them had only 0·17 times per 1,000 car-miles. A study of the figures brings out strongly the superior reliability of the overhead trolley over the conduit plough collector which the railways in Manhattan Borough are compelled to use. Thus 53·27 per cent. of the car defects reported by one conduit railway were due to ploughs alone, whereas the corresponding maximum of overhead current collector troubles was only 3·03 per cent. If the conduit railways had been operated by the overhead system their records would have approached, if not bettered, those of their fellow companies. Other items show wide differences. Thus motor troubles vary from 13·42 per cent. to 51·25 per cent., and car body troubles from 2·78 per cent. to 24·79 per cent. Of course, the widely different conditions of service have much to do with these variations. Taken all in all, our contemporary remarks, the small ratios of interruptions show what can be accomplished by a thorough going maintenance policy even in densely populated cities and in congested streets where the conditions of street railway operations are very arduous.

Trimming and Inspection of Arc Lamps in Philadelphia.—According to the "Electrical World," the trimming of the lamps on the newly-erected twin lamp poles in the centre of Philadelphia was a problem which was not solved until several arrangements had been considered. Finally, an electrically-driven tower waggon which could be operated from the upper platform was designed. This vehicle, weighing about

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3,250 lb., 2,600 lb. of which is due to the battery, is equipped with a 42-cell battery. This is sufficient to drive the waggon at 15 miles per hour on the level with a range of about 30 miles. The controller is mounted on the upper platform, and can be operated from either the upper or lower seat by a tube outside the steering shaft. The reversing mechanism is a Z-slot bushing keyed on the controller tube, which is worked from the upper seat by the foot and from the lower seat by the hand. The steering gear is mounted in the usual manner, and is worked from the upper or lower seat by a shaft which runs through the controller. The brakes can be worked from the lower seat by a foot lever in the usual manner and from the upper seat by a foot-lever, rod and crank. The upper foot lever has an extension, so that the operator can set the brakes from the top seat, climb down and release the brakes from the lower seat, or vice versa. The electric bell is operated from either the upper or lower seat by a floor push in the footboard. The platform is 13 ft. 6 in. from the ground, and an additional height can be secured by hanging a portable stand from the side rails, which will increase the height to either 14 ft. or 15 ft. 6 in., depending on which rail is used. This waggon enables a man to make his round in six instead of nine hours. The waggon is also used for inspection purposes at night, while the sentences "Use electric power" and "Use electric light," which are painted on its sides, give it some utility as an advertising medium.

Current Topics.

Subjects of current interest dealt with in this issue include the following:—

Mr. A. P. Trotter contributes an article on "The Nomenclature of Primary and Secondary Sources of Light."

Mr. D. C. M. Hume contributes an article on "The Electrical Equipment of a Modern Theatre."

Mr. A. Duckham contributes an article on "Transformer Oil."

At the meeting of the Institution of Electrical Engineers last night Mr. W. Aitken read a Paper on "Automatic Telephone Exchange Systems."

We give an account of the discussion that took place at the meeting of the Institution last week on Mr. H. J. S. Heather's Paper on "The Driving of Winding Engines by Induction Motors."

We also give an abstract of Mr. J. H. Reynolds' Paper on "Higher Technical Instruction," read at the recent Imperial Education Conference.

We give an abstract of a Paper by Mr. W. R. Cooper on "The Benkö Primary Battery and its Applications," accepted by the Institution of Electrical Engineers. The revival of the Primary Battery is discussed in our Leading Article.

This week has been notable for the annual meetings of a number of the leading submarine telegraph companies. The keynote of the chairmen of these meetings is the generally satisfactory trade outlook, the necessity for maintaining large reserve funds to meet probable capital requirements in the way of strengthening existing and laying new cables, and maintaining the stability of submarine telegraph stocks as a safe and reliable investment. The loyalty and efficiency of the staffs of the companies at home and abroad has received strong recognition on all hands.

The Coronation Exhibition at Shepherd's Bush was opened yesterday. We give a brief account of the exhibits of electrical interest in the Science Section, which is to be a more prominent feature than in the past.

Norwich Corporation have appointed a special committee to report upon the offer of the local tramways company to sell their undertaking to the Corporation.

Municipal Loans.—A Local Government Board inquiry was held last week at South Shields into the application of the Council for sanction to borrow £8,960 for additional plant, &c. The application was opposed by the local dock company, who wanted a supply of three-phase energy which they alleged could not be given by the Corporation.

An inquiry was also held at Rotherham into the application of the Corporation for permission to borrow money for extension of their electricity undertaking.

Parliamentary.—A Select Committee of the House of Lords have rejected the Matlock Rail-less Traction Bill and have decided to allow the Brighton, Hove & District Rail-less Traction Bill to proceed. The Malvern Bill, seeking similar powers, was withdrawn. The same Committee have this week been considering the Bill of Aberdare Urban Council for tramway and rail-less traction powers.

PERSONAL NOTES.

Mr. J. J. Steinitz is resigning his position as joint general manager of the Brush Electrical Engineering Co. to take up the post of general manager of the Gloucester Railway and Carriage Works, a change which will be to his material advantage. Mr. Steinitz is to be congratulated both on his new appointment, and on the fact that he only leaves the Brush Co. when it has reached a much improved position.

Mr. Dyer, shift engineer to the Barnes electricity undertaking, has resigned, in order to take up a position at Zanzibar.

APPOINTMENTS VACANT AND FILLED.

A telegraph inspector is required for the Bauchie Light Railway, in Northern Nigeria, for two tours, each of 12 months residential service. Salary £250, rising to £300 per annum by annual increments of £10. Applications at once to the Crown Agents for the Colonies, Whitehall-gardens, London, S.W. See an advertisement.

The Allmanna Svenska Aktienbolaget, Västerås, Sweden, require for their estimating department an electrical engineer with large experience in working out estimates for electrical schemes. See an advertisement.

The Electric Construction Co. advertise for a test bed assistant, experienced in testing all kinds of a.c and d.c. dynamos and motors.

A professor of chemistry is required for the University of Otago, Dunedin, N.Z., Salary £600. Particulars fron the High Commissioner for New Zealand, 13, Victoria-street, London, S.W., to whom applications by June 1.

A lecturer is required in the engineering department of the Borough Polytechnic Institute, Borough-road, S.E. Salary £150 to £180 rising to £250. Applications by May 24.

The Yorkshire Electric Power Co. advertise for a superintendent to undertake the control of the department engaged in laying underground and overhead mains, equipment of sub-stations, &c. Salary £250 per annum. Applications to the Company, Thornhill, Dewsbury

Messrs. Mather & Platt, Park Works, Manchester, are advertising for an engineer conversant with all details of the application of electricity to collieries, and paper and textile mills.

Messrs. Hazell, Watson & Viney (Ltd.) advertise for an electrician for their famous printing factory at Aylesbury.

Mr. S. H. Penning, distribution engineer at Woolwich, has been promoted to the position of assistant borough electrical engineer.

INSTITUTIONS AND SOCIETIES.

Institute of Metals.—On Friday last Dr. G. T. Beilby, F.R.S., delivered before the Institute of Metals a lecture on "The Hard and Soft States in Metals." He said that the hardening effect of cold working on ductile metals, and the softening effect of re-heating must have been known to the earliest workers in metals. To the inquiring mind, the phenomena were sufficiently explained as being due to the "compacting" effect of hammering and the "opening up" effect of heat. The advent of more scientific methods of inquiry led to the exposure of this fallacy, and to the discovery of new points of difference in a metal in the two states. The discovery that the polishing of all substances, even of those so hard or brittle as antimony or calcspar, involved the transient liquefaction of a thin layer on the surface, led to the study of this subject from an entirely new point of view. In a pure ductile metal, slowly cooled from the molten state, the structure of the solid was completely crystalline and the metal was in its softest condition. Any permanent deformation of the mass, whether by hammering, by rolling or by wire drawing, hardened and stiffened it. The microscopic examination of the hardened metal showed that its original crystalline structure had been broken up and replaced by a new type of structure. If the hardened metal were raised to a sufficient temperature the softness was completely restored and the crystalline structure was also restored. In the ductile metals the greatest degree of softness was always associated with well-developed crystallisation. The composite character of the hardened structure, which in some cases resembled a bed of broken and distorted strata concreted or cemen

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together by a matrix, could only be explained by the presence of two constituents, namely, the broken-down remains of crystals and an amorphous or glass-like form of the metal by which the mass was so firmly cemented together that it had become vastly more rigid and mechanically stable than the crystalline structure. This amorphous or vitreous form of the metal stood in the same relation to the crystalline form as glass did to the crystalline silicates of which it was composed, or as the clear vitreous "barley sugar" did to the ordinary crystals of the breakfast table. The pure ductile metals could not be obtained in the vitreous state by cooling because their molecules retained sufficient mobility to enable them to marshal themselves in crystalline formation for a range of about 800 deg. below the solidifying point. All the facts showed, however, that when deformation was produced by mechanically-induced flow, the solidification was so rapid that the solid which resulted was in the vitreous condition. The direct bearing of these researches on the obscure subject of molecular structure in solids was pointed out, and a "pulsation cell" hypothesis of the three states of matter was outlined. Prof. Quincke's "foam-cell" theory of solidification was referred to and was applied to the explanation of certain observations made by Prof. Carpenter some years ago. In view of the possible bearing of this theory on questions of foundry practice, it was suggested that the Institute of Metals might offer a prize for the best research on the subject.

Students' Section of the Institution of Electrical Engineers.—In the annual report of this section for the session 1910-1911 it is stated that there have been 10 meetings, the average attendance at which was 82. In addition to these, the Manchester students have held 5 meetings and the Glasgow students four meetings. The opening address was delivered by Mr. C. H. Wordingham, on "The Training of an Engineer," and eight other Papers were read and discussed. The quality of the discussions shows continual improvement, the average number taking part being eight. The committee is of opinion that this result, as well as the large increase in attendance, is to a large extent due to the fact that copies of the synopsis of each Paper have been sent to those members who attend regularly. The committee feels that even better results could be obtained by the provision of a printed abstract. There have been 14 meetings of the Committee, and sub-committees have been appointed to deal with various matters. A tour was arranged to take place in July, 1910, to visit works in the neighbourhood of Birmingham, but the visits were very poorly attended. A tour is being arranged for the summer of 1911 to visit places of engineering interest in Sweden. A preliminary circular has already been issued, and further particulars are now in preparation. Considerable correspondence has taken place between the Students' Committee and the local branches of the Students' Section at Manchester and Glasgow, the subject being the necessity for some alteration in the constitution of the Students' Section, especially in the relation between the Students' Committee, which sits in London, and the Local Students' Committees which sit at Manchester and Glasgow. Correspondence on this subject has also taken place between the Local Students' Committees and the Secretary of the Institution. The whole subject of the constitution of the Students' Section is now under the consideration of the Council. In presenting this report, the committee wishes to place on record its appreciation of the comfort and advantages afforded by the new premises. The committee feels that the improvement in the interest shown in the Students' Section is in no small measure due to these facilities, and expresses the hope that these improvements will continue.

Society of Engineers.—The annual dinner of this Society will be held at the Criterion Restaurant, on Saturday the 27th inst., at 6:30 p.m. Mr. F. G. Bloyd, the President, will be in the chair, and the guests will include Mr. Alex. Siemens, President of the Institution of Civil Engineers, Mr. E. B. Ellington, President of the Institution of Mechanical Engineers, Prof. C. V. Boys, F.R.S., Sir [illegible], F.R.S., and others.

Scottish Section of the Institution of Electrical Engineers.—The annual report of this section states that the past session has been remarkable by a large accession to their membership and by change of organisation. The suggestion by members of the Institution in Edinburgh and district that they should join the Glasgow Section, and that it should assume a title of wider territorial significance was cordially received by this committee. The further proposal to incorporate in this local section all the members of the Institution resident in Scotland was submitted by referendum to the whole of the members, and having obtained an almost unanimously favourable response, it was referred to and approved by the Council of the Institution, which also approved "The Scottish Local Section of the Institution of Electrical Engineers" as the new designation of the section. The Council of the Institution hopes, the report continues, and the committee believes, that the expansion of this local section which has been accomplished will benefit the whole Scottish membership and extend the usefulness and influence of the institution in Scotland. The Institution is the only one among the great scientific institutions of the country which provides the advantages of local section organisations to provincial members, and the greater the distance from the central institution the more pronounced are the advantages of local sections to the members concerned. The report shows that six meetings were held during the session, one being cancelled owing to the death of Mr. J. R. Barr. An annual dinner and a steamer excursion also took place. The membership has increased by 51 during the past session. The report concludes: "The committee during the past session has, through the chairman, had communications with the Council of the Institution regarding a number of matters affecting the local sections. The chief object of these was the closer relationship of the local sections, and specially of this section, with the corporate life of the institution. It was felt that in the past the arrangements as to the representation of this section on the Council in London did not fulfil their purpose of enabling us to take a useful part in the conduct of the affairs of the Institution, and our section has, so far as the deliberations of the Council in London are concerned, been in a position of isolation. Proposals relating to facilitating the attendance of local section representatives at the meetings of Council in London, and to other matters which your committee raised, were submitted to a specially arranged conference of the whole Council in London, to which the chairmen and hon. secretaries of all the local sections were invited. It is pleasant to record that all the proposals of the local sections were treated in the most sympathetic and considerate manner, and, subject to the interests of the institution as a whole, with the evident desire to remove such difficulties as the local sections have experienced. It is expected that the recommendations of the conference will be dealt with by the Council at an early date, after which fuller information will be communicated."

EDUCATIONAL NOTICE.

University of London.—A course of five advanced lectures on "The Application of Hyperbolic Functions to Electrical Engineering Problems," by Dr. A. E. Kennelly (of Harvard University), will be delivered in the Lecture Theatre of the Institution of Electrical Engineers on the 29th, 30th and 31st of May, and the 1st and 2nd of June, at 5:30 p.m. Admission is free by ticket to be obtained from Mr. P. F. Rowell, secretary to the Institution.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, May 19th (to-day)

ROYAL INSTITUTION.

3 p.m. Meeting at Albemarle-street. Discourse on "Recent Experiments with Invisible Light," by Prof. R. W. Wood.

TUESDAY, May 23rd.

FARADAY SOCIETY.

8 p.m. Meeting at the Institution of Electrical Engineers, Victoria Embankment, W.C. Papers on "Recent Advances in Gas Thermometry," by Dr. A. L. Day; "The High Temperature Equipment at the National Physical Laboratory," by Dr. J. A. Harker, F.R.S.; "The Boiling Points of Metals," by Mr. H. C. Greenwood and "The Behaviour of Salicci at High Temperatures," by Mr. A. Blackie. Communications will be read "On the Maintenance of Constant High Temperatures," by Prof. Bodenstein and on "Stellar Pyrometry," by M. Féry.

THURSDAY, May 25th.

ELECTRO-HARMONIC SOCIETY.

6:30 p.m. Annual General Meeting at the Institution of Electrical Engineers, Victoria Embankment.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Meeting at Victoria Embankment. Paper on "The Heating of Cables with Current," by Messrs. S. W. Melsom and H. C. Booth.

FRIDAY, May 26th.

PHYSICAL SOCIETY.

3 p.m. Visit to the National Physical Laboratory, Bushy House, Teddington.

INSTITUTION OF ELECTRICAL ENGINEERS.

4:30 p.m. Annual General Meeting at Victoria Embankment.

SATURDAY, May 27th.

ASSOCIATION OF ENGINEERS-IN-CHARGE.

9 a.m. Visit to the Works of the Cambridge Scientific Instrument Co., Cambridge.

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AUTOMATIC TELEPHONE EXCHANGE SYSTEMS.*

BY W. AITKEN.

Summary.—A description is first given of a switchboard designed by the author, in which the connection is made manually but disconnection is automatic. The full automatic telephone system of the Automatic Electric Co. is next described in detail. A comparison is finally made between the features of automatic and manual systems, and an estimate is made of the comparative cost of working.

In this country the development in the past has been almost entirely with manually operated switchboards. This type of switchboard has progressed from magneto-drop indicator and call-wire working, through various stages with mechanically and electrically restored indicators and branching jacks instead of series jacks, to the full common battery switchboard with parallel wiring and relays controlling lamp signals. From time to time automatic features have been introduced to simplify the operating, and thereby expedite the speed of connection. These automatic features have been principally introduced on the incoming junction switchboards which control the work between different exchanges in the same area, and where it is essential that the operating be of the very best. The insertion of the connecting plug into the jack of the line wanted, in addition to making the connection between the two lines, automatically cuts off the operator's testing circuit, introduces the supervisory signals, and in many cases connects up the ringing circuits so that the subscriber is automatically intermittently rung until he answers.

Keyless ringing incoming junction circuits have been designed both to expedite operating and facilitate maintenance. They allow of the number of incoming junction lines per operator being increased from 27 to 36, with actually less fatigue to the operator, and, by substituting a double make-and-break relay for the electromagnetic ringing key, the wiring of the circuits is greatly simplified and the cost per circuit reduced.

The British Insulated & Helsby Cables (*Ltd.*) have lately introduced small switchboards of my design, in which the connections are controlled by a rotary multi-contact electromagnetic switch, so that when a connection is made manually, it is held electrically and automatically disconnected, and all apparatus restored to the normal condition when the subscriber replaces the telephone receiver after a conversation. This will make the work from the private branch exchange to the central exchange much more positive, and prevent delays occurring at the central exchange due to slow operating at the private branch exchange. These boards are, primarily, designed for small exchanges where there is no regular attendant, say, up to 20 or 30 lines.

The multiple contact electromagnetic switch consists of a rotary selector arm which has an iron disc attached and is fitted over an electromagnet. The electromagnet sheath has the necessary groups of springs attached to connect with the number of extension lines required. Each group of springs is so arranged that when the rotary selector arm is depressed and the magnetic circuit closed, one set of springs breaks from inner ones, which disconnect the line indicator and battery of the extension line, and connect the extension line through to the exchange. The exchange speaking and holding key is linked up to the rotary switch in such a way that when the connection is completed by the rotary switch the holding key is automatically returned to the normal position. Fig. 1 shows the circuit for large boards.

Connector circuits are used, and these are the equivalent of cord circuits on ordinary boards. A relay is provided per line to cut off the local battery, when a connection is put through to the exchange, the electromagnet of the extension line then being in a local circuit; two plungers are depressed to complete a connection. As many connector circuits are provided as may be deemed necessary.

The operating is as follows: When a call is received from the exchange, the operator pulls over a speaking key and, at the same time, automatically restores the indicator shutter; after learning the requirements of the exchange the key is put to the holding position and the attendant rings the extension line wanted through the service switch, and after receiving a response moves the exchange multiple contact switch to 3 (if that is the number required) and depresses the key, when the current from the central exchange holds the electromagnet energised as long as the telephone is removed at the extension instrument. The winding of the electromagnet may be in series with the exchange line, and of 30 ohms resistance, and shunted by a condenser or non-inductive resistance of 70 ohms, so as not to interfere with the speaking efficiency. Instead of the switch electromagnet being placed directly in the line circuit, it may be replaced by a slow acting relay with the switch electromagnet connected in the local circuit. The advantage of this arrangement is that the switch-hook at the terminal station may be moved up and down to pulsate the lamp at the central exchange without disconnecting the circuit at the private branch exchange board. A second connection may thus be obtained through the central without the intervention of the private branch exchange operator. Where ringing current is supplied from the central exchange, the operating is improved by fitting a ringing key in connection with each extension line, so that the attendant, on receiving a demand from the exchange for an extension line, presses the ringing key and rings on the extension line until the line indicator shows a reply, and then moves the selector switch. This avoids the necessity of placing a holding coil across the exchange line whilst the operator is calling the extension.

The first full automatic switchboard used in this country was one patented by Mr. D. Sinclair, when engineer for the National Telephone Co., Glasgow, which was for single-wire circuits only, and was efficient for one junction line and five subscribers' lines. When a subscriber called, his indicator made contact with a sliding bar which connected the calling line to the junction line to the central exchange, and insulated all the other lines. A few of these were in use in Scotland for some time. Little more was done in connection with automatic telephony in this country—unless we take notice of exhibits made by Messrs. L. M. Ericsson of small automatic switchboards, which were in use in Sweden—until Mr. A. M. T. Thomson put forward his semi-automatic system, which was on exhibition for some time at the General Electric Co.'s premises about 1901.

In this system the number required was built up on the instrument and sent in to the exchange as a series of impulses which actuated an electromagnetic counter device which caused the number to be shown in front of the operator. The operator had no telephone, and mechanically, by the usual plugs and cords, connected the subscriber calling with the number revealed. The transfer system of working was adopted so as to save the multiple of the switchboard, and great claims were made for excessively speedy operating, but the system was never put into actual use.

In other countries, particularly in America, automatic systems have been put forward from time to time. In the early days there was the Strowger, Faller, and the Callander systems, and later, we find the Lorimer, the American Automatic Co., and others, but the only system that has *obtained* commercial success and has been introduced on a large scale is what was formerly known as the Strowger system, greatly improved by Keith, and others, and now known as the Automatic Electric Co.'s system.

Most of the leading telephone manufacturers are now busy developing automatic systems, but, practically, there is only one system in common everyday use—that of the Automatic Electric Co., of Chicago. It is claimed by this Company that there are 300,000 telephones working on their system, San Francisco, Oaklands, Los Angeles, Columbus, Grand Rapids, and Chicago, being among the largest installations. San Francisco and Los Angeles are both laid out on a basis of 100,000 lines. The former has already four exchanges with three at Oaklands, across the bay, most of them of 10,000-line capacity. Los Angeles has six main and four branch exchanges equipped for 25,700 lines. These exchanges are on the common battery system. The Chicago system is just being brought into use, and is said to be suitable for 1,000,000 lines.

The greater number of exchanges are on what is known as the three-wire system, the signalling being over the two wires alternately with earth return, but in San Francisco, and other later exchanges all signalling is effected by the intermittent opening of the circuit at the subscriber's instrument. This has greatly simplified the subscriber's instrument. All the facilities given on a manual exchange are now repeated on the automatic, and in some instances with a greater degree of flexibility. In a cosmopolitan city the advantage seems to be with the automatic as regards operating by the public.

The objection is commonly urged that the subscriber cannot be trusted to operate the switch correctly, and that he should not do more than lift and replace the receiver, all operating being done by a trained staff. This opinion, I think, is only held by a few enthusiasts now.

The author proceeds to describe the subscriber's instrument, the connector switch, the selector switch and line switch of the Strowger type as used by the Automatic Electric Co.* In the three-wire system the dial of the subscriber's instrument, as it revolv

* Abstract of a Paper read before the Institution of Electrical Engineers.

* These apparatus were described and illustrated in a Paper by Lee Campbell read before the American Institute of Electrical Engineers and of which an abstract was given in THE ELECTRICIAN of February 24 and March 4, 1910; and also in Sir John Gavey's "James Forrest" lecture (*see* THE ELECTRICIAN, July 1, 1910, p. 467).

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intermittently earths one or other of the wires, and thus completing a circuit from a central battery causes step-by-step electromagnetic mechanism to perform certain functions. In the later system these functions are now performed by the dial simply intermittently opening the circuit which has been completed by lifting the receiver.

In the two-wire system the mechanism is very similar to that of the three-wire, but the electromagnets or relays controlling these are different. Advantage is taken of the slow-acting characteristic of relays having a mass of copper attached, so that two relays in series are actuated by the first completion of the circuit, but only one responds to the dial impulses.

The three relays of the line switch are now combined, in a most ingenious manner, into one having three armatures. The two-wire circuits of a 1,000-line exchange connection are shown in Fig. 2. The system of registering calls when the wanted subscriber answers is shown, and it will be noticed that the connection circuits are considerably complicated thereby.

When a receiver is removed to initiate a call—

1. A circuit is completed from earth 1, springs 2 and 3, line 4, receiver R, microphone M, line 5, springs 6 and 7, winding 8, springs 9 and 10 of master switch relay to battery. Armature 11 is pulled up and

2. Completes a circuit from earth 1, springs 2 and 12, through windings 13 and 14 to battery, and armatures 15 and 16 are attracted.

3. Armature 15 causes springs 3 and 6 to break contact from springs 2 and 7 and cuts the winding 8 from line. (The armature 11 is, however, momentarily retained by winding 14 until another

8. Relay 27 also puts earth on the wire 28 to the private bank to engage the line.

9. When the plunger 20 enters the group of springs 21, a circuit is also completed from earth by the contact *c* through the master switch bank contact 32, by bridge 33 to common connector 34, relay winding 35 to battery. All line plungers are, therefore, rotated to the next disengaged contact or junction by the relay 35 attracting its armature and allowing a spring (motor controlled) to revolve the shaft. Battery is also cut off all lines at springs 9 and 10, so that no call can be made whilst the shaft is rotating.

10. By the removal of the receiver only a subscriber's line has, therefore, been extended to a first selector by a junction line pre-selected; the line switch has been cut off the line circuit and is retained operated in a local circuit; one coil of the meter remains (for the present) in circuit in one wire; the calling line has had an engaging current connected to the private bank; the master switch has carried all the line switches of a group opposite the next junction to a first selector. The circuit is now ready for the dial impulses.

11. Suppose the number wanted to be 734. With the finger in hole 7 the dial is revolved to the stop and the circuit at the instrument is opened 7 times. The selector line relay 26 is de-energised momentarily 7 times. The release relay 27 is slow acting and does not de-energise.

12. Relay 26, therefore, completes a circuit 7 times from earth on middle spring, under contact, through lower back contact on relay 27, line 37, through winding of private magnet relay 37 (which is slow

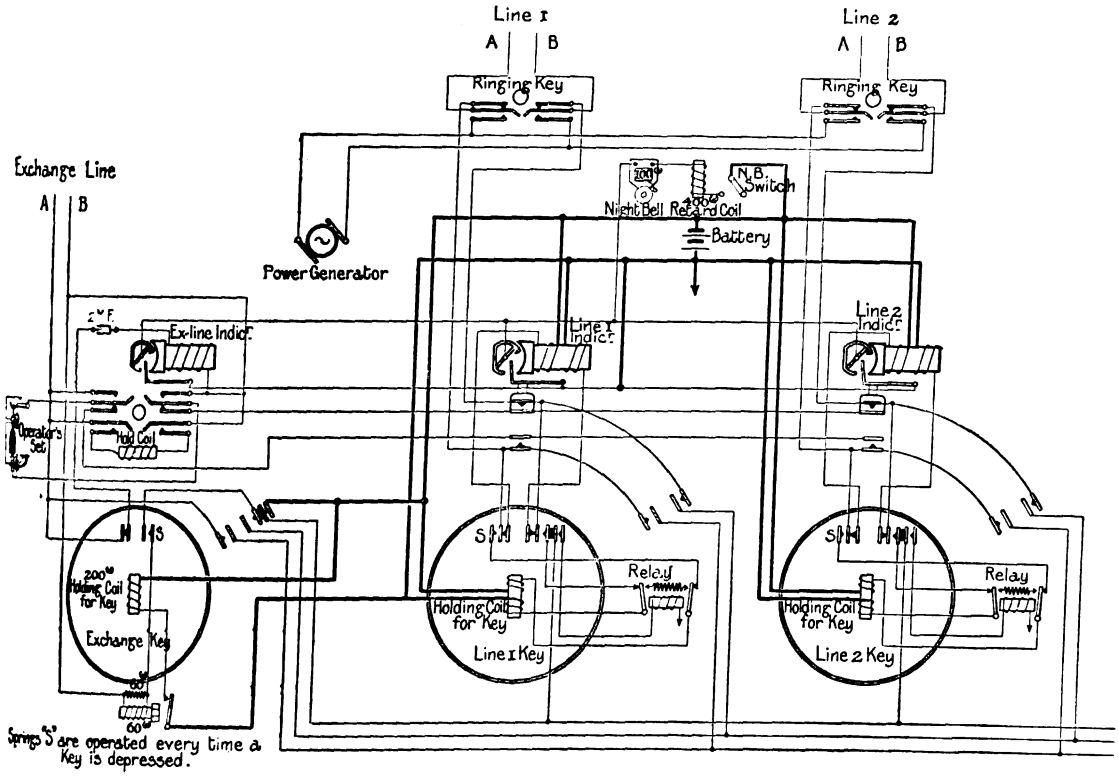

FIG. 1.—DIAGRAM OF COMMON BATTERY AUTOMATIC DISCONNECTING CORDLESS SWITCHBOARD FOR EXCHANGE SERVICE, WITH CONNECTOR CIRCUITS AND RELAYS.

...uit is completed, when armature 16 short-circuits winding 14 by ...tact 17 and 18.) Armature 16 carries the plunger 20, which ...cally engages with the moving vertical bar. When armature ... is attracted, therefore, the plunger 20 is forced forward until the ...rtical disc, passing between the springs in the bank, causes them ... make the contacts shown at 21.

4. Line 4 is then extended by contacts *d* of bank springs 21 and by ...ntact of side switch 25, through one winding of selector line relay ... to earth. Line 5 is extended through meter winding 27, contact ... of bank springs 21, through contact *a* of side switch 22, through ...other winding of line relay 26 to battery, and the line relay is energised.

5. This in turn closes the circuit through the guarding relay 27, which energising

6. Completes a circuit from earth 28, through upper contact of relay 27, contact *b* of bank springs 21, winding 29 of line switch magnet to battery, and this circuit maintains the line switch energised after winding 14 has been short-circuited.

7. Relay 27 also completes a circuit by line 28 through contact *b* of bank springs 21, through meter winding 30, contact 31, spring 17, and contact 18 of line switch to battery. As current is then through both windings in opposite directions the meter is not actuated.

acting and, therefore, remains energised after the first impulse), through winding of vertical magnet 38, through side switch 23 by contact *a* to battery. The vertical shaft therefore lifts the wipers to the seventh bank level.

13. Private magnet relay 37 when energised, by its springs, completes a circuit through the private magnet 41. The private magnet relay 37 de-energises after the seventh impulse, in turn de-energises the private magnet 41, and allows the side switches to pass to the second position, when

14. Another circuit is completed from earth 36, contact springs and winding of rotary magnet 39, through winding of guarding relay 40, through side switch 23 by contact *b* to battery. The wiper shaft is, therefore, rotated one step, and the wipers come to rest if that connector line is free. The rotary magnet 39 closes mechanically the armature of the private magnet 41 and also opens the circuit as shown at 39 by separating the springs. The armature of 39, therefore, falls back and the armature of the private magnet 41 also, and allows the side switches to pass to the third position.

15. If, however, the first connector circuit on that level is engaged, a circuit will be completed from earth through *b* wiper line 24, through side switch 24 by contact *b*, through private magnet 41 to

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battery. The armature of private magnet 41 therefore remains attracted. The armature of the rotary magnet 39 is re-attracted and continues vibrating, at the same time moving the wiper *b* from contact to contact until a free line is obtained, when the private magnet 41 armature falls back and allows the side switch to pass to the third or c position.

16. The calling subscribers' lines (wires 4 and 5) are then connected to the selector wipers *a* and *c*; all selector electromagnets are cut off the line circuit, and the apparatus is maintained in the through position by the wiper *b* completing a circuit from earth through wire 24, side switch 24 by contact *c*, under contact of relay 40, line 27, through winding of release relay 27 to battery.

17. When the selector wipers *a* and *c* make contact with the line tabs on the bank the wires 5 and 4 are extended through the two windings of relay 42 to battery and earth, and this relay is immediately energised as the circuit is completed through the calling instrument. The wire 4 is extended by line switch bank 21, contact *d*, side switch 25 in *c* position, wiper *c*, line 4 and 4*a* bottom contact of relay 43, lower winding of relay 42 to side switch 47 by contact *a* to earth. The wire 5 by line switch bank 21, contact *a*, side switch 22 in *c* position to wiper *a*, by upper under contact of relay 43 to upper winding of relay 42 to battery.

18. Relay 42, when energised, completes a circuit from earth by back contact, through winding of relay 49 to battery.

19. Relay 49 completes the retaining circuit (relay 27) to earth from wiper *b* of selector, through upper back contact of relay 49 to side switch 45 by contact *a* to earth. Relay 49 is slow acting and does not de-energise when impulses are sent through relay 42.

20. No. 734 is being called, and so far the seven impulses have only been sent. The finger is now placed over figure 3 and the dial revolved, and the circuit at the instrument is opened three times, and the relay 42 pulsates three times.

21. A circuit is completed three times from earth by under contact of relay 42, back contact of lower group of springs, relay 49, line 50, through winding of P.M. relay 50, winding of vertical magnet 51, side switch 44 by contact *a* to battery. The vertical magnet, therefore, lifts the shaft with the wipers to the third bank level.

22. At the same time P.M. relay 50 has been energised and completed a circuit from earth by back contact of relay 50, through winding of P.M. 54 to battery, and P.M. has been actuated and has opened the line circuit.

23. Relay 42 remains energised and the circuit of the private magnet relay 50 is, therefore, broken; the private magnet 54 circuit is likewise broken, and it returns to normal, allowing the side switches to pass to the second position.

24. The finger is then placed in the hole over the figure 4 (the last figure of the number 734) and the dial revolved. Relay 42 is again actuated four times, completing a circuit four times from earth, by back contact of relay 42, back contact of lower group of springs 49, winding 50 of private magnet, outside under contact of relay 52, rotary magnet 53, side switch 44 by contact *b* to battery. The rotary magnet 53, therefore, moves the wipers to the fourth group of springs of the connector. P.M. relay 50 again de-energises, and if the line wanted is idle, the private magnet 54 is also de-energised and allows the side switch to pass to the third position.

25. The wire 4 of the calling line is then joined through condenser 65, under contact of relay 55, side switch 48 by contact *c*, to wiper *f* and one side of the called line; and wire 5 of the calling line by condenser 66, the contact of P.M. 54, and the upper under contact of relay 55 to the wiper *d* to the other wire of the called line, and a guarding potential or engaged test is placed on the line called at wiper *e*, from earth at side switch 46 by contact *c*, wiper *e*, winding 56 of line switch of called line to battery.

26. The line switch is energised, the armature 57 being attracted, and the circuit completed from wiper *d* by line 62 to the telephone, and the line switch coils cut off from the line called.

27. The side switch 44 in the third position completes a circuit

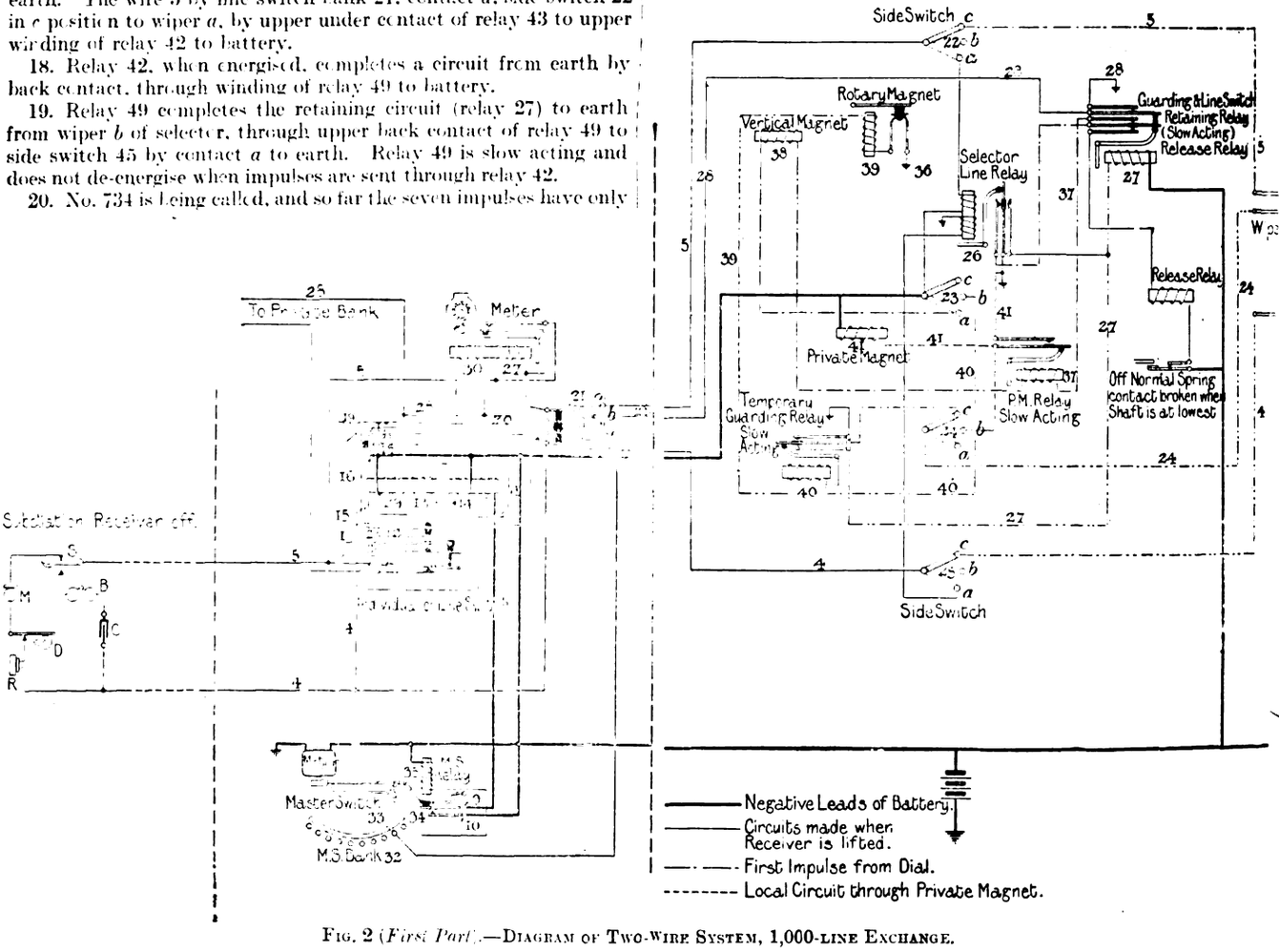

FIG. 2 (*First Part*).—DIAGRAM OF TWO-WIRE SYSTEM, 1,000-LINE EXCHANGE.

28. Relay 55 cuts off the calling line and intermittently connects the called line to the ringing generator 59.

29. When the receiver is lifted to answer, a circuit is completed from earth through side switch 46, by contact *c*, lower winding of relay 60, lower under contact of relay 55, side switch 48 by contact *c*, to wiper *f*, line 61, receiver R^1 and microphone M^1, switch hook upper contact, line 62, outer contact of line switch, wiper *d*, outer under contact of relay 55, contact of relay 54, to upper winding of relay 60, side switch 44 by contact *c* to battery. Relay 60 is, therefore, connected in bridge across the called line and is energised, and current is fed through the windings for the microphone M^1.

30. Relay 60 completes a circuit from earth through side switch 46 by contact *c*, relay winding 43, line 43, left-hand contact of relay 60 to battery. Relay 43 is energised, and a retaining circuit is then completed from winding 43, through middle upper contact of relay 43 through side switch 44 by contact *c* to battery.

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31. Another circuit is completed by relay 60, from earth by side switch 46 by contact *c*, line 60, line 63, through right-hand back contact of relay 60, to side switch 47 by contact *c*, to lower winding of relay 42, so that the resistance of relay winding 63 is cut out of circuit.

32. Relay 43 when actuated as described in 29 reverses the connections between the called line and relay 42, the circuit now being from earth at side switch 46 by contact *c*, back contact of relay 60, side switch 47 by contact *c*, lower winding of relay 42, outer upper contact of relay 43, to the *a* wiper of the selector, line 5, through calling instrument, back by line 4 and *c* wiper of selector, lower upper contact of relay 43, to upper winding of relay 42, to battery.

33. It will be remembered that current is through both windings 30 and 27 of the meter, but in such directions that they neutralise. The reversal of the current by relay 43 now causes this to actuate and register. The meter contact closing short-circuits the winding 27 and the meter is retained in the energised position by the local wind-

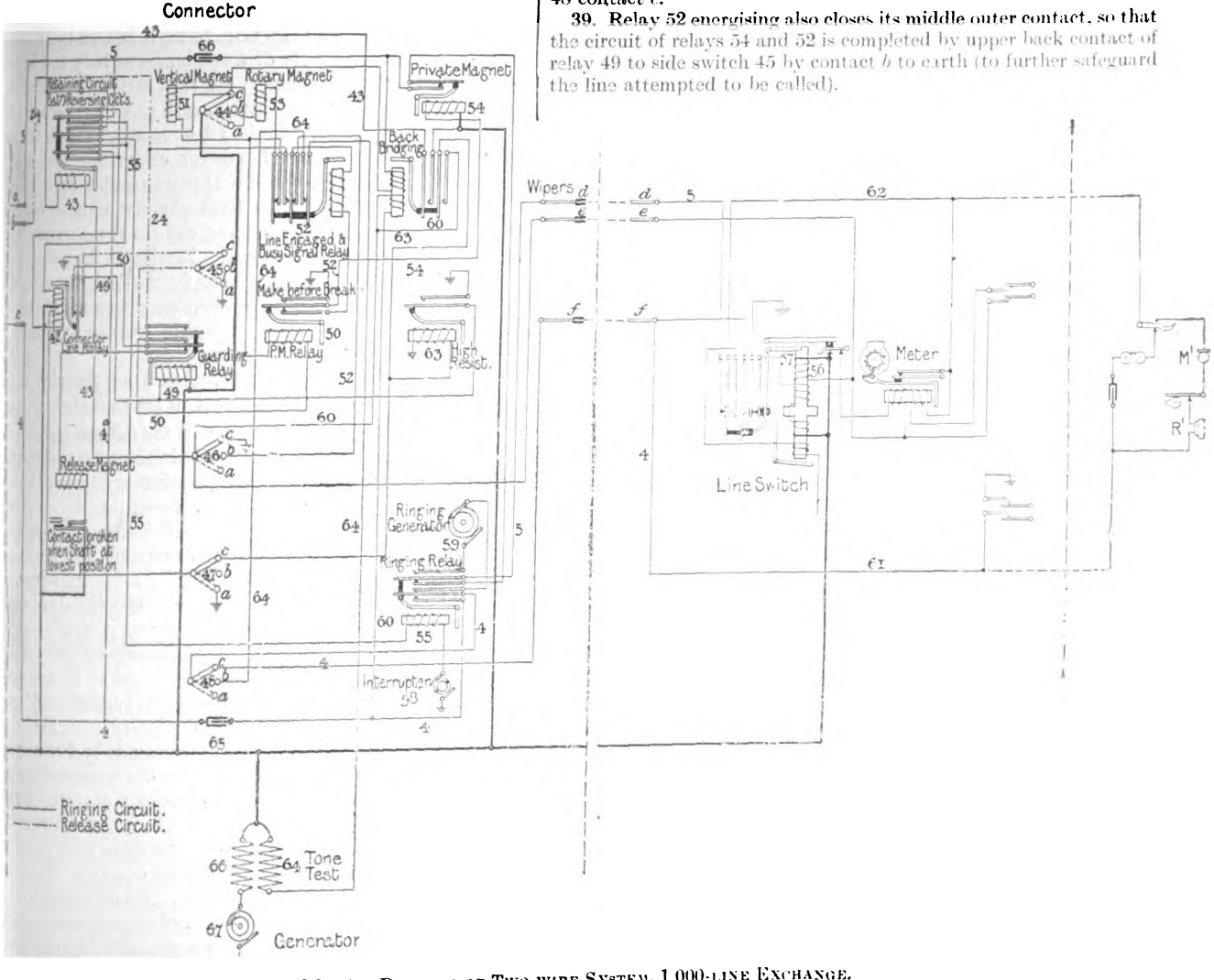

FIG. 2 (*Second Part*).—DIAGRAM OF TWO-WIRE SYSTEM, 1,000-LINE EXCHANGE.

ing 30. No action of either of the subscribers, therefore, can cause it to operate more than once.

34. Relay 63 is used in semi-automatic systems. Being first connected in series with the lower winding of relay 42 and then shunted by relay 60, additional current is sent to line, which may be utilised to operate a supervisory signal on a cord circuit. Being of considerable resistance, and to prevent trouble should relay 42 fail to act, the earth on back contact keeps relay 49 actuated.

35. When conversation is finished and the circuit opened by replacing the calling subscriber's receiver, relay 42 is de-energised. This opens the circuit of relay 49 of the connector and relay 27 of the selector, and both complete a circuit through the associated release magnet. The former from earth and under contact of relay 42, under contact of relay 49, through release magnet winding and contact to battery. The latter from earth and under contact of relay 26 to under contact of relay 27, through release magnet winding and contact to battery. The release magnets attract the dogs and thereby release the wiper shafts which are revolved by the controlling springs, until they fall by gravity to the normal position. In this position the release magnet contacts are open and cut off the battery. All circuits are broken and apparatus returned to normal position for calling.

36. Should the line called for be engaged there will be a guarding potential on the private bank of the connector. This circuit in the connection just described is from earth as side switch 46 at contact *c*, to wiper *e*, through winding 56 of individual switch, to battery.

37. Another connector wiper now making connection with the same line by a multipled bank contact will complete a circuit from earth by side switch 46 (contact *c*), wiper and bank contact *e* of the engaged line, contact bank and wiper e^1, side switch 46^1 by contact *b*, middle under contact and winding of relay 52^1, under contact of P.M. relay 50^1 (lines 52 and 54), private magnet winding 54^1 to battery, all on connector of the line attempting to call the circuit already engaged.

38. With the result that the private magnet 54 opens the circuit of the calling line, the other wire from wiper *f* is open at the side switch 48 contact *c*.

39. Relay 52 energising also closes its middle outer contact, so that the circuit of relays 54 and 52 is completed by upper back contact of relay 49 to side switch 45 by contact *b* to earth (to further safeguard the line attempted to be called).

40. The contact nearest the winding of relay 52 is also closed, and a circuit is completed from the secondary circuit of the busy signal machine 64, line 64, make contact of relay 52, side switch 48, by contact *b*, bottom under contact of relay 55, through condenser 65 over wire 4 and through calling instrument, and back by wire 5 to outer under contact of relay 43, upper winding of relay 42, and by common battery lead to the busy signal secondary winding.

41. The busy machine primary circuit 66 is from earth through interrupter 67, winding 66, through battery to earth.

42. When the receiver is replaced after the busy signal is heard all apparatus is returned to the normal condition.

43. If the line with which connection is desired originated the call, the engaging circuit will be from the selector earth 28, upper outer contact of relay 27, contact *a* of line switch bank, winding 29 of line switch to battery, with a branch to the private bank contact.

When an exchange is over 1,000 and up to 10,000 lines, a second selector is added. When a capacity of 100,000 lines is required, a third selector is used, and so on.

(*To be continued.*)

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THE NOMENCLATURE OF PRIMARY AND SECONDARY SOURCES OF LIGHT.

BY A. P. TROTTER.

It is highly important that the terms used in optical science should be carefully defined, and it is equally essential that those employed in illuminating engineering should be clearly agreed upon. As in mechanical and electrical work, the scientific and the engineering vocabulary may differ slightly, and the mode of measuring the quantities may not be the same. But there must be *no* doubt of the meaning of any term.

The vocabulary at our disposal is so large that there is no need for coining new terms; on the contrary, some words may, perhaps, be excluded from scientific literature. Mr. Haydn Harrison has done well to call attention in his Paper read before the Illuminating Engineering Society* to illuminating units and their definitions, and those who do not altogether agree with him will appreciate the opportunity which is afforded for discussing the subject.

"The emanations from a light source" is too wide a definition of *light*. "Radiant light," wrote Lord Kelvin,† "is light if we see it: it is not light if we do not see it." *Light* is, I think, sufficiently defined as "visible radiation." I cannot agree with Mr. Harrison in coupling *luminosity* and *luminous intensity*. *Luminous intensity* should be the second quantity to be defined. As a matter of fact, the expression, though generally used in France, is seldom found in English, because we prefer the term *candle-power*. There are several ways of defining this quantity, but as there is no dispute about its meaning I will not stop to consider them.

The third quantity to be defined is *illumination*. "Remuneration," defined according to Mr. Harrison, would be "the extent to which anybody is remunerated." This is undeniable, but does not carry an engineer much further. In making definitions it is sometimes well to define the abstract idea independently of the measurable quantity. *Illumination* might perhaps be defined simply as the reception of light on a surface. This prepares us for similar definitions of the correlative idea of *brilliance*. The idea having been defined, a good quantitative definition of the British unit of illumination is "the illumination produced by one candle-power at a distance of 1 ft. on a surface facing the source of light."

Such a definition does not appeal to the mathematical mind. Dr. Rosa says‡ that illumination is the flux-density or flux per unit area on the surface where the luminous flux is received, and gives us the unit, lumens/cm^2. Blondel in 1894,§ in his valuable article on "Photometric Magnitudes and Units," gives a quantitative definition. "The illumination (*éclairement*) e at a point of a surface is equal to the ratio of the luminous flux which falls on a small element of surface to the area of this surface, $e = d\Phi/ds$." or "the illumination produced on a surface of 1 sq. metre by a uniform flux of the lumen." These are not quite the kind of definitions one would offer to a borough engineer for street work. They are rather like measuring rainfall as the ratio of the grammes of water to the area in square centimetres. The lumen is a valuable unit, but I do not think that English engineers are quite ready for it.

The idea connoted by the four terms *brilliancy*, *brilliance*, *intrinsic brilliance* and *brightness* is broadly the same, and is the emission of light from a surface. I am inclined to drop the simple term brilliance or brilliancy as a scientific unit, just as Blondel dropped *clarté*, and to use *brilliance* only in connection with *intrinsic brilliance*, which is the emission of light per unit surface. Quantitatively it is the candle-power per square inch or square centimetre. The mathematician who always spies 4π lurking in the background will prefer *lumens* or *millilumens* per square centimetre. Neither Blondel, Rosa nor Carl Hering draw any distinction between brilliancy of emission and brilliancy or brightness due to reflection. L. Weber, on the other hand, has suggested the distinction, and Mr. Harrison follows him. Abney proposed the term *luminosity* for "brightness resulting from illumination," but he uses it in discussing the brightness of different parts of the spectrum, and does not confine it strictly to reflected light. Rosa, in the Paper referred to, does not mention *brilliance* or *intrinsic brilliance*, but deals with *specific radiation* or *flux-density of radiation*. He uses "*brightness*" and "*surface brightness*," both in connection with a source of light and with the diffuse reflection from an illuminated body, and says that "brightness can refer equally to luminous sources of relatively high specific intensity or to reflecting and radiating sources of low intensities." But a "reflecting source" does not seem to be a good expression. He objects to the use by Blondel and others of e for illumination and radiation, as that gives rise to confusion.

The word "*surface-brightness*," which has been recently introduced in this country, appears to be a literal translation of "*flachenhelle*," and this term seems to be used by Liebenthal both for the brightness of a self-luminous body and for that of an illuminated surface. He says that each element of a glowing body, or, more shortly, each glowing surface-element, has the same *flachenhelle* in all directions,* and in the next paragraph he describes Lambert's observation that a white wall illuminated by the sun appears sensibly equally bright in whatever direction and from whatever distance one looks at it, . . . the *flachenhelle* of an element of the surface is constant at all angles of emission." Lambert in this passage† used *claritas*, a term which he used also for the brightness of a source. He insisted on the distinction between *illuminatio* and *claritas*, but in one or two places refers to *splendor*, apparently for the brightness of a self-luminous body.

Liebenthal seems to use *helligkeit* for the physiological effect on the retina proportional to the *flächenhelle*.

Blondel uses *éclat intrinsique* for the *intrinsic brilliance* of a self-luminous body as well as for the brightness of an illuminated object, and on page 265 of the "Illuminating Engineer" for April protests against any distinction between the two.

The term *luminosity*, having been defined by a high authority, has taken its place in scientific literature, but illuminating engineering is not quite the same thing as physical science. In electrical science we speak of difference of potential and electromotive force, in electrical engineering we speak of pressure or volts. The British public will probably prefer and will more readily understand *brightness* as measured by the new instruments invented by Dow and Mackinney, Edgcumbe and Trezise.

A difficulty in making the distinction recommended by L. Weber and by Harrison and objected to by Blondel is that the intrinsic brilliance or brightness of a translucent shade of opal or ground glass or of silk or paper, is due partly to transmission and partly to reflection. The fact that there are two different ways of measuring or of regarding these magnitudes does not make them separate physical quantities. Electricians are familiar with such magnitudes. A foot-pound is a unit of energy; it is also a unit of work; and it is sometimes convenient to regard it as 0·0018 horse-power-second. An ampere may be measured by volts per ohm., watts per volt, or coulombs per second, as is convenient; and we measure watts as volt-amperes, as C^2R, or as joules per second.

The obvious way of measuring intrinsic brilliance is to take the candle-power emitted per unit area. Luminosity, that is, brightness resulting from reflection, may be measured in the same manner, and from one point of view it is, therefore, the same physical quantity as intrinsic brilliance. The alternative to measuring luminosity by candle-power reflected per unit area is to assume a relation between the reflecting power of the substance and that of an ideal perfectly white and perfectly matt or unpolished material. An area of π square feet of such a material receiving an illumination of one foot-candle, or an area of one square foot receiving a uniform illumination of π foot candles, reflects one candle-power normally, and has a hemispherical candle-power of one-half candle. The experimental difficulty is the illumination of a surface of moderate size to give a measurable candle-power at a distance great

* THE ELECTRICIAN, May 5, 1911, p. 126.
† "Popular Lectures and Addresses," I., 291.
‡ "Bulletin," Bureau of Standards, Washington, VI., 546.
§ "La Lumière Electrique," Sept., and THE ELECTRICIAN, XXXIII., 634.

* "Praktische Photometrie," 77.
† "Photometria," p. 42.

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enough to comply with the law of inverse squares, say 6 or 8 times the greatest dimensions of the surface. Dr. Sumpner has done this* and has found to what extent various substances and coloured papers fall short of perfect whiteness, or unit albedo, as Lambert and modern astronomers call it. He found that white blotting paper reflected 82 per cent. It might be possible to equal this with white cardboard, but there is likelihood of error due to glaze. Compressed magnesia or barium sulphate has a high albedo and good diffusion, but Dr. Sumpner's careful test of the easily obtained material white blotting paper gives a valuable standard. The British unit of luminosity would be the luminosity of white blotting paper illuminated by 1/0·82, or 1·22 foot-candle. A circle of 1 ft. radius of the projected area of a globe of 1 ft. radius has an area of π sq. ft. A milk-white globe of translucent material of 1 ft. radius, having a light within it, and emitting 1 candle power in all directions, would be indistinguishable from a reflecting disc of white blotting paper of 1 ft. radius illuminated by 1·22 foot-candle. The intrinsic brilliance of the former would be identical with the luminosity of the latter. It is on this ground that I see no necessity for making a distinction. The luminosity of each would be that of a disc of unit albedo illuminated by 1 foot-candle.

I observe that Blondel considers that intrinsic brilliancy should be measured in the direction of maximum intensity. I am not aware that the intrinsic brilliancy of self-luminous vapours differs at different angles, though this is the case with all diffusively reflecting material that I have examined. I think it a pity to adopt white blotting paper or any other material as a standard. It is better to determine the absolute albedo, and this may be found with sufficient accuracy for ordinary purposes by assuming Dr. Sumpner's value 0·82, and comparing other materials with it.

Mr. Harrison has used the Whitman sector in exactly the same way and for the same purpose that Whitman did in 1892, namely for an investigation into the luminosity of papers coloured with various pigments. This led, two years later,‡ to the invention of the flicker photometer.

A NEW TYPE OF ELECTRIC FURNACE.§

BY CARL HERING.

The author devised some years ago the following method to make use of the force experienced in the "pinch phenomenon." Let Fig. 1 represent the cross-section of a cylindrical conductor; the "pinch" forces will then tend to act radially as shown by the arrows. If now the conductor be made to be a vertical column of liquid as, for instance, the part marked "resistor" in Fig. 2, consisting of a hole in a non-conducting material closed at the bottom by the electrode and filled with the liquid, then these forces will act horizontally and perpendicularly to the axis along the whole length. If the text-books are correct in saying "like currents attract," the mutual attractions of the parallel elemental currents in such a conductor would simply increase the current density in the centre. But, as the writer has repeatedly pointed out, this attracting force acts not on the currents alone, but on the material constituting the conductor, hence a suction would be created near the periphery and a pressure at the centre. However, these radial forces should in turn cause corresponding vertical forces at the centre and at the periphery, thereby producing a veritable fountain, as shown in Fig. 2, the liquid flowing up at the centre and down at the periphery, as indicated by the arrows; further, the direction of this hydraulic flow is independent of the direction of the electric current, and hence it is the same for direct or alternating currents. This fountain action was predicted by theory; experiment test showed that the prediction, and hence the theory, was correct; the forces and the consequent squirting turned out to be considerably stronger than was hoped for. It, in fact, constitutes a true valveless electromagnetic pump.‖

It will readily be seen that this new phenomenon, which was colloquially named the "squirt phenomenon," is admirably adapted to be made the basis of a liquid resistor furnace. If such a column is made the resistor in which the heat is generated by passing the current through it by means of an electrode at the bottom, the heated liquid will be rapidly expelled and forced to the top against the blanket of slag, while the cooler liquid at the bottom will be sucked down into the hole near the circumference to be in turn heated and immediately expelled with considerable force. With energetic circulation through the resistors, the fatal objections to the use of liquid resistors could be overcome.

In practice one would naturally use two holes, one for each electrode, as that reduces the depth of the hole to one-half. The proportions of the hole—that is, the ratio of the section to the length—are, of course, determined by the resistivity of the material, the amount of heat to be generated, and the relation of the volts to the amperes; the actual dimensions are therefore still a matter of choice. The ejecting force, or "squirting force," increases with the square of the current and diminishes as the cross-section increases. It will be seen therefore that there is some choice left as to the dimensions of these "flowing resistors," as they might appropriately be called.

In most materials there is apparently a very rapid rise of resistivity with the temperature, which is very favourable to the proportions of such resistors, as is also the apparently very rapid increase of the specific heat of iron at the higher temperatures. An analytical investigation of the relations of the various factors which determine the dimensions reveals some interesting and unexpected results. (These will be described in a subsequent Paper.)

The advantages of a furnace based on this principle are numerous. It is ideally simple and cheap, consisting merely of a crucible or hearth with two suitable holes in the bottom plugged with the electrodes. The heat is generated in the material itself, which is just

FIG. 1.

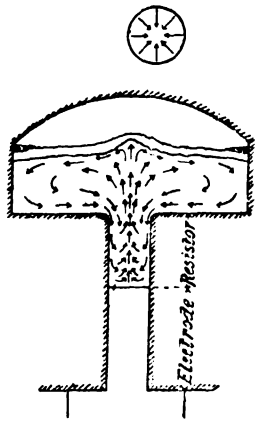

FIG. 2.

where it is wanted: moreover it is generated in the most rational place, namely, at the bottom and not on the top surface; it is conveyed and distributed mechanically, so to speak, throughout the melted mass, and this conveyance of heat is immensely more rapid than it would be by mere conduction or by the slow flow due to differences of density; hence a charge is treated and finished rapidly, whereby the output of the furnace per day is increased and the losses of heat per ton are proportionately reduced. As far as is known now, there is no temperature limit except that of the failure of the refractory lining, as the pinch effect can no longer limit the temperature.

This very active agitation and circulation of the liquid mixes the product rapidly with any of the refining ingredients which may be added, and tends to make the product very homogeneous. Every particle of the liquid is in turn, and repeatedly, brought to the surface where mechanically suspended impurities and gas bubbles are expelled and forced into the slag, and where the metal is exposed to the chemical action of the slag, which is so desirable and important in the refining of steel. Other advantages lie in the fact that the electrodes are very cheap, are not consumed, and as they may be made of metal they are far more economical in energy loss than carbon or graphite would be. No moving and adjusting of the electrodes are required. The interior of the furnace may be made as small as the quantity of the material to be held requires, hence the thermal efficiency of the walls of such a furnace could, no doubt, if desired be made to reach the practical maximum of all types of furnaces. Moreover, as the heat is rapidly distributed mechanically throughout the mass, the maximum temperature need be no higher than that required for the desired metallurgical or chemical action, hence the heat losses,

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* Phil. Mag., Vol. XXXV., 88 (1893) and THE ELECTRICIAN, XXX., 30, 31, 170.

† "Physical Review," III., 241.

‡ "Science," VIII., 2 (1898).

§ Abstract of a Paper read before the American Electrochemical Society.

‖ Dr. E. F. Northrup was the first to suggest and produce a vertical furnace by means of this pinch pressure, but the arrangement was quite different and could not be applied to furnaces.

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which increase so rapidly with the temperature, are correspondingly reduced; in this there is a great advantage over arc furnaces, in which the temperature is necessarily that of the vapour of carbon.

The regulation is simple, rapid and, in fact, ideal; the resistance does not change appreciably with varying amounts of metal in the hearth; the resistance of the resistor, as determined by the voltage and amperage, may perhaps in some cases be an indication of the progress of the metallurgical treatment; and owing to the very rapid circulation, one can feel sure that the treatment is uniform throughout the whole mass.

There is an interesting feature in the fact that when the electrode is made of the same diameter and material as the resistor, the furnace should tend to become self-regulating as to temperature. When, for instance, the temperature becomes higher, the electrode automatically becomes longer and the resistor therefore shorter, whereby less heat will be generated; and the reverse when the temperature becomes lower. The place where the electrode ends and the resistor begins is, of course, that section across which no heat flows; the heat generated below this section flows out to the terminal, and that generated above it flows into the furnace; it is this plane that automatically moves up or down.

The counter E.M.F. which must necessarily be generated by the movement produced is an advantage, as it shortens the resistor, and the energy corresponding to this counter E.M.F., of course, also ultimately generates heat by friction, and is therefore recovered.

By using a bath of some suitable metal in the bottom of the furnace as the prime receiver of the heat, the furnace is adapted to be used to melt non-conductors like glass, or to heat granular ores, reduce and volatilise such metals as zinc and arsenic from their ores, &c. By dissolving carbon in the iron in one part of a bath, and the oxide in another part, iron can be reduced from its ores, and the CO gas produced can be burned to preheat the ore, whereby the total energy of the carbon may be utilised, notwithstanding the fact that an authority recently said this was theoretically impossible. The power factor can, of course, be made very high, probably practically unity, and unlike in the induction furnace the frequency need not be abnormally low.

An interesting feature of the principle on which this type of furnace is based is that, contrary to the more usual cases, the larger the furnace the better, and the less will be the difficulties, because the resistors then become shorter and thicker. There are, of course, many modifications which at once suggest themselves, and which will be tried in due course. It would be quite simple, for instance, to add gaseous fuel heat, or the heat of an arc, in the upper part; or to add the electrical parts to existing open hearth or other furnaces and use the electric heat only for the final treatment.

The transformer is best attached directly to the bottom or side of the furnace, as the furnace currents are, of course, of low voltage, hence large in amperes. The flexible connections to a tilting furnace then, consist merely of the two thin primary wires. The furnace is readily adapted to three-phase current.

THE ELECTRICAL EQUIPMENT OF A MODERN THEATRE.

BY D. C. M. HUME.

The art of amusement and the science of relaxation have now been brought to such a pitch of advancement that the various apparatus employed therein have long ago passed the makeshift stage, and it is now the exception to find any but the best of machinery in even the minor haunts of happiness.

To the engineer there is much of interest in the installation of a modern theatre, and very weighty problems in mechanical and electrical equipments are often to be solved. Considerable weights have to be handled expeditiously; considerable areas have to be economically lighted; certain effects must necessarily be to hand; heating and ventilating have to be studied, and in all this the consulting engineer has to be a very all-round engineer to control the business, especially when under the stringent rules of the L.C.C. and certain other governing bodies to whom the safety of the public is a sacred thing. These regulations may always be obtained by anyone interested, but are of too bulky a nature to include in this article. They chiefly treat of such points as compulsory alternations and separate lighting supplies, visible and perpetual exit signs of specified dimensions, fireproof curtains, insulation tests, conductor sizes, &c., all of which necessitate a certain standard of excellence in every installation. This is not only conducive to public safety, but tends to eliminate the cheap job and to dignify the contractor's calling.

Leaving for the time being the architectural and ironwork engineering, which, in the average theatre, is a splendid example of cantilever construction (for example, the Coliseum and Palladium in London; Olympia, in Liverpool, &c., where the absence of pillars is so conspicuous), the stage and flies produce the chief problems from a mechanical point of view.

Stages may be revolving (Coliseum), lifting (Drury Lane), or

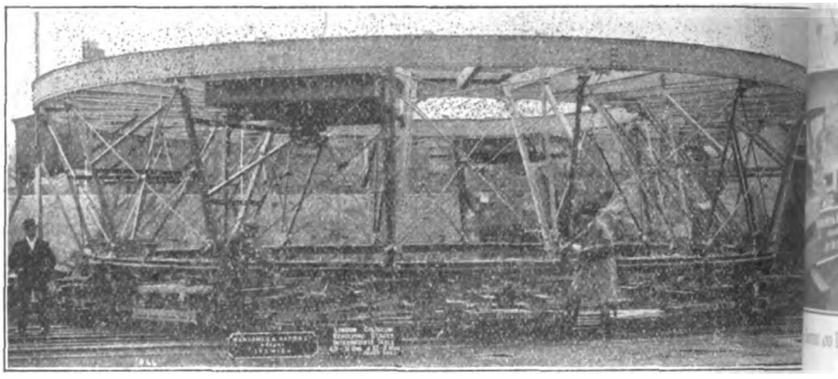

FIG. 1.—INTERMEDIATE RING OF LONDON COLISEUM REVOLVING STAGE.

even sliding. Apart from this, there may be conveniences for mechanical scenery, such as a traverse beam, panoramic gear, power winches, electric and hydraulic lifts, tilting stages, &c.

Revolving Stage.—The best example of a revolving stage is to be seen at the London Coliseum. This stage, which weighs 160 tons, was designed by Mr. E. Wingfield Bowles after many experiments, and is so constructed that it provides facilities for a great variety of spectacles and, at the same time, is the finest method of scene changing yet devised, providing, as it does, a

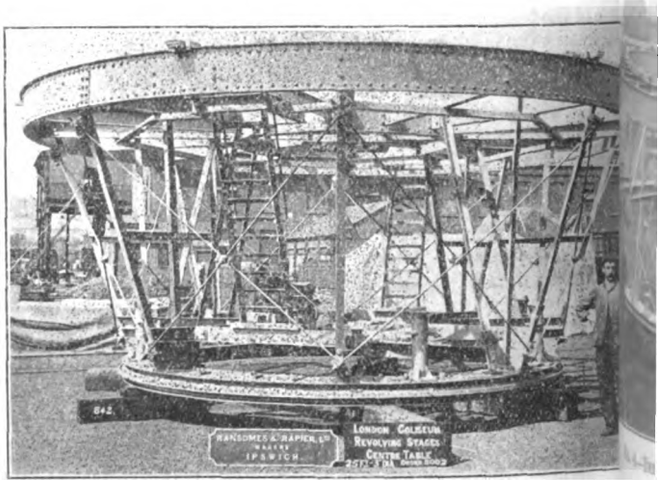

FIG. 2.—CENTRE TABLE OF LONDON COLISEUM REVOLVING STAGE, SH ACCESS LADDERS.

"full set" for every "turn"—that is, a deep set scene complete with side wings and cumbersome furniture, &c., &c.—whereas in a fixed stage short sets or "front cloth" scenes have to be interspersed throughout the performance often to the detriment of the "turn" allocated therein.

The Coliseum stage is 75 ft. in diameter, and around the circle abuts the stationary part of the stage. In all, the available area is 10,000 sq. ft. The main table or revolving stage is divided into three concentric parts, which can be locked t

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gether by flat hinged tablets of iron let flush into the upper surface of the stage or allowed to run separately as independent units. The upper surface is of 3 in. teak radially laid. The outer ring carries mast holes and sockets whereby it was originally intended to support scenery, but the use of these has been discontinued, as they were found to be cumbersome and unsatisfactory. The intermediate ring carries further mast holes and two water tanks of 1,000 gallons capacity, which serve usefully in water spectacles, dives, &c. The centre table carries one trap which admits by way of a staircase to a special

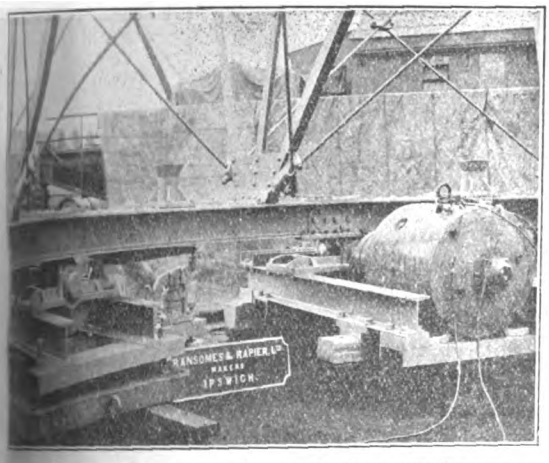

Fig. 3.—Method of Driving and Levelling Coliseum Stages.

stationary platform below, from which the chorus or other performers may be safely "fed on" to the stage even when it is running.

The underside of the stage is a very weird sight, especially when revolving at high speed. It gives one the sensation of being in a continual bridge collapse. Each ring is built upon inverted A frames, at the apex of which is fixed a circular H-rail; this runs on the pulleys of the driving motors, which are themselves stationary. Intermediate levelling wheels are provided, and also centring wheels bearing on a special rail

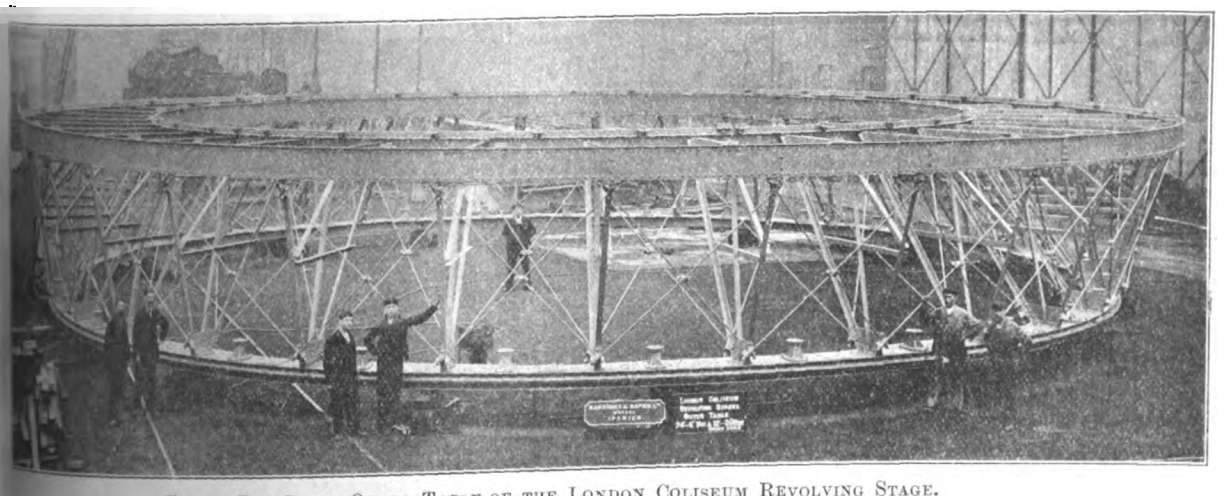

Fig. 4.—The Great Outer Table of the London Coliseum Revolving Stage.

mounted upon the side of the running rail. The diameter of the outer table is 74 ft. 6 in. on the iron crown rail, that of the intermediate being 49 ft. 11 in., and the centre table 25 ft. 3 in. Thus the radial dimensions are approximately 12 ft. 3 in. for each section. The whole depth from crown to running rails is about 11 ft. 6 in., and each ring is electrically and mechanically a separate unit. The maximum gap allowed in the floor grooves on the stage surface is 2 in. The motors are 14 in number, averaging about 15 H.P. each. Two of these drive the centre table, four the intermediate and eight the outside ring.

At top speed the outer edge of the table travels at about 25 miles an hour. Electric and hydraulic brakes are provided which can pull the tables up dead in 2½ revolutions from full speed. The stage was made by Messrs. Ransome & Rapier; various views of it are given in Figs. 1 to 5.

A special switch room is installed for these tables and contains auto-cut-out and fuse panels and the controllers' resistance banks. The controllers themselves are situated in a separate fireproof chamber immediately below the main switchboard platform, and are operated therefrom by means of a winch-handled worm-gearing turning an indexed brass plate mounted on the upper extremity of a vertical shaft, of which the lower extremity gears with the controller drum in the room below. The controllers stand 6 ft. high, and contain some 90 contacts, arranged to start up the machines in series, then parallel in pairs and finally parallel individually with the necessary intermediary resistance steps. The controllers and motors were supplied by the Sturtevant Engineering Co.

Panoramas.—Panorama gear provides a tricky problem, and many are the suspensions that have occasionally been tried, but difficulty is experienced in most designs, either owing to the clips or suspension jambing in the guides, or the cloth climbing the rollers. On the whole, the best system is that used at Earl's Court and at the London Coliseum. The cloth is sewn on to a length of 2¼ in. rope (¾ in. diameter), and from a suitable girder or beam are suspended in pairs vertical rollers about 9 in. deep and 6 in. in diameter. These are machined with a 1 in. shoulder on them, and are arranged to hang ¾ in. apart, and above them is threaded the cloth rope. The rollers are machined all over. The rope carrying the cloth cannot, therefore, drop between the rollers, and so runs on the upper face of the shoulder with the minimum of friction or obstruction. One great advantage of the above panorama suspension is that it will adapt itself satisfactorily to curved or discorced paths.

To minimise noise and economise power the panorama rollers are fitted with roller bearings. It is usual to drive the main panorama drums, which are about 2 ft. in diameter and extend the full height of the scenery (in the case of the Coliseum, 30 ft.) by a worm-gear from under the stage.

Lifting Stage.—Lifting stages are divided into a series of transverse platforms, about 10 ft. deep, which can be elevated into the air about 12 ft. or so, or sunk below the stage level for about 6 ft. These are usually hydraulically operated, and may be seen in use at Covent Garden or Drury Lane almost any night. Their underneath construction is very simple, as they are little single-span bridges running on vertical end guides, and operated by wire cable and a double-winding winch or hydraulic ram. Careful provision against the unequal stretching of the cable and consequent jambing of the guides must be made by compensating pulleys, &c. Hydraulically operated bridges seem to give the best results in practice.

Sliding Stages.—Sliding stages have only been installed in large opera houses on the Continent, and scarcely justify the wasted room they entail. In these the whole stage and scenery

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slide sideways across the proscenium, opening like a vast lantern slide.

Special Scenic Gear.—A traverse rail is a useful adjunct to a stage where spectacle is to be provided, and a good example of this is to be found at the Coliseum, where a single rail runs from the scene dock to the opposite fly floor right across the centre of the flies, and carries on it a travelling crane motor of 4 H.P., which can be attached to hanging platforms reaching to within about a foot of the stage; it can tow them across the stage at about 20 miles per hour, if required, when loaded up to 11 tons. A safety cut-out brake gear is provided to obviate any possibility of accident through overrunning. Loaded with a human freight these platforms make a telling climax to a panorama.

For any particular job such as storage battens for stock cloths, &c., power winches of the usual self-contained type are used. Power curtains other than fireproof are rare, but have much in their favour, as they can be definitely counterbalanced and fixed, whilst electric control admits of perfect speed variation.

Fireproof Curtains.—Under the L.C.C. regulations, the fireproof curtain must be hydraulically operated, and provision must be made for a control next the stage door whereby the watchman can at any moment, in case of emergency, let down this cumbersome screen, and so absolutely shut off the stage from the auditorium. It is not unusual for a fireproof curtain to weigh several tons; they are about 6 in. to 8 in. thick, and

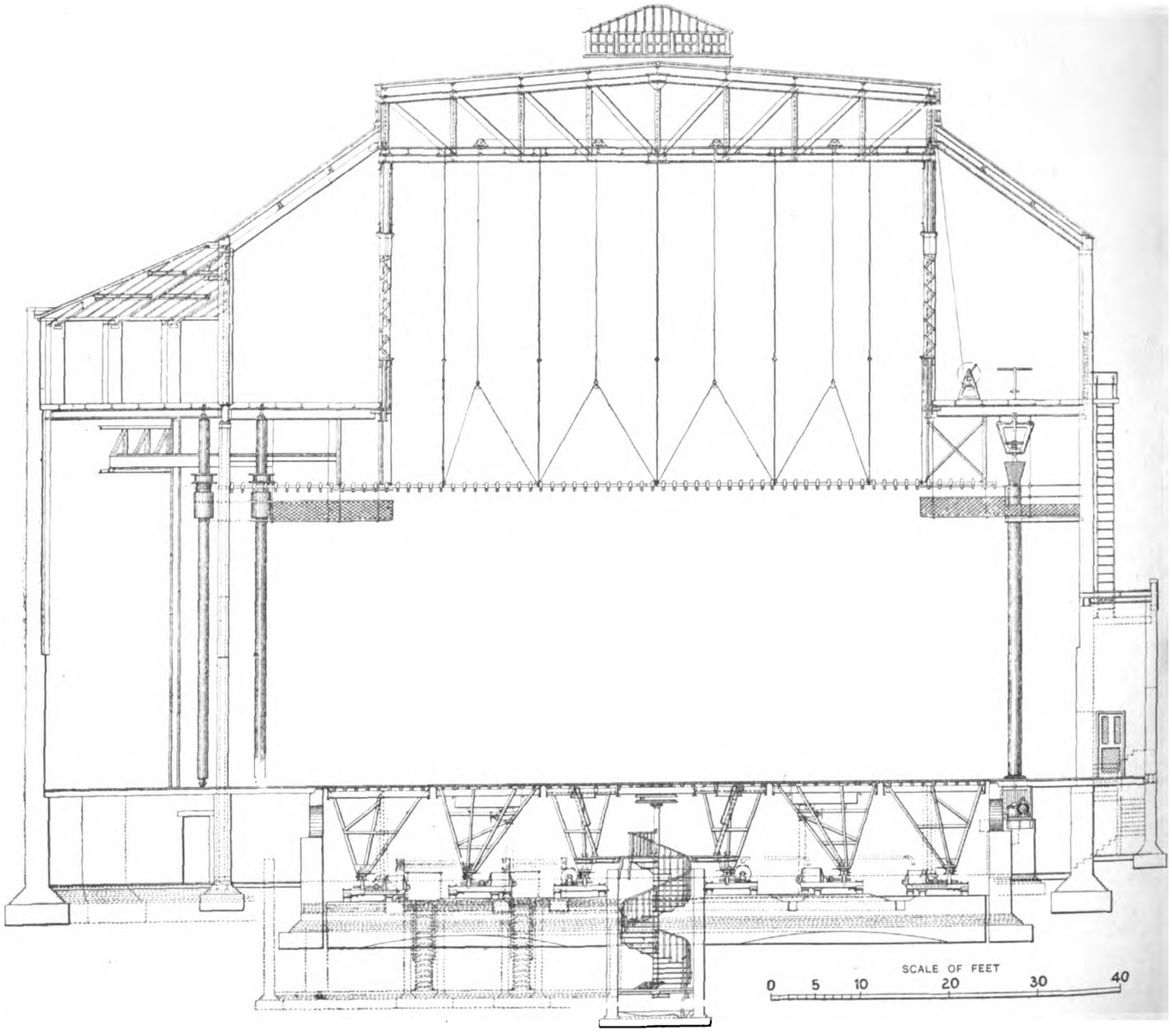

FIG. 5.—SECTION OF THE LONDON COLISEUM STAGE, SHOWING TABLE AND PANORAMA GEAR.

Mechanical Flies.—The mechanical operation of the "flies" is fairly simple, for the reason that it is seldom a success. There are so many "lines" to be dealt with (three to each cloth in most places), and these have to be easily adjusted, made off, slacked out, &c., that any discriminating winch device is, in effect, impracticable. There have been devices patented, and at times installed, consisting of multiple winches on a common power spindle, and arrangement for clutching on and letting go, &c., but they have generally proved themselves a greater nuisance than convenience. They have a tendency to be "fierce," or else to drop their load. Flymen usually prefer to counterbalance the cloths carefully and hoist by hand.

are made of asbestos sheeting and wool mounted on an iron frame very carefully under-counterbalanced, and kept in the up position by pressure from hydraulic mains, which arrangement recently led to the premature closure of several theatres owing to the bursting of the main in the centre of London's theatreland. A hand winch gear is usually provided to cope with such contingencies. The Drury Lane fire was a splendid example of the efficiency of these curtains. Here the whole stage was gutted and yet the auditorium remained untouched. This curtain was the work of the fire specialists, Messrs. Merryweather & Co., as indeed are most of the curtains. Whilst on the subject of fire it may soothe the unsophisticated reader's minds

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to know that all dresses, scenery, properties, &c., are compelled by the L.C.C. regulations to be rendered fireproof by immersion in an approved liquid agent. Something more than stencilling the word "Fireproof" is required. Adjacent to the watchman's fire curtain control is another handle, operating the "sprinkler," a device for producing a miniature rain storm along the proscenium arch in case of fire.

Lifts.—The dressing rooms lift is a great convenience to the producer in any theatre, as it provides a quick way for the chorus to reach their rooms, and so facilitates quick changing. For pantomime, ballet and spectacle this is a positive boon, and should never be left out of a new design if avoidable.

Passenger lifts for the auditorium have not been highly favoured in this country, though in America they are often to be found. In London, they may be seen at the Coliseum and the Playhouse, and serve to feed the first circle and the tea room, though these are, we believe, the only theatres that have them and consistently use them.

So much for the power installations of a theatre. We may now turn to the subject of lighting.

(To be continued.)

THE BENKÖ PRIMARY BATTERY AND ITS APPLICATIONS.*

BY W. B. COOPER, M.A., B.SC.

Principle of the Benkö Cell.—The cell is due to the Hungarian engineer Stephan Benkö, and depends essentially on the idea that if the layer of electrolyte on the positive plate (that is, electro-negative

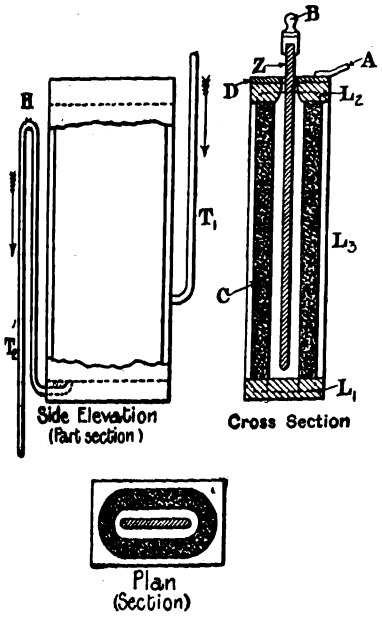

FIG. 1.—DIAGRAM OF BENKÖ CELL.

element) is removed as fast as polarisation sets in, the E.M.F. will be maintained constant. The remedy adopted by Mr. Benkö is to use a carbon electrode sufficiently porous to allow the electrolyte to flow through it, thus continually providing a fresh supply to the surface that is tending to polarise. By so doing not only is very effective depolarisation obtained (depending, of course, upon the depolarising qualities of the solution and its rate of flow), but for a given current the polarisation remains quite constant provided the cell is not overloaded.

The method of putting this idea into practice will be understood more readily by a description of the cell as at present made.

Description of the Cell.—For the sake of clearness the construction is indicated first diagramatically in Fig. 1. Here the carbon is shown at C, and this is best described as a flattened cylinder open at both ends. The hard surface of this carbon, as received from the carbon maker, is removed by scratch-brushing so as to leave it easily porous. The carbon is then provided with a lead cap, L_1, at the bottom, and a lead ring L, at the top, thus providing a vessel open only at the top. A lead shell, L_3, of sheet lead 1 mm. to 1½ mm. in thickness, is then fitted round the carbon, leaving a small space between the carbon and the shell, and is jointed autogenously to the lead cap at the bottom and the lead ring at the top, so as to form a chamber all round the carbon. We thus have two chambers, one inside the carbon and one outside. The outer chamber is provided with a tube, T_1; and a second tube, T_2, is fitted to the lead base and is carried through to the inner chamber. This latter tube is carried up and bent over, and there is a small hole, H, at the top of the bend. Finally, a copper plate, D, corresponding with the lead ring, is soldered on to the lead, and forms one terminal, A, of the cell.* The zinc, Z, is inserted into the inner chamber and carries the second terminal, B. When in action the electrolyte is delivered by the lead tube, T_1, into the outer chamber, whence it percolates through the carbon to the zinc; it then flows off through the lead tube, T_2, the form of which maintains the level constant within the carbon. As there is a hole at H, syphoning does not occur, though this may be made to take place in cells so constructed by closing the hole with a finger for a few minutes. This is often convenient when it is desired to empty the cell. It will be noticed that the current is carried away from the carbon at both top and bottom, and owing to this form of construction, and to the excellent contact between the carbon and the lead, very much heavier currents can be taken than is possible with the usual form of joint.

A working drawing of what I will term the "Type A" cell is reproduced in Fig. 2, in which the lettering of Fig. 1 is retained as far as possible. The zinc plate is carried in an ebonite frame F. The tubes T_1, T_2, are provided with unions and rubber washers, W_1, W_2, for coupling to other tubes as may be found necessary.

Fig. 3 is a view of a single cell with casing, being one of those which

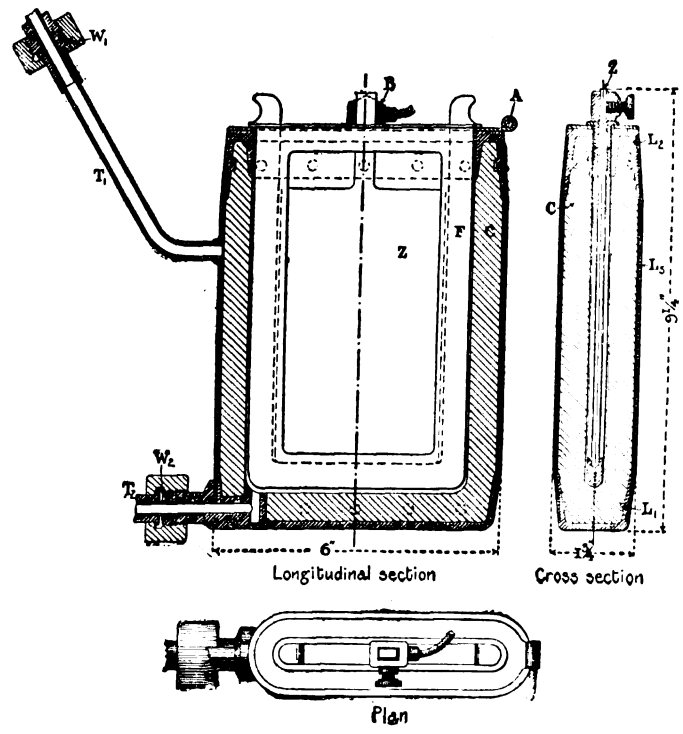

FIG. 2.—SINGLE BENKÖ CELL (STANDARD TYPE.

were tested. It differs in some small details from the cell shown in Fig. 2.

The carbons at present are not made larger than is shown in Fig. 2, but if larger cells are required this is effected by fitting two or more carbons into one shell. These are thus permanently connected in parallel, and the zincs are correspondingly coupled together.

The particulars of the "single" cell are :—

Width	1¾ in.
Length	6¼ in.
Height (including terminals)	9¼ in.
Weight (including zinc)	8·8 lb.
Maximum current continuously with L solution	17·5 amperes
Power	26·25 watts

The current stated is for a voltage of 1·5 volts per cell, the E.M.F. being 2 volts.

In the case of a battery the electrolyte is contained in a lead-lined tank, from which it flows (due to its own head) down to a common supply pipe from which each of the cells is supplied by a tube, the

* Abstract of a Paper accepted by the Institution of Electrical Engineers.

* In later designs this copper plate has been abandoned, the terminal being jointed direct to the lead ring.

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junctions being by ebonite unions and rubber washers, as already described. Similarly the waste from each cell is carried into a common waste pipe, from which an inverted U pipe is taken to maintain the level in the cells, and this discharges into a lower tank. By means of a cock the common waste pipe can be opened to this tank so that the cells can be drained when the supply of electrolyte has been cut off. The arrangement is compact, the width across the front of the stand being only 25½ in. and the depth from front to back being 24½ in. In order to give the necessary head the overall height is 7 ft. 9 in. for a 7-cell battery (and has recently been reduced.) Air pressure might, of course, be used instead of a gravity feed; this would give greater compactness and might be preferable under certain conditions. But even with the arrangement shown, for a battery giving a minimum working pressure of 10·5 volts and a power up to about 260 watts continuously, the space required must be regarded as small.

Tests.

Constancy of E.M.F. and Current.—With a given flow of electrolyte an extremely constant current can be maintained up to a certain limit. This limit depends largely, of course, upon the composition of the

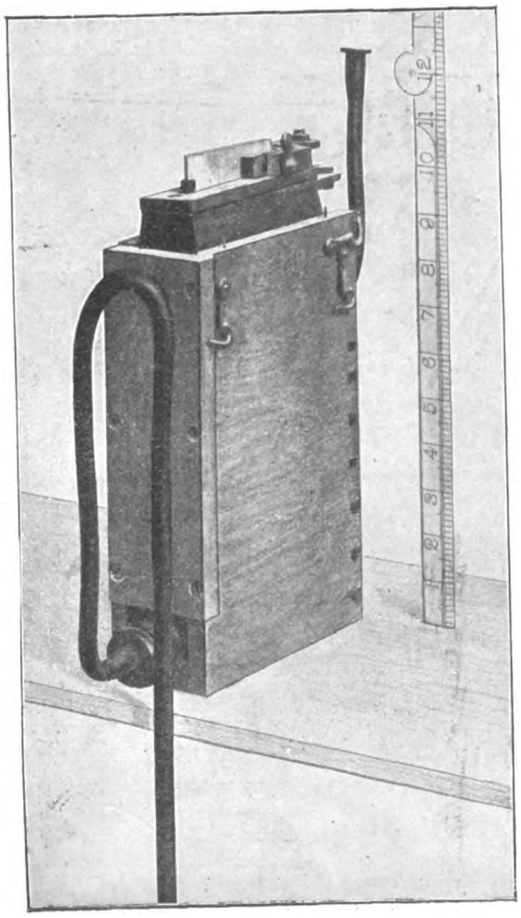

Fig. 3.—View of a Single Benkö Cell used in Tests.

electrolyte. Various electrolytes may be used, and in the case of bichromate solutions Mr. Benkö recommends the following formulæ: For electric light, 60 grammes of sodium bichromate and 120 c.c. of sulphuric acid per litre of water (solution "L"); and for heavy currents 100 grammes of sodium bichromate and 150 c.c. of sulphuric acid per litre of water (solution "P").

The limiting currents obtainable continuously with the two first solutions in terms of the area of the zinc (taking both sides into the measurement) may be taken as follows:—

	Per square decimetre.	Per square foot.
Solution "L"	6 amperes	..... 56 amperes
Solution "P"	10 „	..... 93 „

Local Action.—With an acid electrolyte there must always be a certain amount of local action, and this can be measured. In the present case, however, it is impossible to give any definite figures for this loss in a general way because it varies with the flow of electrolyte and with the current taken from the cell (owing to the fact that this alters the composition of the electrolyte) and with the state of the zinc. It might be thought that serious local action would take place through the tubes connected to the common supply of the electrolyte on the one hand and to the common waste on the other. There is, of course, a potential difference between the tubes of one cell and those of another, but this is localised by the ebonite unions and rubber washers used for coupling up the pipe work, and so far as could be seen no corrosion of the tubes took place during the six weeks this particular battery of four cells was under test. As to how many cells could be coupled up in this way without giving trouble through local currents it is difficult to say.

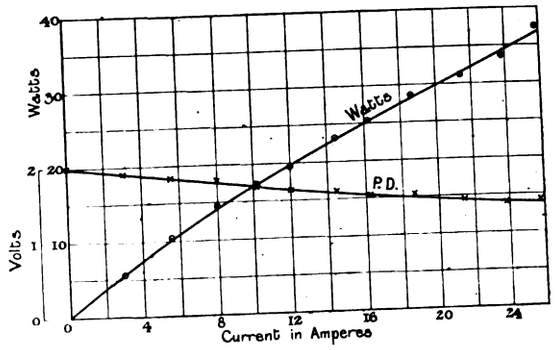

Fig. 4.—Relation of Terminal Volts and Terminal Watts with Amperes.
Type "A" cell. Solution "L."

Internal Resistance and Polarisation.—It is difficult to separate these two quantities with certainty, and no attempt has been made to do so. Fig. 4 shows how the terminal pressure and terminal watts vary as the current is increased. The currents were not taken momentarily from the cell, but the external resistance was decreased step by step as quickly as the readings could be taken, and therefore polarisation no doubt reduced the higher current readings to some extent. The highest outputs shown would not be maintained for any long periods, as the cell is overloaded. This test was made with solution L.

The test shown in Fig. 5 was made with a similar single cell, using the stronger solution P at a head (between the bottom of the tank and the top of the overflow tube) of 45¾ in., which gave a flow of about 1·9 litres per hour. In this test the external resistance was maintained constant, and the fall of current was observed for minutes. The current might have been maintained longer, but the cell became very hot with such a heavy discharge.

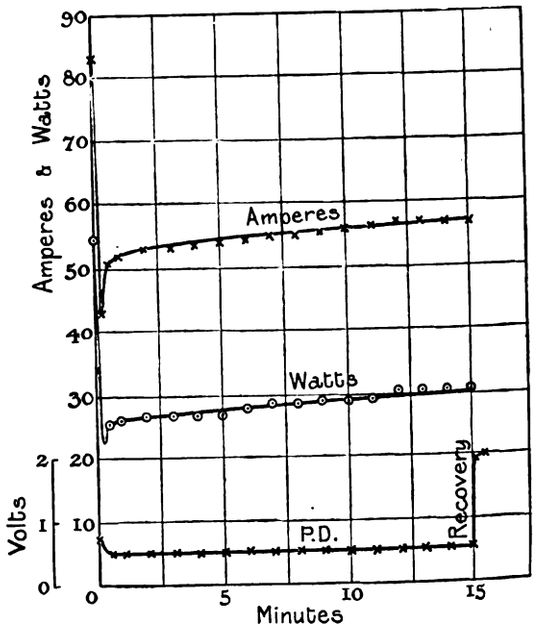

Fig. 5.—Heavy Current Test on Constant Resistance.
Initial Current 83 amperes. Type "A" cell. Solution "P."

Short-circuit tests with the L solution showed momentary currents of 100 amperes at a terminal voltage of 0·5 to 0·6 volt, the current falling to 80 amperes at the end of 5 seconds. With the stronger solution momentary currents of 200 amperes were taken at a terminal pressure of 0·5 to 0·55 volt. It follows, therefore, that the internal resistance is well below 0·01 ohm, an extremely low figure. T

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result is no doubt due largely to the excellent contact between the lead shell and the carbon, both at the top and at the bottom.

Omitting the tank, for which it is difficult to make an allowance, the Benkö cell compares favourably with accumulators as regards current output per square foot of plate, power per pound and power per volume.

Applications.

Laboratory and Miscellaneous Uses.—The Benkö cell has the advantage that it is small, easy to handle, and requires no careful attention. When it is not required it can be left on one side without fear of deterioration, the only desirable precaution being the running of some water through it to free it from the used electrolyte after heavy work. The laboratory, the charging of ignition cells, electro-plating on a small scale, and possibly submarines (owing to the peculiar conditions involved) are fields in which such a battery would prove useful. There is also the electric lighting of yachts having no generating plant. At present this is sometimes effected by means of accumulators which are taken ashore for charging as opportunities may arise. Such a method, however, has obvious drawbacks and limitations, and a convenient primary battery would, no doubt, be welcomed as a substitute.

Telegraphy.—Although accumulators are being employed increasingly in telegraphy, owing to their small internal resistance there are many cases in which they cannot be so applied, and therefore large numbers of primary cells are still in use for telegraphic work. Amongst these, bichromate cells of the quart and three-pint sizes figure largely and involve a good deal of cost and work in their maintenance.

In order to show the capabilities of the Benkö and ordinary bichromate cells (without porous pot), the curves in Figs. 6 and 7 are given. Fig. 6 shows the record taken by a recording ammeter of the discharge of an A type Benkö cell along with plotted curves of terminal pressure and terminal watts. It is seen that a remarkably constant current of over 12 amperes was taken from the Benkö cell for six hours and the current was then increased to over 17 amperes for about two hours.

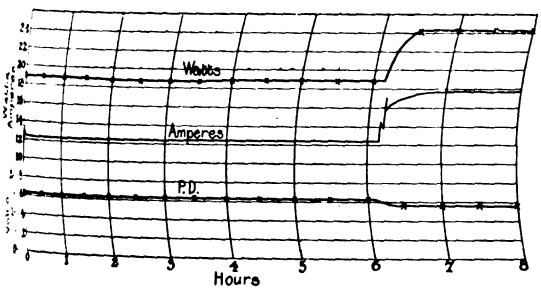

Fig. 6.—Discharge Curves of Benkö Cell.
Type "A." Solution "L."

The bichromate cell used for comparison held three pints of the same electrolyte and had one zinc plate and two carbons; all three plates were 6¼ in. wide and were immersed to a depth of 7¾ in. The area of the zinc was more than double that of the Benkö cell, and the carbon surface also much greater (though a little less in proportion). Yet when this cell was switched on to the same circuit as that which carried 12 amperes in the test just referred to, the current, which rose momentarily to 9·6 amperes, fell quickly below 8 amperes, and continued to fall as shown in Fig. 7.

Where the currents used in telegraphy run merely to some milliamperes, it will be seen that Benkö cells very much smaller than the type A (for example, less than a quarter that size) would give the necessary current for telegraphic work. Such cells have been made, and they present the advantage of occupying a much smaller space than the usual primary cells, and, moreover, are equivalent to the best accumulator in constancy of E.M.F. and low value of internal resistance. Obviously also they would be much simpler to keep in order than a battery of ordinary bichromate cells. A type of Benkö cell has also been developed in which the compartment outside the carbon is filled with very strong electrolyte and the inner compartment is merely filled with water; circulation of the electrolyte then takes place by diffusion, there being no supply and waste pipes, or pressure reservoir. Probably cells of this kind will be the most suitable for telegraphy and for miners' lamps where only small currents are required.

Country House Lighting.—Country houses above a certain size can be supplied very efficiently with electric light by the usual type of private plant. But if the house is below a certain size (for example, one requiring 50 10 c.p. lamps), an oil engine set, with its attendant accessories, presents very marked disadvantages. There is often difficulty in providing the necessary skilled labour, and the smaller the installation the more important the capital charges become. In such cases an owner would often be willing to pay a high price per unit if the first costs were low and the battery could be worked conveniently. Taking market prices for materials the cost per unit is found to be about 2s. per unit, but varies with the conditions. This cost is not prohibitive, and even 2s. 6d. per unit would not be out of the question. The smaller the house the more favourable is the position of the battery as compared with other plant. There are many small country houses where owners would be prepared to wire a few of the principal rooms, and use, say, 200 units per annum at such a price, for even at 2s. 6d. per unit this would only amount to £25 per annum, which sum would often be gladly paid for the advantages gained. A strong feature of such a battery is that it requires no attention when not in use, and in this respect it is at an advantage as compared with accumulators.

The simplest method of working such a battery is to turn on the flow of electrolyte when the light is required, and the flow would be turned off on retiring at night. This would still permit the use of an occasional light during the night owing to the quantity of electrolyte in the cells, and it is stated that two or three 10 c.p. lamps could be supplied for the whole night by the battery here considered. It would seem, however, that some arrangement for the automatic regulation of the flow of electrolyte would be preferable in many cases, as the cost in practice must depend largely on the way in which the battery is used.

With regard to labour, it may be mentioned that the zincs weigh 1 lb., and if we take 3 lb. (a high figure to allow for waste and unused zinc) per unit, then a single cell will give ⅓ unit and a battery of 17 cells will give 5⅔ units before the zincs need be changed. If a house is using 1 to 2 units per day this means that the zincs are changed once or twice a week. As the operation is very simple it takes very little time.

From the point of view of labour the electrolyte is more important than the zinc. With a constant output the amount of electrolyte per unit will be, say, 7¾ galls. If, however, a battery such as we have assumed is allowed to flow steadily at a rate of ½ litre per cell, then a

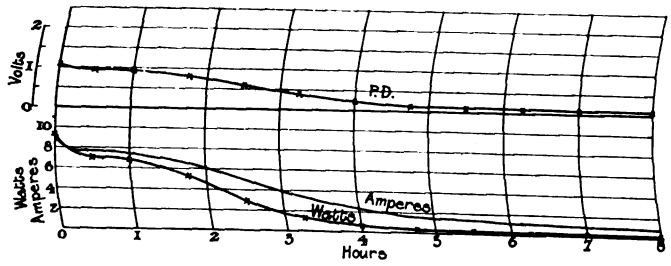

Fig. 7.—Discharge Curves of 3-pint Bichromate Cell, on same Circuit as in Fig. 6.
Solution "L."

5-hour run would require 9½ galls. This emphasises the desirability of automatic regulation of the flow. If hand regulation is adopted and not properly applied the amount of solution required might thus be as much as 15 galls. per day in the winter, or say, 10 galls. per day if the electrolyte is used twice and "refreshed" by adding new electrolyte to it. On the other hand, with automatic regulation this quantity once or twice a week for 1 to 2 units per week would be enough. With proper arrangements the handling of these quantities would take very little time. These figures emphasise the fact that the cost of running depends largely on the method of running.

As far as can be judged the cost of repairs should be very small, or negligible, and equally the interest on capital is scarcely worth considering. It follows, therefore, that electrical energy can be generated at about 2s. per unit under favourable conditions, and this cost will vary according to the carefulness of the regulation.

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from *The Electrician* office, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published under 2s., and 5 per cent. for books published nett. Add 10 per cent. for abroad or for foreign books.]

"Outlines of the Theory of Electromagnetism." By G. T. Walker. (Cambridge, 1910: Cambridge University Press.) 3s. net.

"Public Ownership of Telephones on the Continent of Europe." By A. N. Holcombe. (London, 1911: Constable & Co.) 8s. 6d. net.

"La Théorie Corpusculaire de l'Electricité. Les Electrons et les Ions." By P. Drumaux. (Paris, 1911: Gauthier-Villars.)

"Précis de Télégraphie sans fil." By Dr. J. Zenneck. Translated from the German by P. Blanchin, G. Guérard and E. Picot. (Paris, 1911: Gauthier-Villars.) 12 fr.

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PHYSICAL SOCIETY.

At the meeting held on April 28th at the Imperial College of Science, Prof. H. L. Callendar, F.R.S., President, in the Chair, a

"High-tension Electrostatic Wattmeter"

was described by Prof. E. WILSON.

When using the Electrometer as a wattmeter it is necessary (in order to secure accuracy) that the voltage impressed upon the quadrants shall not be less than a certain minimum depending upon the voltage to be impressed upon the moving system. When the latter voltage is of the order 10,000, the quadrants require a voltage larger than can economically be provided by a shunt. One is led, therefore, to consider intensifying devices.

The "series" or "current" transformer, whose secondary winding is closed on a non-inductive resistance, can be used to give fairly good results, but it is not accurate at all frequencies and is dependent upon wave form.

The author's quadrature transformer is a very simple piece of apparatus which can be relied upon to give for electrostatic wattmeters an electromotive force that is strictly the differential of the current in the primary winding. When so used it is necessary, for accuracy, at all frequencies and on all wave forms, that the integral of the mains voltage shall be impressed upon the moving system, although for sine curves only the differential need be impressed instead of the integral.

The best device to impress on the quadrants a suitable voltage in phase with the currents is a generator with an air-cored magnetic circuit as described in the Paper. The mains current is passed through the field coil of the generator and produces a magnetic field proportional to the current; the armature is driven at known speed in this field, and is provided with a commutator and brushes. The brushes when set accurately have a voltage between them proportional to, and having the same wave form as, the mains current.

Another device depending upon the charging of condensers in parallel and the placing of them in series has also been used for multiplying a small voltage produced by the passage of the mains current through a low-resistance shunt.

Dr. SUMPNER pointed out that the reason why a fairly high voltage was needed on the quadrants together with a strong control on the needle when a very high voltage was applied to the latter was because of the action between the needle and the case; unless the case was quite symmetrical about the axis of the needle.

Dr RUSSELL inquired whether the author was troubled about brush discharges at the edges of the needle.

Mr. E. H. RAYNER pointed out that at low-power factors various errors in the apparatus would become large.

Mr. C. C. PATERSON drew attention to the serious limit of accuracy imposed by not being able to keep the speed constant.

Mr. W. DUDDELL asked if the voltage could not be reduced by means of another quadrature transformer in series with a high resistance instead of being applied direct to the needle.

Prof. C. H. LEES also drew attention to the advisability of reducing the voltage by some means before applying it to the needle.

The AUTHOR, in reply, stated that brush discharges were fatal to accuracy, but could be detected by observing the apparatus in the dark. Non-inductive high resistances for such voltages as 10,000 or more were very expensive and he had avoided their necessity.

A Paper

"On the Behaviour of Incandescent Lime Cathodes,"

by Dr. R. S. WILLOWS and Mr. T. PICTON, was read by Dr. WILLOWS.

Wehnelt has shown that incandescent lime emits a large number of negative ions; if, therefore, hot lime is used as the cathode, a discharge may be obtained in a vacuum tube with P.D.s as low as 30 volts. The alteration with time of these cathodes, under continued use, has been investigated and the following results obtained: (1) When lime is heated on platinum foil, so far from showing fatigue, it actually increases in activity. With P.D.s greater than the saturation voltage this increase may be ninefold. At lower voltages a slow but steady increase up to 100 per cent. has been found. The steady activity falls when the lime is cold; the initial activity may greatly increase. (2) When the lime is heated on nickel foil, if the tube carries a heavy discharge, the current increases to a maximum and then decreases. A greatly increased activity is frequently shown after the lime has been cold for some hours. At the lower voltages the same general variations are shown as with platinum. (3) Great irregularity is frequently shown when the current is first started; at this stage other causes than temperature, such as mechanical vibrations, greatly influence the emission of ions.

Prof. C. H. LEES asked whether the Author had examined the film under the microscope. He wanted to know whether there was any likelihood of the film getting detached from the platinum, and also whether the increase of activity was simply dependent upon the quantity of electricity passed.

Dr. WILLOWS, in reply, stated that he had examined the films with a microscope. The films were very adherent to the platinum. It was impossible to render the platinum free again from the activity with which the lime endowed it. There was no connection between the activity and the quantity of electricity passed. The increase of activity was probably due to the CaO diffusing into the platinum.

A Paper

"On the Formation of Dust Striations by an Electric Spark,"

by Dr. S. MARSH and Mr. W. H. NOTTAGE, was read by Dr. MARSH.

The formation of dust striations by electric sparks has been investigated by many observers. The Paper attempts to explain their formation as being due to hydro-dynamic forces existing between the dust particles while the wave motion is passing over them. The application of this theory to the striations in a Kundts tube has been made by Koenig and Robinson. The wave motion is assumed to be of the spherical progressive type and expressions are obtained from the intervals between consecutive striæ and the distances of the striæ from origin. Measurements were made of striæ formed on a glass plate with vertical central spark. The agreement between theory and experiment is within the experimental error. Experiments with channels of various shapes were made. Illustrations of the various striæ patterns obtained with small obstacles and reflecting surfaces are given, and the use of these as a convenient means of indicating reflecting interference and diffraction of sound waves is pointed out.

Mr. A. CAMPBELL thought the authors' results justified their theory. His own experiments had been made with much slower electric oscillations and with a much less damped wave train than that employed by the authors. In this case he thought it was possible that the distance between the striæ might give the wave length of the oscillations.

Dr. RUSSELL remarked that the formation of striations afforded a very convenient means of determining whether a spark was oscillatory or not. He had found the number per cm. along a long tube was nearly constant, in one case it was 22, while with the same spark 30 striations per cm. were obtained on a glass plate.

Dr. MARSH remarked that the distance between the striæ varied with the amplitude even when the frequency was constant. The striæ interval became slightly smaller along a long tube. Striæ were obtained in progressive wave trains as well as in stationary waves.

A Paper by Prof. E. WILSON and Mr. L. C. BUDD on "PREVIOUS MAGNETIC HISTORY AS AFFECTED BY TEMPERATURE" was taken as read.

TRANSFORMER OIL.

BY ALEXANDER DUCKHAM.

With the steady growth of the electrical supply industry, necessitating the production and use of plant of increasing capacity, particularly of the alternating-current type, more attention has had to be given to the design of commercial transformers. With this increasing size and with competition amongst manufacturers, it has become necessary to obtain the greatest possible value out of the material employed; hence, as the permissible rise of temperature limits the capacity at which an electrical machine can be rated, the cooling of transformers has become of paramount importance. When transformers of only comparatively small capacity were required, air cooling was sufficient, but beyond certain limits this became commercially impossible, to say nothing of the attendant difficulties and of the labour imposed upon the operating staff, and it was necessary to find some more efficient means of dissipating the heat generated and of protecting the transformer. The insulating properties of oils were well known, and notwithstanding their low specific heat and bad conductivity, they appeared to offer the best medium for the purpose. Fairly satisfactory results were obtained, and development upon this line was continued—at first resin oil was used—then mixtures of resin and various mineral oils, and finally mineral oils alone were tried, and as these latter gave the most uniformly satisfactory results it is to this type of oil that our remarks are confined.

In the first place, in order to carry off the greatest amount of heat the circulation must be rapid, and therefore the oil must be quite thin or mobile; but it has, moreover, to work at a comparatively high temperature, and therefore it must not give off appreciable vapour at such temperature. The maintenance of this combination of mobility and high vaporising point, within certain limits, is one of the difficulties which the oil manufacturer has to surmount, because, as is well known, the thin oils have generally low vaporising points, and these latter rise *pari passu* with the increase in body or viscosity. Such evaporation means not only loss of oil, but the vapour may form an explosive or combustible mixture in the transformer or in the chamber in which the transformer is housed.

The oil must, of course, have a fairly high specific resistance or dielectric strength. These two qualities are common to pure hydrocarbon oils in a greater or less degree, and it is with the question

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possible impurities that we want particularly to deal in this memorandum. The impurities exist in two states—*i.e.*, either in suspension or in solution. Those in the first category can be removed by careful filtration, whilst in the second, moisture is the impurity that interests us most, affecting as it does both the specific resistance and the dielectric strength.

Generally speaking, all oils contain a certain amount of moisture, known as their water of saturation, and if the amount present does not exceed this point of saturation, the oils will remain perfectly bright, but any excess will render the oil cloudy or opaque. However, if the highest tests are to be obtained the oils must be freed even from this water of saturation. This is not a difficult works operation, provided the requisite vacuum pans and desiccating media are available, but to attempt to do this by means of direct heat, as is sometimes done on the job when erecting transformers, is inefficient and dangerous.

The desiccated oil is in a somewhat unstable condition, as it will re-absorb moisture from the atmosphere should opportunity be allowed, although such atmosphere may contain absolutely no moisture in the liquid state, such as rain or mist. For example, a sample of desiccated hydrocarbon oil will on exposure to the atmosphere of an ordinary warm and so-called dried room absorb therefrom water up to a definite point of saturation, such point of saturation being controlled by the temperature, barometric pressure and the state of actual saturation of the atmosphere. It is therefore essential that the oil after desiccation shall at once be filled hot into metal vessels which have been previously dried and which can be hermetically sealed for handling and transit, and that before opening these packages again for use, the transformer and its case shall be carefully warmed and dried, special attention being given to ensure that the coil windings have been freed from moisture, and then the oil may be transferred with all possible expedition. Whilst the transformer is working and is at a temperature above that of the atmosphere, the tendency to absorb moisture is a minimum, but on allowing it to cool if the air has access to the case, absorption of water vapour will take place and trouble may result. For this reason it is desirable to entirely fill the transformer cases with oil and, to as far as possible, seal them, provision being made for expansion and contraction, and this can easily be done by means of a syphon bottle, exposing as little surface as practicable to the atmosphere.

Causes of Deposits or Sludges and of the Thickening of the Oil.

It is recognised that the formation of deposit in a transformer oil, under the conditions of actual use, is an extremely serious matter, and one to be guarded against at all costs. At the very least, such deposit necessitates the cleaning of the transformer coils and the filtration of the oil at regular periods, and this operation in itself is a costly and at the same time inconvenient matter, as it necessitates putting the transformer out of commission for perhaps a day or two. But if precaution be not taken in time local overheating and consequent breakdown may result.

We are much impressed with the importance of this subject and by the absolute lack of knowledge as to the cause of the formation of the deposit, we commenced investigation, and in this research we have been greatly assisted by many of the engineers to the large power companies and by the transformer makers who sent us samples of the oil for examination. The work we have now done forms a complete explanation, and moreover has enabled us to put our oils to such exhaustive tests that we are in a position to guarantee practical immunity where the necessary precautions are observed.

The causes may be enumerated as follows :—

(a) The deposition of atmospheric dust.

(b) The thickening of oil due to evaporation.

(c) The action of the oil on the insulating materials and varnishes of the transformer.

(d) Chemical change in the oil.

(a) *Deposition of Atmospheric Dust.*—This is a cause that is quite easy to overcome mechanically by taking care that both the transformer and its case are perfectly clean before the oil is put in, and that there is no free circulation of air over the oil when the transformer is in use. The reason why these floating particles adhere to the windings is well understood by engineers to be due to electro-static attraction, but this force is not always credited with being as powerful as it appears to be in practice, although, of course, floating particles carried by the upward current of the oil in circulation (which, of course, is greatest near the windings) do not require any special force to draw them against such current and through the oil, but once in contact with the coils they appear to adhere permanently.

(b) *Thickening due to Evaporation.*—The darkening of the oil is, no doubt, caused by the temperature at which it is constantly maintained during the working of the transformer. This change of colour is observable to a greater or less degree with all oils and gives the impression that the oil has become thicker and more viscous, it being ascribed to the evaporation of the lighter constituents; this, however, is the case to only a very small extent, for on redistillation of a good quality oil the lighter fractions show very little variation from the proportion in which they were present in the original oil, and the change is, probably, largely influenced by the factors mentioned in paragraph (*d*).

(c) *Action of the Oil on Insulating Materials and Varnishes.*—That there is sometimes an action between the insulating oil and the varnishes used in the transformer was clearly illustrated some few years ago, when we were consulted by a large user as to the formation of deposit which he had attributed to the oil, as, in his opinion, this oil contained paraffin wax in solution, and he thought this wax was gradually deposited as a sludge. It was, however, clear to us that if the oil was fluid and free from deposit when cold, there was no chance at all of paraffin wax being deposited when the transformer was in commission and the oil comparatively hot.

The chemical examination of the deposit showed no sign of paraffin wax, but it was found to consist largely of saponifiable matter, in which were identified lead and manganese soaps—*i.e.*, combinations of lead and manganese with fatty acids. It was easy, by chemical analysis, to establish that the deposit had such a composition, but it was difficult to account for the presence, not only of the fatty acid, but still more so of the lead and manganese. We naturally suspected that they were introduced in some way with the transformer, and discussing the matter with a manufacturer, the insulating materials were suggested. He subsequently submitted to us, amongst other materials for analysis, some sheets of flexible micanite, the composition of which material is well known, and it was found that when immersed in hot transformer oils the sheets to a large extent lost their cohesion, and on separating the flakes of mica it was seen that in certain places the varnish had been washed out by the oil, especially in those places where it had not dried to a solid state, whilst those portions of the varnish which were hard and dry were little, if at all, affected.

It is a matter of common knowledge that in the manufacture of varnishes certain metals—or, rather, their oxides—are used in the form of so called "driers," because they have the unexplained property of rendering more rapid the assimilation of oxygen by the varnish, thus helping the drying or setting. A portion of the fatty acid formed in the deposit resembled those of the linoleic series, that is, such as are found in linseed oil, which oil is commonly used in the manufacture of insulating varnishes.

We have lately found that saponifiable deposits contain other substances answering to some of the tests of a fatty acid, and these will be dealt with in the next paragraph. Fatty acids, moreover, are very apt to attack lead, and the transformer cases from which lead containing deposit has been removed have been made of corrugated sheet iron, leaded in to a cast-iron base. The results which were obtained by us in this case were submitted to the engineer, who had first propounded to us the theory that the deposit consisted of paraffin wax, and he, in his turn, submitted the details of our investigation to certain well-known independent chemists, who went into the matter, and at the end of about 12 months a report was received from these gentlemen in all respects confirming our work.

The transformer makers are able to secure immunity from this form of sludge by discontinuing the use of soluble and insufficiently dried varnishes.

(d) *Chemical Changes in the Oil.*—It is under this heading that we find the explanation of the formation of the greater part of the sludges and deposits that have in the past been the cause of so much trouble. In spite of the fact that mineral oils have been looked upon as stable articles and non-saponifiable and non-oxidisable, yet, in view of the results of the research work we have carried out, we must now consider this to be a merely comparative statement, and that under the conditions appertaining to a transformer, oxidation and consequent formation of saponifiable products and of the other oxygen compounds undoubtedly does occur.

In the first place there is a constant and fairly high temperature; secondly, there is usually a space above the oil where the cables are attached to the terminals and where air can circulate, and it is well known that the presence of ozone and oxides of nitrogen is often detected here.

Now, from experiments we have conducted, we have found that mineral oils in varying degrees, when exposed to heat, and in contact with oxygen, not only rapidly darken and thicken, but do actually throw out a solid deposit in the form of an amorphous brown powder, and the action is more rapid with oxgyen than it is with air, and still more rapid with ozone. These are the agents which we have to com-

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bat in a transformer, and more especially as the electrostatic attraction insures any solid matter depositing on the windings. This discovery is of the utmost importance to transformer users, and would at once suggest tests to which their oil should be submitted before selection. There are some oils that are affected to a very much less extent than others, and by the careful selection of crudes from which the transformer oils are to be distilled, and by their subsequent suitable refining, one can guarantee practical immunity from this sludge.

We are still conducting our research on the exact composition of this deposit, and on the saponifiable oil which is simultaneously formed.

ON SHOCK EXCITATION WITH QUENCHING TUBES.*

BY M. WIEN.

The author has already, in a preliminary note in the "Physikalische Zeitschrift," described a new form of shock excitation, using longer spark-gaps, in which, for the purpose of obtaining a better quenching effect, Geissler tubes were inserted in the exciting circuit, in addition to the spark-gap proper.

To enable others to repeat these experiments the author now gives an account of his experiences with such quenching tubes, although the research is by no means completed.

The first experiments relate to ordinary shock excitation with longer spark-gaps, no quenching tube being used. The arrangement employed is shown in Fig. 1, which is self-explanatory. The coil used, with mercury interrupter, gave 7 to 8 sparks per second. The exciting circuit I. comprised two condensers with compressed gas as dielectric, capacity $0{\cdot}86 \times 10^{-3}$ mfd., and an inductance of 35,000 to 40,000 cm. The oscillatory circuit II. contained two similar condensers of the same capacity, an inductance of 39,500 cm., a hot-wire ammeter and an additional resistance, R_2, of manganin wire immersed in oil. The measuring circuit III., which was only used as control, gave indications by thermo-element and galvanometer.

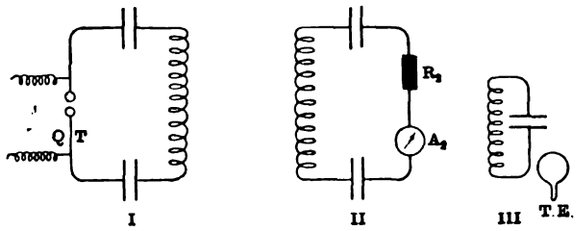

Fig. 1.

With this arrangement, and using zinc electrodes 1 cm. apart, the ammeter showed 0·9 ampere in the oscillating circuit, with close coupling. On diminishing the coupling and simultaneously regulating the tuning a point was eventually reached where the sound of the spark suddenly changed, the ammeter reading rose to 1·3 ampere, and from the shape of the resonance curve obtained with the measuring circuit it was clear that shock excitation was taking place. The degree of coupling at which this effect set in and the value of the current depend, under otherwise similar conditions, very much upon the metal of the electrodes. From the author's experiments it appears that silver cylinders are the best, magnesium the worst. With silver and other metals the spark-gap had to be constantly kept illuminated by an arc lamp for regular sparks to be obtained, but with magnesium this was unnecessary. With silver the critical coupling was sharply defined, a small change causing re-ignitions or complete extinction. With magnesium, on the other hand, the critical coupling is much looser, the change-over ill-defined, while the current maximum scarcely appears. The following table shows the difference in the intensity of the oscillations excited. F is the length of spark-gap in centimetres, A_2 the R.M.S. current in the oscillating circuit. The resistance R_2 had the value 0·75 ohm.

F.	Magnesium electrodes.	Silver electrodes.
0·5	0·46 amperes	0·83 amperes
1·0	0·90 ,,	1·42 ,,
1·5	1·35 ,,	1·75 ,,
2·0	1·75 ,,	2·05 ,,

The difference in the current in the two cases is especially noticeable at the smaller spark lengths.

This form of shock excitation has several defects. The efficiency is, as will be seen later, at high voltages rather small, even with silver, the tuning is difficult and inconvenient owing to the loose coupling, while the shock excitation is no longer pure, since the time taken by the current in the oscillating circuit to reach its maximum is relatively long as compared with its dying away. These defects can be overcome to a certain extent by the employment of multiple gaps and enclosure of the gap in hydrogen, but it can be more simply and satisfactorily effected by the introduction of quenching tubes.

Shock Excitation with Quenching Tubes.—If in the above arrangement a suitable Geissler tube is inserted at the point QT, close to the spark-gap, the quenching effect is greatly improved; the coupling can be made much tighter, and the efficiency rises. The properties of different kinds of quenching tubes will be referred to later on, the following dealing only in general with the mode of action of such tubes.

Resonance Curve of the Uncoupled Exciting Circuit with Quenching Tube.—The insertion of a Geissler tube in an uncoupled condenser circuit has a strong influence on the mode of oscillation; the damping is greatly increased and at the same time the curve is shifted to the right (direction of increased capacity); the wave-length is hence increased. Both these effects increase with decrease in spark potential, but the shift in the resonance curve is much greater in the case of the tube with silver electrodes than with magnesium electrodes. For silver, for a spark-gap of 0·5 cm. the logarithmic decrement is 0·8, and the maximum of the resonance curve is shifted about 12 per cent.; for magnesium and the same spark-length the logarithmic decrement is 0·35 and the increase of wave length only about 2 per cent.

A resonance curve taken of the oscillatory circuit coupled to the exciting circuit shows that, as above remarked, after insertion of the

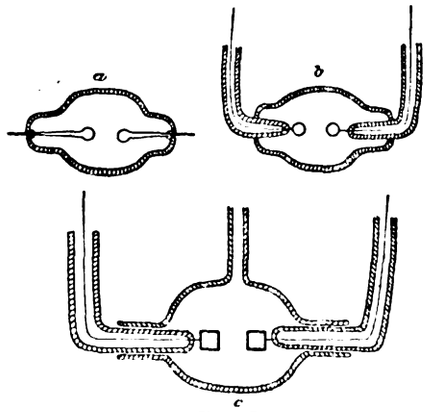

Fig. 2.

quenching tube a pure shock-excitation is obtained, even with a much tighter coupling. If the critical point is passed in making the coupling exceedingly close, the resonance curve does not show the usual two-humped curve of the coupling waves as is obtained when no quenching tube is used, but instead there is a curve with a single though much blunter and smaller, maximum, which corresponds to a sort of incomplete shock excitation. This depends manifestly upon the strong quenching effect of the tube; the re-ignition takes place irregularly—sometimes there is only one—and the spark dies out; the second minimum, or re-ignition occurs twice and the spark dies out at the third minimum, as has been shown by Rau.* The author has only seldom succeeded in securing such regularity of discharge that during a quarter of an hour all the sparks, without exception, have been regularly quenched. It is, however, fairly easy to arrive at a condition where re-ignition occurs in only about 1 or 2 per cent. of the sparks, which is of no practical importance in applications of the method. In all cases where the number of re-ignitions exceeded 20 to 30 sparks—which would be likely to cause trouble in measurements—the author has added a sign to indicate that the conditions were irregular.

Investigation of the Working of Quenching Tubes.—Since the quenching takes place in the immediate neighbourhood of the electrodes the shape of the tube has little influence. The simple wide tubes shown in Fig. 2 (*a*) have proved suitable for general use. Another form which enables cooling means to be applied to the whole tube, is shown in (*b*) of Fig. 2, the tube being cooled by immersion in oil. Yet another form, with the electrode tubes ground in (*c* of Fig. 2), enabling the latter to be changed, has also been used.

In the preparation of a quenching tube it is important to see that

* Translation, somewhat abbreviated, from the "Jahrbuch der Drahtlosen Telegraphie."

* "Jahrbuch der Drahtlosen Telegraphie," IV., p. 52, 1910.

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the interior of the tube is clean and without the least trace of grease. The working on first being evacuated is not regular, but it soon improves with use; the tube as a rule then remains usable for quite a time—often for months—until it is finally destroyed.

Influence of the Coupling.—On diminishing the coupling between the exciting and the oscillatory circuits, from the critical value downwards, the current in the latter circuit only decreases very slowly. In tubes with aluminium, silver and copper electrodes the coupling could be made three times weaker (2 to 3 per cent.) than the critical value (8 to 10 per cent.) without the current falling much more than 20 per cent. from the maximum value.

Influence of Pressure.—Pressures ranging between 0·015 mm. and 30 mm. of mercury were tried and it was found that only at the lower pressures did the quenching effect become irregular; the best pressure lies between 0·1 and 1 mm. The nature of the gas employed has little influence; hydrogen gives, however, a slightly better quenching than the other gases (air, carbon dioxide).

Influence of the Electrode Metal.—The metal of which the electrodes are made has a considerably greater influence on the results. Small cylinders (1 cm. in diameter and 1 cm. long) of different metals were used in the experimental tube described (Fig. 2, *c*), and it was found that silver gave the best quenching, magnesium the worst; aluminium comes between the two, and has a very marked quenching effect, although it cannot be used at such high potentials. As regards size, with larger electrodes (20 sq. cm.) the same degree of quenching could only be reached with lower gas pressures; while the R.M.S. current in the oscillatory circuit is larger with the smaller electrodes (5 sq. cm. and 1 sq. cm.). On the other hand, with high potentials and low pressures, the quenching effect is often difficult to obtain with small electrodes; several tubes with very small electrodes have, however, worked perfectly and regularly even when a 16 times greater capacity ($13·7 \times 10^{-3}$ mfd.) was employed.

Influence of the Sparking Potential and the Capacity.—On increasing the sparking potential the quenching effect is diminished; the coupling has to be made weaker for the same gas pressure. The limit appears to be the potential corresponding to a spark length of 2 cm.

The influence of capacity is very small; with the same tube good results were obtained with capacities as widely divergent as 10^{-4} and $24 \cdot 10^{-3}$ mfd.

Use of Two Quenching Tubes in Series.—The quenching effect is improved by using two tubes placed in series, and with this arrangement a tighter coupling can be reached if required. Both tubes must naturally have about the same quenching effect, as otherwise the addition of a badly quenching tube would have no effect. The following figures show the advantage obtained by the use of two tubes:—

	Maximum coupling		Current.
Aluminium tube I.	5 per cent.		2·9 amperes.
Aluminium tube II.	6 „		2·95 „
Aluminium tubes I. and II.	10 „		3·25 „

It does not follow that the efficiency is increased, since with the two tubes the resistance is greater than with a single tube; but by the use of two tubes in series a good quenching effect could be obtained at the higher potentials, regular quenching being obtained with a spark length of 3 cm., and even with 4 cm. a considerable improvement was observed, as well as an increase in the current.

The Efficiency with Shock Excitation.—The efficiency with the shock method of excitation is the greater the less energy is used up in the exciting circuit till extinction takes place. The total output is determined from the relation $A_1 = \frac{1}{2} N C_1 V_1^2$, where N_1 is the number of sparks per second, C is the capacity and V the sparking potential. The output A_2 of the oscillating circuit can be obtained in the case of shock excitation, simply from the ammeter reading and the resistance, which latter can be either calculated from the resonance current, or else measured by insertion of an additional resistance in the circuit. The efficiency is then given by the ratio A_2/A_1. Efficiency measurements, with shock excitation, but without quenching tubes, and for longer spark lengths, were carried out, using silver and also magnesium electrodes. The following results were obtained with silver electrodes 5 cm. in diameter; the potential was obtained from Müller's results:—

Spark length.	Kilovolts.	A_1	A_2	Efficiency.
0·5 cm.	17·6	0·83	0·52	52 per cent.
1·0 „	31·4	1·42	1·51	47·5 „
1·5 „	44·3	1·75	2·30	36·3 „
2·0 „	56·0	2·05	3·15	31·2 „

In the case of magnesium the efficiency at all spark lengths is never greater than 22·7 per cent.; with silver, as can be seen, the efficiency increases rapidly at the longer spark lengths.

Efficiency with Quenching Tubes.—The following results were obtained with the same arrangement as above but with quenching tube in circuit. Magnesium electrodes were used.

	Spark length, in cm.	Kv.	A_1.	Amps.	A_2.	Efficiency p.c.
Aluminium tube.	0·5	17·6	1·0	0·92	6·34	63·4
	1·05	33·0	3·51	1·80	2·43	69·2
Silver tube.....	1·83	52·4	8·86	3·45	6·90	78·0
	2·45	64·5	13·4	4·40	11·3	83·7
One copper tube	1·0	31·4	3·0	1·95	2·2	73·2
	2·0	56·5	9·75	3·80	8·37	86·0
Two copper tubes	3·0	80·4	19·7	5·25	16·0	81·0
	4·0	102·0	31·6	6·6*	25·3	80·0

The determination of the efficiency is naturally attended by an uncertainty of some few per cent.; the efficiency is, however, certainly higher with copper and silver tubes than with magnesium and aluminium tubes, and is also higher with small electrodes than with large; it also increases with the sparking potential up to a maximum at 2 or 2·5 cm., actually reaching 86 per cent. with potentials of 30,000 volts and over. The efficiency is not noticeably dependent upon the resistance in the oscillatory circuit. Its high value as obtained in these experiments is attributable to the small losses in the exciting circuit (owing to the compressed gas condensers, heavy connecting leads, &c.) The losses in the condensers with shock excitation are not so important as in the case of ordinary excitation; but still, on substituting Moscicki condensers for the compressed gas condensers, the ammeter reading was reduced by 16 per cent., and the efficiency sank from 80 to 69 per cent.

Experiments with Higher Powers.—To arrive at larger outputs there are three means available: Increase of voltage, increase of capacity or increase of rate of sparking. The best voltage as regards efficiency, as has been seen, lies between 30,000 and 60,000 volts, while to arrive at large capacities the gas condensers available were insufficient. Moscicki condensers were, therefore, used. The spark rate was increased by using a Boas resonance transformer, with which considerably greater powers were obtained up to 1 kw. The transformer was supplied with alternating current at 50 cycles per second, and gave, according to the sparking potential, 100, 50, 33, &c., sparks per second. The quenching effect was secured by the employment of the same quenching tubes as were used before, the heating, even with ½ kw. passing for a whole hour, being quite small, only warming up the oil bath (of 2 litres' capacity) about 12° C.

With a low spark frequency the results were practically the same as previously; with higher spark rates, 33 or 50 per second, the sparks became irregular and the efficiency somewhat low, in no case rising above 47·2 per cent. Rotation of the electrodes showed no improvement, but an air blast directed on to the gap served to make the quenching effect and also the ammeter reading very regular for a considerable period, the sound of the spark assuming a quite musical tone. The efficiency is also improved, as will be seen from the following table, which gives results obtained with a tube having copper electrodes

	Spark length.	No. of sparks per sec.	A_1'	Amps.	A_2	Efficiency p.c.
Mg spark gap	0·5	100	52	1·9	26·4	50·7
	0·75	50	140	3·0	65·7	46·9
	0·75	100	200	3·6	94·6	47·3
	1·0	100	400	5·5	221·0	55·2
	1·5	100	820	7·2	379·0	46·2
Ag spark-gap	1·0	50	232	4·0	—	50·4
	1·0	100	420	5·7	—	50·5

In some other experiments with two aluminium tubes in series, with $A_1' = 950$ watts and $A_2 = 485$ watts the efficiency was 51 per cent. The value of the efficiency depends upon the right kind of blast being used; but this is a technical matter which can be considered as solved by the air-blast arrangement of the Badische Anilin-und Sodafabrik. The efficiency of 55 per cent., it should be borne in mind, includes the loss in the resonance transformer, the charging loss at low frequency and the discharging loss at high frequency in the Moscicki condensers. Allowing for these, the efficiency of the shock excitation alone reaches here also the high value of 70 to 80 per cent., as previously found.

The possibility of utilising quenching tubes for the purpose of shock excitation, with small and medium powers, and hence for laboratory purposes, has thus been demonstrated. Whether they are suitable for large powers such as are used in practical radio-telegraphy depends chiefly upon whether it will be possible to make tubes which can support continued heavy loads. The previously described forms of tube easily become spoilt when subjected to long-continued discharges from the resonant transformer; firstly, because of the electrodes becoming heated, and then owing to the glass cracking at the leading in point of the platinum wires; but, above all, a gradual change of the electrode surface sets in, which shows itself in the fact that the points of light which accompany the strong discharges gradually disappear from the surface of the electrodes, and show themselves more around the leading-in wires, where they form a bright bundle of rays. In this manner the glass at these points gets eaten away, and the tube destroyed.

* Irregular.

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THE REVIVAL OF THE PRIMARY BATTERY.

Some 20 years ago there was no more popular subject than the primary battery and its possibilities in regard to the supply of energy for lighting. In the minds of the general public there was always a good chance of the battery competing against a public supply, and arguments to the contrary were generally of little avail. Even when it was realised that zinc was an expensive metal for the purpose of generating electrical energy in competition with coal, the possibility of using bye-products was brought forward as a further argument in favour of the primary battery. This idea was carried so far that the chemica products were apt to be looked upon as the main part of the business, and the supply of electrical energy as the bye product. There was always wanting, however, a sense o proportion in the minds of the promoters of such schemes and failure was the natural result.

In later years the zinc battery was dropped for thi purpose in favour of the carbon-consuming cell. The ide of obtaining electrical energy direct from carbon instead o using a roundabout method of combustion coupled witl thermal and mechanical transformation has always bee fascinating, and many people have worked at the idea; but

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unfortunately, carbon as an element is particularly ill-qualified by Nature for the production of electrical energy voltaically. Whether some other method of using carbon for this desirable end will be evolved, time will show; certainly at present there does not seem much prospect of producing a carbon-consuming cell pure and simple. In some cells, such as that of BORCHERS, it has been assumed, without any good evidence, that the carbon is oxidised voltaically; and in others, such as that of JACQUES, that voltaic action was the source of E.M.F., whereas a thermo-electric origin is much more probable.

We need scarcely remark that the day has long since passed when zinc was regarded as a possible competitor of coal. This, however, does not mean that a good primary battery would not be an extremely useful piece of apparatus. The defects of the usual primary cell are want of convenience, want of cleanliness, and the fact that the current falls off, due to polarisation, after a comparatively short time. When once the current has begun to fall seriously then there is nothing to be done but to re-charge the battery, and this is generally an operation that is by no means convenient.

Elsewhere our readers will find an account of the Benkö primary battery, as described by Mr. W. R. COOPER in a Paper accepted by the Institution of Electrical Engineers. This battery is of considerable interest, as it appears to utilise a new principle of overcoming polarisation. To this end the electrolyte is allowed to flow through the carbon plate continuously, so that the reduced products caused by polarisation are removed as rapidly as they are formed, and therefore the current can be maintained at its proper value up to a certain limit so long as this flow of electrolyte continues. Owing to the special construction adopted, the output obtained is very high, the resistance being particularly low. Since the battery uses zinc and a bichromate solution, it need scarcely be said that the cost per kilowatt-hour is necessarily high compared with the cost of energy obtained from public mains. Further, the cost of energy will depend upon the way in which the battery is used—that is, whether it is so used that the electrolyte is fairly exhausted or so that a good deal of waste takes place. On the other hand, the first cost of a battery of this kind is quite low compared with the cost of the usual generating plant consisting of an oil engine set, and but little space is required. It must be remembered that the use of metal filament lamps on 25-volt circuits has very materially altered the situation, and has rendered very much easier the equipment of quite small installations than was the case a few years ago. Whereas the handling of a battery giving 100 volts might be troublesome, the maintenance of a battery giving 25 volts would be a small matter in comparison. There are many small country houses where electric light would be much appreciated, but whose owners are unwilling to spend money on oil engines and plant of the kind requiring rather special working; yet such people would frequently not object to paying a somewhat high price per unit if the energy could be obtained conveniently. It seems not unlikely that the Benkö primary battery, if properly developed, will meet cases of this kind and will cause an extension of electric lighting in directions where it is not at present available.

REVIEWS.

(Copies of the undermentioned works can be had from THE ELECTRICIAN Office, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.)

Notes on Applied Mechanics. By R. H. WHAPHAM, M.A., B.Sc. and G. PRECE. (London: E. Arnold.) Pp. 206. 4s. 6d. net.

It is pointed out by the authors that this work is primarily intended for the use of Naval Cadets who are being trained under the New Scheme, after they leave Dartmouth, for their six months' work in the two training cruisers. It is the outcome of experience which has been gained in teaching on board those ships, and deals with as much of the subject as can be covered during that period without running the risk of substituting mere cramming for careful and systematic teaching. From this it will be seen that the work is by no means elementary in character; indeed it is only suitable for those who have already received a fairly good grounding in mechanics. As is only to be expected, the subjects dealt with are treated principally from a naval point of view, and the majority of examples given, which are all carefully and accurately worked out, are such as would not only be of interest to a naval student, but such as might, and, indeed, frequently would, arise during the course of his work. It is not to be supposed from this that the text-book is only suitable for Naval Cadets; on the contrary, it is a valuable treatise on the subject of applied mechanics, and should be of use and assistance to all students desirous of completing their knowledge.

The opening chapters deal with the fundamental and derived units, instantaneous centres, machines (considerable attention being given to pulleys), and friction and power measuring devices. Perhaps one of the best chapters, although it is difficult to discriminate amongst so many of almost uniform excellence, is that which deals with relative velocities and problems thereon. The explanations are given simply and distinctly; every point that might present difficulty is made clear, and the examples chosen are such as are of special interest to all whose work is or will be in connection with machinery. Other chapters deal with kinetic energy and momentum; flywheels; simple harmonic motion; engine problems, including curves of effective steam pressures, and crank efforts; stress and strain; bending moment and shearing force; beams and struts; torsion; frameworks, &c., and projectiles. The range of the book is, as will be seen, wide, and it is difficult to mention any portion of the subject that has not received adequate treatment. The authors are to be congratulated on the able manner in which they deal with the various points, and the work is one which can be recommended to all who wish to improve their knowledge of applied mechanics. G. B. B.

Physics. By C. R. MANN and G. R. TWISS. (Chicago & New York: Scott, Foresman & Co.) Pp. 424.

This work, which is intended for beginners in the subject, is divided into two parts. Part I. consists of 15 chapters, pp. 17–299, dealing with Mechanics, Heat, Electricity and Magnetism, Sound and Light; and Part II. contains an additional six chapters, pp. 303–417, treating of the more difficult points encountered.

The book aims at removing what the authors claim to be a common failing in the elementary teaching of physics—viz., that "Definitions, laws and principles are simply stated, memorised by the pupils and justified afterwards, if at all, by illustrations in the way of experiments and practical applications." They claim that a method of treatment that develops the subject from the concrete experiences of the learner is the only method that gives mastery of the subject-matter, and provides the pupil with real training in scientific thinking. Probably it is safe to say that the majority of teachers would support this view.

The authors, in accordance with these ideas, consider it necessary to postpone the subjects of velocity and acceleration, absolute units of force and energy, coefficients of expansion, &c., to the second part, and omit altogether such matters as magnetic moments, the tangent galvanometer and terrestrial

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magnetism. Moreover, they discuss lenses before mirrors, and colour is studied before refraction. But, on the other hand, we find included many points not often mentioned in elementary text books—*e.g.*, the D'Arsonval galvanometer, electric motor, dynamo, telephone, telegraph, three-colour work, aeroplane, steam turbine, wireless telegraphy, electron theory, radium, &c. The result is a most "readable" book, perhaps one of the most interesting works on elementary physics that could be found.

There are 220 illustrations and three plates, and a good summary, and a set of really excellent questions is provided at the end of each chapter. B.W.C.

The Standard Handbook for Electrical Engineers. Third Edition. (New York: McGraw-Hill Book Co.) Pp. xii. + 1497.

It is less than two years since we received the first edition of this Handbook; but already a third edition has made its appearance. In view of the fact that the number of pages has been increased by about 270, it is evident that considerable alterations have been made in the text. In this connection the publishers believe the present edition to be a triumph for the "unit" system on which the book was compiled, and which permits thorough revision of any part of the work. The need for such a thorough revision as is mentioned in the preface certainly somewhat reduces the value of previous issues.

The Handbook still comprises 20 sections; seven of these are contributed by Mr. O. A. Kenyon, who is also joint author of three other sections. Section I., dealing with units, has received little alteration. Section II., however, has been considerably enlarged, the general theory of electric and magnetic circuits having been entirely rewritten, and the calculation of inductance and capacity being given in greater detail. Descriptions of several new instruments have been included in Section III. on "Measurements and Measuring Apparatus."

The greatest addition, however, has been made to Section IV., relating to the "Properties of Materials," which has been nearly doubled in length. We notice that the term "aluminium" now replaces the Americanism "aluminum" in the Tables. The article on the magnetic testing of iron has been entirely rewritten, and now deals very fully with this subject. A valuable addition is also the sub-section giving data of a large number of resistance alloys.

As it is impossible to refer to all sections in detail it must suffice to say that the chief alterations and additions have been made to those parts of the book which treat of transformers, motors, central stations, transmission and distribution, electric locomotives, telephony and standards.

An improvement that will be appreciated by the busy engineer is the thumb index to the various sections.

HIGHER TECHNICAL INSTRUCTION.*

BY J. H. REYNOLDS, M.SC.

Summary—The author discusses the reasons why this country is behind other countries in regard to education. In spite of the fact that the facilities for higher technical instruction have been considerably increased, the number of students studying science as applied to manufacturing industry is small. The author especially pleads for a keener appreciation of the value of knowledge and the subordination of the passion for games.

Owing to the absence of any returns which give, with even an approach to accuracy, any information as to the number and quality of the students engaged in higher technical instruction, it is extremely difficult to make fruitful comparison between the facilities offered in the United Kingdom and those available abroad, especially in Germany. Whilst we have the present confusion in our statistics, we can never hope adequately to realise our true position in relation to foreign nations, especially to those who are our commercial and industrial competitors. It is not, however, by a mere comparison of technical institutions or of students enrolled in them that we can arrive at a true estimate of the relative position of, say, Germany and the United Kingdom. We must know something of the range of studies, of the length of school life, of the methods of instruction, and of the attainments reached by the pupils of the secondary schools, since it is to them that the universities and the technical high schools of the nation must look for students. It is high time that the secondary schools—or such of them as can present satisfactory credentials—should receive State recognition, and be relieved from all external examinations, and their leaving certificates (duly safeguarded as to subjects and length of course) be accepted by higher institutions of learning throughout the Kingdom as giving complete and satisfactory evidence of fitness to enter upon a further stage of advanced study. In my opinion no reform is more urgent than this.

Forty-two years ago there was published in this country a book than which there has been nothing either said or written which more plainly puts before the nation its educational needs and the right measures to supply them. I have in mind J. Scott Russell's epoch-making book "Systematic Technical Education for the English People." The author came to the conclusion that the English nation was nearly the worst educated of the peoples of modern Europe, but that no people would be more responsive to the pains and care of the statesman who should undertake measures for their general, scientific, and technical education. And now, in 1911, the pleas and remedies put forth in Scott Russell's book of 1869 remain as cogent and as greatly in need of enforcement as on the day they were written, and as directly applicable to the present conditions of industry. We were a generation behind the German nation in 1869, and we are hardly less so to-day.

The reasons are not far to seek. For the first three-quarters of the 19th century our people were neglected by their leaders. Neither elementary, nor secondary, nor university education received attention. Not so with Germany. The progress of scientific discovery found Germany ready. In her numerous universities and technical high schools there were men in large numbers who, by reason of their scientific training, were prepared to take advantage of possible scientific industrial developments. In no other way can the phenomenal advance of the German nation be explained, and the evidence of this advance is seen in her enormous output of fine chemicals—which has enabled her to put the whole world under toll—in her great mechanical and electrical engineering developments, and in her mercantile marine. She has created, as Bismarck described it with a certain cynicism, an educational proletariat; but this only meant that she had at command a vast supply of educated labour, the very instrument needed to turn scientific discovery to practical account.

It is perfectly true that we, too, have made great advances in all departments of education in the 40 years under review, but we cannot leave out of consideration the fact that Germany was in a position which enabled her at the very beginning to seize the opportunities offered. Thus, whatever be the progress we have made, the advance of Germany has been maintained, and in some departments of industry her position is now apparently beyond serious challenge.

How then do we stand from the point of view of our educational means and resources? We are only just beginning to make really effective our facilities for secondary education. The average school life of the pupils in our secondary schools is, however, hardly more than three and a half years, possibly less. So long as this prevails there cannot possibly be any satisfactory supply of students to the universities or to technical schools of high grade, nor can the teaching in these institutions be of a satisfactory standard.

We have largely increased our facilities for scientific education. The United Kingdom now boasts 18 teaching universities as compared with half that number 60 years ago, and the enrolments, including the students in university colleges, possibly reach 40,000. In the 22 universities in the German Empire, the enrolments are nearly 58,000, but to these must be added the students enrolled in the 10 technical high schools, namely, 15,885, making the total enrolments nearly 74,000, whilst the age of entrance and the state of preparation required is admittedly much beyond that prevailing in this country. By the recent regulations entrance to the technical high schools requires not only the certificate of complete attendance at a Gymnasium or Real Gymnasium or an Ober-Realschule, but a year's preliminary experience in a works as well. This all helps to establish a position of intellectual strength which goes far to explain the industrial and commercial position of Germany to-day.

It is extremely important to remember the extent to which this country is dependent upon foreign sources for the supply of raw materials for conversion into articles of use, and that in this regard it enjoys no advantages, as it did formerly, over such nations as Germany or the United States. Even the advantage which we enjoy in the supply of fuel ready to hand as a source of cheap power is no longer largely neutralised by the advent of electricity. And because of the very prodigality of our resources in coal, we have neglected in large measure to study the best methods of its conversion into power. Witness for example the production of coke used for metallurgical purposes. Our method of production by means of wasteful over

* Abstract of a Paper read at the Imperial Education Conference.

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of the beehive type has been entirely superseded by those devised in Germany, and firms in this country building coke ovens accept designs of German or continental origin. The truth is, we have got to realise the hard fact that material conditions are tending towards equilibrium, and that superiority can only be maintained by a sedulous cultivation of brain power and a firm discipline.

The facilities for higher technical instruction in the United Kingdom it must be admitted have been largely increased, in considerable measure as the result of the Technical Instruction Act of 1889 and the Customs and Excise Act of 1890, yet it is certain that the number of students in our universities who are studying science with a view to its industrial applications is small by comparison with those so engaged in universities and technical high schools abroad; and still more unsatisfactory is the small number, having regard to the enormous industrial enterprises in which the nation is engaged, and which gave it at the present time the first place in the whole world.

Of the 74 technical institutions which comprise the Association of Technical Institutions, only 27 have any day-students over 16 years of age taking 20 hours per week in science as applied to manufacturing industry, and the total number so engaged is only 1,842, or less than half the number to be found in the Technical High School of Charlottenburg, or of Munich, or of the Institute of Technology at Boston. Moreover, the students of the former are enumerated as from 16 years of age in place of 18, and are in most cases admitted on a not very satisfactory standard of examination, and further include subjects in their course to be found abroad only in Gewerbe or special schools. The Board of Education in its report for the year 1909–10, issued only a few days ago, states that—"The total amount of advanced instruction of the kind provided in technical institutions is still disappointingly small. In some of the more important industries as, for example, engineering, the instruction is largely utilised by students; but in a great many others the supply of students is very small. It is to be deplored that there are several schools in which the well-equipped staffs and the excellent equipment practically stand idle in the day-time through lack of students."

Out of 3,400 day students enrolled in recognised technical institutions in 1908–9, there were 211 students under 16, and only 1,990 took full courses of instruction. Of these, 406 were engaged in work of the third year, and 125 in still more advanced work.

As an illustration of the *different* attitude towards technical training of an advanced character mainly devised for men intended for responsible positions, the present author submits a statement respecting the textile schools in this country and in Germany.

To those desirous of pursuing the subject of technical training, I can commend nothing better or more stimulating than a careful perusal of the Diplomatic and Consular Reports on Scientific and Technical Education in the German Empire, prepared by Dr. Rose, and issued by the Foreign Office. They are a mine of information, and show with striking clearness the wealth of provision made to supply efficient training in every industry of importance, and for all grades of their service. We suffer in this country from a want of appreciation of the value of scientific knowledge and investigation and its application to manufacturing industry—first by the employers and directors of industry, and second, by the immediate managers, whose indifference often amounts to serious hostility. Not until our great industrial concerns are recruited more largely than is now the case from the product of the schools will there be any serious change in this regard.

There is not only the indifference of employers and mangers to contend with, but the short-sighted policy of parents and students, who take the most empirical views of the training upon which they either desire to enter. It is imagined that technical training is a mere matter of manipulation, of dyeing without a knowledge of chemistry, of engineering without an efficient training in mathematics, mechanics, and physics. It is not sufficiently realised that the training given should put the student in the position, not only of clearly understanding the *raison d'être* of the processes in which he will be engaged, but of being able to appreciate the value of problems as they arise, and to enter intelligently into their careful investigation.

No one doubts the Englishman's capacity—there is striking evidence of it, both at home and abroad; it is his salvation, but as a friend of a large American engineering firm in this country, himself a technical high school graduate, once said to me, "I am astonished at the capacity of the Englishman, but why does he not add knowledge to it?"

I would not have it understood that there has not been in the last few years a very considerable change for the better in the attitude and sympathy of employers in their appreciation of scientific and technical training. Many large firms and some public companies have well-known schemes and conditions of admission to their service requiring, according to the position sought, certain definite attainments. It would be of great public advantage if there were published a list of firms and of public departments who have definitely laid down schemes of admission to their service based upon educational requirements, and such firms will gain enormously by their enlightened policy. Moreover, there would further be a great advantage if in Government and municipal undertakings there were offered definite opportunity of practical experience, if only for a limited time, to duly accredited students.

As a nation, we show ourselves impatient of theory, and place our faith in the practical man. We have had, perhaps, some justification for this in the past conditions of industry, but the progress of science has made the theorist indispensable. It can be shown conclusively how completely modern industrial developments find their beginnings in the long-continued, patient investigations of the scientific man in the laboratory, equipped with implements of precision, and conditions indispensable to exact and fruitful research. We cannot afford that all this work, depending upon high scientific training and upon the application of the finest scholarship, should be done mainly abroad.

The provision for higher scientific and technical instruction in evening schools since the Technical Instruction Act of 1889 has much increased in volume and in quality, and in late years especially in efficiency of organisation, but from the very nature of the conditions it is not possible to give, except to a limited extent, really advanced teaching in science or technology to evening students. Indeed it is only possible to arrange it in localities exceptionally situated, where the population is large, and where the industrial conditions are such as to attract a high type of workers. It is in the North especially where these conditions prevail. And as to higher technical instruction, so important to those engaged in industry, the records of the Board of Education and of the City and Guilds of London Institute show only a very small proportion of successes in the honours stages of the various science and technical subjects.

My words are a plea for a keener appreciation of the economical position, of the value of knowledge, of the need of sound theory, of the necessity for a more determined sacrifice of time and money, and especially are they a plea that our young men should subordinate the passion for games, which seems on the increase with all classes, to a keener intellectual zest. How few of our college students in the precious closing years of their student life are content to shorten a summer vacation that they may take advantage of practical experience in the factory, or mine, or workshop? Yet this, as I well know, is a commonplace with a foreign student.

I am keenly sensible of the struggle into which we have entered with the best-equipped nation in the world so far as education is concerned, and I do not wish to see my countrymen fall behind in the race because of lack of enterprise or of shortcomings in education, and I am sure I speak the mind of the best men of our nation, who, in no alarmist spirit, but in cool, calm judgment, declare that her doom is surely set, unless, with the courage that has hitherto never failed us, we rise up and provide for our people the means of the highest education, alike in their best interests as human beings and as needful for the maintenance and development of her trade and industry.

CORRESPONDENCE.

THE ORIGIN OF "ATMOSPHERICS" IN WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The thundery weather of the past few days has given me an opportunity of proving, beyond a doubt, the cause of at least the far larger proportion of the atmospherics, or Xs, so troublesome in wireless telegraphy. The observations were made at a small station at Bushey, which I have recently put up for the purpose of studying these phenomena.

The enormous increase in the number of Xs observed at the station on Wednesday evening, when severe thunderstorms were taking place in Devonshire, is merely a confirmation of my previous observations. The actual proof of the origin of Xs was not made until Saturday night.

At about 8 p.m. on Saturday evening a sharp thunderstorm passed over the station and travelled off in a north-easterly direction, leaving the sky clear overhead. The thunder soon became inaudible, showing that the storm was at least 15 to 20 miles off, although flashes occurred very frequently in the bank of clouds on the horizon. At 8:45 p.m. I commenced to observe these flashes, at the same time listening in my wireless

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receiver. *At every flash, and absolutely simultaneously with it, an ordinary X was audible.* At about 9:24 p.m. two flashes occurred in quick succession in the same locality—a phenomenon I have frequently noticed in thunderstorms—in the telephone of the wireless receiver there was simultaneously audible the double knock so characteristic of many Xs. Later on a flash produced a sharp hissing X, lasting an appreciable fraction of a second. This flash was no doubt a quick succession of partial discharges, though these followed so rapidly as to be indistinguishable to the eye as separate flashes. Visual sensations being semi-permanent, it is, of course, difficult to distinguish successive flashes from one another unless they are separated by quite a large fraction of a second.

In all I observed from 40 to 50 flashes during the evening.

My conclusion is that every visible flash without exception gave rise to an X, also that the single knock, double knock and the short hiss or rattle are produced by discharges apparently common in any ordinary thunderstorm.

Having thus established that every distant flash is the cause of an X, it is of interest to estimate roughly the number and distribution of thunderstorms requisite to provide the Xs actually observed in wireless stations. On Saturday, the storm being a comparatively small one, flashes occurred at intervals of from one to two minutes. Very much greater spark rates are often observed. From my own experience I may mention three cases. The first was at Rouen, in the valley of the Seine. The thunder rolled absolutely continuously for 43 minutes. There was no rain, and during the whole time the sky overhead was lit up with a succession of flashes so rapid as to produce an apparently continuous shimmering light on the houses opposite my window. The second was on the Firth of Clyde, when over 900 flashes were counted in three hours, giving an average of over five flashes per minute. The third was in the Highlands of Perthshire. Here the thunder rolled practically without cessation for two hours and a quarter, flashes being almost as continuous as in the storm observed at Rouen. One such thunderstorm, taking place anywhere within one or two thousand miles, is therefore alone sufficient to account for all the Xs observed at a station during any bad period of several hours, for I have just shown that every flash produces an X.

It is well known to meteorologists that in certain districts, such as Western Tropical Africa, there are, on the average, many thunderstorms every day. From this district therefore must come an almost constant stream of Xs. Their number will, of course, vary with the seasonal and daily variations of thunderstorm frequency already known to meteorologists, and their effect on distant stations will, in addition, vary with the variations of transmissibility of electric waves known to wireless operators.

It is probable that the hissing atmospherics of long duration occasionally observed may be due to brush discharges from the aerial itself. I have not as yet noticed any of these at my Bushey station, but this may be due to the fact that my aerial is a very low one.

It is clear from my observations, however, that ordinary Xs are due to electric waves radiated from thunderstorms, since the simultaneity of lightning flash and X has been proved directly with great accuracy by the coincident perception of the light waves and electric disturbance by the eye and ear of the same observer.

In the near future I intend to erect a directive system of aerials, and thus determine the directions of the thunderstorms responsible for the Xs observed at the station. The results to be obtained should be valuable not only in wireless telegraphy but also in meteorology.—I am, &c.,

London, May 15. J. ERSKINE-MURRAY.

VACUUM METHOD OF FILLING CABLE JOINTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In THE ELECTRICIAN for March 24th, 1911, I find a description of the vacuum method brought out by the Allgemeine Elektrizitäts Gesellschaft for driving off moisture from the joints in filling up high-tension cable boxes.

It is interesting to note that a method practically the same as this has been in use, at the suggestion of Messrs. Pirelli & Co., cable makers in Milan, by the Edison Co., in Milan, since 1896, when laying certain 3,600-volt three-phase cables. I may say that the system then employed was, perhaps, simpler, as it required only one opening in the box. There was a vacuum pump, hand driven, a funnel of the same shape as that described by you with valves, gauge and all the rest.

The system proved very satisfactory and was used extensively for many years; but later experience taught us that by using good quality compound and taking special care, such as heating the box well before the operation, the ordinary way of filling was quite safe even for extra high tension; so that the method was considered as an exaggerated precaution, and was abandoned.—I am, &c.,

Società Generale Italiana Edison di Elettricità,
ING. T. A. BERTINI,
Milan, April 28. Il Direttore Generale.

IMPERIAL TELEGRAPHS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I should like to make a few observations in reply to Mr. Neilson's remarks (as reported in your issue of the 28th ult.) regarding the Paper I recently read to the Royal Colonial Institute.

Possibly because, in common with everybody else, Mr. Neilson had not the Paper to study in advance, he made certain criticisms which he would not, I think, have made had it been otherwise. For instance, he says: "If traffics were greatly increased by reduced rates the number of cables would have to be increased." The last 13 lines of page 3 of my Paper (enclosed herewith) clearly state this. Again, where Mr. Neilson criticises my proposal of an all round Imperial rate he appears to forget my pooling suggestion.

Mr. Neilson said that "he thought the idea that wireless was on the eve of taking the place of cables was a little previous." Can Mr. Neilson—or can you, Sir—show me any passage in this Paper where I make such a suggestion as this? On the contrary, have I not clearly indicated that I regard the wireless telegraphy of to-day more as an adjunct to cables than as a substitute for them?

Mr. Neilson says "the greatest desire of the Government was for the security of communication. That took first place, and was far beyond cheapness." Exactly; and I have not said anything to the contrary in my Paper—though I consider there is also a need for more favourable tariffs. On the other hand, I clearly stated that, in my view, to better secure this much desired "security," certain additional lines should be laid on routes widely different to any existing route. Notwithstanding his remarks about "security," Mr. Neilson appears to consider we are just right in this regard at the moment; for he says: "At all events, the cables provided so many alternatives that it would be hardly worth the while of foreign Governments to cut some of them." My view is that the more cables we have on entirely different routes the greater our degree of safety, and at present this degree is not of a very high order. The position was, however, immensely improved by the All-British Pacific Cable, previous to which our communication with Australia depended upon the eastern route through the foreign regions of the Mediterranean Sea.

It is, I suppose, but natural that outside suggestions of new lines should be opposed by existing cable systems. At one time Sir James Anderson (late managing director of the Eastern Associated Companies) spoke warmly against a cable "all the way from Australia to Mauritius, across the route of the trade winds, to the Cape," whilst adding, "there is not even a sand bank on which to catch fish; there is not a port to which a cruiser or a cable ship can replenish their supply of coal, which they are certain to require to do. There are no ships going there; there is no trade and nobody wants to go there."* The Admiralty, however, thought differently; and contemporaneously with the "All British Pacific Cable"

*"Proc," Roy. Col. Inst., Vol. XIX., p. 213.

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this line was undertaken, under subsidies, as an "Eastern" enterprise, some four years after Sir James Anderson's remarks thereon. It is now, I suppose, recognised as serving an eminently useful purpose, though as warmly criticised beforehand as the All British Pacific Cable still continues to be by those interested in a rival system. The Pacific Cable was additionally said to be impracticable as an engineering work, yet it was laid without a hitch and has never given a moment's anxiety.

Mr. Neilson says: "I do not think Mr. Bright has allowed sufficiently for the danger of ice." On pages 13 and 14 (where indicated) you will observe that I distinctly referred to this objection to all extreme northern routes; and with regard to the rest of his remarks—putting aside the question as to whether he is a better authority than myself as to what "a responsible engineer" would do—I will remind Mr. Neilson that in the year 1906 the Telegraph Construction & Maintenance Co. landed a cable (of a special type) on the coast of Iceland and that this has never given any trouble since.

In closing his remarks at the meeting, Mr. Neilson criticised my views as "large." The Cable Companies came into existence and retained their high estate solely due to the "large views" and enterprise of men like the late Sir John Pender. I might add that it would be strange if only the lines undertaken from time to time by a certain group were good for the nation and Empire.—I am, &c.,

Westminster, May 9. CHARLES BRIGHT.

We have submitted Mr. Bright's letter to Mr. Neilson from whom we have received the following reply:—

TO THE EDITOR OF THE ELECTRICIAN.

SIR,—With reference to Mr. Bright's letter I would first point out that he has already had his proper opportunity—and rightly availed himself of it—of replying to the other speakers and myself at the Royal Colonial Institute.

Curiously, he forgets that other views besides his own were expressed on that occasion, to which I naturally referred when speaking, clearly indicating, however, at the time to which speaker I was replying. This simple fact deprives Mr. Bright's letter of much of its point. As there was nothing in his Paper "on this or that subject," then clearly on such matters I was not criticising his views, but those of some other speaker.

Sir James Anderson's opinions as quoted appear to refer to cables laid on their commercial merits. Given sufficient receipts, for instance, his remarks, I take it, no longer apply. Moreover there is much of Mr. Bright's letter with which one does not disagree.

I would only add that to call a suggested cable a "strategic" line, as some do, does not make it so, but only invites the attention of an enemy to it in the event of hostilities.

Thanking you for the opportunity of replying to Mr. Bright's letter, I am, &c.,

City, May 16. GEO. R. NEILSON.

BATTERY ECONOMICS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR,—While the matter is still fresh in the minds of your readers may I trespass a little further on your valuable space. I will endeavour to be very brief.

I believe the difference of opinion which exists about the relative values of boosters and regulating cells is largely due to personal impressions.

The Britisher comes to the question with the sizes of boosters and cells determined for discharge rigidly fixed in his mind. He compares this with the regulating switches he sees on the Continent, and at once comes to the conclusion that they are too complicated, especially when considering the frightful efficiency of the ordinary type of booster when charging the battery.

But he overlooks the fact that, in following Continental practice, he *must add 20 per cent. additional cells to his battery*, and will now require a booster, *for charging purposes alone*, which is big enough (if made triple-parallel) to deal with his discharge.

What, then, is the objection to using this booster for the discharge? It cannot be on the score of cheapness, for the cost with the booster alone is less than one-third of that with the combined arrangement.

The objections alleged are two:—

1. That the switchgear is more complicated. This is due merely to insufficient information having been given in the paper; for the use of large "selector" switches has been employed, within my own experience, on some of the heaviest direct-current generator panels in the Kingdom for many years with never the least trouble; and the switches would *not be touched* from the beginning to the end of the discharge.

2. That useful current at times of peak is taken up in driving the booster. This is quite true; but useful current is also locked up in idle cells with the regulator method. A consideration of Fig. 4 of my Paper will show that, out of 303 cells, a discharge is obtained which is only equivalent to that from 290 cells fully worked; representing a 4 per cent. loss of locked-up current. With the booster arrangement, for the same size of battery, 6 per cent. of the battery current would be taken up by the booster motor; but out of this energy some 4 per cent *is returned to the battery circuit*; the actual loss being therefore only 2 per cent. Moreover, since the booster only costs about £0·5 per kw., whereas the battery costs about £6·0 per kw., it is obvious that a lot of capital is locked up needlessly in the regulating cells.

It should be mentioned (several speakers having misunderstood this point) that the regulator cells shown in my Figs. 9, 10 and 11 are not really regulating cells at all, but are merely for "floating" purposes, and carry no heavy currents. They can be done away with, if desired, by employing a small "bucking" booster; but 2 or 3 cells are required to compensate for the non-regulating properties of the static booster, where this is employed.—I am, &c.,

Birmingham, May 6. A. M. TAYLOR.

THE DRIVING OF WINDING ENGINES BY INDUCTION MOTORS.

We give below an account of the discussion at the meeting of the Institution of Electrical Engineers last week on Mr. H. J. S. Heather's Paper on this subject. The author being in South Africa, Mr. W. H. Patchell read the Paper and also showed some lantern slides of winding plant in this country.

Mr. W. C. MOUNTAIN considered the Paper written by Mr. Heather of considerable importance and value to the Institution, because it brought forward the possibility and the desirability under certain conditions of using induction motors instead of the Ilgner system; and if it could be shown that winding gears could be economically operated by means of induction motors direct from the supply, he considered that it would be a step forward and tend very largely to popularise the use of electric winding. In considering a problem of this kind the commercial aspect entered very prominently into the case, and, before adopting winding with induction motors supplied direct, one had to consider very carefully the source from which the electric energy was to be obtained. If the supply could be taken from a large power station, in which the fluctuations of current or demand would not be severely felt, then there was no doubt that the induction motor offered a very simple and effective way of dealing with the problem; but if the supply had to be taken from a supply station where the output was limited, then it might be necessary to introduce the Ilgner system or a balancing system of some kind to avoid the heavy peak loads. As an example, Mr. Mountain instanced a winding gear in the north of England which was operated by means of an induction motor of 700 H.P. supplied at 5,500 volts direct from the mains. This motor at the moment of acceleration called for an output from the generating station of 1,700 H.P., and, although this supply was taken from the Newcastle Electric Supply Co.'s power station, which was equipped with eight 6,000 kw. units, five or six of which were probably in operation, every start of the winding gear could be observed in the power station. To consider properly a problem of this kind it was desirable to base one's observations upon a definite problem. He therefore gave some figures from an actual case, and referred to the diagrams reproduced herewith, which represented the working of a

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winding gear of moderate capacity, for which there was a very large demand, the duty being as under:—

Depth of shaft	780 ft.
Time of winding	40 seconds
Time of banking	15 ,,
Average rope speed	19·5 ft. per second
Weight of coal per wind	2 tons 4 cwt.
Circumference of rope	4 in.
Nominal horse-power of gear	250 to 500
Balance rope fitted	
Time of acceleration	8·5 seconds
Maximum velocity	27·5 ft. per second
Time of retardation	4 seconds
Acceleration	2·73 ft. per sec. per sec.
Retardation	5·8 ft. per sec. per sec.
Maximum velocity	23·2 ft. per sec.
Power consumption with induction motor	2·3 units per wind
Do., with Ilgner system, assuming an efficiency of 70 per cent.	2·7 ,, ,,

The diagrams showed that the horse-power required to accelerate was about 440 in each case, and of course, taking current from the supply company, it meant that a demand equivalent to 440 H.P. would be

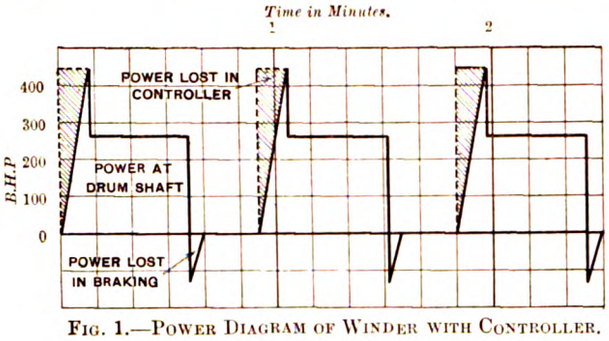

FIG. 1.—POWER DIAGRAM OF WINDER WITH CONTROLLER.

required for each wind; but as the current was switched off the motor before the end of the wind, and no current was consumed between the time of cutting off the supply until the next wind, it would be seen that, although the demand was considerable, the total consumption, allowing for rheostatic losses, was less with the induction motor than with the Ilgner system. They also showed that with the Ilgner system the power supplied to the terminals of the Ilgner set was equivalent to about 215 H.P., or about half the demand of the induction motor set, assuming that the load would be practically constant, although it would not be quite so in practice. The final result, therefore, was that the actual energy consumed with the balancer set slightly exceeded the consumption in the plant fitted with the induction motor. One had also to consider in dealing with any question of winding the desirability of making the winding plant as simple and as efficient as possible, and also capable of ready repair. With the Ilgner type of winding there was a certain

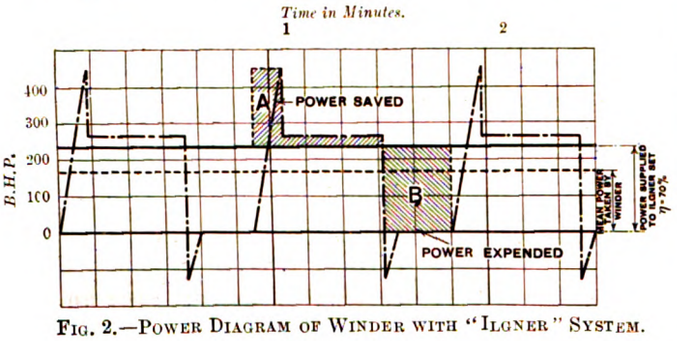

FIG. 2.—POWER DIAGRAM OF WINDER WITH "ILGNER" SYSTEM.

amount of risk due to there being so many links in the chain—*i.e.*, a motor on the balancer, heavy flywheel running in two bearings, a generator, and also the switchgear and the motor on the winding gear—all of which were liable to go wrong; and, as a matter of fact, he knew of one case where the colliery had been laid off for six weeks due to a burn-up of the motor on the balancer set. It would be an advantage if balancing were adopted if the balancing set could be designed so that it would enable the motor in case of emergency to take the supply from the mains direct; but if induction motors were used for this purpose, he considered that, in preference to using a high voltage on the winder motors, it would be desirable so to wind them as regards voltage that the windings could be as simple as possible, preferably plain copper bars in mica tubes with sweated end connections in both stator and rotor. This would render the machine almost perfect as regards simplicity and freedom from breakdown, and he did not consider that with a motor of this type the additional cost of the transformer which would be required would come to very much more than a high-tension motor. There was undoubtedly, not only in this country but abroad, a very big field for electric winding gears, and he had found from experience that for moderate outputs—which would cover a very large field—the geared type of winder with machine-cut helical gearing and moderately low-speed motor, formed a very efficient and satisfactory type of plant, and such an arrangement could be easily fitted with a simple induction motor with rheostatic control, forming, when the conditions of supply admitted, a very economical and satisfactory arrangement.

Mr. G. STJERNBERG could not quite agree with the author as to the efficiency of the induction motor wind. The efficiency with that system depended upon the number of winds. It would be measured not by the average or maximum speed, but by the energy used. The motor losses in both systems were not materially different. In the Ward-Leonard system he put the efficiency at about 0·73 and with the induction motor 0·8. If the ratio of the average speed to total time increased the efficiency decreased. With the Ward-Leonard system it decreased slowly, but with the induction motor quickly. A low limit for efficiency for the Ward-Leonard system would be 0·55, but with induction motors it would be something like 0·35. With the Ward-Leonard system there was no connection with the main circuit; it worked better, and was considered very safe indeed. As to brakes, perfect mechanical brakes were available. The energy stored in the sinking load would be, of course, entirely lost, but there was no limit to the load that could be let down the shaft.

Mr. G. STONEY referred to a 700 H.P. induction motor winder which had a peak load of about 1,700 H.P., and this caused a perceptible fluctuation at the power station, even when the total load was about 30,000 kw. If several winders of this class were connected to a power station it was likely that the fluctuation would be sufficient to be objectionable on lighting circuits. Of course, if a very large number of winders were connected the fluctuations would be much less, as in the case of large tramway stations. One point about the Ilgner system, apart from cost and efficiency, was that the maximum demand was reduced to about one-half. It seemed, therefore, to him that in some cases where there were four cages in the shaft and induction motor winders were used, it might be possible to arrange that one pair of cages were running while the other were standing, and this would bring about much steadier load, as in winders the periods of no-load were approximately equal to those of full-load.

Mr. C. H. GADSBY asked Mr. Patchell, with regard to the winding plant shown in one of the photographs, which plant appeared to have a direct-coupled motor and the winding drum to be some 12 ft. or 14 ft. in diameter. He had been recently engaged on the design of a somewhat similar scheme, and found that, to have anything in the way of a large winding drum gave an enormous rope velocity with any ordinary speed and a direct-coupled induction motor. He would be glad if Mr. Patchell would say what was the rope velocity and the speed of the induction motor in the instance shown.

Mr. B. M. JENKIN, in a written communication, said that it had been pointed out that the maximum demand on the supply when using the Ward-Leonard control system with the Ilgner flywheel was about one-half the demand when using the direct-connected induction motor. From this it was argued that with current from an outside supply the induction motor could be used, as the peak would have to be dealt with by the supply company. The charge for current, however, was often partly based on the maximum demand, so that the owner might wish to keep down the peak. On the other hand, with a private generating station, it would be cheaper to fit a flywheel to the generator and to design the latter with good inherent regulation, so that it could take the short peak load with only a comparatively small drop in speed and voltage. It was to a great extent, the flywheel in the Ilgner system that levelled the peak but it might be less costly to put this flywheel on the steam generator than on a separate motor generator, and practically the same result, of keeping down the size of the generating plant, was obtained.

Mr. R. LIVINGSTONE (communicated) agreed with the author as to the efficiency and ease of operation of the induction motor drive comparing favourably with regenerative systems having the Ward-Leonard control. The efficiency of the winding gear varied from 60 to 80 per cent., and the efficiency of the electrical gear between winding drum and power mains varied from 55 to 70 per cent. when a motor-generator set was used, so that the resulting overall efficiency was only 33 to 56 per cent. With good acceleration and moderately long winds this efficiency could be obtained with the single induction motor drive in spite of the large rheostat losses during acceleration and retardation. Gearing, however, was essential between the induction motor and the winding drum, if a motor having a good power factor and efficiency was used, since the winding drum could not be run at more than 120 revs. per min. for short winds of small power, and 65 revs. per min. for long winds of large power. An induction motor speed of 375 revs. per min. was consistent with good economy up to very large sizes (200 H.P.), but the necessary gearing might be a source of trouble. A common source of trouble in induction motor drives of winding drums or rolling mills was the slip regulator, and the most feasible scheme seemed to be the moving of the liquid in the resistance by means of powerful pumps rather than to move the plates of motors. High rates of acceleration were necessary if induction motors were to be economically used, but there was a point where increased capital cost of motor and gearing outweighed saving in current. He thought that best rates of acceleration would not vary considerably and would be 3 ft. to 5 ft. per second per second with current at ½d. to 1d. per unit. The connection of large winding plant direct to supply mains would necessitate in many cases a flywheel equaliser, and this would be a serious limit to the direct drive by induction motors. The author adhered to braking by means of the motor, but it was a question whether it would not be possible to design a mechanical brake with a suitable cooling device to absorb the energy lost in retardation.

Messrs. J. C. MACFARLANE and H. BURGE (communicated) thought t

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author had made the best of a bad case. They took exception to the assumption that the direct induction motor drive for winding engines was necessarily less costly than a converter system, and also that it was easy to get rid of the large amount of rheostatic waste energy. They put forward the following reasons why the converter system was preferred: Firstly, the current demand from the mains during acceleration was only one-third of that with the induction motor drive; secondly, the control was simpler; thirdly, regeneration was possible; fourthly, the efficiency was higher; and, lastly, these advantages were obtained with practically no addition to cost. They then described a system which they considered had many advantages over both the Ward-Leonard and induction motor drive. In this the three-phase supply was converted to direct current at variable voltage by a special motor generator. The direct current winding motor was shunt-wound with variable field strength arranged to be about twice as great at starting as at full speed. Two similar direct-current machines were also coupled together, the armature of the first being tapped to slip-rings connected to the supply, whilst the excitation of the second was supplied from the first and varied between a positive and negative maximum by a reversing field regulator. Each of these machines dealt with approximately half the power. The power demand was approximately constant and the power factor practically unity. The capital cost for a particular case (300 H.P. average power) was as follows: Induction motor drive £700, Ward-Leonard £850, proposed converter £650.

Mr. W. H. PATCHELL said doubtless the author would reply in the "Journal" to all the points raised, so he did not propose personally to deal with them. Mr. Heather when he prepared his Paper had the courage of his convictions, since he had many plants on order at that time. Personally he thought the question of whether the Ward-Leonard or the induction motor system should be adopted depended primarily upon where the current would be obtained. If a private generating station was to be erected they would not want to instal plant to supply the demand of a large winder driven by an induction motor; whereas the position might be reversed if a supply of power were available from a large station. Mr. Heather, of course, dealt with the subject from his point of view in South Africa, where large power stations were available, and he was able to buy current at a cheap rate. In a letter to the speaker Mr. Heather said his first Ward-Leonard winder was working well, and the power company viewed the winder with equanimity. In stage winding Mr. Patchell thought the direct coupled induction motor undoubtedly presented an immense advantage as regards space occupied if the supply company were prepared to stand the variations of load. Mr. Heather had mentioned the facility with which a winder attendant could be changed from steam to electric operation where the induction motor system was adopted. The preference the men taken off steam driving had for the electric winder was now quite common. The objection to balance ropes was chiefly the swing of the ropes. This swing was very great with a steam winder, but with an electric winder there was no swing at all, so that mining engineers would doubtless now appreciate the advantage of the balance rope. Replying to Mr. Gadsby, the diameter of the rope drum was 16 ft. and the maximum rope speed 63 ft. per second. The winder illustrated was working on a shaft of 516 yds. deep, and the useful load was 3 tons. The output was 1,800 tons per day, or about 200 tons per hour on the nine-hour day rating.

CORONATION EXHIBITION, SHEPHERD'S BUSH.

Notwithstanding that London will this summer be exceptionally well provided for in the way of exhibitions, the Coronation Exhibition at Shepherd's Bush, which was opened yesterday by H.R.H. Prince Arthur of Connaught, is likely to prove at least as popular as its predecessors. Although we hope at a later date to deal in detail with the exhibits of engineering and scientific interest, mention may now be made of the series of scientific exhibits. Judging from a preliminary inspection which, by the courtesy of the Exhibition authorities, we were able to make on Wednesday, it is evident that the science section will on the present occasion be a much more prominent feature of the Exhibition than in previous years. Much more space has certainly been devoted to this section, which comprises in addition to astronomy, meteorology, mathematics, chemistry and geology, &c., optics, mechanics, heat, physics, telegraphy and telephony. In each of these divisions there is an excellent collection of apparatus, and a feature is, for the first time, to be made of demonstrations and of apparatus in actual use. To indicate the extent to which this will be possible we may mention that two dark rooms are being constructed, one of which will be devoted to optical demonstrations, such as stroboscopic methods of measuring the speed of revolving shafts, whilst the second will be employed for demonstrating phenomena in connection with vacuum tubes and also X-ray work.

In the Mechanics division, we noticed Prof. Schwartz' machine for testing indiarubber; this apparatus will be shown in use. An apparatus to illustrate the small negative coefficient of expansion of invar is also being fitted up, whilst Dr. Shaw's electric micrometer will bring home to the general public the method by which measurements of the highest degree of accuracy can be obtained. A number of engineering models have also been lent for exhibition purposes, including some to illustrate alternating-current theory.

In the Heat division we may draw attention to the fact that two electric resistance furnaces will be shown; one by the Cambridge Scientific Instruments Co. will be used in connection with resistance thermometry and the Whipple indicator and various Féry radiation pyrometers, whilst the second, by Mr. R. W. Paul, will enable demonstrations to be made with his thermo-electric pyrometers and "unipivot" instruments.

In the Physics section, which has been organised by Dr. C. V. Drysdale, are included models illustrating the evolution of Lodge's rectifier valves for agriculture and X-ray work, and models by Messrs. Cossor showing the evolution of X-ray tubes. Among the instruments shown may also be mentioned universal shunts, woven wire resistances, vibration galvanometers, mutual inductance standards, a number of well-known Ayrton-Mather instruments, Dr. Drysdale's polyphase wattmeter, alternate current potentiometer, apparatus for measuring permeability, &c., &c. This last-mentioned apparatus is being exhibited by Mr. Tinsley, whilst other of the above-mentioned apparatus is being shown by Mr. R. W. Paul. Prof. T. Mather, F.R.S., has also loaned certain apparatus.

A special effort has been made to obtain a representative display of telegraphic and telephonic apparatus illustrative both of research and practice. The centre of interest is almost certain to be the Marconi transmitting and receiving stations, which visitors will be able to inspect whilst in operation; indeed, they will be permitted to send and receive messages between the two stations.

Mr. Tinsley shows a syphon recorder working on an artificial Atlantic cable, to illustrate various effects experienced in the transmission of telegraphic messages. Messrs. Burgess & Joly have arranged experiments to show the analysis of Morse signals, whilst Mr. B. S. Cohen exhibits apparatus in connection with telephonic transmission. Dr. Fleming has apparatus to illustrate the evolution of his cymometer; and finally we may mention Dr. Drysdale's vacuum tube experiments in connection with Messrs. Cossor to show the transmission of impulses along a helix.

In the above brief *resumé* it has been possible to do little more than indicate a small part of the multitude of apparatus to be found in the Science section, but sufficient has been said to show that visitors to the Exhibition will find in this section sufficient to occupy their attention for many hours.

As regards other sections, we must deal with these on a future occasion, but we may mention that the Education section promises to be of no little interest, and that the London County Council have a very interesting display. This includes one of their tramcars, a truck showing the arrangements of the gear, &c., and a most instructive collection of various ploughs, so that the whole method of operation of a tramcar is made clear, the ploughs being also shown in short sections of conduits.

At a luncheon given to the members of the Press on Wednesday last in the Banqueting Hall, on the occasion of the Press view of the Exhibition, Lord Blyth (vice-president and chairman of the Executive Council) presided over a large gathering. The toast of "Success to the Coronation Exhibition" was entrusted to Lord Rotherham, who made a very humorous speech, Mr. Kiralfy responding.

STATE CONTROL OF TELEPHONES.

On the 9th inst. the Postmaster-General received a deputation from the Liverpool Cotton Association on the subject of the future administration of the telephone service.

The deputation was introduced by Mr. Leslie Scott, K.C., M.P., and the Postmaster-General was accompanied by Capt. Norton, M.P., Sir Matthew Nathan and Mr. A. M. Ogilvie.

The POSTMASTER-GENERAL, in his remarks, said the number of telephone users was at present disproportionate to what it should be, and he looked to its being multiplied three or four-fold. The Post Office and its technical officers had been giving the most minute attention to every problem that could present itself in that connection. With respect to the suggestion that the telephone in the hands of the State might be starved, he said there had never been any difficulty in the provision of capital for the telegraphs, and they had already spent £11,000,000 on telephones also. The trunk service had been immensely developed. He should ask power in the Telephone Bill this year to raise several millions more (apart from the sum to be paid to the Company) for immediate development. He could not agree to the suggestion for a Telephone Committee or Telephone Authority, which could not get capital on easier terms than the Government.

As to the telegraph service, they could easily make the telegraphs pay by ceasing to provide telegraphic facilities in rural districts and by abolishing 6d. telegrams. The assertion that the Post Office was proved

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to be inefficient by the fact that it made a loss of £1,000,000 a year on the telegraphs was contradicted by the earning of a profit of £5,000,000 a year on the postal side. If the Telephone Authority were to take over the telegraphs as well as the telephones it would have to bear the million a year loss which was now paid out of the profit on the postal service. Telephony was a most expert business and highly technical, and on technical questions the suggested Committee or Authority, which would not, presumably, be a technical body, could not give an opinion which would be worth having. As to rates, they suggested that the Postmaster-General would be pressed by the House of Commons to reduce rates, and then they would have the loss on the telegrams repeated. There was a movement among Chambers of Commerce and similar bodies to retain the unremunerative flat rate, with the result that so far as the large user was concerned the telephone service would be run at a loss. There would always be pressure to reduce rates, and it would be the business of the Postmaster-General to prevent rates being put at such a point as would be unremunerative. He suggested that he should have the advice, unless the table of rates to be proposed by the Post Office was generally accepted, of a committee consisting largely of commercial men, who should go into the question of rates after the sum payable to the National Telephone Co. for their plant had been ascertained. The wishes of the deputation to that extent would be met, but a standing committee was a different matter. An Advisory Committee would have to rely as much on the highly efficient technical officers on the engineering side, on the traffic side, and on the staff side as the Postmaster-General had to do.

LONDON'S TRANSPORT FACILITIES.

Before a meeting of the City of London Tradesmen's Club, at St. Bride's Institute, London, on Thursday last week, Mr. A. W. Gattie opened a discussion on this subject.

Mr. GATTIE prefaced his remarks by a reference to the Paper which he read before the Royal Society of Arts on May 3 (and which was fully reported in THE ELECTRICIAN). He referred briefly to the building it is proposed to erect, and its approaches by road and rail, and said it was proposed to give a demonstration of the apparatus at Coventry a few weeks hence. A Royal Commission was appointed to deal with the street-traffic problem some eight years ago, and advised the expenditure of what he described as a preposterous amount of money on street widening. But nothing had been done. Recently the Board of Trade issued a Blue Book, again advising a lavish expenditure of money on street widening, but carefully avoiding the congested central area. There was a business remedy for the difficulty. Widening streets to allow further opportunities for the loitering of vans was an act of folly. We had also the highest freight rates in the world, impassable streets and railway companies paying either a paltry dividend or none at all. The core of the trouble was the slow-going, loitering or stationary van. The best results were to be obtained by putting the centre of distribution in the heart of the busy area. Mr. James Swinburne and Sir Wm. Preece raised no doubt as to the proposed apparatus being able to perform the work he (Mr. Gattie) claimed it would perform.

Mr. ALLAN RAMSAY (secretary of the club) supported Mr. Gattie's scheme heartily, and hoped it would prove a successful attempt to deal with the City-traffic problem.

Mr. JOB MORRIS referred to a scheme he prepared some years ago for carrying goods underground. That scheme was practically adopted by the London County Council in their tunnel under Kingsway, only they utilised it for passengers instead of for goods. Such a scheme as Mr. Gattie's, to be made perfect, must be adopted in its entirety. If the millions that had been spent on tubes for passengers had been spent on such a scheme as this the railways would have been available for passengers. He supported Mr. Gattie's scheme.

In reply to Mr. Geo. Alexander, Mr. GATTIE said it was not proposed to compensate the 800 firms of carriers, forwarding agents and carmen, but they could take shares in the New Transport Co.

Mr. PARKER referred to the chaos which existed at Billingsgate, and wished success to any scheme which could bring order out of it.

Mr. BURTT said it was absurd to send passengers underground and let the roads be occupied by waggons. The proposals for street widening were wicked. It seemed to say: "There is a lot of badly organised traffic, but go as you please and we will give you more room to go as you please."

Councillor THOS. DARRINGTON said Mr. Gattie's idea was an interesting and fascinating one, and they were to be congratulated upon having a gentleman with such a thorough knowledge of the subject to come and stimulate them upon it.

In reply to Mr. Chris. Robinson, Mr. GATTIE said the Clearing House and its cars could deal with the Smithfield meat trade more expeditiously than the vans at present used, but there would be no interference with the work of the markets. The Clearing House could unload a meat train as easily as a fish train. Mr. Cornell, the meat carrier, approved of the scheme.

In reply to Mr. WOOLLVEN, who asked as to the handling of perishable goods, Mr. GATTIE said the Clearing House could deal with 2,000 5-cwt. bales a minute and shunt 170 loads in 10 minutes. The New Transport Co. would be pleased to co-operate with the carriers. The rules for working the company's scheme would be made by the Board of Trade.

A resolution that "after hearing Mr. Gattie on the proposed scheme of a general Clearing House, the club endorses the principle and would support an inquiry by the Corporation of London" was carried unanimously, and a vote of thanks to Mr. Gattie was approved.

THE INSTITUTION OF ELECTRICAL ENGINEERS, BENEVOLENT FUND.

The thirteenth annual general meeting of the contributors to this fund will be held at the offices of the Institution of Electrical Engineers, Victoria-embankment, London, W.C., on Friday, May 26, 1911, at 4 p.m. The statement of accounts to December 31 last shows that the capital of the fund stands at £3,700 invested with the exception of £23. 11s. 6d. in cash. The income for the year is made up of annual subscriptions £95. 13s. 8d., donations £49. 3s. 2d., dividends and interest £120. 10s. 9d., balance as per last account £203. 15s. 11d., total £469. 3s. 6d Expenditure: Grants £51, transferred to capital £200, postages, &c., £2. 17s. 3d., balance down (cash) £215. 6s. 3d. The balance-sheet shows assets: Capital £3.700, from income account £215. 6s. 3d., sundry creditors £1. 11s., total £2,916. 17s-3d.

PARLIAMENTARY INTELLIGENCE.

BRIGHTON, HOVE & DISTRICT RAIL-LESS TRACTION BILL.

On Friday this bill came before a House of Lords Committee, presided over by the Duke of Bedford.

Mr. WEDDERBURN, K.C., for the promoters (the Brighton & Hove Omnibus Co.), said that power was sought to run rail-less cars along the cliffs between Ovingdean and Rottingdean, near Brighton, a distance of 2½ miles. Brighton Corporation opposed on the ground that they supplied water to Rottingdean, and there was danger of damage to the mains by reason of the weight of the cars. Every other local authority concerned supported the bill.

Mr. TALBOT, on behalf of the Corporation, claimed a right to be heard against the bill until it was amended to protect the interests of the Corporation. Parliamentary authority to sanction rail-less traction had hitherto been given only when it was an adjunct to existing tramways.

The Committee decided that the Corporation opposition should be limited to the clause relating to agreements with local authorities as to the supply of electrical energy. The bill might proceed.

MATLOCK DISTRICT RAIL-LESS TRACTION BILL.

On Friday the House of Lords Committee (presided over by the Duke of Bedford) rejected this bill.

Mr. ROBT. HAMMOND, who gave evidence on behalf of Matlock Bath Council (in oppositon to the bill) said the promoters had not made sufficient provision in the estimates for construction and working. Given proper care the system was safe, but if by any chance the "live" and "dead" wires "reversed" there would be danger to the public. The Committee gave no reason for their decision, but it is understood that they were influenced chiefly by the opposition of the local authorities and the alleged unsuitability of the roads for the working of the system.

As a result of the decision the promoters of a similar scheme for the Malvern district withdrew their bill.

ABERDARE URBAN DISTRICT COUNCIL BILL.

A House of Lords Committee (presided over by the Duke of Bedford) commenced on Monday the consideration of this Bill.

Mr. WEDDERBURN, K.C., for the promoters, said the object of the bill was to construct ordinary electric tramways (supplemented by rail-less traction), to make street improvements, &c. £47,000 was the estimated cost of the tramways. There was great necessity for tramways at Aberdare. The working of the tramways would, it was believed, result in profit. The proposal was to have a line of tramways about 2½ miles long with four rail-less routes running from the main line. Glamorgan County Council opposed chiefly because for ¾ mile one rail-less route would go over one of their narrow roads. Counsel denied that any danger would be caused. The opposition of the Taff Vale Co. was competition which, he said, Parliament did not listen in these days), danger in crossing their line, interference with signalling, and the probable necessity of the company having to pay rates in aid owing to the tramway not paying.

Mr. STEPHEN SELLON, engineer to the scheme, said Aberdare was a good field for tramway enterprise. There were no engineering difficulties. He had gone into the financial position, and came to the conclusion that the lines would yield a substantial profit. His estimate of the total cost of the tramways was £33,180, and the capital cost of providing the overhead equipment, cable and cars in respect of the rail-less traction £13. The question of level crossings over railways by tramways was provided for under the Tramways Act, 1870. As to the rail-less traction it was anticipated that about 1d. per passenger would be secured. The fare by rail-less trolley cars was proposed to be exactly the same as the tramcars.

Mr. J. B. HAMILTON (general manager of Leeds City tramways) supported the rail-less portion of the scheme, which he considered would be found to be a profitable undertaking when run in conjunction with tramways. Rail-less traction was admirably adapted to the needs of a town like Aberdare.

Mr. I. E. WINSLOW, consulting engineer and Mr. O WILLIAMS, surveyor to Aberdare Council, also gave evidence.

For the Taff Vale Railway Co. the manager (Mr. Beasley) and Mr. Hammond gave evidence in opposition to the tramway scheme.

Yesterday (Thursday) the Committee passed the tramway and rail-less trolley clauses.

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LONDON TELEPHONE EXCHANGES.

In the House of Commons on Tuesday, Mr. Astor asked the Postmaster-General whether the National Telephone Co. were refusing to connect applicants to the Gerrard Exchange, and whether the Post Office was refusing to connect applicants to the Mayfair Exchange.

Mr. H. SAMUEL said he understood the existing equipment of the National Company's Gerrard exchange was working at its full capacity; and the same was practically true of the Post Office Mayfair exchange. New apparatus was, however, being added at Mayfair to provide accommodation for additional subscribers, and was expected to be ready next month. As soon as the Gerrard exchange came into his hands, steps would be taken to provide additional accommodation there also. The Company stated that they are unable to undertake any extension at present.

METROPOLITAN ELECTRIC TRAMWAYS BILL.

On Wednesday a Select Committee of the House of Commons, presided over by Sir Luke White, passed the preamble of this Bill, the main objects of which are to reconstruct a bridge over the river Lea, and to construct additional tramways on the Middlesex side, &c. Essex County Council have undertaken the work of reconstructing the bridge and Middlesex County Council will construct the tramways which will run over the bridge and link up with the Walthamstow system. Tottenham Urban Council opposed the clause in the Bill which took away from them the right to purchase the tramways constructed in their area, but the Committee decided that the clause should remain.

PURCHASE OF LOTS-ROAD POWER STATION.

On Tuesday a House of Lords Committee passed this bill of the Metropolitan District and London Electric Railway Co.s for the transfer of Lots-road power station from the Underground Electric Railways of London to a joint committee of the two companies.

GREATER LONDON RAILWAY BILL.

The Select Committee of the House of Commons, presided over by Sir J. Compton-Rickett has continued the consideration of this Bill this week and has taken much evidence in support of its provisions.

NEWCASTLE-ON-TYNE CORPORATION BILL.

The tramway clauses of this Bill, which is being considered by a House of Commons Committee, were dealt with on Tuesday and Wednesday.

The tramways manager (Mr. E. HATTON) stated that the total cost of the proposed line from Scotswood to Throckley was £40,248. Eight cars would be provided for at a cost of £5,200, giving a 10 minutes' service morning and night and on Saturdays, and a 15 minutes' service otherwise.

The North-Eastern Rly. Co. opposed on the ground of competition.

After hearing the evidence, the Chairman (Mr. Helme) announced that the preamble, so far as it concerned the tramways, was proved; but in regard to the two proposed rail-less trolley routes the preamble had not been proved.

L.C.C. TRAMWAYS AND IMPROVEMENTS BILL.

A Select Committee of the House of Commons (presided over by Sir Luke White) has further considered this Bill during the week. The proposal to run tramways from the Marble Arch to Cricklewood, via the Edgware-road, was withdrawn.

Oldham & Saddleworth District Rail-less Traction Bill.—The promoters of this bill have notified that they do not intend to proceed further with the measure.

LEGAL INTELLIGENCE.

National Telephone Co. v. the Postmaster-General.

The Railway Commissioners (Mr. Justice A. T. Lawrence, the Hon. A. E. Gathorne-Hardy and Sir James Woodhouse) have continued the hearing of the application of the National Telephone Co. for a declaration that the terms of the agreement under which the lands, plant, buildings, &c., of the company are to be taken over by the Post Office should be construed in a wider and more liberal spirit than that now proposed to be adopted by the Postmaster-General.

Sir Alfred Cripps, K.C., Mr. Danckwerts, K.C., Mr. Morten, K.C., Mr. Ray Lankester, K.C., and Mr. Gaine appeared for the applicants; the Attorney-General, the Solicitor-General and Mr. Branson represented the Postmaster-General.

At the outset of the proceedings on Friday it was pointed out that it was of extreme importance that the arbitration should be practically completed before Aug. 1, 1911, as in the event of its being decided that the Postmaster-General was entitled to reject all duplicate exchanges it would require considerable time for Post Office exchanges to be adapted to the additional work required of them.

The Solicitor-General (Sir JOHN SIMON, K.C.) contended that in competitive areas the Government Department was bound to take over only such plant, &c., as was necessary for its "actual requirements" at the time of the transfer; while in non-competitive areas—that is, where the National Company alone had a service—the Government would feel bound to take over also plant and equipment reasonably provided for the extension of the service.

Mr. Justice LAWRENCE: If it is a fair bargain in non-competitive areas, why should it not be held a fair bargain in competitive areas?

The SOLICITOR-GENERAL: Because I have already provided myself in the competitive areas. It was (he continued) matter of common knowledge that the average use of the telephone in London is low, compared with cities on the Continent and elsewhere, and that a great increase may be anticipated. For that he had allowed in the competitive areas by making provision for the service of the whole of the population. But in a non-competitive area no such question arose. There the Department had to make provision for the plant provided by the company, and of that plant he only claimed the right to reject such as did not reach a specification set up by the Department.

Sir ALFRED CRIPPS said the obligation of the Postmaster-General was to buy "all plant, land and buildings . . . in use by the company on Dec. 31, 1911," subject only to the exception that plant not constructed in accordance with the prescribed regulations might be rejected, as might also be the plant in competitive areas which the P.M.G. should consider not to be suitable for the service he was giving on Dec. 31, 1911—that was to say, in the competitive areas it was possible the company might be working on one system and the Post Office on another. That contingency had been foreseen and consistently provided for throughout the 1905 agreement. If it had been intended to reject the whole of a duplicate system it would have been perfectly easy to have so agreed. There was nothing which required the word "suitable" to be changed into "necessary."

On Monday Sir ALEX. KENNEDY gave evidence on behalf of the company, and explained the working of the telephone service by means of photographs, instruments and models. He said the magneto machine was one of the earliest devices in telephones. Under that practice there was a subscriber's battery. Under the more modern system there was a central battery at the exchange. Witness himself approved of the local battery system, just as he preferred the hand microphone. He could not approve, he said, of the central battery system as established by the Post Office. The most expensive part of a telephone system was, naturally, the cables, &c., which would, in ordinary cases, account for two-thirds of the whole cost of construction. Telephone engineers had not so much to do with the conductivity of the wires as with their capacity for transmitting sounds, which was another and much more complex matter, and was at the bottom of all the schemes of telephonic circuitsand the ascertainment and photography of sound waves. He thought that was the great difficulty in the P.O. system. They had a great system of trunk wires, and in order to improve the audibility over long distances they had put up overhead wires. Sir Alexander gave evidence of the relative merits of insulating materials, and, after explaining the respective merits of gutta-percha and indiarubber, gave his opinion in favour of a dry paper sheathing. He thought the two former substances of very inferior value where high-frequency currents were employed. Besides the local battery system and the central battery system, witness said there was the automatic system. By the automatic system a subscriber could call up any other subscriber without the intervention of the exchange. Witness expressed his own opinion in favour of the local battery system. He understood there were 21 out of 63 exchanges belonging to the National Company within the London area which had been rejected by the Postmaster-General. He was given to understand that all their 21 rejected stations were fitted with the local battery system, and that formed one of the grounds of their rejection by the Postmaster-General. He believed a central battery might be preferable for large exchanges, but he did not think it was at all recognised that they were the best for small exchanges. Purley was an example of the small new exchanges in which the central system had not been adopted.

Major W. A. J. O'MEARA, C.M.G., engineer-in-chief of the Post Office, said that under the Post Office system there was no reason why two subscribers on a private wire should ever have their communications pass through an exchange at all, and it was a more economical system for the subscriber. Direct communication could be established through what might be called a "sorting frame." With the aid of certain apparatus set up in Court witness gave a demonstration of how those private wires should communicate without passing through an exchange.

Replying to questions by Sir Alfred Cripps, Major O'Meara gave examples of how, by the magneto system, it might be difficult or impossible for the person at the exchange to say when one or the other of the persons communicating over the wire had rung off, which would not be possible under the Post Office system.

Sir Alfred Cripps asked if the private wires were not always tested in the exchange, to which the witness replied that it was not so, as a matter of fact.

Sir ALFRED CRIPPS: But if the wires were laid into your exchange you would test them there?

WITNESS: If they were there they would naturally be tested. Witness further stated that the Post Office expected to take over 100 private wires working through the City and central exchanges, through which about 19,000 wires passed.

Major O'MEARA was further cross-examined in order to show that many of the clauses in the notices of rejection given by the Government

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to the company conflicted with each other. Witness said he believed Southall and Purley were the only two exchanges that had been established since 1907. A number of questions were put as to the definition of the "equipment" of an exchange.

Sir ALFRED CRIPPS: Is everything that you find in an exchange, apart from the wires, part of the equipment?—At a certain point a cable comes into the exchange, that cable has to be attached to some structure, and that structure and everything inward is a part of the equipment.

Mr. Justice LAWRENCE: And when you say "equipment" you mean to use it in the wider sense of the machinery necessary to communicate along the system?—Yes.

Sir ALFRED CRIPPS: You make a distinction between iron wires in competitive and iron wires in non-competitive areas. In the one case you say "wires forming part of any telegraphic lines," in the other you say "iron wires forming part of any telegraphic circuit"?—Yes, the iron wires carrying a current in any telegraphic circuit.

Are there not numerous iron wires which are not part of a telephonic circuit?—That may be so. The transformer has iron wires around it, and these are not iron wires in the sense of carrying the current as part of the circuit.

Mr. Justice LAWRENCE: Is iron wire used in a telegraphic line which is not part of the circuit?—Yes.

Sir ALFRED CRIPPS: Do you suggest that iron wires used for the purposes of attachment, as stay wires, &c., should be rejected?—Yes, if the line is rejected.

Mr. Justice LAWRENCE: Let me ask whether a distinction is drawn between iron wire forming part of a telephonic line in the competitive area and iron wire forming part of a telephonic circuit in a non-competitive area?—Iron wire is objected to when it forms part of a circuit and the line is part of the circuit.

His LORDSHIP: So far as I can see, your only objection would be to iron wire forming a part of the circuit?—Forming part of the conducting circuit. It does not refer to that which is used mechanically.

Counsel then referred to the clause in the notice of rejection given by the Post Office to the company which specifies "all instruments, wires and apparatus which fail to satisfy the tests of audibility" specified in the agreement, and asked: If a particular wire did not satisfy the test of audibility, that would be a question of finding out the fault and setting it right?—It might or it might not.

With reference to another notice of rejection in the case of wires carried over an electric railway, Major O'Meara said that would only refer to the section of the line crossing the railway, but all lines carried along an electric railway in such a manner as to afford any danger of contact would be rejected. The portion of the line which was not rejected would be retained. In respect to lines along electric railways, witness said that whether they were overhead or underground they were subject to the notice of rejection. The Post Office itself, he said, had dispensed with all its lines along electric railways and subways in which electricity was used. The notice did not apply only to electric railways; it was given on the ground of want of access.

Sir ALFRED CRIPPS: In your notice you say you exclude "all plant not constructed in accordance with the specification and rules," but the agreement allows for the bringing of such plant under the consideration of the valuation tribunal. How are you going to do that if you start by ruling all such plant out?—If the plant has not been constructed in accordance with the rules and specifications then there is the notice to exclude it.

Have you taken any steps to ascertain what plant, if any, has been so constructed?—I think that is an impossible task at the present time.

Do you mean that you have taken no steps to ascertain whether any of the Telephone Company's plant will come within this objection?—You have already told the Court the number of officers engaged in carrying out this process. It is quite impossible to get any idea of what plant is in existence in the way you suggest.

His LORDSHIP: Does it come to this, then, that the notice is given by way of precaution in case any of the plant should not be constructed in accordance with the rules and specification?—Quite so; it identifies the class of article. The matter had to be decided by June 30.

His LORDSHIP: But you cannot decide until you know what it is you have to come to a decision upon.

WITNESS submitted that that was a matter for the Court.

In re-examination, Witness said that the reason of the objection taken to telephone wires across or along railways which were worked by electric power was that the wires were liable to come into contact with the railway cables which carried dangerous current, and persons using the telephone wire might receive a dangerous shock. Careless workmen, for instance, on an electric railway might easily cause a contact between the live rail or wire and the telephone wire with dangerous results.

In answer to his LORDSHIP, Witness said there had been an increase of 80 per cent. in the development of the London Post Office telephone service since 1902. Since 1905 the number of stations had increased 43 per cent.

Sir JAMES WOODHOUSE: The National Company, I suppose, has developed at an even greater ratio?

Sir ALFRED CRIPPS: It has doubled in the last eight years.

In answer to further questions by his LORDSHIP, Witness said that when the Post Office decided to take up any portion of their line in the case of underground cables, the cable would be taken up and sold for market value, but it was found to be cheaper to leave the disused conduit in the ground. In the case of the overhead wire, the poles would be taken down, and, if nearly new, would be used in connection with some other part of the system; but if the poles were old they would be sold on the ground for what they would fetch. In the case of iron wire (which would only be used in telegraphic work), if it were too old, it would be buried at the spot where it was taken down, but where it was worth it, or in the case of copper and bronze wire, it was sold for its market value. It was seldom worth while to use the wire again.

Sir RUFUS ISAACS then opened his argument upon the contention of applicants that the notices of objection were invalid. What was contemplated, he said, was that when a notice was given the Court should pronounce an opinion on it.

His LORDSHIP: But if the notice given is so bad that the Court cannot pronounce upon it, what are we to do?

The ATTORNEY-GENERAL: The contention here is that the notice does not sufficiently identify, that it is too vague and not comprehensive. I submit that the notice given is sufficient to be understood by persons dealing with the same subject-matter, and they would know to what particular class the notice referred. Of course, if the Court thought some limiting words should be inserted, it had the power to do so.

Sir ALFRED CRIPPS, replying on behalf of the National Co., said if the arrangement were that the property of the Company was to be taken over on "tramway" terms, then all classes would be included prima facie. But there was introduced a procedure under which the Post Office claimed to exclude certain classes of property from the valuation, and it was to make provision for that that the agreement was made. The notices of exceptions given by the Post Office should show what the particular items of plant, &c., were which they claimed to have excluded from the inventory. It was not sufficient for the Postmaster-General to say that the matter was difficult. In substance the Postmaster-General was trying to throw on the National Co. the onus of clearing up that extremely difficult question by saying what was or was not specified for rejection in the notices. On the contrary, the Postmaster-General ought to specifically declare what he would or would not accept. There were three questions by which these notices must be tested: (1) Do they give the National Telephone Co. the information to which it is entitled? (2) Do they give the valuer the notice to which he is entitled? (3) Do they give this court the information to which it is entitled? In none of these matters could the validity of the notices be sustained. The question had been practically discussed as a whole upon the notice referring to the London area which was by far the largest and most important. Any matter at issue in respect of the other areas was capable of adjustment. He argued that the notice was bad, as a whole, but, alternatively, he said that, if the Commission was against him on that point they might decide that it was bad in particular parts.

The Commissioners intimated that they would visit the Avenue and Gerrard (London) exchanges to make a practical examination of the effect of the agreement and notices of rejection.

Yesterday (Thursday) the ATTORNEY-GENERAL submitted that the notice of exception was sufficient if it defined classes of material to be rejected.

Mr. Justice LAWRENCE: Is it sufficient to say you will take over all except such as have some defect?

COUNSEL said he did not think that any engineer could have any difficulty in deciding the subjects to which objection was taken. He submitted that there was nothing to prevent the Court from saying that the effect of any paragraph was to be limited. He agreed that the Court could not amend the notice of objection by extending it, but it was a fallacy to say that they could not limit the scope of the objection. He submitted that the notice No. 2 (dealing with particular localities and exchange areas) was sufficiently specific to indicate, not only the locality but also the character of the things objected to.

Mr. Justice LAWRENCE intimated that the Commission would deliver its judgment on the subject as soon as possible.

Johannesburg Municipal Council v. D. Stewart & Co. (1902) (Ltd.

In the Court of Session, Edinburgh, on Saturday, Lord Ormidale heard counsel on a motion by defendants to adjourn the proof in this action for the recovery of £400,000 damages for alleged breach of contract in connection with the supply of gas plant for generating electricity.

Mr. MORISON, K.C., for plaintiffs, said defendants had recovered 12,000 documents, only a small proportion of which had any bearing on the abandonment of the contract. Delay would involve his clients in great hardship and serious expense. Several witnesses were on their way to this country, and his clients had had to make considerable readjustments of staff to allow their officials to get away.

Mr. MURRAY, K.C., for defendants, denied that the motion was made purely for delay. A special staff of ten or a dozen typists had been engaged upon the productions since the middle of February, and had not yet completed their task, and he was told that, so far as counsel were concerned, it would take a fortnight to even read the papers.

Mr. CLYDE, K.C., for plaintiffs, said defendants had £143,095 of plaintiffs' money in their pockets. If plaintiffs were right, that money would have to be paid back to them, and plaintiffs were apprehensive of delay. If defendants put the £143,095 on the table of the court, they could have their delay, but he opposed the motion on any other conditions.

His LORDSHIP granted the motion, subject to the right of plaintiffs to recover any expenses which the delay entailed. Leave to reclaim was granted.

Hastings & District Electric Tramways Co. (Ltd.)—On Tuesday Mr. Justice Neville granted the petition for the reduction of capital from £500,000 to £372,942. 10s.

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COMMERCIAL AND INDUSTRIAL SECTION.

MUNICIPAL, FOREIGN & GENERAL NOTES.

BRITISH NOTES.

Amalgamated Society of Engineers.—The 60th annual report (for 1910) states that at the end of the year there were 110,733 members, an increase of 3,593 over 1909.

The income from all sources to the general fund was £422,797, against £399,406, increase £23,391. The contributions, fines and levies amounted to £390,649, compared with £370,756. The amount received from entrances was £3,262, an increase of £168, while interest from the fund was £19,195, a decrease of £2,472. The superannuation reserve fund started the year with an accumulated fund of £382,046, and finished with £415,858, an increase of £33,811, while the increase for 1909 was £32,114. The general secretary (Mr. Jenkin Jones) states that this "establishes beyond doubt the absolute security of an old age pension to our members." The combined value of the funds at the close of the year was an increase of £24,956. The cost for donation benefit was £92,067 less than in 1909, whilst the amount paid for contingent benefit was £3,221, compared with £3,211 for 1909. The amount spent in sick benefit was £9,061, £752 less than in 1909. £142,491 was paid for superannuation benefit, increase £5,694. The applications for benevolent grants were considerably less, and the total amount granted was £5,267, against £9,009 for 1909, but the branches abroad who levy themselves paid £282, so the actual amount granted by the council was £4,985.

In regard to the question of maintaining the Parliamentary contingent, the report states: "We are now relying on voluntary subscriptions from the members for the maintenance of our two members, and it is very regrettable to state that the amount of subscriptions received is not encouraging." As to the National Insurance Bill, the general secretary states "that at this moment very important legislation involving two schemes, which probably will require from the workmen 4d. per week for one scheme and 3d. per week for the other, and further contributions from the State and the employer, is proposed. The proposed schemes of the Government are new, but they are highly important, and may have adverse effect from the trade union point of view, and we shall be deeply disappointed, as it may mean another 7d. per week, which must come from the wage of the workman, and which unquestionably requires the watchful eye of the Labour Party and our friends to see that justice is done to the trade unions."

Arc Lamps on Approval.—Owing to the diversity in practice regarding the sending out of arc lamps on approval, and the letting out of arc lamps on hire and hire purchase, the National Electrical Manufacturers' Association have issued the following rules in the hope of producing uniformity in these matters:—

Conditions on which Arc Lamps are to be supplied on Approval or on Hire.

ARC LAMPS ON APPROVAL.

1. *Charge for the Use of the Lamps and Carbons.*—No charge is made for the use of lamps during the approval period, and each lamp will be provided with one trim of carbons. All further carbons used must be paid for.

2. *Use of the Apparatus.*—The lamps must be properly erected in accordance with our instructions and burnt with the carbons which we supply with them. No larger current or higher voltage must be used with the apparatus beyond that stated on the instructions sent with it or in the catalogue.

3. *Packing.*—The goods will be sent properly packed carriage paid to your address, and are to be returned properly packed in the same manner and in original case in which they were delivered, carriage paid to our works, together with an advice note within the time period agreed. Should they be detained longer, we shall be entitled to consider the lamps as definitely purchased by you.

4. *Damage to Lamps.*—The lamps when returned to our works will be inspected, and you will be notified within five days from receipt of the goods as to any breakages or repairs that are necessary, other than those due to fair wear and tear, and these are to be paid for at the usual rates.

5. *Insurance of Goods.*—From the time the lamps reach you to the time of their return to our works they are to be held in trust and insured against fire and theft by you.

ARC LAMPS ON HIRE

(Arc lamps on hire for electrical exhibitions are excluded).

1. *Carbons.*—All carbons supplied are to be paid for.

2. *Carriage.*—The total costs of freight and carriage from the works to the user and back again to be paid by the hirer.

3. *Packing.*—The goods to be sent properly packed by the maker, and also to be returned properly packed in the same manner in the cases in which they were despatched, carriage paid to the maker's works, a suitable advice note of despatch being sent.

4. *Damage.*—The lamps when returned to the maker will be inspected, and the hirer will be notified within five days from receipt of the goods as to any breakages or repairs that are necessary, other than fair wear and tear, and these are to be paid for at the usual rates.

5. *Use of the Apparatus.*—The lamps must be properly erected in accordance with instructions and burnt with the carbons which the makers recommend. No larger current nor higher voltage must be used with the apparatus beyond that stated on the instructions sent with it or in the catalogue.

6. *Loss or Damage of Goods.*—From the time the lamps reach the hirer to the time of their return to the maker they are held in trust by the hirer, who will be responsible for any loss or damage which may occur.

7. *Period of Hire.*—The period of hire shall be reckoned from the time the goods leave the maker to the date they are received by him.

8. *Wiring.*—The hiring prices do not include the cost of wiring for or fixing the lamps and resistances.

9. *Hire Purchase.*—These conditions do not apply to lamps supplied on signed hire-purchase agreements.

Barnes.—The L.G. Board have sanctioned the borrowing of £8,600 for additional generating plant.

Coronation Illuminations.—At *Birmingham* the Council House will be illuminated by the electricity department and the Town Hall by the gas department at Coronation time.—*Taunton* Council have sanctioned expenditure for the electrical illumination of the Municipal Buildings and Vivary Park on the evening of Coronation day.—*Norwich* Electricity Committee announce that they will supply current free for public or private illuminations on Coronation day and on the occasion of the King's visit and at ½d. per 8 c.p. lamp per night on other nights. The Castle, Municipal Buildings and Guildhall will be extensively illuminated.—*Southampton* Corporation are spending £200 on the illumination of the public buildings.—*Nelson* municipal electricity department will supply current at 2d. per unit for illumination purposes on Coronation day, the consumers also paying for the fixing of temporary meters.—*Blackburn* Council have decided to supply current free for Coronation illuminations, the devices for which are submitted by May 31 and approved by their electrical engineer.

Coventry.—At the meeting of the Electric Light Committee last week it was reported that the profit on the past year's working of the electricity department was £16,400.

The plant recently installed at the electricity works was officially inspected by members of the Council and others last week. The plant includes a 3,330 k.v.a. two-phase 50-cycle turbo-alternator, with direct-coupled exciter (by the British Thomson-Houston Co.), surface condensing plant, &c.

Electricity in Mining.—At the meeting of the Kent Coal Concessions (Ltd.) last week the chairman (Mr. Hy. A. Johnston) said that their parliamentary bill for obtaining a transfer of some of the statutory powers of the Kent Electric Power Co., and which would enable them to supply electric power to all their pits, was now unopposed. The first of the power stations was now in course of erection at Tilmanstone, and, according to guarantees, would be actually working by July 8. Those power stations would not only supply their own collieries—they were now indispensable to coal mining—but would attract manufacturers and provide them with cheap power, and enable their company probably to dispose of all their "small" coal.

Glasgow.—Last week the Corporation adopted the recommendation of the Special Sub-Committee on the improved light of the city that, with a view to ascertaining the relative lighting values of the proposed lamps, the pillars at present fitted with electric arc lamps in Argyle-street, Trongate, Sauchiehall-street, Renfield-street, Union-street and Jamaica-street be fitted with the new Metroflame arc lamp, and that an installation of high-pressure gas lighting be made in the streets surrounding the new Mitchell Library and St-Andrew's Halls, also in Granville-street, North-street, and Bath-street, at a cost of £475 for pillars and lamps.

Heckmondwike.—The adjourned inquiry into the application of the Council for permission to borrow £24,159 for the electricity undertaking was held last week. The inspector, Mr. H. R. Hooper, went carefully through the accounts of the undertaking, and evidence was given by the clerk, Mr. Macaulay, and the electrical engineer, Mr. G. H. Carter.

Ilkley.—The Council, who have been considering an electricity scheme prepared by Mr. J. W. Speight, have decided to send a deputation to interview the Board of Trade in reference to an application for a new provisional order.

Mr. Speight estimated the cost of the works at £6,324, but by using town gas instead of suction gas, and only laying distributing mains in the compulsory area, the expenditure would be reduced to £5,024. The annual expenses would be £967, and the first year receipts £1,013. 5s. 5d., leaving a net profit of £46.

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Income Tax Reform League.—An interesting memorandum on "Wasting Assets and Income Tax" has been issued by this League, whose secretary and offices are Mr. G. O. Parsons, F.C.I.S., 25, Abchurch-lane, London, E.C.

Light Railways.—The Board of Trade have confirmed the Blackburn, Whalley and Padiham Light Railways (Revival and Extension of Time) Order, 1911.

Manchester.—At the meeting of the Council last week the annual estimates were submitted and adjusted, and the Electricity Committee suggested that they should hand over £19,496 in relief of rates.

Ald. GOLDSCHMIDT moved that this amount be increased to £24,500.

The Chairman (Mr. HOWARTH) said he did not see how it was possible to increase the amount. Unlike other Committees, they could not put off certain works.

The Committee's proposal was adopted.

The contribution of the Tramways Committee in relief of rates was then discussed.

Ald. GOLDSCHMIDT moved that the proposed contribution be increased by £10,000.

Ald. WILSON said a large sum of money would be required for improvements. If they handed over over all that money in relief of rates it would mean considerable delay in the development of their undertakings.

Mr. JOHNSON: I shall never be satisfied till the Tramways Committee give £100,000 in relief of rates.

Ald. BOWES, chairman of the Committee, said the Committee had always been very generous in their contributions. The question had been most carefully considered and they had come to the conclusion that they could not offer more than £75,000.

After further discussion this was increased to £85,000.

Mansfield.—An inquiry was held on Wednesday into the application of the Council for sanction to borrow £4,000 for extensions of the electricity undertaking.

Marylebone (London).—The charge made for fuse replacements is to be discontinued, except in special circumstances.

The general manager (Mr. A. Hugh Seabrook), in reporting upon the conversion of gas lamps to electricity states that the estimate for the work was £20,900, while the actual cost was £18,313. The estimated number of lamps to be converted was 1,385, the actual number being 1,371. The saving in cost against the estimate would have been greater had not local labour been employed, as the department started with £1,500 in hand by purchasing materials below the estimated figures.

Middleham (Yorks.)—A ratepayers' resolution has been passed in favour of public electric lighting. Two tenders have been received, one from a local trader for electric lighting (with 50 c.p. lamps), for £37 a year, the other from the Middleham Gas Co. (with 12-14 c.p. gas lamps), for £40. Current will also be supplied for private lighting.

Municipal Fire Insurance.—A ta meeting of Glasgow Corporation last week the recommendations of a committee appointed to consider the advisability of the Corporation creating a fire insurance department and taking all risks in regard to Corporation insurance against fire were adopted by 32 to 29 votes. During the discussion it was stated that in the last four years between £18,000 and £19,000 had been contributed to the insurance companies in fire premiums, while the fire claims did not exceed £500.

Municipal Telephony.—At the meeting of Hull Telephone Committee on Monday the manager (Mr. T. Holme) presented a report on the work of the department for the year ended March 31 last.

The gross receipts amounted to £12,550, an increase of £880 over 1909-10, and the gross profit (£5,026) showed an increase of £203. The total amount carried to loan repayment account was £6,976, to sinking fund £2,802 and to reserve (including last year's surplus of £1,323) £5,873, making a total of £15,651, or one-fourth of the capital outlay. The royalty paid to the Government last year was £1,258, bringing the total royalties to £6,224. Gross profit has increased from 6·3 per cent. in 1906 to 8·1 per cent. last year. The capital expenditure during the year was £1,186. The cost per station now stands at £19·95, compared with £20·58 last year, and was below the estimate of £20 given by Mr. A. R. Bennett at the L.G. Board inquiry. The scheme for 3,070 stations has been completed, with over £2,500 of the loans unexpended.

The report of the accountant (Mr. W. H. Smith) states that the ratable value increased from £225 to £723, an additional burden of £207. 15s. After meeting interest, repayment charges and income tax, the net profit was £1,168. 4s. 9d. The results were obtained with a flat rate of £5. 5s. (£5 for private houses).

Norwich.—On Tuesday a special Committee was appointed to consider and report upon the offer of the Norwich Electric Tramways Co. to sell their undertaking to the Corporation.

Presentations.—The directors and secretary of the Carmarthen Electric Light Supply Co. have presented their manager (Mr. Thomas d'Arcy Nassau) with a silver rose bowl on the occasion of his marriage.

Harrogate electricity staff have presented a gold watch to Mr. W. Firth, who is leaving for Australia.

Provisional Orders Revocation.—The Board of Trade have revoked the Newark Electric Lighting Order, 1900, and the Newark Electric Lighting (Amendment) Order, 1907, as from May 9.

Rotherham.—An unopposed inquiry was held on Tuesday into the Council's application for sanction to borrow £27,832 for extensions of the electricity undertaking.

Evidence was given by the Town Clerk and the Borough Electrical Engineer. The Town Clerk said there were 520 consumers and last year 2,669,727 units were sold. The capital expended was £58,310, of which £12,509 had been repaid. The gross revenue was £17,510, working expenses £9,665, interest £2,227, repayment of principal £1,880, net profit £3,740, renewals fund £12,153; total cost per unit sold 1·237d., average price per unit 1·573d. £2,000 of this year's profits had been applied in relief of rates.

South Shields.—An inquiry was held last week into the application of the Council for sanction to borrow £8,960 for extensions of the electricity undertaking.

Mr. FLEETWOOD PRITCHARD, for the Council, said that after what took place at the last inquiry, the borough electrical engineer (Mr. J. H. Cawthra) was instructed to consider whether it would not be advisable to go in for a much bolder and more comprehensive scheme than that put forward on the last occasion, with a view to not only providing the necessary extension of plant, but also effecting greater economy in working. The outcome was the scheme now submitted, and which had been approved by Mr. J. F. C. Snell, the Corporation's consulting engineer. He referred to a letter of the County of Durham Electric Power Supply Co. offering to limit the supply of three-phase power to that which Smith's Dock Co. might require, any further supply of three-phase current being given only with the consent of the Corporation, and intimated that they were prepared to modify their proposals to such an extent as would enable the Corporation to make a saving of £1,500 per annum.

In reply to the inspector (Mr. H. R. Hooper), Mr. SHAW (for Smith's Dock Co.) agreed that the position now was amended to the extent that the proposals which the company were now prepared to submit would effect a saving to the Corporation of £1,500 on the proposals which the Corporation submitted at the last inquiry.

Mr. J. F. C. SNELL outlined the new scheme, which he considered an admirable engineering proposition, which would prove advantageous to the Corporation and result in considerable economy. He felt bound, after a most exhaustive consideration of the situation, to advise the Corporation not to entertain the company's proposals. The reserve fund, out of which it was proposed to take £2,500, now stood at about £10,000. The new scheme would necessitate the removal of two 100 kw. reciprocating sets, upon which the capital still undischarged was £2,500. That, however, would obviate the necessity of extending the buildings.

In reply to Mr. Shaw, Mr. SNELL admitted that, in view of the new scheme, it was a good thing for the Corporation that the last application was not approved. He did not suggest that it was unreasonable for Smith's Dock Co. to want three-phase current for their docks, but they would not gain anything by having it.

Mr. SHAW said that the Dock Co. had the advice of their consulting engineer to the contrary, and they had had the current in use at their other docks at Tynemouth and Middlesbrough for years.

It was intimated by Mr. SHAW that the County of Durham Co. were prepared to meet the Corporation's criticism of their proposals on the points to which the Corporation attached most importance, one of which was in regard to dual control, and to make a new offer which would be an amendment of the third alternative proposal originally submitted.

Mr. J. H. CAWTHRA also gave evidence.

Mr. SHAW, for the opponents, said the Dock Co. were large consumers, and were anxious to have a supply of three-phase current, which they thought was the best for them. The Supply Co. was willing to give that supply.

Mr. R. P. SLOAN outlined the new proposals of the County of Durham Co., which the Corporation had declined. In their latest offer the company were willing to modify the 21 years' agreement provided for in the original proposals to any extent the Corporation desired. He had calculated that in 1915, under the company's scheme, there would be a saving to the Corporation of £272 per annum. His company wished to have power to supply three-phase current to Smith's Dock, but to no other consumer except by the Corporation's consent and to be permitted to instal such converting plant as might be necessary from time to time in the Corporation's power station, the Corporation to supply the accomodation free of charge. The company also desired power to hire out motors to consumers who wished to have them, that being a branch of the undertaking which the Corporation had not touched hitherto. The company further proposed to instal rotary plant and lay cables sufficient to produce power to the extent of at least 3,000 kw., which was twice the amount of power that would be obtained under the Corporation's scheme. The whole of the plant and cables so installed would become the immediate property of the Corporation. The total value of those works would be approximately £15,500, towards which the Corporation was asked to pay £10,080, the amount which they proposed to spend on their own scheme. The reason the company was prepared to do that was that they knew quite well that the Corporation would not spend such an amount of money unless they intended to use the plant, and to use the plant meant to take supply from the company.

Mr. SNELL, recalled, cirticised the company's proposals. There would, he said, be considerable difficulty in converting three-phase into single-phase energy, and there would not be the same reliability of supply which there would be under the Corporation's scheme. He thought the Corporation would be extremely foolish for the saving of £272 per annum to hand over the whole control of their power station to a local company, and not to retain the whole thing in their own hands. It was a question of terms, of course, and if sufficiently generous terms were offered by the company he might not be inclined to object to the Corporation accepting

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them, but on the terms offered it was not worth the Corporation's while, and he could not advise them to place themselves in the hands of the company.

After counsel had addressed the inspector the inquiry closed.

Southampton.—The borough electrical engineer (Mr. H. F. Street) has reported that the department frequently receive applications from ratepayers for supply of electricity through slot meters.

The hire purchase scheme in force does not meet the wishes of these applicants, and they insist on either having a scheme on similar lines to that inaugurated by the gas company or nothing at all, and the department has in this way lost a number of profitable customers. He recommends the adoption of both the slot meter system and the rental system, giving customers the option of either. The Electricity Committee have adopted Mr. Street's proposals.

Truro.—The Council have informed Messrs. J. B. Saunders & Co. they will be prepared to entertain the question of public electric that lighting for a number of years, provided the firm make suitable arrangements for the erection of electricity works.

Wimbledon.—A Committee has been appointed to confer with representatives of the Wimbledon Traders' Association, who demand a reduction in the price of current supplied for outside arc lighting.

Winchester.—The County Council have decided to wire the great hall of Winchester Castle at a cost of £100.

Wireless Telegraph Notes.—Another grand piece of work has been accomplished by the saving grace of wireless telegraphy. A report from New York states that the Ward line steamer "Merida," on the night of Thursday last week, off Cape Charles, Virginia, was in collision with a fruit ship, and sunk five hours after the collision, all her passengers and crew being reported saved. The "Merida" was a vessel of 4,000 tons and had 210 passengers on board. In calm but thick weather the fruit boat (the "Admiral Farragut") of 1,300 tons, loomed up in the darkness, and struck the other vessel heavily amidships. Great panic prevailed on board the "Merida," which, however, being equipped with wireless apparatus, sent out calls for assistance, and intercepted the U.S. battleship "Iowa," which was successful in saving more than 300 of her passengers and crew. Another vessel, the "Hamilton," also responded, and in due course the passengers and crew of the "Merida" were transferred to the merchant ship. All the passengers' baggage was lost, and there is some doubts as to the fate of the captain and four officers of the "Merida."

Workhouse Lighting.—The Essington Board of Guardians have agreed to obtain a specification from Messrs. Vesey Brown & Hall for the electric lighting of the workhouse.

York.—An inquiry was held here last week into the application of the Corporation for sanction to borrow £15,000 for extensions of the electricity undertaking.

The city accountant (Mr. J. W. Davison) having given statistics as to borrowing powers and the financial position of the undertaking,

Mr. Councillor (Mr. H. Craven) said that extensions were required to meet the demands for electric lighting and power and for the supply of current to the tramways. The department had now well turned the corner and was doing well. Several large consumers were negotiating with them for power supply from the Corporation instead of generating their own energy as at present, and arrangements had been made with some of these. The last extension of plant was made in 1904–5, in which year the units sold totalled 904,000. Last year they sold over 1,500,000 units, and the engineer estimated that this year the number would reach 2,500,000, and next year would be approximately 4,000,000 units.

Mr. J. W. Hawe, city electrical engineer, supplied technical details.

The Town Clerk, in answer to the inspector (Mr. H. R. Hooper), said that the reserve fund was £1,128. 14s. 5d., and of that the Corporation had just taken £800 in relief of rates. The undertaking had had £8,000 from the rates.

The Inspector: It is clear it would be much better to have put it to reserve, for it is badly needed. The ½d. in the £ (represented by the £800) will not do anybody any good. It certainly did not help the poor man, because it did not make any difference to him. He paid so much for his rates (including rates) and, if there was any deduction, he did not get any benefit. Cheap power and light was the best thing the city could have, and as an engineer with some knowledge of their station, he should have thought that the £800 would have been better left to the credit of the undertaking than placed to reduction of rates.

On the suggestion of the inspector the application was reduced by £137, the amount unexpended on the switchboard.

The London Electrical Engineers.—The third annual Athletic Sports of this unit of the Territorial Force were held at the London Caledonian Athletic Grounds, Herne Hill, on Wednesday last. The officials included: *Referee*, Major A. E. Le Rossignol; *Judges*: Major H. S. Phillips, Capt. W. H. Merrett, Capt. K. Edgcumbe and 2nd Lieut. H. C. C. Tufnell, and *Timekeeper*: Capt. P. H. Cornish, R.E. The various events with their winners were as follows:—*100 Yds. Race*, Sap. G. M. Drake; *Quarter Mile Cycling Race*, Sap. A. E. Argent; *Long Jump*, Sap. E. P. Gilman; *880 Yds. Race*, Sap. G. M. Drake; *120 Yds. Hurdles Race*, Sap. G. C. R. Stewart; *One Mile Cycle Race*, Sap. A. E. Argent; *440 Yards Running Race*, Sap. G. M. Drake; *High Jump*, Sap. G. C. R. Stewart; *Five Miles Cycling Race*, Sap. W. Clayton; *One Mile Race*, 2nd Cpl. L. L. Barnes; *Inter-Company Tug-of-War*, "B" Company; *110 Yards Swimming Race*, Sap. A. J. Monk; *440 Yards Swimming Race*, Sap. A. J. Monk. The Le Rossignol Inter-Company Challenge for the company obtaining the greatest number of points was won by "C" Company. The times were taken on a Smith's split second chronograph.

Electro-Harmonic Society.—The annual general meeting (to receive the accounts for the 25th season, to elect officers for the 26th season, and to transact the ordinary business) will be held on Thursday, 25th inst., at 6:30 p.m., at the Institution of Electrical Engineers, Victoria Embankment, London, W.C. During the past season 53 new members have been elected, seven members have been lost by death, 53 have resigned, and 18 have been struck from the register. There are now 612 names on the register. The accounts show receipts from subscriptions £311. 6s. 6d., entrance fees £13. 5s., extra concert tickets £13. 0s. 6d., brought forward £59. 2s. 1d.—total £396. 14s. 1d. Expenditure was £335. 5s.; balance £60. 19s. 1d.

COLONIAL AND FOREIGN NOTES.

Aden.—The report of the Aden Chamber of Commerce stated that a supply of electricity for lighting the town and working fans is one of the greatest needs at present. It is suggested that a Government grant might be obtained for an electricity undertaking. Oil is the present illuminant.

Argentina.—The generating station of the Cia. General de Electricidad, Cordoba, was opened on April 3. There are now two companies supplying electricity in Cordoba.

Santa Fé Municipality has refused to grant an extension of time to Winby & Co., concessionnaires for electric tramways, unless they are prepared to pay a fine.

Senor E. de Elia has applied to Buenos Ayres Municipality for a concession for the construction of surface contact tramways, partly on the street level, partly in open tunnels or cuttings, and partly underground. The Public Works Department find that some sections of the route have been granted to the Anglo-Argentine Tramways Co., that others were under National jurisdiction, and that the tunnels would interfere with the main storm water conduits. The applicant has been invited to alter his scheme.

Official statistics show that electrical goods imported into Argentina in 1910 were valued at 5,741,530 pesas (gold) (£1,148,306) compared with 4,216,914 pesas (£843,383) in 1909.

It is stated that a company has asked Villa Dolores (Cardoba) Municipality for a concession for the construction of a telephone system to connect the town with all the neighbouring townships and to extend as far as Villa Mercedes.

A North American syndicate has applied for a concession for the construction of electric tramways from the capital to the suburbs of Ensenada Los Talas, Tolosa, Abasto, Villa Elisa, and ultimately to other suburbs.

Australasia.—Eaglehawk (Victoria) Council have borrowed £6,000 for the erection and equipment of electricity works and have invited tenders for the plant.

A Conference of delegates of the municipal councils of Newcastle (N.S.W.) and its suburbs, the local Chamber of Commerce and the West Wallsend Progress Committee regarding the proposed electrification of the Newcastle district tramways recently passed a resolution that application be made to the Premier to have the electrification carried out as quickly as possible. A deputation to the Premier was appointed. £50,000 has been voted for the scheme.

Ararat (Victoria) Council has for some time desired to establish municipal electricity works, but the success of the undertaking seems to depend upon the Council's obtaining contracts for supplying the public offices and institutions in the district. For years the local gas company charged 12s. 6d. per 1,000 for gas supplied to the public and 10s. for supplies to the Government institutions. When the electricity supply project was mooted gas prices were reduced to 10s. and 8s. respectively, and when the Council's prices for electrical energy were decided upon the gas company (the Mayor of Ararat states) reduced their price to Government to 6s. 8d., with the result that the railway department has entered into a five years' contract. The Mayor asks if it is right for the Government to support the gas company, who have neglected to make necessary extensions of mains and have only made reductions of prices when compelled to do so by the enterprise of the Council. The prices at which the Council propose to supply electricity are 6d. and 3d. per unit for lighting and power respectively.

H.M. Trade Commissioner for New Zealand states that the expenditure of Wellington Harbour Board up to Sept. 30, 1911, will include electric cranes (£2,400) and electric lighting and hydraulic plant (£1,250) for J shed, and other electric lighting plant £10,000.

Customs Duties.—In conformity with a recent decree of the Finnish Senate electrical machinery imported into Finland will in future be subject to a duty of 47·10 Finnish marks per 100 kilogs. (19s. 3d. per cwt.) if not exceeding 2,000 kilogs. and if made mostly of iron; and 14·70 marks per 100 kilogs. (6s. per cwt.) if over 2,000 kilogs. All such machinery down to 100 kilogs. was formerly dutiable at 14·70 marks per 100 kilogs.

A recent customs notice issued by the Australian Commonwealth Government states that reinforced concrete poles for electric

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lighting and other purposes are subject (as wooden poles) to import duty of 30 per cent. ad. val. (British goods 25 per cent.)

Under decisions of the French Customs administration, sliding rails of iron or steel for electric tramway conduits are classified under No. 213 of the Import Duties Tariff (as rails of iron or steel) if rough or simply pierced for bolts, and under No. 525 (as fixed railway material) if thinned and planed or otherwise worked

Electric Traction in Chili.—The Minister of Public Works proposes to submit to the Chambers a bill for the electrification of over 600 miles of railways. It is estimated that the necessary power will be obtained from the numerous watercourses in the county.

South Africa.—A proposal for electric lighting at Koffyfontein has been put forward by the Koffyfontein Mines (Ltd.). This will necessitate the raising of £1,000 by the municipal council, and, if carried into effect, may necessitate for the first time the levying of a rate.

The De Beers Co. have offered to reduce the price of Kimberley Council's bulk supply of electrical energy from 5¼d. to 2¾d. per unit, if the Council agree to reduce the price to consumers to 6d. The Railway Department recently asked for the Council's terms for a supply.

Bulawayo have agreed to pay the Waterworks Co. £1,500 per annum for public electric lighting, including extensions, provided the company came to a satisfactory arrangement with the Electric Lighting Committee with regard to the tariff for private consumers.

Mr. John Roberts, borough electrical engineer, has presented to Durban Corporation a report on the investigations made by him in England, Germany, Holland and Belgium. The report states that in England the conditions as regards electrical undertakings are generally similar to those in Durban. Considering the population, the extent to which electricity is employed at Durban compares favourably with what is done by most English municipalities, and in many instances Durban is ahead. This is to be accounted for by the absence of gas competition. In England the gas companies have vastly improved their methods of applying gas for illuminating purposes, notably by the use of the inverted mantle, and efforts appear to have been made to copy all the features which have made electricity popular.

Uruguay.—The "Review of the River Plate" states that a project, in which foreign capital is interested, has been put forward for an electric railway from Montevideo to Punta del Este, a seaside resort on the Atlantic coast.

The Minister of Public Works is considering a proposal to municipalise and electrify the railway and tramway del Norte.

A British syndicate has presented to the Government a proposal to hold an international exhibition at Montevideo in 1912, with sections for automobiles, aviation, &c.

The states that the Government have not accepted the offer of one of the existing telephone companies to alter its overhead lines, and the President states that the Minister of Industries will study the matter and confer with him (the President), and then insist on the original scheme or introduce amendments convenient for general interests. Our contemporary says this means that the companies are to be frozen out.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Bournemouth.—The annual report of the tramways department states that the total income for the year ended March 31 was £89,767, and after paying expenses, the gross profit was £32,018. After allowing for interest and redemption of stock and loans, rent of leased lines, &c., there is a net deficit of £153.

Bradford.—The net profit on the past year's working of the tramways was £39.374, compared with £32,364 in 1909-10.

The traffic receipts were £256,063 (11·25d. per car-mile), against £245,682 (10·846d.), an increase of £10.380. Traffic expenses (£63,822) show an increase of £177; but on the basis of car-mileage they are slightly less, being 2·804d., compared with 2·825d. Repairs and maintenance came to £32.287, or £139 less; but the cost of electric power showed an increase of £752, being £47.717 (2·097d. per car-mile), compared with 2·073d.). Wages of traffic employés and accident compensations and insurance also showed increases. A sum of £22,000 has been devoted to relief of rates, an increase of £10,000. The income of the parcels department for the year was £8,257, and the expenses £6,599, leaving a surplus of £1,658. Interest on loans showed a decrease of £851, and sinking fund charges an increase of £240. The balance brought forward was £44,006, and adding to the surplus of £39,374 the total is £83,380. During the year the sum of £13,135 was expended upon renewal of track and £20,000 was transferred to relief of rates, leaving a credit balance of £50,244.

Burton-on-Trent.—The accounts of the electricity department for the year ending March show total income £13,089, of which £12,620 was for energy sold, being 1·81d. per unit (compared with 1·875d. in previous year).

Works costs were £4,402=0·631d. (0·712d.) per unit; rents, rates, and taxes £643, or 0·093d. (0·107d.) per unit; management, printing, insurance, &c., £593, or 0·085d. (0·099d.) per unit; total £5,639, or 0·809d. (0·918d.) per unit. Interest and contribution for redemption of loan required £5,082, or 0·730d. (0·808d.) per unit, and the net profit was £2,364, or 0·339d. (against £1,474, or 0·230d. per unit in previous year). Units sold were 1,672,460 (against 1,529,600) including private lighting 323,070 (300,774), public lighting 1,350 (1,190), motors, 690,210 (544,484), heating, &c., 14,585 (16,120), Corporation tramways, 591,847 (617,199), and Ashby Light Railway, 51,398 (49,833). There are 675 (against 605) lighting, and 84 (76) power consumers, the (equivalent) 8 c.p. lamps connected are 37,045 (34,829), and motors connected are 173 (150) with an aggregate capacity of 1,087 (933) H.P. The maximum loads were 524 kw. (500 kw.) for lighting and power and 375 kw. (375 kw.) for traction, the combined load factor was 21·2 (19·95) per cent. and the plant capacity is 1,710 kw. (as in previous year). Average prices obtained were: For private lighting 4·65d. (4·86d.), public lighting 3d. (3d.), power and heating 0·909d. (0·974d.) and traction 1·37d. (1·37d.). £1,138 is being placed to renewals fund and £1,000 contributed to relief of rates, this being the first contribution made by the Department for the latter purpose. Although units sold show 9·35 per cent. increase, cost of fuel is down £91, due to strict supervision of the boiler house and to the use of lower grade fuel to a greater extent than heretofore, and a further £21, due to depreciating the stock of coal by 1s. per ton. All repairs to outbuildings, mains, mchinery and meters have been paid out of revenue.

The accounts of the tramways department for the year to March last show capital expenditure on the Corporation lines £94,803 and on leased lines £11,210, total £106,012. Of this sum £57,611 has been repaid, and the outstanding debt is £57,611. Total revenue was £15,368 8·52d. per car-mile (against 8·47d. last year), including £936 (£932) from Midland Railway Co. for running powers. Operating expenses were 6·41d. (6·47d.) per car-mile exclusive of Midland Railway Co.'s running, the total working expenses, including power, management, &c., being £12,255 and the gross profit £3,113. After meeting capital charges and placing £1,000 to renewals fund there is a deficiency of £682 (against £2,756); 3,131,172 (3,082,804) passengers were carried and 432,911 (428,219) car-miles run.

The accounts of the electricity supply and tramway departments were approved by the Corporation last week.

Bury.—The accounts of the Corporation tramways department for the year ended March show capital expenditure £282,894 (increase £1,748.) Total of sinking fund is £31,200, of which £12,600 has been applied in reduction of debt, and the reserve or renewals fund amounts to £15,361.

The total revenue during the year was £60,696; working expenses were £34,250 and gross profit was £26,447, from which have to be deducted amount due to Salford Corporation, being the receipts less working expenses of the Salford sections (£657), amount carried to joint tramways account, arrived at similarly in respect of the Radcliffe sections £4,574, Heywood sections £3,610, and proportion of special cars, parcels, &c., £23, leaving £4,469 net profit on the Bury section, of which £1,669 has been carried to borough rates and £2,800 to reserve. Car-miles run were 1,573,686 and the passengers carried were 13,236,628. Total revenue per car-mile was 9·26d. and working expenses per car-mile, including power, were 5·552d. The average fare per mile was 0·85d.

Ipswich.—The accounts of the electric supply department for the past year show a surplus, after meeting working expenses and interest on and repayment of loans, of £1,744, compared with £1,080 in 1909-10.

After paying off certain items, including expenditure on street lamps, arc lamps on hire, the last instalment of preliminary expenses, purchase of meters and wages of permanent employés engaged on capital works, there remains £554 which has been transferred to reserve, the latter fund now standing at £1,456. The department seems to have made excellent progress during the year. Excluding the installation department, the total revenue was £15,619, an increase of 10·3 per cent., while working expenses and capital charges increased by only 6·5 per cent. The revenue of the installation department was £3,875, an increase of 27·34 per cent., while the profit (after making due allowance for depreciation of stock), was £186. In addition, wiring on the rental system was installed to the value of £527. The total connections (in kilowatts) are now 2,796, excluding traction supply. The maximum load (including traction) was 1,147kw. Gross capital outlay is £93,481.

The accounts of the tramways department show a deficit on the year of £2,229, against £1,732. This, however, does not represent the whole charge on the rates because the Council have decided, upon the recommendation of the engineer and manager (Mr. F. Ayton), to provide a renewals fund for relaying the entire track within 15 years from the opening of the line. The rates have contributed to this fund during the past year £1,400, but in future the annual instalment is to be £3,421. The passengers carried totalled 5,240,242, the car-miles run being 676,255. The total revenue was £21,738 or 7·714d. per car-mile, compared with £20,883, or 7·775d. per car-mile in 1909-10. Working expenses were £17,952, or 6·371d. per car-mile. The increased deficit is due to cost of repairs to cars and track. The Committee have decided to make the charge for power for the tramways 1½d. during the current year and to consider at the end of the year whether to give a further reduction in the form of a rebate.

Leeds.—The accounts of the electric lighting department for the year to March 31 show capital expenditure £1,005,174, the amount outstanding being £735,407, and the increase during the year £19,118.

Revenue was £104,468 (against £99,068 in previous year) and gross profit £71,326 (£69,288), income tax required £924, interest £28,633 and redemption fund £32,701. The surplus profit (which has been carried

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to relief of rates) is £9,993 (against £8,931). The maximum load was [illegible] kw., or 9,140 k.v.a. (increase 240 k.v.a.), and the capacity of the plant is 15,740 kw. Consumers of energy for lighting are 6,655 (against [illegible] in previous year) and for power and heating 1,351 (against 1,127), the equivalent 35-watt lamp connections being 315,508 (311,812) for lighting and 367,236 (320,917) for power and heating. There are 2,452 ([illegible]) motors in use, their aggregate being 14,689 H.P. (12,836). Units sold were 14,372,765 (12,421,164), of which 4,460,328 (4,575,957) were supplied for private lighting, 926,351 (937,193) for street lighting and [illegible] (6,908,014) for power and heat. Units sold (for all purposes) per equivalent) 35-watt lamp were 21·05 (20·66) and revenue was 3/0·71 ([illegible]) per (equivalent) 35-watt lamp. Total working expenses per unit sold were 0·52d. (0·59d.) and total expenses, including wages on extensions not chargeable to loans account, extraordinary renewals, interest, and redemption fund, 1·58d. (1·74d.). The average price obtained was 1·74d. (1·91d.).

A statement accompanying the accounts points out that the metal filament lamp has continued to affect the profit-earning capacity of the undertaking, but there are strong indications that the period of diminishing revenue is drawing to a close, as the decrease in lighting sales is (for the first time) more than counterbalanced in money by the increased sales for power and heating, and the total revenue exceeds that of the previous year. The working expenses per unit sold are the lowest on record. There is an increase of £1,494 in the amount provided for payment of debt and the total expenditure increased by £4,338.

Loughborough.—At the meeting of the Council last week Ald. Bumpus reported that the gross profit on the electricity department for the year ended March 31 was £1,874, an increase of £1,020 over 1909-10.

Ald. Bowers said they could not credit the whole of the improvement to the improved working of the undertaking, inasmuch as there was a charge for paying off a battery which expired last year. There had been a large increase in the output, particularly for power. The increase in the output for power amounted to 50 per cent., and that for lighting from 12 to 15 per cent. The cost of producing current had gone down from nearly 2½d. in 1908 to 2d. in 1909 and 1½d. in 1910. This year it was 0·9d. [illegible] The standing charges were £2,203, leaving a deficit of £330, against which there was a grant from the general district rate of £1,500 towards the loss on the year's work and the deficit which had accumulated. The whole of that £1,500 went to the previous deficit, less £330 deficit of the present year.

Morecambe (Lancs.)—On the past year's working of the tramways department the profit was £1,272. 16s. 1d., out of which £1,000 has been devoted to relief of rates.

Preston.—The gross profit on the tramways for last year was £[illegible], and the net profit (£4,369) has been added to reserve.

The total income for the year was £37,490, against £37,840; the passengers carried were 8,412,567, against 8,484,589. Parcel traffic increased by £283.

Rotherham.—The net profit on the tenth year's working of the electricity department was £3,740, against £2,922 in 1909-10. The traffic receipts on the tramways department were £33,314, against £[illegible].

Ald. Winter and the tramways manager (Mr. E. Cross) have been deputed to visit places on the Continent for inspecting systems of [illegible] trolley traction.

West Bromwich.—The sale of current by the municipal electricity department for the past year shows an increase of 8.23 per cent. over the figures for 1909-10.

Private lighting revenue was £364, a decrease of £19; public lighting £[illegible], the same as the previous year; tramway traction power £4,756, increase £[illegible], and motive power £5,103, increase £1,660. The net surplus for the year is £1,079.

West Hartlepool.—At the last meeting of the Council it was reported that the past year's working of the electricity department, after providing for all charges (including sinking fund and interest), showed a surplus of £1,505. 12s. 9d., which it was recommended should be carried to reserve.

The average price of coal was 9s. 7½d. per ton, compared with 10s. [illegible] The amount of debt repaid during the year was £3,454, and interest on loans [illegible] £2,917. The gross profit (£7,476) was nearly 7¾ per cent. on the [illegible] capital employed. Out of a total capital of £92,000, £32,000 has been repaid.

Yarmouth.—The accounts of the tramways and electricity supply departments for the year ended March 31 were presented to the Council on Tuesday.

The total tramway revenue was £23,830, increase £507; and after paying working expenses the net profit was £8,126, compared with £6,588 for [illegible]. After paying interest, sinking fund and income tax, the balance [illegible] to be added to appropriation account, compared with £68. 4s. 1d. last year. £113. 6s. 6d. has been appropriated to payment for electricity [illegible] and £1,250 to general renewal fund. Nearly 4,500,000 passengers were carried, an increase of 75,000.

The chairman of the Committee (Ald. Campling) said that the cost of power had decreased by £645, owing to a reduction in the charge and to the system of meters which had been introduced. He anticipated [illegible] a further saving of £200 or £300 in the cost of current by the use of meters.

The accounts of the electricity undertaking showed a gross trading profit, after charging £241. 10s. 7d. for converting public lighting arc lamps to incandescents, of £8,267. Of this, £431 was written off cost of meters, transformers and other works for which there is no sinking fund, £7,466 applied to interest, sinking fund, &c., and £370 added to appropriation account, making it £1,249. 19s. 8d. A sum of £982. 10s. has been added to reserve, increasing this to £4,000.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Hammersmith (London) Borough Council invite tenders for supply and erection of high-pressure steam and feed-water pipes, exhaust steam feed water heater and circulating water pipes, steam valves and feed water heaters, and feed pump. Specification and form of tender from the borough electrical engineer (Mr. G. Gilbert Bell), 85, Fulham Palace-road, W. Tenders to the town clerk (Mr. H. Thompson), Town Hall, Hammersmith, London, W., by 4 p.m., May 31. See also an advertisement.

Dewsbury Corporation invite tenders (by mid-day May 30) for supply and laying of feeder cables and erection of feeder switchboards. Specifications and forms of tender from the borough electrical engineer (Mr. R. H. Campion), 93, Bradford-road, Dewsbury. See also an advertisement.

Stepney (London) Borough Council invite tenders for 12 months' supply of ampere-hour meters, demand indicators and time switches and arc-lamp carbons. Specifications, general conditions and forms of tender from the borough electrical engineer and manager (Mr. W. C. P. Tapper). Tenders must be delivered at 27, Osborn-street, London, E., by noon June 8. See also an advertisement.

Tenders are invited (up to June 27) for supply of 1,400 protectors for use on main distributing frame at magneto exchanges to the Postmaster-General's Department, Victoria. Tender forms and specifications at the Commonwealth Office, 72, Victoria-street, London, S.W. See also an advertisement.

South Shields Corporation want tenders by May 24 for supply and erection of 1,500 kw. high-pressure steam turbine (with surface condenser and pumps) coupled to 1,000 kw. d.c. generator (with switch panel, &c.) and 1,100 kw. a.c. generator (with switch panel, &c.). Specification, &c., from the Borough Electrical Engineer.

Cardiff Corporation want tenders by 10 a.m. May 20 for re-wiring and fitting (for electric lighting) the Corporation Baths, Guildhall-crescent, Cardiff. Particulars from the City Electrical Engineer.

Manchester Electricity Committee require tenders by 10 a.m. May 30 for steam pipes, valves, &c., for Dickinson-street station and for supply of two 8-ton overhead hand cranes for sub-stations. Particulars from the City Electrical Engineer.

Liverpool Overhead Railway Co. want tenders by 10 a.m. June 6 for 12 months' supply of electrical fittings, insulating tapes, ironmongery, &c. Forms of tender, &c., at 31, James-street, Liverpool.

Hackney (London) Council require tenders by 7 p.m. May 25 for supply of 100,000 pairs of yellow flame carbons during the year to March 31, 1912. Specification, &c., from Town Clerk.

Handsworth (Staffs.) Council require tenders by noon May 24 for cables for lighting and tramway purposes. Specification, &c., from Messrs. Kennedy & Jenkin, 17, Victoria-street, London, S.W.

Worthing Corporation require tenders by noon June 12 for supply and erection of two Diesel oil engines and c.c. generators. Specification, &c., from the Borough Electrical Engineer.

St. Pancras (London) Council require tenders by noon May 31 for 12 months' supply of Welsh and other steam coal to their electric stations.

Clacton Council require tenders by noon, May 22, for 12 months' supply of electric service fittings, joint box compound, ironmongery, oils, &c.

Tenders are invited up to July 25 for the supply of 12 sections of a branching multiple magneto lamp signalling switchboard, &c., or one automatic or semi-automatic switchboard, &c.; up to June 14 for supply of a branching multiple magneto lamp signalling switchboard at Ballarat, and a c.b. multiple switchboard to the Postmaster-General's Department, South Australia; and up to June 7 for the supply of 2 nauts single-core submarine cable to the Postmaster-General's Department, New South Wales. Tender forms, &c., from 72, Victoria-street, London, S.W.

The Deputy Postmaster-General, Melbourne (Victoria), will receive tenders until 3 p.m. June 13, for the supply of electric lighting

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material. 12 accumulators and 400 cable distributing boxes and chemicals and glassware for batteries.

Tenders will be received at the Town Clerk's office, AUCKLAND, N.Z., until 4 p.m. of Thursday, June 15, for supply and erection of machinery for the new power station, including water-tube boilers, feed pumps, economisers, conveyor and steam pipes, and induced draught plant; d.c. steam generators, condensers, auxiliary machinery, &c. Specifications, &c., at the offices of the High Commissioner, 13, Victoria-street, London, S.W.

The Town Clerk, WANGANUI, N.Z., will receive tenders until July 12 for supply of generating plant, gas producing plant and battery and booster for the Corporation tramways. Specification can be seen at 73, Basinghall-street, London, E.C. Local representation is necessary.

NAPLES Municipal Authorities require tenders by July 9 for supply and installation of the following plant in connection with the supply of electric power to Naples from the river Volturno:

1. Tubing and accessories for harnessing the water at rate of 7,000 litres a second and for the fall of 190 meters; upset price 702,900 lire (£28,116.)

2. Machinery and apparatus for hydro-electric power station, transmission line (about 57 miles), and transforming station; upset price 1,000,000 lire (£40,000.)

Tenders to Presidente del Consiglio Generale dell' Ente Autonomo Volturno, Naples.

Manufacturers who are prepared to supply 600 km. (372 miles) copper wire 8 mm. dia. are invited to communicate with the Direzione dell' Ente Autonomo Volturno, Naples, who after two months from April 10 will send invitations to tender to firms whom they consider suitable.

Conditions of tender, &c. (in Italian) may be seen at 73, Basinghall-street, London, E.C.

Tenders will be received at the Italian Royal Arsenals, SPEZIA and VENICE, until 11 a.m. June 2, for supply of electric cables and wires (estimated total amount £1,420). Specification (in Italian) may be seen at 73, Basinghall-street, London, E.C.

COPENHAGEN (Denmark) Lighting Corporation want tenders by noon, May 23, for supply of about 3,000 electric meters. Specification (in Danish) at 73, Basinghall-street, London, E.C.

Tenders will be received at the Bourse, BRUSSELS, on May 24 for supply of telegraph cables.

Tenders will be received at the Post and Telegraph offices, PARIS, on May 30, for the supply of 100 tons of 2 mm. and 50 tons of 3 mm. bi-metallic wire.

TENDERS RECEIVED AND ACCEPTED.

London County Council have accepted the following tenders:—

Ibbotson Bros. & Co., bolts and nuts for renewable guard rails, &c., £1,546. 11s. 3d. (Three tenders, varying from £1,546. 11s. 3d. to £1,742. 3s. 9d.); Rees Roturbo Pump Co., electrically-driven pump for driving water from cable manholes, at £110. 10s. Gwynnes (Ltd.) also tendered at £170. 17s. 6d.

The following tenders were received by London County Council for the supply of renewable guard rails:—

Walter Scott (Ltd.) (*accepted*) sandberg (high silicon), manufactured at Leeds), **£9,700** and (high carbon composition, manufactured at Leeds) £8,750.

P. & W. MacLellan, sandberg (high silicon) process (manufactured by Phœnix Steel Works, Germany), £8,168. 15s.

Six firms who were invited to quote for the work were unable to do so, while two tenders were received for the supply of the guard flange section only. The chief engineer's estimate comparable with the tenders is £8,550. The lowest complete tender received was that of P. & W. MacLellan, which provided for the rails, &c., to be manufactured by the Phœnix Steel Works (Germany) by the sandberg process. The Highways Committee were advised that, in addition, the royalty and supervision charges, which were not included in the tender, together with the cost of sending an inspector to Germany, would increase the cost of the work by about £600. The Committee reported having given special attention to the question of the material to be employed in the manufacture of the rails. They understood that a large number of railway and tramway undertakings had for some years past used rails made under the high silicon process, and that very satisfactory results as to the life of the material had been obtained, with consequent saving in expenditure on maintenance. An experiment which was made on a certain section of the Council's tramways, which had been open for public traffic since November, 1907, confirmed the result of the experience on other systems, and tended to show that the life of rails made of that material should be considerably greater than that of rails made of ordinary steel. After careful consideration they had come to the conclusion that the Council's interests would be best served if it accepted the tender of Walter Scott (Ltd.) for the manufacture, supply, &c., of the rails in England by the Sandberg process. The amount of this tender did not include payment for royalties, which would amount to about £300. In addition to the difficulties of inspection, &c., considerable inconvenience is experienced in obtaining work of this nature from abroad, as it is necessary to obtain large shpiments at a time instead of small quantities, as will be required in this particular case.

Bermondsey (London) Council have received the following tenders:—

Boilers.

Howden Boiler Co. (*recommended for acceptance*), **£5,830** and £5,936; British Niclausse Boiler Co., £6,510; Hawksley, Wild & Co. (incomplete), £7,205; Clarke, Chapman & Co., £8,185; Babcock & Wilcox, £7,619, £6,937 and £7,230.

Steam Dynamo.

Siemens Bros. Dynamo Works (Howden engine) (*recommended for acceptance*), **£6,052,** (Belliss engine) £6,447, (Musgrave engine) £6,678; John Musgrave & Sons (Siemens dynamo), £9,749; British Westinghouse Co., (Howden engine) £6,391, (Browett, Lindley engine), £6,761, (Belliss engine) £6,781; Browett, Lindley & Co., (Bruce, Peebles dynamo) £5,985, (British Electric Plant dynamo) £6,067, (E.C.C. dynamo) £6,366; British Thomson-Houston Co., (Howden engine), £6,634, (Browett, Lindley engine) £7,002, (Belliss engine) £7,106; Crompton & Co. (Belliss engine), £6,761. 10s., (Howden engine) £6,561. 10s., (Browett engine) £6,761. 10s.; British Electric Plant, (Howden engine) £5,850. 10s., (Browett engine) £6,210, (Belliss engine) £7,502. 10s.; Jas. Howden & Co. (Siemens dynamo), £6,102, (G.E. Co. dynamo) £6,149, (Crompton dynamo) £6,130, (Bruce Peebles dynamo) £5,960, (E.C.C. dynamo) £6,286; Bruce Peebles & Co. (Howden engine), £5,840, (Browett engine) £6,295, (Belliss engine) £6,530; Dick, Kerr & Co. (Browett engine), £6,515, (Howden engine) £6,194; Electric Construction Co., (Belliss engine) £6,624, (Browett engine) £6,581, (Howden engine) £6,224; General Electric Co. (Belliss engine) £6,413,, (Browett engine) £6,351, (Howden engine) £6,003.

Condenser.

Edward Deane & Beal (*recommended*), **£5,030** and £4,155; Ledward & Beckett, £7,140 and £6,276; Geo. Scott & Son, £3,533 and £3,217; British Electric Plant Co., £7,300.

Electrically-driven Boiler Feed Pump.

General Electric Co. (*recommended*), **£351** and £255; Hayward Tyler & Co., £650; Rees Roturbo Mfg. Co., £261; British Westinghouse Co., £245; Holden & Brooke (not to specification), £209; Nichols Bros., £425.

The Finance Committee have been considering a request by the Electricity Committee to submit an estimate for the purchase of the above plant, but as the Finance Committee are not satisfied that the question of obtaining a bulk supply from an electric supply company has been exhausted, they have deferred the question so that the Electricity Committee may give further attention to the matter.

Fulham (London) Council recently received the following tender for generating plant:—

British Thomson-Houston (*accepted*) (*a*, turbo-alternator) £3,240 (*b*, condensing plant) £1,292; Richardsons, Westgarth (*a*) £3,145, (*b* £1,060; Brush Co., (*a*) £3,300, (*b*) £1,151; C. A. Parsons & Co. (*a*) £3,67 (*b*) £970; General Electric Co., (*a*) £3,372, (*b*) £1,161; British Westinghouse Co. (complete plant), £4,715; J. Musgrave & Sons, (*a*) £3,333, (*b* £1,251; Belliss & Morcom (complete plant), £5,350; Willans & Robinson, (*a*) £3,346, (*b*) £1,140; J. Howden & Co., (*a*) £3,360, (*b*) £1,190 Dick, Kerr & Co., (*a*) £3,370, (*b*) £1,259; W. H. Allen, Son & Co., (*b* £1,389; Mirlees, Watson Co., (*b*) £1,250; Worthington Pump Co., (*b* £1,254.

The Electricity Committee, in reporting on the tenders, stated that the lowest tender for the turbo-alternator which complied with the specification and provided the necessary governing and efficiency tests to be carried out at the makers' works prior to delivery was that of the British Thomson-Houston Co., for £3,240. Messrs. Parsons were the lowest for the condensing plant, but they were not prepared to accept that portion of the contract only. The next lowest was that of Messrs. Richardson Westgarth (at £1,060), in addition to which, however, they required £ in the event of their condensing plant being ordered separately. The committee were advised that the length of the Curtis machine quoted for by the British Thomson-Houston Co. was about 18 ft. 6 in., against 25 ft. 8 in. required by the Richardsons, Westgarth machine, and considerable economy in the comparative cost of the necessary foundations and alterations to the existing buildings would be effected by accepting the Curtis turbine. In all the circumstances, having regard to the adaptability of the Curtis turbine to the available space at the works and the desirability of the whole responsibility as to the efficiency resting with one reputable firm only, the committee had decided (subject to the usual sanction) to place the contract with the British Thomson-Houston Co. for the complete plant.

Marylebone (London) Council have accepted the following tenders for annual supplies for the electricity undertaking:—

Le Carbone (Ltd.), carbons, brushes; Middleton Bros., oils; Aube Grenier & Co., underground cables; Sykes & Sugden, disconnecting boxes and c.i. pits; W. T. Henley's Telegraph Works Co., meter boards; Avon India Rubber Co., rubber tubing and manhole rings; Siemens Bros. & Co., para rubber strip and black adhesive tape; Pooley & Austin, white Silesian tape; St. Helens Cable & Rubber Co., rubber gloves; Callender's Co., Sykes & Sugden and W. Lucy & Co., house service boxes; F. Bird & Co., c.i. piping.

Marylebone Council have also accepted the tender of C. A. Parsons & Co. for a commutator (£220) and that of the Electrical Power Storage Co. for truck capable of carrying 15-20 cwt. (£260).

Bath Electric Light Committee have accepted the tender of the Diesel Engine Co. for a Diesel oil engine, direct-coupled to a 450 k.w. Dick, Kerr d.c. dynamo at £5,451; and that of Dick, Kerr & Co., for a 300 k.v.a. motor alternator at £1,140.

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Chelsea (London) Council have accepted the tender of E. A. Rockalls (at £280) for illuminating the Town Hall, &c., for the Coronation.

Greenock Corporation have placed an order with the British Westinghouse Co. for a turbo-alternator and condensing plant, at £5,987, subject to the Secretary of Scotland sanctioning the expenditure.

Helsby Corporation have placed an order with Venner & Co. for Hookham tramcar meters. The firm's tenders for ordinary meters for Govan, Kirkcaldy and Salford have also been accepted.

Ilkeston Council have placed an order with Callender's Cable & Construction Co. for cables, and that of Ferranti Limited for meters.

Ilkley (Lancs.) Council have accepted the tender of Mather & Platt for a centrifugal pump for the electricity generating station.

Newport (Mon.) Council have accepted the tender of Walker & Co. for a motor chassis for the tramway tower waggon, at £520.

Hereford Council have accepted the tender of Mather & Platt for auxiliary electric pump at £109.

Isle of Thanet Joint Hospital Board have accepted the tender of Gray & Hopper for telephone and bell work at the hospital.

Winchester Council have accepted the tender of E. Green & Son for new sections of economiser pipes at £67.

Woolwich Council have accepted the quotation of C. A. Parsons & Co. for the renewal of a commutator at £95.

Stockton-on-Tees Council have accepted the tender of Richardson, Westgarth & Co. for a 400 kw. turbo-alternator at £2,293.

Selby Council have accepted the tender of Mr. Sykes for public lighting by 50 c.p. electric lamps, at £37 per annum.

Sydney (N.S.W.) Council recently decided to purchase, at the estimated amounts given, 50 Mannesman steel poles from Noyes Bros., at £75; 25 50-ampere 480-volt and 200 10-ampere 240-volt d.c. meters from Ferranti Ltd., at £568. 2s. 6d.; six maximum demand indicators from W. G. Watson & Co., at £34; 150 steel poles from Stuarts & Lloyds, £990.

Commonwealth Contracts.—The following tenders have been accepted by the Australian Postmaster-General's Department:—

Queensland.—Lamson Store Service Co., pneumatic tube installation, £645; India Rubber, Gutta Percha & Telegraph Works Co., Western Electric Co., British Insulated & Helsby Cables, International Electric Co., Siemens Bros. Dynamo Works, British General Electric Co., Lawrence & Hanson, Jas. Paton & Co., and Ringdahl & Co., various telegraph apparatus, material, &c.

South Australia.—R. Johnson, Clapham & Morris, h.d. copper wire and rods; W. G. Watson & Co., 5,000 insulators (£104); British Insulated & Helsby Cables, telegraph apparatus.

BUSINESS NOTICES.

Messrs. Neville Williams & Co. inform us that the Tinol branch of their business has been converted into a limited company and in future all communications relating to Tinol should be addressed to Tinol, Limited, 80A, Southwark-street, S.E. Messrs. Neville Williams & Co. are continuing the electrical manufacturing business as before.

From the 24th inst. the offices of the Kent Electric Power Co. will be transferred to Railway-street, Chatham.

The telephone number of Messrs. Spencer Chapman & Messel is Avenue 1588 (3 lines).

Edgar Hy. and Chas. Hy. Harrison (trading as Harrison & Co., electricians, &c., 35, Broadway, Cricklewood, have dissolved partnership. Debts by Mr. E. H. Harrison.

Sale by Auction.—Messrs. Horne & Co., 35, Old Queen-street, Westminster, S.W., will sell by auction at the Royal Arsenal, Woolwich, at 11 a.m. on Tuesday, May 23, unserviceable and obsolete machinery, including iron and steel scrap, brass, copper, gunmetal, lead, antimony, zinc, &c., electric cable, lathes and tools, pumps, electrical instruments, lamps, &c. May be viewed at the Royal Arsenal, Woolwich, on Friday and Monday, prior to and on morning of sale. Catalogues at the War Office, Whitehall, the Ordnance Office, Tower, and the Ordnance Office, Royal Arsenal, Woolwich. See also an advertisement.

Plant for Sale.—Messrs. Rudders & Paynes, Chester-street, Birmingham, advertise for sale three dynamos, with resistances, switchboard instruments, &c.

Patent Development.—The proprietor of Letters Patent No. 11,154, dated 1909, relating to "Batteries and Battery Holders," desires to dispose of same or to grant licences, with a view to the adequate working thereof in this country. Inquiries to Messrs. Cruikshank and Fairweather (Ltd.), 65-66, Chancery-lane, London, W.C.

Holiday Guides.—We offer no apology for calling attention to the excellent "guides" which are being issued by the leading railway companies in connection with the holiday, health and rest resorts, which are to be found upon their respective routes. The *Great Central Railway Co.* issue a group of interesting and serviceable particulars which can be obtained at any of the company's stations, or at their Goods Receiving Offices, or direct from the Publicity Department, 216, Marylebone-road, London, W.C.

The *London & South Western Co.*, whose service reaches many of the most popular and desirable of the holiday resorts of the country, have just issued a new guide which contains a mass of readable matter, helpful to those in search of where to go and how to get there. This guide can be obtained from the company's booking offices, from their various publicity establishments, or direct from Waterloo Station.

The guide which is edited by Mr. Percy Lindley, and which relates to the *Great Eastern Railway Co.'s* arrangements for their tourist traffic, has just been issued, and can be obtained at the G.E. booking offices, or direct from Liverpool-street Station, London, E.C.

"Record of Sports."—From the Royal Insurance Co., Liverpool, we have received a copy of the eighth edition of the "Record of Sports."

Nearly every kind of sport is dealt with and the volume forms an accurate and up-to-date record of sports. Its new features include a comprehensive series of notable performances and events of aviation, while the records of many other sports have been amplified and the summaries and tabulated statements have been retained.

BANKRUPTCIES, LIQUIDATIONS, &c.

On Friday at the Official Receiver's offices, Liverpool, a meeting was held of the creditors of the British Tungsten Lamp Co. (Ltd.), Huyton Quarry, near Liverpool.

The Deputy Official Receiver (Mr. T. W. J. Britten) said that, although the winding-up order had been made as far back as March 28, the statement of affairs was not yet complete. Mr. H. Lonsdale, the receiver and manager at Liverpool, had advertised the business for sale as a going concern. The unsecured liabilities amounted to £1,549, and the assets were estimated to realise £11,159, leaving a deficiency, after the debenture holders had been reckoned with, of £13,210, or total unsecured liabilities £14,759, and no assets available to meet them. The deficiency account showed a gross profit of £1,780 from the date of the formation of the company in December, 1903, to the date of the winding-up order. No resolutions were passed, but at a subsequent meeting of contributories a resolution was passed that the Official Receiver should continue as liquidator.

John Dennis Carlmark, electrical engineer, 402, High-street, West Bromwich, has been adjudicated bankrupt. The first meeting of creditors will take place on May 26 at 191, Corporation-street, Birmingham, and the public examination on June 2 at the Law Courts, Lombard-street, West Bromwich.

A first and final dividend of 9s. 5½d. is payable at the O.R.'s, Byrom-street, Manchester, to creditors of Wm. Hy. Steed, electrical engineer, &c., 13, Stamford-street, Kingsway, Altrincham.

A dividend is to be paid to creditors of Wm. Hy. Illingworth (trading as the Yorkshire Metal Filament Lamp Co.), 30, Pellon-lane, Halifax, and claims are to be sent to Mr. W. Durrance, 12, Duke-street, Bradford, by May 31.

A first and final dividend of 4s. 1d. will be payable on May 22 at at 26, Baldwin-street, Bristol, to creditors of Valentine Geo. Burkitt, electrical engineer, 38, Park-row, Bristol.

In consequence of the intention of the Company to amalgamate its business with that of May-Oatway Fire Appliances (Ltd.), the Pearson Fire Alarm (Ltd.) is being wound up voluntarily, and a meeting of creditors will be held at the office of Messrs. Fairbairn & Wingfield, 67, Watling-street, London, E.C., on May 26.

Meeting of creditors of May-Oatway Fire Appliances (Ltd.) (in vol. liq) will be held at 92 and 94, Paul-street, Finsbury, London, E.C., on May 30.

Express Cable Inventions (Ltd.) is being wound up voluntarily and Mr. R. H. Gillespie, 29A, Charing Cross-road, London, W.C., has been appointed liquidator. Meeting of creditors will be held at 29A, Charing Cross-road, on May 30.

A meeting will be held at 695, Salisbury House, London, E.C., on June 19 to receive an account of the winding up of the Cascade (1906) Power Co. (Ltd.) (in liq.).

A deed of arrangement has been executed by Arthur Brooke (trading as Fox & Co.), electrical engineer, Bradford-road, Batley. Unsecured liabilities, £917. Estimated net assets £180.

Winding-up Petition.—A petition for the winding up of J. G. Childs & Co. (Ltd.) will be heard at the Royal Courts of Justice, London, W.C., on May 30.

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PATENT RECORD.

APPLICATIONS FOR PATENTS.

*NOTE.—The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application, an asterisk is affixed.*

March 17, 1911.

6,682 THOMPSON. (Ges. für Drahtlose Telegraphie m.b.H., Germany.) Production of electrical oscillations by direct current.*
6,695 ANDERSON, BOWES & Co. & ANDERSON. Electrically-driven coal cutting machines.
6,723 MILNE. Electric incandescent lamps.
6,736. 6,737 SIEMENS BROS. & Co. & RIBER. Fixing and insulating contact springs for electrical apparatus.*

March 18, 1911.

6,783 KÖSTING & MATHIESEN. Alternating-current arc lamps. (Convention date, 29 3 10, Germany.)*
6,833 BARRET & GAIFFE. X-ray bulbs or tubes. (Convention date, 7 9 10, France.)*
6,856 RUBIN. Incandescent arc lamps.
6,861 WALLACE & GRAHAM. Electrical switch or controlling device.*
6,862 WALLACE & GRAHAM. Electrical time switch.*
6,863 WALLACE & GRAHAM. Electrical signs, advertising devices and the like.*
6,869 DAVIES. Equipment for use in submerged electrical communication.

SPECIFICATIONS PUBLISHED.

1909 SPECIFICATION.

18,799 GRAINGER. Electric lamps and filaments. (16 3 10.)
28,813 WASSMER. Electric furnaces.

1910 SPECIFICATION.

101 WILLIS & JOHNSON. Electro-magnetic signalling devices. (2 7 10.)
211 B.T.-H. Co. (G.E. Co., U.S.) Protective devices of the type known as lightning arresters.
5,278 ADAMS MFG. Co. (Cutler Hammer Mfg. Co.) Controllers for electric motors.
5,289 SCHULAR, SCHULAR & EVERETT. Incandescent electric lamps.
5,465 CREESE & DEDERICH. Electric switches.
5,583 COLZI & BARDELLI. Telemeters. (Addition to 23,768 09.)
5,965 JANDUS ARC LAMP & ELECTRIC Co., JONES & CASTELL-EVANS. Arc lamps.
6,207 BASTIAN. Electrically-heated appliances or apparatus.
6,312 HALL. Electric supply systems and apparatus for motor-cars and the like. (Cognate applications, 8,155 10, 9,926 10, 12,893 10 and 17,330 10.)
6,403 AKT.-GES. BROWN, BOVERI ET CIE. Driving of electric rail vehicles. (1 4 09.)
6,431 HALL. Connections for terminal ends of electric cables. (14 9 10.)
6,536 BLECKLY. Arc lamps having two or more pairs of electrodes.
6,595 WATERHOUSE. Electric light pendant fittings.
6,624 ZWEIBERGK. Dynamo-electric machines.
6,634 LORING. Dynamo-electric machines of the homopolar type.
6,768 STORA KOPPARBERGS BERGSLAGS AKTIEBOLAG. Electric furnaces and method of charging same. (19 3 09.)
7,714 COULET. Hydrocarbon incandescent lamps. (16 9 09.)
7,929 HIGHFIELD. Ceiling roses, wall plugs and like electrical fittings.
8,035 DE HOLDEN-STONE. Electric generation and electric superheating of steam.
8,380 BURKITT. Arc lamps.
10,874 HARRISON. Manufacture of incandescent electric lamps.
11,569 CHADWICK & CLARKE. Detachable power-handle for use on electrical controllers on tramcars, motor-cars, trains and the like.
11,792 BRAYER, PERRIER & CLAREMONT. Electric cable.
11,931 STODD. Incandescent electric lamps.
12,347 LAITTE & SAFETY LIGHT (LTD.). Electric switch.
13,123 B.T.-H. Co. (G.E. Co., U.S.) Control and protection of electric motors.
13,124 B.T.-H. Co. & EVEREST. Systems of electrical distribution.
13,305 JABURG. Arc lamps. (2 6 09.)
13,405 VINCENT. Vapour electric lamps.
13,406 ADAMS MFG. Co. (Cutler Hammer Mfg. Co.) Controlling speed of electric motors.
13,410 B.T.-H. Co. (G.E. Co., U.S.) Dynamo-electric machines.
13,739 HERCLES. Primary batteries. (8 7 09.)
14,743 B.T.-H. Co. (G.E. Co., U.S.) Alloys suitable for use as electric resistance conductors.
14,916 CONNER & PEEL-CONNER TELEPHONE WORKS. Telephone systems.
14,925 HARTMANN & BRAUN AKT.-GES. High-frequency resonance-measuring instruments. (31 8 09.)
15,424 HARRISON. Electric incandescent lamps.
15,731 CHAMPION. Construction of electric junction boxes and similar chambers.
16,043 JONES. Imperfect contact resistance devices.
16,844 SIMMS & SIMMS MAGNETO Co. High-tension magneto-electric apparatus.
16,997 SIEMENS-SCHUCKERTWERKE GES. Electric speed-regulation of machines (17 7 09).
17,344 ELECTRIC & ORDNANCE ACCESSORIES Co. & GARNER. Electric circuit closers or starters.
21,339 JOHNSON-LUNDELL ELECTRIC TRACTION Co. (Lundell.) Regenerative electric motors and means for controlling the same.
28,022 ZEISS. Telemeters having two objective reflecting systems, two objective lenses and an ocular system. (17 12 09.)

COMPANIES' MEETINGS AND REPORTS.

Eastern Telegraph Co. (Ltd.)

The seventy-eighth ordinary general meeting was held on Wednesday, under the presidency of Sir JOHN WOLFE BARRY, K.C.B.

The SECRETARY (Mr. A. R. Hardie) having read the notice convening the meeting and the auditors' report,

The CHAIRMAN said: Gentlemen, in connection with the accounts, the gross revenue for the half-year under review amounted in round figures to £670,100, against, for the corresponding half-year of 1909, £620,900, or an increase of £49,200. Messages and other receipts show an increase of £42,400, and it is satisfactory to note that the improvement in the receipts is spread over every branch of our traffic, and appears to be due to a general improvement in trade. Interest and dividends on investments and on cash at bankers on deposit, &c., is £6,800 more than for the corresponding half-year of 1909. With regard to the expenditure side of the accounts, it will be seen that the total ordinary expenses for the half-year amounted, in round figures, to £264,700, against, for the half-year to December, 1909, £250,500, showing an increase of £14,200. This increase is almost entirely due to increased expenditure at our stations, the total expenditure on this account being £13,600 more this half-year than for the corresponding half-year of 1909. About one-half of this increased expenditure is in respect of salaries and wages due to automatic promotions and to the slight augmentation in the number of our staff; rent, fuel and light is £1,100 more, and repairs to buildings £3,000 more than for the corresponding half-year of 1909. Other items included in this account show minor increases, while a few items show slight decreases. There are no other items to which I think it is necessary for me to call special attention; but, to summarise the accounts, I may say that the result of the half-year's working is an increased profit of about £35,000 when compared with the half-year to December, 1909, and we are, therefore, able to make a substantial contribution to our general reserve fund, while maintaining the payment of the usual dividend and bonus.

On the last occasion I had the pleasure of addressing you, I referred to some important renewals of some of our older cables, which we had in contemplation. A portion of this work has been carried out during the half-year, and the cost, amounting to about £37,000, has been charged against the general reserve fund. A further contribution has been made to the fund as a provision for investment fluctuations, £20,000 being taken from the general reserve fund for this purpose. The total provision on this account is now £250,000. The results shown for the whole financial year to Dec. 31, 1910, are undoubtedly satisfactory. Our message receipts reached the highest point in our history, and are well above the figures for 1900-1901, which previously held the record when they were temporarily inflated by the events in connection with the South African War. It is true the working expenses have also increased considerably; but, as I have explained on former occasions, this must inevitably follow, owing to the great increase in the number of words with which we have to deal. The number of words carried has increased during the last 10 years by about 50 per cent. This is accounted for by the important reductions in the rates which, I am glad to say, we have been able to introduce from time to time, and more especially in recent years. The effect of judicious reductions in rates, no doubt, tends to stimulate traffic and increase its bulk. This, together with a general improvement in trade, has had the effect of increasing the gross value of the traffic carried at the lower rates; but I may mention that whereas the number of words carried has increased so much, the percentage of gross revenue to capital has only increased by something under 3 per cent., so that the public are benefiting largely by the reductions to which I have referred. So long as we can efficiently deal with the larger volume of traffic without being obliged to increase our carrying capacity by additional cables, a sufficient margin of income over expenses can be maintained; but if traffic grows at the rate it has been doing during the last 10 years you must arrive at a point when additional cables are absolutely necessary to cope with the work. Therefore, it is very essential that additional cables should be provided as far as possible without increasing our capital account, otherwise the necessary margin of receipts over expenses would gradually disappear. It is when additional cables have to be paid for that we more than ever realise and appreciate the importance of our substantial reserve fund. Gentlemen, this is the policy to which we consider the success of this Company is mainly due, and we believe that the financial position achieved by harbouring our resources is in the best interests not only of the stockholders, but of the country and the telegraphing public as well. With this object in view, it is our aim to make the Company prosperous, for it depends upon the prosperity of the Company as to how far we can confer additional benefits on our customers, either by reducing rates or by providing new cables, thus giving them an improved service, not only in speed and accuracy, but also in reliability of communication. In this regard I may incidentally remark that our efforts are being directed towards the more general use of automatic signalling and recording apparatus, not only to attain increased speed, but to eliminate as far as possible errors in messages caused by the complicated combinations of vowels and consonants which make up the weird artificial words now used in codes by many of our customers. It is about 10 years since we laid any new cables of importance; but, for the reasons to which I have referred, the time is approaching for strengthening our system in the Mediterranean and elsewhere.

I think it may be useful and interesting if I review shortly the financial aspect of the Company to-day, and contrast it with the position 10 years ago, when we decided, in conjunction with the Eastern Extension Co. to establish an alternative line of cables between Great Britain and Australia via South Africa. This Company's share of that great undertaking comprised cables of large carrying capacity from Porthcurnow to Madeira, St. Vincent, Ascension, St. Helena and Capetown, a landline between Capetown and Durban, and a cable between Durban and Mauritius. When this liability of over two millions—on this Company's back alone—was incurred, our general reserve fund was under one million, but subsequent events proved that this important step was fully justified. Owing to the substantial increases in revenue which occurred during the years following, we were able out of our surplus revenue moneys gradually to clear off this large expenditure without any increase to our capital. The balance was cleared off in 1906, since which time we have been able gradually to build up our reserve fund, and it now stands at the substantial sum of £1,620,000, after providing a quarter of a million for market fluctuations of our reserve fund investments, besides charging an additional sum of over half a million during the last 10 years for the renewals of some of our older cables.

Now, Gentlemen, I think you will agree that this is a fine record. I think it is particularly satisfactory when we consider that not only have we been able to do so much in the past, but that we have at the present time a good round sum in reserve to meet expenditure on new cables which must be laid in the near future, as well as for the renewal of some of our older sections to which I have already referred.

You may have noticed what was stated by the Postmaster-General

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House of Commons on November 21 last on the subject of deferred ... at reduced rates, when he said that "proposals were under consideration for a large reduction in the cable rates charged on the chief ... routes for cablegrams in plain language and of a non-... character; but, as the adoption of these proposals involved negotiations with foreign administrations, he was not yet in a position to make a statement with regard to them." As we are always anxious to assist in any scheme which will give the sender of social messages advantages approaching those at present enjoyed by merchants and others who ... codes, thereby greatly reducing the cost of mercantile messages, we have heartily associated ourselves with the proposal, and trust ... negotiations with foreign administrations will be satisfactorily ... I will conclude by moving the adoption of the report and ... on the declaration of the dividends set out therein.

The VICE-CHAIRMAN and MANAGING DIRECTOR (Sir John ... Pender, K.C.M.G.) seconded the motion.

Mr. JOHN NEWTON said he thought that the shareholders should ... like the Directors on a record year's working, and express their ... with the manner in which the Board were dealing with the finances ... Company. He presumed the repairs which had to be made were ... subject to income tax.

The CHAIRMAN, in reply, said he was pleased Mr. Newton ... the policy of the Company—which had been pursued now ... many years—of putting an adequate sum to the Company's reserve ... thus giving a substantial basis not only to the dividend, but also to ... capital value of the shares. The question of income tax chargeable ... had been before the Directors for a long time, and had been ... with the authorities of the Inland Revenue Department, who had ... to an arrangement which the Directors thought fair and reasonable ... the lengths of cable used on repairs and renewals.

... tion was carried unanimously.

Mr. HOLMS warmly testified to the courtesy and efficiency of the staff ... of the stations which he had visited, and concluded by moving ... complimentary vote of thanks.

Mr. NEWTON, in seconding the motion, said he was sure the Directors ... fully appreciated the work of the staff, especially when its efficiency ... observed to by those who had seen it.

... tion was carried unanimously, and the proceedings terminated.

Eastern Extension Australasia & China Telegraph Co. (Ltd.)

The seventy-fifth half-yearly ordinary general meeting was held on ... at St. John Wolfe Barry, K.C.B., presiding.

The GENERAL MANAGER AND SECRETARY (Mr. F. E. Hesse) ... the notice calling the meeting and the report of the auditors.

The CHAIRMAN said: The gross receipts of the Company for the half-year under review amounted, in round numbers, to £337,000, against ... for the corresponding period of 1909, showing an increase of ... which it is satisfactory to find is spread over the whole of the ... system (applause). The working and other expenses amounted, ... numbers, to £154,000, against £143,000 for the corresponding ... 1909, showing an increase of £11,000. When I had the pleasure ... you six months ago I referred to the cost of living in the Far ... particularly in the Straits Settlements, having risen very considerably ... the last few years, and stated that your Directors had found it ... after a careful investigation of the present circumstances, to ... increase the remuneration of the staff in that region in order ... meet the new conditions which had thus arisen. This additional ... accounts for nearly £8,000 of the increased expenditure ... and as the special allowances granted to the staff towards ... last year were made retrospective from January 1, 1910, the ... represents 12 instead of 6 months' special remuneration. ... in the present accounts is consequently nearly double what ... have been under ordinary circumstances. The balance of ... expenditure, roundly £3,000, is more than accounted for by the ... charged for maintenance of cables, &c., compared with the ... period of 1909.

... the figures for the whole year, the results are as follows:— ... amounted to £682,000, against £606,000 for 1909, or an ... £76,000. The expenditure amounted to £305,000, against ... 1909, showing an increase of £6,000. Consequently the net ... year 1910 was £70,000 more than in 1909 (applause). The ... half-year was roundly £165,000, and, after adding nearly ... brought forward from the previous half-year, there remained an ... of over £227,000 (applause). The usual quarterly interim ... 2s. 6d. per share were paid during the past year, and it is ... to distribute a like amount to-morrow, making a total divi... 5 per cent. for the year. It is also proposed to pay a bonus of 4s. ... cent., making a total distribution of 7 per cent. for 1910. ... have been made during the past year to the Main... and Depreciation Funds, and, after applying ... revenue balance to the General Reserve Fund, the sum of ... carried forward.

... that the Eastern Extension and Great Northern ... have been able to assist the Chinese Govern... to reorganise, improve and develop their ... services by advancing to them for these purposes ... interest on account of, and, on the security of, the ... by the companies to the Imperial Chinese Telegraph ... under their existing agreements. In meeting the ... agreements on such terms your Directors have had in ... strengthening of the good relations which, happily, have so long existed between the Chinese Telegraph Administration and the Eastern Extension and Great Northern Companies, but also the material benefit which the expected improvement in the Chinese telegraph service would confer on their international cable service (hear, hear). The Eastern Company are assisting this Company in making this advance, and the transaction will be shown in the next half-yearly accounts as a Reserve Fund Investment.

At the last general meeting I referred to the wireless telegraph installation then in course of erection at the Company's Keeling-Cocos station to enable telegrams to be exchanged between passing ships and that remote place. The installation has since been completed and the public service was opened on the 2nd of March last. So far the traffic has been rather disappointing, but as the facilities become better known and appreciated by shipowners and the public at large, and as the shipping traffic develops, we trust that better results may be obtained. The negotiations with the British Government for extending the wireless service to the Company's Singapore, Hongkong and other suitable stations are still proceeding, and ought soon to be satisfactorily settled. When addressing the shareholders of the Eastern Company a year ago, I mentioned that the Associated Companies had long been anxious to make some special arrangement whereby a considerable addition to the volume of British imperial news might be distributed throughout the whole of the Empire, so that our colonies and dependencies might be more in touch with the facts and ideas of the mother country (hear, hear). It was not an easy matter to bring about a practical scheme acceptable to everyone, and, after much consideration and consultation with those interested in this important matter, we were able to begin a service by arrangement with Reuter's Company. The arrangement enabled that agency to have the distribution of 150,000 words per annum of imperial news at Aden, which place is en route to all the Eastern colonies and dependencies of Great Britain. I also mentioned that the news on the way to Aden, after being made use of at Gibraltar, Malta and Egypt, was sent on to South Africa, and also supplied to the British possessions on the East and West coasts of the African continent. This news service has since been granted to India, where it is giving satisfaction, and negotiations have been in progress for some time past for extending it to Australasia and the British colonies in the Far East, which negotiations, it is hoped, will soon be brought to a satisfactory termination. I now move the adoption of the report and accounts and the declaration of the dividends.

The Marquess of TWEEDDALE, K.T., seconded the resolution.

Mr. REICH: I should like to congratulate you on the very satisfactory report and balance-sheet you have put before us, and I hope the progress made during the last few half-years will continue, and that at some future time you will be able to consider the propriety of giving us a little extra dividend. I find that you have put aside £150,000 towards meeting possible depreciation in your investments. As stocks have gone up in the meantime—a circumstance on which I also congratulate you—I should like to know if this £150,000 fully covers the possible loss which might be shown in the event of the securities having to be realised. I also take the liberty of making a suggestion. It is this: We are much indebted to the staff. I suggest that they are fully deserving of some recognition in view of the event which is to take place next month. (Cheers.)

The CHAIRMAN, in reply, said: With regard to any increase of dividend, the Directors are all unanimously of opinion that it is better for the interests of the Company to keep the dividend stable and the price of the shares stable than to have a fluctuating dividend (hear, hear); and in the case of this Company, I think you will agree with me that the time has scarcely arrived even to consider the possibility of paying an increased dividend. We are able to pay a good dividend and to put such a sum to reserve as to enable us to ensure the admirable working of our Company. It is very gratifying to hear what Mr. Reich says of the staff and of the Company's service. The organisation is one of which we may all be proud, in fact, the whole nation may be proud of the cable service which is administered from these offices, and no one exceeds me in my appreciation of the zealous, intelligent and careful administration of our staff. The position with regard to our investments is this: That the valuation we have put on them in providing for fluctuations in values is approximately right at the present moment. Stocks have gone up in some cases, but our reserve funds in former years were invested in what was then considered the very best gilt-edged securities, when money was very cheap, but there is a large depreciation in those investments. Practically speaking, I think the shareholders may be assured that the sum we have put down is very nearly what the market price of the day would point out as the value of the securities, but, of course, every shareholder must know that, whatever the market price of the day, you could only realise our securities very gradually; otherwise, prices would run away, and we should have a much larger depreciation. To all intents and purposes, we have got in our allowance for investment fluctuations a fair and proper amount, on the assumption that the securities have to be realised from time to time, as they must be for the undertaking of extensive repairs or new works which have to be undertaken by the Company. With regard to the question of a bonus to the staff in connection with the Coronation, all I should like to say just now is that the matter will have the consideration of the Board. It does not merely affect this Company, but all our Associated Companies, and therefore the matter, I think, will have to be considered by a joint meeting of the various Boards.

The motion was then carried unanimously.

The retiring directors, Mr. F. A. Bevan and the Hon. A. G. Brodrick, were then re-elected as directors, and the retiring auditors were re-appointed, after which a cordial vote of thanks to the chairman, directors and staff terminated the proceedings.

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West African Telegraph Co. (Ltd.)

The twenty-sixth ordinary general meeting was held on Wednesday, under the presidency of the MARQUESS OF TWEEDDALE, K.T.

The SECRETARY (Mr. John Cambrook) read the notice convening the meeting and the auditors' report.

The CHAIRMAN then said: The gross revenue for the year under review amounted to £61,797, against for the year 1909 £59,099, an increase of £2,698. Messages show an increase of £4,483; but, on the other hand, the sum received from the Portuguese Government in respect of the guarantee was reduced by £5,071, thus far showing a deficit, as compared with the preceding year, of £588. However, the loss on exchange is, I am happy to say, £2,504 less for 1910 than 1909, and to this should be added £782, representing the increase in interest on investments and cash at bankers, the net result of the year's working being an improvement in the revenue of £2,698. Turning to the expenditure side of the account, it will be seen that the total of the ordinary expenses for the year 1910 was £20,923, as against for the year 1909 £22,257, or a decrease of £1,334—a result almost entirely due to a reduction in the expenses attending maintenance of cables. Your directors recommend the payment of the usual dividend of 4s. per share for the half-year, making, with the previous payment, 4 per cent. for the year, and that the sum of £31,000 be added to reserve. This is the last year we shall be able to add so large a sum to the reserve, for the reason that, as I stated last year, the Portuguese guarantee ceases during the current year. However, our reserve fund now stands at the respectable figure of £268,428, but it must be borne in mind that, although the fund is invested in first-class securities, there is a considerable depreciation in the market value of the various stocks. I now move the adoption of the report and accounts and the declaration of the dividends.

The MANAGING DIRECTOR (Sir John Denison-Pender, K.C.M.G.), seconded the motion, which was carried unanimously.

The retiring director and auditors were re-elected, and a vote of thanks to the chairman, directors and staff terminated the proceedings.

Western Telegraph Co. (Ltd.)

The seventy-fifth ordinary general meeting was held on Wednesday, under the presidency of Sir JOHN WOLFE BARRY, K.C.B.

The SECRETARY (Mr. E. Steer Hodson) read the notice calling the meeting and the auditors' report.

The CHAIRMAN said: The revenue for the half-year ended Dec. 31 last, compared with the same period for 1909, increased by nearly £46,000, but a diminution in the amount of interest on investments, &c., reduced this by about £5,500, leaving a net increased revenue of about £40,500. The reduced amount of interest was consequent upon the sale of reserve fund investments during the year 1910, which represented a cost value of £360,060. These sales were necessary to meet payments for new cables, &c. The increase in traffic receipts was derived from all the countries served by the Company's system. On the other hand, there was an increase in the general expenses at the stations and the maintenance of cables and in the expenses of the repairing ships amounting in all to £22,000. The increased expenditure at the stations was caused by additional staff, to meet increasing traffic, by annual promotions, and by the enhanced value of the Brazilian currency.

When we had the pleasure of meeting the proprietors in November last I referred to the charter of the cable steamer "Cambria" to enable our own steamer "Norseman" to come to England for survey and repairs. The latter vessel has now been on cable work for nearly 25 years, and on examination it is gratifying to say that the deterioration was much less than might have been expected. The overhaul, repairs and installation of wireless telegraph apparatus, &c., cost £7,500. After providing £16,373. 10s. for debenture stock interest and £7,697. 9s. 10d. for income tax, there remains a balance of £245,142. 11s. 6d.; to this is added the sum of £7,512. 18s. 8d. brought forward from June 30 last, making a total of £252,655. 10s. 2d. First and second interim dividends, amounting to £62,379, have been paid, and after transferring £150,000 to the general reserve fund, and £10,000 to the land and buildings depreciation fund, there remains a balance of £30,276. 10s. 2d., which is carried forward to the next account. The revenue for the current period to date compares satisfactorily with former years, but a few weeks ago a reduction of 75 centimes per word in the tariff with Brazil was made, and a considerable increase in traffic will be required to recoup us for the reduction in the charges for telegrams.

The cable between St. Vincent (Cape de Verde) and the island of Ascension, to which reference was made at the last meeting, was successfully completed on December 26 last, and is a valuable addition to the means of communication with South America. It is right to note that we have now a new competitor in South America, for the German cable between the Canary Islands, West Africa and Pernambuco was opened in March last, but sufficient time has not yet elapsed to enable us to ascertain the effect of this competition. No further progress has been made since our last meeting with regard to the projected cable between the island of Ascension and Rio de Janeiro, but we must be prepared to carry this out at short notice, and the estimated large expenditure would, of course, have to be met out of the reserve fund.

Touching the position of our reserve fund, I may point out that in the last few years our great enterprise of laying a direct cable from St. Vincent to Argentina has necessitated an expenditure of about £950,000 and that there can be no doubt that in a similar manner we shall have, though at less expense, to strengthen our communication with Brazil whether it be via Rio direct or Pernambuco. Such demands as these on the resources of the Company are very heavy, but they are demands which must be met, if on the one hand we are to maintain our cable service in a condition to be adequate to our responsibilities to the public and so to ensure as far as possible the stability of our dividends and the steady value of our shares. It is facts such as these that alone abundantly justify the policy of the Board in placing large sums to our general reserve. But we have also to remember that the replacement of our existing cables as they become old—a matter dependent, as it must be, on circumstances beyond our control—will always necessitate the expenditure of money at periods and to an extent which cannot with any certainty be foreseen. Such expenditure, when it amounts to anything beyond ordinary maintenance, could not be charged against revenue without causing violent fluctuations in the amount available for dividend or else it would necessitate the periodical raising of fresh capital, which might be most inconvenient besides being bad in principle. Any such state of things could not be advantageous to the stockholders and would compare prejudicially with the practically stable dividends and steady price of our shares to which we are proud to point as having existed for so many years. These views are, of course, not new, but I have lately received from some valued shareholders letters urging on us the opposite policy of paying larger dividends and contributing less to the reserve fund. As their criticisms affect not merely their own but the interests also of the whole body of shareholders, I have thought it right now to make the above observations on the well-considered policy of your Directors, which has been from time to time emphatically endorsed at several of our general meetings and which I venture to think will once more commend itself to your judgment. I now move the adoption of the report and accounts.

The DEPUTY-CHAIRMAN (Sir John Denison-Pender, K.C.M.G. seconded the motion, which was carried unanimously.

There being no further business, a hearty vote of thanks to the chairman and directors brought the proceedings to a close.

West Coast of America Telegraph Co. (Ltd.)

The fourteenth ordinary general meeting was held on Tuesday, under the presidency of Sir JOHN DENISON-PENDER, K.C.M.G.

The SECRETARY (Mr. Frederick L. Robinson) having read the notice calling the meeting and the auditors' report,

The CHAIRMAN said: Gentlemen, our capital remains the same as last year. The receipts for 1910, £51,217, against £50,416, show a balance on the right side of some £800; and considering that the rate, which was reduced in 1909 from 5s. 9d. to 4s. 2d., was again reduced in the middle of 1910 to 3s. 7d., I think this is a satisfactory state of affairs. The working expenses in 1910 amounted to £39,357, compared with £39,204 in 1909, thus showing an increase of some £150. But we have decreases in travelling expense of £280, in medical expenses of £145, and in maintenance of cables and land lines £513. This, therefore, leaves us a balance on the right side as regards expenses. However, we must not forget that the chief saving, compared with the former year, was £513 in the maintenance of cable and land lines. This is, of course, always a varying amount, according to the number of repairs that have to be carried out by the ships and the extent of cable which has to be used in the repairs. The amount is, therefore, of a very fluctuating character from year to year. It is satisfactory to see that the reserve fund has now assumed the figure of £68,192, to which we can also add the ship's reserve of £5,000; but this reserve, when you come to think of the debenture debt and the income bonds, which amount together to £170,000, is after all not large, although the £170,000 is represented to a very considerable extent by cables and good assets. The only other point which I need mention, I think, is the laying, since our last meeting, of the Western Company's new cable from Ascension to the Argentine and the new German cable, which has been opened for about a month from the West Coast of Africa, where it connects with Europe, to Pernambuco. Those two cables ought to bring us a certain increase of traffic and although the new German cable will, to a certain extent, compete with our good friends, the Western Company, it will also, as far as the Company is concerned, possibly attract some of the traffic which has been across the Atlantic and down the West Coast; so we may, to a small extent, benefit by it. I have nothing else to point out to you, and I move that the report and accounts be adopted.

Mr. F. A. JOHNSTON seconded the motion, and it was carried unanimously, as were also resolutions approving the dividends, re-electing the retiring director and auditors, and according a hearty vote of thanks to the chairman and directors.

Submarine Cables Trust.

The fortieth ordinary annual meeting was held on Thursday, under the presidency of the Most Hon. the MARQUESS OF TWEEDDALE, K.T.

The SECRETARY (Mr. Sidney Collett) read the notice calling the meeting.

The CHAIRMAN said: The revenue for the year ended April 15 last after deducting the necessary working expenses, amounted to £24,0 to this had to be added the sum of £175 brought forward, making in an available balance of £24,208, as against £24,328 in the previous y or a difference of £120. This diminution is more apparent than real, is due to the fact that the last quarterly dividend on the shares of Central & South American Telegraph Co.—usually received before close of our financial year—did not reach us until after April 15. have paid the half-yearly coupons on Oct. 15 and April 15 last at the of 6 per cent. per annum net, absorbing £17,583. This left us wi surplus of £6,625, which, in accordance with the terms of the trust d we have used in the acquisition of 55 certificates; 34 of these were chased in the open market at 119-¼, and as we were unable to acc any more in that way, a further 21 were drawn by lot on the 4th ins

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£120 per certificate. We have thus acquired out of the revenue for the year under review 55 certificates, which have absorbed £6,578, leaving a balance of £46 to be carried forward to the next account. This is the largest number of certificates we have acquired in any year out of the revenue of the trust. We have now acquired and cancelled 1,315 out of the original 4,200 certificates. I now move the adoption of the report and accounts.

Sir JOHN DENISON-PENDER, K.C.M.G., seconded the motion, which was carried unanimously.

The retiring auditors were re-appointed, and a vote of thanks to the trustees brought the proceedings to a close.

West India & Panama Telegraph Co. (Ltd.)

The sixty-eighth ordinary general meeting was held on Wednesday under the presidency of Mr. WALTER BISHOP KINGSFORD.

The MANAGER and SECRETARY (Mr. R. T. Brown) having read the notice calling the meeting and the auditors' certificate,

The CHAIRMAN said: The half-year under review has been an uneventful one. I think you will agree with me that my forecast at our last gathering has been amply borne out by the results submitted to you in the report and accounts now in your hands. As you will have seen, the total income for the half-year is £40,306, or £5,628 more than the receipts to December, 1909, with which we are comparing. This substantial increase, all of it arising from traffic, is the more satisfactory, coming as it does in a December half-year, which with us is invariably the less prosperous half-year, or, as we usually term it, our "lean" half-year. On the expenditure side of the account it appears that the total of £25,019 is £762 in excess of that for the corresponding period of last year. In this, however, is included a sum of £386 for income tax on the interest dividend on the ordinary shares, and as that item did not occur in the corresponding half-year, it ranks now as an increase in our expenditure. In effect, therefore, the increase in our working expenses for the half-year is only £376. At our last meeting I referred to the establishment of the oil industry in the important colony of Trinidad, and I spoke favourably of the benefit likely to accrue from it to our Company. A proposal is made by the Consolidated Gold Fields of South Africa to amalgamate some of the oil lands of the General Petroleum Co., and other tracts of oil lands in Trinidad, in a new undertaking with a capital of £1,250,000. It is said that no enterprise of such magnitude has ever been projected in that island. Should it be carried through successfully, it is only reasonable to anticipate that our Company's business in the island would be materially benefited. Our cables, I am much pleased to say, are in perfect working order, and I am also very glad to say that the receipts for the current half-year show a satisfactory increase. I now move the adoption of the report and accounts, and the payment of the preference and ordinary dividends set out therein.

Mr. HENRY HOLMES seconded the motion, which was carried unanimously.

A discussion ensued as to a vote for the directors' remuneration, after which the retiring director, Mr. Henry Holmes, was re-elected, as were the retiring auditors. A very hearty vote of thanks to the chairman, directors and staff at home and abroad terminated the proceedings.

BERGMANN ELEKTRICITATS GESELLSCHAFT.—At the recent meeting of this company at Berlin it was stated that the cost of the proceedings against them in the English courts as to the metal-filament lamp patents was about 150,000 marks. During the past two years their automobile department had been worked at a loss, but prices were now much better. They had orders in hand for 900 to 1,000 cars, the greater proportion for the English market. They had obtained a 10 years' contract for the ... machines to the recently-formed subsidiary C. Lorenz Co., the ... Frequency Machine Co., and they considered that the patents would have far-reaching effects on the commercial development of wireless telegraphy.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—During 1910 8,940,005 units of electrical energy were sold, compared with 7,856,383 in 1909. The number of houses connected at Dec. 31 last was 5,695 compared with 4,978, and the equivalent connections in 8 c.p. lamps show an increase of 176,066. The profits amount to £85,597. 15s. 5d., and, after paying the interim dividend at rate of 7 per cent. per annum there is, including the amount brought forward and interest, a balance of £58,366. 3s. 11d. The directors recommend that £20,000 be placed to credit of depreciation and renewals account, that £7,500 be added to reserve and that a final ordinary dividend be paid at the rate of 10 per cent. (making 8½ per cent. for the year), which will leave £5,621. 13s. 7d. to be carried forward. The additional plant in the Ultadangha station, as recommended by the consulting engineer, has been duly installed, the high-tension ... and the supply to the jute presses in the Northern district ... in September. The arrangements for the establishment of a ... transforming station in the Cossipore district are well advanced, and the bulk of the work is expected to be completed next year. The directors record with regret to the recent death of the chairman, Mr. Edmund ...

CORK ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.)—At the meeting ... Mr. A. R. Monks said that owing to the increased popularity of electric lighting due to the great economy of metal filament lamps, there was a substantial increase in the number of consumers, representing ... 1,300 ... The demand for electricity for power showed no falling off. The lighting and power revenue for the past year showed an increase of £1,230, and the additional connections obtained during 1910 and the connections obtained since Jan. 1 should result in a further improvement for the current year. The District Council lighting he had previously referred to had been completed. The Council had increased the number of public lamps originally contemplated. They had recently installed, owing to increased demands, an additional boiler, with mechanical stoker and superheater. The traffic receipts were satisfactory, and there was an increase in the takings of £2,054. The total revenue showed an increase of £3,337, and as there was only an increase of £576 in expenses, the gross profits show an improvement of £2,761. The increase in expenses was in connection with the traction side of the business, and was due to heavier maintenance charges for track and rolling stock. They had written £1,772 off house services, wiring consumers' premises, plant on loan, &c., and had transferred £5,000 to reserve for depreciation. They were increasing the dividend to 4 per cent.

DELHI ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.)—Col. Sir Buchanan Scott stated at the meeting on Tuesday that an amicable settlement had been arrived at with the contractors of all their claims in connection with the works contract. The business showed continued increase, particularly with regard to the tramways, which were now showing a profit. The number of power consumers was increasing, and the company was able to undertake contracts on more favourable terms.

ELECTRIC SUPPLY CORPN. (LTD.)—The gross earnings during 1910 amounted to £25,466, an increase of £1,665 over the corresponding period of 1909. Net revenue account amounts to £11,224 against £9,300. After paying interest, £4,774 remains, compared with £3,780. This account has been debited with £814, the actual cost of the year's repairs and renewals. The directors propose to utilise the surplus of £3,960 by placing £500 to renewals account, by writing £1,248 off expenditure on temporary plant and the cost of transferring the Hendon undertaking, leaving £2,212 to be carried forward. During the year 2,479,172 units were sold, against 2,492,416 units in 1909, and there was an equivalent of 135,719 32-watt lamps connected to the mains of the various undertakings of the Company, against 113,699 in 1909.

JOHNSON & PHILLIPS (LTD.)—The report for the year to Dec. 31 states that the profit on trading accounts, &c., after making provision for bad and doubtful debts, and after charging to revenue upwards of £5,337 for maintenance of buildings, plant, &c., amounts to £23,175, with balance brought forward (£942) the amount available is £24,117. Deducting remuneration of directors, auditors' and trustees' fees (£1,563), interest on debenture stock to Dec. 31 (£7,473), reserve *re* debenture sinking fund (£5,438), interest on second debentures (£1,488), depreciation on machinery and plant, &c. (£4,500) and amount written off investments (£1,500), there is a balance of £2,154 to carry forward. The business during the year has shown considerable improvement, and the profit shows an increase of £7,815 over 1909.

HONG KONG TRAMWAYS CO. (LTD.)—The report for 1910 states there was a considerable increase in gross traffic receipts (£3,564), but the net traffic receipts show an increase of £764 only, the difference being due to a further shrinkage in the values of the subsidiary coinage. After careful consideration it has been decided to charge an additional cent for every five-cent fare paid in Chinese copper coins. The working expenses show a decrease of nearly £1,500. After providing for working expenses and payment of debenture interest, there is a profit of £7,988, which, added to amount brought forward, makes £8,557, which is carried forward; £10,000 is to be expended on permanent improvements or additions to the property before payment of any dividend.

LISBON ELECTRIC TRAMWAYS (LTD.)—The result of the operations for the past year shows a net profit of £107,425, added to £481. 13s. 8d. brought forward, making £107,906. 13s. 8d. From this £35,000 has been placed to depreciation reserve and £5,000 to credit of exchange reserve, leaving an available balance of £67,906. 13s. 8d., out of which preference dividend (£25,533. 3s. 8d.) has been paid. An interim dividend of 3 per cent. net (£19,020. 15s. 7d.) was paid on the ordinary share capital, and the directors now recommend payment of a final dividend of 2½ per cent. net (£15,850. 13s.), making 5½ per cent. for 1910; £7,502. 1s. 5d. has been carried forward. Previous to the revolution in October, the traffic showed a considerable increase over former years; since then this expansion has been arrested, and during the period of conflict the operations were completely suspended. After the establishment of the Provisional Government, the employés formulated demands which could not be conceded, and in consequence a strike took place. The company thought it wise to request the arbitration of Dr. Antonio Jose d'Almeida, Minister of the Interior, and the points of difference between the company and its employees were finally settled by his award.

MANILA ELECTRIC RAILROAD & LIGHTING CORPN. (LTD.)—The report for 1910 states that there was an increase in gross earnings over 1909 of $175,340, in operating expenses of $10,588 and in net earnings of $164,751. The apparently abnormal increase in net earnings was largely due to the strike of 1909. The directors have declared four quarterly dividends of 1 per cent. each, leaving $144,356 which had been transferred to surplus account. In order to handle the increase in business the directors authorised the purchase of one 2,500 k.v.a. steam turbine and alternator, with auxiliaries, which should be ready for service by the end of the year.

The Philippine Islands are developing industrially at a rapid rate.

Since the beginning of the current year the dividend rate has been increased from 4 to 5 per cent.

RANGOON ELECTRIC TRAMWAY AND SUPPLY CO. (LTD.)—The directors' report for 1910 states that the new power house has been completed and is now ready to receive the 2,500 kw. turbine, which has arrived at Rangoon. During the year 1,472,471 car-miles were run, an increase of 13,008, and 9,281,817 passengers were carried, against

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9,308,674, the receipts being Rs8,79,245, an increase of Rs2,258. There had been a steady increase in the private lighting and power department. Receipts were Rs2,91,183, against Rs1,98,233, an increase of over 46 per cent., while working expenses were 51·13 per cent., against 64·08 per cent. Gross profits were £46,177 (compared with £45,170 for the 13 months ended Dec. 31, 1909). The directors recommend a dividend on the ordinary shares of 4 per cent. for the year, tax free, carrying forward £822.

REUTER'S TELEGRAM CO. (LTD.)—The directors' report for 1910 states that the balance for distribution amounts to £5,229. 13s. 3d., including £256. 14s. 9d. brought forward. An interim dividend of 2½ per cent. was paid in October and the directors now declare a dividend of 4s. per share, 2½ per cent., making a total distribution (tax free) of 5 per cent. for the year, and leaving £494. 1s. 3d. to be carried forward.

SINGAFORE ELECTRIC TRAMWAYS (LTD.)—The accounts for 1910 show an excess of revenue over expenditure of £31,013. 12s. 1d., the profit for the year, after charging debenture interest, depreciation and royalty being £1,843. 12s. 11d. Compared with 1909, tramway revenue shows an increase of £3,622. 15s. 6d. There were 268,332 more passengers carried and 14,502 more car-miles run, the latter mainly due to the completion of an additional section of route. The number of passengers carried per car-mile has risen from 5·96 in 1909 to 6·04. The revenue from lighting and power supply shows an increase of 38 per cent.

At the meeting on Tuesday Sir FRANK A. SWETTENHAM, K.C.M.G., said there was a considerable increase in the Singapore receipts, but the ratio of working expenses to receipts had risen slightly, being 53 per cent., against 52·3 per cent. The revenue from lighting and power supplies showed an increase of 38 per cent. The increase was the more satisfactory, as during 1909 the company had a large demand for energy from contractors at that time working in Singapore, which demand did not continue into 1910. The Anderson Bridge over the Singapore River, which was opened on March 12 of last year, had increased the receipts for the year by about $20,000.

SWANSEA IMPROVEMENTS & TRAMWAYS CO. The report for 1910 states that the total revenue on the tramway undertaking for the year amounted to £59,308, an increase of £5,769 over 1909. Traffic receipts were £57,469, increase £5,530. Deducting expenses, and including interest, and amount payable to Swansea Corporation on lease account, and after charging £6,000 for renewals, the surplus was £11,285, making, with £1,211 brought forward, £12,496. The directors recommend that £3,000 be placed to depreciation and reserve and after providing for the preference dividends a dividend on the ordinary shares of 4½ per cent. for the year is recommended, leaving £1,047 to be carried forward. Capital expenditure during the year amounted to £1,959. There was also expended £2,321 on renewals of permanent way, electrical equipment and plant, which was charged to the provision for renewals account. During the year the Company paid £2,000 to the British Electric Traction Co. in reduction of the liability in respect of advances for reconstruction. The net profit on the Mumbles Railways and Pier was £1,107, and was payable to the British Electric Traction Co. for interest on moneys provided by them.

VERA CRUZ ELECTRIC LIGHT, POWER & TRACTION (LTD.)—At the meeting on Wednesday Mr. V. W. Yorke said the increase in the various sections of the business had been steadily maintained, while working expenses had been gradually reduced. The question of the provision of additional power to cope with the growing demand had been receiving the attention of the board, and negotiations were now being carried on for a supply of water power.

The net profits in Mexico for 1910 were £24,107 compared with £19,043 for 1909. The balance (including sum brought forward) amounts to £10,293, which it is recommended should be carried forward.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES, &c,

NEW COMPANIES.

BRITISH AMERICAN TRADING CO. (LTD.) (115,579.)—Reg. May 2, capital £100 in £1 shares, to carry on the business of railway, electrical engineering and machinery contractors, agents, &c. Private company. E. E. Griffiths permanent governing director. Reg. office: 7, Idol-lane, London, E.C.

CHARLES HASELER & SON (LTD.) (115,683.)—Reg. May 8, capital £1,000 in £1 shares, to take over business carried on by C. E. Haseler at Birmingham, and to carry on the business of electricians, mechanical engineers, founders, dealers in electricity, &c. Private company. First directors: W. Izon (chairman), C. E. Haseler and C. Lacey. Reg. office: 94, Bridge-street West, Birmingham.

KAI-BITUM PAINT CO. (LTD.) (115,533.)—Reg. April 29, capital £2,500 in £1 shares, to take over the business of the sale of paint, lacquer and glue hitherto carried on by Callender's Cable & Construction Co. (Ltd.) Private company. Reg. office: Belvedere, Kent.

J. MARSE & CO. (LTD.) (115,771.)—Reg. May 11, capital £1,000 in £1 shares, to carry on business of electrical, mechanical and general engineers, founders, &c. Private company. Reg. office: Imperial Buildings, Ludgate-circus, London, E.C.

SPELMONT GAS & ELECTRIC GENERATOR SYND. (LTD.) (115,677.)—Reg. May 6, capital £5,000 in 40,000 preference shares of 2s. each and 1,000 deferred shares of £1 each, to carry on the business of manufacturers of and dealers in machines or apparatus for the production or generation of gas or electricity, &c., and to adopt an agreement with S. P. Eastick. Private company. Reg. office: 71 & 72, Strand, London, W.C.

VENNER TIME SWITCHES (LTD.) (115,468).—Reg. April 26, capital £7,000 in £1 shares, to acquire and turn to account certain inventions relating to improvements in or relating to electrical time switches, &c., and to adopt an agreement with R. F. S. Venner, R. C. Griesbach and E. E. Sharp. Private company. First directors: R. F. S. Venner, R. C. Griesbach and E. E. Sharp (all permanent, subject to holding 150 shares). Reg. Office: 6, Old Queen-street, Westminster, S.W.

MORTGAGES AND CHARGES.

ELECTRICAL FITTINGS CO. (1911) (LTD.)—Debenture dated April 28, 1911, to secure £5,000 and 5 per cent. interest, charged on company's undertaking and property, present and future. Holders: Samuel Heath & Sons.

ELECTRICAL INSTALLATIONS (LTD.)—Memorandum of satisfaction to the extent of £450, on Jan. 16, 1911, of debentures dated Dec. 5, 1906, securing £2,000, has been filed.

ESCARE & DENELLE (LTD.)—Particulars of £6,000 debenture stock created April 14, and secured by trust deed of even date, has been filed, amount of present issue being £3,900. Property charged: leasehold premises and company's undertaking and property, present and future. Trustees: R. T. Smith and H. Samson.

FLOAT ELECTRIC CO. (LTD.)—A second mortgage debenture, dated April 10, 1911, to secure £7,000, charged on company's undertaking and property, present and future, including uncalled capital (subject to first debenture for £2,800) has been filed. Holder: C. J. V. Blundell.

PAIGNTON ELECTRIC LIGHT & POWER CO. (LTD.)—Particulars of £5,000 in debentures, created Nov. 23, 1910, have been filed, the amount of present issue being £2,000. Property charged: company's undertaking and property, present and future, including uncalled capital. No trustees.

TRACTION SUPPLIES CO. (LTD.)—Particulars of £1,000 debenture created Nov. 15, 1910, have been filed, amount of present issue being £600. Property charged: Company's undertaking and property present and future. No trustees.

CITY NOTES.

MEMORANDA (May 18).—**Bank rate 3 per cent.** (March 9, 191 **Price of silver,** 24⅜d. per oz. Consols 81⅛—81⅜ for money and account. Consols Pay Day, June 1; Stock and Shares Continuat Days, May 29 and June 13; Ticket Days, May 30 and June Pay Days May 31 and June 15; Mining Shares Carry Over Day, May

PRICES OF METALS (London).—*Copper*, cash, 54½; three mor 54¾. *Lead*, English, 13⅝—13¾; foreign, 13¼—13⅜. *Spelter*, 24 24⅜. *Tin*, English, 194—195; foreign, 197½ cash, 189½ three mon *Iron*, Cleveland, cash, 46/0½, three months, 46/9½.

CASTNER-KELLNER ALKALI CO. (LTD.)—The directors have decla an interim dividend at the rate of 15 per cent. for the six mor ended March 31.

CENTRAL ELECTRIC SUPPLY CO. (LTD.)—The 4 per cent. guaran debenture stock transfer books are closed from 18th to 31st inst., in sive, preparatory to payment of interest due June 1.

COMPANIES TO BE STRUCK OFF THE REGISTER—The following wi struck off the Register of Joint-Stock Companies, unless cause to contrary is shown before Aug. 5:—

Aberdare Electric Lighting Co., Albion Battery Co., Buenos A Electric Light Co., Heswall District Power Co., Private Wire & Telep Installation Co.

MADRAS ELECTRIC TRAMWAYS.—The traffic receipts for the fortn ended May 15 were Rs.21,953 (increase over corresponding period of year Rs.959). The aggregate receipts from Jan. 1 are Rs.200,600 crease Rs.14,673).

SHANGHAI ELECTRIC CONSTRUCTION CO. (LTD.)—The account 1910 show a profit of £7,584, compared with a loss for the 18 mont Dec. 31, 1909, of £949. After deducting this the balance (£6,635 been carried forward.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee granted quotations to a further issue of £72,100 5 per cent. 30-year mortgage bonds of the *Calgary Power Co. (Ltd.)*; a further issu $996,000 Southern Lines first mortgage 4 per cent. gold bonds o *Manila Railroad Co.*, and a further issue of £21,000 4½ per cent. mortgage prior lien gold bonds of the *Montreal Water & Power Co.* Committee have been asked to appoint special settling days in and quotations to $850,000 5 per cent. bonds (1925) (London issue) of the *Telephone Co. of Canada (Ltd.)*, and £200,000 5 per cent. mortgage d ture stock of *British Insulated & Helsby Cables (Ltd.)*, and to grant q tions to $4,049,000 5 per cent. bonds (1925) (issued abroad) of the *Telephone Co. of Canada (Ltd.)*, and $2,000,000 capital stock o *Kaministiquia Power Co. (Ltd.)*.

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ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	May 10	1,382	+ 86	49	68,178	+ 2,113
Ainsdale	„ 5	219	— 3	18	3,783	— 43
Anglo-Argentine	„ 13	48,502	+ 1,497	19	943,842	+ 110,990
Ashton-under-Lyne	„ 13	407	+ 37	7	2,886	+ 320
Ayr Corporation	„ 13	232	+ 1	52	14,747	+ 450
Barnsley	„ 5	174	— 3	18	3,127	+ 95
Barrow	„ 5	283	+ 33	18	4,349	+ 278
Bath Electric Trams, Ltd.	„ 10	853	+ 146	19	13,419	+ 9
Birmingham Corporation	„ 13	7,136	+ 424	6	44,907	+ 2,982
Birmingham & Midland	„ 5	885	+ 44	18	15,674	+ 1,253
Blackpool and Fleetwood	„ 14	403	+ 29	..	..	..
Blackburn Corporation	„ 10	1,200	+ 233	‡7	7,712	+ 868
Bolton Corporation	„ 14	2,504	+ 194	7	16,214	+ 1,727
Bombay	April 14	3,066	+ 237	15	42,982	+ 2,463
Bournemouth Corporation	May 10	1,644	+ 181	‡6	9,864	+ 721
Bradford Corporation	..	..	..	..	..	..
Brighton Corporation	„ 14	968	— 14	¶6	5,958	+ 581
Bristol Trams & Carriage	„ 12	6,201	+ 852	6	37,279	+ 4,363
Burnley Corporation	„ 13	1,322	+ 95	6	8,261	+ 1,043
Burton Corporation	„ 14	270	+ 4	6	1,670	+ 74
Bury Corporation	„ 14	1,236	+ 106	¶6	8,027	+ 882
Calcutta Tramways Co.	„ 13	R57,752	+ R7,656	19	R1,053,346	+ R23,616
Cannock-Rugeley	„ 13	122	+ 8	19	2,159	— 35
Cardiff Corporation	..	..	..	..	..	..
Carnforth	„ 5	89	+ 6	18	1,276	— 22
Central London Railway	„ 13	4,889	— 803	19	99,660	— 5,458
Chatham & Dist. Lt. Rys.	„ 11	848	+ 86	19	14,600	+ 161
City & South London Rly.	„ 14	3,149	+ 16	19	64,740	+ 2,429
City of Birmingham	„ 5	2,930	+ 46	18	48,376	+ 976
Cork Electric Trams Co.	„ 11	509	+ 59	19	8,394	+ 20
Coventry & Dist. Trams	„ 5	454	+ 40	18	7,799	+ 623
Dover Corporation	„ 13	227	+ 39	6	1,409	+ 252
Dublin & Lucan Railway	„ 12	147	+ 22	19	2,209	— 25
Dublin United	„ 12	5,660	+ 548	19	97,733	+ 1,591
Dudley-Stourbridge	„ 5	807	+ 72	18	13,624	+ 1,092
Dundee Corporation	„ 10	1,161	+ 27	§51	60,709	+ 278
East Ham Council	„ 13	1,091	+ 105	6	6,593	+ 627
Exeter Corporation	„ 12	328	+ 40	6	1,922	+ 119
Gateshead & Dist. Trams	„ 5	981	— 2	18	17,790	+ 884
Glasgow Corporation	„ 13	20,028	+ 1,734	50	894,200	+ 49,734
Grimsby Trams	„ 13	124	+ 12	19	2,207	+ 123
Gloucester Corpn.	„ 10	294	+ 35	..	..	..
Grovesend-Northfleet	„ 5	198	+ 12	18	3,320	— 15
Great Northern & City Rly.	„ 13	1,460	+ 25	19	29,621	+ 1,146
Greenock & Port Glasgow	„ 5	724	+ 101	18	11,230	+ 1,590
Halifax Corporation	„ 9	1,952	+ 349	†6	10,738	+ 1,761
Hartlepool Tramways	„ 5	226	— 7	18	3,925	+ 196
Hastings Elec. Trams Co.	..	..	..	..	..	..
Hong Kong	„ 13	$8,027	— $901	19	$174,845	— $2,321
Huddersfield Corpn.	„ 13	1,860	+ 175	6	11,645	+ 1,537
Hull Corporation	„ 13	2,705	+ 97	6	17,593	+ 1,108
Ilford District Council	„ 13	558	+ 63	6	3,460	+ 404
Ilkeston District Council	„ 10	131	+ 15	6	782	+ 89
Ipswich Corporation	„ 13	421	+ 47	6	2,549	+ 403
Isle of Thanet Co.	„ 13	459	+ 55	32	10,455	+ 516
Jarrow	„ 5	131	+ 9	18	2,093	+ 117
Keighley Corporation	„ 11	198	+ 29	6	1,108	+ 135
Kidderminster & District	„ 5	88	+ 2	18	1,605	+ 64
Kilmarnock Corporation	„ 13	204	+ 16	52	7,885	+ 331
Lancaster Corporation	„ 10	235	+ 34	6	1,758	+ 227
Lancashire Trams Co.	„ 11	1,437	+ 59	19	25,603	+ 274
Leamington United	„ 10	1,419	+ 221	19	23,735	+ 695
Leamington	„ 5	139	+ 5	18	2,455	— 100
Leeds Corporation	„ 13	7,403	+ 472	6	45,832	+ 4,943
Leicester Corporation	„ 13	2,579	+ 185	6	15,124	+ 1,556
Lincoln Corporation	„ 13	609	+ 13	52	30,780	+ 144
Liverpool Corporation	„ 13	119	+ 3	6	822	+ 80
Liverpool Overhead Rly.	„ 6	11,555	+ 545	18	197,740	+ 6,351
Llandudno&Colwyn Bay Ry.	„ 14	1,458	— 12	19	26,677	+ 1,644
London County Council	„ 12	182	+ 23	§23	3,495	+ 117
London Elec. Ry. Co.	„ 3	44,174	+ 3,283	‡5	205,629	+ 15,710
London United	„ 13	13,335	+ 730	19	267,410	+ 14,965
Lowestoft Corporation	„ 13	7,137	+ 1,321	19	109,524	+ 2,418
Maidstone Corporation	„ 13	155	+ 9	32	4,909	+ 196
Mansfield Railway	„ 13	15,990	+ 693	6	99,091	+ 9,035
Margate	„ 13	2,185	— 34	19	39,229	+ 1,027
Metropolitan Dist. Railway	„ 5	211	+ 15	18	3,440	+ 67
Metropolitan Elec. Trams	„ 12	11,449	+ 626	19	222,839	+ 16,122
Middleton	„ 5	8,651	+ 1,462	18	142,178	+ 21,048
Middlesbrough Corporation	„ 5	293	— 6	18	5,337	+ 394
Middleton-on-Tyne Corp.	„ 13	201	+ 63	§6	1,136	+ 273
Newport (Mon.)	„ 13	3,993	+ 204	6	25,644	+ 2,016
Northampton Corporation	„ 13	715	+ 67	6	4,409	+ 395
Northern Adtn & Hyde	„ 12	513	+ 60	6	3,088	+ 381
Nottingham Corporation	„ 5	532	— 18	18	9,690	+ 35
Nottingham (W.B.) Corporation	„ 14	1,993	+ 122	7	14,155	+ 727
Nottingham (W.A.) Elec. Trams	„ 11	157	+ 4	51	8,365	+ 383
Oldham	„ 12	1,572	+ 135	19	31,326	+ 1,603
Peterborough Corporation	„ 5	109	+ 4	18	1,882	+ 121
Plymouth	„ 13	2,113	+ 363	6	12,301	+ 1,050
Portsmouth Corporation	„ 5	1,927	+ 44	18	33,898	+ 3,181
Rawtenstall Corporation	„ 10	745	+ 72	6	4,494	+ 403
Rochdale Corporation	„ 11	672	+ 83	6	3,965	+ 477
Rotherham Corporation	„ 5	105	+ 20	18	1,273	— 42
Salford Corporation	„ 15	4,734	+ 8	§6	30,956	+ 2,511
Sandbach	„ 5	43	..	18	771	+ 16
Sheffield Corporation	„ 14	6,366	+ 461	7	45,203	+ 2,537
South Metropolitan	„ 13	$11,323	+ $1,443	19	$197,875	+ $8,909
South Shields	„ 5	814	+ 57	18	13,090	+ 24
Southport	„ 5	921	+ 74	18	15,530	+ 1,267
Southport Corporation	„ 10	1,156	+ 180	6	6,426	+ 754
Southport Tramways	„ 10	542	+ 128	6	3,135	+ 614
Stalybridge, Hyde, &c. Bd.	„ 5	259	+ 15	18	4,376	+ 61
Stockport Corporation	„ 13	739	+ 68	6	4,978	+ 927
Sunderland District	„ 14	1,213	+ 84	6	7,490	+ 752
Swansea Trams	„ 10	439	+ 39	28	12,346	+ 927
Swindon Corporation	„ 5	1,081	+ 40	18	18,907	+ 1,320
Taunton	„ 10	147	+ 18	6	850	+ 100
Tynemouth and District	„ 5	44	+ 4	18	688	— 9
Tynemouth Trams Co.	„ 5	170	+ 2	18	2,885	+ 116
Walsall Corporation	„ 10	456	+ 74	19	7,819	+ 601
Warrington Corporation	„ 13	1,037	+ 189	6	6,593	+ 1,214
West Ham Corporation	„ 13	565	+ 20	19	10,308	+ 289
Weston-super-Mare	„ 11	392	+ 24	6	2,338	+ 145
Wolverhampton Corporation	„ 4	2,605	+ 243	5	13,311	+ 1,786
Wolverhampton Co.	„ 5	81	+ 20	18	693	— 91
Wolverhampton Corpn.	„ 5	415	+ 2	18	7,556	+ 409
Worcester	„ 10	939	+ 93	6	5,730	+ 651
Workington	„ 5	293	+ 28	18	4,438	+ 104
Yorkshire W.R. Trams	„ 5	94	+ 5	18	1,656	+ 11
Yorkshire Woollen District	„ 14	1,229	— 98	20	24,957	+ 925
	„ 5	1,003	— 2	18	17,827	+ 1,169

(a) These comparisons are with the corresponding period last year. * Partly electrical. † Minus 3 days. ‡ Minus 2 days. ‖ Plus 3 days. ¶ Plus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Share	Last Dividend	Name.	Price Wed., May 17.	Rate per cent. Yielded.	Dividend Due.	Business Week to May 17. Highest.	Lowest.
		Electricity Supply.		£ s. d.			
10	6/0	Bournemouth & Poole Elec. Sup. Ord.	8½—8¾	6 0 0	Mar, Sep	8⅝	..
10	4/6	Do. 4½ per Cent. Cum. Pref.	9¼—9½	4 12 3	Feb, Aug	9½	..
10	6/0	Do. 6 per Cent. Cum. Second Pref.	10⅛—10⅜	5 6 6	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	102 —104	4 6 6	Jan, July	103½	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	7⅞—8⅛	6 1 6	March	7⅞	7⅛
5	3/6	Do. 7 per Cent. Pref.	7⅞—8	4 1 3	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Deb. Stock	99 —103	3 17 6	June, Dec	102½	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	3⅞—4⅛	5 2 6	Feb, Aug	4⅛	..
5	2/3	Do. 4½ per Cent. Pref.	4¼—4⅜	4 17 0	Feb., Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	96 —98	4 1 6	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101½—103½	4 7 0	..	103½	..
5	2/3	Do. City Undertaking 4½% Cum. Pref.	3⅞—4⅛	5 3 0	Jan, July	—	..
5	3/0	Chelsea Electric Supply Ord.	4 —4⅛	5 11 0	March	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	100 —102	4 8 6	June, Dec	..	..
10	8/0	City of London Electric Lighting Ord.	11⅞—12⅛	4 15 0	Feb, Aug	12⅛	11⅛
10	6/0	Do. 6 per Cent. Cum. Pref.	12 —13	4 12 3	Jan, July	12⅛	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	119 —123	4 1 0	June, Dec	—	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	101 —104	4 6 6	Jan, July	104	..
St.	5%	County of Durham Elec. P. D. 5% 1st Mort. Deb. Stk.	92 —94	5 5 3	Jan, July	..	..
10	6/0	County of London Elec. Supply Ord.	7⅛—8⅛	6 3 0	Feb, Aug	7⅛	..
10	6/0	Do. 6 per Cent. Cum. Pref.	10⅞—11⅛	5 5 6	Mar, Sept	11⅛	..
St.	4½%	Do. 4½ per Cent. Deb Stock (red.)	109½—111½	4 0 9	Jan, July	110	..
St.	4½%	Do. Second Deb. Stock	99 —102	4 8 0	May, Nov	..	..
5	4/0	Folkestone Electricity Supply Co. Ord.	4¼—4⅜	5 19 0	April, Oct	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅞—5⅛	4 15 3	Mar, Sept	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red)	97 —100	4 10 0	Feb, Aug	..	..
5	5/0	Hove Electric Lighting Ord.	6¾—7¼	6 4 0	April, Oct	..	..
St.	4½%	Isle of Wight E. L. & P. Co. Deb. Stk.	88 —91	4 19 0	..	..	..
5	5/0	Kensington & Knightsbridge Ord.	7 —7¼	5 16 0	Feb, Aug	..	..
5	6%	Do. 6 per Cent. 1st Pref.	5⅞—6	5 0 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	93 —95	4 4 0	..	..	..
St.	4%	Kensington & Knghtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	96 —99	4 1 0	April, Oct	..	..
St.	4½%	Kent Elec. Power Co. Irred Deb. Stk.	80 —84	5 7 0	Jan, July	..	..
3	1/2½	London Electric Supply Ord.	1⅛—2⅛	2 17 0	Mar, Sept	..	..
5	3/0	Do. 6 per Cent. Pref.	4¼—5⅛	5 17 0	Mar, Sept	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb	91 —94	4 5 0	Jan, July	..	..
5	3/0	Metropolitan Electric Sup. Ord.	3½—4⅛	5 13 0	April, Oct	..	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	4⅛—4⅜	4 14 9	Jan, July	4⅛	4⅛
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	101 —104	4 6 6	June, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	86 —89	3 18 6	Jan, July	..	..
..	4½%	Midland Elec. Corp. for Power Dist. 4½ 1st Mort. Debs.	97 —99	4 11 0	..	..	..
5	2/6	Newcastle Elec. Supply Ord.	3⅞—4⅛	4 14 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non Cum. Pref.	4 —4⅛	5 11 0	Feb, Aug	..	..
100	4½%	Do. 4½ per Cent. 1st Mort. Deb.	98 —100	4 10 0	Jan, July	..	..
100	5%	North Metro. Elec. Power Sup. 5 Morts.	95 —97	5 3 0	..	..	..
1	6%	Northampton Elec. Lt. & P. Ord.	1⅛—1⅜	4 11 6	Feb, Aug	..	..
1	5%	Do. 5% Pref.	1⅜—1½	4 6 0	Feb, Aug	..	..
St.	4%	Do. 4% Debs.	99 —101	3 19 0	June, Dec	..	..
10	10/0	Notting Hill Electric Ord.	12 —12½	5 17 6	March	..	..
5	4/3	Oxford Electric Ord.	6 —5½	5 11 6	March	6½	6⅜
St.	4%	Do. 4% Deb. Stk.	93 —96	..	..	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	8¼—9¼	5 8 0	Feb, Aug	..	..
5	3/6	Do. 7 per Cent. Pref.	6¼—7¼	4 16 6	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	85 —88	3 19 6	Jan, July	..	..
5	..	Smithfield Markets Electric Sup. Ord.	1⅛—1⅞	..	Feb.	..	..
5	4/0	South London Electric Supply Ord.	3 —3¼	6 3 0	April	..	..
St.	5%	Do. 5% 1st Mort. Stock (red.)	101 —104	4 16 0	..	..	..
1	8½	South Metrop'n Elec. Lt & Power 7% 1st Pref	1⅛—1⅜	5 18 0	Feb, Aug	1⅛	..
1	7½	Do. 6 per Cent. 2nd Pref.	⅞—1	6 17 0	Feb, Aug	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	95 —98	4 11 6	April, Oct	..	..
5	1/3	Urban Electric Supply Ord.	½—1	..	April, Oct	..	..
5	1/3	Do. 5 per Cent. Cum. Pref.	2½—3	8½ 6 0	April, Oct	2⅝	2½
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	85 —88	5 2 3	April, Oct	..	..
5	5/0	Westminster Elec. Sup. Ord.	8 —8½	5 17 9	Mar, Sept	8⅛	8⅛
5	2/3	Do. 4½ per Cent. Cum. Pref.	5 —5⅛	4 3 6	Jan, July	..	..
		Electric Railways and Tramways.					
1	..	Bath Elec. Trams Pref. Ord.	⅞—1	..	April	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	⅞—1	6 13 6	Jan, July	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	79 —83	5 8 6	April, Oct	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Deb. Stock	90½—92½	4 17 3	Jan, July	..	..
10	4%	Bristol Tramways & Carriage Ord.	7 —7¼	5 10 3	Feb, Aug	..	..
10	4%	Do Cum. Pref.	7⅞—7¾	5 1 6	..	..	..
St.	4%	Do. 4 per Cent. Debs.	101 —102	3 18 3	Feb, Aug	..	..
10	..	British Electric Traction Ord.	1 —1⅛	..	June, Dec	1⅛	1⅛
10	..	Do. 6 per Cent. Cum. Pref.	4¾—4⅞	..	Feb, Aug	4⅞	4⅞
St.	5%	Do. 5 per Cent. Perpetual Debs.	91 —93	5 2 0	April, Oct	96	94⅛
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	75 —80	5 12 3	May, Nov	77⅛	..
St.	3%	Central London Ordinary Stock	76 —73	3 17 0	Feb, Aug	78⅛	76⅛
St.	4%	Do. 4 per Cent. Pref. Stock	87 —89	4 10 0	Feb, Aug	83⅛	83⅛
St.	2%	Do. Deferred Stock	65 —68	2 19 0	Feb.	70⅛	66⅛
100	4%	Do. 4 per Cent. Debs.	102 —104	3 17 0	Jan, July	..	..
5	2/6	City of Birmingham Trams, 5% Cum. Pref.	4⅛—5	5 0 0	April, Oct	..	..
100	4%	Do 4 per Cent. 1st Mort. Debs.	99 —102	3 18 9	April, Oct	..	..
St.	1½%	City & South London Rly. Con. Ord.	35 —36	4 3 3	Feb, Aug	35⅛	35⅛
St.	5%	Do. 5 per cent. Perp. Pref. (1891)	109 —111	4 10 0	Feb, Aug	..	..
St.	5%	Do. (1896)	104 —106	4 12 6	Feb, Aug	..	..
St.	5%	Do. (1901)	101 —104	4 16 0	Feb, Aug	..	..
St.	5%	Do. (1903)	102 —105	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	100 —102	3 18 6	May, Nov	..	..
10	6/0	Dublin United Trams, 6 per Cent. Pref.	12½—13½	4 10 6	Feb, Aug	..	..
10	12/0	Gateshead and District Trams Ord.	8½—9⅜	6 19 6	..	..	..
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	⅞—1⅛	..	Feb, Aug	..	..
5	..	Hastings & District Elec. Trams, 6% C. P.	1⅝—2	..	Mar. Sept	..	..
St.	4½%	Do. 4½ Deb. Stock	75 —80	5 10 0	April, Oct	..	..
10	..	Imperial Tramways Ord.	3 —3½	..	Mar, Sept	..	..
10	..	‡Do. 6 per Cent. Pref.	4½—4⅝	..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Debs.	70 —72	6 5 0	Jan, July	..	..
..	2/6	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	2 —2⅜	5 5 0	Mar, Sept.	..	..
St.	4%	Do. 4 per Cent. Deb Stock	79 —84	4 15 0	Jan, July	..	..
10	6/0	Lanarkshire Tramways	9½—10½	5 12 3	Feb, Aug	..	..
St.	5%	Lancs Utd. Trams, 5% Prior Lien Deb. Stk.	82 —84	5 19 0	Jan, July	..	..
St.	4%	London Electric 4% Deb. St.	98 —100	4 0 0	..	..	..
St.	4%	Do. 4% Pref.	83 —85	4 14 0	..	99½	98½
10	..	London United Trams, 5% Cum. Pref.	3⅞—4⅛	..	..	84	83⅛
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	78 —81	4 18 9	Jan, July	4⅛	3⅞
St.	..	Mersey Con. Ord. Stock	6 —8	..	Jan, July	79	76⅛
1	1/1⅛	Metropolitan Elec. Tramways Ord.	⅞—1	6 0 0	Feb, Aug	..	..
1	..	Do. Deferred	⅞—1	..	..	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	1—1⅛	..	April	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	105 —105	5 0 0	Feb, Aug	..	..
St.	5%	Do. 5 per Cent. Db. Stk	100 —105	4 5 9	Jan, July	..	..
St.	1½%	Metropolitan Railway Consolidated	51½—52	4 15 3	..	104	103½
St.	2½%	Do. Surplus Lands Stocks	66 —68	2 12 9	..	103	101½
St.	3½%	Do. 3½ per Cent. Preference	90 —92	4 1 0	Feb, Aug	52⅛	51
St.	3½%	Do. 3½ per Cent. "A" Preference	89 —91	3 16 0	Feb, Aug	67	65
St.	3½%	Do. 3½ per Cent. Convertible Pref.	89 —91	3 17 0	Feb, Aug	91½	90½
St.	3½%	Do. 3½ per Cent. Debenture Stock	93 —95	3 13 6	Feb, Aug	93	90½
						94½	94

* In calculating the yield allowance has been made for accrued interest, but not for redemption.
† Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

NAME.	Price Wed., May 17.	Rate per cent. Yielded.	Dividend Due.	Business Week to May 17. Highest.	Business Week to May 17. Lowest.	Shs	Last Dividend
Electric Railways and Tramways—*Continued.*		£ s. d.					
Met. Rly. 3½ per Cent. "A" Deb. Stock	92 —94	3 14 6	Jan, July	93½	92½	100	2$
Metropolitan District Railway Ord.	33 —33½	..	Feb, Aug	90½	90	..	4%
Do. 4½% First Pref.	89 —91	4 19 0	Feb, Aug	..	..	St.	4%
Do. Assented Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	75 —77	4 11 0	Feb, Aug	76½	..	5	5%
Do. 3 per Cent. Consoltd. Rent-charge	77 —79	3 16 0	Jan, July	..	..	5	3/0
Do. 4 per Cent. Midland Rent-charge	103 —105	3 16 0	Jan, July	104	103½	1	0/7½
Do. 6 per Cent. Perp. Deb. Stock	148 —150	4 0 0	Jan, July	149½	148½	1	0/6
Do. 4 per Cent. Ditto	98 —100	4 0 0	Jan, July	98½	..	St.	6%
Potteries Electric Traction Ord.	¼ —½	..	April, Oct	..	..	St.	6%
Do. 5 per Cent. Cum. Pref.	⅜ —½	7 5 0	Feb, Aug	½	..	10	6/0
†Do. 4½ per Cent, Deb. Stock	86 —89	5 1 0	May, Nov	..	..	10	6/0
S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	⅛ —¼	10 2 0	..	..	..	5	2/6
Do. 4 per Cent. Deb. Stock	75 —80	5 0 0	Jan, July	79½	..	St.	4%
Sunderland Dist. Elec. Trms. 5% 1stMtDb.	..	8 4 0	Jan, July	..	..	St.	4½%
UndergdE. Rys. Lon. 6% In. bds with coup 7	64 —66	1 10 3	June, Dec	65½	61½	1	1/0
Do. 5% Prior Lien Bonds	100 —101	4 19 6	..	100½	99½	1	0/7½
Do. 4½% Bonds with coup. 7	99 —101	4 9 3	..	100½	..	St.	4%
Do. 4 per Cent. 1st Power Ho. Dbs.	100 —102	3 18 3	..	..	..	St.	4½%
Yorkshire (W.R.) Elec. Trams. Ord.	⅛ —¼	..	March ..	..	..	5	3/0
Do. 6 per Cent. Cum. Pref.	2⅛ —2½	..	..	2½	..	5	4½%
Do. 4½ per Cent. 1st Debs.	84 —87	5 3 3	Jan, July	..	..	5	2/6
						St.	4½%
Electric Manufacturing, &c.							
Anchor Cable Co. 4½ % Deb. Stock	99 —101	4 9 0	..	..	..	5	3/0
Aron Electricity Meter Ord.	⅛ —⅛	..	..	⅛	..	10	2/0
Do. 6% Cum. Pf.	⅛ —¼	7 4 0	April, Oct	⅛	..	10	3/0
Babcock & Wilcox Ord.	5⅛ —5½	4 14 6	April, Oct	5⅛	5⅛	10	6%
Do. Pref.	1⅛ —1⅛	4 0 0	..	..	..		
British Insulated & Helsby Cables Ord.	6½ —7⅛	6 15 6	July, Feb	..	..	5	2/6
Do. 6 per Cent. Pref.	6 —6½	4 12 3	Jan, July	..	..	5	2/6
Do. 4½ per Cent. 1st Mort. Deb. (red.)	102 —104	4 6 6	Jan, July	..	..	St.	4%
British Thoms'n-Houst'n 4½% 1st Mt.Db.	96 —99	4 11 0	Mar, Sept	..	..	St.	4½%
British Westinghouse 6 per Cent. Pref.	⅛ —¼	..	Feb, Aug	102½	102	St.	21 9
Do 6 per Cent. Prior Lien Dbs. (rd.)	100 —103	5 16 3	..	..	..	St.	5%
Do. 4 per Cent. Mort. Deb. Stock	61 —64	6 5 0	Jan, July	..	..	5	4/0
BrushE.Eng. Co. 4½% Perp. 1st Deb.Stock	59 —64	7 0 6	Mar, Sept	..	..	5	2/6
Do. Perpetual 2nd Deb. Stock	41 —46	9 16 0	Jan, July	..	..	St.	4½%
Callender's Cable Con. Ord.	9⅛ —9⅞	7 12 0	Jan, July	..	..	St.	8%
Do. 5 per Cent. Cum. Pref.	4⅛ —5⅛	4 17 6	Jan, July	..	..	St.	6%
Do. 4½ per Cent. 1st Mort Debs. (red.)	102 —104	4 6 6	Nov, May	..	..	St.	5%
†Castner-Kellner Alkali Co.	3⅛ —3⅜	4 18 3	May, Nov	3⅛	3⅛	40	4½%
Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 —106	4 3 6	Feb. Aug	..	..	100	4½%
Chadburn's (Ship) Telegraph Ord.	1⅛ —1⅜	5 19 0	March ..	..	..	St.	4½%
Consolidated Electrical Co.	⅛ —¼	10 0 0	August ..	..	..	St.	5%
Consolidated Signal Co.	¾ —1	5 0 0	April, Oct	1⅛	..	St.	6%
Do. 6 per cent. Cum. Pref.	⅛ —⅛	6 8 0	April, Oct	..	..		
Crompton & Co (Nos. 1 to 85,000)	⅛ —¼	..	Jan, July	..	..	5	3/6
Do. 5 per Cent. 1st Mort. Debs. (red.)	70 —80	6 5 0	Jan, July	..	..	100	2/6
Dick, Kerr & Co. Ord.	⅞ —1	5 0 0	Sept. ..	..	..	1	4½%
Do. 6 per Cent. Cum. Pref.	¼ —½	5 6 6	Sept ..	..	..	St.	4%
Do. 4½ per Cent. Deb. Stock	97 —100	4 10 0	Jan, July	..	..	5	1/3
Edison & Swan United ("A" Sh.) (£3 pd.)	⅜ —½	..	Feb, Aug	..	..	St.	4%
Do. (£5 paid)	1½ —2½	9 3 0	Feb. Aug	..	..	..	5%
Do 4 per Cent. Mort. Deb. Stock (red.)	69 —73	5 9 9	June, Dec	..	..	1	5%
Do 5 per Cent. 2nd Deb. Stock	78 —81	6 3 6	Mar, Sept	..	..		
Edmundson's Elec. Corp. Ord.	¾ —1	..	Jan, July	⅝	..	100	5%
Do. 6 per Cent. Cum. Pref.	3 —3½	..	May, Nov	3½	..		
Do 4½ per cent. 1st Mort. Deb. (red.)	86 —89	5 1 0	Jan, July	..	..	1	..
Electric Construction Co.	¾ —1	..	Jan, July	..	..	100	5%
Do. 7 per Cent. Cum. Pref.	1½ —2	7 0 0	July	..	..	5	6%
Do. 4 per Cent. Perp. 1st Mort. Debs.	70 —73	5 8 0	Jan, July	..	..	5	0/7½
General Electric (1900) 5% Cum. Pref.	8½ —9	5 9 0	June, Dec	8⅞	8⅝	100	0/7½
Do. 4 per Cent. 1st Mort. Debs.	83 —88	4 11 0	Mar, Sept	..	..	St.	5%
Henley's Telegraph Works Ord.	12⅛ —12⅞	5 16 6	Feb, Aug	12½	..	St.	5%
Do. 4½ per Cent. Pref.	4⅛ —5⅛	4 7 0	Feb, Aug	5⅛	..	100	5%
Do. 4½ per Cent. 1st Mort. Deb. Stock	108 —110	4 2 0	Mar, Sept	..	..	..	5%
India Rubber, Gut. Per., &c., Works	16½ —17	5 17 9	Feb, Aug	16⅛	..	100	$1½
Do 5 per Cent. Cum. Pref.	10½ —10⅝	4 14 0	..	10⅝	10⅜	..	5%
Do. 4 per Cent. Debs. (red.)	96 —98	4 1 6	April, Oct	..	..	St.	6%
National Elec. Construction Co.	⅛ —⅛	..	April ...	..	..	St.	4½%
Richardsons, Westgarth & Co., Ltd. Ord.	⅛ —¼	..	Nov	⅛	..		
Do. 6 per Cent. Cum. Pref.	⅛ —¼	..	May, Nov	..	..	St.	4½%
Do. 4½ per Cent. Perp. Deb. Stock	78 —82	5 10 0	Jan, July	..	..	1	0/6
Simplex Conduits 6 per Cent. Cum. Pref.	4⅞ —5	..	..	..	..	St.	5%
Telegraph Construction & Maintenance.	36½ —38½	5 16 3	Mar, July	37⅛	37⅛	5	3/0
Do. 4 per Cent. Deb. Bonds (1909)	100 —102	3 18 6	Jan, July	..	..		
Vickers, Sons & Maxim, Ltd., Ord.	2⅜ —2⅝	4 14 0	..	2⅛	2⅛	St.	4½%
Do. 5 per Cent. non-Cum. Preference.	1⅛ —1⅜	4 3 0	..	1⅛	..	100	$1½
Do. 5 per Cent. non-Cum. Preferred	110 —113	4 8 6	..	..	..	..	5%
†Do. 4 per Cent. 1st Mort. Db. Sk. (red)	100 —102	3 18 3	June, Dec	100½	..	100	5%
Do. 4½ per Cent. 2nd Mort. Deb. (red.)	104 —106	4 5 0	June, Dec	105	..	..	$2½
Do. 5 per Cent. 3rd Mort. Debs Scrip.	105 —107	4 13 6	..	106½	106	..	5%
J. G. White & Co. 6% Cum. Pref.	14½ —15½	6 11 0	..	..	..	..	4½%
Willans & Robinson Ord.	⅛ —⅜	..	Apr, Oct	..	..	100	4½%
Do. 6 per Cent. Cum. Pref.	⅛ —1	..	Apr, Oct	..	..		
Do. 4 per Cent. 1st Mort. Debs.	55 —65	6 3 0	May, Nov	..	..		
Telegraphs.							
Amazon Telegraph	7⅛ —7½	..	June, Dec	7½	..	5	3/0
Do. 5 per Cent. Debs. (red.)	98½ —100½	4 19 6	Jan, July	99½	99	10	5/0
Anglo-American	69 —71	4 4 6	F,My,Ag,N	70⅛	69⅛	St.	4½%
Do Preferred	113½ —114½	5 5 0	F,My,Ag,N	114½	114	..	5%
Do. Deferred	26⅛ —26⅜	5 13 0	F,My,Ag,N	27	26⅝	5	3/6
Commercial Cable 4 per Cent. Deb. Stk.	88 —90	4 9 0	Jn,Ap,Jy,O	88½	88	5	2/6
Cuba Submarine Ord.	9⅛ —10⅛	5 17 0	Feb, Aug	..	..	100	5%
†Do. Preference 10 per Cent.	17 —18	5 9 0	Feb, Aug	17⅛	17⅛	100	7/2½
Direct Spanish Ord.	3½ —4	5 0 0	April, Oct	..	..	100	$3½
Do. 10 per Cent. Cum. Pref.	7⅛ —8⅛	5 12 6	April, Oct	..	..	100	5%
Do. 4½ per Cent. Deb.	100⅛ —102⅛	4 8 0	Jan, July	..	..	..	..
Direct United States Cable	7⅛ —7⅞	6 3 6	Ja,Ap,Jy,O	7⅛	7⅛	5	..
Direct West India Cable 4½% Rg.Db.(rd.)	100⅛ —102⅛	3 13 0	June, Dec	..	..	10s	..
Eastern Ordinary	137 —140	5 0 0	Ja,My,Jy,O	139	137½	1	0/7½
Do. 3½ per Cent. Pref. Stock	84½ —86½	4 1 0	Ja,My,Jy,O	86½	85½	..	5%
Do. 4 per Cent. Mort. Deb. Stk. (red.)	100⅛ —102⅛	3 18 6	May, Nov	101	100⅛	5	..
Eastern Extension	13⅛ —14	5 1 0	Ja, Ap, Jy, O	13⅛	13⅛	St.	..
Do. 4 per Cent. Deb. Stock	100⅛ —102⅛	3 18 3	Feb, Aug	..	..	St.	5%
Eastern and S.Af., 4% Mauritius Sub. Debs	99⅛ —101⅛	3 19 0	May, Nov	99⅛	..	500	5%
G.N (of Copenhagen), with Coupon 82	31⅛ —32⅛	5 10 0	Jan, July	32	..		
Indo-European	59 —61	5 6 6	May, Nov	..	..	St.	$1
Mackay Companies Common	93 —96	5 4 0	Ja,Ap,Jy,O	..	..	St.	$3⅛
Do. Preference	78 —80	5 0 0	Ja,Ap,Jy,O	..	..	500	5%
Marconi's Wireless Teleg. Co.	1⅛ —1⅜	..	April	1⅛	1⅛	St	5%
Pacific & Europe'n Tel. 4% Guar. Dbs. (red.)	100 —102	3 18 3	June, Dec	..	..	100	8/2½
West Coast of America	1⅛ —1⅜	4 3 0	May	..	..	100	5%
Do. 4 per Cent. Debs.	99⅛ —101⅛	3 18 9	Jan, July	..	..	St.	£10
West India & Panama	2⅛ —2½	1 18 0	May, Nov	2⅛	..	St.	6%
Do. 6 per Cent. 1st Pref.	10⅛ —10⅞	5 10 0	May, Nov	10⅞	10⅞	St.	5%
Do. 6% 2nd Pref.	9⅛ —10⅛	5 17 0	May, Nov	10⅛	9⅛	100	$1½
Do. 5 per Cent. Debs.	102 —104	4 16 0	Jan, July	..	..	..	5%
Western Telegraph	13⅛ —14	5 0 0	Mr,Jn,O,D	13⅛	13⅛	St.	4½%
Do. 4 per Cent. Deb. Stock (red.)	101 —103	3 17 6	June, Dec	102½	..	St.	4½%
Western Union Telegraph, $1,000 4% Bds	105 —108	3 14 0	..	..	..	..	6d.
Do. $1,000 4½% Fdg. & Rl. Est. Gd. Bnds	98 —101	4 9 3	..	..	..	1	..
Telephones.							
Amer. Telephn. & Telegh. Cap. St.	151½ —153½	5 4 0	..	..	..	100	2$
Do. Coll. Trust $1,000 4 per Cent. Bds.	95 —97	4 2 6	Jan, July	..	..	..	4%
Do. 4% Cons. Bonds 1936	112½ —114½	3 10 0	..	..	..	St.	4%
Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101 —103	4 17 0	Mar, Sept	..	..	St.	5%
Chili Telephone	7⅛ —7⅞	5 1 6	August ..	..	..	5	3/0
Monte Video Telephone Ord.	½ —1	6 0 0	Nov	..	..	1	0/7½
Do. 5 per Cent. Pref.	½ —¾	5 11 0	May, Nov	..	..	1	0/6
National Co. Pref. Stock	104 —105	5 14 3	Feb, Aug	104	104	100	6%
Do. Def. Stock	124½ —126½	4 15 0	Feb, Aug	..	..	St.	6%
Do. 6 per Cent. Cum. 1st Pref.	10 —10½	5 11 6	Feb. Aug	..	..	10	6/0
Do. 6 per Cent. Cum. 2nd Pref.	10 —10½	5 11 6	Feb, Aug	..	..	10	6/0
Do. 5 per Cent. non-Cum. 3rd Pref.	5⅜ —5⅝	4 3 0	Feb, Aug	..	..	5	2/6
Do. Deb. Stock 3½ per Cent. (red.)	99 —101	3 9 3	June, Dec	..	..	St.	3½%
Do. 4 per Cent. Deb. Stock (red.)	99 —101	3 19 3	Jan, July	..	..	St.	4%
New York Telephone Co. 30 yr. Bnds.	99 —100	4 10 0	..	..	..	St.	4½%
Oriental	1⅛ —1⅜	4 15 0	April, Oct	..	..	..	..
Do 6 per Cent. Cum. Pref.	1⅛ —1⅜	4 16 0	April, Oct	..	..	..	..
Do. 4 per Cent. Red. Deb. Stock	87½ —89½	4 9 6	Jan, July	..	..	..	..
Telephone Co. of Egypt 4½% Db. Stk. (red.)	99½ —101½	4 8 9	Jan, July	..	..	St.	4½%
United River Plate Ord. (1—150.000)	7⅛ —7⅜	5 3 0	July	..	..	5	3/0
Do. (150,001—190,000)	7⅛ —7⅜	..	..	..	..	5	4½%
Do. 5 per Cent. Cum. Pref.	5⅛ —5⅜	4 9 0	June, Dec	..	..	5	2/6
Do. 4½ Deb. St. Red.	103 —105	4 5 9	Jan, July	..	..	St.	4½%
Financial, Investment, &c.							
Elec. & Gen. Investment 6% Cum. Pref.	3⅛ —4⅛	7 1 0	Jan, July	..	..	5	3/0
Globe Telegraph & Trust	11 —11½	5 2 6	Sp,DcMrJu	..	..	10	2/0
Do 6 per Cent. Pref.	13 —13⅜	4 9 0	Sp,DcMrJu	..	..	10	3/0
Submarine Cables Trust (Cert.)	131 —134	4 9 6	April, Oct	..	..	10	6%
Colonial and Foreign Electric Railways, Tramways, &c.							
Anglo-Argentine 5% Cum. 1st Pref.	5 —5⅛	4 15 3	April, Oct	..	..		
Do. 5% Cum. 2nd Pref.	4⅞ —5⅛	4 17 6	Jan, July	..	..		
Do. 4% Deb. Stock	93 —94½	4 4 6	June, Dec	..	..		
Do. 4½% Deb. Stock	100 —102	4 8 3	..	..	..		
Do. 5% Deb' Stock	102½ —104½	4 15 6	..	..	..		
Auckland Elec. Trams. 5% Deb. (red.)	104½ —106½	4 14 6	Jan, July	..	..		
Brisbane Electric Trams. Invest. Ord	6½ —6⅝	5 18 6	May	..	..		
Do. 5 per Cent. Cum. Pref.	4⅛ —5⅛	4 14 9	May, Nov	..	..		
Do. 4½ per Cent. Db. Prov. Certs.	102 —105	4 6 0	Jan, July	..	..		
British Columbia El..Rly. Df.Ord.	146 —150	5 6 9	Mar, Sept	..	..		
Do. Pref. Ord. Stock	125 —128	4 13 9	May, Nov	..	..		
Do. 5% Cum. Perp. Pref. Stock	107½ —110½	4 10 6	Jan, July	..	..		
Do. 4½ per Cent. 1st Mort. Debs.	100 —103	4 7 6	April, Oct	..	..		
Do. Vancouver Power Debs.	102 —105	4 5 9	Jan, July	..	..		
Do. 4½% Perp. Con. Deb. St.	101 —103	4 2 0	..	..	..		
Buenos Ayres Lacroze Trams 1st Mt. Db.	99 —101	4 19 0	Mar, Sept	..	..		
Buenos Ayres Port & City Tram, 1st Mt. Deb. Stock	93 —98	6 2 6	Feb, Aug	..	..		
Calcutta Tramways (1 to 137,610)	5⅛ —6	5 0 0	Mar, Sept	..	..		
Do. 5 per Cent. Cum. Pref.	5⅛ —5⅜	4 13 0	Jan, July	..	..		
Do 4½% 1st Deb. Stock (red)	101 —104	4 6 6	Jan, July	..	..		
Cape Electric Tram Shares	⅛ —⅜	..	..	..	..		
City of Buenos Ayres Trams Co. (1904) Sh.	5⅛ —5⅞	4 5 0	F,My,A,N	..	..		
Do 4 per Cent. Deb. Stock	96 —97	4 0 9	June, Dec	..	..		
Colombo Tr. & Ltg. 5% 1st Mt. Db.	95 —98	5 2 0	May, Nov	..	..		
Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	100 —102	4 18 0	Feb, Aug	..	..		
Hong Kong Tramways Co. 5 per Cent. 1st Mort. Debs.	78 —82	6 1 6	June, Dec	..	..		
Kalgoorlie Elec. Trams Sh.	⅛ —¼	..	..	..	..		
Do. 5 per Cent. "A" Deb. Stock	94 —97	5 3 0	Jan, July	..	..		
Do. 6 per Cent. "B" Ditto	66 —70	4 5 9	Jan, July	..	..		
Lisbon Elec. Trams. Ord.	1 —1⅛	4 16 0	July	..	..		
Do. 6 per Cent. Cum. Pref.	1 —1⅛	4 16 0	Jan, July	..	..		
Do. 5 per Cent. Reg. Mort. Debs.	98 —102	4 18 0	Jan, July	..	..		
Madras Elec. Trams. 5% Deb. St.	90 —98	5 2 0	Jan, July	..	..		
Manaos Trams and Lt. Co. 5% Debs	93 —96	5 4 0	..	..	..		
Manila Elec. Ry. $1,000 Gold Bonds	100 —102	4 18 0	Feb, Aug	..	..		
Mexico Trams Co. Com. St.	123 —126	5 11 0	..	..	..		
Do. Gen. Con. 1st Mort. 5% Gold Bds.	95 —97	5 3 0	..	..	..		
Do. 6% 50 yr. Mort. Bds.	102 —103	5 16 9	..	..	..		
Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922) (Nos. 601 to 2,000)	101 —103	4 7 6	Feb, Aug	..	..		
†Do. do. (Nos. 1 to 4,600)	101 —103	4 7 6	..	..	..		
Perth Elec. Trams Ord.	⅛ —¼	2 13 6	May	..	..		
Do 1st Mt. Db. Stock	104 —106	4 14 3	Jan, July	..	..		
Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	5⅛ —5⅜	5 4 6	..	..	..		
Do. 4½% 1st Mort. Deb. Stk.	99 —102	4 8 0	..	..	..		
Rio Janeiro Tram, Lt. & P. Co.	103⅛ —103½	4 11 0	..	..	..		
Do. 30 yr. Gold Bnds.	103 —104	4 16 0	..	..	..		
Do. 50 yr. Mt. Bnds	95½ —96½	5 3 6	..	..	..		
Sao Paulo Tramway, Light & Power Co. $100 Stock	168 —170	5 17 9	..	..	..		
Do. 5 per Cent. 1st Mt. $500 Db.	104 —105	4 15 3	June, Dec	..	..		
Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	95 —100	4 10 0	Feb, Aug	..	..		
Colonial and Foreign Electricity Supply, &c.							
Adelaide Elec. S'ply Co. 6% Cu. Pr.	5⅛ —5⅜	5 2 0	Mar, Sept	..	..		
Bombay E.S. & T. 6% Cm. Pf.	10⅛ —11⅛	5 5 6	..	..	..		
Do. 4½ per Cent. Deb. Stk. (red)	96⅛ —98⅛	4 12 0	Jan, July	..	..		
Do. 5 per Cent. 2nd Mort. Deb. Stock	97 —99	5 1 0	..	..	..		
Calcutta Elec. Supply Ord.	7 —7⅛	6 13 6	April, Oct	..	..		
Do. 5% Cum. Pref.	4⅛ —5⅛	4 13 0	..	..	..		
Calgary Power Co. 5% 1st Mort. Bnds.	96 —98	5 2 0	..	..	..		
Canadian Gen. Elec. Co. Com. St.	111 —114	6 3 0	..	..	..		
Do. 7% Cm. Pf. Stock	120 —123	5 14 0	..	..	..		
Castner Electrolytic Alkali Co. (of U.S.A.) 1st Mort. Stl. Debs.	97 —102	4 18 0	Jan, July	..	..		
Elect Development Co. of Ontario	84 —86	5 12 6	..	..	..		
Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	87 —90	5 11 0	Jan, July	..	..		
Indian Elec. Sup. & Trac. Co.	1 —1⅛	..	..	..	..		
Kalgoorlie Elec. Power & Ltg. Ord.	⅛ —¼	..	..	..	..		
†Do. 6 per Cent. Cum. Pref.	⅛ —¼	8 6 6	April, Oct	..	..		
Kaministiquia Power Co. 5% Gold Bnds.	103 —105	4 15 0	..	..	..		
Madras E. S. Corp. Ord.	3 —3⅛	..	..	..	..		
Melbourne E. S. Co. 6% Cum. Pref.	..	..	..	..	..		
Do. 5% 1st Mortg. Deb. Stock	94 —96	5 4 0	..	..	..		
Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	89½ —90½	5 11 0	..	..	..		
Mexican Lt. & Power Co. Com. St.	81⅛ —83⅛	4 16 0	..	..	..		
Do. 7% Cum. Pref. St.	103½ —103⅞	6 9 0	..	..	..		
Do 5% 1st Mort. Gold Bnds.	94 —95	5 5 6	..	..	..		
Monterey Rly. L. & P. Co. 1st Mort. Db. Sk.	89 —91	5 10 0	..	..	..		
Montreal Lt. Ht. & Power Co. Cap. St.	153 —155	5 3 3	F,My,A,N	..	..		
Northern Lt. Power & Coal 5% Gd. Bds	71 —73	6 17 0	..	..	..		
†River Plate Electricity Co. Ord. Stk.	218 —228	4 7 9	April	..	..		
Do. 6 per Cent. non-Cum. Pref. Stk.	107 —114	5 5 0	May	..	..		
Do. 5 per Cent. Deb. Stock	104 —106	4 14 3	Jan, July	..	..		
Shawinigan Water & Power Co. Ca.	114 —117	3 17 0	..	..	..		
Do. 5 per Cent. Bds.	108½ —110½	4 10 6	Jan, July	..	..		
†Do. 4½ Per Con. Mt. Db. St.	102 —104	4 6 6	..	..	..		
Toronto Power Co. 4½% Db. St.	101 —103	4 7 6	..	..	..		
Victoria Falls Power Co. Pref. (1 to 806,000)	⅜ —1⅛	4 17 0	Jan, July	..	..		
Do. (803,081 to 1,700,000)	⅜ —1	..	..	..	..		

* In calculating the yield allowance has been made for accrued interest but *not* for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote the

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THE ELECTRICIAN:

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NOTES.

The Policy of the Post Office.

The statement of the Postmaster-General last week in introducing the annual estimates, as reported in our present issue, is of more than usual interest. Although it does not go so far as to include Mr. Henniker Heaton's scheme of penny-a-word telegrams throughout the Empire, it nevertheless bears striking testimony to the ready way in which the cable companies reduce their rates when any reasonable ground can be shown for doing so. Mr. Samuel stated that he considered the cable companies were entitled to much credit for their readiness to listen to representations in this direction. They have, in fact, consented to a large reduction in the rates charged for plain-language telegrams of the non-urgent character, such reduction amounting to 50 per cent. This will appeal to the ordinary user as distinct from those who conduct urgent business telegraphically, and should certainly lead to an increase in the number of long-distance messages. It is also interesting to note that the number of ships fitted with wireless apparatus has increased during the past year from 130 to 290, and that the number of "Marconigrams" has increased 60 per cent. In regard to the telephone policy of the Post Office the most interesting announcement is that an endeavour is to be made to develop a system of rural telephones similar to that in America, an unlimited use of the telephone being given for £3 per annum to any farmer who is willing to join with four of his neighbours in a "party" line. This is certainly a cheap service, and it assumes, no doubt, that the needs of the farmer, telephonically speaking, are comparatively few. Our experience, however, is that the use of the telephone rapidly increases as the subscriber comes to learn its convenience, and for this reason it would seem that the rate proposed may have to be revised from time to time, or a restriction placed on the number of calls per day per party-line subscriber.

London County Council Tramways.

The present and future position of their tramways was under discussion by the London County Council for some hours on Tuesday last when the Highways Committee presented a report on workmen's cars and estimates for the financial year 1911-1912. As regards the past year, the revenue from the tramways exceeded the working expenses by £900,885, but as the capital charges amounted to £706,481 there was only £49,574 to place to the reserve fund after a sum equivalent to ¾d. per car-mile had been set aside for renewals in accordance with the policy adopted a year or two ago. The present position must have come as a surprise to a large proportion of the Council, and, in view of the fact that the Highways Committee anticipate a smaller surplus from the trams next year, Sir John Benn's description of the present position as a crisis in the history of the undertaking is certainly not wide of the mark. In fact, a decrease of £56,000 in the surplus from the electric lines is estimated. The main complaint appears to be that, whereas the Council have to contribute £118,000 per

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annum for road maintenance, the competing omnibuses are not handicapped in this respect. There is no doubt that the position is unfair to the tramways, and the directors of the tube railways have also drawn attention to the favoured position of the motor-omnibus companies. As the whole question has recently been brought into prominence, the advantages of the omnibus being unduly lauded in leading articles in the "Daily Mail," it is to be hoped that if there is to be competition between the various traffic concerns such competition will be on an equitable basis. It must not be forgotten, however, that the capital expenditure with which the tramways are saddled would probably have stood at a much higher figure if the work had been carried out by a company, since doubt has been expressed as to whether the undertaking has been debited with its fair share of the cost of street improvements, &c.

In connection with the report presented by the Highways Committee it is interesting to have it placed on record that the workmen's fares were responsible last year for a loss of £61,302 on the electric cars, or almost 40 per cent. of the revenue received from these fares, the deficiency including a sum for capital charges and provision for renewals: on the horse cars the corresponding loss was £4,630. As a matter of fact, however, the deficiency is greater than that mentioned, as the working expenses, in making the estimate, were based on the average of the whole operation of the system, whilst really they are greater on the workmen's cars. Under these circumstances it is not surprising that the Committee considered it would be extremely unwise to extend the hours during which such cheap tickets are issued; and they also reported against proposals for granting additional facilities, such as special fares for children and working women.

The Telephone Authority.

At the eleventh hour, when the final arrangements were being made for the transfer of the telephone system in this country from the National Telephone Co. to the Post Office, Mr. Laws Webb came forward with a fresh proposal, a proposal intended to prevent the introduction of another State monopoly. His argument in favour of the telephone system of the country being carried on in future by means of a Telephone Authority has been supported both by the London Chamber of Commerce and by the Associated Chambers of Commerce; in other words, by the business men of the country. The proposal has, in fact, been so well received that the Post Office has thought it worth while to come out into the open and advance arguments on the other side. Both the Postmaster-General and Mr. John Lee have laid great stress on the benefits which will result from the telephones passing under Government control, but they are not able to explain away the undoubted disadvantages of such a transfer.

Further arguments, from what may be called the telephone user's point of view, were advanced by Mr. Faithfull Begg in an address which he delivered before the London Chamber of Commerce last week. He pointed out that the expenses of working the Post Office telephones have always been higher than those obtained by the Telephone Company, while the way in which the accounts are kept in the Government department makes it impossible to tell exactly how things stand. Further, the boasted increase in trunk facilities made during the time these lines have been under Post Office control, is by no means so great as it ought to have been.

In our opinion, every effort ought to be made to prevent the telephones from passing into the control of the Post Office; and we are, therefore, glad to see that Mr. Laws Webb's proposal has received such a large measure of support in so short a time. A telephone system worked by the Post Office will always tend to inefficiency owing to the very nature of the conditions. Further, the pressure brought to bear by organised labour will be certain to cause the service to deteriorate, with the result that facilities will be lessened and, even if the rates are lowered, there will be no compensation for the great disadvantage of not having the telephone always available in country districts, or for its inefficiency when one can use it. As an example of what may be expected from Post Office control, we may instance the practice of closing country telegraph offices on certain afternoons in the week. A telegram may be sent to some one in the area served by the closed office; it is dispatched by messenger from another office farther away and porterage is charged. Thus, not only are the facilities made unavailable, but the public are made to pay for their unavailability. In our opinion, the telephone and telegraph services ought always to be "on tap" wherever they are installed; but if the Post Office obtain control of them there does not seem much chance of this. There is one further point; even if the Post Office were desirous of extending the telephone system at an adequate rate they would be handicapped by the Treasury. The public money is at present ear-marked for much more highly coloured schemes than developing the telephone.

Invisible Light.

Prof. R. W. Wood's Friday evening discourse at the Royal Institution last week was of interest as showing certain possibilities in working with the invisible parts of the spectrum. When it is remembered that if the visible spectrum is represented by half a yard the total spectrum has a length of 500 yards, it can be seen what a very large ground there is in which rays of some utility may exist and might perhaps be usefully employed. By proceeding towards the lower limit we come very near electric waves. Heat waves $\frac{1}{2}$ mm. in length have been isolated by Rubens, whereas the shortest electric wave that has been produced is about 2 mm., thus leaving a very small gap between the two kinds of radiation. Prof. Wood, however, was more concerned with the immediate infra-red and ultra-violet rays, and he showed some very interesting photographs taken by their means. In the infra-red photographs it was noticeable that these rays are reflected very strongly by foliage, giving the effect of bright sunshine, which is intensified by the blackness of the sky unless clouds are present. On the other hand, in ultra-violet photographs obtained

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by a quartz lens covered with a thin film of silver, there is an almost entire lack of shadow, and there are also some other marked differences; for example, Chinese white appears black by ultra-violet rays. Results of this kind induced Prof. Wood to take ultra-violet photographs of the moon, and in these he found certain dark patches which were not present in photographs taken with ordinary light. This indicates that the crust of the moon contains certain rocks which are dark to ultra-violet rays. Thus we are able to obtain further information than has hitherto been possible as regards lunar constitution, though it is impossible at the present time to identify the rocks, as there may be many materials which would be capable of producing such a result.

Earth Currents.—We have received a letter from Mr. W. R. Rawlings in which he mentions a case of fusion of pipes by earth currents. The pipes in question were an iron gas pipe, and a lead water pipe, both pipes being fused at the point of contact. Mr. Rawlings will be pleased to show the specimens to anyone interested in the subject.

"Imperial Telegraphs."—In reference to Mr. G. R. Neilson's letter of last week, Mr. Charles Bright points out that a large proportion of our readers not present at the meeting, and perhaps many miles away, in reading our necessarily condensed report would naturally have assumed that Mr. Neilson's remarks were in reply to him (Mr. Bright), and he wishes to explain that otherwise he would not have written in regard to Mr. Neilson's comment.

Oil Fuel for Steam Boilers.—At a recent meeting of the Boston Mechanical Engineers a Paper on this subject by Mr. B. R. T. Collins was read. A valuable feature of the Paper was the presentation of a series of tests made last autumn at the Redondo (Cal.) plant of the Pacific Light & Power Co. on a 500 h.p. Babcock and Wilcox boiler equipped with a Hammel furnace and burners. The boiler was in regular service under the usual operating conditions. The oil was obtained from the Los Angeles fields, with a heating value of about 18,300 units. A maximum efficiency of 83·3 per cent. was obtained on the tests while running at 109·2 per cent. of the maker's rating, and the water evaporated per pound of oil from and at 212°F. corrected for moisture was 15·81 lb. The average efficiency for seven tests was 80·47 per cent., and the average evaporation 15·29 lb.

Railway Electrification in Prussia.—As the result of the successful experiments which have been carried out with electric traction between Dessau and Bitterfeld on the Prussian State Railways, the Berlin correspondent of "The Times" reports that the Diet is now asked for fresh credits to the amount of £1,366,500—being £871,500 for further work on the Magdeburg section, and £495,000 as a first instalment of the cost of electrification of the section Laubau-Dittersbach-Königszelt, with a number of small branches, in Silesia. The Prussian authorities point out that the electrification of main lines has become a financial possibility with the adoption of alternating current, and while electric traction is held to be in many ways preferable for the railways themselves, great importance is attached to the subsidiary use of the electric installations for industry and agriculture, as well as for lighting and heating. It is, however, held to be uncertain whether electric traction will meet military requirements, and there will, therefore, be no electrification for the present of strategic railways or of lines which are of strategic importance.

Cable Interruptions.

	Date of Interruption.
Aseab–Perim	July 8, 1909
Malta–Tripoli	April 20, 1910
Latakia–Palura	May 26, 1910
Tourane–Amoy	Sept 25, 1910

Combination Baggage Car and Snow Sweeper.—The "Electric Railway Journal" states that the Michigan United Railways Co. has recently equipped at its Albion shops two large snow sweepers. Each of the new machines is so constructed that it may be used during the winter months as a snow sweeper and converted for use as a baggage car during the summer. As the Michigan United Railways electric system includes about 80 miles of third-rail track, provision is made for operating either with third-rail or trolley current collectors, and small brooms are also provided for cleaning the third-rail. These brooms are mounted on extensions of the main broom shaft. Each of the new cars is equipped with four motors. The brakes are supplied from an air compressor and the brooms are operated by motors.

"The Electrical Equipment of a Modern Theatre."—Messrs. J. P. Hall & Co. point out that in the article by Mr. D. C. M. Hume on this subject which appeared in our last issue it is stated that the controllers and motors at the London Coliseum were supplied by the Sturtevant Engineering Co. Messrs. Hall inform us that the motors were manufactured by them, the controllers being supplied by the Sturtevant Engineering Co. to their order.

Sir John Wolfe Barry, K.C.B., F.R.S.—A complimentary dinner was given last week in the hall of the Worshipful Company of Goldsmiths, Foster-lane, London, E.C., to Sir John Wolfe Barry as initiator and chairman of the Engineering Standards Committee. An illuminated address was presented. Sir W. H. White proposed the health of Sir John and referred to the great work which had been accomplished by the Committee over which he presided and its effect upon the extension of the trade of the Empire. In reply Sir John said that the results of the work of the Engineering Standards Committee had been fully recognised by engineers and manufacturers, the chief Departments of the State and other public authorities. The manufacturing and trading interests of this country had been greatly enhanced by the Committee's labours, and the cost of production had been materially reduced. The fact that the Committee was now permanently in session was a gauge of the importance of its work.

Forthcoming Books.—Messrs. E. & F. N. Spon announce the publication at an early date of a "Bibliographical History of Electricity and Magnetism," chronologically arranged by Paul Fleury Mottelay. The work will be divided into three parts. Part I. will cover the period from 2637 B.C. to 1799 A.D.; part II. from 1800 A.D. to 1820–21 A.D.; and part III. will consist of two appendixes giving accounts of early writers, navigators and others referred to by Gilbert in his "De Magnete," of discoveries made by Gilbert, and a general index. The book will contain of about 600 pages.

The Cambridge University Press will shortly issue (both in the series of Cambridge Manuals of Science and Literature) "Aerial Locomotion," by E. H. Harper, B.A., and Allan Ferguson, B.Sc., and "Electricity in Locomotion," by A. G. Whyte, B.Sc. Mr. Whyte gives a full account of the application of electricity to locomotion, and shows the present condition and the developments which may be looked for in the near future.

On the Absolute Measurement of Light.—A Proposal for an Ultimate Light Standard.—At a recent meeting of the Royal Society a Paper on this subject was read by Dr. R. A. Houstoun. The author stated that a thermopile could not be used for the measurement of candle-power because it gave the same value to the energy of every wave-length, invisible as well as visible. The author, however, had found by spectro-photometric investigation in the ultra-violet, visible, and infra-red parts of the spectrum that, if a filter consisting of aqueous solutions of copper sulphate and potassium bichromate of a particular strength in glass cells be placed before the thermopile, then this filter stopped the ultra-violet and infra-red entirely, and let through a fraction of each wave-length in the visible spectrum proportional to its visibility. In other words, it weighted each radiation according to its visibility. The voltage of a tantalum lamp was varied over a wide range, and its

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candle-power as read by thermopile and filters agreed well with the readings of a photometer. Owing to the high sensitiveness of the galvanometer required the method was not suitable for commercial application, except perhaps for integration photometry when a number of thermopiles might be connected in series with the one galvanometer. The importance of the method lay in the fact that it provided a satisfactory basis for heterochromatic photometry independent of the Purkinje phenomenon at all intensities. The author therefore proposed to use it for defining the unit of light intensity. He would define the latter as that source, the total intensity of radiation from which at a distance of 1 metre after passing through his filters would be x ergs/square centimetre, seconds. For the standard candle x should be about 0·8.

"State Monopoly or Popular Control." —In an address on this subject which Mr. F. Faithfull Begg delivered before the London Chamber of Commerce last week the proposals of Mr. H. Laws Webb for the establishment of a telephone authority were further dealt with. The scope of the proposals, Mr. Begg said, had not been thoroughly understood. The Postmaster-General, for example, did not seem to be aware that a complete severance of the whole telephone service from the Post Office administration was proposed, or that the Telephone Authority was intended to be composed of experts in telephone business who would be responsible for the financial result; and at the same time financially independent of the Treasury. One main object was to secure that there should be no confusion between telegraph and telephone accounts, such as had occurred in the past in the Post Office Department, or that the present annual loss on telegraphs should be saddled upon the telephone revenue. The telephone in the past had never had fair play, the Post Office being always governed by fear of injury to the telegraph revenue. The Post Office working of telephones compared most unfavourably with the National Telephone Co.'s working, the former being worked at 74·4 per cent., as against 58 per cent. of the gross revenue in the case of the National Telephone Co. The Post Office earned 3·5 per cent. on its capital and the National Telephone Co. 8·9 per cent. The recent development of trunk wires in the United States had been nearly double that in the United Kingdom, while the increase in the number of stations was much greater in proportion. Basing the calculation on the rate of progress made in the United States, to make up the lee-way in this country, £116,500,000 would have to be spent during the next 10 years. The Postmaster-General had asserted that the separation of the telephone from the telegraph was physically impossible owing to the manner in which the plant was interwoven. This was, no doubt, the honest view of the Post Office officials. Experts thought otherwise, and as a matter of fact the Post Office and the National Telephone Co. were at the present moment mutually leasing overhead and underground wires to each other. There was really no practical difficulty which could not be overcome if a desire to overcome it existed. Moreover, the probable extension was so great that very shortly existing plant would form a small proportion of the whole. No answer had been made to the argument on the political aspect of the question. The telephone staff might easily grow to 100,000 in the near future, and in view of the present system of pressure upon Members of Parliament and others on the part of Post Office employés, this was an exceedingly grave question. In conclusion, the lecturer said he was convinced that unless some plan could be devised to prevent the absolute transfer of the telephones to the Post Office, the system must fall under the paralysing influence of State monopoly and development be arrested. Commercial interests were vitally affected by the question. It was almost impossible to exaggerate the importance of the problem. Keenness of modern competition rendered it necessary to provide every facility for business, and rapid communication was one of the most vital issues. In his opinion a Government department was wholly ineffectual for handling such an extensive, delicate and scientific problem, and the only satisfactory solution would be to establish a telephone authority representing all interests and popularly controlled, as advocated by the London Chamber of Commerce.

Current Topics.

Subjects of current interest dealt with in this issue include the following:—

Mr. D. C. M. Hume concludes his article on "The Electrical Equipment of a Modern Theatre."

Mr. Haydn T. Harrison contributes an article on "The Nomenclature of Primary and Secondary Sources of Light."

At the meeting of the Institution of Electrical Engineers last night Messrs. S. W. Melsom and H. C. Booth read a Paper on "The Heating of Cables with Current."

We conclude our abstract of Mr. W. Aitken's Paper on "Automatic Telephone Exchange systems," read at the meeting of the Institution last week. An account is also given of the discussion that took place. The subject of "Automatic Telephony" is considered in our leading article.

At a recent meeting of the Faraday Society Mr. A. Scott-Hansen read a Paper on "Hydro-Electric Plants in Norway and their application to Electromechanical Industries."

An interesting instrument, known as the "Ampall," has been placed on the market by Mr. R. W. Paul. This enables the current flowing in a circuit to be determined without interrupting the current for the purpose of inserting a shunt or ammeter in the circuit.

We describe a new system of motor car lighting which has been devised by Mr. Gavan Inrig. This is known as the "Carleon" system.

The Home Office have issued a Draft Order under the Mines Accidents (Rescue and Aid) Act, 1910, for the organisation of rescue and aid in cases of accidents in mines.

The Westminster Electric Supply Corporation opened on Wednesday last demonstration rooms at their main offices in Eccleston-place, S.W. An excellent collection of electrical apparatus has been got together, and considerable attention is being paid to the demonstration of the advantages of electric cooking.

Municipal Loans.—An inquiry has been held during the past week at *St. Helens* into the application of the Corporation for permission to borrow £10,800 for electricity supply purposes.—*Walthamstow* Council have applied for sanction to a loan of £5,149 for a feeder cable.—*Poplar* Council have applied to the London County Council for a loan of £42,455 for their electricity undertaking.—*Derby* Corporation made an application last week for power to borrow £8,500 for extensions of the electricity undertaking. There was an increase in the output during the last 12 months of over 913,000 units, bringing the total up to nearly 5,600,000.

Parliamentary.—In the House of Commons last week the Postmaster-General, Mr. H. Samuel, introduced the Post Office estimates for the current year, and made an interesting statement as to the progress of the postal, telegraph and telephone departments. He also announced a series of concessions, including some improvements in the postal service, the reduction of foreign parcel post rates, cheaper and improved cable communication, extended telephone facilities, &c.

On Friday last a House of Commons Committee passed the Birmingham Extension Bill, which authorises the Corporation to acquire control of some of the surrounding districts, with, *inter alia*, their tramways and electricity supply undertakings.

Select Committees of the House of Commons have also been considering during the week the Greater London Railway and the Newcastle-on-Tyne Corporation Bills, and Standing Committee B has made further progress with the Coal Mines Bill.

Legal.—A Divisional Court on Tuesday dismissed a motion by the British Westinghouse Electric & Manufacturing Co. to set aside an arbitration award in regard to an alleged breach of contract for the supply of turbo-generators to the Underground Electric Railways Co. of London. The applicants are taking the case to the Court of Appeal.

An interesting judgment on telephone agreements was given by His Honor Judge Scully at Brighton County Court last week.

Last week the First Division of the Court of Session, Edinburgh allowed the appeal of plaintiffs in the action brought by Johannesburg Municipal Council against Messrs. D. Stewart & Co. (1902), Ltd. (for damages for alleged breach of contract), from an order granting defendants further time to prepare their defence.

PERSONAL NOTE.

Mr. Geo. Tate, for 10 years works manager to Arc Lamps (Ltd.) informs us that he has severed his connection with the Company Communications for Mr. Tate should be addressed to 3, Blenheim road, St. Albans, Herts.

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APPOINTMENTS VACANT AND FILLED.

An assistant lecturer and demonstrator in physics is required for University College, Nottingham. Applications by June 1 to the Registrar, from whom particulars can be obtained.

A demonstrator in physics is required for Durban (Natal) Technical Institute. Salary £300, rising to £400. Further information from W. A. Narbeth, Langford House, Eltham, Kent, to whom applications by June 7.

A demonstrator in physics is required for Armstrong College, Newcastle-on-Tyne. Salary £100 rising to £120. Applications to Mr. F. H. Pruen, Secretary, by June 23.

Mr. A. A. Dirks has now been permanently appointed as electrical engineer to the Post and Telegraph Department at Melbourne, in succession to Mr. H. W. Jenvey (retired) and Mr. T. Howard has been appointed manager of the telegraph branch, in succession to Mr. W. Radford.

Mr. F. E. Spencer (Melbourne) has been appointed electrical engineer to Redfern (Sydney) Council, in succession to Mr. J. Balfour.

Mr. J. E. Jinks, formerly traffic manager of Ballarat (Victoria) tramways, has been appointed superintendent of Launceston (Tasmania) tramways.

Mr. T. R. Stancombe, of Barnsley, has been appointed sales engineer to the Yorkshire Electric Power Co.

Mr. K. Bulpit has been appointed shift engineer at Barnes.

INSTITUTIONS AND SOCIETIES.

Royal Society.—The following Papers were read before this Society at their meeting yesterday afternoon: "Experiments on the Compression of Liquids at High Pressures," by the Hon. C. A. Parsons, F.R.S., and Mr. S. S. Cook; "Energy Transformations by X Rays," by Prof. W. H. Bragg, F.R.S. and Mr. H. L. Porter; "Spectroscopic Investigations in Connection with the Active Modification of Nitrogen. I.—Spectrum of the Afterglow," Prof. A. Fowler, F.R.S. and the Hon. R. J. Strutt, F.R.S.; "An Optical Method of Measuring Vapour Pressures; Vapour Pressure and Apparent Superheating of Solid Mercury," by Mr. C. Cuthbertson and Mrs. M. Cuthbertson; "The Hartley Tube Spectra of Mercury," by Dr. F. Horton; "The Production of Characteristic Röntgen Radiations," by Mr. R. Whiddington.

Royal Society of Arts.—The annual conversazione of this Society will be held at the Natural History Museum, Cromwell-road, S.W., on Tuesday next, May 30, from 9 to 12 midnight. Sir John Cameron Lamb, C.B. and the members of the Council will receive the guests.

Yorkshire Section of the Institution of Electrical Engineers.—At the annual general meeting of this section of the Institution of Electrical Engineers, which was held on May 17th, the following gentlemen were elected for the ensuing session: *Chairman*, Mr. T. Harding Vice-*Chairmen*, Messrs. Wilson Hartnell and W. Emmott; Mr. H. Dickinson; *New Members of the Committee*, Messrs. D. A. Parr, H. Visger, W. N. Y. King and E. S. Rayner. The meeting sympathetic reference was made by the chairman to the death of Sir Nathan Bodington, Vice-Chancellor of the Leeds University, and a vote of condolence was passed to Lady Bodington in her bereavement.

Victorian Institute of Electrical Engineers.—At the recent annual general meeting it was reported that the membership roll was 114, an increase of 48 over the previous year.

The Council for 1911 was elected. The President is Mr. P. Rosling; Messrs. J. H. D. Brearley and W. H. Alabaster being vice-presidents and Mr. E. H. W. Westwood. Secretary. It was reported further that strong endeavours had been made to bring about amalgamation with the New South Wales Electrical Association, and it was expected that something definite in the matter of the formation of the Victorian Institute of Electrical Engineers would be settled shortly. A discussion took place regarding the licensing of wiremen.

Mr. W. G. Murray desired that the municipal authorities be approached in the matter. The only way to obviate bad workmanship was to subject the wiremen in the same way as was done with engineers and plumbers. This would give the authorities control over the men. If a man wired a building in a faulty manner, then he should have his licence suspended for 6 or 12 months, and that would be the means of keeping a standard of work. A man should also be made responsible for the material used as well as for the work done.

Mr. P. Rosling stated that the committee had considered the matter, but nothing could be done without passing an Act of Parliament. He, therefore suggested that the matter should be left over until the wiremen's wages board was settled.

Mr. E. H. W. Westwood said that in Wellington (N.Z.) no wireman was allowed to touch the council's mains unless he held a licence, but he believed the whole thing had proved a failure.

It was decided to bring the matter before the Council.

The Tramways and Light Railways Association.—The "Journal" of this association for June contains copies of the Board of Trade Regulations regarding guard wires; the Home Office Report regarding street accidents caused by vehicles; details relating to the association's congress to be held at Edinburgh in July, and various other general matters relating to the association.

EDUCATIONAL NOTICE.

"The Application of Hyperbolic Functions to Electrical Engineering."—A series of lectures on this subject addressed to advanced students of the University of London and others interested will be delivered by Dr. A. E. Kennelly on May 29th and the four following days at the Institution of Electrical Engineers. The lectures will begin at 5:30 p.m. The ground to be covered is sufficiently indicated by the following syllabus. *Lecture I.*—Hyperbolic angles and their properties; the relations between circular and hyperbolic angles; applications of hyperbolic functions to continuous-current lines of uniform resistance and leakance. *Lecture II.*—The simple representation of artificial lines, and alternating-current lines by hyperbolic angles; equivalent lines (T and π). *Lecture III.*—The distribution of voltage and current over alternating-current power-transmission lines as simplified by the use of hyperbolic angles. *Lecture IV.*—The distribution of voltage and current over telephone lines, both simple and loaded: (1) by hyperbolic angles; (2) by equivalent circuits. *Lecture V.*—The hyperbolic theory of voltage and current on composite telephone lines and on long submarine telegraph cables; miscellaneous applications of hyperbolic functions in electrical engineering. Admission to these lectures is free by ticket to be obtained from the secretary of the Institution.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, May 26th (to-day).

PHYSICAL SOCIETY.

3 p.m. Visit to the National Physical Laboratory, Bushy House, Teddington.

INSTITUTION OF ELECTRICAL ENGINEERS.

4:30 p.m. Annual General Meeting at Victoria Embankment.

SATURDAY, May 27th.

ASSOCIATION OF ENGINEERS-IN-CHARGE.

9 a.m. Visit to the Works of the Cambridge Scientific Instrument Co., Cambridge.

MONDAY, May 29th.

UNIVERSITY OF LONDON.

5:30 p.m. First Lecture (at the Institution of Electrical Engineers) on "The Application of Hyperbolic Functions to Electrical Engineering," by Dr. A. E. Kennelly. *The remaining lectures of the course will be delivered on the four following evenings at the same time.*

THURSDAY, June 1st.

ROYAL INSTITUTION.

3 p.m. Meeting at Albemarle-street. Lecture on "Changes Effected by Light," by Mr. T. Thorne Baker.

FRIDAY, June 2nd.

ROYAL INSTITUTION.

9 p.m. Meeting at Albemarle-street. Discourse on "Radio-telegraphy," by Commendatore G. Marconi.

THE LONDON ELECTRICAL ENGINEERS.

Officer Commanding, Col. H. M. Leaf.

The following orders have been issued for the current week:—

Monday, 29th, "A" Company.—Infantry Drill, 7 to 8 p.m. Technical Drill, 8 to 10 p.m.

Tuesday, 30th, "B" Company.—Technical Drill, 7:30 to 10 p.m.

Wednesday, 31st, All Companies.—Annual Course of Musketry at Purfleet Rifle Ranges. Tickets can be obtained at Headquarters on application.

Thursday, June 1st, "C" Company.—Recruits' Infantry Drill, 6:30 to 7:30 p.m. Technical Drill, 7 to 8:15 p.m. Company Drill at Millbank Barracks, 8:30 to 9 p.m. Dress, Drill order.

Friday, June 2nd, "D" Company.—Recruits' Infantry Drill, 7 to 8 p.m. Company Drill, at Millbank Barracks, 7:30 to 9 p.m. Technical Drill, 9 to 10 p.m.

Saturday, June 3.—No parades.

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AUTOMATIC TELEPHONE EXCHANGE SYSTEMS.*

BY W. AITKEN.

(*Concluded from page 203.*)

Summary.—A description is first given of a switchboard designed by the author, in which the connection is made manually but disconnection is automatic. The full automatic telephone system of the Automatic Electric Co. is next described in detail. A comparison is finally made between the features of automatic and manual systems, and an estimate is made of the comparative cost of working.

We will recapitulate the operation of a 1,000-line equipment. On an exchange of this size there will be 1,000 line switches (*i.e.*, one per line), 100 first selectors and 100 connectors. It is found in practice that a 10 per cent. basis is ample for ordinary exchanges; very rarely are there more than 10 connections (or 20 telephones talking) per 100 lines. After the receiver has been lifted, and before the dial has been revolved to the stop, the line switch has done its work and connected with an idle selector. If the number desired is 865, the caller will place a finger over the number 8 and revolve the dial to the stop. The selector will step up to the eighth level of contacts and come to rest on the first set of contacts if these are disengaged; if, however, that line to a connector is already engaged, the shaft will continue to rotate automatically until an idle connector line is found. The finger will then be placed over the figure 6, and the dial revolved to the stop, when the connector will step up to the sixth level, but will not make contact with any line. The finger will then be placed over the figure 5, and the dial revolved to the stop, when the shaft will rotate until the fifth group of springs on the sixth level is reached. When stations below 100 in an exchange of 1,000 lines are called the number is preceded by O, so that the sequence of operations may remain the same, or the two figure numbers will be omitted. On 100,000-line systems, instead of using five figures to identify a line, four figures are used preceded by a letter, as being easier to remember, and generally the letters indicate different exchange, as the system is usually built up of 10 exchanges, or 10 groups of exchanges, each having a capacity of 10,000 lines.

It has been found in practice that 10 per cent. of lines between first and second selectors in very large installations is unnecessarily high, owing to the rapidity of service, and a "secondary line switch" has been introduced to reduce that number. Both line switches act automatically and are quite independent of any movement of the dial. This still further reduces the number of lines between exchanges. To equalise the traffic on the first selectors an intermediate distributing board is introduced between the primary and secondary line switches. By the introduction of secondary line switches any subscriber's line may use any first selector and any junction line is made available to any first selector.

The opinion is commonly held that the automatic system is most inflexible, but quite the contrary has proved the case in practice, and all special services, such as metering or registering calls, party line working, private branch exchange working, &c., are now standardised.

Party Line Working.—A four-party frequency system is used with the bells of the subscribers' instruments tuned to respond to frequencies of $16\frac{2}{3}$ cycles, $33\frac{1}{3}$ cycles, 50 cycles, $66\frac{2}{3}$ cycles. A group of party lines will be multipled over four connectors, and to each connector will be supplied ringing current of one frequency only, so that when a connector is brought into use only one particular subscriber on the line can be called.

Call Offices.—These are operated in a simple but very ingenious manner. The subscriber calls in the usual way, but when the called station answers the reversed current actuates an electromagnet in the coin box which short-circuits the microphone and places a shunt about the receiver, so that the caller can but faintly hear the party called. On the insertion of the requisite coin the talking is made normal.

Sub-District Stations.—A great feature of the automatic system is that it is not essential to concentrate a great number of lines in any one building. The system will work as efficiently if 10,000 lines are in one building as in 10 exchanges of 1,000 lines each. The apparatus, with the exception of, probably, the power plant, will be exactly similar, but the street cable plant will be very different. Instead of 10,000 lines converging to one centre, there will be, in addition to the shorter converging lines, the 10 per cent. of lines between first and second selectors between exchanges. It will thus be seen how efficiently the automatic system meets the varied needs of a great city, where a residential district of a few years ago with few telephones becomes a busy business centre requiring many telephones.

In existing manual systems automatic district stations may be used with advantage as valuable adjuncts, either to avoid expensive underground cable work, the provision of new manual plant, or expensive additions to existing plant of limited capacity. The instruments on such an automatic equipment would be of any of the well-known patterns without any automatic feature whatever. At the district station they would be connected to line switches for outgoing work. At the manual exchanges these junction lines would end on the usual line and cut-off relay, answering jack, and calling lamp, or on single cord equipment like manual incoming junctions. On the removal of the receiver to call, the line switch would connect with a disengaged junction instantly, and the line lamp would glow, and the operator would complete the connection in the usual way, the service being absolutely similar to a connection in a purely manual exchange. Fig. 3 shows such an arrangement. For outgoing calls from the manual exchange, an operator would have, in addition to the ordinary double cord equipment, a switch to connect up a dial-calling device by which, after making the connection, she would call the number required in a manner similar to a subscriber calling on a full automatic system. All the lines in the district station are multipled on to connector banks to allow of them being called. Another method is to multiple the outgoing junctions over the manual board and on to a controlling operator's position which may be away from

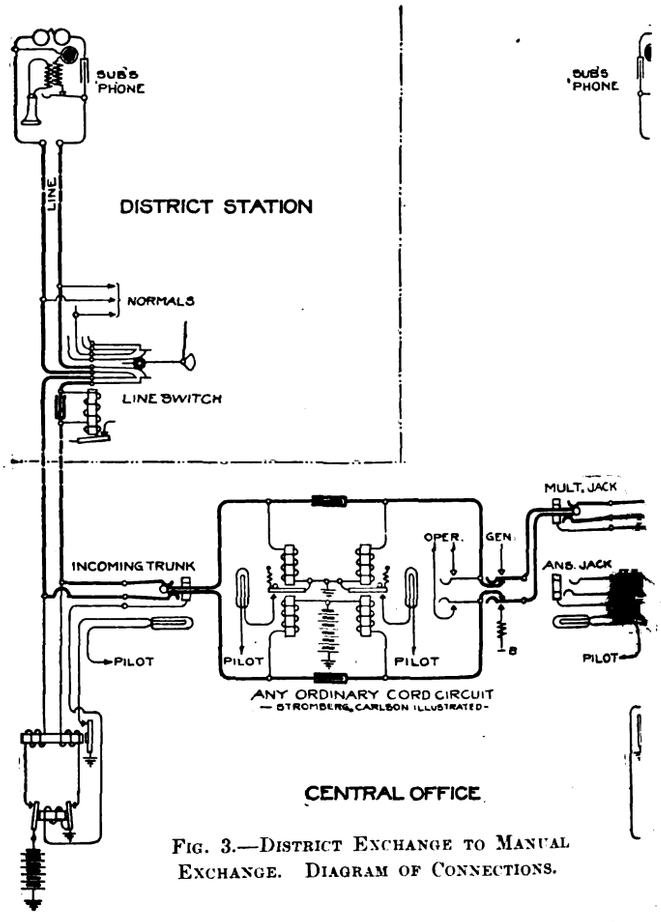

FIG. 3.—DISTRICT EXCHANGE TO MANUAL EXCHANGE. DIAGRAM OF CONNECTIONS.

the multiple. This operator would have a key in each junction switch in the dial-calling device and a lamp to indicate what lir were engaged.

Such an important and far-reaching subject as a change from manual to an automatic system must be considered very seriou from various points of view. In some countries objection has be raised to the automatic system because it will do away with one fo of employment which is very suitable for women; in new countr where women are scarce the automatic appeals as a way out of great difficulty. Considering the question, however, quite ap from sentiment, it will be interesting to investigate it, briefly a generally, from the points of view of efficiency, capital cost, a maintenance.

Efficiency.—The manual system is now as near perfection from operating point of view as it can be brought, and increased efficier can only be obtained by refinements due to more expert operat and thorough supervision. The principle of working is that the su scriber should only remove the receiver, state his requirements, a replace the receiver on the switch-hook, all operating beyond be performed by experts. This sounds good and simple, but it depen firstly, on the articulation of the speaker, who may be from a county or any country, and, secondly, on the ear and understand

* Abstract of a Paper read before the Institution of Electrical Engineers.

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of the operator to interpret the words before giving effect to them. Again, in a city like London, something like 75 per cent. of the calls are over junction lines, which means that the first operator has to repeat the number required to a second operator. In the automatic system the responsibility for getting any number, no matter how large, is entirely on the caller. If a blunder is made, the caller has only himself to blame. For rapidity of service the automatic has the advantage unquestionably, and the secrecy of the conversations will also appeal to many.

Capital Cost.—This, for the actual exchange equipment in small exchanges, is much more with automatic than with manual, but as the increase in size they approach nearer until at about 10,000 lines they are equal in cost. This is for single exchange equipment, but when the telephoning of a great city is considered the results may be very different. The subject is, however, very complex and would require very careful study of a particular area to determine exact cost. This may be noted, however, that whereas the manual system increases with an ever-increasing ratio owing to the increase of junction lines with their complicated circuits, huge multiples, and attendant operators, the cost of the automatic system increases much more gradually. The apparatus increases on the per centage basis, and the junction lines are actually fewer, as they carry a greater number of subscribers' calls owing to the rapidity of the service.

The figures obtainable re cost are very few and are based entirely on American practice. The cost of installing, both manual and automatic equipments, will be greater, I think, in this country than in America. The following schedule of comparative costs for manual and automatic exchanges of 5,000 and 10,000 lines is taken from a paper by Mr. Lee Campbell. The cost per line of the manual exchanges given is low if ancilliary lamps are used. The increased cost of automatic equipment is more than counterbalanced by the reduction in cost of building, the cubic space necessary being only half that required for a manual equipment.

The manual system is seen at its worst when sub-division takes place. Owing to the cost of line equipment it is not economical practice to concentrate all lines on one large central exchange, even were this could cope with the requirements of a town. It is usually advisable, therefore, to have district exchanges, and the schedule shows the results when 10,000 lines are divided between two 4,000-line and two 1,000-line exchanges. Owing to junction work the A operators' load is reduced from say, 240 calls per busy hour to 115. B operators have to be introduced for work between exchanges, and the total operators will be increased from about 99 to 140. The cost of buildings will also be much greater. The automatic equipment will not be increased seriously, the cost for power plant will be greater, the cost of buildings will not be so serious as with the manual. For while the automatic the efficiency will remain the same as if concentrated in one building, whilst in the manual the service will be considerably slower, and the liability to wrong connection much greater owing to the repetition of numbers, &c.

It is a very difficult matter to deal with the saving effected in conductor cable for lines, unless a particular town be laid out for each case; but, generally, I think, it must be conceded that as the efficiency remains always at 100 per cent. efficiency, no matter how the lines are distributed, there must be a great saving owing to the possible reduction of the average length of the subscribers' lines, the greater number of junction lines owing to their greater carrying capacity under automatic conditions, and to the greater flexibility and the feasibility of opening an automatic exchange owing to the greater telephonic density of a district, whereas a manual exchange could not be opened at the cost of reducing the efficiency and increasing the operating cost of the whole area. The cost of buildings works out much less on an automatic system as the equipment is much less in compact—no kitchen, rest-room, and other conveniences for operators are necessary. The furnishings, decorations, electric light and fittings are much simpler.

Maintenance.—All operators' expenses are saved except such as are required for trunk service, information desks, and the like. Against this, of course, has to be placed the cost of electricians or mechanics. One good man is usually provided for every 1,000 lines.

The Automatic Electric Co. have lately published a certificate over the signature of the President of the Citizens Telephone Co., Grand Rapids, that the cost of replacing parts, due to defective workmanship, or material, or ordinary wear and tear, during seven years, amounted to $962·62, an average of $137·52 per annum, or 0·9d. per line per annum, for the average of 7,500 lines in service. This sum included all central equipment, except power plant, and also the dial switches in the telephones.

Similar data for manual equipments is not readily available. From figures obtained in connection with the Chicago manual system the average cost of repairs on central equipments and instruments is about 27s. per line per annum, the cost of repairs on exchange equipment alone averaging about 17s. For Seattle the figures are given as 10s. per line per annum line and exchange equipment, and 10s. per subscriber's instrument. It would be interesting to hear what the costs of repairs are in this country, and further figures regarding automatic equipments.

Semi-automatic systems have been suggested as meeting the requirements of future development, but it is very doubtful if they can be made an economical success, and they seem to me to be good only as a transition measure. The "Traffic Distributor" system of the Automatic Electric Co. meets the requirements in an efficient manner. In this the multiple of a manual exchange is retained, but the answering jacks, calling lamps, line and cut-off relays, and intermediate distributing frame are omitted. The keyboard equipment is simplified in that, instead of double cords, only as many single cords are provided as the operator can attend to. From the main frame, lines in parallel to the multiple are carried to Keith primary line switches, with their 10 per cent. of lines to secondary line switches, so that the number of lines is reduced until they are just sufficient to carry the traffic. These lines are then distributed among as many operators as are necessary to cope efficiently with the work, the lines ending on the single cords already mentioned. Switching devices are introduced so that position after position may be thrown out of use, and the work therefore concentrated so that it can be dealt with in the most economical and efficient manner. It is to be noted particularly that the calls are distributed in rotation to the different operators, so that all have an equal amount of work to perform.

The instruments at the sub-stations are exactly the manual common battery instrument, and the subscriber calls by lifting the receiver. Immediately the line switches act one after the other and extend the line to the plug and the lamp associated with the plug glows. (Meantime the master switch has moved all lines of a group to the next spare circuit to the next operator so that the line is pre-selected.) The operator pulls over the speaking key to answer, lifts the plug, tests and completes the connection in the usual manner.

Time does not permit of the subject of automatic telephony being dealt with exhaustively. The Lorimer, the American Automatic Co.'s and other systems would require another Paper to deal adequately with them. That there is a great future before automatic telephony I am convinced, and my Paper can only be looked on as preparing the way for more detailed consideration of the subject.

We give below an abstract of the discussion on Mr. Aitken's Paper which took place last week at the Institution of Electrical Engineers.

Mr. J. E. KINGSBURY suggested with regard to nomenclature that what was now termed automatic switching should be called machine switching and what was called full automatic should be described as machine calling and machine switching. That would differentiate three different systems: Full automatic, semi-automatic, and so-called full manual. Mr. Aitken was a "whole-hogger" for the full automatic, and did not believe anything else could be other than transitory. He (Mr. Kingsbury) did not say he was wrong, but the installation or modification of a telephone system was a work of considerable cost and extreme gravity; and it was a complex engineering problem mixed up with a complex

	5,000 lines.		10,000 lines.	
	Manual.	Automatic.	Manual.	Automatic.
Cost per line—switchboard equipment without junctions	£ s. d. 3 11 6	£ s. d. 4 3 0	£ s. d. 5 0 0	£ s. d. 5 0 0
" " instrument	1 15 0	2 5 0	1 15 0	2 5 0
" of fireproof building (land, furnishings, offices not included)	1,637 0 0	855 0 0	3,500 0 0	1,750 0 0
Operating repairs, maintenance, per line per annum	1 5 0	0 8 10	1 13 6	0 9 4
" " power, light, taxes, depreciation, equipment and building renewals *	2 1 0	1 4 0	2 10 0	1 5 6
" operating and maintenance per line per annum	—	—	3 10 0	1 6 6
" per line, switchboard equipment per annum	—	—	4 14 0	4 18 0
" per line, switchboard equipment and buildings per annum	—	—	5 4 6	5 2 0

* Depreciation of manual taken at 10 years; automatic at 12 years.

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social problem. Mr. Carty, who read a Paper on this subject a short time ago, indicated that telephone engineers must be careful that they might not be led away by the enthusiasm of the inventor or manufacturer. Mr. Aitken had turned the tables on the telephone engineer, and he (Mr. Kingsbury), as a manufacturer, said it was only enthusiasts who thought the public were incapable of operating a telephone calling machine. Mr. Aitken said the telephone, in transmitting the intelligence to the operator, might be indistinct; so might the telephonic conversation, and if a telephone could be made to transmit a conversation it ought to be able to transmit the number the subscriber required. Would the subscriber always be sure of sending the right number by machinery? He did not wish to depreciate the subscriber, but there was a difference between sending a machine call on the telephone and operating an automatic machine for a pennyworth of chocolate. He had condemned proposals made for placing upon the subscriber the responsibility of any errors in switching, and he again entered his objection on the same grounds. Those responsible should take care the service was a sound and perfect one, and not seek to evade any responsibility.

Mr. F. Gill said he must disclaim credit for the suggestion Mr. Aitken attributed to him in the Paper. Something he had said must have been inverted, because the National Telephone Co. thought the intervention of the private exchange operator was very important; he hardly thought she could be got rid of by automatic gear, no matter how it was worked. Calls coming in had to be filtered and the correct representative found, while calls going out had to be nursed through, and the expensive time of the principal saved by the less expensive time of the operator. It was better to give the supervisory signal to the private branch exchange than to the central. Some subscribers did not furnish good attention at their private branch exchanges, but that did not make any difference to the principle. Opposite page 26 of the Paper there was a diagram of a 100,000-line system. All down the 10,000-line exchange the junction lines between primary and secondary line switches were on a 10 per cent. basis, but each 1,000 subscribers might have different calling rates, and therefore he should say the number of subscribers' lines for each 100 such junction lines need not necessarily be 1,000. In other parts of the Paper the author referred to 10 per cent. of the junction lines; he (Mr. Gill) assumed that was only illustrative, and that the junction lines would be proportioned to the traffic. On page 28 of the Paper there was a mention of 22½ calls per junction per busy hour; but it would be unsafe for anybody to translate those figures into this country until it could be shown that they applied. They did not apply in London, where the duration of the actual conversation was very much longer than was indicated by those figures. There was also a reference to all special services being given by the automatic system. All special services was rather a large order. In the National system there were 60 different instructions which might require to be given to the operator as to the way different services should be handled, and there must be different rates to meet the different conditions and requirements of the public. Last time he (Mr. Gill) was in the States he came across the old figure (which Mr. Aitken gave) of one man per 1,000 lines for maintenance. He thought he had run that one man to earth, for he found he worked eight hours per day, and that there were really on the pay roll three men per 1,000 lines working eight hours per day each. No advocate of the manual systems objected to using automatic gear; the question was where should it be used. Mr. Aitken truly said the proper thing to do was to study an area. The manual system was better here and the automatic system was better there. The only way to set to work was to take a large area and study it right out to the bottom in all its bearings, having first determined the kind of service to be given, and then, he thought, a conclusion might be arrived at. In the table of costs on page 37 Mr. Aitken did not indicate the traffic figures on which the costs were based. The costs would be largely dependent on the calling rates, &c. The Paper by Mr. Carty was well worth reading by anybody interested in the subject. He took an area, studied it, and gave his results, and his results put a serious onus on anyone wishing to prove either that the automatic was or was not the proper system to use.

Mr. A. Whalley said there was evidence in Mr. Aitken's Paper that the subject of automatic telephony could not be pooh-poohed, and that it was time for the business man to be consulted. If there were 300,000 telephones working on this system there must be something in it. It was claimed by the advocates or manufacturers of the automatic system that the disconnection of the exchange lines was instantaneous. The bulk of conversations in London were carried on through several exchanges with manual operators, each of whom must observe the clearing signal and be free to attend to it. Each of the manual operators was provided, as a rule, with 17 pairs of cords, and had to attend to between 100 and 200 subscribers who were sending calls in, and at the same time to receive signals from those already connected demanding instant disconnection. The result was there was a longer wait than there ought to be for exchange lines to be disconnected. All users of the telephone in London knew that the service was far from being as quick as it was with identically the same apparatus in New York. If there were any serious intention of quickening up and improving the service and saving the time of the business community by adopting the latest system, an effort should be made to investigate by sending someone to stay in the States and compare the automatic systems with the manual practice, and even if the cost were double, it would be worth while having a 10,000 to 50,000 line exchange put down on trial if there was going to be any saving of time to the business man.

Mr. M. S. Conner said it would be wise to analyse of what the automatic system consisted. It would appear that it consisted of doing a certain number of things automatically, and a certain number by machines under the control of the subscriber. He believed all it did really automatically, with the exception of the instantaneous disconnection, was found in the manual equipment. The automatic registering of calls, the ringing of party lines and the connecting of each subscriber with a different jack were well known in the manual system. He believed the apparatus for reducing the junction lines between exchanges was more the result of the decimal system of junctions than of the automatic system. All that had to be compared in the two systems was the making of connections by machines and by operators. After making investigations, he felt that the automatic system, so called, was a successful one; the subscribers liked it, the service was quick, and he thought they were reduced to considering the question from a financial point of view. The expense of operators was rarely one-fourth of the total expenses, and under good management should only be one-fifth, even if the system reached 30,000 or 40,000 subscribers. This figure was made up in cost of maintenance and depreciation in the automatic systems. One could hardly read the five pages of the Paper describing the putting through of a connection by the automatic system without realising the enormous number of parts and the enormous number of contacts that had to be made before the connection was established, and if the cost of a piece of mechanism could be judged by the number of parts, the automatic must cost more than the manual system. They should not compare the oldest form of telephone used on the manual system with the latest form used on the automatic system. The maintenance of the subscribers' instrument in the former case might be anything from $1 to $10 (4s. to £2); but in the latter it appeared to be less than 2 c. (1d.) all the way through. About four years ago he made a visit to the automatic exchange at Columbus, Ohio. It was in the afternoon, and four or five "trouble clerks" were taking down complaints as fast as they could answer the calls. At an ordinary exchange at St. Louis, that had more subscribers than the Columbus exchange, there was only one employ at the trouble clerks' desk at 11 o'clock in the morning, the busiest time of the day; and he was reading the morning paper. In regard to Mr Aitken's figures as to cost of buildings, operators were employed in automatic exchanges, and therefore accommodation must be made for them and there was no reason for having more elaborate premises if there were more of them. Audited balance-sheets of automatic exchanges did not show greater earning power than manual systems. Some of the balance sheets showed rather small expenses, but there were larger additions to capital, and the capital value of the stations increased each year, which was not a healthy sign. It was evident to him that, up to the present no automatic system gave a quite reliable service at the same expense as the corresponding service could be given by modern manual equipment. Mr. Aitken stated in the Table in his Paper that a manual switchboard had a life of 10 years, but there were a large number that had been in operation more than 15 years, and he believed the Postmaster-General was expected shortly to acquire a large number of exchanges that had been in operation more than 10 years. By means of recent improvements in the choice of materials the life of articles which rapidly wore out, such as springs, jacks and plugs, had been greatly prolonged, and a multiple switchboard could now be got that would be in good operating condition after 25 years, apart from the replacement of plugs and cords. The automatic systems installed from 14 to 15 years ago had passed away a long time since. Switching mechanism, consisting of the vertical and rotary motions of the vertical shaft of the selector and connector did not go through a cycle of operations. The first step of both of these motions was easy, the second was not always easy, and the first step must get a great many times more wear than the last. When this step was enough to throw the wipers out of adjustment the switch jumped, and the vertical shaft must be replaced in a short time. There might be hope for automatic telephony if, by some improvement or invention, a large proportion of the number of parts required to make up the mechanism could be done away with. If that were done, what remained could be made in a more robust and scientific manner and otherwise made equal to the quality of the apparatus used on manual equipments. When it was remembered that the Strowger patents were taken out in 1888, and that during 23 years enormous sums of money had been expended in bringing this device to perfection, one got rather discouraged as to any advantageous outcome. The semi-automatic system appeared to have the disadvantages of both systems and the advantages of neither.

Mr. R. Scruby said much might have been done in automatic telephony in England, as there was not the same opposition to withstand as there had been in the United States. He was sure the automatic was the best system in the end, although he did not forget the high efficiency of the manual services of the Allmanna exchange in Stockholm and the China Town exchange (worked by Chinamen) in San Francisco. He had an automatic instrument in the house he lived in at Dayton, Ohio, and never got a wrong connection. A cosmopolitan telephone was a necessity. He had great difficulty in Stockholm in getting people on the telephone, owing to his atrocious Swedish, and if the automatic system had been installed he would have used the telephone oftener, as everybody he wanted to speak to could speak English. He trusted Mr Aitken's Paper would be a means of starting the automatic telephone service in England.

Mr. T. Holme, in a written communication, thought the author had made out a case for the automatic system for large inter-office schemes, as the elimination of B as well as A operators, and the economies in junctions would materially affect the rental to be charged for the service. The costs on page 37 of the Paper needed revision from the British point of view. They had a 10-line automatic exchange in connection with the service at Hull in a village about 6 miles from the central exchange. It consisted of the usual rotary and release mechanism, with a busy back circuit which was only set up when an engaged line was tried. The subscribers' instruments were fitted with hand generators, and they rang through at

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getting up a number. The capital cost was £4 per subscriber for the exchange apparatus and £2. 10s. for the instruments. The system had been working just a year, and the maintenance cost for that time was extremely low.

Mr. A. L. STANTON, in a written communication, said the perusal of the Paper showed that the cost of installing single exchange equipments under 10,000 lines was much less with the manual than with the automatic system. In this country most exchanges came within that category. Further, his experience was that complex questions involved by efficient intercommunication and distribution did not, at least in provincial areas, admit of consideration along American lines. Staffs on automatic systems must be trained to cope with duties demanding a higher order of average ability than was now to be found available on manual service. It would be of interest to know what information was available regarding the reliability of adjustments, what effects resulted from variation in voltage, and what was the minimum insulation value for distribution permissible. It was very evident the problems to be faced when considering this country as a field of probable development for full automatic equipment were such as would demand very serious attention from a financial point of view. He was of opinion that at no distant date conditions would arise containing the groundwork of full automatic possibilities. Small areas would appear to be suitable localities for testing this equipment.

Mr. D. H. KENNEDY submitted that the system described by Mr. Aitken was better described by using two words than one—it was the automatic switching system. The manual switching system had been referred to as the non-automatic signalling system (that meant the magneto system) and the automatic signalling system (which referred to the central battery system).

Mr. W. AITKEN, in reply, said he had no idea of doing away with the operators in branch exchanges. Although the Automatic Electric Co. recommended full automatic for the main exchanges, in their private branch exchanges, to meet local conditions that existed in warehouses and works where it was not always convenient to put a connection through they always had a manual operator, and that was why it appeared from the statistics there were so many operators required for automatic systems—they were using branch exchanges. The automatic disconnecting board (shown on the table) was primarily meant for offices where there was no regular attendant. Mr. Conner seemed to be discouraged with the progress made with automatic systems. He (Mr. Aitken) thought there was every reason for encouragement from the progress made as regarded development and manufacture of late years. In America the system was progressing, and an independent company had gone into competition with the manual system in Chicago. Mr. Conner acknowledged that the blocks and cords in the manual exchanges were a very serious item of cost. There was no doubt about that, but from all the statistics he (Mr. Aitken) had been able to get hold of there appeared to be comparatively few wearing parts in the automatic system. The wipers were practically the only parts that had to be renewed fairly frequently. The vertical shafts had to be renewed at times, but he had not heard of them as being a serious cause of expense. He did not think the 2 c. (1d.) per annum really was the full cost of the maintenance of the system, but he gave it for what it was worth. It was supplied by the president of an operating company, who would naturally be expected to make the best possible bargain with the Automatic Co.

NOTE ON CROVA'S METHOD OF HETEROCHROMATIC PHOTOMETRY.*

BY H. E. IVES.

Summary.—The author's investigation shows that the oft-repeated statement that the equivalent wave-length is the wave-length of maximum sensibility is in error, and that any equivalent wave-length is such to a given degree of accuracy for but a limited range of black body temperatures.

Crova suggested as a method of comparing the intensities of different coloured lights a comparison of their intensities at a single wave-length. By this means the actual photometry is reduced to the photometry of lights of the same colour. For its utility and accuracy this method depends on the validity of a certain assumption—namely, that there can be found a wave-length at which the relative energy emission in different illuminants is proportional to their total light. Such a wave-length may be looked for near the brightest part of the spectrum, since, owing to the very pronounced maximum of visual sensibility near 0·545μ and its rapid drop in value on either side, this point of maximum brightness is not greatly different for all the common incandescent illuminants. Obviously the method can only be applicable to light sources possessing continuous spectra, such as the black body, and sources whose energy distribution is not greatly different from the black body.

Crova found experimentally that he could measure the relative illumination from sunlight and from a Carcel lamp by a determination of the relative intensity at wave-length 0·582μ. It has been commonly assumed that this wave-length would also serve for the comparison of any illuminants lying between these two in colour, either with one of these or with each other. Applications of the original idea of Crova have also been made by Lord Rayleigh and other scientists.

While this method of heterochromatic photometry has not been very widely used, partly because of its limitation to continuous spectra and partly because of practical difficulties, it is nevertheless of considerable experimental and theoretic interest. In connection with a problem on the efficiency of incandescent solid radiation, in which incandescent lamps are to be employed, the writer has found it convenient to make use of Crova's method. It seemed advisable before so doing to investigate the range within which the method

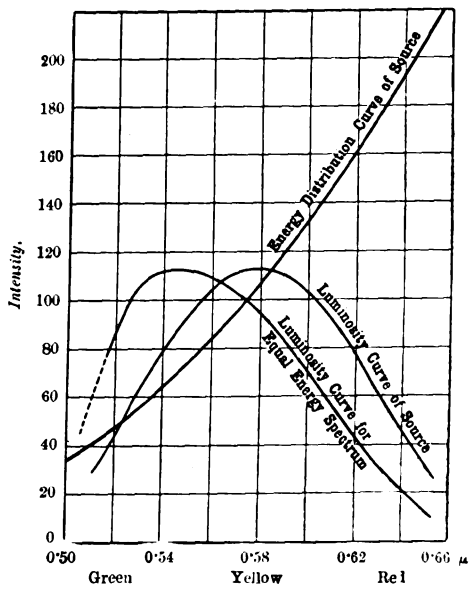

FIG. 1.

would be valid; and from this investigation it appears that certain of the assumptions commonly made in its use are not entirely correct—namely, (1) that the equivalent wave-length is that corresponding to the maximum of visual sensibility, and (2) to use the equivalent wave-length idea over a large range of illuminant colours (such as black body temperatures) without raising any question as to the limits within which the method holds.

The error in the first assumption, taking a tungsten lamp, is most clearly indicated diagrammatically in Fig. 1. Here is given the actual luminosity curve of a source (tungsten lamp through prism, &c.) and the luminosity curve for a spectrum of equal energy at all wave-lengths. The latter is the product of the luminosity values for the source by the reciprocals of the energy values. The curves

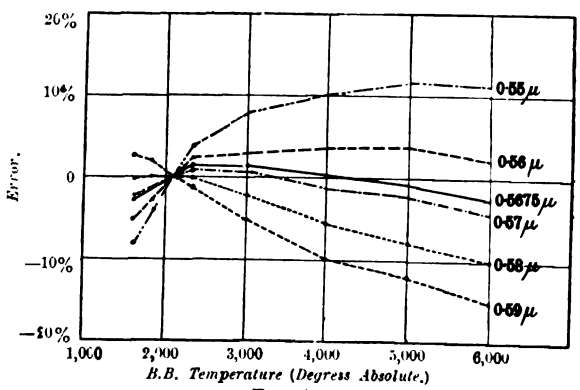

FIG. 2.

are drawn to be approximately of the same area, and, on the assumption that these areas are proportional to total light, it is at once evident that the wave-length of maximum sensibility, 0·545μ, does not give the relative light values, the error being about 20 per cent. The relative areas of the curves are actually given by the energy values at about wave-length 0·565μ. In other words, the equivalent wave-length lies somewhere between the maxima of luminosity of the sources under comparison, and the wave-length of maximum sensibility does not enter in.

With regard to the second assumption, Fig. 2 gives in graphical form some calculations on its validity in the case of the black body.

* Abstract of an article in "The Physical Review."

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The method of obtaining these data is as follows: Black body energy emission curves were calculated from the Wien equation; these were then each multiplied by the luminosity values corresponding to the spectral wave-lengths. These values were taken from a recently determined normal luminosity curve, from observations by five observers at a moderately high illumination. The areas of the resultant curves (the type of which is exhibited in Fig. 1) are taken as proportional to the total light, as measured on a photometer.

Having in this manner determined the relative light values, the relative values for the energy at various wave-lengths were read off the energy distribution curves. A table was then made out, taking the light and energy values at 2,100 deg. abs. arbitrarily as the unit, and the changes in total light with temperature were compared with the changes in the emission at various wave-lengths in the spectrum. Fig. 2 gives the errors introduced by limiting the photometry to light of one wave-length, where the standard of intensity is the black body at 2,100 deg. When the measured light is the same in colour as the standard, any wave-length may be employed, hence the error at this point is zero.

Several facts are here brought out. First, no one wave-length can be used as an equivalent wave-length for more than a certain definite range of temperature for any given allowable error. The horizontal portion of each curve shows the temperature range through which the corresponding wave-length may be used as an equivalent to total light. In the second place it appears that the wave-length of maximum visual sensibility—in this case 0·545μ—is not the equivalent one for any black body comparisons except between 5,000 deg. and 6,000 deg.; that is, far above the temperatures represented by any incandescent lamp, or other artificial illuminant of the incandescent solid type.

Wave-length 0·5675μ has been picked out by trial as the one which could be employed for an equivalent wave-length over the longest range with the least error. The error with this wave-length is less than 3 per cent. in either direction. If, however, the method is to be used only within the limits of temperature represented by the ordinary incandescent lamps—namely, 1,600 deg. to 2,400 deg. abs.—wave-length 0·58μ should be chosen. These results were very satisfactorily confirmed by measurements on a tantalum lamp over a wide range of voltages.

HYDRO-ELECTRIC PLANTS IN NORWAY AND THEIR APPLICATION TO ELECTROCHEMICAL INDUSTRIES.*

BY A. SCOTT-HANSEN.

Summary.—The author details the electrical development which is likely to take place in the employment of the water power of Norway owing to electrochemical progress. He also describes a number of hydro-electric stations which are at present working or being erected.

On looking at the map of Norway it will be perceived an overwhelmingly large proportion of the country—in fact, 97 per cent.—consists of mountains and moorlands, lakes and marshes. Of this, the forests cover one-fourth, while the bulk is represented by mountain pastures, moorlands and sterile wastes at an altitude of 2,500 ft. or more above the sea. A large portion of the high mountainous land concentrates itself towards the west coast. Considerable mountain ranges rise from the elevated plateaux, the highest peak being Galhöpiggen, about 8,200 ft. above the sea, and in consequence of the meteorological conditions the west coast has a vastly greater rainfall than the interior or eastern parts of the country. In the Diocese of Bergen the rainfall has in places been recorded up to over 158 in. a year, especially in the vicinity of the glaciers Folgefond and Jostedalsbræ. A very few miles behind the chain of coast mountains the rainfall is very considerably diminished, and on the line of the watershed may be reckoned at under 40 in. On the eastern side, the rainfall diminishes gradually to 15·8 in. and even less.

Owing to the intermittent character of the supply due to snow, it is of primary importance to be able to store as much as possible of the supplies which, during the melting of the snows, would escape to sea. The nature of the country is peculiarly adapted for such storage, being indented with lakes of various size, which, owing to the depth and narrowness of the valleys, have frequently very contracted outlets. It is, therefore, easy to convert such lakes, at comparatively little outlay, into most valuable reservoirs, in which to store in summer the water arising from the winter snows, and, by letting out these stored supplies as required to supplement the natural flow and to maintain the regular amount needed for the production of constant power. To give an idea of the greatness of the possibilities in this direction, it may be mentioned that in one watershed—the eastern watershed of Skien from Mösvand to Hiterdalsvand—where the natural water-power was originally equal to about 50,000 H.P. the available horse-power can be raised to about 375,000.

The total water-power in Norway has been estimated at from five to seven million horse-power, but this is probably too low an estimate, as, although all the larger watercourses which are at all well known are included, there are undoubtedly numerous smaller and little-known falls that have not been reckoned, but which, when the time comes, can and will be made use of. Moreover, large portions of Northern Norway are practically unknown as regards their hydrography.

As regards facilities for storing up the water supply in reservoirs formed by damming the mountain lakes and rivers, in almost every instance firm rock foundations will be met with on which to build dams or in which to make channels, tunnels, or on which to lay pipes or conduits, flumes and so forth. The cost is, therefore, comparatively small, and though it will be dependent on various circumstances, it may be taken that the stations can supply power at prices of from about 22s. to 44s. per horse-power year at the power station—prices which enable the waterfalls to be taken into the service of the great industries.

The industries that are able to make use of the large powers, for instance, 50,000 H.P. to 100,000 H.P. for a single waterfall, are, not those which require power to actuate machinery, but must be of electrochemical or electrometallurgical nature. In the course of the present year the oxidation of the nitrogen of the atmosphere will make use of 170,000 H.P. to 180,000 H.P., and will, it is hoped, in the course of a few years employ further about 300,000 H.P. In the manufacture of calcium carbide about 60,000 H.P. are employed, and in other electrochemical and electrometallurgical industries about 20,000 H.P.; all the result of developments within the last 10 or 15 years.

FIG. 1.—A TIMBER "SNAG" AT THE VAMMA DAM.

Some characteristic examples of the constructional works executed at some of the largest waterfalls were illustrated by means of slides and showed the difficulties that were encountered and had to be overcome.

Glommen, the largest river in Norway, forms at its lower end a series of falls, aggregating about 300 ft., in a length of about 35 miles. This river has a discharge of up to 220 tons per sec, even in winter, since the latest regulation of the lake Mjösen. The fall can yield about 40,000 H.P. The water is led from above the fall through a channel blasted in the rock. In the power station there are at present installed five sets of electric generating machinery supplying three-phase alternating current at a frequency of 50. About 10,000 kw. of the power generated is transmitted by a line, 31 miles in length, to Christiania and the neighbourhood, and the remainder to the town of Sarpsborg, at a voltage of 60,000 volts in each case. Owing to the great difference between the level when the river is high or low, the power units are constructed with vertical shafts.

Another fall fully developed is that at the town of Sarpsborg, the last fall on the Glommen. Here are two power stations—Hafslund on the eastern, Borregaard on the western side of the river. Hafslund station is constructed for 24,000 H.P., which is chiefly supplied to electrochemical factories, amongst them a calcium carbide factory and zinc-smelting and refining works. This station also furnishes power to the thickly populated district round the town of Fredrikstad. At Hafslund the power units are also constructed with vertical shafts.

Borregaard is developed for a total of 26,000 H.P., which is exclusively used by the large works belonging to the proprietors—the

* Abstract of a Paper read before the Faraday Society.

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Kellner Partington Paper Pulp Co.—who chiefly manufacture wood-pulp and cellulose, but also have a carbide factory and a manufactory for ferro-silicum. These works are the largest in Norway, and employ between 2,000 and 3,000 hands.

Vamma, the third of these power stations on the lower part of Glommen River, is situated midway between the two previously mentioned, and is now in course of erection. The river at this point is about 220 yds. in width, and the dam has to be built in at least two sections. One-half of the river is shut off by a coffer dam of wood, made as impervious to water as possible. The space thus laid dry is cleared and blasted till a foundation is obtained in the solid rock, whereupon the lower part of the dam is built up in concrete, leaving openings in which large pipes are fixed in order to take the water when the river is low. This work can only be done in winter, when the river falls to between 100 and 200 tons per sec. As in this case enormous quantities of concrete are necessary, it was not possible the first winter to do more than to construct the foundation of the dam. In April the first flood may be looked for, and everything must be removed or it will be swept away. As spring advances the water rises rapidly, and in the course of a month increases to about 3,000 tons per sec., which flows with tremendous force over the foundations of the dam, and then the timber-floating begins.

A passage over the dam, when it is finished, has to be provided for the timber, and it is not easy to foresee what the timber may do. For instance, at Vamma it has been found that the timber can pile itself up in immense quantities in front of the dam and also at the sides, by which considerable damage may be done and a number of logs be smashed. If such a "snag" cannot be quickly cleared, there is possibility of the masses damming up the whole river and incal-

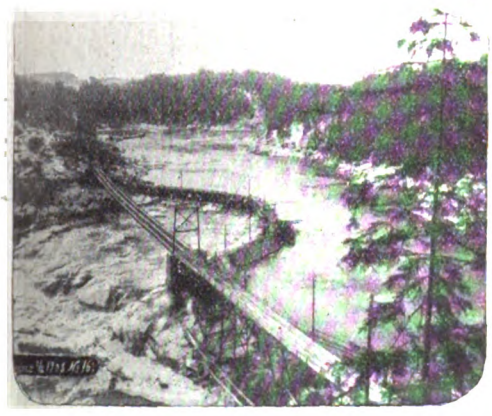

Fig. 2.—The Dam, Vamma.

culable damage being done. During the autumn the water diminishes, and in November or December work may be resumed on the dam. The discharge having gone down to about 400 tons per second, it is carried off through the openings in the foundations, while the other half is shut off by a coffer dam. This work is now almost completed. A typical "snag" on the Vamma Dam is shown in Fig. 1.

The dam at Vamma (Fig. 2) is to be about 90 ft. high, and the power station will be in the centre of the river-bed immediately below the dam. There will be 10 or 12 units or sets of machinery, each of about 7,000 H.P. The power will be partly used for supplying light and motive power, and partly for a factory for nitrogenous products. This Vamma dam will be one of the largest in Europe, and is specially interesting as being constructed in a rapid river discharging a very considerable amount of water.

There are a number of minor water-power stations in the south of Norway, mostly supplying the towns, including those of Christiania, Drammen, Larvik, Skien, Krageröe, Christianssand, Gjössing-fjord, Vadheim and Trodjeim.

At Telemarken there is first the Svælgfoss station (Fig. 3) with a capacity of 40,000 H.P., which supplies the well-known factory for nitrogenous products at Notodden. This power station is of a different type from those described on the Glommen, as the river flows here with a rapid fall between perpendicular cliffs, and the power station is constructed for a fall of about 165 ft., with a flow of 75 tons per second.

At the head of the fall, where the river is constructed in a ravine of only a few yards width, a dam has been built raising the original level of the water about 45 ft. A tunnel of about 500 sq. ft. in section leads the water to a reservoir, from which it is conveyed by four flumes through the solid rock direct to the turbines in the power station. The latter is placed in the river bed, up against the wall of the cliff, so that it looks almost like a swallow's nest built against the wall.

In the power station are four sets of machinery, each of 10,000 H.P. capacity, and which are, indeed, capable of developing over 13,000 H.P. each. The power is transmitted to Notodden by a cable 4 km. in length at a voltage of 10,000 volts. The current is three-phase alternating at a frequency of 50.

By regulating the height and outflow of some large lakes on the high mountains, it is believed that the amount of water discharged by the river will be brought up to about 90 tons per second, and in order to utilise this the Norsk Hydro-Electric Nitrogen Co. have just commenced the construction of another power station to which the water will be conveyed by two long flumes from the same reservoir. The power station will be placed some 100 metres further down the river, and will be fitted with two sets of machinery each of 10,000 H.P., of which one will serve as a reserve for both stations.

Notodden saltpetre works will, in the course of the present year, obtain a considerable addition to their available power from a station which is being installed about ¾ mile down the river, at Lienfoss. A dam about 55 ft. high has been built here right across the river, and immediately below it the power station has been constructed for 15,000 H.P. and a reserve of 5,000, there being four sets of 5,000 each. The machines work here, as at Svælgfoss, at a primary tension of 10,000 volts.

In order to utilise the power obtainable from the Reeking waterfall, the Rjukan Co. have constructed a railway from Notodden to the south end of Lake Tinsjö, a distance of 20 miles. The Norsk Hydro-Electric Co. have built a dam at the outlet of the lake. This dam is of concrete of unusually wide and deep foundations, as no

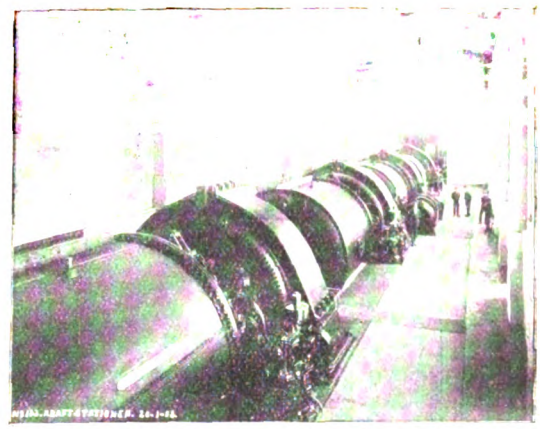

Fig. 3.—Interior of Svælgfoss Power Station.

solid rock was reached, the natural barrier consisting entirely of stones and gravel and sand. This dam for regulating the flow from the lake raises the level 4 metres, and thus provides a reservoir of 250 tons of water.

The terminus of this line immediately adjoins the dam, and the train is there run on to a steam ferry, which in two hours brings it to the western bay called Vestfjord, near the head of the lake—at the entrance to the Vestfjord-dal. The train then proceeds up the Vestfjord-dal as far as Saaheim, 10 miles away.

The dam at Mösvand is entirely of concrete, with flood-gates by which the flow of water can be accurately and at all times regulated. A weir is provided, to prevent the water flowing over the dam itself when the reservoir is full. The building of the dam was attended with considerable difficulties, for it is at an altitude of 3,000 ft. above the sea, which means a great deal in those latitudes, and on the high mountain wilds. About five miles below the Mösvand dam is another dam, forming the intake for the power station. A tunnel of 2½ miles in length and 260 sq. ft. in section conveys the water to a reservoir entirely blasted out of the solid rocks at the top of the southern slope of the valley. The tunnel (to the power station) is in the southern face of the hill, and has a fall of 1 in 300. It was made by driving adits into the rock at certain intervals from outside, and when these had reached the prescribed position, tunnelling right and left parallel with the face of the cliff. The rock excavated was brought out through the adits and forms dumps below, which mark the position of the tunnel. A thousand feet below this is the power station, the water being brought down in ten huge flumes placed together like gigantic organ pipes. The ten flumes are placed on foundations at regular intervals; the mountain side had to be entirely denuded of earth and stone, so that the foundations or beds

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could be laid on solid rock. The power station is situated on a niche or shelf recessed in the rock, from which there was formerly no means of communication with the other side, where the road lies. As soon as the water has passed the turbines there, it is conveyed by another tunnel about 3 miles in length to a place close to the factories where another fall of nearly 1,000 ft. brings it to Power station No. 2, of about the same size as the first, namely, 140,000 H.P.

The natural surroundings render the work particularly difficult, the whole valley through which the river runs being for several kilometres below the Rjukanfoss a huge chasm with perpendicular sides hundreds of metres in height. Connection between the power station and the opposite side is formed by a suspension bridge of 330 ft. span, the roadway of which is about 330 ft. above the river-bed.

Dwellings for the engineers and employés are on the north side of the valley. The mountains are so high and steep that for months of each year the sunshine never reaches the dwellings.

From the plateau on which the power station and the buildings are situated, the road winds rapidly down to the valley. A railroad blasted out of the very steep hill-side goes from the power station down to the factories at which the terminal station of the railway proper is situated. The line to the power station was built to bring the heavy machinery right up to the power station. There are 10 units of 14,000 H.P. capacity. The turbines, on account of the great height of the fall, are Pelton wheels, and the generators, owing to the difficulty of making such large units, are constructed as double generators.

The most important thing in power stations with so great a fall is the arrangements of the turbines and their regulators, and the flumes which are subject to a pressure at Rjukan of up to 30 atmospheres.

FIG. 4.—THE TYSSE FALLS POWER STATION, SHOWING FLUMES FIXED AGAINST FACE OF CLIFF.

The lower part of the flumes are therefore made of welded plate of great thickness—up to 1 in. The diameter of each pipe is 5 ft. The upper half of the flumes, where the pressure is less, are made of riveted steel plate.

The working voltage is here, as at the Svælgfoss and other establishments connected with Notodden, 10,000 volts, the current being three-phase alternating with a frequency of 50. The power is transmitted through 60 wires, either copper or aluminium, to Saaheim, where the factories are situated. These factories, which, like those at Notodden, are intended for the manufacture of nitrogenous products, cover a large space. Thus, the electric furnaces cover over 86,000 sq. ft.—and the absorption towers a similar area.

At Tyssefalls in the Hardangerfjord, some few kilometres north Odda, there is another station.

The Tysse river has a relatively very small catchment basin, only 1,500 sq. miles, and the river proper has an aggregate fall of 1,300 ft. in a length of 3 miles. The catchment basin is nearly circular, and includes a whole number of lakes which empty themselves into the Ringedalsvand, a large lake. By means of all these lakes an ideal regulation of the water-supply can be accomplished. The Ringedalsvand is particularly adapted for the purpose of a reservoir, as a extra height of about 100 ft. can be obtained, partly by raising the level by a dam, partly by lowering it by means of an artificial outlet.

The primary regulating work has raised the minimum of the discharge, from as low as 35 cub. ft. per second, to 350 or 420 cub. ft. —that is to say, that instead of going down at times to about 4,000 H.P. a minimum of 40,000 of 50,000 is easily maintained.

Owing to the very steep and mountainous nature of the country the difficulties presented in building the pipe-line were, of course, considerable (Fig. 4.) The tunnel is over two miles in length, and is at a height of over 1,320 ft. above the fjord; it was constructed by first driving adits from outside the face of the cliff, and these have in most instances been unusually difficult of access. Placing the flumes or water pipes, and making the foundation for them, was not less

FIG. 5.—POWER STATION, TYSSE FALLS.

difficult. Not only had the bed to be blasted out of the face of a cliff so steep that most of the dislodged fragments went right into the fjord, but some of the flumes lie against a perfectly smooth precipice which rises at an angle of 60deg. about half-way up the hillside for a distance of about 330 ft. It was necessary at first to fix ladders by iron bolts to the cliff, until footholds could be cut in the rock to enable work to be begun at this spot. The laying of the pipes was accomplished with the aid of a Decauville rail track, which was laid from the fjord right up to the discharging reservoir. The trucks were

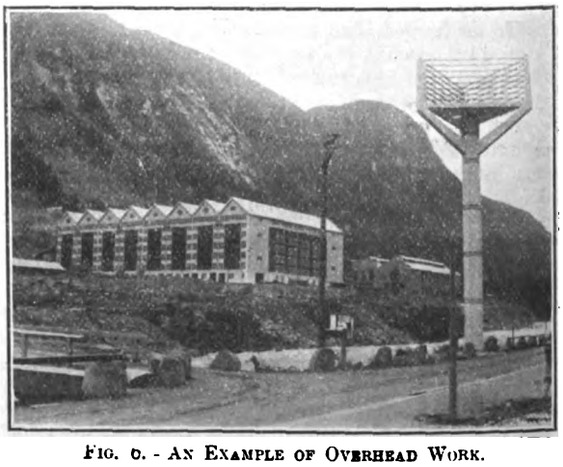

FIG. 6. - AN EXAMPLE OF OVERHEAD WORK.

hauled up by a wire rope, which went over a roller at the extreme top, and which was worked by an electric windlass placed about half-way up the precipitous slope. Notwithstanding the many risks and the difficulties encountered, the entire undertaking was carried out without a single man being injured.

The power station (Fig. 5) contains seven sets of machinery, each of 4,500 H.P. capacity, and the power is transmitted at a primary tension of 12,000 volts by cables on two rows of posts to Odda, where it is

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used in the large calcium carbide works belonging to the Alby United Carbide Factories, and also by the cyanamide works of the North-Western Cyanamide Co. Some of the power will also after this summer be utilised by the Hardanger Electric Iron and Steel Works, the first in Norway to smelt iron ore and produce iron and steel by the processes patented by the Swedish Elektrometall Co.

In taking the cable to Odda considerable difficulties were also met with, especially the risk of the communication being severed and works thus stopped by avalanches or rocks falling from a very steep cliff, along which the cable had to be carried for a length of about a mile and a quarter. Several such stoppages having occurred the first year, it was decided to pass the cable through a tunnel in the cliff, and this has been accomplished with the most satisfactory result. Further developments are projected for this unique power station (Tysse), which it is estimated will be capable of yielding from 60,000 H.P. to 100,000 H.P. when the water supply has been fully regulated. It is not yet determined to what uses the remainder of the power shall be applied, but both zinc smelting works and iron works have been spoken of, and the enlargement of the power station has been resolved upon.

THE ELECTRICAL EQUIPMENT OF A MODERN THEATRE.

BY D. C. M. HUME.

(Concluded from page 209.)

Lighting.—The first thing that must be noted here is the local regulations, and the best thought out of these are those of the London County Council, who have a special department for this class of work under the charge of experienced officials and inspectors. Great care is thus taken of the safety of the public.

Under the L.C.C. provision has to be made whereby all danger or "police" lights, &c., are fed from a special intake from other mains than those supplying the auditorium and stage. The reason for this is to ensure lights at all the exits should a failure of the main supply take place and a panic ensue, this in addition to the alternative lighting agent of gas or oil which is likewise compulsory. This regulation applies to the exit signs in a theatre, which signs must be easily seen, of a certain size of letter, and on no account extinguished during the time the theatre is open. Owing to the large load that a theatre represents, it is usual to take in the three-wire system at each intake and balance the theatre as a whole.

This enables the consulting engineer still further to safeguard the public, as he can arrange all foyer, passage and "police" lights on alternate wiring off the one intake, balancing them independently on this intake.

The main intake is usually situated on the stage side of the proscenium, and the best theatres have a stand-by change over in case of failure of supply. The company that has the greater part of London's theatres—the Charing Cross Electricity Supply Co.—have a special theatre mains doing nothing else, which arrangement is most necessary when one considers that any theatre may switch on or off a total load of some 30 kw. The Charing Cross Company use a battery on these mains, and can take a sudden load of 3,000 amperes on or off without dropping the network volts. It is such an arrangement that permits Drury Lane, to have dark changes, in spectacular pantomimes without loss of popularity in the neighbourhood of brilliancy in the production. It is a curious load that is provided by theatres, and it is interesting to see machine after machine started up from 7:15 to 7:45 p.m. every evening at the various stations and sub-stations of theatreland.

From the stage intake it is preferable to balance the stage against the auditorium where possible, thus obviating the nuisance of having three wires on the stage, but sometimes, as in Glasgow, for instance, this is not permitted by local regulations and makes the stage wiring rather complicated and the switchboard a source of joy to the designer.

Stage Lighting.—Stage lighting may be divided into two halves, incandescents and arcs. The principal illumination is derived from a solid square frame of lamp banks arranged round the proscenium and directed towards the stage. This frame consists of the float or footlights on the ground, proscenium lengths at the side, and No. 1 batten behind the first "border" or masking "cloth" above. This system is reduplicated, with the exception of the ground lights, once, twice or thrice according to the size of the stage, the side lights being supplied by wing ladders or side lengths hung on the back of the scenery wings. The battens or overhead lights usually diminish in length and capacity as they get up the stage. The record batten is 55 ft. four-colour, namely, No. 1 at the Coliseum.

In the ancient days, gas bunch lights were used in the wings, consisting of a cluster of burners in a circular reflector. Similar electrical fittings are only used in modern theatres for special effects of local lighting. Electric bunches were also employed around the circus ring at Liverpool Olympic, but did not find favour except for spectacles, &c. The main lights of the building and vertical arcs from a "lime gallery" directly above the ring light up the arena as well as anything.

Provision has also to be made for additional effect lights, floor lengths, &c.

The float runs the whole width of the stage, and is generally wired on three circuits, but in theatres where spectacle and magnificent productions are expected, the proscenium lengths and No. 1 (and sometimes No. 2) battens and the float are wired for four circuits, which can be lamped up in colours as required. A common arrangement is white, amber, red and blue (or green).

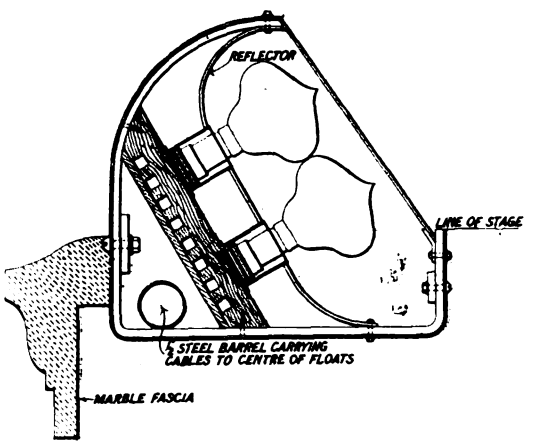

FIG. 6.—SPECIAL 4-COLOUR FLOAT AT THE LONDON COLISEUM.

The float should be arranged in an iron trough fitted with lids for use in the day time when the dust is rife and people and things are apt to pass over it. A good white enamel background is as good as anything. Glazed brick does not keep its colour, nor sheet tin its polish. Lamps should be arranged to give their best light to the stage though they are often installed in exactly the opposite way, *i.e.*, with the point towards the performers. A successful lamp, though expensive by reason of not being a standard pattern is the T lamp with two filaments. This makes a very neat and small float, the latter attribute being especially advantageous, as this is one of the most obvious of the lighting apparatus from the audience's point of view. An error is often made in trying to obscure the end by sinking the float in a bevelled trough which, though taking it down out of sight, often produces a hard shadow about 4 ft. up the back cloth. The float is best wired from the centre in either direction, with each circuit alternately wired from two distribution boards. Fig. 6 shows a four-colour float and Fig. 7 an arrangement of battens.

Proscenium and side lengths follow the float in general construction. Side lengths, by reason of not being permanencies, are made up on wood bases and protected with a netting cover from exterior damage. The floor lengths may be conveniently and cheaply made up of heavy casing as a base and small vertically projecting pieces, on either side of which is mounted a batten-holder to take the lamps which thus lie end to end along the length.

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The float and proscenium lights are permanent, but the battens, wing ladders, floor lengths, &c., are subject to constant change of position, and must, therefore, be fitted with a removable connector, and for this reason, even in the longest of battens (Coliseum 55 ft.) all wires are brought out at one end ready to make off into plugs.

Stage plugs are of several designs, and perhaps the best is the Bowles type (Fig. 8), in which the actual contacts are of an ordinary knife switch design and very positive. It is impossible to put these plugs in wrong with reversed poles, &c., because the male portion slides into grooves in the lid of the plug-box, and must be introduced therein before the box can be closed and contact made. The lid has a snap fastening, and an accidental pull on the lead does not pull out the plug. Another point about this plug is that it can be made to accommodate a number of circuits in one plug. The plug can also be used for main batten connections, which are placed on a rule as the fly floor. The box itself is of iron and asbestos lined. Contacts are of ample surface, well separated and protected. The Siemens plug is of smaller dimensions and when installed at an angle is possibly easier to connect. In this, the male portion is held in position with a pistol catch to prevent premature disconnection.

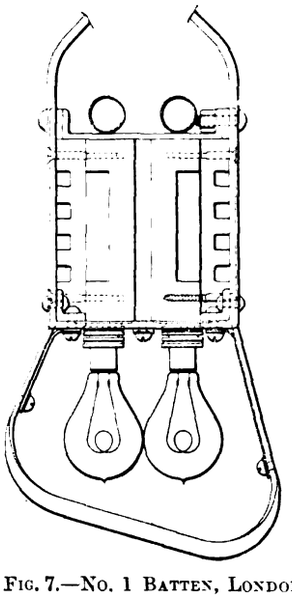

Fig. 7.—No. 1 Batten, London Coliseum.

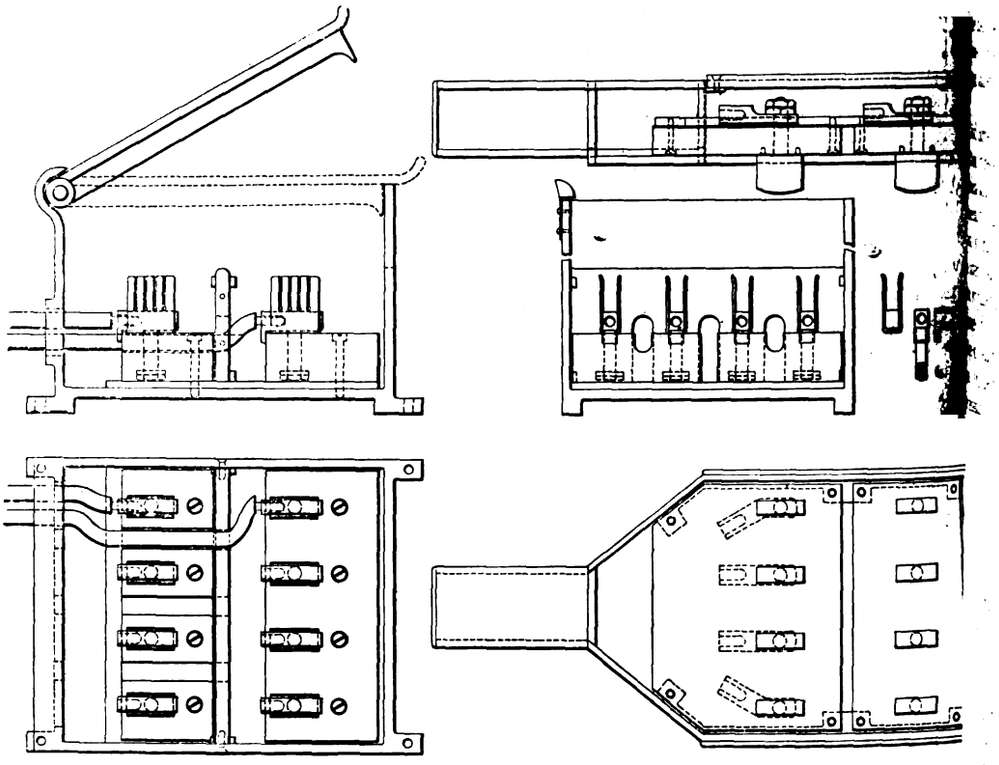

Fig. 8.—The Bowles Stage Plug.

Other designs are of the two-pin and concentric types, the poles being kept distinct in the former by making the pins of different lengths. This distinction of poles is necessary because of the stage level arcs which take their supply from plugs.

At the Chelsea Palace both the two-pin and concentric types are to be found, the former being on the alternating supply and the latter on the direct current supply, both of which are installed on that particular stage.

Stage plugs are situated preferably in cast-iron boxes just beneath the stage level, and are reached through a trap in the boards, known theatro-technically as "dips." At the London Coliseum, owing to the revolving stages, plugs were impracticable, so a plug truck was made (an illustration of which we give in Fig. 9) which carried a four-colour master plug; this could be plugged on to a central point under the middle table of the stage, the truck acting as a distribution board for the stage surface.

Battens, float, proscenium and side lengths, &c., have to be wired in two, three or four circuits according to the ambition of the theatre, so that colour effects can be produced accurately. Nos. 3, 4, &c., battens are often left single-circuited or double lamped. The most ambitious theatres, such as Drury Lane, Covent Garden, Coliseum and the New Theatre, are wired with four circuits practically throughout, and this allows of great latitude of effect when lamped with white, amber, blue, red, or great brilliancy when lamped two white, one blue, one red, &c. Where very great brilliancy is required, such as in ballet lighting on occasion, recourse has been made to double battens—*i.e.*, two white battens back to back. This has been done at the Alhambra with great effect.

A word on the colour of lamps. A metal filament gives a very bright light, but in the opinion of the writer this is somewhat white for uses other than big stage spectacles; carbon lamps are better except on low voltages. Another point is that owing to the breakage of filaments under the rough usage theatre lamps receive, it is the number of lamps per year that counts with theatre work. As to tints, amber should be decided and free from red or brown. Blue should be a good ultramarine or cobalt and not turquoise or violet or green whilst red should be a rich ruby port colour. Any of these, of course, can and should be varied to suit the particular production on hand. "Dip" lacquer should be avoided where possible except for temporary effects; a good stained glass lamp keeps its colour always, whilst dip is uncertain of colour and apt to burn or peel off. The only objection to stained lamps is the price. Dip is cheaper but it is the greatest mistake to use a cheap dip which either peels off or burns light.

Switchboards.—In many theatres this conning tower of the stage is all too inadequately provided for, being put in any odd corner by the inconsiderate architect, or cut down to the minimum size by the stage manager rapacious of room for his productions. We have in mind such boards as the Gaiety, Hippodrome (old board) and the Alhambra; in contrast with which we may cite such boards as Covent Garden, the Coliseum, Drury Lane and the New Theatre. The last of these is a very fine board, but it is somewhat at a disadvantage by reason of its installation in the prompt side flies, some 25 ft. above the stage. The result is, the electrician is dependent on bells, telephone and pilot lamps, and cannot judge any niceties of effect from his board.

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The largest board in England is the Coliseum, including stage controls; next come Covent Garden and Drury Lane and the Palladium.

A theatre board is best arranged in three main panels—stage, dimmers and house—which in themselves are best arranged as follows: The stage board carries all switches relative to the stage lighting and only these. All 'bus bars, contacts and switches should be on the front of the board, except in isolated cases, and switches should be arranged in horizontal lines according to circuits or colours. Thus a four-colour board has five rows of switches—*i.e.*, four colours and one row of special effect switches. Circuit switches controlling the same points should be arranged vertically above one another, as the board must be so arranged that the electrician knows by instinct where his switches are. Thus, float white, amber, red and blue blinding lights (dark change lights shining straight at the audience, usually lamped red) will all be arranged vertically above each other. On the end of each row should be mounted a main switch controlling that row by which a "black-out," or total extinguishing of all lights, is instantly effected. These mains should be placed on the end of the board nearest the stage, and may be mounted on a separate panel with advantage. There is no necessity for any meters on this board, but any point out of sight of the board should be indicated thereon by a pilot light. Main switches *must* be of a quick break sparkless type or the green flash is seen all over the darkened theatre. Plain cartridge fuses or other clean-blowing fuses under thumb nuts should be used, and every switch and fuse should be clearly labelled.

The dimmer board carries the necessary gear for dimming the lights with some form of resistance, and so providing means for many beautiful effects and blends.

Dimmers are generally of the two types—metallic and liquid. The former consists of ordinary resistance coils and rheostat switches, and the latter of salt solutions acting as water resistances and operated by pulley gear or the like. For the former there is the advantage of economy of room and mechanism, with the disadvantage of inelasticity of adjustment; in the latter the converse obtains. On the whole, from the producer's point of view, the liquid resistance is much the better owing to its flexibility.

The ordinary wire dimmer consists of coils of wire strung on frames in the usual way, or embedded in porcelain enamel. About 30–50 terminals should be provided to give proper regulation, for anything in the way of a jerk in the lights is to the producer as a red rag to a bull. The regulating switch may be of two kinds, the simple rheostat type (Alhambra and Empire switchboards) or the wheel type of control (Gaiety). In the former the contacts are usually vertically arranged as radial double clips into which slides a knife switch pivoted on a horizontal bar running across the board. In the latter, cable gear operates a sliding contact on the coil banks situated above the board in special fireproof cases. In any type of dimmer, the resistances have to be, by local and L.C.C. regulations, installed in a fireproof room or chamber by themselves which is fitted with a self-closing door. It is best to put the fuses on the resistance circuits in this room as well.

Liquid resistances are usually of the Lyons type, which consists of long cylindrical earthenware pot, not unlike a common drain-pipe section, in the base of which is fitted a truncated cone of copper, a connection to which passes through the side of the jar through a rubber bung cork. Above this fixed terminal is arranged the movable terminal consisting of a vertical copper rod about 6 in. or 8 in. longer than the dimmer pot, the lower end of which is fashioned into a hollow cone registering exactly on the cone of the fixed terminal at the base of the pot. This rod carries a terminal screw at the top and can, by means of suitable pulley gear, be raised or lowered in the pot at will. The jar is filled with a 10 per cent. solution of common salt, which does not corrode the case, but gets rather hot. At 1 ampere per square inch of plate surface the voltage absorbed by such a resistance is 1 volt per $\frac{1}{10}$ in. of electrolyte between the plates. This is a useful approximate formula. A special salt is produced by the makers of dimmer gear which has the advantage of not getting too hot or bubbling unduly. The most improved dimmer pot has no bottom contact, but the pot is made double, and a copper strip runs from the cone at the bottom up between the two sides of the pot, and so provides a terminal at the top, and thus prevents any possibility of the liquid leaking out.

The design of a dimmer gear does not consist in producing a mere winch wheel, but arrangements have to be provided so that any individual circuit may be dimmed separately or the whole dimmed to darkness from various positions of individual dimmer wheels. Thus, proscenium, float and No. 1 batten ambers may be on full, and whites three-quarter dimmed, Nos. 2, 3 and 4 battens red full, No. 5 batten and floor lengths red and blue half dimmed. It is then required to fade out the whole scene or gradually produce a sunset effect, &c. It is clear from this that provision must be made for dropping the individual dimmers in either of their extreme positions, the common shaft on which they are mounted continuing to operate any dimmer not in one of such positions.

This is very efficiently effected in the mechanism of Messrs. Moy & Bastie, in which the horizontal main shafts are operated from a hand wheel gearing with a worm gear which ensures an even and fairly slow effect. Each individual dimmer wheel (around the circumference of which runs the pulley cable) carries, however, a small radial handle by which it can be individually worked. On the main shaft on each side of every wheel is fixed a rachet, the one on one side being right-handed,

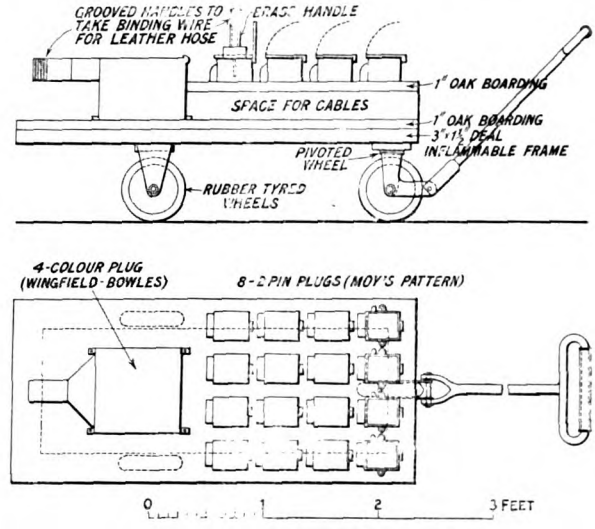

FIG. 9.—PLUG TRUCK, LONDON COLISEUM.

and the one on the other left-handed; the wheel itself is free upon the shaft. Mounted upon one spoke of the wheel are two small pawls which normally engage upon the aforesaid rachets, thus locking the wheel to the shaft in both senses of rotation. When, however, the dimmer wheel is turned to its extreme position, it is necessary to unlock it from the shaft and this is effected by means of a small stationary inclined plane fixed upon the panel of the dimmer board; this receives the extended arm of the pivoted pawl, and is so set as to raise it clear from the rachet and free the wheel in that sense. Meanwhile, the rachet and pawl on the other side of the wheel and locking it to the shaft in the other sense of rotation remains in action, so that a reversal of the main shaft picks up all the wheels again at once whatever their individual positions may be. These dimmer wheels carry two laminated switch contacts which serve to short-circuit the dimmer pot in its "all-out" position, thus saving unnecessary heating of the pot and liquid, and giving the full voltage to the lamps. To operate one dimmer by itself it is necessary to trip the pawl by hand. Each dimmer should be fitted with a pilot lamp at the top of the dimmer board, and this lamp should have a tumbler switch to itself.

A similarly acting mechanism depends on the action of a jambing screw with a quick pitch thread, the nut of the screw coming against a stop in the extreme positions, and so unscrewing a quarter turn and disconnecting the wheel.

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These gears can be applied to wire resistances if the step contacts be arranged suitably.

There is another type of liquid resistance which has, however, not been received very enthusiastically by reason of the fact that it necessitates the actual resistance being upon the board. In this type a sector-shaped earthenware tank is provided, through which a radial plate sweeps when operated by the handle rigidly attached thereto. The idea of this device is to eliminate the dimmer room as a separate chamber, but this is a doubtful advantage.

The house board is a simple switchboard, and should always be installed if possible on a separate panel to the main board. It carries switches controlling the ceiling lights in the auditorium, the balcony and circle fronts, &c., in fact, all lights in the auditorium other than those coming off the "backs" board—that is, under balcony points, back walls, &c. The auditorium board has a main switch controlling the whole, and should, therefore, be installed as near as possible to the main stage board. In a small theatre it may form part of this with advantage. All stage boards must carry cartridge fuses for each switch.

Before leaving switchboards, mention must be made of the board installed at the Glasgow Coliseum (Fig. 10), which is unique in that it is a three-wire board in which the two sides are kept 6 ft. apart according to regulation, and yet one man can work the board as easily as if it were a one-pole board. This is effected by mounting all the live switchgear on the back of the board, which stands out 3 ft. from the wall of the building. The switches are of the claw type, and are operated by an insulated rod running through the board slate and terminating in a mushroom head of ebonite on the front side. The right-hand panel of the board takes one pair and the left-hand panel the other, and between the two panels is a rigid uralite permanent builder's partition. Thus, the distance of any live part of the one panel to any live part of the other has to be measured up and over and down this partition, whilst the actual operating knobs are but a foot apart in some cases.

Into each knob is let a small stained ivory disc showing the colour of the circuit it controls, the name thereof being on an ivory tablet on the slate itself. This board looks exceedingly neat, and is fast to work. It was designed by Mr. E. Wingfield Bowles, the theatre Consulting Engineer, and was made by Messrs. Blackburn & Starling, of Nottingham.

Idealists have advocated an electrically operated switchboard from a keyboard in the auditorium. This, whilst giving the engineer excellent scope for providing beautiful effects, is scarcely feasible in the average theatre.

All the stage passage lights, dressing rooms, &c., are best controlled from the doorkeeper's lobby on a special distribution board fed direct from the intake.

Arcs.—The other section of stage lighting is the arcs. These are arranged as a rule as follows: Half way up each side of the proscenium there are two or more arcs—"perch arcs"—up on the fly-rail arcs as required. In some theatres (for instance, the Gaiety) a special fly arc gallery is provided; this is a good idea which allows the fly rail arcs to cover the whole stage instead of having to shine down between cloths, &c., hanging in the flies. On the stage level portable arcs on stands are required. Special stage plugs are installed for this service as a rule, and it is well to use different patterns of plugs for the arcs and incandescents respectively. Plug points are arranged at every arc position and resistances are permanent, installed for choice with the arc fuse boards in a special fireproof chamber. Very large stages sometimes have arcs across the flies (for example, His Majesty's Theatre, where they are across the proscenium arch, and the Coliseum, where they are on the bridge about half way up the stage). The lamps themselves need to be hand fed, and should be provided with boxes which must be light-proof at the joints, as a stray beam of searching white light cannot be countenanced on any self-respecting stage. Such boxes must be fireproof a lined with uralite or asbestos, and so made that a droppi spark is impossible. In the front of these boxes are placed t colour screens made of glass or other suitable medium, a behind them is located the lens when in use. When the lens not in use a piece of plain glass should be used to protect t screen if not of glass.

A shutter is a useful accessory to any lamp as it permits instantaneous "blacking out" for dark changes, &c. T may either be a cut-off or a mask disc between the arc and t lens.

Arcs are not necessarily switched at all, but if desired to they should be controlled from the stage board on a separ panel. If the Bowles plug is used it forms a switch in its though a master arc switch should be provided near the thea main switch, which latter should, in common with the thea main fuses, be kept under lock and key in charge of electrical engineer.

With regard to lenses, these must be good; the cheap l gives an unsightly beam with ringed rainbow edges, and

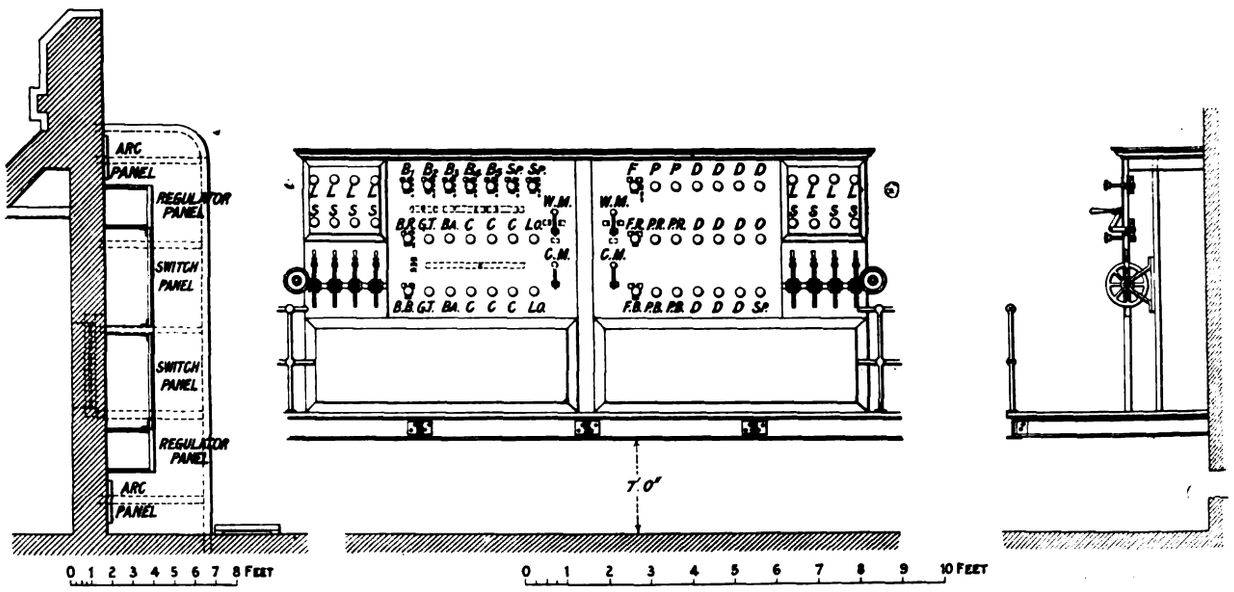

FIG. 10.—MAIN STAGE SWITCHBOARD, GLASGOW COLISEUM.

F = Float. G.T. = Grand Tier. BA. = Balcony. C.M. = Colour Master. B.R. = B Red. B.B. = B Blue. C = Ceiling. Lo. = Local. D = Dip. P.R. = Pros. Red. P.B. = Pros. Blue. W.M. = White Master. F.R. = Float Red. F.B. = Float Blue. P = Pros.

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tracts from the spectacle more than it helps it. A good lens is achromatic: it costs a deal of money comparatively, but it is worth it in effect.

All plain lenses are subject, however, to one great drawback: they have an edge, and a great ring of light is shown round the objective, which effect is highly inartistic and positively crude in dark scenes. This may, however, be overcome and the simplest and, at the same time, the best relief to this trouble is the device invented and patented by Mr. G. A. Applebee, of the Gaiety Theatre, wherein a piece of mica is arranged between the arc and the lens, and has the effect of taking all the edge off the "spot" or "focus," and converting it from a bright spot into a bright place on the stage, and giving it a softness without loss of power.

Nowadays in music-halls we have the biograph to deal with, and it may make its appearance in the theatre proper ere long. This must be installed as low down as possible in a fireproof room, and will require to have its own adjustable resistance therein. This circuit should be provided with fuses up to about 100 amperes, dependent on the throw required. In this circuit there are many special conditions to comply with peculiar to the cinematograph alone.

An unusual feature, and one peculiar to the type of building, are the arc galleries of the Liverpool Olympia, Manchester Hippodrome and the London Hippodrome; these are square ... in the very roof of the building shining downwards upon the arena directly below, a throw of about 100 ft. There is also a practice nowadays of using focus lights from the back ... above the gallery, &c. One of the first theatres to use this was the King's, Hammersmith. It is a laudable attempt to eliminate or minimise the twin attendant shadows of the perch arcs. The London Coliseum tried horizontal front arcs, but they were abandoned after some months' trial in favour of the gallery arc.

It is impossible to give any details about fittings, as it is a matter of taste, but in general it is best to sacrifice magnificence ... and to spread the lights (see Coliseum tier lights and St. James' roof lighting). So far interior arcs have not been employed, save in concert halls, but the flame arc has certain claims for recognition in connection with this work and would bear investigation; for outside lighting they are undoubtedly the only light.

The author feels that the above notes are somewhat sketchy. It is impossible, however, to describe adequately so general a subject as lighting and power in theatres in a short article of this nature; nevertheless, he hopes the reader will have gained some slight insight into what is really a very interesting branch of electrical engineering.

The author is indebted to Mr. Wingfield Bowles for his courtesy of the loan of several special drawings for this article.

THE MECHANICAL DESIGN OF INDUCTION MOTORS.*

BY H. L. SMITH.

Summary.—The author deals with the various parts of induction motors individually, and discusses the points that have to be borne in mind in the mechanical design of these machines. Slot dies, punchings, base plates, shafts, end shields, bearings, belt pulleys and binding bands are considered.

Reference is first made to the importance of getting work through quickly. The author then discusses slot dies, and emphasises the importance of being perfectly definite in the terms used, such as ... slot. The dies for punching the centres of core plates are ..., and when designing a line of machines a selection of dies should be formed at suitable intervals, and the core plates designed to use a die from this selection. Here a large firm has the advantage over a small one, in that it can afford to arrange its series at closer intervals. The diameters of the various sizes of stators ... should be arranged in regular sequence, so that the same ... is used for the gap of a large machine can be used for the ... diameter of a small one, the gap in the stator being the even ..., and the allowance for air-gap being put on by circular-... the rotor core plates.

*Abstract of a Paper read before the Rugby Engineering Society.

Stator Frames.—The guiding principle to be borne in mind when designing any machine like an induction motor, or a machine tool in which there are quick revolving parts running in a stationary frame, is that the frame should be of cast iron and massive to resist vibration, and the revolving parts should be of wrought iron, mild steel, or similar material, and light. Applying these principles to the several parts of an induction motor, we see that (1) the frame should be cast iron and massive; (2) the end shields should be cast iron and massive, the ends being a flat plane and not an oblate cone; (3) the shaft should be of ample diameter; (4) the stator flanges should be ordinary cast iron and massive, never malleable cast iron; (5) the rotor flanges should be malleable cast iron or even steel where necessary, and light; (6) the spider, being a part revolving at less peripheral speed than the flanges, can be ordinary cast iron.

The side of the stator frame near the bottom on each side should have a thick pad cast on inside for taking the terminal box, and, in order to facilitate quick delivery, it should be so arranged that the frame can be put in hand straight away, without having to wait for the arrangement of the terminal box to be finally fixed up.

As regards the important question of cost, it should not be lost sight of that a strong casting is cheaper to machine than a light one, because it can be gripped in the jig more firmly. A light casting in the machine shop is a thing which has to be put up with, and should be employed only when the engineering conditions demand it.

Base Plates.—In order to avoid any confusion in the terms used, it is convenient always to refer to the bearing at the collector end of the machine as No. I., the bearing at the driving end as No. II., and the outboard bearing as No. III. Also, in making the drawings for a line machine, it is a useful convention to put the No. I., or non-driving end, at the left-hand side of the paper throughout the series.

It is possible to recognise three grades of elaboration in design—viz., (1) the simple monolith, or plain plate style; (2) the rolled steel joist; and (3) special for large structures or high-speed work. The general characteristics of these grades of designing as regards castings are as follows: In Grade I. the patterns are cheap to make and there is less slicking of the mould in the foundry; but there is more material used. In Grade II. the cost of the patterns is greater, also the cost of the moulding per ton of material; but the castings may be 10 times as strong, and leave the mould often as straight as a die, and therefore in a condition more likely to promote cheap machinery. Also, the castings being stronger, they can be held more firmly in the machine without fear of springing, and hence, as often as not, the extra slicking of the mould is offset by greater ease in machining. Generally, Grade I. of design would be used for stationary parts, or when there is only one article required off the pattern; Grade II. for ordinary running parts, or when there are a fair number required off each pattern; while Grade III. would be used when the speed is high or for repetition work, when the number of articles is so great that the cost of the patterns becomes negligible in comparison.

It is a matter of common knowledge that a rolled-steel joist is much stronger to resist a direct load than one applied laterally, and yet the section of the ordinary base plate is that of a channel iron turned on its side with the web uppermost; or it may be compared to a flanged beam with the upper flange enormously increased and the lower flange removed altogether. The result is that such base plates sometimes leave the foundry warped badly, requiring machining pads ¾ in. thick. It is only in the case of heavy work ordinarily that a base plate is provided with lower flanges. The provision of a lower flange has also the advantage that it reduces the pressure on the concrete foundations. This pressure, in any case, should not exceed 4 tons per square foot, and if it can be arranged to be less than this so much the better.

The author gives a "basis design" for a long, simple base plate for a third-bearing machine, and believes that the base plate, being a stationary portion of the machine, and not standardised to any extent, should in general be designed on Grade I. lines and massive; but this depends to a certain extent upon the destination—*e.g.*, if a machine has to go to Japan, the design of the base plate would be on Grade II. lines, and different from what it would be if it had to go only to Coventry.

Shafts.—An important point to be borne in mind in designing shafts is that, since turning is one of the cheapest of manufacturing operations, and the shaft in point of peripheral speed comes within the slow-moving category, it should be of ample diameter.

The amount by which the spider is thrown out of centre owing to the deflection of the shaft due to the weight of the rotor is dependent to a certain extent upon the class of fit of the spider upon the shaft. If the spider is a heavy force fit upon the shaft, then the portion of the shaft inside the spider hub becomes one solid mass with the latter, and so is not included in the effective length of the shaft subject to deflection. If, however, the spider be not such a good fit upon the shaft, and be considered to bear hard at two points,

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then between these points the bending moment is uniform and equal to the maximum, and that part of the shaft is bent into an arc of circle. By deducting this length inside the spider hub from the total length between the centres of the bearings we get the effective length of the shaft subject to deflection for an average case.

Considering this, the author calculates that the deflection is given by $\frac{0{\cdot}021}{10^6} \cdot \frac{Wl^3}{D^4}$, where W = weight of rotor in pounds, D the diameter of the shaft in inches and l its effective length. The shaft is usually designed so that the deflection due to the weight of the rotor alone should be about 7 per cent. of the air-gap, and to this deflection has to be added the extra deflection of the shaft due to the magnetic pull, also the deflection of the stator frame, both of which are uncertain quantities and difficult to calculate, so that the total deflection comes to about double the deflection calculated above for the weight of the rotor alone.

In order to reduce the risk of the portion of the shaft under compression receiving any permanent set during the operation of forcing the shaft into the spider, it is advisable to arrange for the full pressure to come on only at the final forcing of the spider into position. By arranging for the spider to be a sliding fit at the start the length of shaft under compression is reduced, and the shaft is in the position of being a column with the base rigidly fixed, thus again increasing the strength. This arrangement can be simply effected by the following device: It is the custom in large manufacturing concerns for the allowance for the fit to be left on the shaft, the hole being the even dimension; but there are certain necessary exceptions—*e.g.*, the force fit for a coupling is different from that for a pulley, and seeing that it is not known until the last moment whether the machine is to have a pulley or a coupling, the only way in this case is to make the shaft the even dimension and to allow for the fit on the pulley or coupling. On the other hand, in the case of a spider, ordinarily the hole would be the even dimension and the allowance on the shaft.

The shaft would be gripped by a special hollow mandrel hydraulic press, which would take hold of it close to the neck, hold both shaft and spider concentrically, and force the shaft direct into the spider. With such a machine it would be possible for the large expensive keys at present used to be reduced in size by one-half; and this is where a large firm has the pull over a small one, in that a small firm cannot afford thousand-ton hydraulic presses, and often not even proper grinding machines for differentiating easily between the various fits.

End Shields.—The outstanding features in the design of an end shield are (1) that it may be massive, being a stationary portion of the machine; and (2) that it may be designed on the Grade I. style—*i.e.*, on simple monolith lines, if tight for room. The shape of an end shield, especially that portion of it which shrouds the stator winding, is governed by considerations other than those purely of mechanical severity. From its very nature it must be a combination of bent struts and crooked tie rods in cast iron. If the design with a certain thickness of material looks too weak, it may be reinforced, if economy of space is essential, not only by ribbing it up, but also, alternatively, by increasing the thickness of the metal.

The redeeming feature of the Grade I. style of designing is that it conduces to ease in moulding, and this cheapness of moulding may offset any extra weight of metal required.

The great advantage of employing end-shield bearings over pedestal bearings and protection caps is that the former, having only a single plate beyond the stator winding, do not necessitate so long a shaft, thus improving deflection. For instance, the shaft of a motor designed to give 50 H.P. at 720 revs. per min. had to be lengthened exactly 6 in. to accommodate pedestal bearings and protection caps in place of the usual end shields.

In the case of explosion-proof motors the ribbed style is necessary, because there the ribs are used to dissipate the heat. The ribs would be all on one side of the end shield, and seeing that cast iron is six times as strong in compression as in tension, this points to the conclusion that the ribs should be on the inside and in compression, while the plate should be on the outside and in tension, especially as the heat is conducted away equally well whichever side of the plate the ribs are on. The explosion of marsh gas and air may rise to 130 lb. per square inch, and the end shields and collector cover should be designed strong enough to resist this. Under the influence of the explosion, the end shield tends to assume a spherical shape. Those portions of its contour which shroud the stator end windings, and which are, or should be, already spherical, are in pure tension. If they deviate from the true spherical form, they are by the amount of such deviation subject to compound stresses, analogous to those in a crooked tie rod under a load due to gravity. If truly spherical, and therefore in pure tension, they do not need any ribs, while, as regards the flat plate which forms the end of the end shield, the ribs should be on the inside and in compression. On the outside they are a source of weakness rather than of strength. If a flaw occurs in the thin rib it does not matter in compression, whereas in tension it is like the weak link of a chain. The flange where the end shield is bolted to the stator frame can be ribbed externally to the spherical portion of the end shield, or it can be made thick enough to stand on its own merits. The straining actions on an explosion proof end shield are exactly opposite to those on an open-type end shield. In the former, it is the flat plate at the end which requires special attention, whereas in the latter it is the curved portion round the stator end windings.

Bearings.—From an engineering point of view the bearing at the driving end should be about three times as large as the bearing at the small end; but from a commercial point of view they should be the same size at each end, so as to be interchangeable. The question whether to make the bearings the same size or not may be answered by saying that for small machines the commercial aspect should be predominant, and for larger machines the engineering; where to leave off is a matter for judgment.

In rope-driving third-bearing machines it makes a convenient arrangement to have a coupling between the rotor and middle bearing, close to the latter, so that the rotor can be removed without dismantling the rope drive. The shaft in this case is in the position of being a "continuous beam," and the coupling ought, properly speaking, to be at the point of contrary flexure, but it is usually more convenient to place it close to the middle bearing. In working out the bearing pressures for such a case, the addition of the loads due to the pull of the ropes and the weight of the rotor respectively is vectorial.

In designing ball bearings provision has to be made for the rotor to take up its position at the magnetic centre of the machine, which does not always coincide with the geometrical centre. The maximum variation that is likely to occur in practice may be taken at $\frac{1}{8}$ in. on either side of the geometrical centre line.

Belt Pulleys.—In determining the width of belt necessary to carry the given power, we have that the useful pull in pounds ($T_1 - T$) multiplied by the velocity in feet per minute (V) = the foot-pounds of work done per minute. The breadth of belt required depends also on the loss due to centrifugal effect at high speeds and on the diameter of the pulley when the latter is small, so that the formula may be written in the form $b = k_1 k_2 k_3 k_4 HP/V$. The different values of the multipliers are given in the Paper in four tables.

The author finally gives an example of the method of calculating binding bands.

PHYSICAL SOCIETY.

At the meeting held at the Imperial College of Science on May 12th Prof. H. L. CALLENDAR, F.R.S., president, in the chair,

"Diagrams of Stream Lines past an Elliptic Cylinder"

were exhibited by Sir GEORGE GREENHILL and Col. R. L. HIPPISLE and a Paper on

"The Method of Constant Rate of Change of Flux as a Standard Determining Magnetisation Curves of Iron."

by J. T. MORRIS and T. H. LANGFORD, was read by Prof. J. T. Morris.

The research described was instituted with the object of finding what differences there were between the magnetisation curves for a given sample of iron when determined (1) by the older methods in which the flux is changed suddenly, (2) by a method in which it is changed exceedingly slowly and at a uniform rate.

The methods experimentally examined were:—

1. Method of constant rate of change of flux.
2. "Slow cyclic" hysteresis loops by method 1.
3. "Step by step" magnetisation curve.
4. "Step by step" hysteresis loops.
5. Method of reversals.
6. Alternating-current magnetisation curve.

Details are given of the theory and practical working of method 1. In this method the magnetising current is continuously increased through a primary winding by a specially designed resistance at such a varying rate as to maintain a constant voltage generated in a secondary winding. A certain amount of skill is required in operating the resistance, but an average experimenter may easily acquire it with a little practice. The complete change of the current occupies times varying from one up to some five minutes.

Tables are given of the magnetisation curve determined by the different methods at a number of values from H 0·3 up to 70·0, and of the permeability from B 500 up to 17,000.

At low values of the magnetising force the uniformly varying

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method gives results of some 200 lines per square centimetre in excess of the older methods.

As regards the time required for determinations by the various methods experimentally examined, ballistic methods are undoubtedly the most tedious. The alternating-current method (method 6) has considerable advantages in this respect, a full set of readings of magnetising current and induced voltage occupying a very short time. When, however, it is necessary to take oscillograms at various points in order to plot curves of form factors, the time required is enormously increased. The method of uniformly-varying flux (method 1) is peculiarly adapted for use where time is a consideration, and at the same time a high degree of accuracy is desired. A complete magnetisation curve may be taken in a very few minutes, and the mean of many such curves obtained in, say, one hour, the iron being demagnetised between each test.

The method of "uniformly varying flux" appears to possess advantages, both scientific and practical, over the older methods in use for the testing of ring samples of magnetic materials. It avoids difficulties due to eddy currents and magnetic viscosity, which effects are themselves due primarily to rapid or irregular changes of flux. Besides rapidity of experiment it also has the advantage of accuracy of operation under standard or predetermined conditions of magnetic change.

The method is, therefore, commended for the carrying-out of magnetic tests, especially where great accuracy under definitely known conditions of experiment are essential.

DISCUSSION.

Mr. A. CAMPBELL remarked that it was rather difficult to say whether the tests made with a slowly varying flux that were required in practice. He thought tests made with cyclical changes were more useful. The differences in the results given by the two methods were important. He pointed out that the method could be used for the determination of iron by substituting a known mutual induction for the iron under test.

Dr. A. RUSSELL pointed out that the value of H was different at the inner and outer radii of the iron ring used by the authors.

Dr. S. W. J. SMITH said it would have been interesting and instructive if the authors had performed a similar series of experiments by the ballistic methods upon some material freer from magnetic viscosity than iron. Experiments made upon a sample of nearly pure iron in weak fields did not seem to be explicable along the lines suggested by the authors for the iron they used.

Prof. C. H. LEES drew attention to the extraordinary simplicity of the magnetisation curves. It looked as if $1/\mu$ were a linear function of H.

The PRESIDENT remarked that by superposing on the constant magnetising field an alternating field which was gradually reduced to nothing, the larger values of the permeability were obtained. For weak fields this was over 1000000. This effect was due to the residual magnetism left by the alternating field.

Prof. J. T. MORRIS, in reply, stated that they had not tried their method with widely different speeds. In reply to Dr. Russell, he stated that the inner ring was tested by the different methods. Replying to Mr. Campbell, he had thought of the present method as a means of measuring mutual induction.

The PRESIDENT gave a demonstration of the action of the electric temperature regulator designed by him for experiments by the continuous electric method on the specific heat of water in 1897, and described in the Phil. "Trans.", A., 1902. The expansion of liquid in a bulb causes a thread of mercury to make contact with a platinum wire, closing a relay which puts a 16 c.p. lamp in series with a similar lamp in the regulator tank. If the wire is fixed, hunting occurs owing to the mercury sticking to the wire and to lag of the heating bulb. This is prevented, either by causing the wire to move slowly and continually through a distance of about 1 mm. with a period of 5 to 10 seconds, or by fixing the lamp bulb close to the regulating bulb. The hunting was demonstrated by means of a platinum thermometer reading to 0·001° C. Other details of construction were explained. The same type of regulator is now being employed in experiments of the variation of the specific heat of water by a method in which two steady currents at different temperatures are allowed to mix, or share their heat, the resulting temperature being observed.

BOOKS RECEIVED.

Copies of the undermentioned works can be had from *The Electrician* office, post free to any address, immediately, on receipt of published price, adding 3d. for books published under 5s., and 5 per cent. for books published nett. Add 10 per cent. for abroad or for foreign books.

"The Engineering Index Annual for 1910." (New York and London, 1911: The Engineering Magazine.") 10s.

"Annual Report of the Smithsonian Institution, 1909." (Washington, 1910: Government Printing Office.)

"Mitteilungen aus den Elektrotechnischen Institut der Grossherzoglichen Technischen Hochschule Fridericiana zu Karlsruhe." By Dr.-Ing. E. Orlich. Band II., 1909-1911. (Berlin, 1911: J. Springer.) M.10.

"Journal of the Institution of Electrical Engineers." Vol. XLVI., No. 206.

ALTERNATING-CURRENT MOTORS FOR ELEVATOR SERVICE.*

BY W. H. PATTERSON.

Squirrel-cage motors used for this service are designed with high resistance end rings, so as to develop maximum torque at starting. They will develop about twice full-load torque and take about 2·5 times full-load current when connected directly across the line. The control is by means of a simple reverse switch, thereby replacing the more expensive controller and rheostat required by a phase-wound motor. It is important that the torque be maximum at the start, for though the efficiency may be slightly improved by decreasing the rotor resistance, the motor would not then start at heavy loads. Moreover, as the required torque decreases after starting, an increased torque of the motor would cause a very sudden and disagreeable acceleration.

The best results are obtained when the slip is about 20 per cent. The full-load power factor was shown by the author to be about 80 per cent., and full-load efficiency about 70 per cent. While the apparent efficiency is low, it should not be compared with that of constant-speed motors, as in this service efficiency is unimportant compared with the other characteristics. The efficiency of the elevator machine itself approximates 50 per cent., and the power factor at starting varies from 70 to 80 per cent.

The wound rotor type machines have somewhat better starting conditions, developing twice full-load torque with about twice full-load current.

In discussing the conditions governing the size of motor required, it was shown that the nominal rating is of slight importance compared with the starting torque developed. The service conditions must then be considered to make sure that the operation is not continuous for long enough periods to cause overheating.

Squirrel-cage motors are made in sizes up to 18 H.P., this being the practical limit, due to starting current. They are used for freight elevators up to speeds of 100 ft. per minute, and in passenger service up to 150 ft. per minute. The wound secondary type is satisfactory for elevators of all capacities up to 250 ft. per min.

Elevators operating at higher speeds are practically always two-speed machines, a feature which eliminates the alternating-current motor, since with any given resistance in the rotor circuit the speed will vary with the load. Another feature limiting the use of alternating-current motors is the fact that with them dynamic braking can only be accomplished by the use of a small motor-generator set to supply direct-current excitation to the primary. However, alternating-current motors have been in use in elevator service for several years and have thoroughly demonstrated their adaptability for conditions within their range.

DISCUSSION.

Mr. F. E. TOWNE (Otis Elevator Co.) described the magnet control of slip-ring motors, and commented upon the difficulties in their application as compared with direct-current motors, particularly with regard to braking.

Mr. H. D. JAMES emphasised the importance of safety and reliability in this service, since failure might mean loss of life. This had probably retarded the development, because no changes which might possibly reduce the factor of safety could be tried.

Mr. J. E. MARTIN (Allegheny County Light Co.) presented some facts from the standpoint of the central station. He stated that the elevator load of a central station was generally confined to a district remote from other power loads, these same districts invariably having the most dense lighting load. In fact, the elevator load followed very closely the development of the lighting load and maintained a fixed ratio of about 11 per cent. of the total connected load. The load factor averaged about 40 per cent., as against 24 per cent. for lighting, and the demand factors had a smaller difference. The peak load on elevator installations occurred during the periods 7:30 a.m. to 8:15 a.m., 11:30 a.m. to 12:15 p.m 1 p.m. to 1:45 p.m., and 4:30 p.m. to 6 p.m. None of these peaks overlapped the lighting peak, excepting that occurring between 4:30 p.m. and 6 p.m. This showed that it was highly desirable to use one distribution system in the districts where the elevator load was found. The greatest disadvantage to be met in carrying out this principle was the intermittent nature of the load. On a circuit having an elevator load exclusively, the weight of copper had to be greater for a given load than for any other kind of service. It had been found advantageous and satisfactory to combine the elevator load with the lighting and a miscellaneous motor load if the elevator load did not exceed 5 per cent. of the total. This low limit was due to the heavy starting current and showed how important were the starting characteristics and how desirable it was to improve them.

* Abstract of a Paper read before the Pittsburg Section of the American Institute of Electrical Engineers.

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With "THE ELECTRICIAN" for Sept. 14, 1906, was issued the first of a series of "Industrial Supplements," to be published from time to time with "THE ELECTRICIAN." The fifty-third issue of the Supplement published (Gratis) with the number of "THE ELECTRICIAN" for September 23, 1910, was the last of the monthly issues. "THE COMMERCIAL AND INDUSTRIAL SUPPLEMENT" to "THE ELECTRICIAN" is now issued weekly (Gratis). It will be found towards the end of the present issue.

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AUTOMATIC TELEPHONY.

The large audience which assembled at the Institution of Electrical Engineers last week was a testimony to the growing interest of English engineers in the subject of automatic telephony. Although in this country the authorities have not as yet seen their way to introduce what is known as the automatic system in any of the public exchanges, the development of the system in America and on the Continent has been considerable, and its introduction is said to have been attended with satisfactory results.

When a radical departure from ordinary practice, such as this system presents, is under consideration there are many weighty factors on both sides which demand careful and earnest study; the operating engineer who has to decide between the relative merits of the new system and the old has a very great responsibility, and his decision can only be arrived at after a long and patient investigation which will take into account the conditions at present obtaining and also the conditions which will exist some considerable number of years ahead.

The great innovation in automatic telephony is, of course, the abolition of the trained intelligence of the operator and the substitution therefor of a highly ingenious and compl

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mechanism controlled by the untrained subscriber. It is around this point that much of the discussion centres, although, when carried to its logical conclusions, it embraces directly or indirectly the whole field of telephone engineering. In the manual system it has always been one aim of the engineer to reduce to a minimum the operations to be performed by the subscriber and, with a view to the reduction of maintenance expenditure, to make the subscriber's instrument as simple as possible. With the automatic system a comparatively complex instrument is used, and the operations to be performed by the subscriber are somewhat involved when compared with the simplicity attained on the other system.

As regards the exchange equipment, the automatic system has long since passed out of the experimental stage, and as it exists to-day is a remarkable testimony to the ingenuity and perseverance of the engineers responsible for its development. It can undoubtedly be relied upon to perform satisfactorily, to a very large extent, the functions of the human operator. There are, however, some operations which cannot be accomplished without the aid of human intelligence, and to carry out these successfully a certain number of human operators must be provided even in an automatic exchange.

A very important function of the operator who constitutes the human link in every connection on a manual system is not to be overlooked. No call can be completed without a preliminary conversation between the subscriber and the operator, with the result that every line is under the constant surveillance of an expert, and many incipient faults are thereby detected before the efficiency of the service is to any extent impaired. It is difficult to see in what manner a similar advantage can be obtained on the automatic system.

A comparatively large staff of highly-trained mechanics must be provided at the automatic exchange, and although the apparatus is so exceedingly ingenious and fascinating, it must not be overlooked that the maintenance charges on such a large amount of complicated mechanism as is found in an automatic exchange must of necessity be high. For similar reasons it seems inevitable that the depreciation charges also will be considerably higher than with the manual system.

A noteworthy aspect of automatic working is the fact that splitting up the system into a relatively large number of switching centres does not appreciably affect the service and does not increase the operating costs to anything like the same extent that a similar division would do on a manual system. As all calls are completed over junctions between the various groups of selectors it is to a large extent immaterial where these groups are located provided that undue costs are not thereby introduced. It is therefore possible to divide the subscribers up into geographical groups and to locate each of such groups from a small exchange located at the most economical point. By this means considerable economy in the plant can be made.

It is claimed for the automatic system that by its means the speed of the service is increased. If the time taken by the subscriber to operate the dial switch is not taken into account this claim can probably be justified. It must be remembered, however, that the automatic system does not eliminate any delays due to delinquencies of subscribers, and in a properly managed manual system whatever delays occur are due in a large measure to this cause rather than to any inherent delays in manual operating. A distinct advantage of the automatic system is the instantaneous disconnection of all the circuits concerned when the subscriber replaces his telephone, thereby leaving his line free for incoming calls in an appreciably shorter time than on the manual system. This has an important bearing in connection with junction working, since it results in the call-carrying capacity of a junction being increased.

The manual system as embodied in its modern form is the result of long years of development. It has proved itself in the past capable of meeting the continually growing demands of the telephone service, and in the opinion of some of the highest authorities it is well qualified to continue to do so in the future. Before abandoning such a system, engineers must satisfy themselves that in the automatic they have an alternative which will enable them to supply an equally efficient service at the same or a lower cost, and which will provide successfully for the ever-growing demands of a great public service.

REVIEWS.

(Copies of the undermentioned works can be had from THE ELECTRICIAN Office, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.)

Applied Mechanics for Engineers. By JOHN GRAHAM. (London: Edward Arnold.) Pp. viii. + 304. 5s. net.

The joint efforts of the author and publisher have resulted in the production of a very satisfactory book. The printing, illustrations and binding are well done, and the subject-matter, being in a style that is very readily followed, will be appreciated by all users. The author's course of lectures at the City and Guilds of London Finsbury College form the basis of the treatise. The elements of the subject are fully but concisely treated; the amount of descriptive matter respecting the practical application of the elements considered is wisely kept at a minimum.

Although it is unusual to introduce into a book on "Applied Mechanics" chapters dealing almost entirely with the expansion of steam in an engine cylinder, the author has seen fit to do so in this instance in order to lead up in a connected manner from the consideration of simple harmonic motion problems to the study of crank effort diagrams, and the balancing of machinery. A chapter on governors is also given.

The work on bending is treated in the usual text-book way—bending-moment diagrams considered without reference to the shearing force diagrams, and a few pages further on shearing force diagrams considered without reference to the preceding bending-moment diagrams. One objection to this method is that the student, not being shown at the commencement the close relationship between these diagrams, does not see any satisfactory reason for drawing a shearing force diagram; and further, when he does draw a shearing force diagram he finds that he has no apparent use for it. The Culmann polygon method of drawing bending-moment diagrams is too cumbersome to appeal to the designing engineer, and its very limited application does not warrant its having so prominent a place in text-books.

The earlier chapters naturally treat of the motion of matter and lead up to problems on energy and work. The three chapters on hydrostatics and the flow of water through pipes are well written. Graphic statics are treated fairly fully, and some consideration is given to braced girder work. A. C.

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Elementary Telegraphy. By H. W. Pendry. (London, 1910: Whittaker & Co.) Pp. viii + 216. 2s. 6d. net.

This book is written specially to meet the requirements of the ordinary grade of the subject as published in the syllabus of the City and Guilds of London Institute. The author claims that a first text-book of this sort has been long wanted, and in this he is no doubt correct. To a great extent the order in the syllabus has been followed, this being most convenient to the candidates for examination. A number of questions are appended to each chapter, which are partly original and partly selections from recent examination papers. The author recommends the student to work these exercises systematically, and the careful preparation of the questions would seem to render this advice valuable. There are 200 illustrations in the book, which help to give the student clear ideas of the forms of instruments used in telegraphy, and of the mode in which they are connected up. The mathematical expressions which are employed do not go beyond simple equations, and, so far as they go, are thoroughly in keeping with the rest of the descriptive matter.

Chapter I. deals with fundamental principles, units, the phenomena observed when we come to work with electro-magnets, and the construction of bobbins. Batteries of the popular forms—the Daniell, the Leclanché, the bichromate, dry, and secondary cells are well described in Chapter II. Appropriately, the reader is then introduced, in Chapter III., to the instruments in common use for simplex and duplex working, together with the forms of galvanometers, with their shunts, which are ordinarily employed in England. Switches, resistance coils and condensers as used in the British Post Office are included. Within a short compass there are set out, in Chapter IV., the main features of construction of aerial, subterranean and submarine lines. A full-sized section of a composite telegraph and telephone air space cable, and another of a Continental quad gutta-percha cable, are illustrated and instructively described. Chapter V. deals with signalling systems, including duplex, C.B. arrangements, condenser, impulse, and omnibus circuits, the Hay and Vyle and Smart duplex, and special Wheatstone and key circuits. The mode of using and of connecting up to distribution, main cabinet and table fuse cases, and the universal battery are also treated. Chapter VI. contains descriptions of modern methods of prevention of disturbance by earth currents and lightning. This is followed by an appendix giving questions set at the City and Guilds Institute in 1908–10. A useful index concludes the book. The work is a good one and deserves to be largely used, for it contains all the information likely to be required by the elementary student presented in a well-condensed and able manner.

Annuaire pour l'An 1911 du Bureau des Longitudes. (Paris: Gauthier-Villars.) Pp. 640 with Appendixes. 1 fr. 50 c.

This annual contains, firstly, details which are likely to be of interest to astronomers. This part comprises constants, data and information, in the usual pocket-book style, regarding the sun, the moon and other heavenly bodies. The second part contains tables giving geographical data of the principal countries, together with the latitude, longitude and population of the chief towns and cities. Conversion tables for the money, weights and measures of the various countries are also given. The information seems to have been adequately brought up to date since the last issue, though the volume is about 100 pages smaller. This decrease is due apparently to the fact that no dissertation on a special subject is included. Unlike most French books of its kind, this annual possesses quite an adequate index.

Spon's Architect's and Builder's Pocket Book. (London: E. & F. N. Spon.) Memoranda Section, pp. liii. + 372, 2s. 6d. net, post free. Prices Section, pp. liii. + 239, 2s. 6d. net, post free.

Since the last edition it has become necessary, owing to the inclusion of new matter and the consequent increase of the thickness of the volume beyond pocket-book size, to divide the Memoranda from the Prices section. In the first of these the memoranda are arranged in alphabetical order, and all the information has been brought up to date. The subjects covered are exceedingly varied, the range being comparable with that of "all Lombard-street to a China orange." As regards electrical work, nearly 30 pages are devoted to the question of lighting by this means. Some useful figures are given regarding the amount of light that should be used for illuminating various areas. A model specification for a self-contained lighting plant is given in full, as well as extracts from the wiring rules of the Institution of Electrical Engineers. The section gives a number of prices for doing work in the building trade, the standard taken being for operations of average size, carried out under the ordinary conditions in the London district and including profit. Electrical work figures in this section as well, the cost of wiring and fitting electric light when casing or tubing is employed being given.

L'Année Electrique, Electrothérapique et Radiographique. By Dr. Foveau de Courmelles. (Paris, 1911: Libraire Polytechnique Ch. Béranger.) Pp. 348. Fr. 3.50.

This edition varies but little from its predecessors. In specially written chapters an adequate *résumé* is given of the progress made during 1910 in apparatus, heating, electric traction, wireless telegraphy, hygiene and medical electricity. We imagine that this book is written for such medical men as desire to know a little of what is going on outside their own sphere of usefulness. For this reason we think an index might have been provided. We have drawn attention to this point before, but it is a defect often found in French books.

THE NOMENCLATURE OF PRIMARY AND SECONDARY SOURCES OF LIGHT.

BY HAYDN T. HARRISON.

The short Paper I read before the Illuminating Engineering Society has already justified itself by producing from Mr. Trotter one of the most valuable articles (The Electrician, May 19th, p. 204) on the subject of the terms used in optical science. But it will be noted that those terms which have been already defined do not include one which is badly needed—namely, that which will differentiate between illumination derived from light radiated from a point and illumination reflected from a large area.

In order that the necessity for such a term may be made clear I will take a simple example. Let us suppose a room in which the walls, ceiling and floor all have a high reflecting efficiency. In the centre of that room is placed a single light source, and below this, but protected from the direct rays, is some object such as a small sphere. Now, to the human vision that sphere will not appear spherical, however highly it is illuminated, because the illumination is derived equally from all directions. In other words, the illumination might be good as far as degree is concerned, but would be a failure as far as seeing solid objects is concerned.

Illumination, as defined by the terms at our disposal, does not differentiate between the class of illumination which makes visible the details of solid objects and that which will not. Illumination is the quantity and quality which stimulates the eye in discrimination of outlines and perception of colours; then in order that we may know the extent to which it is likely to assist us in the discrimination of outlines, it is necessary to know the area of the source from which the light emanates and also the direction. A monochromatic solid object, like statuary for instance, demands that every curve or angle must reflect varying degrees of light back to the eye in order that it can be seen in detail, and this applies in varying degree to all objects except plain artificial ones, such as pictures, where the artist has done what the varying degree of illumination has to do in the case of a solid object. Therefore, if an illuminating engineer specifies only the degree of illumination in foot

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candles, or any of the other terms at present in use, he must not be surprised if the result is not satisfactory.

Having found this difficulty, I sought for some term that would distinguish between the rays from light sources which produce the effect of light and shade and those which do not. The latter were described in my Paper as the cause of shadowless illumination.

It is obvious that in cases where the light is radiated from one or more sources the effect of light and shade will be produced, whereas if it emanates from all directions, being reflected by the luminosity of the surrounding surfaces, the opposite effect will be the result. Therefore, if the term luminosity is to be used to indicate the reflecting value of these surfaces, I suggested that Lumens should be allotted to light flux obtained by reflection. The objection to this appears to be that the term "Lumens" has already been appropriated. Therefore it would perhaps be advisable to coin a new term for the light-emitting power of a secondary source, and a new unit to describe the value of the illumination derived.

This is not the first time a problem of this sort has had to be faced. For instance, the electrical law W = E.C., which Varley and Tait have both pointed out, bears a remarkable resemblance to the law of lighting, is not correct when applied to alternating current passing through an inductive circuit; hence the word "true-watts" has often to be used. In the same way the physical value of illumination is not always equal to surface radiation per square centimetre multiplied by the area of the light source. Therefore, the unit required is that which distinguishes between the light flux which produces contrasts and that which does not. It would then be possible to judge the true physical value of the resulting illumination.

All illumination derived from a source of comparatively small area will accentuate contrasts of light and shade, and that derived from a relatively large area will reduce them. So, mathematically, the unit is required to describe the degree of divergence from the $i = \frac{CP}{D^2}$ formula, where candle-power is taken as emanating from a point source; in other words, a factor which reaches unity when illumination is derived equally from all directions, and a maximum when illumination is derived from one infinitely small point.

There should be no difficulty in giving this unit a mathematical value. For example, if a lamp gives 0·01 ft.-candles at a distance of 10 ft., it will give x foot-candles measured at 1 ft. from an albedo plain surface of practically infinite area illuminated by a 1 c.p. lamp at a distance of 5 ft. Thus the new unit would denote a shadow-giving efficiency of $\frac{0{\cdot}01}{x}$, and could be measured by an ordinary illumination photometer by measuring the illumination on the bright and dark side of an object. The difference would give the relative shadow value of direct and indirect lighting, which would be the maximum if all the lighting were obtained from a point source, and a minimum when the light is obtained equally from all directions.

I trust the readers of this will agree with me as to the need for a new unit to denote light and shade efficiency, as, until some suitable term is forthcoming, it will have to be described as a shadow efficiency or similarly ambiguous phrase.

It is interesting to note that in daylight the shadow efficiency is greatest with bright sunlight and lowest when the sky is overcast, thus emphasising my point that if a lesson is to be learnt from Nature, the most unpleasant illumination is of the shadowless type, or when the illumination derived has a very low shadow efficiency.

It must not be gathered from these remarks that I consider heavy shadows an essential for good illumination, but that I consider the presence of shadows produces an efficient illumination physiologically. Certain conditions require different degrees of light and shade, and the best effect for each class could be ascertained by experiment and properly specified, provided there was a unit or standard by which to specify them.

THE HEATING OF CABLES WITH CURRENT.*

BY S. W. MELSOM AND H. C. BOOTH.

Summary.—Investigations on the rise in temperature of various sizes of conductors carrying current are discussed, the effect of stranding, of installing in tubes, wood casing, &c., and of various methods of insulating and covering being described. The results of this research are incorporated in the recently issued sixth edition of the Wiring Rules of the Institution.

This Paper describes an investigation made at the National Physical Laboratory at the request of the Wiring Rules Committee of this Institution in order to determine the temperature rise and current-density for a given temperature rise in cables of various sizes and with different types of covering. A length of 40 ft. of each cable was tested. The insulation of the cables was of the standard pattern, the paper-insulated ones being lead covered, and the rubber-insulated (with the exception of the 0·3 sq. in., which was only rubber covered and taped) being taped, braided and compounded.

Conditions under which Tests were Made.—The rubber-covered cables, marked A on the curves, and the paper-insulated lead-covered cables, marked E on the curves, were in each case laid out flat along the wooden floor of the room, the lead and return being close to and touching each other. The concentric paper-insulated lead-covered cables (F_1 on the curves) were laid straight out along the floor, the current being led into the inner and returning by the outer lead.

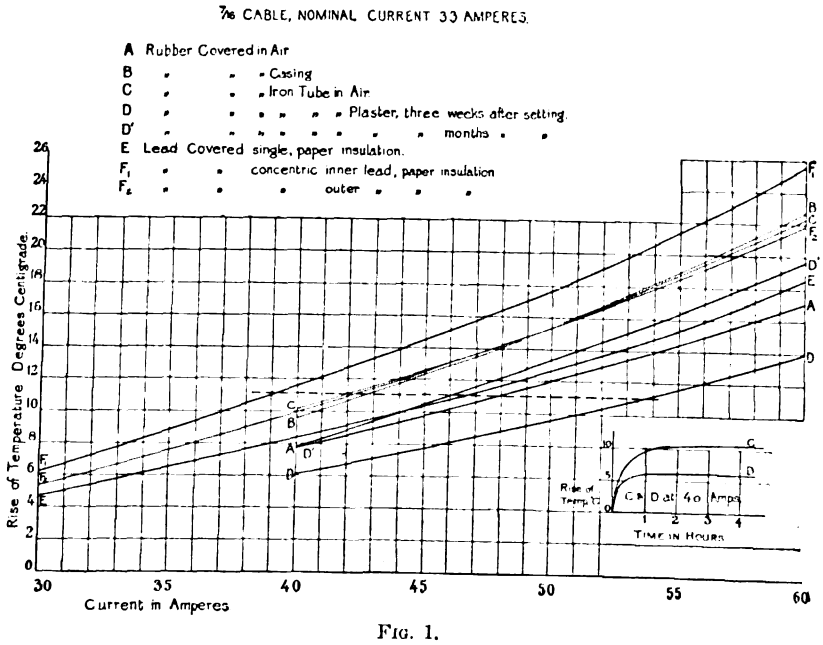

FIG. 1.

In the case of the rubber-covered cables in casing, marked B on the curves, the casing used was in each case twin and of the standard size for the various cables, and was supplied by the Wiring Rules Committee. The casing, however, in some cases allowed of a rather larger air space than in others. The ideal condition from the point of view of dissipation of heat is to have the cable nicely filling the groove. The casing was laid flat along the floor. Observations made with it screwed to a board and supported on one edge, with the wires one above the other, showed no difference whatever from those made with the casing laid flat and with both wires in the same horizontal plane.

The iron tubes used were supplied by the Committee. In each case both the lead and return cables were drawn into the same tube; and as there was a considerable amount of air space inside the tubes, this would tend to retard the dissipation of heat. The cables marked C on the curves were drawn into the iron tubes and laid straight out along the floor. In the case of those marked D and D' the tube was embedded in a block of plaster running the whole length of the tubes, the plaster being 4 in. deep by 6½ in. wide.

* Abstract of a Paper read before the Institution of Electrical Engineers.

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Measurement of Temperature Rise.—The increase of temperature of the cables was determined by measuring the increase of conductor resistance. The initial temperature of the cable was assumed to be that of the air. Observations taken both on a rising and falling air temperature showed that even the larger cables followed the slow variations of air temperature very well. The room in which the tests were made was specially adapted for constancy of temperature and was free from any draught.

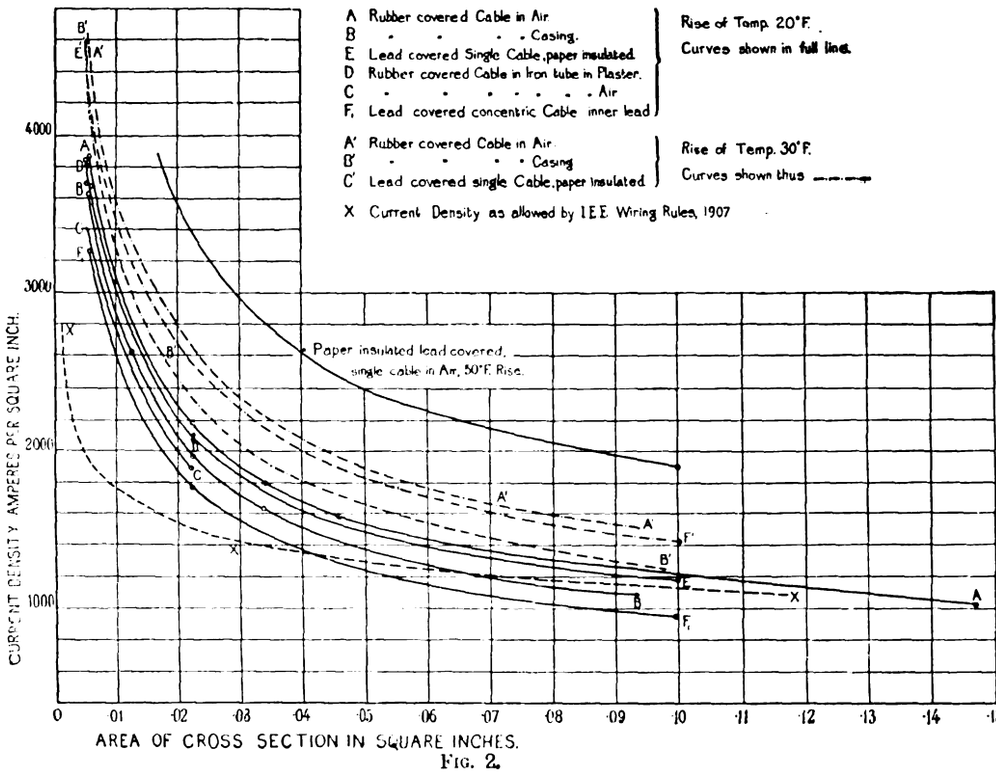

FIG. 2.

An interesting point was raised by Mr. Wordingham in connection with this method of determining the temperature rise. It was that there was a possibility of the strands of the larger cables when hot coming into better contact than when cold, and that, consequently, the resistance of the conductor would not rise proportionately with the temperature. This point was investigated by enclosing the 0·5 sq. in. paper-insulated lead-covered cable in a long wooden box, which was heated by means of woven resistances to a temperature of 50° C. As the temperature coefficient of the conductor was thus found to be 0·396 per cent. per degree Centigrade, as against 0·40 per cent. obtained by the more accurate method of measuring the separate wires in an oil bath, the variation in resistance, if any, due to tightening of the strands does not affect the accuracy of the results. The temperature determined throughout the tests is, of course, the mean temperature of the conductor over its cross-section, and not the maximum to which any part may have risen. Dr. A. Russell has stated that the temperature difference is very small.

In order to ensure that there was no extraneous heating or cooling at the ends, the connections from the cable to the standard resistance were made with cable having the same cross-section as that under tests, the joints were wrapped with canvas wrapping and the potential leads from the cable to the bridge were taken off at a point just inside the joints.

The current was taken from a large battery and was kept quite steady throughout the tests.

In order to ascertain if there was any large difference between the heating with direct and alternating current, a test was made with the paper-insulated lead-covered cable and the rubber cable 0·5 sq. in. section with alternating current of 50 cycles per second. The cable was heated by means of alternating current, the measurement of resistance being made by changing over to direct current immediately before the observation was made. The results agreed with those obtained with direct current to within about 3 per cent., this being within the probable limit to which the alternating current was kept constant.

Results.—Three small cables (1/14, 3/18 and 7/21) were first tested to ascertain the difference between stranded and single conductors. In order to make a correct comparison, the results were corrected for the small differences in cross-section between the conductors. It was found that the difference in the current required for a given temperature rise was only 3 per cent. between 1/14 and 7/21 cable, the actual temperature difference being only 1°F. with a current of 20 amperes.

Fig. 1 is typical of the results obtained with different types of covering for a 7/16 cable. In general, the current-carrying capacity of rubber cables for a temperature rise of 20°F. is about 10 per cent. less when they are run in casing than when they are laid out along the floor—*i.e.*, in air (the latter, of course, approximates to the conditions of cables cleated to a wall or in a wood chase). There is also very little difference between the rubber and paper-insulated cables when laid under similar conditions. It is, perhaps, interesting to note that the difference between rubber cable in casing and in iron tube in air (*i.e.*, laid along the floor) is very small. When, however, the iron tube is embedded in plaster the cooling is distinctly better, the curve being nearly the same as that obtained with the lead-covered single cable.

Figs. 2 and 3 show the results for the whole series of cables tested in current-density per square inch of conductor for a given temperature rise. Each of the cables examined was run with a steady current until a final maximum rise of temperature above that of the surrounding air was attained, the time ranging from two up to five or six hours.

For each type of cable and each condition of running a curve was drawn, showing, for a specified final temperature rise, the connection between the cross-sectional area S and the current-density *i*. It was found that in certain cases—*i.e.*, single rubber-covered cables in air and in wood casing and paper-insulated lead-covered cables, both single and concentric—the connection between cross-section and

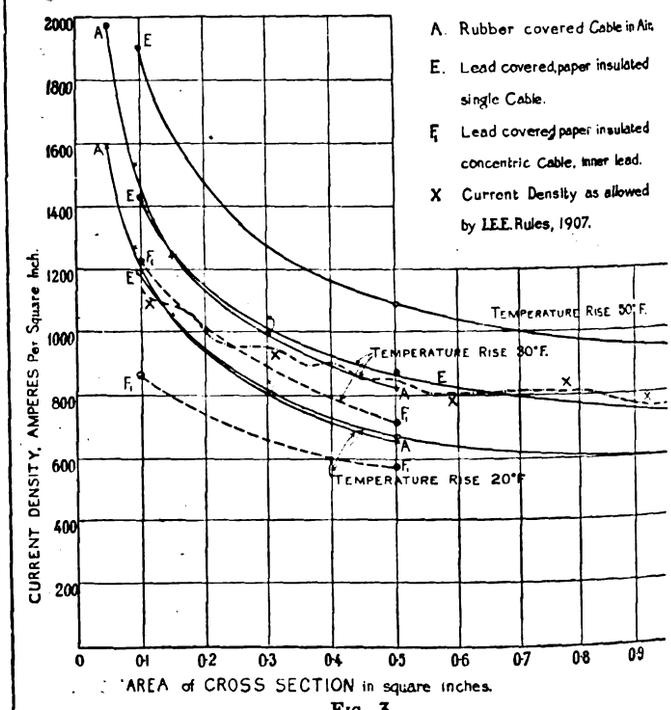

FIG. 3.

current-density could be fairly represented by a formula of the type $i = K(D/S)^n$, where n is a constant and K depends on the system of units adopted and the amount of the temperature rise. If i is the current-density in amperes per square inch, S the cross-section of the copper in square inches, and D the diameter of the outside covering

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the cables in inches, then, for a rubber-covered cable in air, $i = 364\,(D/S)^{0.461}$; for similar conductor in casing $i = 309\,(D/S)^{0.66}$, and for a lead-covered cable, $i = 429\,(D/S)^{0.5}$, the temperature rise assumed in each case being 20°F. For a 30°F. rise K is 457, 358 and 336 respectively for the above three types, n being unchanged. For a 30°F. rise K = 688 for a lead-covered cable.

The authors next explain the reasons which suggested the use of this particular type of formula, this being obtained and the various constants discussed.

CURVES SHOWING HEATING OF 19/14s CABLE LAID UNDER VARIOUS CONDITIONS.

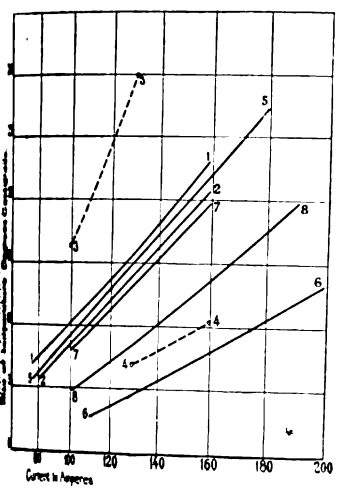

FIG. 4.

The dotted curves marked X in Figs. 2 and 3 give the current-density allowed by the present (1907) Wiring Rules. It will be seen that this gives a temperature rise of about 20°F. for cables of from 0·046 sq. in. to 0·15 sq. in., rising to rather more than 30°F. for cables up to 1 sq. in. section. For cables smaller than 0·05 sq. in. the temperature rise with the current-density at present allowed is much less than 20°F.

Tests under Extreme Conditions.—In Fig. 4 are shown results obtained with 19/14 cable laid under various conditions.

The question of the heating of buried cables is a most important one. It has been somewhat outside the scope of the present work, however. So far as the authors are aware, no attempt has been made by the engineers responsible for large cable systems to determine the temperature rise in the cables as laid. It would not be very difficult to obtain data of this sort, which would be extremely valuable. A test of the voltage drop along a length of cable from the distributing station to the first distributing box at various currents or conditions of loading could be easily made. It would, however, probably be insufficient to take the total volts at each end of the cable, as the difference would be so small, but if a small wire were run back along the cable the voltage drop could be taken sufficiently accurately on a low-reading voltmeter.

Intermittent Load Tests.—The extent to which the nominal rating of cables might be modified where the load is intermittent in character was also investigated. The authors of the present Paper took a period of four-minutes' running, followed by six-minutes' rest, and, as a variation of this, a period of two-minutes' running followed by three-minutes' rest; and in each case measured the rise and fall of temperature going on in the cable under these conditions of working. A 19/14 rubber-covered cable, the nominal rating of which under the new rules is 119 amperes, was chosen for the test, and was run at 50 per cent. overload. The results show that in the shorter period the maximum peak of the temperature curve just reaches the 20°F. limit. In the case of the longer period that limit is slightly exceeded.

CORRESPONDENCE.

THE ORIGIN OF "ATMOSPHERICS" IN WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As Dr. Erskine-Murray now proposes to use directive aerials for his investigations on the origin of "atmospherics," it may be of interest to state that in the early days of directive aerials (1907) it was noticed by the writer, and also by Messrs. Bellini and Tosi, at the Dieppe station, which was fitted with a directive system, that such atmospherics as were received on the directive receiver were by no means uniformly distributed in azimuth; and though the idea of using these aerials for this purpose has only lately suggested itself to radio-telegraphists, meteorologists were quick to see the important information which directive aerials might give them. In the latter part of 1908 a Bellini-Tosi directive receiving aerial with radiogoniometer was installed at the Meteorological Observatory at Antananarivo, in Madagascar, in order that observations of atmospheric discharges could be carried out, and, as this was over two years ago, it would appear that a considerable fund of information should already be available, especially as the station is situated where there should be abundant material for observation.—I am, &c.,

London, W.C., May 22. L. H. WALTER.

NEW DEMONSTRATION ROOMS OF THE WESTMINSTER ELECTRIC SUPPLY CORPORATION.

Further evidence of the publicity campaign which has been organised by the electric supply companies of London was the opening on Wednesday last of the new demonstration rooms of the Westminster Electric Supply Corpn. at their main offices in Eccleston-place, Belgravia, S.W. This Company has for some years demonstrated on a small scale the capabilities of electric lighting and electric appliances, but the extensive and exceptionally well equipped new demonstration rooms should enable the Company to develop the publicity side of their undertaking in a more effective manner. The equipment and arrangement of the rooms certainly leave little to be desired, and visitors cannot fail to be impressed both by the attractive display of apparatus and by the demonstrations of its capabilities.

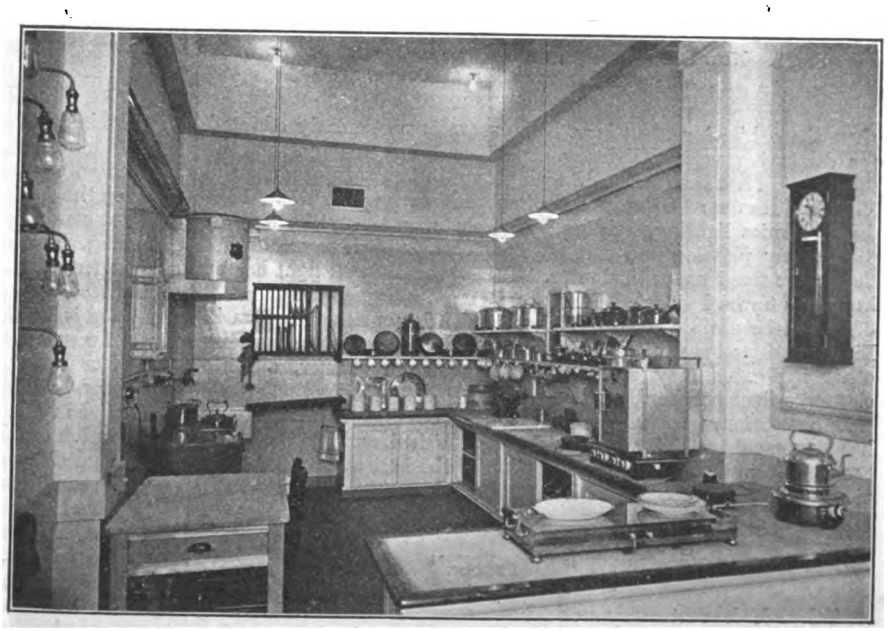

FIG. 1.—MODEL ELECTRIC KITCHEN IN THE NEW DEMONSTRATION ROOMS OF THE WESTMINSTER ELECTRIC SUPPLY CORPN.

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In this connection the greatest credit is due to the Company for the effort which they are making to popularise the use of electrical energy for purposes other than lighting. A model kitchen is included in a bay of the main room, and in addition to the demonstrations which will be given of the use of various electric-cooking utensils, ladies will be invited to send their cooks to the Company's rooms to investigate and obtain experience in the actual use of electrical apparatus. Moreover, the attendant will visit consumers' houses to instruct and advise on the use of electric-cooking apparatus, so that consumers are not likely to refrain from adopting electric cooking on account of ignorance of its possibilities. As regards cost, the Company are satisfied that electric cooking with energy at 1d. per unit is no more expensive than gas at 2s. per 1,000 cubic feet.

We noticed in the model kitchen, of which a view is given in Fig. 1, that a constant supply of electrically heated water is obtained from a "Therol" water heater. A "Tricity" cooker is also much in evidence, and visitors to the rooms on Wednesday last were able to sample a number of foods cooked in this oven, verifying for themselves the statement that electrically cooked food surpasses in flavour that cooked by ordinary methods.

As regards the main showroom, of which a view is given in Fig. 2 herewith, the Company has had more especially in view the practical application of the various systems that may be employed, rather than the exhibiting of fittings. The room is particularly adapted for displaying various lighting effects, and for this purpose the illumination has been arranged with groups of lamps to produce the following results: Upward reflection, downward reflection, concealed cornice lighting, lighting by brackets on the walls, &c. A particularly pleasing and soft effect is obtained where white silk shades are fixed under the lamps. This gives diffused light below, as well as upward reflected light.

As will be noticed from the view of the demonstration room in Fig. 2, various types of electric radiators are shown, whilst among other apparatus may be mentioned a vacuum cleaner, a knife cleaner, a floor polisher, flat irons, &c.

In conclusion, we need scarcely add that the demonstration room has been most tastefully decorated and furnished, and the Company are to be congratulated on what is one of the best arranged exhibitions of electric apparatus we have seen.

FIG. 2.—NEW DEMONSTRATION ROOM AT THE OFFICES OF THE WESTMINSTER ELECTRIC SUPPLY CORPN.

THE "AMPALL."

Although the customary method of measuring the current flowing in a conductor is to include an ammeter in the circuit, cases frequently arise where it is inconvenient or impossible to break the circuit for the purpose of inserting an ammeter. The Ampall, a new instrument which has just been placed on the market by Mr. R. W. Paul, of Newton Avenue Works, New Southgate, N., enables the amount of current to be ascertained without breaking the circuit.

The apparatus, which is illustrated in Fig. 1 herewith, comprises a "Unipivot" millivoltmeter, a contact block with potential points and plug leads. The contact block is strapped by leather bands to the bare conductor in which it is desired to determine the current flowing, the plug leads are connected up and the reading of the millivoltmeter noted; this reading multiplied by the cross-section of the conductor in square inches gives the value of the current in amperes. In order that this may result, the millivoltmeter scale is arranged so that it reads 1,000 when the difference in potential between the contact points is 2 millivolts; and the distance between the contact points on the block strapped to the conductor is arranged so that there is a P.D. of 2 millivolts when the conductor is carrying 1,000 amperes per square inch. This distance is approximately $2\frac{3}{4}$ in.

It will be seen, therefore, that the millivoltmeter reading gives the current density in the conductor; and the product of this reading and the area of the conductor furnishes the required value of the current flowing. An important feature of the instrument is that it enables the amount of current from a fraction of an ampere up to any value to be ascertained, and there is always an open reading on the scale. The method of using the apparatus and of fixing the contact block will be clear from Fig. 2, which illustrates the Ampall in use for reading the current in a copper battery connection. It must be noted

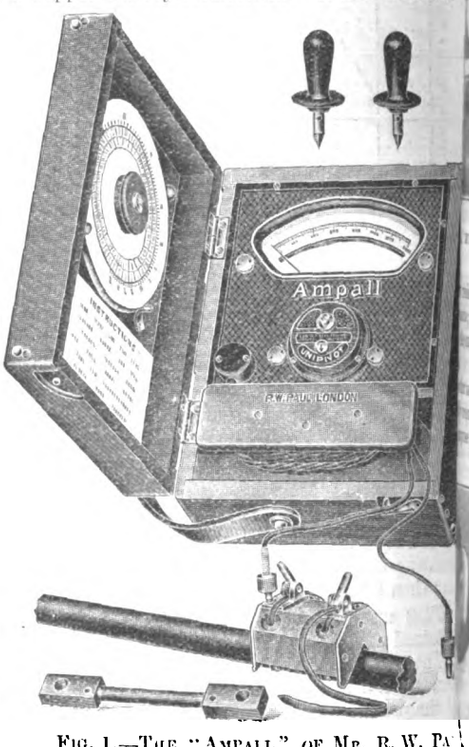

FIG. 1.—THE "AMPALL" OF MR. R. W. PA

that the instrument is calibrated for copper conductors, so that wit conductors of other metals, the reading must be multiplied by th percentage conductivity and divided by 100, or else the distanc between the contacts must be correspondingly altered. In the cas of a flat conductor, or one of irregular shape, no difficulty arises attaching the contact block, which is arranged so that it press against the surface. We may mention that the apparatus has r cently been employed successfully for conductors measuring 5 in. b 2 in., and it should prove valuable for measuring currents in variou parts of power or lighting systems, and in connection with electrolyt or furnace work. A simple circular slide rule is also provided; this graduated both in square inches and in sizes of stranded cables, an enables the value of the current to be read off quickly.

Attention must, however, be called to the fact that the Ampall not intended for use as a precision instrument, but in unskilled hand readings can be ascertained within a few per cent. Exact results ca be obtained in skilled hands if due regard be paid to the conditions the test. Thus, the instrument does not compensate for the rise temperature of the copper conductor under test. As, however, rise in temperature of 20° F. covers the majority of cases, the distan apart of the contacts has been fixed on the assumption of a temper ture rise of 10°F. (the actual distance apart of the contacts is 2·87 in

In addition to its use for measuring current the Ampall provides simple means of testing the conductivities of contacts, joints, fuse or materials generally. For this purpose hardened steel points (se at the top of Fig. 1) and a copper resistance (seen in the foregrou of Fig. 1) of 20 microhms for use as a standard are included. T standard 20-microhm resistance requires to be inserted in the circu By taking readings on the millivoltmeter of the P.D. across this res tance and across the contact or bar to be measured, the conductivi

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can be at once obtained. Where it is possible to adjust the current, the procedure can be simplified by adjusting the current so that a reading of 200 is obtained on the millivoltmeter across the 20 microhm resistance. The unknown resistance in microhms is then obtained by dividing the reading by 10. The apparatus is seen in Fig. 3 in use for testing the conductivity of a carbon rod. An exten-

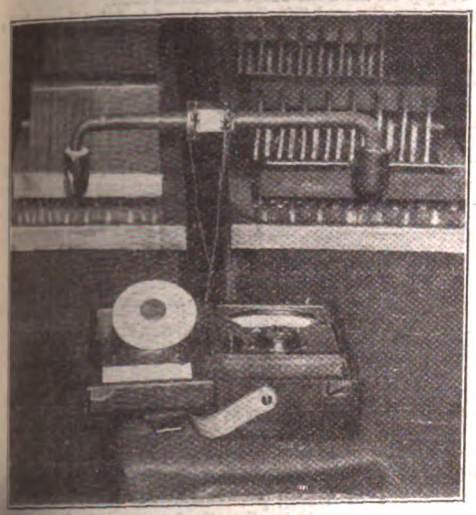

Fig. 2.—The "Ampall" in use for Reading the Currents in a Battery.

sion piece of 90-ohms resistance is also provided, and can be easily fixed to the plug contacts; as the resistance of the millivoltmeter is 10 ohms, the use of the extension piece results in the scale reading directly in microhms.

As illustrating a further use of the Ampall, we may mention a case where it is occasionally required to read the current in a number of circuits. For this purpose it is not necessary to fix ammeters

Fig. 3.—Testing the Conductivity of a Carbon Rod.

or shunts in each circuit, but a contact block would be tied to any part of each circuit and leads brought to the contacts of a multiple-way switch; the contact blocks being adjusted to suitable lengths, direct readings in amperes are obtained on an "edgewise" Unipivot instrument.

THE "CARLEON" SYSTEM OF LIGHTING FOR MOTOR CARS.

During the last year or two considerable attention has been paid to the problem of providing a satisfactory system of electric lighting for motor cars. The difficulties to be overcome in evolving such a system are many, among them being that of obtaining a practically constant voltage at varying speeds of the engine, and of ensuring that the battery shall not be subjected either to insufficient or unduly heavy charging.

One of the most interesting systems that we have seen is known as the "Carleon." This is due to Mr. Gavan Inrig, of Medina Works, Kew Green, S.W., and brief mention of it was made in our "Industrial Supplement" of Feb. 17 last, though, unfortunately, the name of the inventor was incorrectly stated as Turig. Mr. Inrig has been engaged on the problem of car lighting for many years, and produced a special dynamo for this purpose as early as 1898. The present "Carleon" generator is constructed on different lines from those usually followed, the voltage of the machine being maintained constant over a wide range of speed by varying the air-gap between the armature and the field magnets.

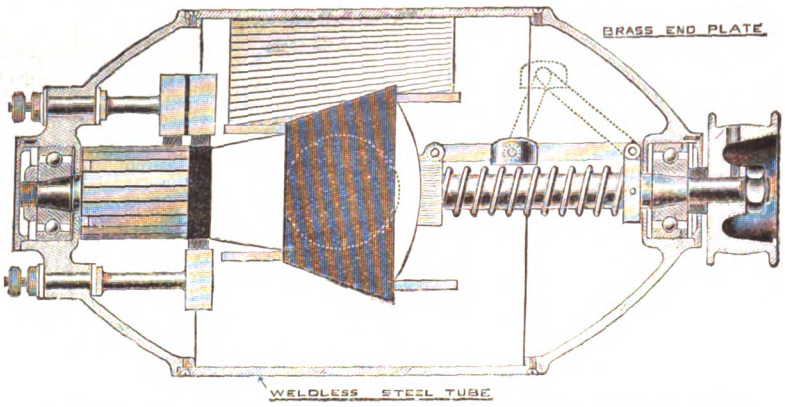

Fig 1.—Diagram Illustrating Principle of "Carleon" Generator

As will be seen from Fig. 1, the armature is cone shaped, and its position relative to the field magnets is adjusted by a centrifugal governor. The total travel of the armature is 1½ in., and in its limiting position each air-gap is ⅜ in. This position, however, is not likely to be reached, since at 4,000 revs. per min., the armature is only displaced 1 in. The lower limit at which the armature supplies current to the lamps or battery is 1,400 revs. per min.

The generator, of which a view of an early type is given in Fig. 2, is a four-pole shunt machine, and four brushes are used to collect the current from the commutator. Two additional brushes are attached to the end of the spindle and are displaced radially by centrifugal force when the armature is rotating, their position being controlled by two springs. Each of these brushes, which are not indicated in the diagrammatic representation of the generator in Fig. 1, and which are insulated from one another, comes into contact with at speeds above 1,400 revs. per min. and short-circuits two insulated brass rings fixed inside the generator casing. This serves

Fig. 2.—Early Type of "Carleon" Generator.

to connect the armature to the main terminals of the machine when the normal voltage is reached, so that a switch is unnecessary. The maximum output of the machine is 10 amperes at 15 volts, but a smaller generator is being put on the market to meet the requirements of taxicabs. The larger generator weighs 21 lb.; its overall length is 8½ in. and its diameter 6 in.

The battery is connected permanently to the terminals of the machine, so that charging takes place whenever the generator runs at a higher speed than 1,400 revs. per min., the pressure being 14 - 15 volts. The storage battery marks a new departure in the construction of accumulators, neither lead nor acid being employed. One set of plates consists of zinc and the other of a star-shaped carbon rod embedded in a block containing manganese peroxide, graphite, zinc chloride and sal ammoniac. These ingredients in certain proportions are made into a paste with distilled water and pressed into a block containing the star-shaped carbon at the centre. The electrolyte comprises crushed oats, crushed rice, zinc chloride and sal ammoniac. The cell is therefore of the dry cell Leclanché type.

Ten cells are employed and the advantages claimed for the battery

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are that there is no paste to fall out and make short-circuits, no acid or fumes, so that the terminals cannot be corroded, its weight is 50 per cent. less than that of lead accumulators, it requires no attention and is absolutely fool-proof. In this last-mentioned connection it is interesting to note that the battery is claimed to be in no way injured by heavy charging currents. Thus, a current of 30 amperes has been found to cause no harmful results. In other respects the battery, which is at present being manufactured in the 40-ampere-hour size, is charged and discharged in the usual manner. A disadvantage is that during normal discharge its voltage decreases from 1·5 to 0·9 volts, so that when the speed of the engine falls below the minimum for charging, a decided diminution in light is obtained on the lamps. As a good light is usually of particular importance when bringing a car to rest rapidly this feature must be off-set against the disadvantages of lead accumulators. The latter can, however, be employed with the "Carleon" generator if desired. The weight of the 40 ampere-hour battery mentioned is 26 lb., and its dimensions are 16 in. long, 7 in. wide, and 7¾ in. high.

Attention may also be called to the "Carleon" motor lamps. Fig. 3 shows a sectional view of one of these. A special feature is

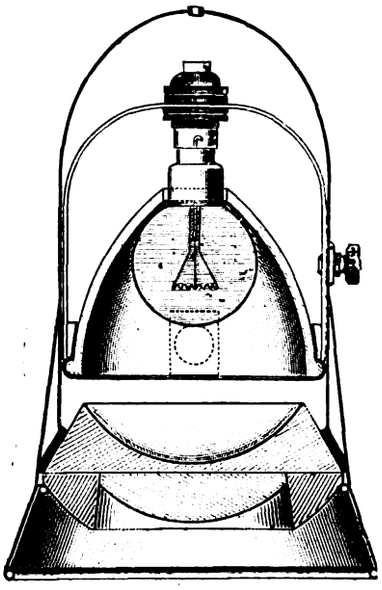

FIG. 3.—"CARLEON LAMP."

the reflecting hyperbolic mirror, made of double glass, silvered between. By this method of construction, the brightness of the reflectors remains unimpaired. The light passes through a concave lens and is projected through an annular dioptric lens in a parallel beam of light straight in front of the car. It is claimed that all glare and dazzle has been eliminated by this arrangement of lenses. It is interesting to notice that no special shape of lamp bulb is necessary, it being possible to employ any bulb up to 2 in. diameter.

Electric Traction in Switzerland.—Some weeks ago we announced that the Swiss railway authorities were taking steps for an extensive electrification of their lines. We understand from "The Times Engineering Supplement" that the authorities have already acquired several concessions for water power in the region of the Simplon, in the cantons of Uri and Ticino, and elsewhere; and now they have just concluded an agreement with the authorities of the canton Valais. By this agreement they obtain the right to utilise the power of the waters of the Rhône between Fiesch and Mörel, where electricity works are to be built. On the Gothard line about 10 miles of water conduits have been built between Arolla and Bellinzona, preparatory to the electrification of this line from Lucerne to Chiasso. It is calculated that between 25,000 and 30,000 H.P. will be obtainable from these works alone. The concessions for utilising the water power on both sides of the Gothard Pass, in the cantons of Uri and Ticino, have also been secured. The electrification of the railways will naturally entail a heavy initial cost, the price paid for the concession in the Rhone Valley alone having been £15,200, besides an annual payment of £1,600. It is estimated that when the Valais works are ready the *minimum* yield of power will be 15,500 H.P.

PARLIAMENTARY INTELLIGENCE.

POST OFFICE ESTIMATES.

On Thursday evening last week the House of Commons went into Committee of Supply on the Post Office Estimates, when

The Postmaster-General (Mr. SAMUEL) explained that the vote for the year (amounting to over £21,000,000) exceeded that for last year by £1,750,000, due mainly to the taking over by the Post Office in January next of the business of the National Telephone Co.; £480,000 was required for the first quarter's working expenses and £131,000 in connection with the inventory and for rearrangements of telephone equipment, the total amount in respect of the transfer of the Company being £798,000. The balance of the increased expenditure was due to normal growth of Post Office work (£343,000), to telephone repayment charges, provision of a new cable ship, &c. The estimated revenue was £25,740,000, increase £2,000,000. The estimated Post Office profit for the year would be £4,615,000, increase £666,000.

Postal Reforms.

Mr. Samuel announced that he proposed on Coronation Day to issue postcards and letter-cards at ½d. and 1d. respectively, that was, at the face value of the stamps upon them. The actual cost of the postcard to the Post Office would be ⅓d., and it was impossible to defend the present charge of a farthing. A satisfactory margin of profit would still remain. He proposed to make two alterations so as to meet objections of the stationery trade. He saw no reason why the Post Office should supply postcards at the face value and give wholesale firms special facilities for obtaining their stationery for nothing, and he had made arrangements to discontinue the practice of selling postcards in uncut sheets. And, further he had made arrangements to allow the free stamping of official stamps upon any postcards privately manufactured and presented for stamping. He also proposed to sell 2s. worth of stamps for 2s. in the little book hitherto containing only 1s. 11½d. worth of stamps. Also on Coronation Day the public would be able to obtain most of the stamps of the new issue bearing the image of King George. He proposed to improve the perforation of stamps and letter-cards, and after the new issue had been made he would place on sale postage stamps in the form of rolls as well as sheets. In consequence of representations from Chambers of Commerce and the trade there would also be provided in the near future halfpenny certificates proving that the letters to which they referred had been posted, but the use of these certificates would be no substitute for registration. Another change to be shortly carried out affected the rates for foreign parcel post. This country exported more than £5,000,000 worth of goods in that way, and showed an increase of 60 per cent. in the last seven years. Many of the rates were higher than those charged by Germany. The English portion of the foreign parcel post rate was at present 5d. for parcels under 2 lb., 10d. for packets of less than 7 lb., and 1s. 3d. between that weight and 11 lb., and he proposed a reduction of about 50 per cent. in those charges. The loss to the revenue would be £19,000 a year, but that would, he was confident, be speedily recouped by growth of the business. On May Day he had the pleasure of sending and receiving from the Postmaster-General of Australia messages of congratulation on the coming into operation of the 1d. post from the Commonwealth to the United Kingdom, thus completing the system of Imperial penny postage with the exception of a few small islands in the Pacific.

Submarine Cable Communication.

The subject of ocean cable communication had been fully considered, and he had decided that the control of the rates should be secured by means of the licences granted for landing cables on our shores. As these licences came up for renewal they would set forth that if, in the opinion of the Government, cabling rates were excessive, formal objection would be taken to them, and if the owning company disagreed with this objection it would be referred to arbitration. He considered cable companies were entitled to much credit for their readiness to listen to representations made to them, particularly in one direction. They had all consented to a large reduction in the rates charged for plain language telegrams of a non-urgent character. He had been negotiating with all the leading companies with headquarters in England, and both the Atlantic and the Eastern group of companies had agreed to reduce their rates by 50 per cent. for telegrams in plain language. Arrangements were also being made for accelerating the telegraphic service between this country and the Continent by the adoption of new telegraphic appliances, and new cables would be laid where required.

Wireless Telegraphy.

The year had seen a rapid extension of the erection and use of wireless telegraphy. His predecessor (Mr. Sydney Buxton) purchased the coast stations belonging to the Marconi Co. and Lloyds, and these were now being operated by the Post Office. The purchase had proved wise and far-seeing. During the year the number of ships fitted with wireless apparatus had increased from 130 to 290. Marconigrams had increased 50 per cent. over the previous year. He now proposed to erect new stations at or near Newcastle-on-Tyne and on the island of Valentia. Wireless telegraphy, by a curious coincidence, had been brought prominently before the notice of the public by its use in the sensational murder case in which Dr. Crippen was concerned, and it would be remembered that the electric telegraph was originally regarded by the public as a toy, and it was not until a murderer, who had escaped from Slough, was apprehended as he was leaving the train at Paddington railway station, that the public took a real interest in the electric telegraph.

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Telephone Transfer.

After Whitsuntide he hoped to be able to introduce the Telephone Transfer Bill. During the year there had been a satisfactory development of the Post Office telephone system, the increase representing 13 per cent., while the revenue from the trunk wires had increased by 15 per cent. Another interesting feature had been the laying of a submarine telephone cable of a new type between this country and France. This would afford improved hearing and would extend the length of telephonic communications with the Continent. He was waiting for the French Government to construct certain new land lines and to lay a new telephone cable, and when these additional facilities were available he hoped to be able to reduce by 50 per cent. the charges for telephonic communication between England and France. He was also endeavouring to develop in this country a system of rural telephones similar to that which existed in America, and the Post Office was offering the unlimited use of a telephone for £3 per annum to any farmer who was willing to join with his neighbours (there must be not less than five on a "party" line) in subscribing to the telephone system.

Conditions of Service of Employees.

After referring to the work of the Savings Bank Department, Mr. Samuel dealt with the question of the conditions of the services connected with the Post Office. In regard to the subject of remuneration, he said, impossible to go into isolated cases of the telegraphists in the largest towns, of the London sorters, or into matters connected with the other branches of the service; if any revision of the general position were to be made it must be a general revision affecting the whole staff, numbering now some 217,000 persons, who, when the National Telephone Co. was taken over, would be reinforced up to the number of 20,000. At the same time, however, he must agree that the recommendations of the Hobhouse Committee could not be allowed to stand for ever. The work of the telephone operator, it was agreed, put a great strain on the nervous system, and it was necessary to take steps to mitigate it as far as possible. He had consulted the medical officers and had arranged that certain improvements should be adopted. Some of the operators were employed for six hours one day and 10 hours another in order that the working of a particular exchange should be facilitated. This was too long, and would be abolished. Other improvements were in prospect, including an improved headgear. They were also experimenting with a special type of chair, so that operators and others need not be subjected to periods of continuous standing.

Finally, the right hon. gentleman dealt with the boy messengers and the future position of the lads who enter that service. The entire statement was received with much interest.

NEWCASTLE-ON-TYNE CORPORATION BILL.

The tramway clauses of this Bill were passed by a Select Committee of the House of Commons last week. On Friday it was explained to the Committee that the Corporation had come to terms with the Newcastle-upon-Tyne Electric Supply Co. and the whole of the questions between the Company and the Corporation had been settled. By the agreement the Corporation are to take all current required by the Corporation for any purposes outside the city boundaries, except for the existing tramway at Gosforth, at a price which would be found satisfactory to the Corporation.

COAL MINES BILL.

The Bill was further considered by Standing Committee B of the House of Commons on Tuesday.

Referring to clause 16, which provides for monthly inspection of mines by two workmen by two of their number or any two persons, not being mining engineers, who are practical working miners, Mr. MASTERMAN moved an amendment to provide that the practical working experience required must have had not less than five years' practical experience.

Mr. MASTERMAN proposed that workmen's inspectors should, in the case of an accident occurring in a mine, be allowed to go, "together with the representative of the workmen, or with a mining or electrical engineer appointed by the workmen," to the place where the accident occurred, and to make such inspection as might be necessary for ascertaining the cause of the accident. The men should have an opportunity of obtaining the best advice in case of accident. The men's inspectors, however, would not have any knowledge of scientific mining, or of the electrical working of a mine.

Mr. MASTERMAN accepted the amendment with the addition of the word "the" before "representative."

The clause, as amended, was added to the Bill, as were also clauses 17, 18, and 19.

Rural Telephones.—In the House of Commons on Wednesday the Postmaster-General (Mr. H. Samuel) stated, in reply to questions, that there would be no objection on the part of the Post Office to accept as subscribers to the proposed farmers' telephones other persons connected with the industries, who lived a considerable distance from a telephone exchange. In general, however, traders of various classes who lived in the vicinity of a telephone exchange would not find that it met the conditions of their business to share a line with a number of other subscribers, and the ordinary exchange lines were better suited for their requirements. If country doctors thought it convenient, and were able to meet the requirements as to these cheap telephones, he did not, as at present advised, see any objection to their inclusion in the scheme.

Greater London Railway Bill.—During the week a Select Committee of the House of Commons heard further evidence in favour of this Bill.

On Wednesday evidence was taken on behalf of the L. & N.W. Railway Co. in opposition to the scheme.

Mr. HERBERT WALKER, outdoor goods manager for the southern section of the L. & N.W. Co., challenged the financial figures of the promoters. To pay a dividend of 4 per cent. on the proposed ordinary capital of £4,000,000 the projected railway would have to earn a gross revenue of £533,333 per annum. That meant earning £177 per mile per week over the whole length of 57 miles, or £205 over the 50 miles which were given as a through run. This was considerably more than twice as much as the Great Eastern and 33 per cent. more than the Tilbury line earned. He did not think the railway would get one-fourth of the present dock traffic, but, even if it did, that would provide an annual revenue of something under £30,000.

Birmingham Extension Bill.—This Bill was finally passed by a House of Commons Committee on Friday and now awaits Royal Assent. The Bill extends the municipal boundary so as to include Handsworth, Aston, Erdington, Yardley and a portion of King's Norton and Northfield and the tramways and electricity undertakings in those districts will also be acquired by the Corporation.

LEGAL INTELLIGENCE.

British Westinghouse Electric & Mfg. Co., Ltd. v. Underground Electric Railways Co. of London (Ltd.)

This case came before a Divisional Court (Mr. Justice Pickford and Mr. Justice Lush) on Tuesday, on a motion by the British Westinghouse Co. to set aside an arbitration award in regard to an alleged breach of contract for the supply of turbo-generators to the Underground Co.

Sir A. Cripps, K.C., Mr. Disturnal and Mr. Tangye were for appellants, and Mr. J. Roskill, K.C., Mr. A. B. Shaw and Mr. L. Macassey for respondents.

Sir A. CRIPPS, K.C., said the question for the Court was of great importance, involving a complicated matter of law, and important also in relation to the amount of money involved, some £120,000. What he had to show in order to succeed was, first of all, that there was an error in law on the face of the award, and, secondly, that what had been done upon that matter of law on the face of the award was in itself bad. The main point which he raised on that, although very important, was a short one. Respondents (the Underground Electric Railways Co. of London) gave an order to the British Westinghouse Co. for the supply of certain turbines with motive machinery for the supply of electrical energy for their underground railway system. They supplied the turbines, but were told by the arbitrator that they were not in accordance with the terms of the contract. The breach had been admitted, and the question was as to how the damage in consequence of the breach should be settled. The question between the parties arose after the turbines were admitted to be bad so far as the contract was concerned. After they had been running for a time the Underground Co. substituted Parsons turbines, and appellants said that the measure of damages, under the circumstances, should be only the additional cost thrown upon them by running the Westinghouse turbines and substituting Parsons turbines. By the substitution they had mitigated the damage, a matter which ought to have been taken into account in the award. They were agreed that up to the point of the substitution of the Parsons turbines there had been damage; but appellants said that under the conditions disclosed in the substitution of the Parsons for the Westinghouse machine respondents not only mitigated the damage, but obtained a great benefit or profit for themselves which ought to have been considered in estimating the measure of damage. When they had got to that stage they asked the arbitrator (Mr. Lyttleton, K.C.) to state a case for the opinion of the Court. That case was stated and heard before the Divisional Court. For present purposes he would assume that the opinion of the Divisional Court was against him on the points submitted, but the question was how far benefit or profit was to be taken into consideration in estimating the true rate of damage. If their lordships thought that this Court would be bound by the opinion of the other Divisional Court to which the points were submitted by the arbitrator's case, then they would have to go to the Court of Appeal.

Mr. Justice PICKFORD said that the Court was of opinion that it ought to follow the decision of the other Divisional Court.

Sir A. CRIPPS said that the same points would arise as those which were discussed in the Divisional Court over which the Lord Chief Justice presided. If the arbitrator had followed the judgment he had not followed the advice given by the Lord Chief Justice.

Mr. Justice PICKFORD said that what the arbitrator would have to follow would be the answers to the questions which he had submitted for the opinion of the Court where they were answered by the judge specifically.

Sir A. CRIPPS said that the Lord Chief Justice had not answered the questions simply in the affirmative or the negative, because he did not think he would be doing justice to the case by so doing. The first point was whether, as a matter of law, they were entitled to bring to the mind of the arbitrator that the true cost was not what had to be paid, but whether they obtained beneficial results. In all cases of damage they came back to the simple test of cost in order to arrive at the true measure of damage. Respondents also contended that they were entitled to

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recover the cost of the installation of the Parsons machinery. It was almost impossible to answer the questions submitted by the arbitrator with a simple "yes" or "no" apart from the context of the judgment. What appellants said was that they must ascertain the actual cost to which respondents had been put, bearing in mind that the Parsons machines had a larger scope than the old turbines, and could be worked much more economically. Owing to the march of invention, the Parsons machines were much better than the old ones, and could the arbitrator award as damages the whole cost of putting in a much better machine—machines which would work under conditions that would save respondents £20,000 a year?

Mr. Justice LUSH: You say that they are putting a heavy profit into their purse.

Sir A. CRIPPS said that it was not for the Court to say what the amount of the profit was, but the whole effect of the substitution must be taken into consideration. The arbitrator was entitled to take into consideration the effect of the Parsons machines, and he said that on that account mitigation of damages must be brought in. The arbitrator had stated a case on certain points of law, and judgment was given by the Divisional Court on those points, and that judgment formed part of the award. He could not imagine a more important point for discussion in a case of that kind than how to get at the true costs. To do that they must have the set-off of the benefit from profit.

Mr. Justice PICKFORD: You are really asking us to say whether the answers which appear on the record of the Divisional Court are right or wrong.

Sir A. CRIPPS said what he desired to argue was that, in face of the questions, it was impossible to answer them with a simple "yes" or "no." They were partly questions of fact and partly of law.

Mr. Justice LUSH said that the Court could only deal with the motion upon the assumption that there had been a mistake on the face of the award. If they could show that the arbitrator was not understood accurately by the Divisional Court then they could appeal; but that did not appear to be so in that case.

Mr. ROSKILL, K.C., for respondents, said that the Divisional Court, in giving their opinion, had answered certain questions, and from that decision he contended there was no appeal. He did not think it right that he should be kept out of the money because the other side wanted time. If it were decided to take the case to the House of Lords, there would be a delay of at least another year.

Mr. Justice PICKFORD: If you want security I have no doubt it can be given.

Mr. ROSKILL said that the costs were enormous, the out-of-pocket expenses alone amounting to some £13,000. The question of costs, apart from the question of security, was one which pressed rather hardly upon his clients.

Mr. Justice PICKFORD said that the reasonable thing would be for appellants to pay the costs under the usual undertaking.

The summons was then dismissed, with costs.

Telephone Agreements.

At Brighton County Court on Friday last Judge Scully delivered judgment in an action brought by the National Telephone Co. against a subscriber. The Company had removed their instruments from the premises of the subscriber (Mr. A. Romaine) who had given up his tenancy. The Company sought to make defendant liable for a year's subscriptions in advance.

His Honour held that the recovery of the instrument determined the contract, leaving defendant liable for any rent due up to that time, but not to any rent for a future period.

Anderson v, Cutts & Hoult,

In the Sheffield County Court last week Mr. T. Scott Anderson, consulting engineer and electro-metallurgist, claimed £100 damages from Messrs. Verdon O. Cutts and Ernest Hoult, engineers, of Sheffield, for the wrongful use and publication by them, to the prejudice of plaintiff, in a booklet entitled "The Electrical Manufacture of Steel in the Verdon Cutts and Hoult Electro-Bessemer Furnace," of information wrongfully collected by defendant Cutts whilst in plaintiff's service as clerk, from books, letters and other documents belonging to plaintiff. In the alternative, damages were claimed for infringement of plaintiff's copyright in books and documents from which material had been taken. An injunction was also asked for.

Mr. T. E. Ellison, for plaintiff, said that, after consultation, both sides were agreed that the publication of the pamphlet was one that could not be supported. Defendants had agreed to give an undertaking that no further publication of the pamphlet should be made, and that the copies which had not been circulated should be destroyed, and had consented to pay £10 damages and costs.

Mr. WADDY, for defendants, said both his clients were young men. Mr. Cutts when he left plaintiff started a business in competition with his old employer, as he was perfectly entitled to do. During the latter part of his employment with plaintiff a large amount of correspondence and technical work was entrusted to Mr. Cutts, and amongst other things he wrote for the purposes of a catalogue an article which afterwards found its way in a much altered form into the Verdon Cutts booklet. In those circumstances Mr. Cutts committed a mistake, and he accepted the position quite frankly. He took a wrong view of his legal position. Defendants willingly gave the undertaking mentioned by Mr. Ellison.

Judgment was entered accordingly.

Andrews v, Abertillery Urban District Council,

Last week the Court of Appeal allowed the appeal of plaintiff from an order of Mr. Justice Warrington dismissing plaintiff's action for a declaration that defendant Council were not entitled to place electric light standards on plaintiff's land at Llanhilleth. The facts of the case were reported in THE ELECTRICIAN for March 10 (p. 874), and the Court now granted a mandatory injunction to remove a standard erected on land not repurchasable by the public authority in front of plaintiff's house, and gave plaintiff costs of the appeal.

Johannesburg Municipal Council v. D. Stewart & Co. (1902) Ltd.)

In the Court of Session last week their Lordships of the First Division allowed an appeal of plaintiffs from an order of Lord Ormidale postponing the hearing of proof until October, defendants being liable for expense to which plaintiffs might be put.

The LORD PRESIDENT said their lordships were of opinion that the time allowed for the preparation of the case had been ample, and that it would really be a scandal to justice in that court if there was a further postponement.

London County Council.—On Tuesday the Highways Committee presented a report on workmen's cars, &c.

For the year ended March 31 last the receipts from workmen's electric car services amounted to £158,040, and the total expenses to £219,3[illegible] leaving a deficiency of £61,302. On the horse cars the receipts were £3,203, and the deficit £4,630. The report states that every mile run by a workmen's car is run at a loss, and they feel that if, apart from the normal increase in workmen's car-mileage, there is also an extension of the period within which workmen's fares are charged, the result from a financial standpoint is likely to be disastrous. Although there has been an increase recently in the car-mileage run on the Council's tramways, and an increase in the number of passengers carried, the result of concessions made from time to time to the travelling public has been to effect such a reduction in the net revenue per £100 of capital expended, that a point has been reached when further concessions would be very unwise, at any rate for the present, if the tramways are to be maintained on a self-supporting basis.

The estimates of the tramways undertaking for the next financial year were also submitted by the Highways Committee, who had put the total capital expenditure to the end of March at £11,600,000, and it is estimated that a further sum of £2,400,000 will be required to complete the work of electrification and the construction of authorised tramways. As a result of the working of the electric lines during the coming year, the estimated surplus is £915,690, and an estimated deficiency of £14,805 on the horse lines, making a net surplus on working of £900,885, to which has to be added £11,500 representing interest on bank balances and sundry receipts. The expenses and capital charges are estimated at £724,541, leaving a net surplus of £187,844, of which it is proposed to apply £138,270 to renewals fund and £49,574 to general reserve.

Practically the whole of the new tramways for which Parliamentary authority has been obtained had been constructed, but it was not possible in regard to many of the routes to carry passengers right through to their destination. This difficulty would be met as regards many of the routes if the present termini could be linked up with one another, or the lines extended to some well recognised traffic point, and that was a question to which the Committee were giving careful consideration. The Committee made a considerable point of omnibus competition, and also as to the advantages enjoyed by such competitors in having to pay nothing for the use of the roads and also to the fact that they choose only the routes, whereas many of the tramway routes were in localities where the traffic was only good at certain hours of the day.

The Finance Committee, in their report on the estimates, say that the estimated surplus balance for 1911-12 is less than the revised estimate of the surplus for 1910-11, notwithstanding further large expenditure on capital account during the year, and also that the surplus originally estimated for 1910-11 will not be realised. The falling off of passenger receipts, which was responsible for the reduction of the surplus, was largely to the wet and cold summer and autumn months. It appears to be desirable that the Council should bear in mind the possibilities of other forms of traffic adversely affecting the passenger receipts of the Council's tramways. Although the receipts had not been maintained at the original estimate of 1s. a car-mile, it had until recently been anticipated that by economies in working a surplus of 5d. a car-mile might still be looked for. From the figures in the 1911-12 estimates it appeared that a lower figure would have to be substituted, and the estimates provide for a figure of 4½d.

A lengthy discussion took place on the report, and several amendments were moved to the effect that the electrification of the remaining portions of the system should be proceeded with without delay, but these were rejected and the report adopted.

Light Railways.—The Merthyr Electric Traction and Lighting Co. are applying for an order amending their 1899 order by substituting 35 for 25 years as the period during which the order will be in force, and authorising an agreement with Vaynor and Penderyn Urban District Council.

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COMMERCIAL AND INDUSTRIAL SECTION.

MUNICIPAL, FOREIGN & GENERAL NOTES.

BRITISH NOTES.

Amalgamated Association of Tramway and Vehicle Workers.—The 21st annual conference of this Association was held at Newcastle-on-Tyne last week.

Mr. Stearman, in the course of his presidential address, said the increase in membership was a record. The improvements in the conditions of the labour of a large percentage of the members was satisfactory. The process of speeding-up, of putting cars upon the road of an ever-increasing carrying capacity, of inter-running with other tramway undertakings, of increasing the number of tickets and other increases, called for serious consideration and action in the direction of obtaining more time for leisure and recreation. Members should also work to reduce the length of time between the minimum and maximum rates of pay. The concessions obtained by Northampton and Salford, and the aims and objects of the Manchester branches, to reduce hours of labour, appealed to him as most consistent. There was undoubtedly a growing desire on the part of tramway authorities not to be content unless huge profits could be made and handed over to relief of rates. That lent itself to the perpetuation of many evils, and it was becoming increasingly difficult for tramway employés to obtain even slight improvements by which they might be able to do their work with more ease and comfort. These facts went to prove that there was a greater need for continuous activity in developing their organisation.

Birmingham.—At the last meeting of the Council the salaries of Mr. J. McDonell, traffic superintendent, and Mr. S. B. N. Marsh, accountant of the tramways department, were increased from £250 to £300 per annum.

Cathedral Lighting.—The cathedral church of St. Giles, Edinburgh, has recently been provided with an electric lighting installation, under the direction of Mr. R. S. Lorimer, A.R.S.A.

Derby.—An unopposed inquiry was held last week into the Council's application for sanction to borrow £8,500 for extensions of the electricity undertaking.

The Town Clerk (Mr. G. T. Lee) said that the application was made in connection with the estimated capital expenditure for the year, and it was necessitated by the continued growth of the business. The total output was now 5,573,706 units per annum, an increase in 12 months of [illegible] units. That was the largest increase since the works were opened. Last year there was a slight loss of £78. 18s. 4d., due to the fact that there was no particular output from the new power station. Although this year's accounts had not been completed, it was certain that there would be a large net profit. The outstanding debt was £217,915, which was less than it had been for the past three years, £93,624 having been applied in repayment of capital.

Eston.—The Council have appointed a sub-committee to report on a communication from the Cleveland & Durham County Electric Power Co. as to the supply of electricity in the district.

Inquest.—An adjourned inquest was held last week on two platelayers named Christy and Young, who were killed in the Duffryn Woods, Abercwmboi, on the 9th inst. Mr. W. N. Atkinson, chief inspector of mines, represented the Home Office, and Mr. R. Nelson, H.M. electrical inspector of mines, was also present.

W. Callaway, foreman platelayer of the Powell-Duffryn Co., said the two men worked in his gang, and on the 9th inst. they proceeded to the [illegible] Woods to prepare some holes for electric standards. Witness [illegible] smoke rising higher up in the wood, and he sent Young to inquire into the cause of it. Later he sent Christy to a neighbouring [illegible] to fetch some tools. He had to walk in the same direction as Young had gone. Subsequently the two men were found lying dead in [illegible] to the electric pole, which had caught fire.

[illegible], another platelayer, found the two men dead. Christy was [illegible] one of the electric stays.

Mr. [illegible] Hann, deputy general manager of the Powell-Duffryn Co., said one of the insulators on the pole, near where the men were found, had come loose, with the result that the current leaked to the stay [illegible] supported the pole. That had caused the fire. He was of opinion that the insulator had come loose on account of the pulling of the wire.

W. [illegible], foreman at Powell-Duffryn power station, said the voltage [illegible] was 3,000.

To Mr. Nelson: The leakage was not sufficient to cause the relays to [illegible].

[illegible] Flanders, electrical engineer, stated that the voltage of the leaking current was 1,850.

[illegible] Thomas said the line was in perfect order after the erection of the [illegible] pole on the night preceding the accident. The new pole was [illegible] higher than the pole next to it.

A verdict of death by misadventure was ultimately returned.

Loughborough.—An unopposed inquiry was held on Friday into the application of the Council for sanction to borrow £2,310 for extensions of the electricity undertaking.

Mine Rescue Work.—The Home Office has issued a draft order under the Mines Accidents (Rescue and Aid) Act, 1910, as to the formation of rescue brigades in mines.

The order states that rescue brigades consisting of not less than five persons employed at the mine, selected on account of their knowledge of underground work, coolness and powers of endurance, and certified to be medically fit (a majority of whom shall be trained in first aid and shall hold a certificate of the St. John's Ambulance Association or of the St. Andrew's Association) shall be organised and maintained at every mine as soon as is reasonably practicable. These rescue brigades are to be on the scale set out in the order, which further directs that sets of portable breathing apparatus in the proportion of two sets to each rescue brigade shall be maintained at every mine. At every mine which maintains a rescue brigade there must be provided two or more small birds or mice for testing for carbon monoxide; two electric hand-lamps for each brigade; one oxygen reviving apparatus; a safety lamp for each member of the rescue brigade for testing for firedamp; and an ambulance box. It is also required that at each central rescue station not less than 15 complete sets of breathing apparatus shall be maintained, together with 20 electric hand-lamps and four oxygen reviving apparatus. A motor car is also to be kept in constant readiness.

National Association of Colliery Managers.—The British Westinghouse Electric & Mfg. Co. took advantage of the annual meeting of this Association at Manchester on May 18, 19 and 20 to invite the members to pay a visit to their works and inspect some of their apparatus particularly suitable for mines.

A good number of members availed themselves of the offer, and made a tour of the shops under the guidance of several Westinghouse engineers. A special exhibition of mining switchgear had been arranged, including a complete line of 750, 3,300 and 6,600 volt mining switch pillars, also examples of type "S" gate end switch boxes, specially designed for use in shallow headings; oil switches, circuit-breakers, auto-starters, liquid starters, controllers, rheostats, &c. A variety of switchboards of all types was seen going through the shops, and full access to details of manufacture was freely given. There were also on view steam turbines, condensers with Leblanc air pumps, turbo-blowers, r.t. Moore turbine-driven high lift pump for 400 g.p.m. against 827 ft. running at 3,000 r.p.m., large and small gas engines, motors, generators and other apparatus, including two-speed motors, 180 H.P., 400-volt d.c. driving Worthington hydraulic pump 250 g.p.m., 800 lb. per sq. in. for L. & N.W. Railway's London-road station.

National Electrical Manufacturers' Association.—Next meeting of Council will be held at Balfour House, Finsbury-pavement, E.C., June 1, at 2:30 p.m.

Osram Lamps in the French Navy.—The French ironclad "Vérité," upon which the President of the French Republic shortly starts upon his voyage, is illuminated throughout by Osram lamps.

Poplar (London).—Application is to be made to London County Council for a loan of £42,455 for the electricity undertaking.

A new agreement is to be entered into with the Port of London Authority for supply of electricity to the docks for nine years. The Port Authority will take 750,000 units per annum for general use with a maximum demand of 150 kw. on the Council's peak, and about a further 100,000 units per annum for Millwall dry dock pumps, with a maximum demand of 350 kw., but the dry dock main pumps shall not be worked upon the Council's peaks, the peaks to be considered as being between 4 p.m. and 6 p.m. on week days in November, December, January and February. The price to be 0·60d. per unit for direct current at 230 and 460 volts.

Presentation.—Harrogate electricity staff have presented Mr. W. Firth, jointer, with a gold watch on his departure for Australia.

Provisional Order Revocation.—The Board of Trade have revoked the Clitheroe Electric Lighting Order, 1904, as from May 13.

St. Helens.—An inquiry was held on Tuesday into the application of the Council for sanction to borrow £10,800 for extensions of the electricity undertaking.

The borough electrical engineer (Mr. E. M. Hollingsworth) stated that the loans sanctioned to date amounted to £175,157. On Sept. 2 last sanctions were obtained for £10,206, but only £6,000 of that had been borrowed. Most of the work then sanctioned had been completed and they were overspent by nearly £1,600, for which they would have to apply for leave to borrow.

The inspector (Major Stewart) asked what had caused the tremendous jump this year in the demand for electric current.

Mr. Hollingsworth said that they supplied many of the small works of the town, and several of the large manufacturers had come on during

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the last 12 months. It was due to the general application of power. People were finding out the great advantages of electric driving.

After going through the figures, the INSPECTOR remarked that it was evident that there was a need for more plant at the works to meet all the demands. He commented on the low cost of production at the works. When they first started the cost was 6·33d. per unit, but it had now gone down to 0·65d. per unit.

Stockton-on-Tees.—The Council have decided to carry out extensions of the electricity works at an estimated cost of £6,000 and £7,000. The scheme has been prepared by the borough electrical engineer, Mr. J. J. Smith.

Trowbridge.—The Council have referred to the Electricity Committee an application by the local electric supply company for sanction to use overhead Dires for the uspply of electricity to private consumers.

Walthamstow.—The price of current to lighting consumers is to be reduced by ¼d. per unit, and an equivalent reduction is to be made for current supplied under the Osram lamp maintenance scheme.

The inclusive arc lighting rate is to be reduced from £4 to £3. 15s. per flame lamp of 500 hours burning, and £3. 10s. for enclosed type lamps.

Application is to be made to the L.G. Board for sanction to borrow £5,149 for laying a feeder cable.

Permission has been given to the Premier Advertising Co. to erect cabinets in various parts of the district, and these cabinets are to be supplied with current at 2d. per unit.

Wigan.—On the 16th inst. two electrically-driven centrifugal pumps at the pumping station were started by the chairman of the Water Committee (Ald. Richards). The pumps were supplied by Rees Roturbo Mfg. Co.

Wood Green.—The Council are taking a plebiscite of the ratepayers on the question of entering into an agreement with the North Metropolitan Electric Power Supply Co., for a supply of electricity in bulk.

COLONIAL AND FOREIGN NOTES.

Argentina.—The "Review of the River Plate" says "a concession has been granted to the Empresa Telefónica del Chubut, Richelet y Ca., for 30 years for the provision of telephone lines in Comodoro Rivadavia. The National Government may expropriate at any time by payment of capital cost, plus 15 per cent.

Electricity supply works and electric tramways are to be established at Necochea.

Gandulfo & Co. have asked the Provincial Government to rescind the decree which declared lapsed their concession for the construction of an electric tramway between Evellaneda and La Plata.

It is stated that the syndicate represented by Mr. Herlitzka, and in which the French Bank of the River Plate is interested, has obtained a controlling interest in the Anglo-Argentine Electricity Co.

Australasia.—H.M. Trade Commissioner, Equitable Building, Melbourne, has applications from Australian firms desiring to represent British manufacturers of machinery, engine packing, electric light fittings, &c.

Adelaide Council propose giving notice of intention to purchase the undertaking of the Adelaide Electric Supply Co. prior to the date authorised by the Act under which the company are working (Dec. 11, 1911). The company decline to accept the notice prior to that date, and the Council may promote a special bill to give more liberal terms.

Mr. E. H. McKinney, formerly hydraulic engineer to the Government, has suggested that an electric power scheme should be combined with the extensive irrigation scheme which is being carried out at Burrinjuck (N.S.W.). Mr. McKinney estimates that £10,000 would cover the cost of the power stations and plant, and that the whole of this capital could be redeemed in one year by the receipts from sale of energy. He estimates that 10,000 H.P. can be obtained from a dam now under construction on the Murrumbidgee river.

The Mount Lyell Mining Co. (Tasmania) propose to generate electrical energy by water power obtained from Lake Margaret.

Perth (W. Australia) City Council have complained that the Perth Electric Tramways (Ltd.) give an insufficient service. The company state that this is due to the practical prohibition of overtime by the award of the Arbitration Court in the dispute between the company and its employés.

The Royal Commission on (Melbourne) Suburban Traffic recently took the evidence of Mr. A. F. Showers (Mayor of Essendon), who said he was of opinion that any profits from the tramways should be devoted to extensions and the profits should be apportioned according to the municipal valuation and not on a car-mile basis. His Council had endeavoured to secure a conference for the appointment of a Metropolitan Council to control all matters common to the metropolis, such as tramways, electricity supply, &c. Railway electrification would take people away from the congested areas and would be an effective way of meeting tramway competition. The reason the Essendon tramways were not paying more than working expenses and depreciation was that they were not linked on to the Melbourne lines. The Mayor of Brighton (Mr. Edmonson) and Mr. F. Ferdinando (Moorabbin Shire Council), who also gave evidence, were in favour of municipal control of tramways, and opposed the conference scheme of representation and distribution of profits.

Mr. A. BATSON (town clerk), of Fitzroy, said his Council was in favour of municipal ownership of tramways. The Councils required the revenue from tramways for relief from taxation. He did not think it desirable to take over the present tramways before the expiration of the lease. The Mayor of Richmond (Mr. D. L. Davies) gave similar evidence.

Mr. R. P. WILSON was re-called, and dealt with the proposed re-grading and duplication of the Caulfield and Camberwell lines. He said these alterations were necessary under the present steam system, but could be avoided by adopting electric traction. He proposed the d.c. system at 800 volts. If the electrification scheme had been in force the department would have increased its profits by £60,000 during the present year, and next year the increase would have been £80,000. Mr. Wilson subsequently repeated this evidence before the Railways Standing Committee.

Mr. Fredk. Black, electrical engineer, of Wellington, N.Z., has been engaged to report on the electrical plant and power required at the Ross Goldfields (Reconstructed), Ltd.

Mr. P. J. Pringle, general manager of the Electric Supply Co. of Victoria, has informed the motormen and conductors on the company's Ballarat tramways that he cannot concede their demand for wages of 8s. per day. A wages board will shortly deal with the question.

Eaglehawk (Victoria) Council have accepted tenders at par for the loan of £6,000 for the equipment of electricity works.

A deputation of the Kadina and Wallaroo (S. Australia) Councils recently waited upon the Premier of South Australia and advocated the erection by the Government of an electric power station at Wallaroo. It was stated that Kadina Council had erected a station but could not cope with the demand for energy. Wallaroo Council at present purchase electricity from Wallaroo & Montana Smelting Co. at 5d. and 4½d. per unit, on a sliding scale, and retail it at 6d. The Premier said the proposal would form part of a scheme for supplying power and light at Wallaroo railway yard and jetty and other places, and he hoped to introduce a Bill next session.

Electric coal cutters have been tried in the Cullen Bullen (N.S.W.) Invincible Colliery, have been found satisfactory, and are to be permanently adopted.

The Mayor of Auckland (N.Z.) recently performed the ceremony of driving the corner pile of the Corporation's new electric power station. The Council have raised a loan of £225,000 for extension of their electricity undertaking.

Queensland Electrical Energy Supply Co. propose to supply current to Cairns, Bundaberg, Mackay and Warwick. Bundaberg and Warwick Councils have given their assent conditionally. Cairns Council recently refused assent to a similar proposal by a company.

Mansfield (Victoria) ratepayers have asked the Shire Council to secure a supply of electricity in the town.

Melbourne Electric Supply Co. have commenced the laying of mains for the electric lighting of Camberwell.

An agreement has been signed for the supply of electricity by the Melbourne Electric Supply Co. to Hawthorn (Victoria) Council for 14 years, after which date the works can be acquired by the Council.

Ararat (Victoria) Council have been informed that a supply of current for lighting the local asylum would be taken from the proposed municipal electricity works, and the Council will probably proceed with the scheme.

Manly (N.S.W.) Council, who own electricity works, have given a guarantee to a new company formed to extend the system to additional streets, beaches, &c.

Goulburn (N.S.W.) Council are seeking authority to establish electricity works, and Mr. J. E. Donohoe, of Balmain Electric Lighting Corpn. is preparing a report on the matter.

A committee of Tenterfield (N.S.W.) Council was recently appointed to consider the question of public lighting by electricity or gas.

Austria-Hungary.—Ganz & Co. are about to extend their works at Budapest at a cost of about £104,000.

Miskolez municipal authorities have decided to establish electricity works at a cost of £25,000.

Brazil.—A Consular report states that imports at Bahia during 1909 included machinery to the value of £134,388 (compared with £125,315 in 1908), rails and accessories £42,694 (£45,890), electric cables £11,658 (£2,149), wire £23,496 (£19,156) and electrical appliances £35,697 (£52,500).

Franco-Spanish Electric Railway.—The completed portion of the electric railway from Villefranche and Vernet-les-Bains to the Spanish frontier, upon which £1,280,000 has been expended, is to be opened about mid-June for public service. The line is the property of the French Midi Co.

Hospital Lighting, &c.—The new General Hospital, Rangoon (India), which, with the nurses' home, &c., covers 23½ acres, and cost about £272,000 to build, is lighted electrically throughout by an independent steam-driven plant, which also supplies power to 270 punkahs, numerous small fans, large ventilating fans in the main building, paying patients' blocks and special nursing wards; also for working five lifts, two sets of refrigerating plant and the electric sterilisers and heaters and the X-ray and electro-therapeutic installation.

Italy.—The Soc. Anon. des Tramways de Bologne has recently obtained authority to extend their Bologna electric tramways.

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Montenegro.—It is stated that the Government have recently granted concessions for the electrification of the Antivari-Virpazar railway, the construction of certain electric railways, and the erection and equipment of hydro-electric works.

Roumania.—The communal authorities of Slatina have obtained permission to borrow £32,000 for electric lighting, water supply, &c., and for purchase of tramway material.

Russia.—The British Consul at Batoum states that a British electrical engineer has applied for permission to promote a scheme for utilising river and lake waters in the highland districts of the Caucasus for the generation of electrical energy. The proposals include hydro-electric stations at Lars on the road beyond Vladikavkaz and on Lake Gotchkha for the Northern Caucasus and the trans-Caucasus respectively. A technical commission appointed by the Government has approved the principle and has drawn up conditions.

Spain.—La Electricidad has been formed, with a capital of £37,000, to take over and enlarge Messrs. Frêne, Agazzi & Co.'s electricity works at Sabadell.

La Electra Valenciana has been formed at Valencia, with £83,000 capital, to distribute electrical energy generated by the Hidro Electrica Española.

Turin International Exhibition.—The British section of this Exhibition was informally opened to the public on 19th inst. The official inauguration of the section will take place later.

Uruguay.—The bill providing for harbour improvements at Montevideo has been redrafted. An electric power installation, to cost about £24,450, is included, but this portion of the works will not be put up to public tender.

The Finance Minister of Uruguay recently requested the director of the Government electric light station at Montevideo to make a report on all existing electric light stations throughout the country, with a view to their nationalisation, and to formulate a scheme for establishing other stations.

Wireless Telegraph Notes.—We referred last week to the excellent service rendered by the wireless telegraph service on board the "Merida," which was sunk as the result of a collision off Cape Charles, Virginia. We now learn that the equipment which performed that good service was supplied by the United Wireless Telegraph Co., of New York.

According to the "Pall Mall Gazette," the naval airship which was launched at Barrow on Monday is to be provided with a wireless station. The report states that a special set of instruments has been devised and will be experimented with in due course.

The Australian Commonwealth Meteorological Department appears to have had a shock. Arrangements had been made for the exchange of wireless messages between the service and mercantile ships to enable reports to be made of weather developments, but, so far, there being no land stations, only one message had been received at the time the report we are commenting upon had come to hand. This report was followed by an account for 50s., but the ... think this a rather expensive start—in fact, unless the shipping interest is prepared to assist the Meteorological Department in a spirit of liberality and philanthropy there is some likelihood that the ... exchange of these messages will be delayed for a time. Under the arrangements made by the Australian shipping companies for the installations on their boats a royalty has to be paid to the ... on every message sent, and it is argued that should the proposal to utilise the existing ships for reporting meteorological conditions be carried out the Government must be prepared to bear a share of the cost. A large number of the vessels on the coastal trade between Melbourne, Sydney and other Commonwealth ports are equipped with wireless apparatus.

Two wireless telegraph installations have been erected in German East Africa on the shores of Lake Nyanza, one at Bukoba and the other at Muanza.

A statement having been circulated that there would be communication between the Eiffel Tower Paris, and Canada during the ... proceedings in England, when, it was stated, M. Fallieres would exchange messages with Sir Wilfrid Laurier, the Canadian Premier, the Marconi Co. write to say that it is not possible to send messages to Canada from the Eiffel Tower, nor have any messages been transmitted, the only station capable of carrying on the operation being the Marconi trans-Atlantic station at Glace Bay, Canada.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Birmingham.—The annual reports and accounts of the electric supply and tramways departments were approved by the Council on ...

In submitting the accounts of the Electric Supply Committee, Mr. ... said that the progress of the department during the past year had been considerable. There had been an increase of 30 per cent. in the units sold for private supply, and considering they had now reached very large figures in respect of output, a percentage like that was very satisfactory. It was principally for power supply, and the demand seemed to be as brisk as ever. The tramway supply had fallen by 9 per cent., due to the more economical use of current by the motormen since meters had been placed on the cars. The Tramway Committee would have two more routes open later in the year, and they were hoping to show an increase again in 1912. They had generated 4,000,000 units of current more at a cost of only £700 more than last year. That showed the value of a large load factor. He thought they had pretty nearly reached the limit of economy in generating cost. There were only four towns in the country to beat them—Bradford, Sheffield, Leeds and Stalybridge. Liverpool, Manchester and Glasgow were behind them in that respect. Rates and taxes had increased from £5,746 to £14,822, due to reassessment. At present they were the highest rated supply department in the country according to their size. The gross profit (£115,375) might strike them as large on a turnover of just over £200,000. It showed, however, they were not selling current under cost, and he did not think it was excessive considering they had such heavy capital charges to meet. Next year he thought they would have no further outlay in regard to reconstruction, and they would perhaps have recovered to some extent from their reassessment. After providing for interest and sinking fund, the net balance was £35,449. 4s. 9d., and of this sum the committee had carried £20,000 to renewals fund, leaving a surplus of £15,449. 4s. 9d., which it was proposed to pay to the credit of the Improvement rate, an increase of £5,193. 14s. 9d. The net increase in lamp connections (lighting only) amounted to an equivalent of 10,331 16 c.p. lamps, against 13,378. The net increase in motors connected was 5,344 H.P. (3,987 kw.), against 5,720 H.P. (4,267 kw.). The total length of new mains laid during the year as 14,063 yds., against 20,680 yds. The committee recommended that the following alterations in the charges for high-tension current be made, to take effect from the next quarterly meter readings: (1) That consumptions be calculated on a quarterly basis instead of an annual one, (2) that a reduction from 1d. to 0·95d. per unit be made to consumers using between 62,500 and 125,000 units per quarter, and from 0·9d. to 0·85d. per unit to consumers using between 187,500 and 250,000 units per quarter; (3) that the existing rates be extended so as to provide for a charge of 0·65d. per unit to consumers using between 750,000 and 1,000,000 units per quarter, and of 0·625d. per unit to consumers taking 1,000,000 units and upwards per quarter. In March, 1909, the committee pointed out, that special rates were being quoted with the consent of the Council in respect of exceptionally high load factors. At that time it was not possible to arrange a schedule of rates, as each case had to be dealt with according to the particular circumstances. The committee have now had sufficient experience to enable them to prepare such a schedule for consumers with load factors of 40 and 60 per cent.

The Tramways Committee reported that the capital for the year ended March 31 was £13,163 for reconstruction of Bristol-road route, &c.

Gross profit was £122,503, compared with £111,990 in 1909–10, increase £10,513. The committee decided to allocate £41,000 to relief of rates and place £24,000 to reserve, the balance being required for payment of interest and sinking fund. The use of meters on the cars resulted in a saving of about £5,000 for the nine months during which they had been in use. The number of passengers carried on the city lines was 84,727,449, against 81,310,868. There are 56 miles 67 chains of single tram track belonging to the department, and the average traffic revenue per car-mile was 11·58d., against 11·63d. last year, the total revenue being £318,882, against £308,283. Working expenses were £196,379, against £196,293, and the average expense per car-mile was 7·300d., against 7·569d. The average fare paid per passenger was 0·9d., and the average cost per passenger 0·8d., same as in the preceding year. The number of car-miles run on the city lines was 6,536,471, compared with 6,292,009; and the number of car-miles run inside and outside the city was 7,575,662, against 7,339,693. The percentage of working expenses to receipts was 61, against 64 per cent. The whole of the cars are to be provided with top covers before the commencement of next winter. The leases of the Bristol-road and Hockley lines to the City of Birmingham Tramways Co. will expire on June 30 next, and from that date the lines will be worked by the Corporation, who have to purchase the rolling stock, feeders and overhead equipment. It is intended to convert the cable tramways from Colmore-row to Hockley Brook to the overhead system. The standards and overhead wires are being erected, so that the new system may come into operation on July 1, though the reconstruction of the permanent way will have to be carried out subsequently. In connection with these two routes and the doubling of Garrison-lane route, the following additional capital will be required: Rolling stock (including 60 new cars and 130 top covers), £61,379; reconstruction of track (Colmore-row to Hockley Brook) and doubling of portion of Garrison-lane tramway), £31,928; overhead equipment, £2,714; feeder cables and switch pillars for Hockley route, £2,585; additional machinery and plant, £1,200—total, £99,805. In addition a further sum will have to be borrowed when the amount payable to the Company has been ascertained. The committee have arranged with Handsworth Council (which from Nov. 9 next becomes part of the city) for the working of the tramways in Handsworth as between July 1 next and Nov. 9.

Exeter.—For the year ended March 31 the receipts of the electricity undertaking were £18,286, working expenses £8,895.

Gross profit was £9,391, and after payment of interest and sinking fund, &c., the surplus was £2,333. The reserve and renewals fund amounts to £9,204. 6s. 9d. The number of consumers increased by 121 in the past year. It is recommended that the charge for current for private lighting be reduced from 4½d. to 4d. per unit.

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The total tramway receipts were £16,165. 17s. 8d., a decrease of £763. 4s. 7d. compared with 1909-10. Current consumption has been greatly reduced by the use of meters, 62,554 units less than last year having been used, although 2,120 more car-miles were run. The charge for current has been reduced by ¼d. per unit, a saving of £203.

The accounts were approved by the Council on Wednesday.

George Town (Penang.—The report of the municipal electricity department for 1910 states that a new 300 kw. British Westinghouse steam dynamo and a Babcock boiler were put in service and the erection of the new condensing plant, including Korting motor-driven pump and Rees Roturbo equipment, was nearly completed.

There are 603 private consumers (increase 180), the equivalent 30-watt lamps connected being 7,755. The metal filament lamp has had an entirely beneficial effect on the undertaking, as the greater efficiency of the new lamps has led to a rapid increase of small consumers. Supply was given for a 7-ton crane used in building the Swettenham pier extension, and the resident engineer for that work reported that the working costs of the crane were 26·37 per cent. less than those of a steam crane of the same capacity. There were 842 fans connected. Revenue was $134,863·52, after deducting rebates, &c. (increase $21,633·73). Works costs were $64,548·11 and total costs $78,680·64, a decrease of 0·09 cents. per unit sold. Net profit was $9,697·64 (against $1,961, in previous year).

The receipts on the tramways were $81,1319·76 (against $65,381·75), operating costs were $61,324·91 (increase $1,060·07), and the gross profit was $19,994·85 (against $5,116·91), or about 4·2 per cent. on the capital expended. 2,638,517 (2,040,047) passengers were carried and 335,213 (281,412) car-miles run. Traffic revenue per car-mile was 24·22 cents (23·23 cents) and operating costs were 18·29 cents (21·42 cents).

Grimsby.—The accounts of the electricity department for the year ended March 31 show capital expenditure £106,817 (increase £4,499), of which £82,282 is outstanding.

Year's revenue was £21,421 (compared with £19,486 in 1909-10), gross profit was £10,848 (£10,043), capital charges were £6,262 (£6,176), and net profit was £4,586 (£3,867). Coal cost 0·244d. (0·270d.) per unit sold, generation costs were 0·511d. (0·607d.), distribution 0·055d. (0·046d.), and management, &c. 0·325d. (0·268d.). The total cost, 0·871d. (0·921d.), is the lowest on record, although rates and taxes increased £580. There are 1,006 (803) consumers, and units sold were 2,750,847 (2,350,869). After meeting out of the net profit the cost of alterations in street lamps (£9.05) and cost of new meters (£502), it is proposed to contribute £509 to rates in each of the two next half-years, and to transfer £1,890 to reserve. Sales of current for power purposes increased by over 30 per cent. The coal used was 7·31 lb. (8·36 lb.) per unit sold, a saving of 12 per cent., of which 10 per cent. (five-sixths of the saving) is attributed to the superheaters.

Heston and Isleworth (Middlesex).—The accounts of the District Council's electricity undertaking for the 15 months ended March 31 show capital expenditure £61,327 (increase £4,398), of which £8,911 has been repaid.

Revenue was £10,387 (compared with £7,861 for 12 months to Dec. 31, 1909), working expenses £4,784 (£3,733), gross profit £5,603 (£4,128), capital charges £4,791 (£3,687) and net profit £812 (£441). Units sold were 854,754 (against 605,616), of which 329,059 (228,271) were for power, 257,611 (172,398) for public lighting and 267,904 (204,947) for private lighting. There are 781 (646) consumers, and the equivalent 32 watt lamps connected for private lighting are 27,274 (24,715) and for public lighting 2,031 (1,879). The motors connected aggregate 408 H.P. (337 H.P.). The maximum load was 432 kw. (405 kw.), and the combined load factor 18 per cent. (17 per cent.). Fuel cost 0·37d. (0·44d.) per unit sold. Generation costs were 0·73d. (0·84d.), and total costs were 1·11d. (1·21d.).

Loughborough.—The accounts of the electricity department for the year to March 31 show capital expenditure £32,685 (increase £549).

The year's revenue was £4,213 (compared with £3,301), working and general expenses were £2,339 (against £2,447), and gross profit was £1,874 (£854). Capital charges were £2,335 (£2,401), and there is now a balance at debit of net revenue account of £1,074 (£2,215). There are 401 (336) consumers, and the total connections are equal to 29,764 (26,653) 8 c.p. lamps; units sold were 531,886 (357,129). There are 99 (90) motors of 517 H.P. (480 H.P.) connected. Works costs were 0·419d. (0·563d.) and total costs 0·569d. (0·909d.).

Sutton Coldfield.—The accounts of the electricity department for the year ended March 25 show capital expenditure £46,459 (increase £3,863), of which £11,268 has been repaid.

Revenue was £5,917, working and general expenses were £2,651, gross profit was £3,191, and net profit £173, and this, with a balance of £292 brought forward from previous year, is carried forward. Units generated were 470,810, of which 90,100 were supplied to public lamps, and 300,706 to private consumers by meter. The total maximum supply was 256 kw.

Sydney (N.S.W.)—The income of the electricity department for 1910 was £166,046, and the balance, after meeting working costs, interest and sinking fund, depreciation (£17,774) and preliminary expenses (£301) was £24,712.

The City Electrical Engineer and City Treasurer recommend that 50 per cent. of this surplus be written off goodwill of purchased companies, 45 per cent. be placed to renewals and replacement account, and 5 per cent. carried forward. The debenture account was increased by £190,000, making a total of £750,000, the other liabilities including purchased companies (£56,956), bringing the total liabilities to £958,367. The assets include plant £708,888.

Warrington.—The accounts of the tramways department for the year to March 31 show capital expenditure £102,128 (no increase). £22,573 has been repaid and £9,064 placed to reserve.

The year's revenue was £20,775 (£20,169), working expenses were £12,528 (£11,406), and net profit (after providing for capital charges) was £2,344 (£2,750). 5,375,572 (5,206,980) passengers were carried, 438,884 (435,774) car-miles run and 528,220 (528,139) units used. Average total revenue per car-mile was 11·360d. (11·108d.), and working expenses were 6·850d. (6·281d.), including power.

TRADE NOTES AND NOTICES.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1911 Edition of the Big Blue Book is READY, price 15s., post free in the United Kingdom, 15s. 9d. The volume brings a great mass of very valuable statistical and technical data quite up to date, and the Directorial Division has been thoroughly revised and amplified up to February 24th.

All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters receive every attention in the new volume, which aggregates more than 2,000 pages. The Directory Division is complete and thoroughly accurate, and has been completely revised. The Big Blue Book contains more names of live electrical firms and persons than any other Directory published, and this notwithstanding that all mere lists of members of Societies and Institutions (so easily and cheaply available) are excluded, as unreliable and of little value for Manufacturers' and Dealers' purposes. The full set of valuable Statistical and Engineering Tables, &c., have been very carefully revised and extended, and are now issued in a handy form. These are included in the 1911 Big Blue Book, making it the most complete work of the kind ever published.

TENDERS INVITED.

The Council of the Metropolitan Borough of POPLAR invite tende for supply, delivery and erection of one 3,000 kw. turbine alternato complete with surface condensing plant; two water-tube boile with superheaters, air heaters, fans and chimneys; one 30-ton ele tric overhead travelling crane and water softening plant. Specific tion and form of tender from the borough electrical engineer a manager (Mr. J. Horace Bowden), Glaucus-street, Bromley-by-Bo E. Tenders to the town clerk (Mr. L. Potts), Council Offices, Hig street, Poplar, London, E., by 10 a.m. Monday, June 19. See also advertisement.

OLDHAM Corporation Electricity Committee invite tenders for t supply, erection and delivery of one 1,200 kw. mixed-pressure ste turbine, coupled direct to two d.c. generators in tandem, togeth with barometric condenser, pumps, &c. Copies of specificatio general conditions, &c., from the borough electrical engineer, Mr. Wilmott Newington, Greenhill, Oldham. See advertisement.

Tenders are invited (up to June 27) for supply of 1,400 protecto for use on main distributing frame at magneto exchanges to t Postmaster-General's Department, VICTORIA. Tender forms a specifications at the Commonwealth Office, 72, Victoria-stree London, S.W. See also an advertisement.

HAMMERSMITH (London) Borough Council invite tenders supply and erection of high-pressure steam and feed-water pip exhaust steam feed water heater and circulating water pi steam valves and feed water heaters, and feed pump. Specificat and form of tender from the borough electrical engineer (Mr. Gilbert Bell), 85, Fulham Palace-road, W. Tenders to the to clerk (Mr. H. Thompson), Town Hall, Hammersmith, London, W by 4 p.m. May 31.

STEPNEY (London) Borough Council invite tenders for 12 mont supply of ampere-hour meters, demand indicators and time switc and arc-lamp carbons. Specifications, general conditions and for

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of tender from the borough electrical engineer and manager (Mr. W. C. P. Tapper). Tenders to 27, Osborn-street, London, E., by noon June 8.

DEWSBURY Corporation invite tenders (by mid-day May 30) for supply and laying of feeder cables and erection of feeder switchboards. Specifications and forms of tender from the borough electrical engineer (Mr. R. H. Campion), 93, Bradford-road, Dewsbury.

MANCHESTER Electricity Committee want tenders by 10 a.m. June 2 for 12 months' supply of carbons, dynamo brushes, incandescent lamps, insulators, cables, &c., Forms of tender from Mr. F. E. Hughes, Town Hall, Manchester.

The Penrikyber Navigation Colliery Co., PENRHIWCEIBER, R.S.O., Glam., want tenders for 12 months' supply of electrical fittings, castings, ironmongery, paints, oils, waste, &c., Forms of tender from the Secretary.

DEVONPORT Electricity Committee want tenders by noon June 8 for 12 months' supply of d.c. meters, paper-insulated cables and rubber-covered wires. Forms of tender, &c., from the Borough Electrical Engineer.

BLACKPOOL Corporation want tenders for two years' supply of arc lamp carbons. Form of tender, &c., from the Borough Electrical Engineer.

BELFAST Asylum Committee require tenders by noon June 12 for the electric lighting of two villas at Purdysburn. Specifications, &c., from the Town Clerk.

BECKENHAM Council want tenders by 4 p.m. June 12 for the wiring of houses. Forms of tender, &c., from the engineer, Electricity Works, Beckenham.

HESTON and ISLEWORTH Council require tenders by noon June 14 for supply of metallic filament lamps for street lighting. Particulars from the Engineer, Electricity Works, Hounslow.

LIVERPOOL Overhead Railway Co. want tenders by 10 a.m. June 6 for 12 months' supply of electrical fittings, insulating tapes, ironmongery, &c. Forms of tender, &c., at 31, James-street, Liverpool.

WORTHING Corporation require tenders by noon June 12 for supply and erection of two Diesel oil engines and c.c. generators. Specification, &c., from the Borough Electrical Engineer.

Tenders are invited up to July 25 for the supply of 12 sections of a branching multiple magneto lamp signalling switchboard, &c., or one automatic or semi-automatic switchboard, &c.; up to June 14 for supply of a branching multiple magneto lamp signalling switchboard at Ballarat, and a c.b. multiple switchboard to the Postmaster-General's Department, SOUTH AUSTRALIA. Tender forms, &c., from 72, Victoria-street, London, S.W.

The Deputy Postmaster-General, MELBOURNE (Victoria), will receive tenders until 3 p.m. June 13, for the supply of electric lighting material, 12 accumulators and 400 cable distributing boxes and chemicals and glassware for batteries.

Tenders will be received at the Town Clerk's office, AUCKLAND, N.Z. until 4 p.m. of Thursday, June 15, for supply and erection of machinery for the new power station, including water-tube boilers, feed pumps, economisers, conveyor and steam pipes, and induced draught plant; d.c. steam generators, condensers, auxiliary machinery, &c. Specifications, &c., at 13, Victoria-street, London, S.W.

The Town Clerk, WANGANUI, N.Z., will receive tenders until July 12 for supply of generating plant, gas-producing plant and battery and booster for the Corporation tramways. Specification can be seen at 73, Basinghall-street, London, E.C. Local representation is necessary.

Tenders will be received at the Italian Royal Arsenals, SPEZIA and VENICE, until 11 a.m. June 2, for supply of electric cables and wires (estimated total amount £1,420). Specification (in Italian) may be seen at 73, Basinghall-street, London, E.C.

AUCKLAND (N.Z.) Harbour Board want tenders for supply of two electric motors (15 B.H.P. and 20 B.H.P.), with gear. Particulars from Messrs. W. & A. McArthur (Ltd.), 18 & 19, Silk-street, Cripplegate, London, E.C.

TENDERS RECEIVED AND ACCEPTED.

West Ham Corporation has accepted the following tenders:—
Walter Scott (Ltd.), 500 tons steel girder rails and 13 tons steel fish-plates, £3,360, 7s. 6d.; Bayliss, Jones & Bayliss, tie bars, fish-bolts and anchor plates, £412. 16s. 8d.; Edgar Allen & Co., points and crossings and construction of layouts in cast steel, £520. 11s., ditto in manganese steel (including "leg crossings"), £1,972. 6s. 4d.; Watlington & Co., traction poles and fittings, £771. 14s. 2d.

Greenock Corporation electricity department have placed the following contracts in connection with the extension to Dellingburn power station:—
Babcock & Wilcox, water-tube boilers with chain grate stokers, and coal and ash bunkers and conveying plant; British Westinghouse Electric & Mfg. Co., one 2,000 kw. turbo-alternator, with condensing plant, and two 500 kw. rotary converters.

London County Council have accepted the following tenders:—
T. Butlin & Co. (£1,006), S. Griffith (£117) and Martin & Son (£1,591), for iron castings for the Tramways department.
Brecknell, Munro & Rogers, £76. 18s. 2d. (lowest tender), for overhead fittings for Bow and Hammersmith car-sheds. (Seven tenders received; highest £108. 16s. 10d. Chief officer's estimate £110.)

Southend Council have accepted the following tenders:—
J. T. Halsey, wiring work at the Sanatorium, £46. 15s.; E. A. MacGregor, wiring school medical examination room, £5. 3s.; J. Stone & Co., apparatus for electrically controlling points, £45; E. Allen & Co., tramway points and crossings, £267; Peckham Truck Co., special flexible truck, £125; W. Bane & Co., permanent way tie-bars, 10¼d. each.

Walthamstow Council have accepted the following tenders:—
Midland Eng. Co., natural draught cooling tower, £900, concrete tank and foundations for cooling tower, £260; Walsall Elec. Co., two switchboard panels, £247; Hurst, Nelson & Co., one spare set tramway wheels, £31. 5s.

Messrs. Ransomes & Rapier recently obtained a contract for the supply of two electric travelling cranes (to lift 20 tons on the main and 5 tons on the auxiliary lift), with motors, &c., for the Eastern Bengal State Railway workshops.

Prahran-Malvern (Victoria) Tramways Trust have placed a contract with Noyes Bros. for rails, fishplates, fastenings and bonds for the Dandenong-road line at £6,624.

Islington (London) Guardians have accepted the tender of the Private Telephone Co. for the installation of a new fire alarm system at the school, at £65. 10.

Luton Council have accepted the following tenders:—
W. H. Allen, Son & Co., condenser, £1,455; E. Green & Son, economiser, £191, and renewal of sections, £13. 15s. each.

Messrs. Siemens Bros. Dynamo Works have obtained a contract from Rochdale Tramways Committee for the supply of Tantalum traction lamps for the ensuing 12 months.

The D.P. Battery Co. have secured the contract for the new storage battery for Hindhead electricity works.

Melbourne (Australia) City Council have placed a contract with Mr. W. C. Rowe for 6,000 50 c.p. Pope metal filament lamps.

Thanet Board of Guardians have accepted the tender of R. Anderson & Co. for lightning conductors, at £33. 15s.

Essex Education Committee have accepted the tender of Joslins Limited for wiring Colchester secondary schools, at £439. 9s. 6d.

Works Driving.—Messrs. Siemens Bros. Dynamo Works have obtained an order for the electrical equivment of the new works of the Carlyle Trading & Investments Trust, at Bromley (London), E., including the supply of generators, motors, switchboards and electric lighting. The wiring has been sublet to Messrs. Walter Mossop & Co.

Oil Eliminators.—The Paterson Engineering Co. inform us they have received a repeat order from Birmingham Corporation for supply of one of their oil eliminators with quartz sand filter for the removal of all trace of oil from 350,000 lb. of condensed steam per hour with a peak load of 500,000 lb. This, with the eliminator installed at the Summer-lane generating station in 1908, will (it is claimed) constitute the largest plant of its kind in existence. The combined plant will have a capacity of 800,000 lb. per hour.

Country House Lighting.—Messrs. Semens Bros. Dynamo Works have secured an order for a country house lighting installation at Chudleigh, Devonshire, including generating plant, storage battery, switchboard and lighting. The wiring, which is being carried out with Stannos wires on the concentric system, has been sublet to Messrs. A. H. Brooking & Co., Exeter.

Yorkshire Boilers.—During the last month the Yorkshire Boiler Co. have received (amongst other contracts) orders for a 24 ft. by 8 ft. 6 in. Yorkshire boiler for Bingley, two 24 ft. by 7 ft. 6 in. for 180 lb. pressure for Edinburgh, and one 24 ft. by 9 ft. 6 in. for Leeds.
The guaranteed evaporation of the two 7 ft. 6 in. diameter boilers is 1,800 gallons per hour, and that of the 24 ft. by 9 ft. 6 in. 1,500 gallons per hour. The company are also installing two 24 ft. by 8 ft. 6 in. Yorkshire boilers in the Halifax district, and one 24 ft. by 8 ft. in Huddersfield, and have just completed the application of one 20 ft. by 9 ft. to a dye-works in Dewsbury.

Coronation Illuminations.—Messrs. Siemens Bros. Dynamo Works have obtained the contract for a complete scheme of Coronation illuminations and decorations for the Piccadilly Hotel.
In accordance with their usual custom, the firm are sub-letting the actual contracting, and in this instance the work is entrusted to Messrs. Duncan Watson & Co., of Berners-street, London, W.
Croydon Town Hall is to be illuminated electrically on Coronation Day,

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at a cost of £100.—*Willesden* Council will allow consumers on the maximum demand system to have their indicator short-circuited for two consecutive nights in Coronation Week at a charge of 1s., and other consumers will be charged at 1½d. *per* unit, with an inspection fee of 2s. 6d.

Commonwealth Contracts.—The Australian Postmaster-General's Department has accepted the following tenders :—

Victoria.—Geo. Sweet, glazed earthenware conduits; Richd. Taylor, cement concrete conduits; J. A. Newton & Co., open circuit condenser telephones; Western Electric Co., Lawrence & Hanson and Chappel & Nichols, telephone apparatus and material.

New South Wales.—Western Electric Co., apparatus for William-street, Sydney, telephone exchange (£780) and for Mosman exchange (£620); additional apparatus and material for Petersham exchange (£912) and for Edgecliffe exchange (£905); Federal Potteries (Brunswick, Victoria), 57,500 lineal ft. of ducts.

Queensland.—India Rubber, Gutta Percha & Telegraph Works Co., Wheatstone bridge and rheostats; R. W. Paul, two galvanometers; J. Campbell & Sons, split pipes; and Gell Telegraphic Appliances, two Gell perforators.

Western Australia.—General Electric Co., tinned copper, rubber-insulated cotton-covered taped and braided wire; Western Electric Co., W. T. Henley's Telegraph Works Co., J. Bartram & Sons and Mills & Co., telephone apparatus and material.

BUSINESS NOTICES.

Messrs. Siemens Bros. Dynamo Works (Ltd.) have removed their Calcutta office from 12, Dalhousie-square, to Clive-buildings, Clive-street.

The Rees Roturbo Mfg. Co. have opened a branch office at Norfolk House, Victoria Embankment, London, W.C. Telegrams: "Hydroturbo London"; telephone: City 9156.

Messrs. W. T. Henley's Telegraph Works Co., who have hitherto been represented in India by agents, have recently opened an Indian branch office at 13-1, Clive-row, Calcutta, and Mr. C. H. R. Thorn has been appointed manager of the Company in India. Messrs. Greaves, Cotton & Co., Bombay, and the Russe Engineering Works (Ltd.), Calcutta, will continue to stock the Company's wires and cables.

Messrs. S. A. Sillem, F. A. Donnison and W. Sillem having transferred their interests in the Phœnix Electric Heating Co., electric cooking and heating apparatus manufacturers, 17, Morwell-street, Tottenham Court-road, London, W.C., to Mr. S. Douglas Cox, who has held the position of manager to the Company for the past three years, Mr. Cox will continue to conduct the business at the same address, under the existing title.

Gilbert A. Beckett and Chas. C. Aronsberg, electricians, &c., 57A, Renshaw-street, Liverpool, have dissolved partnership. Debts by Mr. Aronsberg.

Patent Development.—The proprietor of Letters Patent No. 11,154 1909, relating to "Batteries and Battery Holders," desires to dispose of same or to grant licences, with a view to the adequate working of the patent in this country. Inquiries to Messrs. Cruikshank and Fairweather (Ltd.), 65-66, Chancery-lane, London, W.C.

The proprietors of British Letters Patent No. 13,228 1905, relating to "Telephone Transmitters," and No. 13,311 1905, relating to "A telephonic dictating machine," desire to license British manufacturers to work same in this country. Applications to Messrs. Boult, Wade & Tennant, Chartered Patent Agents, 111 and 112, Hatton-garden, London, E.C.

The proprietors of patent No. 4461/08 for "Improved Process of and means for Manufacturing Filaments for Illuminating and Heating Purposes" also desire to enter into arrangements for exploiting same in this country. Applications to Messrs. Haseltine, Lake & Co., 7 & 8, Southampton-buildings, Chancery-lane, W.C.

The proprietor of patent No. 10,580/1900, for "Improvements in electric furnaces of great power," desires to enter into arrangements by way of licence or otherwise for exploiting same in this country. Further particulars from Messrs. Gedge & Feeny, 60, Queen Victoria-street, London, E.C.

Swedish Chamber of Commerce Year-Book.—We have received from the Swedish Chamber of Commerce in London (5, Lloyd's-avenue, E.C.) a copy of the Chamber's year-book for 1910, which contains much useful information and interesting statistics, trade reports, charts, &c., relating to trade and commerce between Great Britain and Sweden.

The work contains, in addition to the fourth annual general report of the Chamber and the transactions of the year, a list of members of the Chamber, names and addresses of Swedish traders' representatives in Great Britain and Ireland, reports on the iron, steel, timber, paper and glass trades, &c. There is also a large sheet giving particulars of the imports into the United Kingdom of articles partly supplied by Sweden.

BANKRUPTCIES, LIQUIDATIONS, &c.

The examination of Alphonse Christian Wampach, electrical engineer, Formby Lodge, Seabrook-road, Hythe, took place on Saturday. Liabilities £1,392; deficiency £1,342.

A dividend is to be paid to creditors of Tasker, Sons & Co. (Ltd.) and claims are to be sent by June 14 to Mr. G. S. Greening, 18, Norfolk-row, Sheffield, or Mr. T. G. Shuttleworth, Royal Insurance-buildings, Church-street, Sheffield.

A first and final dividend of 2s. 6¼d. will be payable on May 30 at 30, Mosley-street, Newcastle-on-Tyne, to creditors of Edward Surtees, electrician, 22, King-street, South Shields.

Herr Rudolf Busch, 5A, Lindenstrasse, Cöpenick, has been appointed trustee in the bankruptcy of Conrad Felsing, jun., cable machinery maker, Cöpenick, near Berlin.

The Australian Electrical Co. (Ltd.) is being wound up voluntarily. Mr. E. Pears, 20, Copthall-avenue, London, E.C., is liquidator. Meeting of creditors at 20, Copthall-avenue on May 29.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

*NOTE.—The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application, an asterisk is affixed.*

March 20, 1911.

6,905 ATKIN. Electrically-controlled presses and the like.
6,961 SHEARS. Track brakes for tramway and like vehicles
6,983 BARNES. Luc joints for the lids of electric accumularot boxes.*
6,984. 6,986 OLIVER ARC LAMP (LTD.), OLIVER & PELL. Flame arc lamps or the like.
6,988 B.T.-H. CO. & NEEDHAM. Electric lamps.

March 21, 1911.

6,996 EDWARDS & STAIT. Electric tramways motor-controller, back run electric brake.
7,021 RAILING & BARTLETT. Cooling the commutators and brushes of dynamo-electric machines.*
7,045 FRIED. KRUPP AKT.-GES. Continuous electric current generators with separate excitation. (Convention date, 18 5 10.)*
7,061 AKT.-GES. BROWN, BOVERI ET CIE. Variable frequency commutator machines. (Convention date, 11 4 10, Germany.)*
7,067 TOUSEY. X-ray tubes.*
7,086 HARDY & HUNGERBUHLER. Separators for secondary batteries.*
7,092 JOHNSON & PHILLIPS & BROCKIE. Devices for suspending, lowering and hoisting electric and other lamps.
7,097 SCHULTZ. Switches and interrupters for electric circuits.
7,103 B.T.-H. CO. (G.E. Co., U.S.) Boron compounds and methods of producing the same.*
7,104 B.T.-H. CO. (G.E. Co., U.S.) Electric switches.

March 22, 1911.

7,161 WATERHOUSE. Electric lampholders.
7,198 MUNRO & RAIL-LESS ELECTRIC TRACTION CO. Trolley bases for electric traction systems. (Divided application on 11,157 5 5 10.)
7,220 FUSS. Electrical potential regulators. (Convention date, 22 3 10, Germany.)*

March 23, 1911.

7,235 TAINTON & PRING. Electro-deposition and refining of zinc.
7,266 GLEAVES & HOLLIDAY. Electric tramcars.
7,295 OZONAIR (LTD.) & JOSEPH. Transforming continuous currents into alternating currents.*
7,306 CURTIS. Electric lamps.
7,307 READ. Electric lamps.
7,320 B.T.-H. CO. (A.E.G., Germany.) Resistances for regulating induction motors.

March 24, 1911.

7,341 FAIRLESS & PRENTICE. Adjustable carrier for gas or electric light reflectors, shades, globes and the like.
7,373 BIRKETT & THORNTON. Electric switch of rotatory type for electric light or power purposes.
7,376 LEE GUINESS. Magneto trip mechanism for internal combustion engines.
7,386 ROUSE. Thermo-electric motor.
7,395 DICKSON. Arc lamps.
7,416 SCHRODER. Time switches for electric lighting. (Convention date, 23 5 10, Germany.)*

March 25, 1911.

7,501 SIEMENS-SCHUCKERTWERKE G.M.B.H. Arc lamps. (Convention date, 26 3 10, Germany.)*
7,504 FULLER & FULLER. Electric condensers.
7,511 KRANNICHFELDT. Device for insulating the twisted ends of electric wires.*
7,519 MARCONI'S WIRELESS TELEGRAPH CO. & ROUND. Receivers for wireless telegraphy.
7,522 HILL. Electric meters and the like.

March 27, 1911.

7,568 MEREDITH. Sparking plug.
7,569 FRISBY. Current detectors.
7,579 MURRAY. Synchronising arrangement for a multiplex printing telegraph system.
7,582 WALKER. Spark generator for wireless telegraphy.
7,611 CLEMENT. Telephone exchange systems.*
7,631 SIEMENS BROS. DYNAMO WORKS. (Siemens-Schuckertwerke G.m.b.H., Germany.) Braking polyphase series motors.*
7,635 LEVY & GEORGE. Circuit breaker.
7,645 BONAPARTE. Safety interrupter.
7,668 ALLGEMEINE ELEKTRICITATS-GES. Voltage regulators. (Convention date, 26 3 10, Germany.)*
7,669 B.T.-H. CO. (Allgemeine Elektricitäts-Ges., Germany.) Meters.
7,675 GENN. Terminals or connectors.

March 28, 1911.

7,697 PURLE. Electrically-produced heat for domestic and other purposes.
7,705 TAYLOR. Changing the frequency of alternating currents
7,731 DELL & SON & RICHARDS & STEWART. Reversing mechanism for metal-planing machines.
7,736 SCHATTNER. Rheostats.*
7,749 BALSILLIE. High frequency electric currents.
7,764 SIMPSON. Electric energy and apparatus therefor.
7,770 B.T.-H. CO. (G.E. Co., U.S.) Indicating apparatus for magnetic compasses and the like.

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March 29, 1911.

7,765 Holmes & Holmes. Controlling electric motors.

7,803 Lauder. Lamp lock and shade holder for incandescent electric lamps.

7,852 Siemens Bros. & Co. (Siemens & Halske Akt.-Ges., Germany.) Telephone exchange circuits.*

7,862 H. Aron Elektricitatszahler-fabrik G.m.b.H. Electrical clock. (Convention date, 7/1/11, Germany.)*

7,868 Barrollier. Machines for making the joint between the filament support and the lamp bulb in incandescent electric lamps. (Convention date, 29/3/10, France.)*

7,872 Johnson. Continuous electric switch.*

7,876, 7,877 & 7,878 Fales. Telephone systems. (Divided Application on 1,422/10, 19/1.)*

7,882 Ellson. Reversing mechanism for electrically-driven machine tools.

7,894 B.T.-H. Co. (Allgemeine Elektricitäts-Ges., Germany.) Time relays.

Maroh 30, 1911.

7,921 Spruce. Controller for stopping power machines in case of accident or emergency.

8,004 Schwab. Incandescing bodies for electric lamps. (Convention date, 9/4/10, Germany.)*

8,018 Schuer & Haddrell. Flame arc lamps.

8,023 Monnot. Electric heaters. (Convention date, 1/4/10, France.)*

8,032 Strelow. Meters. (Addition to 21,240/10. Convention date, 30/3/10, Germany.)*

8,033 Strelow. Measuring instruments. (Convention date, 30/3/10, Germany.)*

8,039 H. T. W. Bowell & G. B. Bowell. Electric clocks.

8,044 Rogers. Alarm signal.

March 31, 1911.

8,063 Wright & Burnside. Contact breakers.

8,082 Kochs. Separation of liquids by electrical treatment.

8,133 Oertel. Arc lamps.*

8,149 Alexanderson. Control of alternating current electric motors. (Convention date, 2/4/10, United States.)*

8,150 Allgemeine Elektricitats-Ges. Regulators. (Convention date, 1/4/10, Germany.)*

8,151 Rennert. Regulating devices for furnace-dampers, valves, and the like. (Convention date, 1/4/10, Germany.)*

April 1, 1911.

8,206 Morris & Lister. Switches, circuit-breakers and the like.

8,224 Bloxam. (Robert Bosch, Firm of, Germany.) Carbon-holder for distributors of electrical ignition machines.*

8,225 Blackall & Jacobs. Operating railway block telegraph indicators.*

8,226 Bull, Arnesen & Sizer. Wireless telegraphy.

8,238 B.T.-H. Co. & Wise. Controllers for electric motors.

April 3, 1911.

8,275 Ogilvie & Adams Watkin Co. Resistances and controlling devices.

8,253 Crook. Selective electric sigalling over a number of conductors.*

8,340 Lindos. Magneto-electric machine.

April 4, 1911.

8,356 Boddam. Hydraulically-balanced electric lifts.

8,375 Hirst & Chapman. Wall plugs and sockets.

8,387 Goldschmidt. Method of and means for receiving electric waves. (Convention dated, 4/4/10, Germany.)*

8,392 Siemens Bros. Dynamo Works & Koettgen. Ventilation of dynamo-electric machines.*

8,411 Hurt & Hurt. Sparking plugs.

SPECIFICATIONS PUBLISHED.

1909 Specifications.

[illegible] Marino. Separators for use in electrical batteries and electrolytic apparatus. (Cognate Application, 4,398/10.)

1910 Specifications.

3,663 Hope. Fusible cut-outs for controlling electric circuits. (Cognate application, 15,662/10.)

[illegible] Field & Ferranti. Electric circuit-breakers and the like.

[illegible] McGinness. Trolley-head collectors.

[illegible] Adams Mfg. Co. (Cutler Hammer Mfg. Co.) Controllers for alternating current motors.

[illegible] Adams Mfg. Co. (Cutler Hammer Mfg. Co.) Pressure-regulating devices.

[illegible] Elner & Holmstrom. Cooling devices for telephone transmitters. (3/4/09.)

[illegible] Neuhold. Telephone systems. (20/4/09.)

[illegible] Conradi & Conradi. Fusible cut-outs.

[illegible] Barry & Clarke. Rheostats.

[illegible] Cervenka. Incandescence filament or body and process for manufacturing the same. (23/10/09.)

[illegible] Tucker. Switches.

[illegible] Collins. Electric incandescent lamp holders.

[illegible] Adams Mfg. Co. (Cutler-Hammer Mfg. Co.) Means for starting and controlling electric motors.

[illegible] Rankin. Electric controlling and regulating apparatus.

[illegible] Float Electric Co. & Sandy. Cells or cases for electric batteries.

[illegible] Regnart. Holders for electric incandescent lamps.

[illegible] Baldwin. Sound-reproducing devices of the telephone receiver type.

[illegible] Harrison. Exhaustion of incandescent electric lamps.

[illegible] Steel & British Ever-Ready Electrical Co. Holders or fittings for electric incandescent lamps.

[illegible] Sirstyn. Electric condensers. (12/5/09.)

[illegible] Rausch. Time signalling apparatus.

[illegible] Clarke Chapman & Co. & Harris. Resistances.

[illegible] Conner & Peel-Conner Telephone Works. Coating electric cables.

[illegible] B.T.-H. Co. (G.E. Co., U.S.) Leading-in conductors for electric lamps and other similar devices.

[illegible] Lake. (Weston Electrical Instrument Co.) Synchronising alternating current generators.

[illegible] Siemens Bros. & Co. & Dieselhorst. Conductors.

[illegible] Engel. Electrical contact device. (Addition to 6,765/08. Convention date not granted.)

[illegible] Simpson. Electric furnaces. (1/9/09.)

[illegible] Pritchett. Accumulator boxes.

[illegible] Moore. Electrical switches operated by a vehicle passing along a railway.

[illegible] Anderson, Russell & Gray. Systems for the distribution of electric energy. (Addition to 21,219/09.)

[illegible] Skaupy. Manufacture of electric metal filament lamps. (6/12/09.)

[illegible] Hannemann. Primary galvanic batteries.

[illegible] Adams Mfg. Co. (Cutler-Hammer Mfg. Co.) Motor controller circuits.

[illegible] Siemens Bros. Dynamo Works. (Siemens Schuckertwerke Ges.) Control devices for electric cars on routes in which two different voltages are supplied.

[illegible] Burney & Bell. Telephone systems.

[illegible] Fairweather. (Hart Mfg. Co.) Electric switches.

[illegible] Dymond. (Ges. fur Drahtlose Telegraphie.) Arrangement for producing but slightly damped electrical oscillations.

[illegible] Krone & Kahle. Inverted lamps.

[illegible] Siemens & Halske Akt.-Ges. Manufacture of metallic filament incandescent lamps. (9/6/10.)

[illegible] Miram & Seidel. Electro-magnetic clutches. (14/2/10.)

[illegible] Miram & Seidel. Electromagnetic clutches. (25/7/10, addition to 19,786/10.)

[illegible] Siemens Bros. Dynamo Works. (Siemens Schuckertwerke Ges.) Cooling dynamo-electric machines. (Patent of addition not granted.)

[illegible] Siemens Bros. & Co. (Siemens & Halske Akt.-Ges.) Circuits for telephone exchanges.

21,310 Siemens Bros. Dynamo Works, Bolton & Willcocks. Electric switches for high-tension currents.

21,583 Siemens Bros. Dynamo Works. (Siemens-Schuckertwerke Ges.) Rotary field electric transformers.

22,410 Fairweather. (Stein.) Sub-station telephone.

22,411 Fairweather. (Stein.) Telephone system.

23,121 Schroter. Manufacture of metal filament electric lamps. (19/1/10.)

23,535 Atwood. Incandescent electric lamps. (3/1/10.)

23,577 Macquaire. Sparking plugs. (30/10/09.)

23,958 Milch. Control of alternating current induction motors.

24,122 Western Electric Co. (E. Zwietusch & Co.) Protective covering for flexible electric conductors.

24,286 Krauss & Maschinen-fabrik und Muhlenbauanstalt G. Luther Akt.-Ges. Magnetic separators.

24,549 Skaupy. Incandescent metal filament lamps. (13/7/10.)

24,668 Cambridge Scientific Instrument Co. & Darwin. Thermo-electric circuits.

25,179 Manny & Binzel. Selective-signalling devices.

25,280 Goldthorp. Receiving apparatus for wireless telegraphy. (29/10/09.)

26,568 Wilderman. Electrolytic cells for the electrolysis of alkaline salts. (22/12/09.).

26,959 Hesseln. Two-fluid galvanic cells. (11/2/10.)

27,448 Robertson. Device for carrying electric cables, conduits, rods or the like.

28,057 American Automatic Telephone Co. & Goodrum. Electric switches. (Divided application, on 29,963/09, Dec. 22.)

28,356 Siemens Schuckwertwerke Ges. Electric searchlights. (26/1/10. Addition to 12,556/08.)

28,396 Gottschalk. Telephonic instruments.

28,397 Gottschalk. Guards for telephone transmitters.

28,552 Paillet, Ducretet & Roger. Discharging electricity from textile and other materials during manufacture.

29,593 Macdonald. Electric motors.

29,654 Dicker. (Automatic Electric Co.) Electrical impulse transmitting or calling devices for telephone systems. (Divided application on 1,298/10, Jan. 18.)

29,927 Beck. Telemeters. (30/12/09.)

29,941 Kunkel. Dynamo electric machines. (29/12/09.)

30,313 Evershed & Vignoles, Ltd. Hand spikes for making electrical connections.

1911 Specifications.

252 B.T.-H. Co. (G.E. Co.). Resistance units.

513 Carl Zeiss (Firm of). Telemeters. (17/1/10.)

847 Lundberg, Lundberg & Lundberg. Plug and socket connections for electric light and power purposes.

950 Siemens Bros. Dynamo Works & Laughton. Shade carriers for electric, gas or other lamps.

2,014 Siemens & Halske Akt.-Ges. Electric transmission of signals comprising combined numerals. (9/2/10.)

2,017 Boult. (Smith.) Secondary or storage batteries.

COMPANIES' MEETINGS AND REPORTS.

ANGLO-PORTUGUESE TELEPHONE CO. (LTD.)—The directors' report for 1910 states that the gross revenue was £54,391, of which operating, management and general expenses absorbed £31,222 and royalties to the Portuguese Government £1,553, leaving a gross profit of £21,614. After providing for debenture interest (£2,316), sinking fund (£1,283), income tax (£684) and appropriating £10,000 to reserve (which now amounts to £37,000), the amount available, including £5,392 brought forward, is £12,722. In December an interim dividend of 3 per cent. (£3,000) was paid, and the directors now recommend a final dividend of 5 per cent. (tax free), making a total distribution of 8 per cent. for the year, leaving a balance of £4,722 to be carried forward.

ELECTRIC SUPPLY CORPN. (LTD.)—Mr. J. G. B. Stone, who presided at the meeting on Monday, said the lamp connections had increased from 113,699 to 135,719 8-c.p., a satisfactory increase of 19 per cent., to which Dumbarton was the largest contributor. The lamp connections at Hendon at the beginning of the present month had increased to 44,644 8-c.p., with 4,400 awaiting connection. There was a small decrease in the total number of units supplied, although their revenue had increased. The decrease was due to the reduction in the supply to the tramway company at Dumbarton and to the strike of the shipbuilding employés in that district. In spite of a shrinkage in output from those causes they had an increase in gross revenue of £1,665 and of £1,924 in profit. They thought the shareholders would receive some dividend this year. They did not like to commit themselves to what it would be, but they hoped it would be somewhere in the neighbourhood of 3 per cent.

KALGOORLIE ELECTRIC POWER & LIGHTING CORPN. (LTD.)—The directors' report for 1910 states that, although the plant was only lightly loaded for the first eight months, largely owing to the fire at the Great Boulder Perseverance mine, the profits in Kalgoorlie show an increase over those for 1909. The additions made to plant and machinery during the year include new boilers and condensing apparatus, as well as the new engine and alternator referred to as the new unit in last year's report. On March 31 the tramway company exercised their option under the contracts with this company to pay the existing price for a further term of five years.

LISBON ELECTRIC TRAMWAYS (LTD.)—The chairman (Mr. L. Breitmeyer) stated at the meeting on Wednesday that the company had more than maintained its successful position during 1910. They had carried 49,925,167 passengers, earning £328,599. 14s. 2d., against 47,995,076 passengers and £301,426. 15s. 3d. for 1909, leaving a net profit of £132,980, against £129,351. 1s. 9d. in the preceding year. Those figures would have been considerably increased had not the revolution, which broke out in Lisbon in October last, disorganised the business life of the city, and in fact the tramway operations were entirely suspended for three days, and some considerable time elapsed before the entire traffic on all lines was completely re-established. Mr. Rommel and himself went to Lisbon immediately after the overthrow of the Monarchy, and they remained there for some time, interviewing the principal officials of the Provisional Government and of the municipality, &c. They considered all complaints and made many concessions, but all their endeavours failed to avert a strike, which took place some time after their return to London. Under the peculiar circumstances, the directors thought the wisest course to adopt would be to request Senhor Almeida, the Minister of the In-

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terior, to act as arbitrator, and the result of his arbitration and the determination of his award were successful in putting an end to the strike. The company, however, was obliged to make great sacrifices, both as regards reduction of working hours, increase of wages and the granting of holidays with pay, and as a consequence their operating expenditure would be considerably increased, while they could hardly expect for some time to come that the rate of expansion of traffic would be resumed on the scale obtaining before the revolution. Therefore, the board deemed it prudent to limit the final dividend to 2½ per cent., making a total of 5½ per cent. for the year. The tramways had sustained no damage whatever, and, bar the suspension of traffic, no injury had been done to their undertaking. The tramways were now in full working order. The equipment, rolling stock, permanent way, &c., were in excellent condition, and their employés had lately shown a spirit of loyalty, when a general strike of workers was attempted, which proved that their concessions to them had not been made in vain. They were still at issue with the Lisbon municipality in the interpretation of the contracts between the company and that body. The unreasonable demands made upon the company had left the board no alternative but resistance through the law courts. The directors would let no opportunity slip of coming to a friendly understanding with the municipality, and, in fact, negotiations were still being carried on to that end.

PEASE & PARTNERS (LTD.)—The directors' report states that an agreement has been entered into with the Newcastle-on-Tyne Electric Supply Co. to put down a power generating station to use the spare heat and gas from coke ovens at Bowden for generating electrical energy. An arrangement had also been entered into with the Newcastle Company and their allied companies in Durham and Cleveland for the supply of electrical power at reasonable rates to all the company's other collieries, mines and works as required.

POTTERIES ELECTRIC TRACTION CO. (LTD.)—The capital expended during 1910 amounted to £1,784. 12s. 4d. The total receipts were £110,489. 17s. 11d. The traffic receipts (£92,349. 19s. 8d.) showed an increase of £418. 5s. 7d., and the return on the investment in the North Staffordshire Tramways Co. an increase of £1,156. 14s., consequent on the declaration of a bonus of 2s. per share on the ordinary shares. Working expenses increased by £2,320. 10s., of which £1,089. 16s. 8d. was for permanent way. Deducting expenses and adding amount forward the balance was £27,384. 16s. 5d. The directors recommend that £2,302 10s. be placed to reserve, £7,525. 9s. to renewals account, and that after paying preference dividend (£12,250), a dividend be declared of 2 per cent. on the ordinary shares (£4, [illegible] 495. 17s 5d. being carried forward. During the year the Board of Trade released the Company from its obligations to construct certain authorised extensions in the outlying districts of the Potteries.

RANGOON ELECTRIC TRAMWAY & SUPPLY CO. (LTD.)—At the meeting last week the chairman (Mr. F. Tobin) stated that they had issued £22,000 debenture stock to meet the cost of the new power house, &c. The directors had placed £7,500 to reserve for renewals. The tramway receipts continued to increase, while in the supply of electricity for public lighting and power there was distinct progress.

REUIER'S TELEGRAM CO. (LTD.)—The chairman (Hon. Mark F. Napier) stated at the meeting on Wednesday that the utmost care would be taken in the development of their new banking branch, the progress of which, so far, had given every prospect of eventual success. As a result of last year's operations they had been able to add a substantial sum to the general and telegraphic remittance reserves, which had been combined. With regard to the equalisation of dividends, he pointed out that, although they had done very good business of recent years, the uncertainty of affairs all over the world had taught them to provide for a possible rainy day. They had not had many in recent years, but he remembered the time when the company had to meet very strong competition. The difference in the cost of transmitting messages was a matter they had to provide against.

TRACTION & POWER SECURITIES CO. (LTD.)—The directors' report for 1910 states that there is a credit balance of £26,482, which, added to £5,623 forward, gives £32,105. The directors have applied £1,920 to writing down certain securities and transferred £25,000 to investment account, leaving £5,185 to be carried forward. The Clyde Valley Electrical Power Co. continues to make good progress. The gross revenue and profit for 1910 much exceed those of any previous year. The earnings of the Mersey Railway Co. again showed an increase. The engagements of the Société Electrique Westinghouse de Russie, in connection with the contract guaranteed by the company, have been fully met.

URBAN ELECTRIC SUPPLY CO. (LTD.)—The gross profits for 1910 amount to £47,268. 10s. 9d., and, after deducting London expenses, the balance is £44,911. 16s. 8d. The profit balance is £30,971. 11s. 11d., which falls short by £1,528. 8s. 1d. of the amount (£32,500) required to meet the 5 per cent. guaranteed dividends on the capital. This deficit has been provided by Edmundsons' Electricity Corpn. under their contract. Provision has also been made of £2,221. 5s. 6d. depreciation of plant and machinery. The profits for 1910 exceed by £33,192. 17s. 5d. the amount of £12,107. 0s. 6d. required to meet debenture interest. In view of the expiry on Dec. 31 last of the contract under which the dividends have hitherto been guaranteed, of the necessity for increasing the provision for depreciation, and of the fact that the debt owing to the contractors is now bearing interest, the directors have decided to defer any declaration of dividend for the current year until the accounts for the year are available. The equivalent of 525,160 33-watt lamps were connected to the mains of the various undertakings at Dec. 31 last, against 476,596 in 1909 and 437,503 in 1908.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES, &c,

NEW COMPANIES.

ELECTRIC BLEACHERS (LTD.) (115,837.)—Reg. May 18, capital £100 in £1 shares, to acquire and turn to account patent No. 1,941 of 1911, and to carry on the business of manufacturers of apparatus used in connection with bleaching. Private company. Reg. office: 39, Victoria-street, Westminster.

MANSELL (LTD.) (115,871.)—Reg. May 17, capital £500 in £1 shares (450 7 per cent. cumulative preference and participating and 50 founders'), to take over the business of electricians, electrical and mechanical engineers and contractors, &c. Private company. Reg. office: 13, Cecil-court, Charing-cross, London, W.C.

SCANDINAVIAN FOIL CO. (LTD.) (115,831.)—Reg. May 17, capital £20,000 in £1 shares, to acquire any patents in Norway or Sweden and elsewhere, to carry on the business of manufacturers of and dealers in aluminium and aluminium foil, and to adopt an agreement with the International Foil Co. First directors: S. O. Larsen, J. E. Vik, O. Roakvam, W. C. James, E. Ames, A. P. Sinnett and A. J. Faulding.

SHACKLETON'S (LTD.) (115,880.)—Reg. May 17, capital £2,000 in £1 shares, to carry on the business of manufacturers of and dealers in bricks, tiles, pipes, pottery and earthenware, &c., to acquire the business carried on by C. W. Shackleton as the Polesworth Electrical Appliances Co. Private company. C. W. Shackleton is first managing director. Reg. office: 47, Temple-row, Birmingham.

STATUTORY RETURNS.

BUDE ELECTRIC SUPPLY CO. (LTD.)—Return to April 29 gives capital as £7,000 in £1 shares. All shares taken up. £7,000 paid. Mortgages and charges, £2,500 mortgage debentures.

CAMBRIDGE ELECTRIC TRAMWAYS SYND. (LTD.)—In return to Feb. 22 capital is £5,000 in £10 shares. 107 shares taken up. £9. 0s. 4½d. per share called up on 90 shares, £10 per share on 10 and nil on 7. £911. 12s. 1d. paid. Mortgages and charges, nil.

MORTGAGES AND CHARGES.

BRITISH DIATORIC MFG. CO. (LTD.)—Particulars of £4,000 debentures, created as to £2,000 on June 25, 1908, and as to £2,000 on April 25, 1911, have been filed, amount of present issue being £2,000. Property charged: Company's property, present and future, including uncalled capital. No trustees.

LANCASHIRE DYNAMO & MOTOR CO. (LTD.)—Issue on May 8 of £5,600 debentures, part of a series of which particulars have already been filed.

RECEIVERSHIPS.

ELECTRICAL FITTINGS CO. (LTD.)—W. K. Sutton, of Driffold, Mayfield-road, Moseley, ceased to act as receiver or manager on March 31.

FERABIN LAMP & ELECTRICAL ACCESSORIES (LTD.)—Notice of the appointment of G. E. Corfield, 119, Finsbury-pavement, E.C., as receiver and manager, on May 12, under powers contained in debenture dated Nov. 23, 1910, has been filed.

JAMES SCOTT (LTD.)—Notice of the appointment of H. Beswick, 7, Sweeting-street, Liverpool, as receiver and manager, by order of Court dated May 6, has been filed.

CITY NOTES.

MEMORANDA (May 25).—**Bank rate 3 per cent.** (March 9, 1911). **Price of silver,** 24⅛d. per oz. **Consols** 81⅛—81⅛ for money and for account. **Consols Pay Day, June 1; Stock and Shares Continuation Days, May 29 and June 13; Ticket Days, May 30 and June 14; Pay Days May 31 and June 15; Mining Shares Carry Over Day, May 26.**

PRICES OF METALS (London).—*Copper*, cash, 54⅞; three months 55⅛. *Lead*, English, 13¼—13⅜; foreign, 13⅛—13⅛. *Spelter*, 24¼—24¾. *Tin*, English, 196—197; foreign, 203¼ cash, 189¾ three months. *Iron*, Cleveland, cash, 46/11, three months, 47/7.

ANGLO-ARGENTINE TRAMWAYS CO. (LTD.)—Mr. T. Frame Thomson has been appointed deputy-chairman of this company.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have been asked to appoint special settling days in and grant quotations to fully and partly (50 per cent.) paid scrip for £385,000 4½ per cent. preference stock of the *Central London Railway Co.*, and a further issue of 20,000 £10 fully and partly (£4) paid shares of the *City of Santos Improvements Co.*; and also to grant quotations to $1,847,000 additional consolidated mortgage 5 per cent. 50-year coupon bonds of the *Havana Electric Railway Co.*, a further issue of £27,000 4½ per cent. first mortgage prior lien gold bonds of the *Montreal Water & Power Co.*, and partly paid scrip for £200,000 5 per cent. first mortgage debentures of the *Rhondda Tramways Co.*

UXBRIDGE & DISTRICT ELECTRIC SUPPLY CO. (LTD.)—This company is making an issue of £75,000 5 per cent. first mortgage debenture stock at par. The issue is guaranteed by Callender's Cable & Construction Co.

WINNIPEG ELECTRIC RAILWAY CO.—The directors have declared a quarterly dividend at the rate of 12 per cent. per annum.

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ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line	Week ended.	Amount	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	May 17	1,362	+ 12	50	69,541	+ 2,125
Airdrie	" 12	218	+ 5	19	4,001	− 38
Anglo-Argentine	" 20	47,993	+ 4,343	20	991,835	+ 115,333
Ashton-under-Lyne	" 20	422	− 53	8	3,308	+ 267
Ayr Corporation	" 20	265	− 4	1	265	+ 4
Barnsley	" 12	187	+ 17	19	3,314	+ 113
Barrow	" 12	272	+ 22	19	4,621	+ 300
Bath Electric Trams, Ltd.	" 17	1,167	+ 6	20	14,586	+ 15
Birmingham Corporation	" 20	7,093	+ 613	7	52,101	+ 2,469
Birmingham & Midland	" 12	885	+ 84	19	16,559	+ 1,337
Blackpool and Fleetwood	..	..	..	..	..	..
Blackburn Corporation	" 17	1,156	− 228	†8	8,868	+ 615
Bolton Corporation	" 21	2,563	− 327	8	18,788	− 1,400
Bombay	April 21	2,779	− 10	16	45,761	+ 2,453
Bournemouth Corporation	May 17	1,653	− 489	‡7	11,517	+ 231
Bradford Corporation	" 20	5,245	− 1,216	7	39,123	+ 2,271
Brighton Corporation	" 21	890	− 363	¶7	6,849	+ 218
Bristol Trams & Carriage	" 19	6,285	− 1,682	7	43,564	+ 2,681
Burnley Corporation	" 20	1,322	− 245	7	9,583	+ 798
Burton Corporation	" 21	260	− 67	7	1,930	+ 7
Bury Corporation	" 21	1,254	− 262	¶7	9,281	+ 619
Calcutta Tramways Co.	" 20	R55,120	+ R5,600	20	R1,158,466	+ R29,216
Camborne-Redruth	" 20	123	− 54	20	2,283	− 89
Cardiff Corporation	" 13	2,367	+ 260	6	14,353	+ 1,116
Cavehill	" 12	86	+ 15	19	1,362	− 6
Central London Railway	" 20	4,997	− 1,740	20	104,657	− 7,198
Chatham & Dist. Lt. Rys.	" 18	827	− 241	20	15,428	− 79
City & South London Rly.	" 21	3,104	+ 43	20	67,844	+ 2,472
City of Birmingham	" 12	3,021	+ 267	19	51,397	+ 1,243
Cork Electric Trams Co.	" 18	560	+ 2	20	8,953	+ 22
Devonport & Dist. Trams	" 12	468	+ 92	19	8,267	+ 715
Dover Corporation	" 20	207	− 63	7	1,617	+ 190
Dublin & Lucan Railway	" 19	138	− 67	20	2,347	− 92
Dublin United	" 19	5,585	− 613	20	103,318	+ 1,019
Dudley-Stourbridge	" 12	812	+ 135	19	14,437	+ 1,128
Dundee Corporation	" 17	1,159	− 31	¶52	61,563	+ 329
East Ham Council	" 20	985	− 371	7	7,579	+ 241
Exeter Corporation	" 19	333	− 74	7	2,254	+ 44
Gateshead & Dist. Trams	" 12	1,018	+ 66	19	18,808	+ 950
Glasgow Corporation	" 20	20,027	+ 528	51	914,227	+ 50,352
Glossop Trams	" 20	119	− 9	20	2,326	+ 114
Gloucester Corpn.	" 17	298	− 57	..	..	..
Gravesend-Northfleet	" 12	207	+ 28	19	3,528	+ 13
Great Northern & City Rly.	" 20	1,442	+ 104	20	31,053	+ 1,250
Greenock & Port Glasgow	" 12	744	+ 101	19	11,975	+ 1,691
Halifax Corporation	" 16	1,830	− 748	†7	12,569	+ 1,013
Hartlepool Tramways	" 12	255	+ 29	19	4,180	+ 225
Hastings Elec. Trams Co.	" 18	968	− 376	..	..	..
Hong Kong	" 20	$8,178	− $816	20	$183,023	− $3,137
Huddersfield Corpn.	" 20	1,816	− 353	7	13,461	+ 1,184
Hull Corporation	" 20	2,648	− 325	7	20,216	+ 781
Ilford District Council	" 20	511	− 269	7	3,972	+ 136
Ilkeston District Council	" 17	132	− 34	7	915	+ 55
Ipswich Corporation	" 20	372	− 183	7	2,921	+ 208
Isle of Thanet Co.	" 20	429	− 347	33	10,834	+ 169
Jarrow	" 12	144	+ 27	19	2,237	+ 144
Keighley Corporation	" 18	191	− 45	7	1,300	+ 89
Kidderminster & District	" 12	107	+ 27	19	1,711	+ 91
Kilmarnock Corporation	" 20	164	+ 2	1	163	+ 2
Kirkcaldy Corporation	" 17	275	+ 28	7	2,033	+ 255
Lanarkshire Trams Co.	" 18	1,501	+ 8	20	27,101	+ 282
Lancashire United	" 17	1,358	− 131	20	25,097	+ 571
Leamington	" 12	149	+ 18	19	2,603	− 82
Leeds Corporation	" 20	7,255	− 1,317	7	53,088	+ 3,328
Leicester Corporation	" 20	2,460	− 454	7	17,584	+ 1,102
Leith Corporation	" 20	621	+ 14	1	621	+ 14
Lincoln Corporation	" 20	127	− 32	7	918	+ 48
Liverpool Corporation	" 13	11,529	+ 650	19	209,269	+ 7,000
Liverpool Overhead Rly.	" 21	1,483	− 144	20	28,160	+ 1,500
Llandudno&ColwynBayRy.	" 19	200	− 239	¶24	3,695	− 122
London County Council	" 10	44,869	+ 4,263	‡6	250,497	+ 19,972
London Elec. Ry. Co.	" 20	18,470	− 2,105	20	280,830	+ 12,860
London United	" 20	6,334	− 3,340	20	115,858	− 1,422
Lowestoft Corporation	" 20	146	− 62	33	5,055	+ 195
Manchester Corporation	" 20	16,133	− 955	7	115,229	+ 7,539
Mersey Railway	" 20	1,964	− 107	20	41,223	+ 920
Merthyr	" 12	209	+ 21	19	3,649	+ 88
Metropolitan Dist. Railway	" 20	11,591	− 989	20	234,430	+ 15,133
Metropolitan Elec. Trams	" 12	9,263	+ 2,432	19	151,741	+ 23,481
Middleton	" 12	346	+ 63	19	5,683	+ 457
Nelson Corporation	" 20	160	− 25	§7	1,296	+ 254
Newcastle-on-Tyne Corp.	" 20	3,967	− 14	7	29,611	+ 2,002
Newport (Mon.)	" 20	690	− 210	7	5,100	+ 185
Northampton Corporation	" 19	509	− 224	7	3,597	+ 157
Oldham, Ashton & Hyde	" 12	581	+ 61	19	10,261	+ 366
Oldham Corporation	" 21	2,018	− 73	8	16,173	+ 654
Perth (N.B.) Corporation	" 15	124	+ 30	52	8,489	+ 413
Perth (W.A.) Elec. Trams	" 19	1,544	+ 19	20	32,870	+ 1,625
Peterborough	" 12	118	+ 6	19	2,001	+ 127
Plymouth Corporation	" 20	1,930	− 506	7	14,231	+ 544
Potteries	" 12	1,921	+ 205	19	35,819	+ 3,386
Preston Corporation	" 17	764	− 213	7	5,258	+ 186
Rotherham Corporation	" 18	672	+ 128	7	4,638	+ 350
Rothesay	" 12	111	+ 22	19	1,384	− 19
Salford Corporation	" 22	4,856	− 842	§7	35,812	+ 1,680
Sheerness	" 12	47	+ 4	19	818	+ 21
Sheffield Corporation	" 21	6,410	− 322	8	51,618	+ 2,328
Singapore Trams	" 20	$10,431	+ $784	20	$203,306	+ $9,693
South Metropolitan	" 12	993	+ 270	19	14,083	+ 294
South Staffs	" 12	895	+ 105	19	16,426	+ 1,373
Southampton	" 17	1,129	− 316	7	7,555	+ 469
Southend Corporation	" 17	557	− 175	7	3,692	+ 439
Southport Tramways	" 12	317	+ 65	19	4,694	+ 126
S'bge, Hyde, &c., Jt. Bd.	" 20	752	− 244	7	5,730	+ 720
Sunderland Corporation	" 21	1,164	− 168	7	8,654	+ 584
Sunderland District	" 17	443	− 108	29	12,789	+ 819
Swansea Trams	" 12	1,089	+ 61	19	19,996	+ 1,384
Swindon Corporation	" 17	148	− 22	7	993	+ 77
[illegible]	" 12	42	+ 4	19	730	− 5
Tynemouth and District	" 12	212	+ 42	19	3,098	+ 158
Tyneside Trams Co.	" 17	462	− 77	20	8,281	+ 523
Wallasey Corporation	" 20	1,061	− 107	7	7,660	+ 1,106
Walsall Corporation	" 20	553	− 165	20	10,860	+ 125
Warrington Corporation	" 18	383	− 38	7	2,721	+ 107
West Ham Corporation	" 11	2,746	+ 449	6	16,056	+ 2,236
Weston-super-Mare	" 12	108	+ 45	19	801	− 46
Wolverhampton Co.	" 12	431	+ 43	19	7,987	+ 452
Wolverhampton Corpn.	" 17	949	− 325	7	6,679	+ 326
Worcester	" 12	315	+ 74	19	4,753	+ 178
Wrexham	" 12	97	+ 10	19	1,753	+ 21
Yorkshire W.R. Trams	" 21	1,235	− 641	21	26,192	+ 284
Yorkshire Woollen District	" 12	1,060	+ 122	19	18,887	+ 1,291

(a) These comparisons are with the corresponding period last year. * Partly electrical.
† Minus 3 days. ‡ Minus 2 days. ‖ Plus 3 days. ¶ Plus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Shrs	Last Dividend	Name	Price Wed., May 24.	*Rate per cent. Yielded. £ s. d.	Dividend Due.	Business Week to May 24. Highest.	Lowest.
		Electricity Supply.					
10	6/0	Bournemouth & Poole Elec. Sup. Ord.	8¼—8¾	6 0 0	Mar, Sep	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref.	9½—9¾	4 12 3	Feb, Aug	9⅜	..
10	6/0	Do. 6 per Cent. Cum. Second Pref.	10⅜—10⅞	5 6 6	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	102—104	4 6 6	Jan, July	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	7¾—8¼	6 1 6	March....	8⅛	8
5	3/6	Do. 7 per Cent. Pref.	7½—8	4 1 3	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Deb. Stock	100—103	3 17 6	June, Dec	..	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	3⅞—4⅛	5 2 6	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	4⅜—4⅝	4 17 0	Feb., Aug	4⅜	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	96—98	4 1 6	Jan, July	98	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101½—103½	4 7 0	..	103	102½
5	2/3	Do. City Undertaking 4½% Cum. Pref.	3⅞—4⅜	5 3 0	Jan, July	..	..
5	3/0	Chelsea Electric Supply Ord.	4—4½	5 11 0	March....	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	100—102	4 8 6	June, Dec	..	..
10	8/0	City of London Electric Lighting Ord.	11¾—12¼	4 15 0	Feb, Aug	12 3/16	11 15/16
10	6/0	Do. 6 per Cent. Cum. Pref.	12—13	4 12 3	Jan, July	..	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	119—123	4 1 0	June, Dec	102½	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	101—104	4 6 6	Jan, July	..	..
St.	5%	County of Durham Elec. P. D. 5% 1st Mort. Deb. Stk.	92—94	5 5 3	Jan, July	..	..
10	6/0	County of London Elec. Supply Ord.	7⅝—8⅛	6 3 0	Feb, Aug	7⅞	7 27/32
10	6/0	Do. 6 per Cent. Cum. Pref.	10⅞—11⅜	5 5 6	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Deb Stock (red.)	109½—111½	4 0 9	Jan, July	110	..
St.	4½%	Do. Second Deb. Stock	99—102	4 8 0	May, Nov	99½	..
5	4/0	Folkestone Electricity Supply Co. Ord.	4⅛—4⅝	5 19 0	April, Oct	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4¾—5¼	4 15 3	Mar, Sept	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red)	97—100	4 10 0	Feb, Aug	..	..
5	5/0	Hove Electric Lighting Ord.	6¾—7¼	6 4 0	April, Oct	..	..
St.	4½%	Isle of Wight E. L. & P. Co. Deb. Stk.	88—91	4 19 0	..	..	..
5	5/0	Kensington & Knightsbridge Ord.	7—7¼	5 16 0	Feb, Aug	7⅛	..
5	6%	Do. 6 per Cent. 1st Pref.	5¾—6	5 0 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	93—95	4 4 0	..	..	..
St.	4%	Kensington & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	96—99	4 1 0	April, Oct	..	..
St.	4½%	Kent Elec. Power Co. Irred Deb. Stk.	80—84	5 7 0	Jan, July	..	..
3	1/2½	London Electric Supply Ord.	1¾—2¼	2 17 0	Mar, Sept	..	..
5	3/0	Do. 6 per Cent. Pref.	4¾—5¼	5 17 0	Mar, Sept	4 15/16	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb	91—94	4 5 0	Jan, July	92½	..
5	3/0	Metropolitan Electric Sup. Ord.	3¾—4¼	5 13 0	April, Oct	3 15/16	3 15/16
5	2/3	Do. 4½ per Cent. Cum. Pref.	4⅛—4⅝	4 14 9	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	101—104	4 6 6	June, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	86—89	3 18 6	Jan, July	..	..
..	4½%	Midland Elec. Corp. for Power Dist, 4½ 1st Mort. Debs.	97—99	4 11 0	..	98½	..
5	2/6	Newcastle Elec. Supply Ord.	3¾—4¼	4 14 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non Cum. Pref.	4—4½	5 11 0	Feb, Aug	..	..
100	4½%	Do. 4½ per Cent. 1st Mort. Deb.	98—100	4 10 0	Jan, July	..	..
100	5%	North Metro. Elec. Power Sup. 5 Morts.	95—97	5 3 0	..	..	..
1	6%	Northampton Elec. Lt. & P. Ord.	1¼—1 5/16	4 11 6	Feb, Aug	..	..
1	5%	Do. 5% Pref.	1 3/32—1 5/32	4 6 0	Feb, Aug	..	..
St.	4%	Do. 4% Debs.	99—101	3 19 0	June, Dec	..	..
10	10/0	Notting Hill Electric Ord.	12—12½	5 17 6	March....	..	..
5	4/3	Oxford Electric Ord.	6—6½	5 11 6	March....	..	..
St.	4%	Do. 4% Deb. Stk.	93—96	..	..	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	8¾—9¼	5 8 0	Feb, Aug	..	..
5	3/6	Do. 7 per Cent. Pref.	6¾—7¼	4 16 6	Feb, Aug	7	..
St.	3½%	Do 3½ per Cent. Deb. Stock (red.)	85—88	3 19 6	Jan, July	..	..
5	..	Smithfield Markets Electric Sup. Ord.	1⅜—1⅞	..	Feb.	..	..
5	4/0	South London Electric Supply Ord.	3—3½	6 3 0	April	3 1/16	..
St.	5%	Do 5% 1st Mort. Stock (red.)	101—104	4 16 0	..	..	..
1	8¾	South Metrop'n Elec. Lt & Power 7% 1st Pref	1⅛—1¼	5 18 0	Feb, Aug	..	..
1	7½	Do. 6 per Cent. 2nd Pref.	⅝—⅞	6 17 0	Feb, Aug	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	96—99	4 11 0	April, Oct	..	..
5	1/3	Urban Electric Supply Ord.	½—1	..	April, Oct	½	..
5	1/3	Do. 5 per Cent. Cum. Pref.	2½—3	8 6 0	April, Oct	2½	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	85—88	5 2 3	April, Oct	..	..
5	5/0	Westminster Elec. Sup. Ord.	7¾—8¼	6 5 0	Mar, Sept	..	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	5—5½	4 3 6	Jan, July	..	..
		Electric Railways and Tramways.					
1	..	Bath Elec. Trams Pref. Ord.	⅛—3/16	..	April	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	⅝—⅞	6 13 6	Jan, July	11/16	[illegible]
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	79—83	5 8 6	April, Oct	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Deb. Stock	90½—92½	4 17 3	Jan, July	91	..
10	4%	Bristol Tramways & Carriage Ord.	7—7¼	5 10 3	Feb, Aug	..	..
10	4%	Do. Cum. Pref.	7⅝—7⅞	5 1 6	..	..	..
St.	4%	Do. 4 per Cent. Debs.	101—102	3 18 3	Feb, Aug	..	..
10	..	British Electric Traction Ord.	1—1⅛	..	June, Dec	1⅛	1 1/16
10	..	Do. 6 per Cent. Cum. Pref.	4—4½	..	Feb, Aug	4⅜	4⅜
St.	5%	Do. 5 per Cent. Perpetual Debs.	94—98	5 2 0	April, Oct	96	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	75—80	5 12 3	May, Nov	..	..
St.	3%	Central London Ordinary Stock	75—77	3 19 0	Feb, Aug	77	76
St.	4%	Do. 4 per Cent. Pref. Stock	87—89	4 10 0	Feb, Aug	89½	..
St.	2%	Do. Deferred Stock	67—69	2 19 0	Feb.	67	66½
100	4%	Do. 4 per Cent. Debs.	104—106	3 16 0	Jan, July	..	..
5	2/6	City of Birmingham Trams, 5% Cum. Pref.	4¾—5	5 0 0	April, Oct	4 15/16	..
100	4%	Do 4 per Cent. 1st Mort. Debs.	99—102	3 18 9	April, Oct	..	..
St.	1½%	City & South London Rly. Con. Ord.	34—35	4 7 0	Feb, Aug	34⅜	34½
St.	5%	Do. 5 per cent. Perp. Pref. (1891)	109—111	4 10 0	Feb, Aug	111	..
St.	5%	Do. (1896)	104—106	4 12 6	Feb, Aug	..	..
St.	5%	Do. (1901)	103—106	4 15 6	Feb, Aug	105	..
St.	5%	Do. (1903)	103—106	4 15 6	Feb, Aug	105	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	101—103	3 18 6	May, Nov	..	..
10	6/0	Dublin United Trams, 6 per Cent. Pref.	12½—13½	4 10 6	Feb, Aug	12 1/16	..
10	12/0	Gateshead and District Trams Ord.	8⅜—8⅞	6 19 6	..	..	..
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	⅞—1⅛	..	Feb, Aug	..	..
5	..	Hastings & District Elec. Trams, 6% C. P.	1½—2	..	Mar. Sept	..	..
St.	4½%	Do. 4½ Deb. Stock	75—80	5 10 0	April, Oct	..	..
10	..	Imperial Tramways Ord.	3—3½	..	Mar, Sept	..	..
10	..	‡Do. 6 per Cent. Pref.	4¼—4¾	..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Debs.	71—73	6 5 0	Jan, July	..	..
..	2/6	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	2¼—2¾	5 10 0	Mar, Sept.	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	79—84	4 15 0	Jan, July	..	..
10	6/0	Lanarkshire Tramways	9¾—10¼	5 12 3	Feb, Aug	..	..
St.	5%	Lancs Utd. Trams, 5% Prior Lien Deb. Stk.	82—84	5 19 0	Jan, July	..	..
St.	4%	London Electric 4% Deb. St.	98—100	4 0 0	..	99¼	99
St.	4%	Do. 4% Pref.	84—86	4 14 0	..	84½	..
10	..	London United Trams, 5% Cum. Pref.	3¾—4¼	..	Jan, July	4⅛	3⅞
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	76—79	5 3 0	Jan, July	79½	76½
St.	..	Mersey Con. Ord. Stock	6—8	..	Feb, Aug	..	..
1	1/1½	Metropolitan Elec. Tramways Ord.	⅞—1 1/32	6 0 0	..	1 3/32	..
1	..	Do. Deferred	⅛—3/16	..	April	[illegible]	[illegible]
1	0/6	Do. 5 per Cent. Cum. Pref.	⅞—1 1/32	5 0 0	Feb, Aug	[illegible]	[illegible]
St.	4½%	Do. 4½ per Cent. Deb. Stock	102½—104½	4 7 0	Jan, July	..	..
St.	5%	Do. 5 per Cent. Db. Stk	100½—103½	4 18 0	..	103	101½
St.	1½%	Metropolitan Railway Consolidated	51¼—51¾	2 13 3	Feb, Aug	52¼	51¼
St.	2¾%	Do. Surplus Lands Stocks	66—68	4 1 0	Feb, Aug	67	66½
St.	3½%	Do. 3½ per Cent. Preference	90—92	3 16 0	Feb, Aug	91¼	90⅜
St.	3½%	Do. 3½ per Cent. "A" Preference	89—91	3 17 0	Feb, Aug	90¼	..
St.	3½%	Do. 3½ per Cent. Convertible Pref.	89—91	3 17 0	Feb, Aug	90¼	90¼
St.	3½%	Do. 3½ per Cent. Debenture Stock	93—95	3 13 6	Jan, July	94	93¾

* No allowance has been made for accrued interest or redemption.
† Ex Dividend ‡ The London Stock Exchange Committee have declined to quote these.

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ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shrs	Last Dividend	Name.	Price Wed., May 24.	*Rate per cent. Yielded. £ s. d.	Dividend Due.	Business Week to May 24. Highest.	Lowest.
		Electric Railways and Tramways— *Continued.*					
St.	3½%	Met. Rly. 3½ per Cent. "A" Deb. Stock..	92 –94	3 14 6	Jan, July	93½	
St.	..	Metropolitan District Railway Ord.....	32½–32¾	..	Feb, Aug	90	32½
St.	3½%	Do. 4½% First Pref.	89 –91	4 19 0	Feb, Aug	..	..
St.	3½%	Do. Assented Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	75 –77	4 11 0	Feb, Aug	76½	75½
St.	3%	Do. 3 per Cent. Consoltd. Rent-charge	77 –79	3 16 0	Jan, July	78½	..
St.	4%	Do. 4 per Cent. Midland Rent-charge	103 –105	3 16 0	Jan, July	..	..
St.	6%	Do. 6 per Cent. Perp. Deb. Stock.....	148 –150	4 0 0	Jan, July	149½	..
St.	4%	Do. 4 per Cent. Ditto.....	98 –100	4 0 0	Jan, July	100	99
1	4½d.	Potteries Electric Traction Ord.	¼ –⅜	..	April, Oct	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.....	⅜ –½	7 5 0	Feb, Aug	⅜	–
St.	4½%	†Do. 4½ per Cent, Deb. Stock.....	86 –89	5 1 0	May, Nov	..	..
1	1/2½	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	½–¾	10 2 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock.....	75 –80	5 0 0	Jan, July	..	..
100	5%	Sunderland Dist. Elec. Trms. 5% 1stMtDb.	..	8 4 0	Jan, July	66	64½
..	10/0	UndergdE.Rys.Lon.6% In. bds with coup 7	64 –66	1 10 3	June, Dec	..	..
–	5%	Do. 5% Prior Lien Bonds.....	100 –101	4 19 0	..	101	99
–	4½%	Do. 4½% Bonds with coup. 7	99 –101	4 9 3	..	101½	100½
..	4%	Do. 4 per Cent. 1st Power Ho. Dbs. ..	100 –102	3 18 3	..	..	..
5	..	Yorkshire (W.R.) Elec. Trams. Ord.....	⅜ –½	..	March ..	..	..
5	..	Do. 6 per Cent. Cum. Pref.....	2¾–2¾	..	..	..	..
St.	4½	Do. 4½ per Cent. 1st Debs.....	84 –87	5 3 3	Jan, July	–	..
		Electric Manufacturing, &c.					
St.	4½%	Anchor Cable Co. 4½ % Deb. Stock	99 –101	4 9 0		–	..
1	..	Aron Electricity Meter Ord.....	⅛–⅜	..	..	..	..
1	0/7½	Do. 6% Cum. Pf.	⅝–¾	7 4 0	April, Oct	⅞	..
1	3/2½	Babcock & Wilcox Ord.	5⅛–5⅜	4 14 6	April, Oct	5¼	5⅛
1	0/7½	Do. Pref.....	1⅛–1½	4 0 0	..	..	..
5	6/0	British Insulated & Helsby Cables Ord...	6½–7⅛	6 15 6	July, Feb	7	..
5	3/0	Do. 6 per Cent. Pref.....	6 –6½	4 12 3	Jan, July	6½	–
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)..	102 –104	4 6 6	Jan, July	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt.Db.	96 –99	4 11 0	Mar, Sept	..	..
5	..	British Westinghouse 6 per Cent. Pref....	⅛–½	..	Feb, Aug	..	–
100	6%	Do. 6 per Cent. Prior Lien Dbs. (rd.)..	100 –103	5 16 3	..	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock.....	61 –64	6 5 0	Jan, July	..	..
St.	4½%	BrushE.Eng. Co. 4½% Perp. 1st Deb.Stock	57 –64	7 0 6	Mar, Sept	41½	..
St.	4½%	Do. Perpetual 2nd Deb. Stock.....	41 –46	9 16 0	Jan, July	..	..
5	5/0	Callender's Cable Con. Ord.....	9¼–9½	7 12 0	Jan, July	9⅝	..
5	2/6	Do. 5 per Cent. Cum. Pref.....	4½–5⅛	4 17 6	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort Debs. (red.)..	102 –104	4 6 6	Nov, May	3¼	3⅛
1	1/6	†Castner-Kellner Alkali Co.....	3⅛–3⅜	5 1 9	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)..	103 –106	4 3 6	Feb. Aug	..	..
1	7½d.	Chadburn's (Ship) Telegraph Ord.	1⅛–1⅜	5 19 0	March ..	..	..
1	0/8½	Consolidated Electrical Co.....	⅛–¼	10 0 0	August ..	⅛	..
1	0/6	Consolidated Signal Co.....	½–1	5 0 0	April, Oct	..	..
1	0/7½	Do. 6 per cent. Cum. Pref.....	⅝–⅞	6 8 0	April, Oct	..	..
3	..	Crompton & Co (Nos. 1 to 85,000)	⅛–¼	..	Jan, July	..	..
100	5%	Do. 5 per Cent. 1st Mort. Debs. (red.)..	70 –80	6 5 0	Jan, July	..	..
5	1/0	Dick, Kerr & Co. Ord.....	¾–1	5 0 0	Sept.	..	..
5	0/7½	Do. 6 per Cent. Cum. Pref.....	1 –1½	5 6 6	Sept	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock.....	97 –100	4 10 0	Jan, July	..	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	⅞–⅞	..	Feb, Aug	⅞	..
	..	Do. (£5 paid)	1¼–2¼	9 3 0	Feb. Aug	71½	70½
St.	4%	Do 4 per Cent. Mort. Deb. Stock (red.)	69 –73	5 9 9	June, Dec	..	..
St.	5%	Do 5 per Cent. 2nd Deb. Stock.....	78 –81	6 3 6	Mar, Sept	..	..
..	..	Edmundson's Elec. Corp. Ord.....	⅛–⅜	..	Jan, July	..	..
5	..	Do. 6 per Cent. Cum. Pref.	2¾–3¼	..	May, Nov	..	..
St.	4½%	Do 4½ per cent. 1st Mort. Deb. (red.)..	86 –89	5 1 0	Jan, July	..	..
2	..	Electric Construction Co.....	¾–1	..	Jan, July	..	..
2	2/9½	Do. 7 per Cent. Cum. Pref.....	1¾–2	7 0 0	July	..	..
St.	4%	Do. 4 per Cent. Perp. 1st Mort. Debs..	70 –73	5 8 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref. ..	8⅞–9¼	5 9 0	June, Dec	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.....	83 –88	4 11 6	Mar, Sept	..	..
5	10/0	Henley's Telegraph Works Ord.....	12½–12¾	5 16 6	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	4⅛–5⅛	4 7 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	108 –110	4 2 0	Mar, Sept	..	..
10	15/0	India Rubber, Gut. Per., &c., Works....	16½–17	5 17 9	Feb, Aug	19½	10½
10	5/0	Do 5 per Cent. Cum. Pref.	10½–10¾	4 14 0	..	97½	..
100	4%	Do. 4 per Cent. Debs. (red.)	96 –98	4 1 6	April. Oct	..	..
1	..	National Elec. Construction Co.	⅛–⅜	..	April	..	..
1	..	Richardsons, Westgarth & Co., Ltd. Ord.	⅝–¾	..	Nov	..	..
1	..	Do. 6 per Cent. Cum. Pref.	¾–⅞	..	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. Perp. Deb. Stock....	78 –82	5 10 0	Jan, July	..	..
5	..	Simplex Conduits 6 per Cent. Cum. Pref.	4½–5	..	..	..	..
12	36/0	Telegraph Construction & Maintenance..	35½–38½	5 16 3	Mar, July	37½	36½
100	4%	Do. 4 per Cent. Deb. Bonds (1909)	100 –102	3 18 6	Jan, July	..	..
1	1/0	Vickers, Sons & Maxim, Ltd., Ord.....	2⅛–2¼	4 15 0	..	2¼	2⅛
1	0/6	Do. 5 per Cent. non-Cum. Preference..	1⅛–1⅜	4 3 0	..	1⅜	1⅛
St.	5%	Do. 5 per Cent. non-Cum. Preferred ..	110 –113	4 8 6	..	..	..
St.	4%	†Do. 4 per Cent. 1st Mort. Db.-Sk. (red)	99 –101	4 0 0	June, Dec	..	..
100	4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.)	104 –106	4 5 0	June, Dec	105	..
100	5%	Do. 4 per Cent. 1st Mort. Deb.-Sk. (red)	105 –107	4 13 6	..	105½	105¼
10	10%	Do. 5 per Cent. 3rd Mort. Debs Scrip...	14½–15½	6 11 0	..	..	..
1	..	J. G. White & Co. 6% Cum. Pref.	⅛–¼	..	Apr, Oct	..	..
5	..	Willans & Robinson Ord.....	½–1	..	Apr, Oct	..	..
St.	4%	Do. 6 per Cent. Cum. Pref.....	55 –65	6 3 0	May, Nov	..	–
		Telegraphs.					
10	..	Amazon Telegraph	7⅛–7⅜	..	June, Dec	..	..
100	5%	Do. 5 per Cent. Debs. (red.)	99 –101	5 0 0	Jan, July	103½	99½
St.	15/0	Anglo-American	69 –71	4 4 6	F,My,Ag,N	114½	113½
St.	30/0	Do Preferred	113½–114½	5 5 0	F,My,Ag,N	..	..
St.	30/0	Do. Deferred	26⅛–26⅜	5 7 0	F,My,Ag,N	26½	26½
St.	4%	Commercial Cable 4 per Cent. Deb. Stk...	88 –90	4 9 0	Jn,Ap,Jy,O	87½	88½
10	6/0	†Cuba Submarine Ord.	9½–10½	5 17 0	Feb, Aug	10⅛	..
10	10/0	†Do. Preference 10 per Cent.	17 –18	5 9 0	Feb, Aug	..	..
5	2/0	Direct Spanish Ord.	3⅞–4	5 0 0	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.....	8½–8¾	5 16 0	April, Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	100½–102½	4 8 0	Jan, July	..	..
10	2/0	Direct United States Cable.....	7⅜–7½	6 3 6	Ja,Ap,Jy,O	7½	7½
100	4½%	Direct West India Cable 4½%Rg.Db.(rd.).	100 –102	4 9 0	June, Dec	..	..
St.	25/0	Eastern Ordinary	137½–140½	5 0 9	Ja,My,Jy,O	138½	137½
St.	17/6	Do. 3½ per Cent. Pref. Stock.....	84½–85½	4 1 0	Ja,My,Jy,O	85½	85½
St	4%	Do. 4 per Cent. Mort. Deb. Stk. (red.)..	100½–102½	3 18 6	May, Nov	102	101
St	2/6	Eastern Extension	13½–14½	5 1 0	Ja, Ap, Jy, O	14	13½
10	4%	Do. 4 per Cent. Deb. Stock	101 –103	3 18 6	Feb, Aug	102½	102
25	4%	Eastern and S.Af., 4% Mauritius Sub.Debs	99½–101½	3 19 0	May, Nov	101	99½
10	26/0	E.N (of Copenhagen), with Coupon 82 ..	31½–32½	5 10 0	Jan, July	32	31½
25	52/5	ndo-European xd and bonus	55½–59½	5 6 6	May, Nov	58	57
100	5%	Mackay Companies Common	93 –96	5 4 0	Ja,Ap,Jy,O	..	..
100	4%	Do. Preference	78 –80	5 0 0	Ja,Ap,Jy,O	..	..
1	..	Marconi's Wireless Teleg. Co.	1½–1¾	..	April	1⅜	1⅓
100	4%	Pacific & Europe'n Tel.4%Guar.Dbs.(red.)	100 –102	3 18 3	June, Dec	..	..
2½	1/3	West Coast of America	1¼–1½	4 3 0	May	1½	..
100	4%	Do. 4 per Cent. Debs.....	99½–101½	3 18 9	Jan, July	..	..
10	1/0	West India & Panama	2½–2⅝	1 18 0	May, Nov	2⅝	2½
10	6/0	Do. 6 per Cent. 1st Pref.	10¼–10⅝	5 10 0	May, Nov	..	..
10	15/0	Do. 6% 2nd Pref.	9¼–10½	5 17 0	May, Nov	..	–
100	5%	Do. 5 per Cent. Debs.....	102 –104	4 16 0	Jan, July	..	..
10	3/0						

Shrs	Last Dividend	Name.	Price Wed., May 24.	*Rate per cent. Yielded. £ s. d.	Dividend Due.	Business Week to May 24. Highest.	Lowest.
		Telephones.					
100	2$	Amer. Telephn. & Telegh. Cap. St.	152½ –154½	5 4 0	..	153½	152½
..	4%	Do. Coll. Trust $1,000 4 per Cent. Bds.	95½–97½	4 3 0	Jan, July	95½	95½
St.	4%	Do. 4% Cons. Bonds 1936	113½–115½	3 10 0	..	..	..
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101 –103	4 17 0	Mar, Sept	..	..
5	3/0	Chili Telephone	7⅛–7⅜	5 11 6	August ..	..	..
1	0/7½	Monte Video Telephone Ord.....	½–1	6 0 0	Nov	..	..
1	0/6	Do. 5 per Cent. Pref.	½–¾	5 11 0	May, Nov	..	..
St.	6%	National Co. Pref. Stock.....	104 –105	5 14 3	Feb, Aug	104	104
St.	6%	Do. Def. Stock	128 –130	4 13 0	Feb, Aug	130	130
10	6/0	Do. 6 per Cent. Cum. 1st Pref.....	10 –10½	5 11 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.....	10 –10½	5 11 6	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.....	5⅛–5⅜	4 10 0	Feb, Aug	5⅛	5⅛
St.	3½%	Do. Deb. Stock 3½ per Cent. (red.).....	99 –101	3 9 3	June, Dec	99	99
St.	4%	Do. 4 per Cent. Deb. Stock (red.).....	99 –101	3 19 3	Jan, July	99	99
..	4½%	New York Telephone Co. 30 yr. Bnds.....	99 –100	4 10 0	..	..	..
1	1/0	Oriental	1⅛–1⅜	4 18 0	April, Oct	..	..
1	0/7½	Do 6 per Cent. Cum. Pref.	1⅛–1⅜	4 16 0	April, Oct	..	..
St.	4%	Do. 4 per Cent. Red. Deb. Stock.....	87½–69½	4 9 6	Jan, July	8..	..
St.	4½%	Telephone Co. of Egypt 4½%Db.Stk.(red.)	100 –102	4 9 0	Jan, July	..	..
5	3/0	United River Plate Ord. (1—150,000) ...	7⅛–7⅜	5 3 0	July	..	..
3	4½%	Do. (150,001—190,000).....	7⅛–7⅜	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅛–5⅜	4 9 0	June, Dec	..	..
St.	4½%	Do. 4½ Deb. St. Red.....	103 –105	4 5 9	Jan, July	..	..
		Financial, Investment, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref...	4 –4½	7 1 0	Jan, July	..	..
10	2/0	Globe Telegraph & Trust	11 –11½	5 2 6	Sp,DcMrJu	..	..
10	3/0	Do. 6 per Cent. Pref.	13 –13½	4 9 0	Sp,DcMrJu	..	..
10	6%	Submarine Cables Trust (Cert.)	131 –134	4 9 6	April, Oct	..	..
		Colonial and Foreign Electric Railways, Tramways, &c.					
5	2/6	Anglo-Argentine 5% Cum. 1st Pref.	5 –5½	4 15 3	April, Oct	..	..
5	2/6	Do. 5% Cum. 2nd Pref.....	4⅝–5⅛	4 17 6	Jan, July	..	..
..	4%	Do. 4% Deb. Stock	95½–97½	4 3 0	June, Dec	..	..
St.	4½%	Do. 4½% Deb. Stock	101 –103	4 8 3	..	..	..
St.	8%	Do. 5% Deb Stock	103 –105	4 16 0	..	..	..
St.	6%	Auckland Elec. Trams. 5% Deb. (red.)....	104½–106½	4 14 6	Jan, July	..	..
5	4/0	Brisbane Electric Trams. Invest. Ord	6½–6¾	6 3 0	May	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅞–5⅛	4 18 9	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Certs.....	102 –105	4 6 0	Jan, July	..	..
St.	8%	British Columbia El..Rly. Df.Ord.	146 –150	5 6 9	Mar, Sept	..	..
St.	6%	Do. Pref. Ord. Stock	126 –129	4 14 0	May, Nov	..	..
St.	5%	Do. 5% Cum. Perp. Pref. Stock.....	109 –112	4 10 6	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs.....	100 –103	4 7 6	April, Oct	..	..
40	4½%	Do. Vancouver Power Debs.	102 –105	4 5 9	Jan, July	..	..
100	4½%	Do. 4½% Perp. Con. Deb. St.	101½–103½	4 2 6	..	..	..
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	99½–101½	4 19 6	Mar, Sept	..	..
St.	6%	Buenos Ayres Port & City Tram, 1st Mt. Deb. Stock	93 –98	6 2 6	Feb, Aug	..	..
		Calcutta Tramways (1 to 137,610).....	5½–6	5 0 0	Mar, Sept	..	..
		Do 5 per Cent. Cum. Pref.	5½–5¾	4 13 0	Jan, July	..	..
100	2/6	Do 4½% 1st Deb. Stock (red).....	10. –104	4 6 6	Jan, July	..	..
1	4½%	Cape Electric Tram Shares	5⅜–5⅝	..	..	..	..
		City of Buenos Ayres Trams Co. (1904) Sh.	5⅛–5⅜	4 5 0	F,My,A,N	..	..
5	1/3	Do 4 per Cent. Deb. Stock.....	96 –99	4 0 9	June, Dec	..	..
St.	4%	Colombo Tr. & Ltg. 5% 1st Mt. Db.....	95 –98	5 2 0	May, Nov	..	..
	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	100½–102½	4 18 6	Feb, Aug	..	..
100	5%	Hong Kong Tramways Co. 5 per Cent. 1st Mort. Debs.	78 –82	6 1 6	June, Dec	..	..
1	5%	Kalgoorlie Elec. Trams Sh.	⅜–½	..	..	..	..
100	5%	Do. 5 per Cent. "A" Deb. Stock.....	94 –97	5 3 0	Jan, July	..	..
100	6%	Do. 6 per Cent. "B" Ditto	96 –70	4 5 9	Jan, July	..	..
5	0/7½	Lisbon Elec. Trams. Ord.	1 –1½	4 16 0	July	..	..
100	0/7½	Do. 6 per Cent. Cum. Pref.	1 –1½	4 16 0	Jan, July	..	..
St.	5%	Do. 5 per Cent. Reg. Mort. Debs.....	98 –102	4 18 0	Jan, July	..	..
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	96 –98	5 2 0	Jan, July	..	..
100	5%	Manaos Trams and Lt. Co. 5% Debs	95 –97	5 4 0	..	..	..
100	5%	Manila Elec. Ry. $1.000 Gold Bonds.....	100 –102	4 18 0	Feb, Aug	..	..
100	$3½	Mexico Trams Co. Com. St.	124½–127½	5 11 0	..	..	..
100	5%	Do. Gen. Con. 1st Mort. 5% Gold Bds.	96½–97½	5 2 3	..	..	..
St.	6%	Do. 6% 50 yr. Mort. Bds.....	102½–103½	5 17 0	–	..	..
St.	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922) (Nos. 601 to 2,000)	101 –103	4 7 6	Feb, Aug	..	..
		Do. do. (Nos. 1 to 4,600)	101 –103	4 7 6	..	..	..
1	0/6	Perth Elec. Trams Ord.	⅛–⅜	2 13 6	May	..	..
St.	5%	Do 1st Mt. Db. Stock	104 –106	4 14 3	Jan, July	..	..
5	3/0	Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	5⅛–5⅜	5 4 6	–	..	..
		Do. 4½% 1st Mort. Deb. Stk.	99 –102	4 8 0	..	..	..
		Rio Janeiro Tram, Lt. & P. Co.....	112½–113½	4 8 6	..	..	..
		Do. 30 yr. Gold Bnds.	103 –104	4 16 0	..	..	..
		Do. 50 yr. Mt. Bnds	96½–97½	5 3 0	–	..	..
		Sao Paulo Tramway, Light & Power Co. $100 Stock	176½–178½	5 12 9	..	..	..
		Do. 5 per Cent. 1st Mt. $500 Db.	105 –106	4 15 0	June, Dec	..	..
		Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	93 –100	4 10 0	Feb, Aug	..	..
		Colonial and Foreign Electricity Supply, &c.					
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.....	5½–5¾	5 8 0	Mar, Sept	..	..
10	6/0	Bombay E.S. & T. 6% Cm. Pf.....	10¾–11¼	5 5 6	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stk. (red).....	96½–98½	4 12 0	Jan, July	..	..
5	5%	Do. 5 per Cent. 2nd Mort. Deb. Stock..	98 –100	5 1 0	..	..	..
5	2/6	Calcutta Elec. Supply Ord.	7 –7½	6 13 6	April, Oct	..	..
100	5%	Do. 5% Cum. Pref	4⅞–5⅜	4 13 0	..	..	..
100	7/2½	Calgary Power Co. 5% 1st Mort. Bnds....	95 –98	5 2 0	–	..	..
100	$3½	Canadian Gen. Elec. Co. Com. St.....	111 –114	6 3 0	..	..	..
100	5%	Do. 7% Cm. Pf. Stock	120 –123	5 14 0	..	..	..
100	5%	Castner Electrolytic Alkali Co.(of U.S.A.) 1st Mort. Stl. Debs.	97 –102	4 18 0	Jan, July	..	..
500	5%	Elect. Development Co. of Ontario.....	83 –85	5 14 0	..	..	..
St.	5%	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	87 –90	5 11 0	Jan, July	..	..
5	..	Indian Elec. Sup. & Trac. Co.	1 –1½	..	..	..	..
10s	..	Kalgoorlie Elec. Powsr & Ltg. Ord.	⅛–⅜	..	..	..	..
1	0/7½	†Do. 6 per Cent. Cum. Pref.	⅝–¾	8 6 6	April, Oct	..	..
5	5%	Kaministiquia Power Co.5% Gold Bnds...	103 –105	4 15 0	..	..	..
		Madras E. S. Corp. Ord.	3 –3½	..	..	..	..
		Melbourne E. S. Co. Cons. Ord. St.....	23 –33	..	..	..	..
St.	..	Do. 5% 1st Mortg Deb. Stock.....	94 –96	5 4 0	..	..	..
St.	5%	Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	89½–90½	5 9 0	..	..	..
St.	$1	Mexican Lt. & Power Co. Com. St.	84½–86½	4 13 6	..	..	..
St.	$3½	Do. 7% Cum. Pref. St.	103 –110	6 8 3	..	..	..
500	5%	Do 5% 1st Mort. Gold Bnds.....	94½–95½	5 5 0	..	..	..
St	5%	Monterey Rly. L. & P. Co.1st Mort.Db.Sk.	89½–91½	5 10 6	..	..	..
100	8/2½	Montreal Lt. Ht. & Power Co. Cap. St....	154 –157	4 16 0	F,My,A,N	..	..
100	5%	Northern Lt. Power & Coal 5% Gd.Bds ..	71 –73	6 17 0	..	..	..
St.	£10	†River Plate Electricity Co. Ord. Stk.	218 –228	4 7 9	April	..	..
St.	6%	†Do. 6 per Cent. non-Cum. Pref. Stk. ..	107 –114	5 5 0	May	..	..
St.	5%	Do. 5 per Cent. Deb. Stock	104 –106	4 14 3	Jan, July	..	..
100	$1½	Shawinigan Water& Power Co.Ca.....	115 –118	4 6 0	..	..	..
	5%	Do. 5 per Cent. Bds	108½–110½	4 10 6	Jan, July	..	..

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NOTES.

Electric Lamps for Miners.

It has long been realised that a good electric lamp for use by miners would be ideal from the safety point of view, but there have been so many difficulties to be overcome in detail before attaining a really satisfactory result that the electric miner's lamp has not yet made any great headway. The want of such a lamp is felt more than ever at the present time, and is emphasised by an important announcement by the HOME SECRETARY, to the effect that a colliery proprietor has placed £1,000 at his disposal as a prize for the best electric lamp or lamps fulfilling certain specified requirements. These our readers will find set out in another column, and they are mostly of a very reasonable, and indeed essential, character. The only stipulation that we feel is open to serious criticism is that a lamp must give not less than 2 c.p. continuously for ten hours. This is a much larger candle-power than is usual with ordinary miners' lamps. In itself, of course, there is no objection to the increase in light, as it may assist the miner in his work, and there would be no difficulty in producing such a light for the time stipulated but for the fact that a miner's lamp to be of practical value must have its weight kept below quite a low figure. On this account we fear this stipulation may result in a lamp which, technically, fulfils the specified requirements, but which, nevertheless, will be impractical from the miner's point of view. In any case, however, we hope that designers and manufacturers will take up the challenge seriously. They will doubtless be encouraged to do so by the fact that, in his report on the Pretoria pit disaster, issued this week by the Home Office, Mr. R. A. S. REDMAYNE, H.M. Chief Inspector of Mines, suggests that serious consideration should be given to the possibility of replacing the gauze lamp in fiery mines by the electric lamp.

The Pretoria Pit Disaster.

THE report to which we have just referred is an effective answer to the ill-considered and reckless statements that have been made by some of the miners' representatives as to electricity being responsible for the disaster at Hulton Colliery last December. Mr. REDMAYNE, after holding an exhaustive inquiry into the circumstances of the explosion, is perfectly satisfied that the use of electricity in the mine had no bearing whatever on the disaster. This official pronouncement will be welcomed by electrical engineers, and we are sure it will do much to allay any fears that may have arisen in the minds of colliery managers as to the desirability of extending the use of electrical apparatus. It will certainly do much to strengthen the hands of managers in resisting the demands of the miners to have electrical apparatus removed from the pits. This opposition of labour to improved methods of working is to be regretted, but it will doubtless disappear as the number of mines using electrical apparatus increases.

"The National."

FOR a moribund institution the National Telephone Co. is "dying hard." There was no dullness or dolefulness about the huge gathering of the staff of the Company assembled at the Hotel Cecil on Thursday last week, to celebrate the seventeenth Annual Staff Dinner. These gatherings

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have always been notable for expressions of loyalty to and zeal for the National Co.'s interests, and for the recognition that the directors have rendered to the staff on this account. But at this concluding family gathering there was a friendliness and a warmth in the proceeding throughout that must have been comforting to those who are called upon to part company after so many years of true camaraderie. The severance, if such it may be termed, was certainly softened by the kindly words of the President and by the sincere and hopeful words of the Postmaster-General, whose fine speech and graceful references to the merits of the men who are shortly "going over," were received with what was clearly the utmost respect. The remarks of Mr. SAMUEL, we are sure, conveyed to the hearts of his audience a feeling of relief which, so far as they touched upon some of the chief points at issue, could be felt, and there is to-day a hopefulness in telephone ranks that has hitherto been noticeably absent. The rank and file of the National Company, we are sure, give a large meed of credit for this to the directors and chief officials of the Company. The annual dinners, now, alas, terminated, have furnished the opportunity for cordial intercommunication between the scattered elements of this great undertaking, and will be remembered with feelings of great pleasure. We must be satisfied here with our expression of pleasure tempered with regret, and refer our readers to the full report of the proceedings which is given on a subsequent page, taking the occasion to compliment the Postmaster-General upon the manner in which he responded to a great opportunity. It must be remembered that nearly 18,000 men and women are directly interested in his statement.

The Heating of Cables with Current.

OWING to the absence of the president and vice-presidents, it fell to Dr. R. T. GLAZEBROOK to preside at the meeting of the Institution of Electrical Engineers last week. The fact that the Paper under discussion was by two members of the Staff of the National Physical Laboratory, and dealt with a valuable series of investigations carried out at Bushy House, rendered his presence in the chair particularly appropriate. This research was undertaken, it will be remembered, at the request of the Wiring Rules Committee of the Institution, and the Table of limiting currents in the new edition of the Rules has been based on the results detailed by Messrs. S. W. MELSOM and H. C. BOOTH in their Paper. In view of the criticism that has been raised in certain quarters as to the supposed excessive current density allowed in the case of small conductors, Mr. C. P. SPARKS, Chairman of the Wiring Rules Committee, showed at the meeting last week that the current carrying capacities now tabulated in the Rules rested for the first time on a logical basis; that is, a limiting rise of temperature had been adopted instead of a pressure drop. When it is remembered that the maximum increase in temperature permitted on this basis is only 20° F. in the case of rubber-covered conductors, it is obvious that there is a very large factor of safety; and the next step will now be to determine what is the maximum temperature rise that can really be allowed with safety. In view of the general desire that this should be done, we expect that when the seventh edition of the Rules makes its appearance the Table of Conductors will be still further modified. For the present, general satisfaction is expressed at the considerable saving that can be effected in the cost of wiring, particularly in heating and power installations, Mr. RAWLINGS going so far as to say that the recent revision of the maximum current-carrying capacities of conductors would do more than anything in the past to bring about a day load for central stations. Whilst welcoming anything that will cheapen the cost of installations, it must be remembered, however, that this is only part of the problem of encouraging consumers to adopt electrical apparatus, and most progress must be looked for from improved publicity methods, of which the new demonstration rooms of the Westminster Electric Supply Corporation, mentioned in our last issue, are typical.

Messrs. MELSOM & BOOTH'S Paper suggests several lines for further research; one, in particular, which should prove of exceptional value to the electric supply industry, is the comparative rise in temperature and the safe current-carrying capacity of underground cables laid on different systems. Preliminary investigations of this kind are referred to briefly in the Paper, and the results were reproduced in Fig 4 of our abstract last week, but these only apply to a single conductor; experiments on three-core cables would be particularly valuable, since the current density permissible in such cases would probably be much less than in the case of single cables. It is, however, useful to learn from the authors' experiments that the rise of temperature of a paper-insulated lead-covered cable laid in damp ground is less than half that where the cable is installed underground in an earthenware pipe.

Electricity Supply in the Colonies.

AFTER perusing the annual reports for the past year of electricity supply and tramway undertakings in this country, which are now coming to hand by almost every post, it is especially interesting to receive from Mr. O. V. THOMAS, engineer and manager of the municipal electricity supply department at George Town, Penang, a copy of his annual report for 1910. We notice that the metal-filament lamp has had an entirely beneficial effect on the business of the Penang undertaking, a very satisfactory result being the rapid extension of the supply to small consumers in the native business quarters, who require from three to six lamps each. During the past year the number of units sold to private consumers increased by over 40 per cent. but more striking, perhaps, is the fact that in recent year the output for public lighting has exceeded the privat supply. On the present occasion, however, the position i reversed, and the figures are 265,121 and 326,525 unit respectively. A traction supply of 200,090 units brings the total output to 791,736 units. For this output, the tota costs, excluding capital charges, were 9·94 cents (equivalent to about 2½d.) per unit sold, fuel accounting for 3 per cent. of the total. It is satisfactory to notice tha the balance of revenue over working expenses represente 9·6 per cent. on the capital expenditure, but owing to hig capital charges (interest 5 per cent., sinking and renewa

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fund 3 per cent.) the net profit was only $9,698 (representing about £1,130); this, however, was considerably greater than in the previous year.

Publicity Committee Conference.—The Electric Supply Publicity Committee held its first annual conference at the Institution of Electrical Engineers on Tuesday, Mr. H. B. Renwick, Chairman of the Committee, presiding. There was a good gathering of leading representatives of the supply industry present, and a complete account of the proceedings will appear in our next issue. The Chairman reviewed the leading features of the work of the Committee, and referred to the large amount of literature which had been distributed relating to electricity supply for all purposes. He also expressed the satisfaction of the Committee at the result of the work accomplished.

Scientific Management.—The April number of the "Engineering Magazine" is a special issue devoted to the subject of Scientific Management, and among the contents we notice an article by Mr. R. W. Hutchinson, jun., on "The Applications of Electricity in Mining Industries." The author deals with the subject in a general way, illustrating the range of electrical applications to mining. He classes distributing systems for mines under three headings: (1) Continuous current for haulage, power and lighting; (2) continuous current for haulage and polyphase alternating current for power and lighting; and (3) high-potential alternating current for distribution to sub-stations, where it is converted into continuous current or low-pressure alternating current, or both. The first system is considered to be best adapted to mines in which power has not to be transmitted a great distance; the second for the same conditions in dusty or gaseous mines; and the third where a large mine or number of mines can be supplied from one central power plant. In future articles, cables and wiring, lighting, haulage, pumping, &c., are to be considered. Other articles in the special issue to which attention may be called are: "The Most Resourceful Utilisation of Water Powers," by Mr. H. von Schon; "Industrial Uses of Reinforced Concrete Construction," by Mr. J. P. H. Perry; and "Power Plant Betterment by Scientific Management," by Mr. W. N. Polakov.

The Discrimination of Colours.—In a Paper on this subject read at a meeting of the Royal Society, Dr. F. W. Edridge-Green stated that if a definite portion of the spectrum be isolated it appeared monochromatic, the size of the monochromatic region varying with the luminosity and wave-length of the light and the colour perception of the observer. Lord Rayleigh had expressed the opinion that he could discriminate between the colours in a monochromatic region even to the extent of distinguishing between the colours of the two D lines. The author, however, did not find this possible when special precautions were taken to have a pure spectrum and to avoid the physiological effect of contrast through varying intensities of the areas to be compared. The monochromatic area might be modified without altering its monochromatic appearance: the intensity of the light source being increased to compensate for the diminished luminosity. The monochromatic area might also be examined through a double-image prism, or be projected by means of a double-image prism upon a screen, so that the violet side of one area would be adjacent to and just touch the red side of the other area. In this way the monochromatic area might be made as large as desired, the intensity of the source of light being increased as required. An arc light gave two very bright areas of colour. This method was the most favourable for the detection of any difference; the monochromatic areas, however, still remained monochromatic.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Assab–Perim	July 8, 1909 ...	—
Malta–Tripoli.....	April 20, 1910 ..	—
Latakia–Palurs	May 26, 1910 ...	—
Tourane-Amoy	Sept 25, 1910 ...	May 29, 1911

Mr. W. E. Lane.—The Executive Committee of the Electro-Harmonic Society are organising a presentation to be made to the honorary secretary (Mr. W. E. Lane) on his marriage.

The Committee have thought that it would be the desire of members that the opportunity should be taken to present to Mr. Lane some slight token of their regard and of their appreciation of the services which he has ungrudgingly rendered with such conspicuous success as honorary secretary of the Society during the past 10 years. It is proposed that the subscription should be limited to 2s. 6d. each, in the hope that the full membership of the Society will participate. The Committee suggest that a list of the subscribers should be presented to Mr. Lane with the testimonial. Mr. R. K. Gray has consented to act as treasurer, and Mr. J. E. Kingsbury is acting as secretary to the fund. Contributions should be sent to Mr. Kingsbury, 7, Serjeants' Inn, E.C., before June 5.

Visual Sensation in the Alternating Magnetic Field.—In the April "Proceedings" of the American Institute of Electrical Engineers, Mr. A. H. Babcock refers to the recent Paper by Dr. J. B. Whitehead, of which an abstract was given in our issue of April 7th: Mr. Babcock points out that in 1897 while experimenting with some choke coils with large leakage connected across the receiving end of one of the first long distance high-tension lines placed in operation in Central California, a very marked sensation of flickering light was noticed whenever his head was moved through the leakage field. The matter was reported to the late Dr. F. A. C. Perrine and was investigated by him, though, if recollections of that occurrence are correct, he was practically the only one experimenting who did not corroborate the observations of the others. No record can now be found of any publication of these tests, though Mr. F. G. Baum confirms the writer's recollections of the experiments. The reactance used was a 150 kw. Stanley transformer of the vertical core type, in which the iron circuit was opened sufficiently to produce practically full-load current when the 2,200-volt coils of the transformer were connected across the station 'bus-bars and the high-tension coils were open-circuited.

Electric Lamps for Miners.—The Secretary of State for the Home Department announces that, in order to encourage the production of safe and efficient types of electric lamps for miners, a colliery proprietor has placed at his disposal the sum of £1,000 to be offered as a prize for the best lamp or lamps fulfilling the requirements specified below. Mr. Charles Rhodes (a former President of the Institute of Mining Engineers) and Mr. Charles H. Merz (a member of the Departmental Committee on the Use of Electricity in Mines) have consented to act as judges. The conditions of the competition are as follows:—

1. The competition will be open to persons of any nationality.

2. It will be in the discretion of the judges to award the whole of the prize for the lamp which they consider to be the best; or to divide the prize; or to make no award if no lamp appears to them to be of sufficient merit.

3. Lamps must be addressed care of C. Rhodes, Esq., at the Home Office Testing Station, Rotherham, and must reach the testing station not later than December 31st next; a spare globe should accompany each lamp.

The requirements which should be fulfilled by any lamps submitted for competition are as follows: (1) The lamp should be of sound mechanical construction so as to withstand rough usage. (2) The lamp should be of simple construction and easy to maintain in good order and repair. (3) The lamp should be so constructed as to render impossible the ignition of inflammable gas either within or without the lamp. (4) The lamp battery should be so constructed that any liquid which it may contain cannot be spilled when the lamp is in use, and means should be provided for dealing with any gas which may be generated by the battery. (5) The materials used and the construction should be such that metals and other parts will not be liable to deterioration by corrosion as a result of the action of the "electrolyte," &c., used in the battery. (6) The lamp should be effectively locked so that it cannot be opened without detection. (7) The lamp should be capable of giving an amount of light not less than 2 c.p. continuously for a period of not less than 10 hours. (8) The light should be well distributed outside the lamp. A movable reflector to concentrate or to shield the light may be provided.

In addition to the above requirements regard will be paid to (*a*) the first cost of the lamp; (*b*) the cost of maintenance; (*c*) convenience in handling; and (*d*) the weight of the lamp when charged and ready for use.

Hulton Colliery Disaster.—The reports of Mr. R. A. S. Redmayne (H.M. Chief Inspector of Mines) and Mr. S. Pope on the explosion at the Pretoria Pit last December have been issued by the Home Office this week. Mr. Pope's report deals

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with the proceedings at the inquest and is concerned with the legal aspect of the question. He does not recommend any prosecution. Mr. Redmayne, after holding a formal investigation, states that he is perfectly satisfied that the use of electricity in the mine had no bearing on the disaster; and he has come to the conclusion that the explosion originated at a fall at the furthest in-bye point of the intake airway of the No. 2 face of the North Plodder. In all probability, he says, a second fall took place immediately before the explosion, accompanied by the liberation of a quantity of gas; and this gas was, in his opinion, ignited by a safety lamp becoming overheated, falling through the gas, or by its being damaged by the fall of stone. Mr. Redmayne suggests that mining engineers and others connected with the working of gassy collieries should seriously consider the possibility of the replacement, or partial displacement, of the gauze lamp in fiery mines by the electric lamp. The conclusion which he thinks may be drawn from the evidence submitted at the inquiry as regards the electrical plant is the importance of its proper supervision. A daily report as to the condition of the electrical apparatus was made at the mine, but it is not sufficient, he says, merely to state that the condition of apparatus was found to be "good." He is of opinion that the Hulton Colliery was understaffed. It is interesting to notice that the armoured cables in use throughout the mine satisfactorily resisted the effects of the explosive blast, heat and heavy falls of ground and were found afterwards to be mechanically and electrically perfect. It may also be noted that Mr. Redmayne considers it unwise to use electricity at the coal face in a gassy mine, such as this was, and that under the new Rules proposed its use would be prevented.

Tramway Progress in Berlin.—The report of the Grosse Berliner Strassenbahn for the year ended December 31, 1910, as published in the "Elektrotechnische Zeitschrift," shows that a dividend of 8½ per cent. was declared on a capital of £5,000,000. The rolling stock now consists of 675 double-truck motor cars, 917 single-truck motor cars and 1,036 trailers. The last mentioned have seats for 24 passengers and standing room for another 16 on the end platform. The number of passengers carried during 1910 was 427,700,000, as against 396,610,000 in 1909. The gross earnings were £2,038,560 in 1910 and £1,888,964 in 1909. The distances run were 60,281,160 car-miles in 1910 and 55,823,700 in 1909, the earnings being 8·4d. and 8·3d. per car-mile respectively. The operating expenses were 55·58 per cent. of the gross earnings in 1910, as against 54·82 per cent. in 1909; 7·04 passengers were carried per car-mile. The length of track is now 331·4 miles. £25,000 was placed to the road depreciation account and £26,250 to the account for renewal of rolling stock. Under the agreement with Berlin and the neighbouring municipalities the company paid over £139,320 of its gross earnings to the local authorities.

City and Guilds of London Institute.—The report of the Council for the year 1910 mentions that the Central Technical College will in future be conducted by a Delegacy representing the City and Guilds of London Institute, the Imperial College of Science and Technology and the Goldsmiths' Company, in pursuance of the supplemental charter recently granted to the Institute and the new schedule attached to the charter of the Imperial College. The name of the College will also be changed to the City and Guilds College (Engineering). In consequence of this change in the management a scheme has been provisionally adopted by the Delegacy involving the reorganisation of the mathematical and chemical departments. In recognition of their long and valuable services to the Institute, the Executive Committee has appointed Prof. Armstrong Emeritus Professor of Chemistry, and Prof. Henrici, Emeritus Professor of Mathematics and Mechanics, on their retirement at the end of the present session from their professorships at the City and Guilds College. The Council record their high appreciation of the services rendered by Profs. Armstrong, and Henrici since the establishment of the College in 1885, and of their untiring zeal in developing the courses of study in their departments. The annual report of the Dean, Prof. W. E. Dalby, which is contained in an appendix to the Council's report, refers, in addition to the usual statistics, to the increase in the equipment of the College. The total number of students attending diploma and special courses at the Central Technical College was 474 in the session 1909-10, compared with 469 in the previous session. Of these students 102 took the electrical engineering course, as against 113 in 1908-9 and a maximum number of 160 in 1904-5. The total number of students, however, receiving instruction in electrical engineering was 321 (including 80 students from the Royal College of Science and School of Mines), as against 318 in 1909. At the close of the session in July, 1910, the diploma of associate of the City and Guilds Institute was awarded to 80 matriculated third year students, as against 98 in the previous year. The diminution in the number of students entering the Technical College, Finsbury, is receiving the anxious consideration of the Executive Committee; the possible causes of the decrease are stated to be entirely external to the College; the one which has had most effect is believed to be the continued depression in the electrical industries; indeed, it is only in the electrical department of the College that any serious decrease in the number of students entering for the day course of instruction has occurred. The establishment of many other technical colleges both in the metropolis and the larger provincial towns has also had some effect, as well as the desire amongst students in recent years to obtain a university degree. If this desire should abate there should again be a demand for such courses as the Finsbury College was designed to provide. In the meantime some slight alterations have been made in the programme, the age of admission being raised from 14 to 15 years, and a regular time table arranged for third year engineering students. The total number of day students during the 1909-10 session was 153, as against 182 in 1908-9, the respective numbers taking the electrical engineering course being 57 and 67. The evening department of the College was attended by 233 students, compared with 291 in the preceding session.

Current Topics.

Subjects of current interest dealt with in this issue include the following:—

Mr. J. Rezelman contributes an article on "The Reactance of Asynchronous Motors with Squirrel-Cage Rotors."

Mr. H. Smith contributes an article on "A Method for the Detection of Harmonics in an Alternating Current, and for the Measurement of Inductances."

At the annual general meeting of the Institution of Electrical Engineers on Friday last the report of the Council was presented. We give an abstract of the report and also refer to it in our Leading Article.

We give an account of the discussion that took place at the Institution on Thursday last week when Messrs. Melsom and Booth read their Paper on "The Heating of Cables with Current."

At a recent meeting of the Institution of Mechanical Engineers Mr. J. E. Dowson read a Paper on "Gas Producers."

We describe a new form of telescopic mast.

At a recent meeting of the Derby Society of Engineers Mr. J. Hürdén read a Paper on "The Electric Furnace."

We give an abstract of an article in the "Electrical World" which describes a method of producing "artificial daylight" from the light given by a tungsten lamp.

The annual dinner of the National Telephone Co. last week, besides being the last official occasion on which the staff will so meet together, was noteworthy for an important statement by the Postmaster-General.

The report of H.M. Chief Inspector of Mines, Mr. R. A. S. Redmayne, on the Hulton Colliery explosion has been issued by the Home Office. Mr. Redmayne is of opinion that the electrical plant had nothing whatever to do with the explosion.

An interesting consular report from Norway gives particulars of the progress made in electric smelting of steel, &c., in Norway. A consular report also gives information as to the progress of hydro-electric schemes, construction of tramways, &c., in the United States.

Municipal Loans.—An inquiry was held at *Bradford* on Tuesday into the application of the Council for permission to borrow £50,000 for extensions of their electricity undertaking.—An inquiry was held at *Hull* on Wednesday into the application of the Corporation for

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sanction to a loan for extensions of their electricity supply undertaking.

Legal.—Judgment was given by the Railway Commissioners on Monday in favour of the National Telephone Co. in regard to their application for a declaration that the terms of the agreement under which their plant, property, &c., are to be taken over by the Postmaster-General should be construed in a wider and more liberal spirit than that proposed to be adopted by the Postmaster-General.

Sheriff Gardner Millar on Monday dismissed the appeal of Glasgow Tramways Committee against the assessment of their undertaking.

On Friday last Mr. Justice Neville dismissed an application by the Z Electric Lamp Manufacturing Co. for an interim injunction to restrain the Osram Lamp Works (Ltd.) from threatening plaintiffs or their clients with legal proceedings in respect of alleged infringement of defendants' Letters Patent.

Companies' Reports.—The directors' report of Callender's Cable & Construction Co. gives an interesting *resume* of the progress made by the company during the past year.

OBITUARY.

E. Ristori.—We regret to record the death, which recently occurred, of Mr. E. Ristori, A.M.I.C.E. Mr. Ristori's early training in engineering was received in Italy. After some connection with railway work and explosives manufacture, he organised, in 1894, the British Aluminium Co., of which he was managing director until 1901, and he was responsible for the Kinlochleven power scheme of the company. Deceased was interested in electro-chemistry as well as electro-metallurgy.

Baron E. B. d'Erlanger.—The death is also reported of Baron d'Erlanger, who was chairman of the New General Traction Co. and a director of the Norwich and Coventry tramway companies.

PERSONAL NOTES.

Mr. F. Monkhouse, who for the past seven years has been assistant manager to Arc Lamps (Ltd.), has now terminated his connection with the firm, and communications may be addressed to Mr. Monkhouse, 17, Blandford-road, St. Albans.

The electrical engineer to the Corporation of London, Mr. A. A. Topham, has been granted further leave of absence owing to continued ill-health.

Mr. J. G. McLean has resigned his position as engineer and manager of the Woking Electric Supply Co., which he has held for over 10 years. Future communications for Mr. McLean should be addressed Heathside, Woking.

APPOINTMENTS VACANT AND FILLED.

Messrs. Mather & Platt (Ltd.), Park Works, Manchester, advertise for an estimating engineer, used to electric power schemes.

A junior clerk is required thoroughly experienced and competent for the office staff of works department of electrical undertaking in country town near London. Salary £156 per annum. See advertisement.

Wireless electrical fitters, experienced in fitting electrical installations, are required. Applications to the Electrical Engineer, H.M. Dockyard, Devonport. See an advertisement.

A lecturer in electrical engineering and allied subjects is required for the Natal Technical Institute. Salary £300, rising to £400. Further information from Mr. W. A. Narbeth, Langford House, Bexley, Kent, to whom applications by June 7.

A teacher of electric wiring is required one night a week during the present session at the County School, Twickenham. Salary for each lesson of 2½ hours. Applications by June 10 to Mr. F. [illegible], Council School, Stanley-road, Teddington.

A demonstrator in physics is required for Armstrong College, Newcastle-on-Tyne. Salary £100 rising to £120. Applications to Mr. E. H. Priest, Secretary, by June 23.

On Wednesday Lancaster Town Council appointed Mr. Geo. C. [illegible] who has been carrying out the duties on probation during the [illegible] months borough electrical engineer and tramways manager, and also decided to increase his salary by £50 per annum for [illegible] months.

Mr. R. K. Butler, shift engineer at Hounslow, has resigned to take an appointment with the Underground Electric Railways Co. and Mr. [illegible] Blake, an improver at the works, has been appointed to [illegible].

INSTITUTIONS AND SOCIETIES.

Association of Mining Electrical Engineers.—A largely attended meeting of the East of Scotland branch of this Association was held last Friday evening, May 26th, in the Royal Hotel, Dunfermline, Mr. C. Augustus Carlon, of the Fife Coal Co., in the chair. The following officials were appointed for the ensuing session: *President*, Mr. C. Augustus Carlon (Fife Coal Co., Leven); *Vice-President*, Mr. H. Gordon Fraser (Fife Coal Co.); *Hon. Secretary*, Mr. Thomas Davidson (16, Rutland-square, Edinburgh); *Hon. Treasurer*, Mr. Robert Scott (Musselburgh); *Council*, Messrs. David Beveridge (Kelty), W. E. Townsend (Edinburgh), James Walker (Lochgelly), J. M. Keenan (Niddrie), R. W. Hogarth (Edinburgh), Wm. Lang (Mary Pit, Lochore), Neil A. Wilkie and R. H. Willis (British Electric Plant Co.).

With a view to creating and stimulating interest in the branch the meeting discussed the desirability of holding a series of meetings in such districts as Wemyss (Fifeshire), Alloa (Clackmannanshire) and Polmaise (Stirlingshire). The general opinion was that if these meetings were methodically arranged and systematically organised they would result in a considerable accession to the membership of the branch.

Institution of Mechanical Engineers.—The annual conversazione took place on Friday evening last at the Institution, St. James's Park, S.W., the guests being received by the President (Mr. E. B. Ellington) and Mrs. Ellington. As on previous occasions there was no lack of entertainment, an excellent selection of vocal and instrumental music being performed. This was much appreciated; whilst for those visitors desirous of more technical entertainment a lecturette by Prof. E. G. Coker, D.Sc., on "Optical Determination of Stress" was provided. The success of the conversazione was attested by the large gathering who thronged the rooms and staircase of the Institution throughout the evening.

Royal Society of Arts.—The annual conversazione was held on Tuesday evening last in the Natural History Museum, South Kensington, the guests being received in the Central Hall by Sir John Cameron Lamb, C.B., C.M.G., chairman, and other members of the Council. The entertainment provided was more varied than usual. The band of H.M. Royal Artillery performed a selection of music in the Central Hall, whilst a vocal and instrumental concert was given throughout the evening in the Shell Gallery, and a miscellaneous entertainment in the Fish Gallery. The last mentioned programme included several dances and dialogues; but as nearly the whole of the audience had to view these through various cases of specimens, much of the entertainment was lost.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, June 2nd (to-day).

ROYAL INSTITUTION.

9 p.m. Meeting at Albemarle-street. Discourse on "Radio-telegraphy," by Commendatore G. Marconi.

THURSDAY, June 8th.

ROYAL INSTITUTION.

3 p.m. Meeting at Albemarle-street. Lecture on "Practical Progress in Wireless Telegraphy," by Mr. T. Thorne Baker.

FRIDAY, June 9th.

PHYSICAL SOCIETY.

8 p.m. Meeting at the Imperial College of Science. Agenda: "The Lüders Lines on Mild Steel," by Mr. W. Mason; "Exhibition of a Model illustrating the Passage of a Light Wave through Quartz," by Dr. H. S. Allen; "Tables of Circular and Hyperbolic Functions for Complex Values of the Argument," by Mr. A. Johnstone; "On the Measurement of Contact Differences of Potential," by Prof. A. Anderson and J. G. Bowen; "Exhibition of Gyroscopic Apparatus," by Sir G. Greenhill, F.R.S., and "A New Method of Approximate Harmonic Analysis by Selected Ordinates," by Prof. S. P. Thompson, F.R.S.

ROYAL INSTITUTION.

9 p.m. Meeting at Albemarle-street. Discourse on "Applications of Physical Chemistry to the Doctrine of Immunity," by Prof. Svante Arrhenius.

THE LONDON ELECTRICAL ENGINEERS.

Officer Commanding, Col. H. M. Leaf.

The following orders have been issued for the current week:—

Monday, June 5th, "A" Company.—Technical Drill, 7 to 9 p.m.
Tuesday, June 6th, "B" Company.—Technical Drill, 7 to 9 p.m.
Wednesday, June 7th.—Gymnastic Classes, 7 to 10 p.m.
Thursday, June 8th.—Recruits' Drill (Infantry Drill), 7 to 8 p.m. Technical Drill, 7 to 8 p.m.
Friday, June 9th.—Recruits' Infantry Drill, 7 to 8 p.m. Technical Drill, 7 to 9 p.m.
Saturday, June 10th.—No parades.

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THE PRESENT STATE AND FUTURE PROSPECTS OF HIGH TENSION CABLE MANUFACTURE.*

BY DR. LEON LICHTENSTEIN.

Cable manufacture is one of the oldest branches of electrical engineering, the first cables being made early in the eighties for direct current at 110 volts with insulation of impregnated jute; the first high-tension cables were made 10 years later with similar insulation, and were of the concentric type for 2,000 volts. Paper soon superseded jute, the first stranded cables for 10,000 volts with paper insulation dating from about 1900; and the first transmission scheme using paper cables at 20,000 volts was carried out in 1908, while nowadays such cables are ordinary up to 25,000 volts. Rubber cables have developed more slowly, and seem likely to recede in view of the price of rubber. The differences in rubber, due to source and the methods of the factory, make this kind of insulation likely to be unsuitable for power transmission in spite of its elasticity, flexibility and excellent water-resisting properties. The present article is therefore confined entirely to paper cables and their prospects.

The highest limits of voltage are far out of sight, for the present at any rate; but a few words are necessary to explain the present position, and relate to problems that have been already solved. High-tension conductors for 20,000 and 25,000 volts are made normally with conductors whose sectional areas range up to 400 sq. mm., and with external diameters over the lead covering up to 90 mm. or 100 mm. The thickness of the insulation varies from 11 mm. to 13 mm. Not many years ago 9 mm. of insulation were required for 10,000 volts; and this fact denotes progress, which is due not to a lower standard of safety in working but to improved chemical, physical and mechanical processes. The following figures taken from tests made in the Siemens-Schuckert works illustrate this. A number of short lengths of different types of three-core cable were taken. They were mostly about 5 metres long. One with 5 mm. of insulation between the conductors and between the conductors and the lead covering broke down at 70,000 volts in 30 minutes; another with 4·9 mm. of insulation broke down in 30 minutes at 50,000 volts; another with 6·4 mm. of insulation broke down in 5 minutes at 115,000 volts; a fourth, with 7 mm. of insulation, broke down in 5 minutes at 120,000 volts; and a fifth, with 12 mm. of insulation broke down in 33 minutes at 180,000 volts. These were admittedly newly made pieces that had not been bent to and fro in the manner usual for testing purposes; but the figures obtained from other pieces that had been so bent were not very largely different. In fact, this difference was so small that it might be well to advise the abandonment of bending tests, both in the interests of buyer and seller. Not long ago there was a difficulty in making cables with sector-shaped conductors with areas of more than 150 sq. mm.; but now they can be made up to 500 sq. mm., and are not much stiffer than with round conductors of equal capacity. They have, however, the advantage of being smaller in overall diameter and of weighing less.

The capacity of modern cable factories is of interest, but the following facts relate solely to that of the Siemens-Schuckert works, and though this may appear to treat the matter only from one point of view, it is probably better than to confine one's self to generalities which everybody already knows. The Nonnendamm works make cables, the cores of which weigh as much as 8,000 kg., in one length, the weight of the cable when ready for laying being about 15,000 kg. In order to give an idea of the size of a cable of this kind it may be said that an armoured three-core cable with conductors of 25 sq. mm. weighing 15,000 kg. is nearly 2 km. long. Still, it must be admitted that these great lengths are not very easily handled during the process of laying; but there is the great and counterbalancing advantage which results from an absence of joints, and which is very valuable with high pressures. The large armouring machines in the works are probably as big as any in existence. In one case the length of the machine is 30 metres, the number of wire coils is 48, each weighing when full 500 kg.; the whole is driven by a motor of 170 H.P., the speed of working being at the rate of 0·6 metre per second. Other machines for other processes are also of a similar size.

For power transmission, cables have the great advantage, as compared with overhead schemes, of freedom from the effects of lightning and other weather influences, and these points are not nowadays under-estimated. But the deciding factor is, often enough, the voltage; and this may have the effect of putting the cables out of court. Attempts to increase the practicable limit of voltage are not new. O'Gorman's proposal to build cables out of insulating materials of differing dielectric constants was theoretically interesting but insufficient from the practical standpoint. It is only quite lately that pressures of 50,000 and 60,000 volts have seemed possible. The railway from Dessau to Bitterfeld may be taken as a type of some of the latest work, energy being transmitted at 60,000 volts. The length of the transmitting cable, which duplicates an overhead line, is 4·5 km., and the frequency is 15. The cable system consists of two single cables buried in asphalt, the pressure between each conductor and the lead covering being therefore 30,000 volts; each cable was tested, after laying, at 50,000 volts to earth for 10 minutes. The results obtained in practice will be awaited with some interest. In further illustration of the probably practicable upper limit of voltage, from the point of view of the pressure-resisting capacity of a cable, it may be stated that at the Siemens-Schuckert works a cable length was taken which was 61 metres long and had 13 mm. of insulation. It withstood a pressure of 220,000 volts for 18 minutes and of 330,000 volts for several seconds without breaking down. Pressures of 50,000 and 60,000 volts are not, therefore, likely to be out of the question for transmission schemes for long.

But this change will not take place suddenly. The pressure is likely to be gradually raised from its present limit of 25,000 volts, but above 40,000 or 50,000 volts technical manufacturing processes are not the only things to be taken into consideration. Dielectric losses may be important enough to require careful estimation, and work has been done in regard to this matter by Humann, Monasch and Höchstaedter, the last of whom worked with pressures up to 60,000 volts, though confining his experiments to the cables of one factory. It is much to be desired that his experiments should be repeated by others so as to have a more general outlook on the possibilities of the future. Cables with two and three cores for 30,000 volts present no problems in dielectric losses of any importance, unless the length of the transmission line should be very great; but above this pressure, if progress is to be made, something will have to be done to convince possible buyers that their fears are groundless. The author's view is that cables carrying 40,000 volts can be safely recommended without fear of serious dielectric loss, even of the two and three-core types with single conductors the limit can be set much higher. Makers might, perhaps, undertake guarantees as to dielectric losses, and test the cable after laying in this respect, but for the present this suggestion must remain in an indefinite form. A necessary preliminary is to reconcile the ordinary methods of measurement by bridge and wattmeter. Höchstaedter's oscillographic methods are too cumbersome for everyday use. It may be here mentioned that Siemens & Halske are making wattmeters which read accurately with power factors of 0·03 and even less. These instruments have an astatic arrangement which frees them from being susceptible to the action of an external field.

The effect of the dielectric losses on the temperature of the cable requires a few words of explanation. The following experiment shows the nature of this effect and its extent. A three-core lead covered cable without armouring, 15 metres long, was put under a pressure of 80,000 volts for 5 hours. The sectional area of the conductors was 50 sq. mm., and the thickness of the insulation 13 mm. A thermometer was attached to the lead covering, and the readings were taken through a telescope. When a condition of equilibrium had been reached, it was found that the temperature was about 3° above that of the atmosphere. At 40,000 volts the rise would be less than 1°C., and if the cable were buried in the ground it would be even less than that. From this it seems that the dielectric losses up to 40,000 or 50,000 volts are unimportant in cables of good make. The determination of the losses under these conditions by the buyer or in his interests, could only have the effect of excluding cables which were reasonably defective even though they could withstand the pressure tests.

The heating of high-tension cables requires some new elements to be taken into account. It is fair to say, for instance, that since the regulations of the Verband Deutscher Elektrotechniker were drawn up the situation has been somewhat modified. A high-tension cable must be classified not so much by voltage as by thickness of insulation. Latterly the sizes have considerably increased. The tables, which have been published under authority, allow only for single cables with 2 mm. or 3 mm. of insulation, and for two and three-core cables up to 9 mm. This ought now to be extended up to 15 mm. or 16 mm. of thickness of insulation; greater thicknesses than these are somewhat rare. As a result of experimental work, the author published some years ago the currents which could be carried by single cables up to 5 mm. of insulation by single cables, and by three-core cables up to 17 mm. If these figures are further corrected for the heating due to dielectric losses, they show that the loads allowed by the official regulations ought to be decreased by about 30 per cent. The figures only extend up to 120 sq. mm. of sectional area, and therefore need amplification. Cables for more ordinary voltages also need further consideration in this respect, especially seeing that everybody who has anything to do with estimates for cables and transmission schemes knows that the governing factor is the permissible tempe-

* Abstract of an article in the "Electrotechnische Zeitschrift.

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ture rise and not the voltage drop along the line. Questions as to capacity also arise, though they are only important beyond 30,000 volts and on very long lengths of cable. At any rate, below 20,000 volts, capacity need not be taken into consideration, and it is necessary to emphasise this point, seeing that buyers often make careful demands with regard to this point, which they complicate by all sorts of hypothetical conditions which they consider possible but are in reality quite unlikely. Obviously, the capacity has nothing to do with the pressure-resisting qualities of the cable, and it is not easy to understand the importance which a buyer thinks ought to be attached to the capacity of a cable which is to be used on direct current at 220 volts. The capacity of a cable decreases with increasing thickness of insulation, but the charging current is proportional to the voltage and the length of the line, which are often interdependent quantities. The charging current often rises very much with the voltage. Taking a concrete case: suppose 10,000 kw. is to be transmitted with a frequency of 50 and a power factor of 0·9 and a loss of 5 per cent. At 20,000 volts a three-core cable of 185 sq. mm. sectional area of conductors would be required having regard to the permissible heating, and the length of the line would be 15·5 km. At 50,000 volts the cable would have a sectional area of 70 sq. mm. and the length of the line would be 35·6 km. The capacities of the two systems per kilometre would be 0·28 mfd. and 0·18 mfd. and the charging currents per kilometre 1·76 and 2·83 amperes, the total charging currents being 27 and 100 amperes. That is to say, at 50,000 volts the charging current is 8·4 per cent. and at 50,000 volts 17 per cent. of the working full load current. This gives some idea of the problems which lie before the designer of the future. A large charging current is obviously a nuisance. At no-load it indicates a certain loss, and leads to difficulties owing to well-known properties of alternating machinery, which would be particularly noticeable on rapidly fluctuating loads. At full-load things are certainly different, and the charging current tends to improve the load factor. One remedy for all this is, obviously, to lower the frequency. This at once decreases the dielectric losses and the charging current. Frequencies of 25, and even of 15, have been found suitable for railway work, but for ordinary transmission work a frequency of 25 in connection with cables has not been sufficiently tested. It cannot, therefore, be said that a lowering of the frequency is always practicable.

Another method is that of compensation by choking coils inserted in parallel, and this has been specially examined by Roessler in his work on the subject. Undoubtedly a suitable design of choking coils in the generating station would much improve the power factor of the generator; but it would do nothing to touch the heating referred to the charging current. Several choking coils at suitable points on the line would be necessary, but a great deal would still be open to discussion, including questions affecting the size, position and construction of the coils. It might well be the subject of useful experimental work for somebody to carry out Roessler's suggestions at 50,000 volts on a cable transmission line. Transformers on consumers' premises may somewhat tend to neutralise the charging current, and something might, perhaps, be done by suitably designing these transformers, though it is not easy to say exactly how much. The problem touches largely unexplored ground, but it is by no means only of theoretical interest. It has very serious practical importance, and with the electrification of main railway lines some means will have to be discovered for neutralising heavy charging currents at 40,000 and 50,000 volts. Neither is the matter likely to be without influence on the design of generating machinery, which must be capable of giving a fluctuating output under these exacting conditions at a constant voltage.

A few words may be devoted to the unavoidable joints and end-connections on high-tension cables. On ordinary voltages they sometimes give trouble, and this is hardly to be wondered at seeing that a cable is a purely mechanical product while a joint contains much of the human element and is often made under most awkward conditions in the open street. Big cable companies have much greater chances of success in this work than small private buyers. They have more experienced workmen, and possibly a greater interest in success, even though careful supervision on the spot is generally impossible. At high voltages this is still more important, and it is hardly too much to ask that the laying of these cables should be entrusted always to the makers. At the present moment, the makers are able to undertake satisfactory joints and end-connections for 60,000 volts, and the work done on the Dessau-Bitterfeld line may be quoted as a case in point, where the end connections were tested at a pressure which corresponded to 240,000 volts between the conductors.

As for the testing pressures that will have to be employed in the future, these will doubtless be very high. Probably, however, at very high pressures an excess of 25 or 50 per cent. over the working pressure ought to suffice. Still assuming that double the working pressure is still considered necessary, a pressure of 120,000 volts will be required. The Siemens-Schuckert works are extending their testing arrangements in view of general expansion, and a description of their new arrangements will probably be made public before long. Supposing an output of 400 kv.-amperes to be available, this would suffice for a length of 0·5 km. of cable of 95 sq. mm. sectional area at 120,000 volts, and for four times this length at half the pressure. This is, of course, a pretty considerable output for a purpose of this kind, though the real output, represented by the driving motor, is obviously much less than the apparent output. As for the testing of cables after laying in position, it is probable that pressures of 80,000 and 100,000 volts will have to be considered.

THE ELECTRIC FURNACE, WITH SPECIAL REFERENCE TO THE MANUFACTURE OF HIGH-CLASS STEEL.*

BY J. HÄRDÉN.

Summary.—After referring to early arc and induction furnaces, the author describes the Roechling-Rodenhauser furnace, and gives particulars as to the costs of operation. He next describes the "Paragon" furnace, a combination of an arc and a resistance furnace, and discusses generally the field for electric furnaces.

The author first describes briefly early experiments with electric furnaces, referring to the work of Siemens, Ferranti, Moissan, Stassano, Héroult, Girod and Kjellin, and explaining the features of arc and induction furnaces.

The induction furnace is admirably adapted for melting pure raw material in charges up to 2 or 3 tons; but, owing to its nature, it is not a refining furnace, or suitable for the purification of inferior grades of steel in large quantities. The essential of rapid and efficient refining demands that a large area of the charge shall come in contact with the slag used for refining. If the Kjellin furnace was specially constructed for refining, the power factor would be unduly low and the handling of the slags most difficult. To overcome this defect the firm of Hermann Roechling & Co., of Volklingen, Germany, who had experimented with an 8-ton Kjellin furnace at their works, designed the modified induction furnace known as the Roechling-Rodenhauser furnace. In this two or three limbs of the core pass vertically through the hearth, the energising coils being placed on these limbs in a similar manner to those in the Kjellin furnace. In addition to this, a special secondary winding of heavy copper bars is also placed outside and around the primary coils. The combined power induced in these secondary windings is about 35 per cent. of the total power of the furnace; the remainder is directly transmitted by induction to the charge.

The current induced in the secondary copper winding is conveyed to a set of steel plates inserted in the walls of the lining; these plates are covered with a material forming a conductor of the second class. Consequently, when the molten charge of pig-iron is poured into the furnace, these portions of the lining will become conductive, and allow the current to pass through. They then act as a kind of Nernst glower on a large scale, which, after being heated by the current, in turn heats the steel. The effect of this arrangement is that a much larger hearth can be used, because the close proximity of the secondary coil to the primary tends to increase the power factor considerably, also a high degree of refining can be carried out in a most economical manner.

It is ordinary practice to take hot basic Bessemer steel having an an analysis of about C 0·3 per cent., S 0·07 to 0·08 per cent., P 0·06 to 0·07 per cent., and refine to high grade steels of the analysis required with only traces of S and P. The consumption of electric energy will vary from 100 to 300 kw.-hours per ton, depending upon the degree of refining required. A specimen charge is as follows:—

Basic Bessemer steel charged: S 0·071, P 0·077.

Finished steel: C 0·14, Si 0·01, Mn 0·41, S 0·032, P a trace.

This steel is specially suitable for tubes for marine water-tube boilers.

In order to give an idea of the cost of the operation, the materials used and the kilowatt-hours consumed are given below, from which calculations can be readily made:—

			s.	d.
Weight of finished ingot			7,000 kg.	
Materials and alloys used:—				
Lime	550 kg. at	10s. per ton	5	6
Roll mill scale	30 kg. at	13s. ,,	0	4
Ferro silicon (50 per cent.)	30 kg. at	200s. ,,	6	0
Ferro manganese (80 per cent.)	20 kg. at	180s. ,,	3	6
Cost of materials per 7,000 kg.			15	4

* Abstract of a Paper read before the Derby Society of Engineers.

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	s.	d.
Materials used per 1,000 kg.	2	2½
Power consumed per 1,000 kg. (1,381 kw.-hours divided by 7)=197 units at 0·25d. per unit	4	2
Lining	0	10
Labour	2	0
Per 1,000 kg.	9	2½

Another combination of this type of electric furnace and the open-hearth furnace has been in operation for some time. In this case, hot basic pig-iron analysing approximately C 4·0 per cent., P 1·8 per cent., S 0·6 per cent., is charged into a 25-ton Wellman gas-heated rolling furnace. This furnace is used to reduce preliminarily the carbon and phosphorus by the addition of ore, &c., and at the same time takes the place of a mixer. Charges of about 3½ tons at a time are withdrawn and charged into an electric furnace, where the phosphorus is eliminated, and finished in a second electric furnace of the same size, where the sulphur is extracted and carbon and other corrections made. The P and S are easily reduced to traces.

There are several electric furnaces at this plant, the steel made being used chiefly for steel castings. The whole of the electric power is generated by blast-furnace gas engines at a very low cost per kilowatt-hour, and consequently the costs of refining are exceedingly low.

A special feature of the furnaces built on the induction type, either of the Kjellin or Roechling-Rodenhauser system, is their very steady load. In this respect these furnaces compare very favourably with the true arc furnaces, where the whole of the power is transferred to the charge through one or more arcs. Owing to the unavoidable irregularities on the surface of the charge in arc furnaces, the resistance of the arcs varies constantly, and causes the current to fluctuate violently. Consequently, it is necessary to provide for a generator of considerably larger kilovolt-ampere capacity and fly-wheel effects than would be required if the furnace imposed a steadier load.

It is true, however, that the induction furnace has a lower power factor. As a comparison, take a furnace of each type of a capacity of 5 tons, to be operated in each case from a 25-cycle generator. A furnace of the Roechling-Rodenhauser type will have a power factor of 0·65 to 0·70, while a plain arc furnace has a power factor of about 0·85 to 0·9. This is, in the latter case, due to the fact that the arc furnace is operated at a low voltage, 60 to 70 volts only in the arcs, and a correspondingly high current, which will cause a lower power factor than usual, owing to the inductance set up in cables, &c. (*see* "Electro-chemical and Met. Ind." for 1909). The power fluctuations in an arc furnace may vary between 0 to about 35 per cent. overload (*see* "Transactions" of the Iron and Steel Institute for 1909). Let us assume, say, 25 per cent. The total power supply may in both cases be about 520 kw. This means a generator capacity of 750 kv.-amperes for the induction furnace, and for the plain arc furnace $520/0{\cdot}9+145=725$ kv.-amperes. The difference is, as will be seen, very slight, and may even be in favour of the induction type if it is considered that the generator for the plain arc furnace must be built mechanically strong enough to withstand the current fluctuations.

It has been stated that steel produced in arc furnaces shows a lack of homogeneity and the presence of "ghost lines." It is probable that for these reasons Stassano designed the device of rotating his furnace on a vertically inclined axis. In induction furnaces, especially those of the three-phase type, the charge acts somewhat as the rotor in an alternating-current motor, and produces a very strong and efficient mixing of the charge. In fact, this rotating effect is sometimes so strong that certain measures must be taken to counteract it.

It has long been recognised by steel makers generally that, although the plain induction furnace is an excellent tool in the hands of the crucible steel maker, a furnace which would permit more extensive refining, and also the construction of large units, at the same time having the advantages embodied in the induction furnace system, is much to be desired. It is because of the comparatively low power factor of larger furnaces of the plain induction type that this class of furnace has not been constructed in large units to any great extent. In order to overcome this, the Roechling-Rodenhauser furnace, which is partly a resistance furnace and partly an induction furnace, was designed. A considerable number of these furnaces have been erected and are in operation abroad, giving very good results. Some steel makers, however, are of the opinion that it would be an advantage if a furnace could allow superheating the slag for refining purposes, but at the same time enable the metallurgist so to regulate the heat of the charge that gases could be expelled without difficulty. At the same time, the perfect circulation of the bath should be maintained so as to secure a perfectly uniform material.

A new furnace on these lines, which has been given the name "Paragon" furnace, has been designed by the Grondal Kjellin Co. This furnace is a combination of an arc and a resistance furnace, which makes it very much like an open-hearth furnace, and it may, indeed, be worked exactly in the same manner. The slag blanket is kept at the desired temperature by means of arcs playing over the surface of the slag, while the remainder of the heating power is transmitted to the bath by means of terminal plates, such as are used in the Roechling-Rodenhauser furnace. The result of this combination is that the slag may be heated to any desired temperature while dephosphorisation and desulphurisation take place; but the heating effect of the arcs need not be increased to such an extent as to keep the whole charge superheated, which, of course, would tend to overheat the steel immediately beneath the arcs; but a carefully regulated amount of current can be at the same time sent through the resistance plates, thus also heating the charge from underneath.

When the dephosphorisation and desulphurisation is finished it may be desirable to alter the gradient of heat in the furnace so that the lower portion of the bath is hotter than its surface, in order to expel the gases more readily. This result is obtained by diminishing the power transmitted through the arcs and increasing the power transmitted to the side plates. In fact, it is even possible to extinguish the arcs for a time and keep the bath liquid by means of the side plates, which for this purpose are provided with a cooling device of enforced air. The metallurgist has, therefore, the power of controlling the gradient of heat in the bath at will.

This combination has another advantage—viz., that the electrodes do not require to be of such large section for a given capacity of furnace as would be the case if the total amount of power were transmitted by means of the arcs only, owing to the fact that normally about 50 per cent. of the total power is transmitted through the arcs, while the other 50 per cent. is transmitted through the side plates. The advantages claimed, therefore, are threefold. Firstly, the size of electrodes for a given furnace capacity is only about half that of an arc furnace, and, consequently, with a given electrode section available, the melting capacity of the furnace can be nearly doubled. Secondly, the roof is not subjected to such severe strain, owing to the reduced size of the electrodes and to the smaller amount of power transmitted through the arcs; therefore the maintenance of the furnace costs less and the roof lasts longer. Thirdly, the control of the load factor of the furnace is better, because the current flowing through the resistance plates is perfectly steady, whereby the heavy current fluctuations otherwise caused by large arcs are very extensively compensated. The result is that no special machinery is required either for compensating for the lower power factor of a true induction furnace, or designed with a large flywheel effect, as in the case of a simple arc furnace, on account of its fluctuating load factor.

The power consumption per ton of steel should also prove more economical by means of this combination, as the high temperature of the steel is only required during desulphurisation, it being well known that dephosphorisation does not require such a hot slag as desulphurisation, and it follows that the higher the temperature of the steel for any length of time the greater also the heat losses during the process. In view of this, the total melting and refining process should be more economical with this combination. It therefore appears that this type of furnace includes several of the advantages of the induction furnace—viz., a good circulation of the charge inasmuch as it is heated from below as well as from above, and a high load factor. The power supply transformers also may be situated in an adjoining building, protected from dust and injury and entirely beyond the reach of the workmen. The low voltage current only requires to be transmitted to the furnace by means of insulated 'bus bars and cables.

In conclusion, a few words should be said to correct a widely spread misconception with regard to the scope of electric furnaces generally. It is frequently assumed that the electric steel furnace is intended to supersede and render obsolete the open-hearth furnace. This assumption is quite incorrect. It appears to be far more economical, however, at least in cases where large quantities of medium quality steel are required, first to melt the material in a gas-fired furnace, remove the carbon and phosphorus, which require only a comparatively low temperature; then to pour the partially refined steel into the electric furnace, where the phosphorus, sulphur, occluded gases and other injurious compounds can be removed. The removal of these latter impurities requires a considerably higher temperature than the foregoing stages, and it is obvious that if the temperature must be raised by means of a gas flame applied on the surface of the bath the heat losses must be very great.

The elimination of the occluded gases is the last and, it may be said, perhaps the most important stage of refining, if a really high quality of steel is to be obtained. In order to meet this demand the Grondal Kjellin Co. have also designed a furnace called the gas-fi

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Paragon furnace. The furnace is essentially designed like an ordinary Siemens open-hearth furnace with basic lining, while terminal plates are built in in the sides, as in the case of the Paragon furnace previously described. The charge is melted and pre-refined by means of gas in the ordinary way, after which it is de-gasified by means of electric heating only.

In the case of an open-hearth furnace gas is constantly supplied, together with oxygen sufficient for the combustion. If the flame is made to be reducing—*i.e.*, not to have any excess of oxygen—it is difficult to obtain the desired temperature; but it is just this very oxygen that is to be expelled. Hence it is obvious that the electric heating will be of the greatest use in this latter stage. And this is just what the Continental steel makers have recognised, and have, therefore, installed their electric furnaces in conjunction with open-hearth furnaces; in fact, instead of discarding any existing open-hearth in favour of the electric furnace, new ones are being built. In fact, no less than 30 induction furnaces are in existence or under construction.

In the case of crucible steel the problem is different. Here, where no impurity whatever is tolerated, and where the price of the steel is high, the exclusive melting by means of the electric furnace seems fully justified and economical, as experience has clearly shown. The same also applies to places where natural sources of power, other than coal are available, where it probably will be found cheaper to produce the steel wholly by electricity instead of transporting coal.

GAS PRODUCERS.*

BY J. EMERSON DOWSON.

Summary.—A brief survey is here made of certain types of gas producers, the theory of their action and the composition of the gas produced being given. A comparison is also made between suction plants and pressure plant, and the effects of varying loads, &c., are discussed.

The author here considers only certain types of gas producers, and discusses their leading features from the theoretical and practical points of view. He proposes first, however, to review briefly the principles and conditions on which the production of producer gas depends, and it will be seen that, subject to minor variations, the chemical reactions are and must be the same in kind for pressure or for suction gas. In practice the gas used for furnace work is generally made from bituminous coal, and for engines and small heating work it is made from bituminous or semi-bituminous coal, or from anthracite or coke; but in some cases brown coal, lignite, peat, charcoal, &c. are used. The composition of the gas is largely influenced by the nature of the fuel, but a further important consideration is that for nearly all purposes (except furnace work) the gas must be free from tar and other condensable products. Speaking generally, producer gas is made by forcing or drawing air (with or without the addition of steam or water vapour) through a deep bed of fuel in a closed producer, an important characteristic of the process being that no external heat is applied.

If there were a shallow fire in the producer and an abundant supply of air, the carbon and other combustible constituents of the fuel would be completely oxidised, and the products of this complete combustion would be incombustible and useless as a gaseous fuel. If, however, there is a considerable depth of fuel in the producer (as there should always be in practice) there will be an excess of highly heated carbon, and this will react on the carbon dioxide and reduce it to carbon monoxide. The proportion of combustible to incombustible gas necessarily depends on the fuel used and on the actual conditions of working.

The final result of the complete combustion of carbon is the same whether it takes place all at once in an open fire, or whether carbon monoxide is first formed in the producer and is afterwards burnt to carbon dioxide. Theoretically when carbon is converted to carbon monoxide in the producer about 30 per cent. of the heat of combustion of the carbon is liberated; the remaining 70 per cent. will be liberated when the carbon monoxide is afterwards burnt to carbon dioxide in a furnace, engine, &c. It should, however, be understood that all the heat set free in the producer need not be lost, a large proportion being carried away in the form of sensible heat by the gas. In furnace work when the furnace is close to the producer, the loss of sensible heat is small; but when the gas is used for engines or for heating work requiring small cocks and burners, it must be washed and scrubbed, involving cooling and a considerable loss of sensible heat. When the air used for making gas in the producer is mixed with steam, the heat losses are reduced, part of the sensible heat being absorbed.

* Abstract of a Paper read before the Institution of Mechanical Engineers.

The following figures show the composition of the gas made in the Siemens producer from bituminous coal and in the author's own producer of the steam-jet pressure type (with superheated steam) with anthracite:—

	Percentage by volume.		
	Siemens.	Dowson.	Mond.
Carbon monoxide	23·7	25·17	11
Hydrogen	8·0	18·9	29
Carbon dioxide	4·1	5·98	16
Nitrogen, &c.	64·1	49·36	44

As anthracite yields less hydrogen than bituminous coal, the increase of hydrogen (derived from the steam) is therefore very marked. The weight of steam decomposed varied from 0·5 lb. to 0·7 lb. per pound of fuel gasified.

The above table also gives the composition of gas from a Mond producer, where an excess of steam (over 2 lb. per pound of fuel) is used to favour the production of ammonium sulphate.

When the author first used producer gas to work gas engines the compression pressures were low compared with those now in use, and it was considered important to have as high a percentage of hydrogen as possible, as it insured the prompt ignition of the charge in the cylinder. Much higher compressions are now used, chiefly because they raise the heat efficiency of the engine; and as the mixture of gas and air is more highly compressed it is ignited more readily. It has, therefore, become less important to have a high percentage of hydrogen; in fact, it is now considered by many to be a drawback, as there is then greater risk of pre-ignition. From the engine point of view it is better to limit the quantity of steam, but for the practical working of the producer it is still desirable to use a liberal quantity to check the formation of clinker and to reduce the loss of sensible heat. It is difficult to meet these somewhat conflicting ideals, and in practice a sort of compromise is effected by having about 12 to 15 per cent. of hydrogen in the gas. For large furnace work it is often best to have the gas as dry as possible when it reaches the furnace, as the presence of steam lowers the flame temperature. For such work the temperature of saturation of the air-blast for the producer usually varies from about 40°C. to 60°C., but this depends a good deal on the size and character of the coal used in the producer.

Lowe, of the United States, made in 1874 a new departure altogether, and produced what is technically known as "Water Gas." It usually contains approximately 44 per cent. by volume of CO, 48 per cent. of H, 4 per cent. of CO_2, and 4 per cent. of N_2.

Suction plant is next discussed. The production of the steam required to make good gas and to keep the temperature of the fire low enough to prevent the formation of an excessive amount of clinker presents many difficulties. Some makers have a water vaporiser inside the producer, whilst others prefer to have the vaporiser outside the producer and to heat it by the sensible heat of the gas after it has left the producer. The latter system has the advantage of cooling the gas more, but the amount of steam raised is less than in the other systems, and there is the risk that the gas will not always be hot enough to make the full quantity of steam required. This not only affects the percentage of hydrogen, &c., in the gas, but has an important bearing on the formation of clinker.

Apart from producing a sufficient quantity of steam when the maximum volume of gas is required, there is the further necessity for regulating the quantity of steam drawn into the fire when the load on the engine is variable. Some makers of suction plants try to get over the difficulty by having regulating valves worked by the engine, by means of which the admission of steam to the fire is governed by the engine. Some merely allow a vent in the vaporiser for the excess of steam to escape when the load is reduced; others have used the suction of the engine to draw water into the vaporiser in very small quantities, just enough at each suction stroke to give the steam re-

Table I.

	Suction plant. 40 B.H.P. (Hot start.)	Pressure plant. 40 B.H.P. (Hot start.)	Pressure plant. Average of 7 different sizes. (Hot start.)
Hydrogen	15·64	19·8	17·36
Methane	1·16	1·3	1·20
Carbon monoxide	20·13	23·8	25·55
Carbo dioxide	6·09	6·3	5·77
Oxygen	0·74	...	0·30
Nitrogen	56·24	48·8	49·82
Calorific value (higher scale).			
B.Th.U. per cubic foot	135·3	164·4	161·0
Calories per cubic metre	1,204	1,463	1,432

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quired for the quantity of gas to be consumed. This can only be done provided the vaporiser flashes the water into steam.

To compare the gas made in a suction plant with that made in a steam jet pressure plant of the same power, the author gives in Table I. the percentage composition by volume of the gas with a 40 B.H.P. plant of each type working with anthracite, and also the average results of seven different pressure plants of various sizes ranging from 8 H.P. to 300 H.P.

From this it appears that the calorific power of the pressure gas is approximately 20 per cent. higher than that of the suction gas. There is also rather more fluid friction to allow for when suction gas is used. The practical result is that there is a loss of about 5 per cent. in the maximum power of the engine when worked with suction gas. This is not important for small engines, but for those of larger size it must be considered. On the other hand, the heat efficiency of a pressure plant with independent boiler must necessarily be lower than that of a suction plant.

In considering the two types of plant for engine work, our general conclusions may be as follows: A suction plant has certain practical advantages: it costs less and occupies a smaller ground space, but the gas made in it is not so strong as in the older form of pressure plant, and in some cases this advantage of the latter is important. The fuel consumption per horse-power-hour and the labour required are about the same in both types of plant, provided the steam required is raised without an independent boiler. The consumption of water is the same in both types. It is also worth mentioning that where there are several engines to serve, the arrangement of the gas pipes is greatly simplified, and their cost is proportionally reduced, also the engines can be started more readily, when the gas can be taken from a small gasholder instead of from several suction plants.

As to variations in the quality of suction gas when the engine is working with light and variable loads, in a suction plant the quantity of gas produced is regulated by the action of the engine, as there is a draught of air and steam through the producer every time gas is admitted to the engine. Speaking generally it may be assumed that the best gas will be made when the producer is worked uniformly near its maximum capacity. At any rate of production considerably less than the maximum the calorific power of the gas will be lower. To test this practically, the author had some trials made with a 40 B.H.P. engine working with a full load and with no load at all. The gas was made with ordinary gas coke. The following analyses represent the average percentage composition by volume of the gas in each test:

Table II.

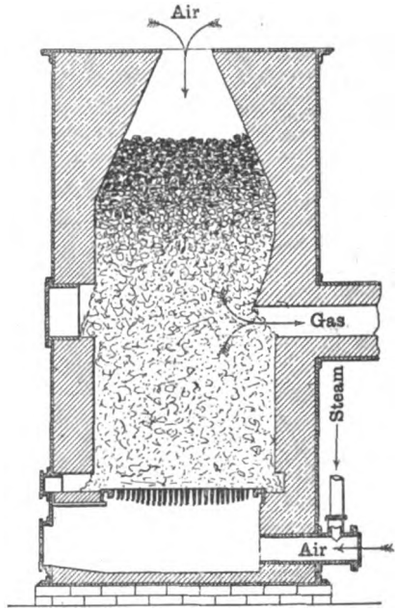
—	Full load.	No load.
Carbon monoxide	27·65	22·4
Hydrogen	9·85	7·0
Carbon dioxide	3·8	4·9
Oxygen	0·3	0·5
Nitrogen, &c.	58·4	65·2
Calorific power.		
B.Th.U. per cubic foot	128·9	101·0
Calories per cubic metre	1,147	899

The author had this further tested at Derby (1906) during the trials of suction plants made on behalf of the Royal Agricultural Society. As was to be expected, the gas contained smaller percentages of carbon monoxide and hydrogen, and larger percentages of carbon dioxide and nitrogen during the no-load periods. Also it was noticed that while the gas made with no-load on the engine, immediately after starting in a cold producer, had a low calorific power and did not materially improve while the producer continued to work without load, yet after the producer had worked for a time at full load, and had become thoroughly heated up, with a good depth of bright fire, it gave gas of considerably higher calorific power than before when the load was again removed. The explanation of this is mainly a question of temperature.

If the producer were worked by the continuous suction of a fan, instead of by the frequent intermittent suctions of an engine, the quality of the gas would be practically the same under full load, but during the no-load period the effect would not be quite the same. With a fan there would be a steady draught of the volume of air required, and there would be a shallow zone of fire near the grate, which would be maintained at a sufficiently high temperature to make good gas; and gas of good quality would be produced as long as this hot zone was sufficiently deep in relation to the size of the fuel. If the air for the producer were drawn in by an engine without load a greater depth of fuel would be heated by reason of the more rapid draught of air through the fire; but a good deal of heat would be dissipated before the next suction. This points to the importance of maintaining the temperature of the fire as high as possible when the producer is worked at a reduced load by the suction of an engine; and a step in this direction is to reduce the quantity of steam proportionally to the volume of air drawn in. It is not easy to fulfil all the conditions without complicating the apparatus, but it is well to consider what will give the best results, so that a near approximation may be obtained.

It is well known that after an engine has been working under a light load for some time with a suction plant there is risk of stoppage if the full load is put on suddenly. Moreover, when this occurs, it is often attributed to an insufficient supply of gas. This is a mistake, as the volume of gas necessarily varies directly in proportion to the load on the engine; it is the quality of the gas which is at fault. During the light-load period the temperature of the fire falls, and for a few moments after the full load has been put on the fire is not hot enough to effect the necessary chemical reactions. There is too little hydrogen, and not enough of the carbon dioxide is reduced to the monoxide. The remedy is to put on the full load more gradually, so that the engine may be kept running at full speed in spite of the weakness of the gas, and to check the admission of air to the cylinder; the fire in the producer will recover rapidly, and there will soon be a full supply of gas of good quality. The author gives particulars of some tests to illustrate this point.

Analyses of suction gas made in small plants have been given, and the author next gives the composition of the gas made in a 350 B.H.P. suction plant of his design. The fuel used was "carbonite" from Huddersfield, and during an ordinary day's run the average percentage composition by volume of the gas was:—Hydrogen 7·92, carbon monoxide 30·38, carbon dioxide 3·04, oxygen 0·42, nitrogen



DOWSON PRODUCER.

58·37. The percentage of hydrogen was low, but the CO was high, and with its high compression the engine worked well.

It has been shown that producer gas can be obtained with almost any kind of carbonaceous fuel, but for engines and small heating work all tarry vapours must be eliminated before the gas reaches the valves, cocks, &c. Hitherto this has been done by centrifugal tar extractors, washers, and other apparatus which add to the complication and cost of the plant. Some attempts have been made to draw off the tarry vapours from the upper part of the producer and to return them to the lower part of the fire where combustion takes place, but so far as the author is aware none of these plants have been altogether successful, as some of the tarry vapours go forward with the gas and must be removed by extractors or washers, &c. Another method of fixing the tarry vapours is to work the producer with a down draught instead of an up-draught. In this way the tarry vapours from the raw fuel (put in at the top) are compelled to pass through the whole depth of the fire so that they may be converted into fixed gases. It is almost impossible to do this effectually in continuous work, owing to the difficulty of maintaining a suitable temperature. It is also difficult to burn the fuel completely, and usually there is an accumulation of small carbon or coke, mixed with clinker and ash, in the lower part of the producer.

The author has always held to the opinion that the tarry vapours should be got rid of in the producer itself, and that it cannot be right to let tarry gas leave the producer, and then be obliged to remove the tar by extractors, &c. With this in view, he designed, in 1903, the

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producer illustrated herewith. This producer is double acting—that is, air is drawn in through the top and through the bottom of the fuel column. The coal is put in at the top, and the upper part of the fire burns downwards. The hydrocarbons are distilled off and various useful reactions occur; the coke which remains sinks down gradually into the lower part of the producer. The coke is there converted into ordinary producer gas by the upward current of air (accompanied by steam) which is drawn in at the bottom. The mixture of gases leaves the producer through an outlet about half-way between the top and bottom.

When working with ordinary bituminous coal, or with lignite and several other varieties occur, there is no tar; it is disposed of altogether in the producer, and no mechanical or other tar extractor is required. After leaving the producer the hot gas passes through an external vaporiser, to cool the gas, and so raises the steam required for making the gas. It then passes through suitable scrubbers and is ready for use in the engine to be worked with it. This bituminous plant can be worked by the suction of an engine, or when the gas is to be passed into a gasholder for distribution to several engines, or to heating apparatus, there is an exhauster to draw gas from the plant and deliver it into a holder.

It took a long time to perfect the details of this plant, but one for 300 H.P. was started in October, 1908, at the works of Messrs. Kenrick & Sons, of West Bromwich, and has been working regularly ever since. The results were so satisfactory that in October, 1909, they started a second plant of this type for 700 H.P., and both plants are now serving 13 gas engines which were previously worked with anthracite pressure gas. The author has not an analysis of the gas made in the smaller plant, but in the larger one the percentage was as follows: Carbon monoxide 23·9, carbon dioxide 7·2, hydrogen 16·0, methane 1·0, nitrogen 51·9. The calorific power of the gas is nearly as high as that of gas made with anthracite in an ordinary suction plant. The fuel used at West Bromwich had the following composition: Fixed carbon 55 per cent., volatile matter (other than moisture) 30, moisture 8, ash 7, calorific value 13,400 B.Th.U. per lb. The coal costs 8s. a ton delivered, as against 23s. for anthracite. On an average of several months the consumption of bituminous coal was about the same as with anthracite—namely, about 1 lb. per indicated horse-power-hour—including all stand-by, cleaning and starting losses. The gas has no tar when it leaves the producer, and none is found in the scrubbers or overflow water; and Messrs. Kenrick have stated that the gas from the bituminous coal is as clean as the anthracite gas previously used. They clean the engine valves only once in about three months.

Among other plants of this type in use Messrs. Faire Brothers, of Leicester, are now working one for 400 B.H.P., and they find that their engines work as well with it as with the anthracite plant they previously used. In their case they use a coal of the following composition when dried at 212° F.: Fixed carbon 57·90 per cent., volatile matter 37·50, sulphur 1·0, ash 3·60, moisture 11·10 per cent., calorific value 12,100 B.Th.U. per lb.

At first the author thought that these plants would not be suitable for small powers, but more recently he has had a 30 H.P. suction plant of this type working regularly for about eight months, and it has given no more trouble than an ordinary suction plant working with anthracite or coke. The engine valves were not cleaned for five months.

M. Bontillier & Cie., of France, have a producer in which bituminous coal is forced into the bottom of the fire by means of a screw feed, and as the producer is worked with an up-draught from a blower the tarry vapours distilled off at the bottom pass through the incandescent fuel above. Power is, of course, required to send in the coal, and the rate of feed must be regulated to suit the rate of consumption. The author has seen a plant of this type working well with semi-bituminous Belgian coal, containing 12 to 13 per cent. volatile matter. He does not know what the result would be with English coal, which usually contains not less than 30 to 35 per cent. of volatile constituents.

In conclusion, the author points out that for engine work the stand-by loss of a steam boiler is much greater than that of a gas producer, and the explanation is not far to seek. For a given horse-power the producer is much smaller, and has far less radiating surface than a boiler, it has no water in it to be heated, and in a few minutes it can be worked up to its maximum production after standing almost any length of time. With a boiler, except in the vertical or portable type, there is a large amount of external brickwork to be heated, and there is a considerable quantity of water, even in the tubular type. When the boiler is standing the water and the brickwork lose heat, and not only more time but more fuel is required to make up this loss than in the case of a gas-producer. Doubtless the heat efficiency of a good boiler is high when it is working to nearly its full capacity, but the reverse is the case when it is standing. Table III. gives some comparative results.

Table III.

Type of boiler.	Steam power.		Gas power.	
	Max. h.p. of boiler.	Coal per standing hour.	Max. h.p. of producer.	Coal per standing hour.
		lb.		lb.
[illegible]	100	14·0	250	5·1
[illegible]	450	*37·5	250	3·9
[illegible] & Wilcox	210	67·0	100	2·1
" "	210	67·0	250	4·5
" "	500	180·0	225	3·8
[illegible]	500	112·0	375	1·8
[illegible]	400	50·0	...	...
[illegible]	400	44·7	...	...
Average	...	71·5	...	3·5

*Exclusive of raising the steam-pressure from 90 lb. to 120 lb.

THE REACTANCE OF ASYNCHRONOUS MOTORS WITH SQUIRREL-CAGE ROTORS.

BY J. REZELMAN.

Summary.—The leakage reactance of a 2 pole 50 H.P. induction motor is analysed. The rotor winding is found to exert no magnetising effect upon the end coils of the stator winding. The losses on short circuit are determined for various frequencies.

In the preceding article* the reactance of asynchronous motors with *wound rotors* has been analysed; let us now determine the leakage of a motor with *squirrel-cage rotor*.

Three phase motor 50 H.P., 2 poles, 50 ~, 3,000 revs., 380 volts between phases.

Stator. ϕint = 265 mm. $\tau = 417$ mm.
$l = 180 - 2 \times 7{\cdot}5$ mm. $l_i = 170$ mm.
slots = 24 (20 × 40) $t_s = 34{\cdot}7$ mm.
$S_s = 9$ $p = 1$ $q = 4$, Fig. 1.

Rotor Single air gap $\delta = 1{\cdot}5$ mm.
slots = 41 (7·5 × 23) $t_r = 20{\cdot}3$ mm.
$S_n = 1$ $p = 1$ $q = 6{\cdot}85$, Fig. 1.

The stator is wound *per pole*.

Phase I. $l_s = 670$ mm. $l_{sa} = l_{s'b} = 360$ mm.
Phase II. $l_s = 850$ mm. $l_{sa} = l_{s'b} = 540$ mm.
Phase III. $l_s = 955$ mm. $l_{sa} = l_{sb} = 645$ mm.

$U_{sa} = U_{sb} = 150$ mm.; $l_{sc} = 310$ mm.; $U_{sc} = 380$ mm. for phases I., II. and III.

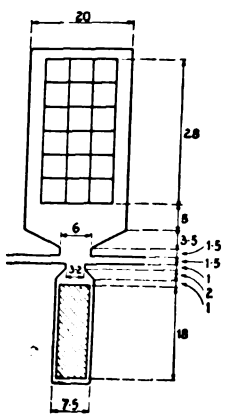

FIG. 1.

Auxiliary turns (20) had been placed in the middle and following l_s of *Phase II.*, Fig. 2; the E.M.F. induced in the end coils of this phase will then be $\frac{72}{20} = 3{\cdot}6 \times$ that induced in the 20 auxiliary turns.

Complete tests have been carried out:—

(A) With end-shields, without rotor.
(B) With end-shields, with rotor.
1. Single phase per phase.
2. Single phase two phases in series.
3. Three phase.

The experiments have given the following results.

* THE ELECTRICIAN, March 10, 1911.

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Table I.

		e_{0-1}	e_{0-2}	e_{0-3}	e_{I-II}	e_{I-III}	e_{II-III}	$e_{aux.}$	l.	c	
Readings with a current of 45 amperes in phase	I.	*20·2*	4·5	3·9	25·2	24·7	...	...	45	50	Without rotor.
	II.	4·8	*23·1*	5·4	28·0	...	28·9	*2·75*	45	50	
	III.	4·26	5·42	*24·5*	...	29·0	30·0	...	45	50	
Ditto.	I.	*18·8*	2·62	2·22	21·6	21·1	...	...	45	50	With rotor; the position has no influence on result.
	II.	2·6	*21·4*	3·3	24·3	...	24·9	*2·7*	45	50	
	III.	2·2	3·2	*22·6*	...	24·9	26·1	...	45	50	

Table II.

		e_{0-1}	e_{0-2}	e_{0-3}	e_{I-II}	e_{I-II}	e_{II-III}	$e_{aux.}$	I.	c.	
Readings with a current of 45 amp. in 2 phases in series	I.-II.	24·0	26·9	...	*51·0*	23·0	28·0	*3·42*	45	50	Without rotor.
	II.-III.	...	27·2	28·8	28·0	28·2	*56·1*	*3·64*	45	50	
	I.-III.	23·8	...	27·8	23·0	*51·4*	28·3	...	45	50	
Ditto.	I.-II.	20·9	23·0	...	*44·3*	20·0	24·2	*3·10*	45	50	With rotor, the position has no influence on result.
	II.-III.	...	25·0	24·0	24·2	24·7	*49·0*	*3·62*	45	50	
	I.-III.	20·0	...	24·0	19·8	*44·4*	24·8	...	45	50	

Table III.

	e_{0-1}	e_{0-2}	e_{0-3}	e_{I-II}	e_{I-III}	e_{II-III}	$e_{aux.}$	I_I	I_{II}	I_{III}	c	
Readings on measuring a current of 45 amperes in phase II.	26·8	*27·0*	29·0	46·7	49·0	48·3	*3·56*	50·2	*45*	46·8	50	Without rotor.
Ditto.	22·8	*23·6*	25·8	40·8	42·7	42·8	*3·44*	50·5	*45*	47·0	50	With rotor, the position has no influence.
Ditto.	181·0	*181·0*	181·0	317·0	317·0	317·0	3·68/*3·78*	48·4	*45*	45·8	50	With rotor rotating at 2,925 revs. cos ϕ = 0·92.

We establish that the E.M.F. induced in the auxiliary turns, and hence in the end connections, is the same *with* or *without* rotor. As shown by Fig. 2, the end rings of the squirrel cage are in fact too distant from the stator coils to exercise a demagnetising influence on them, and the induction coefficient A thus retains its value.

Further the experiment three phase (Table III.) shows that, for the same current in phase II., the E.M.F.s induced in the auxiliary coils are the same with the rotor *turning* or *fixed*.

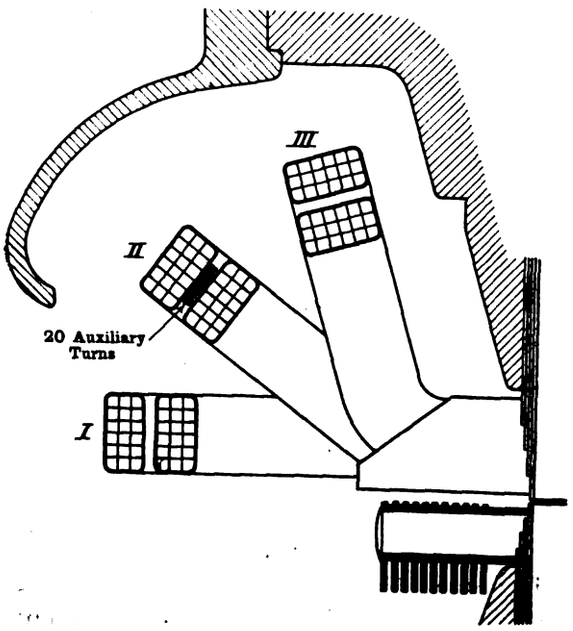

FIG 2.

The mutual induction between the end coils of the different phases is about $\frac{3·5}{2·7}=1·30$.

The reactance is independent of the position of the rotor relatively to the stator; there is thus no formation of a *common* field of a high order, which results from the property of the squirrel-cage winding to create in the air gap a repetition of the M.M.F. corresponding to that of the stator. It follows then that the reactances x_{sn} and x_{sk} *per phase* must be the same with single phase *one phase only* as for *two phases in series*; the total reactances per phase can only *differ* by the augmentation of x_{ss} due to the mutual induction between the *end coils*.

The experiments on single phase, one phase only, of such a motor (Table I., with rotor) thus enable us to determine directly the mutual induction between the end coils by measuring the E.M.F.s induced in the open phases. It is to be noted that the reactance *without* rotor is higher than *with* rotor:—

On single phase, one phase only, by 8 per cent., and on single phase, two phase in series by 15 per cent., the difference

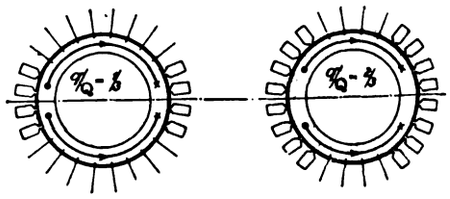

FIG. 3.

between the 8 and 15 per cent. being due to the mutual induction between the end coils.

(A.) *Without Rotor.*

One Phase only: $Q=12$, $q=4$

by calculation $\lambda_n=1·89$ and $\lambda_k=5·78$

whence $x_{sn}+x_{sk}=0·275w$.

The values for the induction coefficient A of the end coil are found to be

$A_I = 0·274$

$A_{II} = 0·272$

$A_{III} = 0·241$

Two phases in series: $Q=12$; $q=8$

$\lambda_n=1·89$ and $\lambda_k=6·85$

whence $x_{sn}+x_{sk}=0·60w$.

The coefficient of mutual induction between the end coils of phases I., II. and II., III. is 1·29, whilst that for I., III. is 1·21.

(B) *With Rotor.*

One phase only. Stator: $Q=12$, $q=4$ ..... $q/Q=\frac{1}{3}$

Rotor: $Q=20·5$, $q=6·85$..... $q/Q=\frac{1}{3}$

by calculation $\lambda_{n_1}=1·87$; $\lambda_{n_2}=2·46$,

$\lambda_{k_1}=0·835$; $\lambda_{k_2}=1·18$,

whence $x_{sn}+x_{sk}=0·167w$.

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We know the value of the reactance of the end coils of the stator (determined above, in (A)), and thus find for the end rings of the rotor

$$x_{rII}=0{\cdot}068w.$$

From an inspection of Fig. 3 it is apparent that the two rings in reality represent a winding *per pole*.

By taking l_r equal to the arc corresponding to the middle of the slots

$$l_r=l_{ra}=l_{rb}=\frac{\pi\times 236}{2}=370 \text{ mm.}$$

and

$$U_{ra}=U_{rb}=156 \text{ mm.}$$

Hence

$$\lambda_{ra}=\lambda_{rb}=0{\cdot}46\times 2\left(\log\frac{2\times 370}{156}+A\right)=0{\cdot}63+0{\cdot}92A$$

and

$$L_{ra}+L_{rb}=2\times\frac{12{\cdot}5\times 50\times 18^2}{1\times 2\times 10^8}\,37(0{\cdot}63+0{\cdot}92A)=0{\cdot}0473 +0{\cdot}69A=0{\cdot}068,$$

whence $A=0{\cdot}30$ and $R=1{\cdot}44$.

Two phases in series.

Stator ..... $Q=12$, $q=8$... ..... $q/Q=\frac{2}{3}$

Rotor ..... $Q=20{\cdot}5$, $q=13{\cdot}7$ ..... $q/Q=\frac{2}{3}$

$$x_{sa}+x_{sb}=2\times 0{\cdot}167=0{\cdot}334w.$$

In a similar manner the reactance of the rotor end rings is found to be $x_{rII}=0{\cdot}115w$, that is to say, $\frac{0{\cdot}115}{0{\cdot}068}=1{\cdot}7$ times the value for *one phase only*.

Other experiments have been carried out on this motor; measurements have been made of the watts absorbed when a

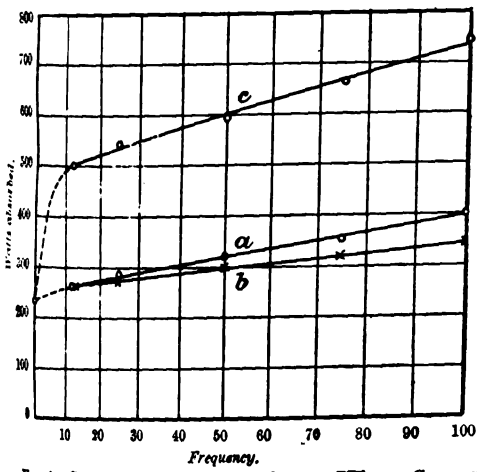

FIG. 4.—SINGLE PHASE, PHASES II. AND III. IN SERIES; CURRENT, 45 AMPERES CONSTANT.

a, With end-shields, without rotor; *b*, Without end-shields and without rotor; *c*, With end-shields and with rotor.

constant current of 45 amperes has been passed through phases II. and III. in series, single phase, the frequency being varied from 0 to 100 cycles—

(*a*) Without rotor, with end-shields.
(*b*) Without rotor, without end-shields.
(*c*) With rotor, with end-shields.

Table IV.

Cycles	I.	Watts.	*c*.	
5·16	45	226	0	
15·9	45	264	12·0	
55·9	45	320	50·0	(*a*) Without rotor, with end-shields.
110·9	45	400	100·0	
82·3	45	354	75·0	
26·5	45	286	25·0	
15·6	45	260	12·7	
33·9	45	300	50·0	
109·2	45	346	100·0	(*b*) Without rotor and without end-shields.
79·8	45	320	75·0	
26·6	45	276	24·2	
16·5	45	500	12·5	
47·1	45	596	50·0	
91·3	45	740	100·2	(*c*) With rotor and with end-shields.
66·5	45	668	75·0	
26·2	45	542	25·0	

The losses have been plotted as a function of the frequency (Fig. 4). By comparing (*b*) and (*c*) the losses in the rotor at $50\sim$ are found to be: $596-300=296$ watts and at $12{\cdot}5\sim$ the losses are only $500-260=240$ watts. This diminution with the frequency explains why the slip of an induction motor (especially with a rotor wound with bars of large section) is smaller than the value calculated from the watts measured on short-circuit. In the rotor of a three-phase motor, the frequency of the current corresponding to the slip is so small that the corresponding supplementary losses are negligible.

For the same reason the permeance of the rotor may vary with the speed, since it contains magnetic material subjected to induction. On short-circuit, with the rotor fixed, the high-frequency impedes the magnetisation, whilst at normal speed it may be sufficiently reduced to permit of the free formation of the lines of force.

PROTECTION OF ELECTRICAL TRANSMISSION LINES.*

BY E. E. F. CREIGHTON.

Summary.—The object of this Paper is, primarily, to describe a new method of protecting line insulators against arcs to earth and the consequent surges which accompany such accidental arcs. The apparatus for accomplishing this is described, and its scope of application and limitations pointed out. Secondly, to point out the trend of the developments in line protection, to record some experimental data relating to the problem of line protection and to speculate on certain lightning effects.

In the past, considerable attention has been given to the protection of electrical apparatus. For the protection of medium and high-tension apparatus the aluminium arrester has had sufficiently long use to attest its undoubted value. There has, however, been no type of arrester developed suitable to the protection of line insulators, and, judging from our present knowledge of lightning phenomena, there is little prospect of such a development being made. In general, arresters are not suitable for line protection, and there is nothing yet offered which does not involve an interruption of service when an accidental arcing to earth takes place, as well as permitting surges of high frequency and of considerable energy in the system.

The problem of line protection may, for present purposes, be divided into two parts: (1) The suppression of the arc that follows a lightning discharge over an insulator. (2) The prevention and suppression of short-circuits between phases (this phenomenon occurs relatively rarely). This Paper has to do mostly with the first division of the problem, and a three-phase circuit only is considered.

If one phase becomes accidentally earthed, its potential will be reduced to the effective potential drop along the arc. If this phase has attached to it a single-phase switch which will connect it to earth, the wire will be reduced to earth potential, and the arc around the insulator will be extinguished by lack of potential—*i.e.*, shunted out. The insulator reassumes its normal condition of insulation as soon as the arc vapours are cooled below the temperature of conduction, in general taking but a small fraction of a second. If the earthing switch is now opened, the circuit will assume again its normal condition of equality of potential of each phase above earth without interrupting the service.

Selective Relay.—Between the phenomenon of the arcing earth and the closing operation of the single-pole switch there must be an intermediate device which picks out the phase that is earthed and closes the proper relay to operate the single-pole switch.

In Fig. 1 the circuit connections are shown for an electrostatic selective relay. Three insulators are set at angles of 120 deg., facing each other in a horizontal plane. The pin of each insulator is insulated by being fastened to another insulator and connected respectively to the three phases. The electrostatic fields produced at the heads of these insulators act mechanically on three earthed aluminium plates placed in front of them. These three aluminium plates are connected together by three light radial rods. At the centre these rods connect to the bottom of a pendulum, pivoted at the top so that it can swing in any angle away from the vertical. This gives a balanced mechanical system which remains stationary for all voltages so long as they are equal. If, however, as in the case assumed, one phase (C) is earthed, the electrostatic force on the corresponding aluminium plate is weakened and on the other two plates strengthened. The result is that the pendulum moves over against the contact, marked SC in Fig. 1. Making this contact operates the trip coil on a single-pole oil switch. This relay is easily adapted to all high voltages, but the forces drop off so much for low voltages that it is then found

* Abstract of a Paper read before the American Institute of Electrical Engineers.

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necessary, so far, to resort to potential transformers and electromagnetic coils.

Fig. 2 shows a diagrammatic sketch of the connections of an electromagnetic selective relay. Three potential transformers, TA, TB and TC, are connected in Y and the neutral is earthed. The secondary of each is connected directly to a solenoid. The solenoids stand in a vertical position, and each has hung over it a core of iron suspended to a three-arm lever pivoted at the centre C. Just above each lever is a contact point which, when closed, trips the single-pole earthing switch corresponding to the phase. The operation is the same in principle as the electrostatic relay.

The safety auxiliary devices consist of damping resistance in connection with the switch, interlocks between the three independent single-phase switches, and an interlock on the selective relay, as an extra safeguard against closing two single-phase switches at once.

Every circuit containing inductance and capacity is subject to electric oscillations when an arc takes place in any part of the circuit. Where capacity predominates the arc current is seldom continuous. Resonance implies repeated impulses or oscillations. If the arcing earth has a resistance in series equal to the critical value given by the equation $R=2\sqrt{L/C}$, each single impulse will die out without oscillation. Even if the resistance is only one-fifth the above value the oscillation disappears quickly. The accidental arc around an insulator is extinguished as quickly as possible by the switch; it is then necessary to extinguish the arc to earth in the switch as it opens. To eliminate the dangers from oscillations, damping resistance is placed in the switch pot. This resistance is thrown in series as the switch rod moves out (Fig. 3).

The three single-pole switches of the suppressor are provided with a common interlocking device operated by a solenoid, which prevents any two switches from getting in the closed position simultaneously, and thus causing a short-circuit.

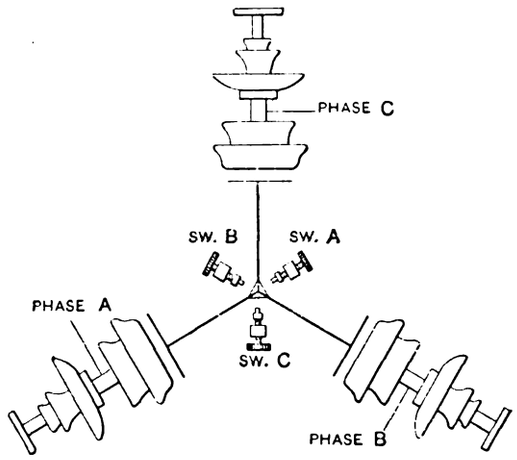

FIG. 1.—DIAGRAM OF ELECTROSTATIC SELECTIVE RELAY.

As a further precaution against accidental short-circuits in the switches, the natural conditions of construction of the relays make it impossible to close two trip coils simultaneously. The three contact points on the selective relay, which are connected to the trip coils, are so widely spaced that the pendulum cannot swing against two at the same time.

So far an arc around an insulator has been considered. In this circumstance the protecting switch closes, and opens automatically a fraction of a second later. If, on the other hand, the insulator is defective and punctures, the line potential will re-establish an arc to the iron pin. This will cause the switch to close again. This second time it is locked shut until the attendant opens it by hand. This second stroke lock comes into action only if the switch starts to close the second time immediately after the first time. In other words, if the switch stays open for a fraction of a second after the first stroke, the second stroke lock becomes inoperative. With the arc shunted out, the dangers from arcing earth surges are avoided. The system can continue to operate with a metallic earth until the fault is located and the faulty line cut out. The chief source of danger in such operation is in the possibility of a second stroke of lightning establishing another arcing earth on another phase before action is taken to clear the feeder.

Cable Systems.—When the insulation of a cable fails the damage is permanent. The distance from the conductor to the metallic sheath is so small that the normal impressed difference of potential is sufficient to re-establish an arc, even if it were automatically extinguished. It is seldom indeed that an accidental arc is established in a cable from conductor to conductor. The usual case is a failure of one conductor to the sheath. When this occurs there is nothing to be done but earth the faulty phase to the sheath, and thus extinguish the arc. This simplifies the switch operation, for it is necessary for the switch to close once and stay closed until the feeder has been cleared.

As to the safety of operation with one phase earthed, the factor of safety on the other two phases is somewhat reduced by the fact that their potential is increased by 73 per cent., but this should not produce a serious strain. There is no arc to produce high frequency, therefore there is left to consider the possibility of obtaining resonance in any part of the circuit at the frequency of the generator and of such harmonics as may be prominent. The capacity current flowing into the two non-earthed phases must pass through the inductance of the generator and connecting transformers. Taking into account the possible wide variations of inductance and capacity in all systems, one is forced to acknowledge a chance of obtaining resonance with a phase metallically earthed, but resonance in itself has no terrors. The increment of energy in the resonant surge is always small relative to the energy given out even by a small transformer. If a transformer, for example, is loaded even with a few lamps, the resonant potential will be held down by the absorption of the energy of the surge in the lamps. If, on the other hand, the transformer is not loaded and it is in a condition of resonance, its resonant energy will be absorbed by some parallel loaded transformer. When the possibility of resonance internally between coils of a transformer is considered it can be stated positively, I believe, that there is none. Also the natural frequency of a local surge between coils is invariably too high to resonate with the frequency of the impressed potential from the generator.

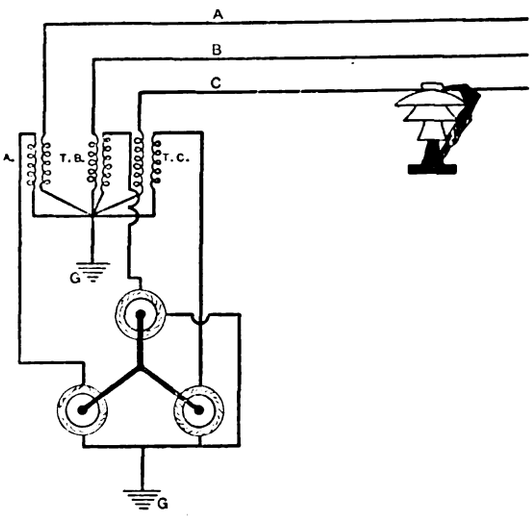

FIG. 2.—DIAGRAM OF ELECTROMAGNETIC SELECTIVE RELAY.

As a further and final safeguard against possible rises in resonant voltages when a phase is metallically earthed, a reasonable amount of resistance can be kept in the circuit to earth. This resistance will absorb the resonant energy if it appears. There is a limit to the amount of resistance on account of the permissible IR drop. This must not be such as to re-establish the arc at the fault.

Tests of the Arc Suppressor.—Tests were made on a line of the Schenectady Power Co., 21 miles long. The delta potential is 33,000 to 35,000 volts at 40 cycles. An insulator was made defective by meansof two wires from cap and pin respectively, which were held within sparking distance of each other, and the gap length around the insulator was shortened until the arc would, when started, hold continuously. A number of oscillograph records are given in the Paper.

The best location of the arc suppressor is usually at the power house, although cases may arise where some central switching station gives greater convenience. To get figures on the limitation of a device, the line constants of a 45-kv. system are used as a basis. The Y potential to earth is normally 26 kv., the charging current about 0·15 amperes per mile, the inductive resistance about 0·75 ohms per mile, and the impedance 0·86 ohms per mile at 60 cycles. Assume one phase earthed at the power house by the operation of its protecting switch, caused by an insulator arcing over at a distant point. The potential of this phase at the generator is zero, but the line wire is not zero throughout its entire length. There may be a considerable potential at the faulty insulator. This is found by multiplying the total charging current in the line by half the impedance.

Since all the treatises on the subject of line capacity assume a

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normal condition of no phase earthed, the electrostatic capacity to earth can be and is neglected. The author, therefore, considers at some length the capacity of a system with one phase earthed. Earthing a phase of an electrical system has about the same electrical effect as the mechanical shifting of a cart wheel axis from the centre of the wheels to some eccentric point out near the rim of the wheels. At a high speed the cart would then progress by jumps. If the earth is arcing, the electrical conditions correspond to a flat wheel on the cart. Every time it drops it bumps and sets up vibrations or oscillations throughout the body or system.

The remainder of the Paper is a general discussion of protective problems. The author concludes as follows: There are numerous minor problems, but the main problems which are to be solved before absolute continuity of service can be attained are: Protection against direct strokes of lightning, the suppression of short-circuits, the suppression of internal surges and the prevention of malicious or wilful interference. More or less satisfactory solutions of all but the last-mentioned problem are in sight. Will the demand for great continuity of service warrant the expense involved in getting such service? A collection of a considerable amount of data shows conclusively on analysis that the greatest number of interruptions in lightning infested localities is due directly and indirectly to the single arcing earth around an insulator, or in cable systems to a single puncture from one phase to the cable sheath. The arcing earth

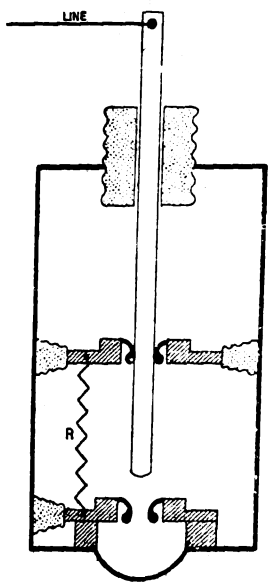

FIG. 3.—DAMPING RESISTANCE IN THE SWITCH POT.

suppressor, backed up by aluminium arresters, will prevent interruption of service and damage to apparatus in the majority of these cases. This improvement should in general bring the service above the existing standards or requirements. It may be possible to meet the higher demands in the future as they grow.

INSTITUTION OF ELECTRICAL ENGINEERS.

At the annual general meeting of this Institution, which took place on Friday last, the president, Mr. S. Z. de Ferranti, read the report of the Council, an abstract of which is given below. The honorary treasurer, Mr. R. Hammond, made a statement relating to the finances of the Institution. The adoption of the report was then moved by the President and seconded by Mr. J. F. C. Snell. A number of resolutions of thanks were then put to the meeting and carried. These included: "The Honorary Secretaries of the Local Sections and the Secretaries Abroad," proposed by Mr. J. F. C. Snell and seconded by Mr. L. Gaster; "Mr. Robert Hammond for his services as honorary treasurer," proposed by Major W. A. J. O'Meara and seconded by Mr. Sidney Sharp; "The Honorary Auditors," proposed by Mr. W. Clark and seconded by Mr. R. W. Hughman; "The Honorary Solicitors," proposed by Mr. R. A. Chattock and seconded by Mr. S. Rentell.

The President then announced that as no further nominations had been received the Council for the next session would be that already circulated to members (the list was given in THE ELECTRICIAN of April 28th). On the motion of Mr. W. Clark, seconded by Mr. R. W. Hughman, Mr. Sidney Sharp and Mr. H. Alabaster were elected honorary auditors for the forthcoming session. The meeting then adjourned.

The following is an abstract of the report of the Council:—

Growth of the Institution.—Since the last annual general meeting applications for admission into the Institution have been received from 502 persons, of whom 20 have been elected as members, 193 as associate members, 32 as associates, and 221 as students. 100 foreign members, 58 associate members, and 14 associates have been transferred to the class of members, 12 associates and 111 students to the class of associate members, and 14 students to the class of associates.

Members Deceased.—Among well-known members who have died since the last annual general meeting are Sir John Aird, Bart., Mr. G. Byrg, Mr. B. T. Ffinch, C.I.E., Mr. Geo. Flett, Sir W. B. Gurdon, C.B., K.C.M.G., Sir J. Clifton Robinson, and Mr. J. Wetzler.

Meetings and Papers.—During the past session 17 general meetings, one special general meeting, and 21 council meetings have been held. The usual standing committees have met regularly throughout the session, and several occasional committees appointed by the council for the consideration of special matters have also met with, the total number of committee meetings held during the session being 109. There have been 50 meetings of local sections, viz., 7 at Birmingham, 7 at Dublin, 6 at Glasgow, 11 at Manchester, 12 at Newcastle, and 7 at Leeds and Sheffield. The annual dinner of the Institution took place at the Hotel Cecil, London, on February 2, 1911. Annual dinners and other social functions were held at Birmingham, Dublin, Glasgow, Leeds, Manchester, and Newcastle, which were well attended by members and guests, and at which several members of Council were present.

Scholarships.—The Council have awarded Salomons Scholarships of the value of £50 each to Richard Michael Clark, of University College, and to Edward M. Teare, of the Finsbury Technical College; and a David Hughes Scholarship of the value of £50 to Francis Lewes Otter, of the Central Technical College.

Premiums.—The list of premiums for Papers has been revised and in future premiums will be awarded in accordance with the list shown below. In considering Papers, those published in the "Journal" without being read at a meeting, will not, after this year, be considered separately from those read at meetings.

Name.	Subject.	Value.
		£
Institution	Any	25
Ayrton.....	Practical Applications of Electricity.....	10
Fahie	Telegraphs and Telephones.....	10
John Hopkinson .	Design and Construction of Electrical Machinery	10
Kelvin	Scientific Research	10
Paris	Any	10
Webber	Military and Naval Applications of Electricity.....	10
Extra Premium ...	Any	5

The following premiums for Papers have been awarded by the Council this year. In accordance with precedent, in deciding upon these awards the Council have not taken into account Papers contributed by present members of Council. The Institution premium, value £25, to Sir R. A. Hadfield, F.R.S., and Prof. B. Hopkinson, F.R.S., for their Paper, "The Magnetic Properties of Iron and its Alloys in Intense Fields." The Ayrton premium, value £10, to Mr. H. T. Harrison, for his Paper, "Street Lighting by Modern Electric Lamps." The Fahie premium, value £10, to Mr. Donald Murray, for his Paper, "Practical Aspects of Printing Telegraphy." The John Hopkinson premium, value £10, to Messrs. A. P. M. Fleming and R. Johnson, for their Paper, "Chemical Action in Winding of High-voltage Machines." The Paris premium, value £10, to Mr. W. T. Taylor, for his Paper, "Modern Long-distance Transmission of Electrical Energy." An Extra premium, value £5, to Dr. E. Rosenberg, for his Paper, "Control of Electric Winding and Hoisting Engines." A premium, value £5, to Mr. C. C. Hawkins, for his Paper, "The Theory of the Static Balancer." Students' premiums: A Students' premium, value £10, to Messrs. G. W. P. Page and G. J. Scott, for their Paper, "Single-phase Commutator Motors, especially the Latour Winter Eichberg Type." A Students' premium, value £5, to Mr. Hugh C. May, for his Paper, "Notes on the Design and Construction of Dry-core Lead-covered Telephone Cables." A Students' premium, value £5, to Mr. Allan Monkhouse, for his Paper, "Recent Electric Locomotive Practice and the High-tension Direct-current Railway System." A Students' premium, value £5, to Messrs. R. C. Plowman and E. F. Hetherington, for their Paper, "Exhaust Steam Turbines." A Students' premium, value £5, to Mr. A. R. Stelling, for his Paper, "Organisation and the Reduction of Manufacturing Costs."

Scottish Local Section.—At the end of last March the Council granted a request from members residing in Scotland that the name of the Glasgow Local Section should be changed to Scottish Local Section, and that it should include all members residing in Scotland.

Students' Sections.—At the opening meeting of the session an address to the students was delivered by Mr. C. H. Wordingham. Ten meetings of the Students' section have been held, at which Papers were read and

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discussed. The Students' Committee organised a visit to Birmingham in 1910, when the following works and places of interest were visited: The British Thomson-Houston Co., Rugby; Messrs. Belliss & Morcom; Messrs. Humber, Coventry; the Electric Construction Co. and Corporation tramways, Wolverhampton; Messrs. Alfred Hickman, Bilston; the Birmingham University; Messrs. Siemens Bros. Dynamo Works, Stafford; the General Electric Co.; the Birmingham Corporation generating station; and the Sandwell Park Colliery, to all of whom the cordial thanks of the Institution are due. The annual dinner of the Students' Section, held on February 18, 1911, was well attended. The Glasgow and Manchester Students' Sections have each completed a successful session, having held six and nine meetings respectively. Visits were made to various works by the kind permission of the firms concerned.

The Institution Building.—During the last week of June, 1910, the offices were transferred to the Institution building from 92, Victoria-street, Westminster, S.W. The structural alterations were completed and the lecture theatre, the common room, and the library were ready for use on the occasion of the delivery of the Inaugural Address of the President, on November 10, 1910. The Council believe that the influence of the Institution on the interests of the electrical industry can be greatly extended by the practice of gathering together various kindred institutions and associations. With this in view the Council have granted the use of the lecture theatre and of meeting rooms to a number of engineering bodies, among others the Institution of Post Office Electrical Engineers, the Municipal Electrical Association, the Faraday Society, the Röntgen Society, the National Electrical Manufacturers' Association, the National Electrical Contractors' Association, the Associated Municipal Engineers of Greater London, the Junior Institution of Engineers, and the Society of Engineers. The use of the lecture theatre has also been granted to the University of London for the delivery of a course of lectures on "The Application of Hyperbolic Functions to Electrical Engineering Problems," by Dr. A. E. Kennelly, of Harvard University, from May 29 to June 2, 1911. The Council desire to draw the attention of members to the common room which is available for use as a reading and smoking room, and for appointments and interviews. It is also generally possible for members to obtain the use of one of the committee rooms, especially in the morning, by applying to the secretary a few days in advance.

The British Electrotechnical Committee.—The British Committee for 1911 is constituted as follows:—Mr. A. Siemens (*president*), Col. R. E. Crompton, C.B., Mr. W. Daddell, F.R.S., Mr. K. Edgcumbe, Mr. S. Z. de Ferranti, Sir John Gavey, C.B., Dr. R. T. Glazebrook, C.B., F.R.S., Mr. R. Kaye Gray, Mr. R. Hammond, Mr. R. W. Hammond, Mr. C. Le Maistre, Prof. T. Mather, F.R.S., Mr. W. M. Mordey, Mr. H. W. Miller, Major W. A. J. O'Meara, C.M.G., Mr. W. H. Patchell, Sir W. H. Preece, K.C.B., F.R.S., Lord Rayleigh, Dr. A. Russell, Mr. J. F. C. Snell, Dr. S. P. Thompson, F.R.S., Mr. A. P. Trotter, Mr. E. B. Vignoles Mr. C. H. Wordingham, and Mr. P. F. Rowell (*secretary*). During the last session progress has been made with the preparation of the list of electrotechnical terms. The nomenclature sub-committee have under consideration the German list of terms submitted at the Brussels Conference, and definitions are being prepared for the terms not already in the English list. On August 8, 9, and 10, 1910, an unofficial Conference, arranged by the Belgian Electrotechnical Committee and presided over by Prof. Eric Gérard, Director of the Institut Electrotechnique Montefiore at Liège, was held in Brussels in the Council Chamber of the Ministry of the Belgian State Railways. The British Committee were represented by Mr. Alex. Siemens (*president of the Committee*), Mr. W. Daddell, F.R.S., Mr. K. Edgcumbe, Mr. Robert Hammond, Major W. A. J. O'Meara, C.M.G., Mr. W. H. Patchell, and Mr. P. F. Rowell (*secretary*). The Conference discussed a number of propositions in reference to nomenclature, symbols, the direction of rotation for vectors, and the rating of electrical machines; and eventually passed certain informal resolutions embodying suggestions on these subjects with a view to their being considered by the various committees and, if approved, ratified at the next meeting of the International Electrotechnical Commission which will be held in Turin in September, 1911. At the conclusion of the sittings the members of the Conference were entertained by the Belgian Committee to a number of functions and visits to places of engineering interest at Charleroi, Liège and Antwerp.

Wiring Rules.—The revised edition (the sixth) of the Wiring Rules, which was published on May 1, has been prepared to meet as far as possible the developments of the electrical industry. In preparing this edition the Council have had the assistance of some of the principal Fire Offices, the Incorporated Municipal Electrical Association, the Electrical Contractors' Association, and the Cable Makers' Association, all of whom were represented on the Committee who carried out the work of revision on behalf of the Council. The figures in the table relating to the current-carrying capacities of conductors are based on an exhaustive series of tests carried out at the National Physical Laboratory on the temperature rise of conductors. The new rules have been adopted by 49 fire offices, and they are accepted as standard practice and their use recommended by 232 supply authorities.

Model General Conditions for Contracts.—A draft revision of the model general conditions for contracts has been completed, and the clauses are at present under further consideration with a view to their being made acceptable to a larger number of interested bodies.

Electricity in Textile Mills.—The Committee appointed to consider this subject have had several meetings.

Street Lighting Specification.—The Council have appointed a committee consisting of representatives of this Institution, and of representatives nominated by the Councils of the Institution of Gas Engineers, the Institution of Municipal and County Engineers, and the Illuminating Engineering Society, to consider the preparation of a specification for street lighting to be issued jointly under the auspices of the various interested bodies.

Kelvin Lecture.—The third Kelvin lecture will be delivered next autumn by Dr. R. T. Glazebrook, C.B., F.R.S. The subject will be Lord Kelvin's work in connection with fundamental units, and to a considerable extent the lecture will be experimental.

Examinations for Associate Members.—The Council have decided to hold examinations of candidates for election and transfer to the class of associate members after January 1, 1913. Candidates will be required to pass—(*a*) An examination in general knowledge, and (*b*) an examination in one of the four special subjects: (1) Power, lighting and traction, (2) telegraphy, (3) telephony, (4) electrochemistry and electrometallurgy. The questions will be set with the object of showing that the candidates possess a good general education and a reasonable amount of fundamental knowledge in one of the branches of the profession. Due consideration will also be given to the practical side of electrical engineering, and moreover the candidate's admission or rejection will not depend solely on his answers to the papers set, but these will be considered in conjunction with the candidate's practical experience, which must be in accordance with the requirements of the articles of association. In lieu of examination, candidates will be allowed to present a thesis, Paper, or other contribution to electrical knowledge, and they will be liable to be examined orally by the examiners on the subject presented. Certain degrees or diplomas will procure exemption from the whole or part of the examination, and the Council will have power in approved cases to grant exemptions. The complete details are under consideration with a view to publication at an early date.

Examinations for Students.—The Council have decided that from January 1, 1913, candidates for election as students shall be required to pass or to have passed either the matriculation examination of one of the British Universities or some school-leaving or other equivalent examination which shall satisfy the Council of the candidates' general education. In view of the number of existing examinations, which is already very large, the Council deemed it wise not to conduct a special examination. Full details will be available at an early date.

Journal.—It has been felt for some time that it would be desirable to make arrangements for a more frequent publication of the "Journal," so as to ensure that members shall receive promptly full and accurate reports of the Papers read and of the discussions at the meetings of the Institution and of the local sections, and the Council have accordingly given instructions for a report to be prepared on the subject. The value of the lectures and of the Papers and discussions at the informal meetings mentioned elsewhere in this report would be greatly increased by early distribution among the members as a whole, and especially those residing abroad or at a distance from the place of meeting. It is also hoped that the result would be to render the "Journal" more efficient as a means of communication between the Council and the members. The advantages of publication at shorter intervals than six weeks (as under the present system) are so obvious as not to require mention in detail, but in view of the gross expenditure on the "Journal" which at present stands at £2,040 per annum, exclusive of salaries and cost of office accommodation, and would necessarily be increased by such a change, at least during the first few years, the decision of the Council in regard to this matter will largely be governed by the funds at the disposal of the Institution.

Lectures.—The Council have under consideration the subject of lectures at meetings of the Institution and of the local sections. The lectures would be on electrical subjects or on subjects scientific, economic, financial, or commercial, connected with electrical science or engineering, treated in a general manner, and if possible illustrated by experiments. The underlying idea of the lectures is to bring before the members general surveys treated by authorities who have specialised in their own subjects, the object being to keep the members in touch with those outlying branches of electrical science and engineering which are not usually considered in the Papers read before the Institution, and also to keep members informed of the progress of allied sciences of interest to electrical engineers. The lectures, the matter for which would not necessarily be new, would be published in the "Journal" in short abstract only, and it is not intended that there should be any discussion on them. It is proposed to hold two lectures each session, either on the evenings reserved for ordinary meetings or some other evening.

Informal Meetings.—There are many subjects of considerable interest to a limited number of the members, which for various reasons are not of sufficient importance or of sufficiently general interest for the ordinary meetings of the Institution, and the Council have accordingly under consideration arrangements for informal meetings for reading Papers and discussing matters relating to such subjects. The Papers would be short, so as to leave ample time for discussion. To begin with, it is suggested that four meetings a session be held, which could be increased later if required. A short abstract of the Papers would be published in the "Journal," together with an abstract of the discussions.

Summer Meetings.—It is proposed to consider whether arrangements can be made for holding meetings of the Institution in the districts of the different local sections. Each meeting would last for three or four days, part of the time being given to the reading and discussion of Papers and part to visiting the industries of the particular district.

Subscriptions and Entrance Fees.—The Council feel that the time has

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now arrived when the development of the Institution, as well as the maintenance of its prestige among the great engineering institutions of the world and the possibilities in the direction of increasing of its usefulness to the profession, make it imperative that the members should contribute higher annual subscriptions and entrance fees. These are at present less than those paid to other professional Institutions of equal standing. This matter has recently been under the consideration of the Council, and at the next revision of the articles of association proposals on this subject will be placed before the members.

Articles of Association.—The committee appointed to consider the alterations required in the articles of association will shortly present their report to the Council.

Benevolent Fund.—The committee of management report that the Benevolent Fund of the Institution shows a satisfactory increase for the past year. On Dec. 31, 1910, the capital account of the fund stood at £3,700, as compared with £3,500 at the end of 1909. The donations to the fund in 1910 include one of £20 from the committee of the Electrical Engineers' ball, and one of £8. 8s. from the "25" club. The Council desire to acknowledge their indebtedness to the generosity of these and other donors and subscribers who have supported the fund. Grants in aid amounting to £51 were made during 1910. The Wilde benevolent trust fund stands at £1,846. 4s. 6d.

General Accounts.—The report of the hon. treasurer, Mr. Robert Hammond, is as follows: The balance carried to the general fund at the end of 1910, being excess of income over expenditure, was £3,053. 0s. 2d., as compared with £3,283. 3s. 11d. for 1909, a decrease of £230. 3s. 9d. In this comparison no account is taken of outlays in connection with the acquisition and structural alteration of the Institution building. The balance sheet sets out the total investments other than the investments of the trust funds. The total assets amount to £102,686. 17s. 6d., against which have to be set liabilities amounting to £42,851. 15s. 10d., leaving as the net assets of the Institution £59,835. 1s. 8d. This amount is almost entirely locked up in the acquisition of the lease of the Institution building, in the structural alterations, and in the expenses incurred prior to occupation. The investments in stocks and shares included in the above appear in the accounts at cost price with a book value of £3,133. 2s. 10d., and their value at the current market prices on April 27, 1911, was £2,864. No alteration has taken place during the year under consideration in the two scholarship trust funds. The Wilde Benevolent Trust Fund has been increased by the investment of an amount of £101. 8s. 6d. transferred from income account, and it now stands at £1,846. 4s. 6d. This fund has been increased during the year by £30. 9s., and stands at £642. 12s., which amount now figures in the accounts as a loan to the building fund, the investments of the fund having all been realised. An overdraft is shown of £816. 6s. This amount has been transferred to the building fund. In consequence of the acquisition of the lease of the Institution building, the fund has been augmented as follows: (*a*) permanently, by transfer of £816. 6s. from the entrance fees fund, and by revenue from subscriptions, donations, and sundry other items, £90 11s. 6d.; (*b*) temporarily by loans, on mortgage from the Economic Life Assurance Society £11,500, from life compositions fund £30. 9s., and from general fund £4,047. 15s. 11d., against which £599. 17s. 11d. has been repaid to the Economic Society on account of existing loans. This makes a net increase of £15,904. 4s. 6d., and the fund now stands at £15,990. 3s. 11d. The general fund has increased to the extent of £3,053. 0s. 2d. during the past year, and now stands at £13,188. 10s. 10d.

Library.—The Council wish to draw the attention of the members to the present arrangement of the library. The whole of the books published since 1880 have been classified, and a subject index is being prepared. The eastern half of the shelves under the gallery contain the classified portion of the books, the bound volumes of the principal periodicals being on the western half of the shelves. The books of the Students Library are on the central shelves above the gallery; 76 new books have been purchased since May, 1910, and 181 books and pamphlets have been presented by members, authors, and publishers. The total number of readers during the past 12 months was 1,024, of whom 47 were non members. The Council have under consideration the question of a lending library and the opening of the library in the evenings.

Museum.—Some of the historical apparatus which has been presented to the Institution is temporarily on view in the glass cases in the library, and a room in the basement has been set apart for the exhibition of other historical apparatus in the possession of the Institution. The apparatus is in process of being sorted and classified.

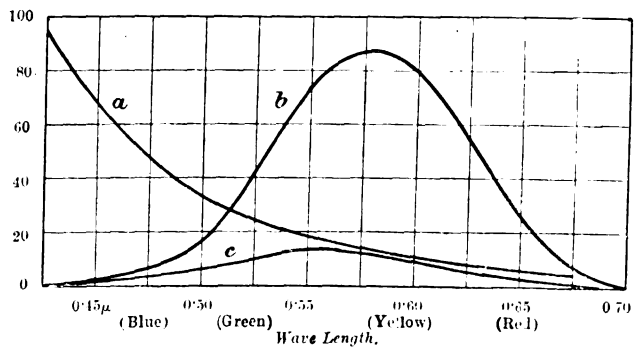
SUBTRACTIVE PRODUCTION OF ARTIFICIAL DAYLIGHT.*

BY H. E. IVES AND M. LUCKIESH.

Most forms of artificial light are very unlike daylight in colour. Incandescent illuminants, such as gas flames and incandescent electric lamps, have the colour of incandescent solids at comparatively low temperatures, such as 2,000° C., while the colour of daylight corresponds more nearly to an incandescent solid at a much higher temperature, about 5,500° C. This means that, when giving the same total illumination, our common illuminants as compared with daylight are deficient in blue light and have an excess of red light. The difference is really very large, and were it not met by a comparatively great power of adaptation in the eye would seriously interfere with our comfort under artificial illumination. Whatever disturbance of vision this change from daylight colour may cause, there is one practical necessity which even the adaptive power of the eye cannot entirely meet—namely, the selection and matching of colours. For certain technical purposes it consequently becomes of importance to secure artificial daylight for use in the absence of the natural article.

One way of doing this is by the use of absorbing media over the lamps. This may be termed the subtractive method, to distinguish from the additive method, the latter being illustrated by the combination of a mercury arc-lamp with tungsten lamps. The nature of the absorption and the method of calculating the resultant loss in efficiency in this subtractive method have been treated elsewhere by one of the present writers.* From that investigation it appears that the transmission of the absorbing screen should be the reciprocal of the relative brightness of the illuminant and daylight at each part of the spectrum. Since that work was done more extensive data have been obtained on the colour value of daylight, and on this basis the necessary absorbing medium to transform tungsten lamplight into "daylight" has been calculated. It should have the transmission throughout the spectrum shown in curve *a* of the diagram herewith. Curve *b* shows the luminosity or brightness distribution in the tungsten lamp; curve *c* the same after transmission through the medium *a*. Comparison of the areas of *b* and *c* shows the resultant candle-power to be 15 per cent. of the original. This is the "daylight efficiency" of the tungsten lamp, and corresponds to about 10 watts per mean spherical candle.

The present Paper is an account of an attempt to obtain coloured glasses and other media approximating to the curve *a*. In the first place, however, attention must be called to the variable character of "daylight." This is of a perfectly definite character; it consists in a very uniform increase or decrease in the intensity of the spectrum toward one end or toward the other. The curves illustrated give a fair average. Again, as to the characteristics of "white" light to make it suitable for colour matching. While a white may be made in which certain colours are entirely missing, such a light



a. Transmission of ideal absorbing medium. *b*. Luminosity curve of tungsten lamp. *c*. Luminosity curve of tungsten lamp through ideal absorbing medium.

TRANSMISSION AND LUMINOSITY CURVES.

would be unsuitable for colour matching. For the ideal white all the colours should be present and in the proportions of daylight. A study of the colours of most natural objects, however, reveals the fact that those colours are very rarely pure isolated spectral hues, but rather long diffused bands of spectral light. As a consequence, a white light consisting of isolated colours may yet possess enough colours to have very little disturbing effect on ordinary coloured objects. Just how many spectral colours should be present is not a matter easily capable of exact statement, but certainly there should at least be three—red, green and blue—and preferably more.

Now we may apply these general considerations, plus some experience and experiment, to the case of artificial daylight and state the following requirements: (1) The total light should appear white. (2) All the spectral colours should be present, but if gaps or irregularities exist in the spectrum the three principal colours—red, green and blue—are necessary.

These requirements fall far short of being exact specifications, but at present it is difficult to see how the various factors to be considered can be reduced to more exact terms. In the work which follows the deviations allowed from the desired character are justified by the experience of the writers as to the actual permissible amount of deviation from the conditions outlined above.

Some sort of blue glass or other medium is called for. Coloured glass is preferable to dyed films or solutions of coloured material, because of its practicability in handling and in permanence. A study of a large selection of samples of coloured glass revealed two shades which might be used—ordinary pot blue, or cobalt blue, and signal green. The first alone transmits blue, an isolated spectral band of

* Abstract of an article in the "Electrical World."

* "Bulletin," Bureau of Standards, June, 1909. (THE ELECTRICIAN, Vol. LXIV., p. 932.)

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yellowish green, and the deep red. Used alone over a tungsten lamp it gives a purple light, because of the transmitted red. Signal green alone makes the light too green, but it reduces the red that the cobalt blue transmits. A combination of the two appeared promising. Wedges of these glasses were ground and tested for transmission at various thicknesses on the spectrophotometer. From the measurements a combination of the two glasses was chosen which approximates the curve desired. A grave defect of this combination is the pronounced band of yellow-green transmission of the cobalt. In order to reduce this, recourse was had to dyes. A dye—rozazeine—was found by trial which has an absorption band so situated as to cover very well the undesirable yellow-green band of the cobalt glass.

With these two glasses, plus a gelatine film flowed upon one of them and containing a specified amount of dye, an absorbing combination was obtained which produces with a tungsten lamp a very satisfactory approach to "daylight." In the spectrum the total light is "white." No gaps and no bad depressions or humps exist, and the three elevations are in red, green and blue. In short, the conditions outlined above are approximated.

With these glasses a "daylight window" has recently been constructed. This consists of a tin box 16 in. by 12 in. by 20 in. holding six 60-watt frosted-tip tungsten lamps. The bottom of the box consists of the two glasses, one coated with the gelatine film containing the dye, the other a rough glass acting as a diffuser. The whole box rests upon legs 15 in. high. The surface to be illuminated is placed beneath, where an illumination of about 30 ft.-candles is obtained, this value being ample for purposes of colour matching. This window has proved extremely satisfactory on test. The light appears "white" and all colours assume their daylight appearance under it. It has been temporarily used for lighting a desk, and the soft white colour has proved very pleasing. It constitutes a very satisfactory demonstration of the possibility of producing daylight by the subtractive method. The specific consumption is high, being from 10 watts to 12 watts per candle. On the other hand, the first cost is extremely low.

TEST ON 5,000 KW. TURBO-ALTERNATOR.

The tests on the first of the two new 5,000 kw. steam turbo-alternators, which the British Westinghouse Electric & Mfg. Co. is supplying to the Clyde Valley Electrical Power Co., show an even better result than those recently obtained on the 3,000 kw. turbo-alternator, supplied by the same Company to the Bristol Corporation. Particulars of this last-mentioned plant were given in our issue of April 28th. The tests were carried out at the Motherwell power house on April 8th and 9th in the presence of Mr. D. A. Starr, the general manager of the Clyde Valley Electrical Power Co., Messrs. Strain and Robertson, the consulting engineers, and other officials.

The turbines are of Westinghouse latest improved impulse type, which we described in the article referred to above, and are arranged to use high pressure steam at 175 lb. per square inch pressure and 150° F. superheat, both measured at the stop valve. The conditions specified for carrying out the tests were as follows :—

Normal output 5,000 kw., three-phase, 25 cycles, 11,000 volts.	
25 per cent. overload for	6 hours.
Full load for	6 hours.
¾ load for	2 hours.
½ load for	2 hours.
¼ load for	2 hours.

The results of the tests are as follows :—

Output in kilowatts	1,346	2,715	3,902	5,066	6,487·5
Speed, revs. per min.	1,500	1,500	1,500	1,500	1,500
Steam pressure (lb.)	174	176	175	174·5	174·5
Steam temperature (deg. F.)	518	519	542	552	544
Steam superheat (deg. F.)	141	141	164	175	167
Vacuum corrected to 30″ bar.	28·13	28·28	28·58	28·68	28·53
Cir. water inlet temp. (deg. F.).	43·9	43·7	44·0	44·0	43
Cir. water outlet temp. (deg. F.).	48·0	52·6	57·0	60·0	65·5
Total steam consumption (lb.)	24,780	40,130	53,125	65,860	85,880
Steam con., lb. per kw.-hour	18·41	14·78	13·61	13·00	13·24

We understand that Mr. Starr, general manager of the Power Company, the consulting engineers, and the directors have expressed their gratification at the results obtained and at the reduction of the generating costs which has taken place since the turbo-generator was put in commisison.

THE COMET TELESCOPIC MAST AND HOIST.

The efforts of numerous inventors to produce a satisfactory telescopic mast have hitherto been singularly unsuccessful, for, though there is an undoubted market for reliable apparatus of this kind, the difficulties to be overcome are considerable. It is claimed that the Comet mast, which we describe and illustrate herewith, represents an eminently practical piece of apparatus of a robust nature, which is easily portable, which can be rapidly erected, and in which the very simplest mechanical parts are employed.

The mast consists of a series of welded steel tubes of gradually decreasing diameter and thickness, which are adapted to slide telescopically within one another. The novelty of the design lies in the method employed for extending the mast, for which purpose an un-

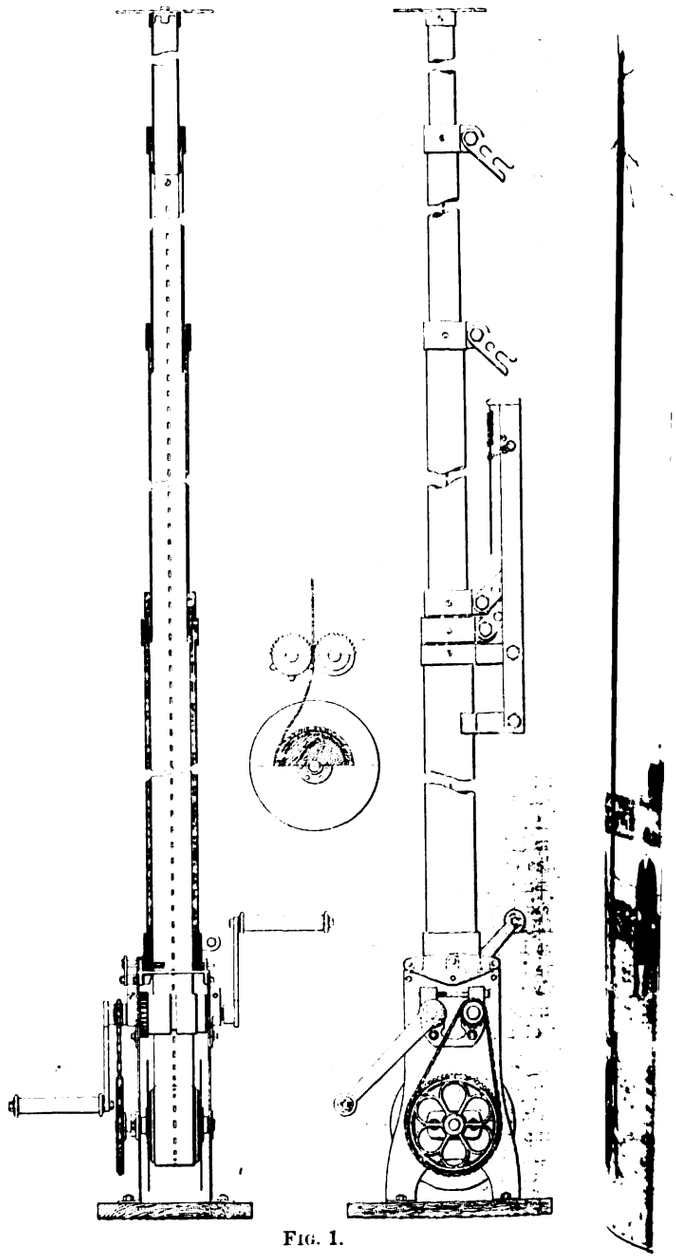

FIG. 1.

tempered perforated steel band is employed. The width of the band follows the internal diameter of the tubes, so that it has a stepped profile as seen in Fig. 1. Within each section the band is a sliding fit, and occupies the full diameter of the circular tube, or, where the tube is of square section for raising heavier loads, the band occupies the full diagonal. As the diameter and the diagonal are respectively the longest lines which can be placed within a circle and square, it is obvious that no further guide is necessary, the band acting as a rigid piston to thrust or push its load upwards.

When the winch handle shown in Fig. 1 is revolved, the teeth of the moving roller engage in the perforations of the band, and cause it to rise in the tubes, and, at the same time, the band is unwound from a drum geared to the crank-handle shaft by a chain and sprocket

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arrangement. The band carries the smallest tube with it, and, when fully extended a collar on the latter engages internally with the top collar of the next section causing this section to rise also. As the latter commences to rise, the forked lever engages with the pin of the fixed bracket as shown. This has the effect of turning the lever down and clamping these two sections together, so that the mast when fully extended is practically rigid. At the base of the tubes a retaining device is fitted which automatically releases each tube in its turn. The extension of a portable mast is very rapidly carried out, for instance, a 100 ft. mast can be raised to its full height in 60 seconds.

Figs. 2 and 3 show a 150 ft. mast recently supplied to the order of the Japanese Government. These light masts readily lend themselves to mounting on field carriages, in which case the collapsed mast lies horizontal when in motion, and is adapted to be swung into vertical plane on trunnions when required for service.

In addition to light portable masts, the Comet principle has been successfully applied to various descriptions of hoisting apparatus capable of dealing with considerable loads. Fig. 4 illustrates a Comet building mast, which will carry a load of 5 tons, and measures 65 ft. when extended. Rectangular lattice masts are in course of construction for loads up to 12 tons. These loads considerably exceed those to which an ordinary wireless mast is likely to be subjected on permanent service, and telescopic lattice masts of rectangular section may be readily constructed for such stations. In this case the advantages are that, owing to the small compass into which the mast collapses, it is easily transported and shipped, and can be raised into a vertical position and extended without employing the customary costly and complicated gear, so that the erection comes well within the province of the ordinary installing engineer, and, in the case of a foreign contract, it is no longer necessary to ship and transport lengthy and heavy spars, or to pay the expenses of a riggers' staff to deal with them at their destination.

Although it is easy to obtain light topmast spars of suitable length on the spot, it frequently happens that a heavy wooden lower-mast is not procurable, and this has often to be transported from a considerable distance.

In the case of permanent masts the adjacent tubes or lattice sections are clamped together by hand as each is fully extended. The mast may be galvanised or painted, and arrangements are provided for withdrawing the band and detaching the winch mechanism for protection or for use with another mast if required.

Light portable masts, suitable for military, temporary or experimental wireless work, are supplied for heights varying from 40 ft. to 240 ft., and we understand that the Comet masts have been supplied to and adopted by the British and foreign Governments and by the principal wireless telegraph Companies. In addition to masts pure and simple, the Comet Telescopic Mast Co. manufacture a large number of hoisting and elevating appliances of a portable nature, such as masts carrying a platform for artillery observation or searchlight work, portable towers for overhead tramway constructional and maintenance work, hoists and derricks.

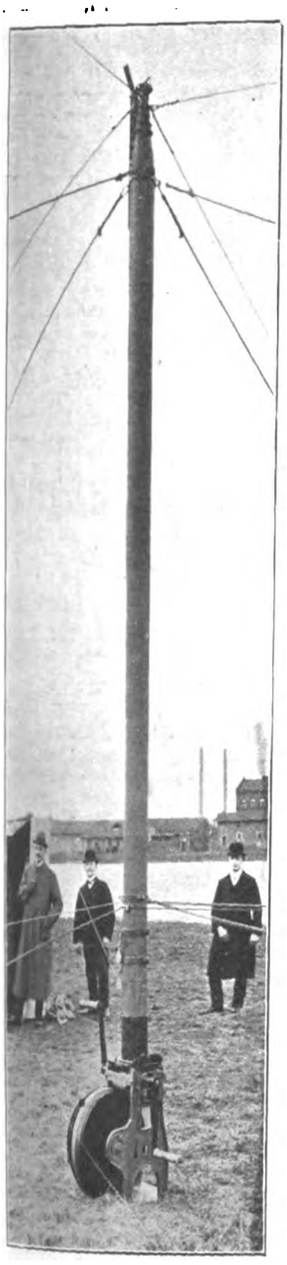

Fig. 2.—Comet Mast collapsed.

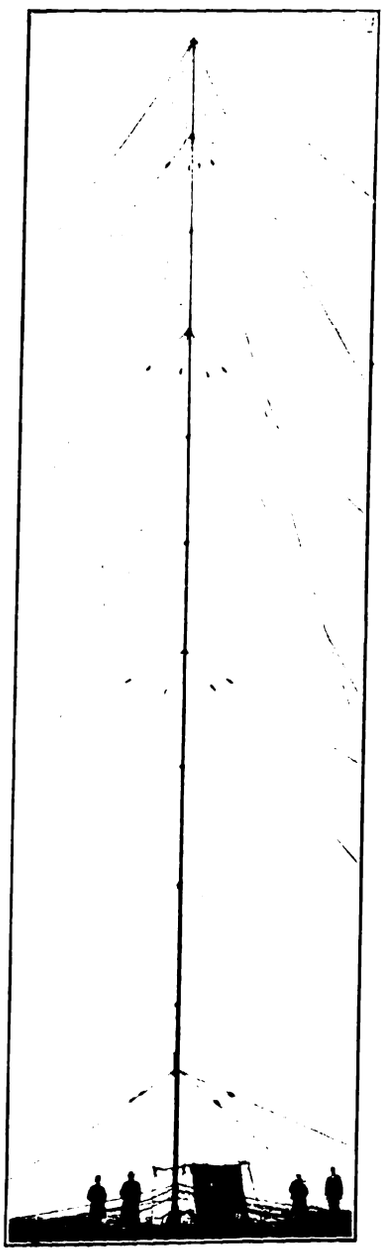

Fig. 3.—150 ft. Comet Mast extended.

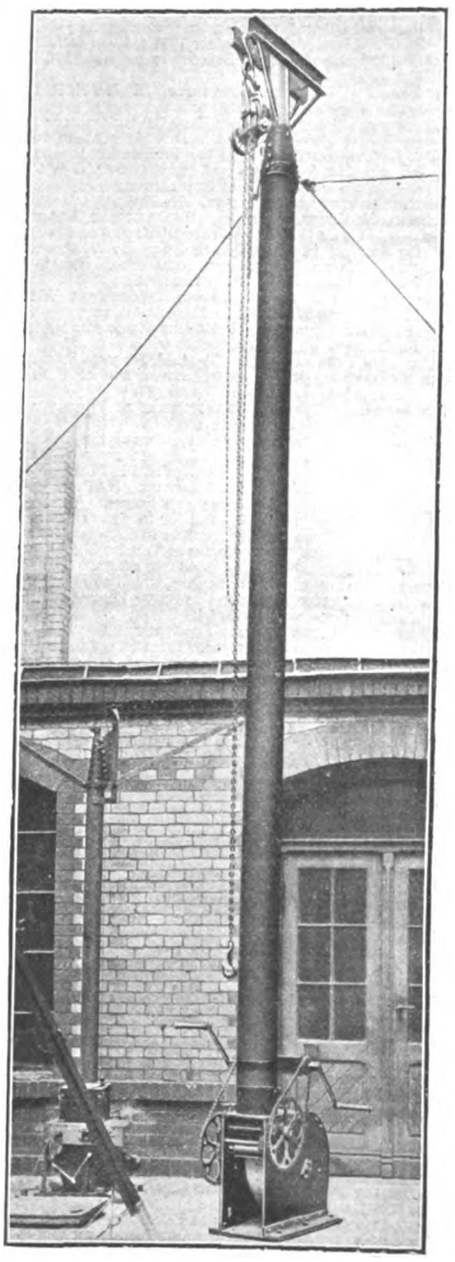

Fig. 4.—Comet Building Mast.

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"THE ELECTRICIAN" INDUSTRIAL SUPPLEMENT.

With "THE ELECTRICIAN" for Sept. 14, 1906, was issued the first of a series of "Industrial Supplements," to be published from time to time with "THE ELECTRICIAN." The fifty-third issue of the Supplement published (Gratis) with the number of "THE ELECTRICIAN" for September 23, 1910, was the last of the monthly issues. "THE COMMERCIAL AND INDUSTRIAL SUPPLEMENT" to "THE ELECTRICIAN" is now issued weekly (Gratis). It will be found towards the end of the present issue.

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THE INSTITUTION OF ELECTRICAL ENGINEERS.

The report presented at the Annual General Meeting of the Institution last week shows evidence of increasing activity, although the roll of membership does not indicate quite that rapid growth we should like to see. The number of members added year by year is steady but somewhat small. Perhaps this is to be expected under the present conditions of the industry, and in any case it would not be reasonable to expect the growth that was evident a few years ago to be maintained through all time. The commodious premises forming the home of the Institution should now provide some additional attraction. Possibly this is the reason why the membership has grown rather more this session than last, and we hope that the influence of this new asset will be still more apparent in the forthcoming session. By no means the least valuable of the privileges attaching to membership of the Institution is the use of the Library. Hitherto, however, the number of members who have availed themselves of this facility has been small. The fact that the Library is not open in the evenings, except when a meeting is being held, has doubtless somewhat restricted its utility; we are therefore pleased to see that the Council have under consideration opening the Library in the evenings. A further proposa

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under consideration, which will particularly appeal to provincial members, is the formation of a Lending Library.

With regard to the Papers that were read, these form a fairly formidable list, though we doubt if the average standard of these Papers was quite so high as that reached on former occasions. We notice that the number of regular premiums to be awarded in future to authors has been extended, and we think this is a move in the right direction. So long as the Institution can afford it, the premiums given should be substantial.

One of the most important announcements is that the Council have appointed a committee, consisting of representatives of the Institution and representatives nominated by the Council of the Institution of Gas Engineers, the Institution of Municipal and County Engineers and the Illuminating Engineering Society, to prepare a specification of street lighting to be issued jointly under the auspices of these bodies. The subject is one of very great importance at the present time and anything that can be done to clear up the present unsatisfactory state of affairs will be welcome. The Society first to move in this matter was the Illuminating Engineering Society, but we gather that this movement has been dropped in favour of the Committee appointed by the Institution of Electrical Engineers. We are very glad to see that the Council has taken action in this matter, for it is one that should essentially be handled by the Institution as one of the senior Societies.

There are those who feel that there are already too many meetings of Societies in London and that there is great difficulty in finding sufficient time to attend them. Nevertheless it may be quite desirable to hold informal meetings such as those which the Council now propose in addition to the ordinary general meetings. There is a feeling that the Institution in London lacks that element of sociability so characteristic of local sections. This defect should be remedied to some extent by the proposed informal meetings, the more so as there are many people who do not care to take part in a formal discussion where the remarks are to be reported, but who are willing to speak at an informal gathering. Another suggestion is to hold summer meetings in the districts of the local sections, each meeting lasting three or four days. With these innovations we think it will be admitted that most tastes should be satisfied. Perhaps we may express the hope that the new Council will not throw too much stress upon Mr. ROWELL.

The report shows that the Council have at length pledged themselves to examinations for admission to the class of associate member, and this policy is to come into force after January 1, 1913. Very little information is at present available, but it appears that in addition to an examination in general knowledge, it will be necessary for the candidate to pass in one of four special subjects. It is, of course, impossible to say whether this course will be satisfactory without the fullest details. We are glad to see, however, that due consideration is to be given to the practical side of electrical engineering and that the candidate's admission or rejection will not depend solely upon his answers to the papers. This, we think, is most important, because what we desire is to determine whether the candidate is likely to succeed as a practical engineer, with a proper grounding in theory, rather than an expert theoretically, but possibly useless in practical work.

REVIEWS.

(Copies of the undermentioned works can be had from THE ELECTRICIAN Office, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.)

General Foundry Practice. By WILLIAM ROXBURGH. (London: Constable & Co.) Pp. xii. + 296. 10s. 6d. net.

The author, after having spent over 30 years in the foundry, and having passed through all the stages from moulder to foundry manager, proposes to put the results of this experience at the disposal of his fellow foundry men, and to help them out of their difficulties. The major part of the book consists of a description of the best ways to prepare moulds, ventilating ducts, pouring gates, &c., for different castings, and explains the most usual troubles to be expected, as well as the best way to obviate them. The number of examples selected is not quite representative, but no doubt the author's experience was the determining factor in the selection. This part of the book will be read with interest, as it is a report of practical experiments, and throws a light on many points of importance to engineers in general.

The author's attempt to generalise, however, and produce a text-book for draughtsmen and students does not appear to have succeeded. In the first place, it is not systematic, all subjects being treated in separate chapters without logical sequence. Thus, moulding and burning of faulty castings are dealt with before anything is said of shrinkage and pattern making. The laying out of a foundry with the conditions for running it on economical lines is explained in the first chapter, whereas one would naturally expect it to form the conclusion of the book. On the other hand, the tables of the analysis of iron of different makes, its qualities and influence on the results obtained, are given in one of the last pages. Again, plain physical explanations of many phenomena would be far simpler than the complicated experimental explanations given by the author, *e.g.*, the remarks on "blistering" or "scabbing" of castings. The treatment of several items is also very far from exhaustive, especially the most important question of mixing iron to obtain castings to a given specification. No attempt is made to solve this problem, the author merely stating that chemists are employed in large foundries for this purpose.

The chapters on such important subjects as the production of malleable iron and brass are kept so very short that the treatment of the respective matter is necessarily incomplete, and therefore hardly useful for practical purposes.

Finally, I should like to mention that, whilst a practical man may introduce a certain number of trade expressions, and may not be expected always to use a terse literary style, it should be a matter for the publishers to have the proofs read with a view to smoothing off the phrases which strike one most disagreeably throughout this book, and, where necessary, to correct expressions like "a good going cupola," and others which openly defy grammar.

R. ORSETTICH.

Imperial Telegraphic Communication. By CHARLES BRIGHT, F.R.S.E., M.Inst.C.E., M.I.E.E. (London: P. S. King & Son. 3s. 6d. nett.

Mr. Bright is a persistent writer on matters relating to telegraphic communication and he has taken the opportunity offered by the meeting of the Imperial Conference now sitting in London to prepare in handy book form a collection of the Papers he has read and articles he has contributed to various societies and to the reviews. Included in the list is the Paper recently read before the Royal Colonial Institute. However one may differ from Mr. Bright as to the practical utility of some of the suggestions he has put forward from time to time, there is no denying that he has given much attention to this important question, and it is only right that due credit should be given to him on this account. He has done the spade work. We think Mr. Bright is wrong in coming to the conclusion that the public discussion of cable rates has led to the reduction in rates of which he takes account. We feel little doubt that the majority of these reductions have been brought about, in the first place, by negotiations ranging over

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long periods between the cable companies and the different Governments, and more especially as the result of understandings and agreements between the respective parties as influenced by the volume of traffic, as in the case of the rates for Indian traffic. Presumably in this matter Mr. Bright is only one of the public, and so is unacquainted with the constant flow of negotiations going on in connection with these matters. Besides being timely, Mr. Bright's book is an instructive contribution to a subject in which the public are becoming interested and every day better informed. It is largely concerned with the history of telegraphic communication and records many of the principal events that have led up to the development of the great system of submarine telegraphy which now encircles the earth and makes speedy communication possible with all countries.

Engineers' Pocket Dictionary: English-German-Dutch. By W. H. Steenbeek. (London: Whittaker & Co.) Pp. 158. 2s. net.

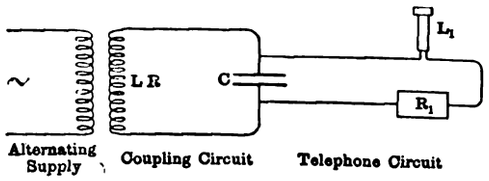
This book is intended by the author for the use of engineers who belong to either the English, Dutch or German nations on occasions when they are working in one of the two countries other than their own. An English engineer, supervising the erection of plant in Holland, and ignorant of Dutch, will, it is hoped, turn to this book with a sigh of relief and find there the phrase which he desires laid down in the language of the country. The theory is excellent, but we are not so sure about the practice. The way for those who depend upon books of this class for conveying their thoughts in a foreign language is hard. For one thing idiom seems there to find no place, though idiom is the principal feature of all conversation. Again, in this particular book, the translation is not always well done. For instance, "Freilauf" is not a correct rendering of the phrase "air-gap" when used in an electrical sense, nor is it explained that "Morgen" may sometimes mean "to-morrow" as well as "morning." This may lead to confusion in Germany. We recommend the learner to use this book with caution. It should, nevertheless, prove useful as a refresher to the engineer who is already well acquainted with Dutch or German. Its small size makes it convenient for carrying in the pocket.

A METHOD FOR THE DETECTION OF HARMONICS IN AN ALTERNATING CURRENT, AND FOR THE MEASUREMENT OF INDUCTANCES.

BY H. SMITH, B.SC.

Summary.—The author determines the harmonics in an alternating current by coupling to the circuit under test (by means of a transformer) a circuit including inductance and capacity, these being varied until the natural frequency of the circuit is the same as that of any desired harmonic. The harmonic is detected by a telephone across the capacity. Inductances are measured by substitution in a tuned circuit, the inductance being readjusted to give the note again after inserting the unknown inductance.

In alternating-current work the distortion of the current wave due to resonance between harmonics and some part of the circuit is a frequent and well known occurrence, but I do not remember the principle of resonance being utilised for the



examination of the harmonics present in an alternating supply. The method described below appears to offer a very sensitive and, at the same time, very simple test for the presence of harmonics up to a very high order.

If we have a circuit consisting of an inductance L and a capacity C, we can produce an oscillating circuit of low frequency, which can be coupled with the alternating supply which is to be examined. By altering the value of C we can give to the circuit the same period as any of the harmonics. To test when the circuit is in resonance with any particular harmonic, a telephone is joined across the condenser, and a note is heard which has the same pitch as the frequency of the circuit. It is necessary that a fairly large resistance (10,000 ohms or more) should be placed in series with the telephone. As C is varied from zero upwards, all the harmonics are heard in turn in the telephone, each harmonic producing a note which rises to a maximum with a certain value of the capacity. To find what harmonic has been reinforced by resonance, all that is necessary is to find the pitch of the note with a sonometer and divide by the frequency of the fundamental; or if L and C are known, the frequency of the circuit divided by the frequency of the fundamental will give the harmonic. Also, since the pitch of the note is the frequency of the circuit, if C is known and L unknown, the value of L may be calculated from the formula $n=\frac{1}{2\pi\sqrt{LC}}$, where n is the pitch of the note. As C is varied till a particular note in the telephone reaches a maximum intensity, the current through the telephone due to any particular harmonic must also be a maximum.

Let L and R be the inductance and resistance of the coupling circuit, L_1 and R_1 be the inductance and resistance of the telephone circuit. Then it can be shown that the current through the telephone is given by

$$i=\frac{E}{\sqrt{C^2\omega^2x_1^2x^2-2\omega^2C(L_1x^2+Lr_1^2)+X^2}}$$

where $x_1^2=R_1^2+\omega^2L_1^2$,
$x^2=R^2+\omega^2L^2$,
$X^2=(R+R_1)^2+\omega^2(L+L_1)^2$ and $\omega=2\pi n$, where n is the frequency of the harmonic,
E = E.M.F. produced by the change of the lines of force through the coils of the coupling circuit.

This is a maximum (the capacity being varied) when the denominator is a minimum, *i.e.*, $\frac{d(\text{denominator})}{dC}=0$, This gives

$$2C\omega^2x_1^2x^2=2\omega^2(L_1x^2+Lr_1^2)$$
$$\therefore C=\frac{L_1x^2+Lr_1^2}{x_1^2x^2}$$
$$=\frac{L}{x^2}+\frac{L_1}{x_1^2}=\frac{L}{R^2+\omega^2L^2}+\frac{L_1}{R_1^2+\omega^2L_1^2}.$$

The inductances of the telephone used varied from 4 millihenries to over 100. R_1 was made to be over 10,000 ohms, so that the value of the second term was quite negligible compared with the first. As the resistance of the coupling coil (never more than 15 ohms) was negligible, compared with ωL, the value of C necessary to produce a maximum current in the telephone for any particular harmonic is given by

$$C=\frac{1}{\omega^2L},$$

but $\omega=2\pi n$, where n = frequency of harmonic,

$$\therefore n^2=\frac{1}{(2\pi)^2LC}$$
$$\therefore n=\frac{1}{2\pi\sqrt{LC}}.$$

Therefore the condition that the current through the telephone should be a maximum for a particular harmonic—the resistance of the telephone circuit being very large—is that the coupling circuit should be in tune with the harmonic. If the telephone has a very small resistance and a fair inductance then C is given by $n=\frac{1}{2\pi\sqrt{\frac{L_1+LC}{L_1L}}}$ and good notes are heard. Generally, however, the resistance of the telephone amounts to about 100 ohms. It therefore produces the best notes when a large resistance is put in to prevent it affecting the oscillations of the main circuit.

Observations.—In the results given in Table I., C is the capacity in microfarads necessary to produce a certain note in the telephone at its maximum intensity, P_1 is the frequency of the coupling circuit under these conditions and P_2 the pitch of the note. Needless to say, to produce perfect agreement betwe

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the numbers, the tuning of the coupling circuit must be fairly sharp (this is so if the resistance of the circuit is kept low) and the ear of the operator sensitive to pitch.

L=0·157 henry, resistance of telephone circuit=10,000 ohms to 100,000 ohms.

R=15 ohms.

Period of alternating current=about $\frac{1}{80}$ sec.

Table I.

C 2·75 mfd.	1·02 mfd.	0·5 mfd.	0·31 mfd.	0·21 mfd.	0·11 mfd.	0·09 mfd.
P. 242 ...	398 ...	568 ...	721 ...	877 ...	1,212 ...	1,339
P. — ...	388 ...	560 ...	708 ...	859 ...	1,153 ...	1,462
Number of harmonic,	3rd.	5th.	7th.	9th.	11th.	15th.	17th.

It was found that the capacity necessary to produce a maximum intensity for a given note varied from time to time. The pitch of the note varied in the same way. Even while listening the pitch of a note would sometimes flatten or sharpen a little, due no doubt to the alteration in speed of the machines producing the current.

Table II. shows how the capacity varied from time to time.

Table II.

2·6 mfd.	1·0 mfd.	0·5 mfd.	0·3 mfd.	0·2 mfd.	0·16 mfd.	0·11 mfd.
2·8 „	1·06 „	0·55 „	0·33 „	0·23 „	0·17 „	0·13 „
2·75 „	1·02 „	0·5 „	0·31 „	0·21 „	—	0·11 „
2·3 „	0·97 „	0·5 „	0·3 „	0·2 „	0·15 „	0·11 „
Number of harmonic,	3rd.	5th.	7th.	9th.	11th.	13th.	15th.

The 13th harmonic produced only a faint note and was sometimes slipped over altogether.

The resistance used in the telephone circuit was a variable one, from 10,000 to 100,000 ohms. Sufficient resistance was put in to bring out the character of the note, but not too much to make it inaudible by reducing the current.

To test for higher harmonics a smaller inductance was used so as to be able to use large capacities. Unfortunately I was not able to measure this inductance except by the principle explained in this Paper.

Table III.

C	2·0 mfd.	2·4 mfd.	2·8 mfd.	3·4 mfd.	4·17 mfd.	5·0 mfd.	6·3 mfd.
P.	2,212	2,099	1,877	1,701	1,587	1,469	1,303
Induct.	2·58 m.h.	2·39 m.h.	2·55 m.h.	2·4 m.h.	2·41 m.h	2·34 m.h.	2·36 m.h.
C	2·1 mfd.	2·5 mfd.	3·0 mfd.	3·5	3·6 mfd.	4·3 mfd.	5·4 mfd.	7·0 mfd.
P.	2,252	2,056	1,930		1,779	1,608	1,434	1,274
Induct.	2·32 m.h.	2·49 m.h.	2·28 m.h.		2·28 m.h.	2·30 m.h.	2·32 m.h.	2·28 m.h.
Number of harmonic,	27th.	25th.	23rd.		21st.	19th.	17th.	15th.

Here the pitch of the note is taken as the frequency of the coupling circuit, and from this the value of the inductance was calculated in millihenries. All the harmonics produced very fine notes until the 15th was reached, when a much louder note was heard.

The results given in Table III. were taken on two different occasions. The disparity for the value of the inductance given in the two cases was probably due to the sonometer not being quite in tune in one or both cases.

The current used was the alternating current supplied to the College by one of the Newcastle companies. Two machines of practically identical structure are used on the College circuit; both are turbo driven, revolving armature dynamos.

Measurement of Inductances.—For measuring inductances smaller than a millihenry a method of substitution must be employed. If the coupling circuit consists of a known inductance and capacity (L and C) which is tuned to a certain harmonic, and the inductance (L_1) to be measured be then placed in the coupling circuit, a new value of the capacity (C_1) will be needed to tune to the same harmonic. We therefore have $L_1 = L(C - C_1)$, from which we can calculate L_1. Provided the standard inductance with which we are comparing is known accurately, this is a fairly satisfactory and a very quick method for measuring an inductance less (but not much less) than 1 millihenry. Inductances larger than 2 millihenries can be measured directly as explained in a previous part of the Paper. Inductance as large as 157 millihenries I have been able to measure very easily, and probably much larger inductances than this can be measured by this method. Everything depends, however, on the resistance of the inductance not being too large.

THE HEATING OF CABLES WITH CURRENT.

We give below an account of the discussion that took place at the meeting of the Institution of Electrical Engineers last week, when Messrs. S. W. Melsom and H. C. Booth read their Paper on this subject. An abstract of this Paper appeared in our last issue.

Mr. C. P. Sparks drew attention to the exceptional nature of the Paper. It had been written and brought before them at the request of a Committee of the Institution, and it described the outcome of an investigation that had lasted over two years. The Wiring Rules Committee had on several occasions considered the question of investigating the permissible current-density in conductors, but the difficulty arose due to the time and expense involved, and it was not until the Committee got the help of the National Physical Laboratory that it was possible to investigate the matter thoroughly. The Committee considered that the industry owed a debt of gratitude to the Laboratory and to Dr. Glazebrook. Further, they had been greatly assisted by the cable makers in supplying the necessary materials. In the past the governing factor as to size of conductors was the pressure drop, the heating hardly coming into the question at all. The new Rules recently issued by the Institution were based upon the permissible temperature rise, a more reasonable basis. Attention had been drawn in some quarters to the fact that the Wiring Rules permitted what at first sight appeared to be an exceedingly high current-density in small conductors; but it was not pointed out that the Rules at the same time lowered the permissible current-density for large rubber cables. A study of the Paper would show that they were working on a very conservative basis. It had also been suggested that it was the wiring contractor who had brought about the alteration to his benefit; as a matter of fact, contractors had nothing to do with it. The real reason for the investigation was the largely increased use of electricity for power work. The engineers of the electricity supply undertakings were fully alive to this, and were the people responsible for bringing about the alteration. The leading insurance companies, the supply companies and the municipalities had adopted the rules after these had been submitted to them. There could not be such a consensus of opinion in favour of the Rules unless they were drawn on a practical basis. The Committee hoped that they would be able to go even further in the future, and investigate the question as to what was the critical temperature rise. The deterioration of rubber and paper over long periods would, he hoped, be investigated, and it might be found that it was possible to go beyond the present current limits. In conclusion, he thought the Paper would remain as a standard work.

Mr. H. Human said the subject was one in which he took considerable interest. In 1884, when getting out a set of rules for his Company, he realised that to limit the current per conductor on a basis of a certain number of amperes per square inch was a fallacy, and that the only rational way was by a temperature limit. He therefore got out a table allowing a rise of temperature due to current of 10° C., based upon the work of Prof. G. Forbes. In 1891 he found it necessary to re-cast it upon the later data of Dr. Kennelly, who tackled the subject afresh from the point of view of rubber-covered conductors in casing. But when in 1897 the Institution revised their Rules and issued a current-density table upon a basis of 10° F. rise of temperature, he scrapped his own table for the sake of uniformity. It now turned out that that table was founded upon insufficient data. Fortunately the smaller sized conductors carried an ample margin of safety, and even most of the larger sizes were well within the present limit of rise of temperature, so no harm had been done. The new Table carried the hallmark of the National Physical Laboratory, and in his opinion would live as long as they were committed to rubber and copper.

Mr. J. F. C. Snell said that, although they now found that small cables had been much under-rated and some of the larger sections had been over-rated under the old Wiring Rules, they could console themselves with the thought that no evil results had happened. The new issue of the Rules rated cables in the correct way—viz., on the temperature rise of the conductor. He hoped that further investigations would be made on the lines of Fig. 17 of the Paper. It was shown that, where a high current-density was required for a short time each day, lead-covered or armoured cables laid direct in the soil were capable of carrying higher currents than those either laid solid or in ducts. It would be very valuable if the authors could continue their researches and ascertain to what current-density underground cables could be safely used, especially three-core paper-covered cables. He noticed that the authors did not deal specifically with the effect of current-density and temperature rise upon the dielectrics used; this would be interesting information, and form a useful extension of the treatise at present before them.

Mr. W. R. Rawlings said that the Paper was a text book and was really beyond criticism. He had seen some of the tests carried out, and could testify to the care taken. He thought the new rules had done more for the wiring contractor than for the supply station engineer. They would sell fewer large cables, but 10 times the number of small wires. Where it would cost under the old rules £100 to lay down a small heating installation it could now be done for £30. A large number of heating installations had simply been barred by the enormous cost of carrying them out under the old rules. He thought the Paper, in conjunction with the Wiring Rules, would do more to bring about the desirable day load for central stations than anything hitherto brought forward.

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Prof. A. W. PORTER said the authors had the kindness to refer to a small experiment of his shown at the Royal Society soirée on the anomalous affect of lagging thin wires. That was not the first time the experiment had been shown by him. He showed the identical experiment eight years ago, and it had been seen since by a number of engineers. He was rather surprised that it was not apparently known to the members of the Wiring Committee. The first time it was shown at a scientific society was about two years ago (Nov. 13, 1908) in a Paper read before the Physical Society. The present Paper was one of very great interest. There were, no doubt, a number of things in the Paper which he could not have predicted accurately from the experiments he had made up to date; but, in the rough, one might have years ago predicted approximately the results which the authors had obtained. They could not, however, rely upon theoretical conclusions, and they must have experimental verification of what might have been predicted. The authors were to be congratulated upon being the first to obtain experimental evidence of the necessary thoroughness and precision.

Mr. A. WHALLEY asked whether the outer lead of the concentric cables was insulated, and also whether the results obtained with lead-covered rubber cables were identical with those for lead-covered paper cables. Lead-covered rubber cables were used extensively in ship installations, and information on the current density permissible in such cables would be valuable.

Mr. C. C. PATERSON pointed out that, from the point of view of voltage drop, although on the smaller sizes of wire the new rules increased the permissible current-density from 1,500 to 3,000 amperes per square inch, lighting installations using tungsten filament lamps would not be worse off than those that were designed under the old rules for carbon filament lamps. On account of the temperature coefficient of tungsten lamps, a 2 volt drop on the line with tungsten lamps caused about the same change of candle-power as a 1 volt drop with carbon lamps, and so nearly twice the current-density was possible. This appeared to him one of the chief justifications for the adoption of the new rules for lighting installations.

Mr. T. E. RITCHIE said that in practice it had been considered an advantage to have the grooves in wood casing no larger than necessary. This opinion the authors had demonstrated to be correct. With reference to the increase in the rating of the smaller cables, he could assure them that the effect of this alteration on the motor industry would be immediate and pronounced. Attention had not been called to the importance the alteration would also have on arc lamp wiring; in that a certain drop in pressure had to be provided, so there would be no difficulty in running up to the full limits of the new curve. That was so interesting a point that he had worked out the cost on the new basis for a large arc lamp installation at a locomotive works, where the wiring amounted to a very considerable sum. He found that the saving in capital outlay represented no less than 17 per cent. He also asked the authors whether they had considered the question of pit-shaft cables, which would differ materially from any of those referred to in Fig. 17. In pit shafts there was dampness and very unusual conditions in the way of forced draught.

Dr. R. T. GLAZEBROOK, who was in the chair, said it was very gratifying to him to listen to the remarks that had been made in regard to the work of the Laboratory. The way the Laboratory had been assisted was an instance of how when manufacturers realised that an investigation was really helpful to their industry they were ready to come forward in a practical manner. The work connected with the issue of the new Wiring Rules had been no light task, and they were much indebted to Mr. Sparks and other members of the Committee for their efforts to bring the rules to their present condition. Suggestions had been made for still further work in the same direction, and if the work could proceed they would be glad to do it at the Laboratory.

Mr. C. BEAVER (communicated) said he had always been surprised that while the tables dealt with single cables up to 1 *square* inch, they ignored twin, concentric and multicore cables, in which the maximum current densities would be decidedly lower for a given temperature rise. He pointed out that it was not so easy as the authors inferred to conduct heating tests on cables as laid *in situ*. The authors did not state what the original temperature was in their experiments. To a considerable extent this factor determined the temperature rise. Again, one or two of their observations did not hold for buried cables, namely, that there was little difference between rubber and paper-insulated cables laid under similar conditions: also as to there being only a small difference between rubber cable in casing and in iron tubes in air. For certain ranges of time before a final steady temperature was reached, and particularly when dissipation of heat was chiefly effected by radiation or convection, and not by conduction, the effect of reflection of heat from the interior of a lead sheath was quite marked and appreciably accelerated the rate of heating. This might be of importance to central station engineers in connection with intermittent or peak loads. Many other more or less unexpected results limited the application of the authors' conclusions.

Dr. A. RUSSELL (communicated) thought the authors' theory on the cooling of cables might be considerably improved by taking into account the important results recently obtained by the French physicist, Boussinesq. (In his communication Dr. Russell indicates therefore a more rigorous method of proof and gives a historical résumé of the problem.)

Mr. S. W. MELSOM, in reply, said, with regard to the effect of temperature on the insulation resistance of the cables, Mr. Snell mentioned that the decrease would be about 4 per cent. per degree Centigrade, whereas, according to observations made by the authors, the decrease in the insulation resistance of a paper-insulated cable was more nearly 50 per cent. for a rise of temperature of 1°C. He had not intended to intimate that Prof. Porter had recently shown the experiment for the first time at the Royal Society, but only that he had there seen it for the first time. Prof. Forbes had suggested in 1884 that the results would be as shown. With regard to Mr. Whalley's remarks, the outer as well as the inner leads of the paper-insulated lead-covered concentric cables were insulated. The authors had not made any experiments with lead-covered rubber-insulated cables, but the temperature rise in such cables could be readily calculated. It was obvious that they would not get any hotter than rubber cables without the lead sheath. Dr. Kenelly's formula was, of course, simple; but it was not strictly accurate for covered cables, as it did not take into account the variations brought about by the varying outer diameter of the covering. With regard to Mr. Ritchie's remarks, curve No. 4, Fig. 17, showing tests of a cable when placed in an air shaft, was the nearest approximation they had been able to get in the laboratory to a colliery shaft.

CORRESPONDENCE.

THE ORIGIN OF "ATMOSPHERICS" IN WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to the correspondence under the above heading in your last issue, I should like to point out that I proposed the use of directive aerials for the investigation of the origin of "atmospherics" some time before any of the experiments mentioned.

The following is an abstract from a Paper ("Proceedings" of the Royal Society, A, Vol. LXXVII., 1906) which I presented to the Royal Society on March 15, 1906, on the subject of directive aerials:—

"When using horizontal receiving wires arranged as described in this Note, I have often noticed that the natural electrical perturbations of the atmosphere or stray electric waves, which are generally prevalent during the summer, appear to proceed from certain definite directions which vary from time to time. Thus, on certain days, the receiving instruments when connected to wires which are oriented in such a way as to possess a maximum receptivity for electric waves coming from the south will give strong indications of the presence of these natural electric waves, whilst on differently oriented wires the effects are at the same time weaker or imperceptible. On other days these natural electric waves may apparently come from other directions.

"It would be exceedingly interesting to investigate whether there exists any relation between the direction of origin of these waves and the known bearing or direction of distant terrestrial or celestial storms from whence these stray electric waves most probably originate. A considerable number of observations would be necessary to determine whether there exists any relation between the bearing of storm centres and the direction of origin of these natural electric waves. I propose to carry out some further investigations on the subject."—I am, &c.,

Adelphi, W.C., May 30. G. MARCONI.

NATIONAL TELEPHONE COMPANY'S STAFF DINNER.

IMPORTANT STATEMENTS BY THE POSTMASTER-GENERAL.

The 17th annual dinner of the National Telephone Co.'s staff was held at the Hotel Cecil, London, on Thursday evening last. Mr. ALBERT ANNS again occupying the chair. The company supporting Mr. Anns included the Rt. Hon. H. L. Samuel, M.P. (H.M. Postmaster-General), Mr. Geo. Franklin (President of the National Co.), Mr. S. H. Sands (vice-president), Lord Harris (director), Sir Robert Hunter (G.P.O.), Sir John Gavey, Mr. W. A. Smith (director), Mr. C. S. Agnew (director), Mr. G. H. Robertson (director), Mr. Alexander Siemens (President of the Inst. of Civil Engineers), Mr. S. Z. de Ferranti (President of the Inst. of Electrical Engineers), Major W. A. J. O'Meara (G.P.O.), Mr. Stanley J. Goddard (general superintendent of the Company), Mr. Frank Gill (chief engineer of the Company), Mr. W. Duddell, F.R.S., Mr. G. F. Preston (G.P.O.), Mr. W. E. Hart, Mr. A. Ross, Mr. G. Sutton, Mr. W. Aitken, Mr. J. C. Chambers, Mr. R. B. Claxton, Mr. C. B. Clay, Mr. A. E. Cotterell, Mr. H. M. Darville, Mr. J. E. Kingsbury, Mr. P. P. Kipping, Mr. F. A. B. Lord, Mr. G. Morgan, Mr. C. F. Moorhouse, Mr. C. J. Phillips, Mr. T. Fletcher, Mr. E. J. Hidden, Mr. B. S. Cohen, Mr. C. W. Salmon, Mr. F. E. Sims, Mr. H. T. Waddy, Dr. R. M. Walmsley, Mr. F. D. Watson, &c.

After the loyal toasts, the CHAIRMAN gave the toast "The National Telephone Company," and said: Gentlemen, this is a memorable occasion, not only because it must of necessity be the last of these annual

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gatherings, but because it is our good fortune to have with us to-night, for the first time in our history, His Majesty's Postmaster-General. I need not say how warmly we welcome him, or how much we appreciate his presence and that of the other representatives of the Post Office. The British Post Office we know stands pre-eminent among the nations of the world in connection with the collection and delivery of letters. When we talk of the Post Office in telephone circles we naturally think of the Parliamentary chiefs who have presided over the destinies of that Department during the period of the existence of the National Company; and when we remember that the position of Postmaster-General has been filled, as it is at the present time, by able and distinguished men, and when behind the Government there is Sir Robert Hunter, you will appreciate how strenuously the directors have had to fight, in cricket parlance, to keep their end of the wicket up; and it is not improbable that on January 1, 1912, we may still be "not out" (laughter and cheers). Last year we lamented the loss of many loyal servants of the Company, through no fault of their own, but because they were forced to leave the Company's service to seek employment elsewhere. It was a great relief to all of us, and one we received with much thankfulness, when the President, with the hearty concurrence of every member of the board, declared that, no matter at what cost, these dismissals should cease, and our reward has been the increasing prosperity of the Company. There was another matter about which we were very unhappy last year—as to your future as servants of the Crown. I was hoping, and I had good ground for hoping, that the President to-night would have been able to indicate to you that a satisfactory arrangement had been made regarding your future as servants of the State; but this confirmation of my hopes is not yet. After your splendid services for the State—for they have been rendered to the State, of which you have been licensees and have contributed largely to the national revenue—and having regard also to the recommendation of the Select Committee of 1905 that no servant of the Company should suffer in the transfer, I feel that it is not right and is not just that you should continue to suffer this cruel anxiety with regard to your future prospects as servants of the Crown. My contention is, and I submit it very respectfully, that if the rules and regulations of the Civil Service do not adapt themselves to the present condition of affairs, then these rules and regulations should be amended, so that justice (and you are asking for nothing but justice) should be granted to every member of the staff (hear, hear). I know this is a matter upon which you feel very keenly, and I cannot trust myself to say anything more, except to reiterate my firm conviction, which I have expressed on several previous occasions, that in the end you will all receive fair treatment. Since the last dinner you have started on the colossal task of making an inventory of the multitudinous items which are called our plant. There has been recently a census of the people, and this has been a great task, but in regard to details it will not compare with the work which you have in hand. In the census papers we were asked to state our ages, but we were not asked to state what our expectation of life was, what our unexhausted capacity was, or on what basis we were making provision for the depreciation taking place in us day by day (laughter). Taking all the facts into consideration, it is not to be wondered at that a doubt has arisen in many men's minds as to the necessity for this colossal work in order to determine what is the value of our undertaking; but Parliament has so declared it, and all we have to do is loyally to carry out the terms of the agreement of 1905.

I will now give you a few figures to show the extent and magnitude of the Company's business. On December 31, 1910, we had 1,570 exchanges open, over 530,000 stations, and £16,000,000 had been expended on capital account. I want to say in regard to the last item that, in view of the uncertainties of 1911, the directors' policy has always been to charge the capital account as lightly as possible, and to let the heavier burden fall on revenue. I mean that had we been a continuing company, such as, for instance, a railway company, the capital account would have been swollen, very properly, to a considerable extent. What I wish you to understand from this is that the capital account does not represent the full amount you have spent on this business, in the same way as revenue account does not disclose the true profits derived from this undertaking. Our gross revenue is over £3,400,000, and, as you know, the first charge on this revenue is the Government tax, which was last year about £230,000, and will before the end of the licence mount to a total of 3¾ millions of money—that is to say, you have made the nation a present in the shape of royalties of an amount nearly equal to the value of two "Dreadnoughts." On the top of these royalties you have rates and taxes of about £150,000, and this taxation is without representation! Despite this burden, however, you have shown a net profit of over £1,100,000—a great achievement.

With regard to the staff, of which I am proud to be a member, and which represents about 18,000 men and women, I must use the words of the President at the recent meeting of shareholders, "that the staff, for efficiency and loyalty, was second to none of any of the companies with which he was associated or had any knowledge." I am thankful that, so far as the staff is concerned, there is no question of its necessity or its suitability to conduct the business which you have hitherto carried on so successfully. Now, what is to be paid for this great business and for this organisation? Well, you are not to be paid for the business and you are not to be paid for the organisation. The proposal is that you should be paid only for a portion of your plant, land and buildings, and that at a depreciated value. Taking these facts into consideration, I think you will agree with me in my remarks of last year, that it will be a transaction without parallel in the commercial history of the world. In these circumstances I cannot and will not believe that the Government will approach a settlement, either as regards the staff or as regards the shareholders, in a niggardly spirit. When Benjamin Disraeli, with the foresight so noticeable in members of the gifted race of which he was a brilliant example, acquired the Khedive shares of the Suez Canal Company, the advantage to the country was very great; but I consider that that will be as nothing compared with the advantage that will come to the nation from the social, domestic and commercial point of view, from this telephone business, if it passes into the hands of the State or to some Authority that has a free hand, a thing which we never had; unlimited capital, which we never had; and statutory powers to enable it to do the work in the quickest and most economical manner, which, again, we never had. I do not mean that we have not done well; on the contrary, you have every reason to be proud of the magnificent business you have created and established in despite of the almost unsurmountable obstacles and difficulties that have been placed in your way by Government, by local authorities, and by individuals. When the true history of the National Telephone Company comes to be written, I feel confident the verdict of posterity will be that we deserved well of the nation (cheers). It may be that, to some of us, the next few months will bring the parting of the ways, and we may have to say good-bye to the loyal comrades with whom we have worked in kindly fellowship for so many years. For some of us it may mean making a new start in life, perhaps in the New World, where energy so often meets with its due reward; but when the end comes I confidently anticipate that the President, voicing the sentiment and feelings of the board of directors, will send to each and every one of you the message, "Well done, thou good and faithful servant." Now for the last time I have to ask you to wish the National Telephone Company during the few remaining months of its existence a continuance of that bright prosperity that is at present shining upon it, and with the toast I couple the name of one who has been a just chief and true friend to every one of us, our President, Mr. Franklin (loud cheers).

Mr. Geo. Franklin, who was accorded a hearty reception, in reply, said: It is with a feeling of real pleasure I respond to the toast of the "National Telephone Company" on the occasion of this, our last annual dinner. I would remark that if this is a funeral feast, and if the meats of which we have partaken are the baked meats which accompany such an occasion, we have no reason to be downhearted. I am able to assure the Postmater-General to-night, as I have assured his predecessors, that among all the valuable assets which will be taken over with the property of the National Telephone Co. none are of greater value than the able and devoted staff of the Company. I am speaking for all my colleagues in bearing testimony to the feeling which the board of directors have with regard to the satff. Mr. Anns has reminded us that 31 years ago, or thereabouts, the National Telephone Co. was born of the Post Office, and I may say that the Post Office stands in the position of parent of the Company. We read that man was born unto trouble. Certainly the National Telephone Co. has been born unto a succession of troubles. Year after year since it came into existence the Company has been the object of a series of attacks, and perhaps we must recognise in this a form of parental discipline or concealed parental affection. Parents, we learn, often find their children a source of expense; but in this case it is the child which has found the parent a great source of expense. No less than 23 per cent. of the Company's net earnings, or 10 per cent. of its gross earnings, have been absorbed by its parent, and this has been exacted for the full term of 31 years or thereabouts, and for no consideration at all. Possibly on the demise of the offspring, which is to take place shortly, the latent affection of the parent, which has so far been concealed from our eyes, will be revealed and become more manifest, in which case many of the difficulties which appear to confront the lawyers and surveyors will be things of the past. There are certain solid facts which remain to us, and one of these is that the number of messages transmitted during the past year over the Company's system number something like 1,500,000,000, and this, I think, is a record of which any company can be proud. Mr. Anns has also referred to the gross income of the Company, some 3½ millions, and to the number of our stations, about 550,000. These figures are eloquent, and show that, notwithstanding the difficulties which have been imposed upon us, we have endeavoured—as Englishmen do as a rule—to grapple with them and turn them to the best possible account. This brings me to the position of the staff, and I would like to take this opportunity of referring to the great additional burden which has been placed upon the staff this year by reason of the inventory now being prepared for the benefit of the Postmaster-General. This will altogether occupy something like 15 months, and a very large staff is engaged upon it. The point I wish to make is that the board of directors are full of appreciation of the staff's ready response to the call made upon them in connection with the taking of this inventory, are full of appreciation of the admirable way in which this inventory has been made so far, and are full of appreciation of the fact that without any hesitation the officers of the Company responded willingly to the heavy call thus made upon them. A no smaller meed of appreciation should be given to those who are stopping at home and doing the work of those who have gone on to the inventory staff. This latter service is only a little less heroic, certainly no less serviceable, and, as I have said, none the less appreciated by the directors. As to the transfer of the staff to the service of the State, I wish to say that the policy and desire of the Board is that no officer of the Company shall be prejudiced by reason of his transfer. This was a recommendation of the Select Committee of 1905, a recommendation which I have no doubt will have full weight with H.M. Postmaster-General, who has given us the pleasure of his company here to-night. Those of us who have seen and watched with keen interest the attitude which the present Postmaster-General has assumed on questions affecting the large staff under his authority may, I think, feel assured that he will not be unmindful of his duty to the staff which he is about to take over from this Company, or of the recommendation, which is just and necessary, that all members

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of the Company's Pension Fund Staff shall be placed upon the establishment of the Post Office under conditions not less favourable than they are at present enjoying. As to the remainder of the Company's staff, a large number will, I understand, be placed on the establishment of the Post Office, and in all these cases the directors will endeavour to obtain fair and equitable treatment—this not only in the interests of justice, but we belive in the best and truest interests of the Post Office.

One matter of very great interest to the staff is the method of dealing with the pension fund. Without going into legal technicalities, I understand that it is not provided in the pension fund trust that the fund should be closed and wound up on the expiration of the Company's licence. The directors, however, and the trustees of the fund, consider that it is very desirable in the interests of the staff that the funds shall be closed on December 31st next, and the assets distributed as quickly as possible thereafter. The central committee of the Staff Transfer Association have asked that steps shall be taken to have the fund wound up on December 31st. This can only be done by the consent in writing of the majority of the members of the fund, and I am advised that the position of existing pensioners must not be adversely affected. These are the arrangements which are the necessary sequence of the termination of the Company's licence, and, although I am unable to carry the matter further, there is one gentleman among you who may be able to do so; and if we can convince him, as I think we can, that the taking of any other course than that I have indicated with regard to the pension fund staff will bring about an injustice, then I am sure the present Postmaster-General is the very last man to do anything of that nature. Before I conclude I wish to repeat, on behalf of my colleagues, our warm appreciation of the valuable service which has been rendered by the staff in the years which have gone by, and of the admirable manner in which the peculiar difficulties of the position have been met. These difficulties could never have been surmounted but for the vigilance and uprightness of the staff (loud cheers).

Mr. S. J. GODDARD proposed the toast of "Our Guests." He said: We welcome Mr. Samuel to-night, not only in his capacity of one of H.M. Cabinet Ministers, but also as representative of that great department which has always been so intimately connected with the telephone service, and will be more intimately connected with it in future. We welcome him as representing those members of his staff with whom we are, each of us in our several spheres, continually brought into contact day by day. Another of our guests is Mr. Ferranti, President of the Institution of Electrical Engineers. With the names of these two gentlemen I couple this toast. We have also with us Mr. Alexander Siemens, President of the Institution of Civil Engineers, and Mr. Duddell, the inventor of that most extraordinary piece of apparatus the oscillograph. There are very many more of our old friends with us, including Mr. Claxton, who has borne a great share in the heat and burden of the day; also Mr. Preston, who, once with the National Company, is now successfully working with the Post Office. All these guests we honour and welcome.

The Right Hon. HERBERT L. SAMUEL, M.P., H.M. Postmaster-General, in responding, said: Mr. Chariman and Gentlemen, I appreciate, I need hardly say, very greatly the honour which you have conferred upon me in including me in your list of guests at the staff dinner of the National Telephone Company, and I must thank you for the invitation you have extended to me so kindly and for the welcome you have given me with such cordiality. On my own behalf and on behalf of my fellow guests I thank you very warmly. There are, it is true, certain divergencies of interests between the Post Office and the National Telephone Co. which are now in process of more or less amicable settlement. The settlement certainly is being conducted, and I think will be conducted, without any bitterness. The points at issue which remain for decision arising out of the execution of the policy decided upon between the two parties six years ago will be decided, I feel sure, with good feeling on both sides, and the presence at this board to-night of so many of the heads both of the Company and of the Post Office is a happy proof of the good feeling shown on both sides. You gather hereto-night at what you have been told by previous speakers is the last dinner of the National Telephone Co's staff. You will naturally feel some sentiment of regret at the severance of a connection which has lasted for so many years between yourselves and the Company, a well managed Company, which has built up a great business with profit to its shareholders in spite of those onerous exactions on which the President dealt, with advantage to the British public, and with, I trust, advantage to those whom I see around me to-night. This is a domestic gathering, my presence at which, I feel, almost might be regarded as an intrusion (No, no.) You here, I am afraid, may look on the Postmaster-General as a portentous shadow falling across the brightness of this festive gathering (laughter). I do not know whether any of you are acquainted with the beautiful poem of him whom I regard as the greatest of living poets, William Watson. He uses these words:—

Ah! but the apparition (myself in this case) the dumb sign,
The beckoning finger, bidding us forego
The fellowship, the converse, and the wine,
The song, the festal glow.
And ah! to know not, while with friends we sit,
And while the purple joy is passed about,
Whether 'tis ampler day divinelier lit
Or homeless night without.

Well, if I am to be regarded as the apparition, the dumb sign, the beckoning finger, I can assure you there is every probability that you will find, not homeless night, but ampler day divinelier lit when you go over to the other world which the Post Office opens to you (Cheers.) I can assure you that throughout, the interests of the staff of the Company have been fully considered and will be fully considered, and that it is not merely my desire, but my determination, and the determination of the heads of my department, to see that full justice is done to all and to each of the members of the staff of the National Telephone Co. on their transfer to the State (Cheers.) You are aware of the general lines upon which, so far as the staff is concerned, the transfer will be effected, for they were declared to the House of Commons by the then Postmaster-General, Lord Stanley, in a Memorandum read to that House in 1905. I should tell you to-night that it has been thought advisable in certain particulars to modify certain conditions then expressed, but I may relieve your minds by saying that all those modifications are favourable to the members of the staff (Cheers.) Lord Stanley then said that the Postmaster-General, whoever he might be—and, as we all know, Postmasters-General are a fleeting race (laughter) and he foresaw, no doubt with some certainty, that he would not be, when 1911 came, holding the position he then occupied—but he announced, and his pledge is binding upon his successor, that whoever in 1911 should be Postmaster-General would take into the service of the Post Office the members of the National Telephone Co.'s staff who were not clearly disqualified, and who were not in the fortunate position of being in receipt of great salaries, to whom continued employment would of course be a matter of entire indifference (laughter.) But the rest of the staff who had not less than two years' service would, Lord Stanley stated, be taken into the employment of the Post Office. But I have since been able to announce that not only those who have more than two years' service, but the whole of the staff, irrespective of the length of their service, with some very few and exceptional cases, would be taken into the service of the Post Office; and we are looking forward to having the advantage and assistance of those highly trained and highly efficient body of men, many of whom will be taken into our employment, if they so desire, although their service with the Company has been less than the specified period of two years (Cheers.) Secondly, it was announced that no medical examination would be imposed on the staff as a condition of their admission into the Civil Service of the Crown, a medical examination which would otherwise be necessary. Not only will that pledge be adhered to (it was qualified by possible exceptions in cases where the sick leave of individuals had been quite abnormal), but the other examination, the literary examination, which is necessary for ordinary entrance into the Civil Service, will be waived in the case of the employés of the National Telephone Co. Another paragraph in the Memorandum dealt with circumstances relating to the employés of the Company who had subscribed to the Company's Pension Fund, and it was declared that if it could be shown that by the closing of that Pension Fund, and by the substitution of a system of Civil Service Pensions, the general body of the staff would be placed in a substantially less favourable position, then the Postmaster-General would consider the expediency of allowing members of the staff to add two years to their service with the State for superannuation purposes. On further consideration I have determined, after consultation with the Treasury, that it is not necessary to impose the condition that was mentioned by Lord Stanley, and we shall not embark upon any inquiry whether or not the general body of the staff are disadvantaged by the transfer in respect of pensions, but we shall grant a general allowance of two years' additional service to those who desire to claim it. After all, it deos not seem to be a very fair thing that individuals should suffer merely on the ground that the general body of the staff do not suffer. The condition in itself is not really consistent with abstract principles o justice. But there is a further provision which will be found in the Telephone Transfer Bill which it will be my duty to introduce into the House of Commons in a few weeks' time, and I think this has not yet been publicly announced. We propose to allow an option to all those who now contribute to the Company's Pension Fund to assign their share in the Fund, if they so desire, to the Postmaster-General when the Fund is wound up, and in exchange they will be allowed to count all the years which they have spent in the service of the Company, and during which they have contributed to the Fund, as though they were years spent in the service of the State for pension and superannuation purposes (cheers. Those who have been original members of the Pension Fund, who were in the service of the Company before the Pension Fund was established will be allowed to count all the years they have spent in the service of the Company as though they were years spent in the service of the State for the purpose of a pension (cheers.) They will count as though they had been years spent in the service of the State in the offices to which these officers are transferred in the service of the Post Office. Those are the more important modifications which will be proposed, all of which as I have said, will be of advantage, and some of them greatly to the advantage of members of the Company's staff. There are other minor ones on which I need not dwell. Though comparisons are always odious certainly this is not the occasion on which to embark an any comparison of conditions of service which you will enjoy in the Post Office, and those you have enjoyed in the Company. I may perhaps mention only one fact. Many of those whom I see around me will, so I am informed, when they come into the employment of the Post Office, in their subsequent years have the benefit of one week's more leave in the year on full salary (laughter and cheers.) That alone, I think, will be a powerful attraction on the part of the new love compared with the old (laughter). One week in each year spent wherever it may be, on the South Coast, in Devonshire, in Wales or on the Continent—will, I trust, be largely devoted to singing the praises morning, noon and night, of the admirable arrangement of the Post Office Department (laughter). Gentlemen, I know there has been in your ranks anxiety for some time past as to the conditions that may await you in the new service to which you are going. There have been fears that the Telephone Company's staff may be, so to speak, thrown into the mass of the 200,000 employés of the Post Office, to find themselves lost there that they will become mere cogs in the wheel of official routine; th

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their specialised skill may be unrecognised; that personal zeal and merit may be ignored among the great mass of the employés of the Post Office Department. Gentlemen, that will not be so. The Post Office is not ignorant of matters relating to telephony. It is well aware that it is a highly specialised, highly technical industry. We have passed the stage of the engineer of whom I have heard, who for years fervently entertained the belief that the difference between a telegraph wire and a telephone wire was that the telegraph wire was solid and the telephone wire was hollow (laughter). You will not find engineers of that kind when you come to the Post Office. We have learned much with respect to telephony. We know how difficult a business it is, how carefully every development needs watching, how vitally important it is that all the details of management should be conducted by men of zeal, capacity and efficiency—men who have a real interest in their task—and I can assure you that your knowledge and experience will not be allowed to be wasted when you come into the service of the State. The telephone work under the Post Office will be kept, in a very large measure, distinct from other Post Office work (hear, hear). There will be a much larger measure of differentiation than in the case of the telegraph, for example, from the remainder of Post Office work, and we feel sure by that means we shall best promote the interests of the public and best please the great commercial interests to whom the telephone service is becoming year by year of greater importance. Further, we shall follow the wise policy, as I regard it, that has been adopted by your Company of allowing a wide measure of discretion to local offices (cheers). We are aware of the danger of over-centralisation. The tendency in the Post Office in these days is decentralisation, and we do not propose to fall into the error of over concentrating at headquarters the management of telephone business throughout the country. We are quite alive to the importance of doing what, I believe, your directors have consistently endeavoured to do, and that is to encourage a high standard of scientific and technical attainment on the part of all officers of the staff, and every encouragement will be given in that direction. Nor need you fear that promotion in the Post Office will be determined by mere dead routine rules of seniority, and that merit will not be taken into account. It may be that in earlier years that was one of the faults of the Post Office system. It does not exist to-day; and although seniority must be always an element in the choice of officers for promotion, it is never regarded in the Post Office nowadays as the chief element, but merit, capacity, efficiency, zeal—these are the main considerations in the selection of officers for the higher posts (cheers). As it is in the other branches of the postal service, so will it be in the telephone branch, and zealous officers of the Company—and I know many of you are keen men, anxious to do your duty, your very best—need not fear when they come into the service of the State that their individual characteristics will be overlooked. They may feel sure that each man's personality shall count (cheers). Well, gentlemen, I know, for I have kept in touch with the movements that have been proceeding among the staff of the Telephone Company, that there has been some measure of anxiety among the officers, and it is not strange that men should feel uneasy if they think that their lives are going to be moulded this way or that by great external forces far beyond their control. It will be, indeed, a satisfaction to me if anything which I have said to-night, and, what is more important than words, if the deeds which will follow later, may in some degree relieve any uneasiness that has existed in your minds. I trust that the new will grow out of the old without any shock, with the minimum of hardship to individuals whose lives are affected, and indeed with great advantage to large numbers of them, and with the minimum of disturbance to the public, whom this splendid and prosperous corporation has served for so long (prolonged cheers).

Mr. S. Z. de Ferranti, who also replied, said: I feel there is little left for me to say. But I cannot do less than thank you on behalf of the guests here this evening for the kindness which you have extended to us in giving us this great hospitality. You have heard much of what will happen, or is likely to happen, in your future, much of what has been done by your great Company in the past. I cannot help, being here, with a great degree of sadness at the passing away, shortly to take place, of this great commercial undertaking. It is going to be merged, or rather absorbed, in the Post Office; but still, as I say, there is this passing away of your great industrial concern. This business has been conducted under much the same conditions as prevailed with the early electric lighting companies in this country. I have had to do with them in the past, and I know what it is to live and work under those exceedingly difficult conditions—conditions which greatly retard the progress and development of any industry. I know what it has been in the past to fight Parliaments before one could give a supply. I fully appreciate, from my own experience of that in London years ago, what the difficulties of the National Telephone Co. have been in many cases, and I can only feel sorry that such a great enterprise as the telephone should have been handicapped by an unfortunate necessity. There are many other difficulties, which you on the staff well know, which your Company has had to contend with. Those, however well you have been able to meet them, have largely absorbed your time and energies, and have taken you from the greater development which you might have accomplished if the Company had been working under more genial conditions (hear, hear). The incentive to do well in work very largely depends upon what we are going to get out of the results accomplished, and I must say that I regret that this transfer is being made to the Government, because in the service of the Government one can hardly expect to be working for a profit, and therefore one of the great human inducements is removed for doing the best work, for striving for the highest efficiency and making the greatest progress—namely, the greater reward that greater services will bring (cheers). As you have heard this evening, what many of you already knew, of the enormous development of this Company under the circumstances that have prevailed, or in spite of these circumstances. You have installed for the public more than half a million stations, an enormous and wonderful result. What do we find in the United States—truly, a country of more than double the population. Let us compare. Are they better people than we are, more enterprising? Do they deserve a better service? The fact is that they have seven million stations. And why is it they have gone ahead more, prospered more, and done more for the service of the community? It is because they have not had to sacrifice themselves, or to be sacrificed, for the benefit of the nation (hear, hear). You, gentlemen, have been handicapped in your work, and your great Company is coming to an end. Why? For the greater benefit of the State and of the individuals composing that State. That is at least what we are told. But is it really so? I only wish I could think that that will be the result which will be brought about. Gentlemen, I must again thank you for your hospitality to us, your guests, this evening. I wish you, I am sure, on behalf of the guests, every happiness and prosperity in the new position you will find in the future, and I must congratulate you upon falling into such sympathetic and able hands as those of the Postmaster-General, who will soon be your chief (cheers).

Mr. F. Douglas Watson then proposed "The Health of the Chairman." Mr. Anns, he said, had been their chairman at these annual gatherings on several occasions, and his urbanity in the chair, as on many other occasions elsewhere, was a great satisfaction to the staff. It was the last staff dinner that they would ever have, in that particular connection at all events, and there was a certain pathetic interest attaching to it on that account. He was sure they were all pleased to have had Mr. Anns in the chair (cheers).

The Chairman having briefly replied, a very pleasant function concluded. The speeches were interspersed with some excellent songs and humorous interludes.

BEST VOLTAGE AND SYSTEM IN RAILWAY WORK.*

BY C. R. DARBY.

Under the conditions which exist in North America, direct current and single-phase are applicable to either level or grade work; while three-phase will probably be limited to the latter where its regenerative feature of returning energy to the line may be of value. The relative economy of the different systems of electrification is dependent on the density of traffic and the character of power available, rather than on the length of the railway.

The principal conditions which determine railway equipment are: (*a*) Profile of road; (*b*) transportation required (i.e., weight of trains or seating capacity of cars); (*c*) frequency of trains; (*d*) length of individual runs or distance between stops; (*e*) schedule required; (*f*) length of railway to be electrified.

From a level country to a limiting grade of 1 to 1½ per cent. there will be little difference in the relative values of the systems. With steeper grades the conditions will be more favourable for alternating current. Heavy individual train units favour the alternating-current system with the exception of the locomotives; light trains or multiple-unit operation favour the direct-current system.

Infrequent service with a relatively small number of locomotives favours the alternating current; frequent service the direct current. With increase in number of trains, the direct-current systems gain relatively faster than the alternating current in economy of operation, due to relatively decreased sub-station operation, increased sub-station efficiency, and lower cost of equipment maintenance. It is therefore well to consider what the ultimate traffic density may be and select the system best suited to meet these requirements.

Variations in the distance between stops and schedule required will not affect the relative value of systems unless extreme requirements, such as high schedule speed with short runs, make the use of direct current imperative. For a similar character of service throughout, the railroad may be of any length without affecting the relative desirability of the various systems. What is suitable for the first 50 miles will be equally suitable for any extension.

An examination of the above variables will show that a change in the conditions to be met will radically change the relative economic value of the systems of electrification.

The single-phase system, by reason of the apparent simplicity of its elements and the utilisation of higher potentials for the contact conductor than is possible with the direct current, is admittedly very attractive. There is the other side of the question that the single-phase commutating motor is much higher in first cost and maintenance than the direct-current motor. Over this subject of alternating current single-phase *v.* direct-current systems there has been a great deal of controversy. It is my opinion that comparative results obtained up to the present time are in favour of direct current.

Desirable as would be a standard system for all classes of service, we cannot hope to establish such a standard should it impose an additional expense without adequate return. For trunk-line service a higher potential than 600 volts will unquestionably be used; 1,200 volts direct current will prove economical in some cases, but a still higher voltage is required to provide economically for the heavier

* Abstract of an article in the "Canadian Electrical News."

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intermittent service. Whether this potential will be 1,800 or 2,400 volts direct current or 11,000 volts alternating current cannot be settled arbitrarily.

Interurban Railways.—The author next considers the interurban railway situation in the United States. The available schemes of electrification are: 600-volt direct current, 1,200-volt direct current, and single-phase, the three-phase being objectionable on account of the complications of the necessary double overhead distribution system.

The application of single-phase to new projects has been practically abandoned, there having been one or two new installations in the last three years. This arrested development of a system which for a short time held forth considerable promise has been brought about by a general recognition of its limitations. Experience has shown these to be: (*a*) Excessive weight of rolling stock; (*b*) excessive cost of rolling stock; (*c*) high cost of equipment maintenance; (*d*) increased power consumption; (*e*) rapid depreciation of motor; (*f*) rapid depreciation of car bodies and trucks; (*g*) increased cost of maintaining track and roadway. Moreover, it is recognised that any interurban road in the United States must be capable of operating over existing city tracks from 600-volt direct-current trolley, a condition which hampers the single-phase system on account of increased complications in the control system.

For interurban railways a potential of 1,200 volts direct current has been selected, because, with the motors wound for 600 volts, the car may be operated at the same speed from either 600 or 1,200-volt-trolley, by connecting the motors all in parallel for 600-volt operation, and two in series with two groups in parallel on a 1,200-volt section.

While comparing favourably with single-phase alternating current in the cost, operating expense, and reliability of the generating and distribution systems, the superiority of the car equipment of the 1,200-volt system gives this system a most pronounced advantage. The importance of this feature cannot be over-estimated. The 1,200-volt car equipment contains no radical departure from 600-volt practice, in design, construction or arrangement. The motor has the same rugged structure, the same capacity for overloads, and the same long life of bearings and brushes as its most successful prototype, the 600-volt motor. The control and auxiliaries are almost identical with a standard 600-volt equipment. The motors may be wound so that each will operate directly on 1,200 volts when in parallel, or so that two will be in series when at full speed. In the first case only half speed can be obtained on 600-volt sections; while, with the second arrangement, half speed, or, by paralleling the motors, the same car speed as on 1,200-volt, can be had on 600-volt sections. Both arrangements are in use, but in most cases two motors in series are preferable.

There will be an additional cost of operation and maintenance with the single-phase system for the items of track and roadway, due to additional weight of cars, car-shop expenses in providing greater facilities for shop inspection and repairs, and greater skill in superintendence of equipment. In a number of instances this has been found to amount to several cents. per car-mile. A conservative estimate would require at least ½d. per car-mile to be added for these items.

A comparison between the two systems brings out the fact that even for conditions selected as favourable to the single-phase system, the 600-volt direct-current system is the more economical, considering operation, maintenance and fixed charges. An examination of the elements which enter into the first cost and operation of a system will show at once that as the density of traffic increases there is a rapid gain in the relative advantage of the direct-current over the single-phase system.

The saving effected by the 1,200-volt direct-current system is so marked that a great increase in the adoption of this potential for this class of interurban railroad may be anticipated, and on the other hand it will not be surprising if the single-phase interurban system is entirely discarded in America, unless some improvement is made in the art and a more economical equipment made available.

ELECTRICAL TRADES BENEVOLENT INSTITUTION.

The following additional contributions have been received:—

Donations.	£	s.	d.
Crompton & Co.	5	0	0
Bourne (J.) & Son	1	1	0
Clarke, Forde & Taylor	3	3	0
F. Ormiston & Sons	3	3	0
Graham (Alfred) & Co.	3	3	0
Wiggins (F.) & Sons	1	1	0
Hay, H. J.	1	1	0
Gerson, J.	1	1	0
Johnson, Matthey & Co.	10	10	0
Swinton, A. A. Campbell	1	1	0
Murray, Lee	2	2	0

Subscriptions.	£	s.	d.
Lawton (J.) & Sons	1	0	0
Lundberg (A. P.) & Sons	2	2	0
Shield, W. S.	1	1	0
General Accessories Co.	1	1	0
Davidson & Co.	1	1	0
Chard, F.	0	10	6
Wilson, C.	0	10	6
Benson (W. A. S.) & Co.	0	10	6
Butler, H. W.	1	0	0
Clarke (E.) & Co.	1	1	0
"Electrical Industries"	2	2	0

LEGAL INTELLIGENCE.

National Telephone Co. v. Postmaster-General.

JUDGMENT.

The Railway and Canal Commission gave judgment in this case on Monday.

Mr. Justice A. T. Lawrence, in giving the judgment, reviewed the facts. By clause 3 of the agreement of Feb. 2, 1905, (he said) the Postmaster-General could (by notice to the company before Jan. 1, 1911) exclude from the purchase plant which he considered would be unsuitable for the Post Office service. If the company did not agree with the Postmaster-General they must obtain from that Court, before June 30, 1911, a decision that the plant objected to was "suitable," otherwise the Postmaster-General's objection was to prevail, and the plant objected to would remain the property of the company. The Postmaster-General had given 17 notices of objection which were said to be bad in whole or in part. For the Postmaster-General it was contended that he could object to any plant that he did not want. For the company, on the other hand, it was said that the clause had no such meaning, that it gave power to object only on the ground of the quality or character of the particular plant. The first thing that struck one upon this was that the word "unsuitable" pointed more aptly to quality than to quantity; next it was surprising that a vendor who had to keep his plant in use in order that it should be sold at all, should agree to leave it in the hands of the purchaser to provide as much other plant as he pleased, which would thus exclude his property from even "tramway terms." The agreement seemed to protect the Postmaster-General in very clear language from having any excessive plant imposed upon him. It was true that the company was a licensee only, whose property would be put out of use by the expiration of the licence. But he was a licensee who had performed a great public service and who was ready to agree to "tramway terms." What was now being done in providing new plant and new exchanges to take the place of the company's plant was practically to "scrap" the company's plant in the condemned exchanges. That did not seem to him to be just, and he should require clear words to induce him to hold that such a power was intended to be conferred upon the one party to this agreement by the other. The words did not seem to him to be clear: on the contrary, when all were read, and each received its natural meaning they failed to support such an argument. It was true the words "actual requirements" might mean real needs, but the telephone was a highly specialised instrument, and electrical science and its applications were constantly developing and producing new and ingenious devices, and he thought the words "suitable to the actual requirements" of the service seven years hence might very well apply to the quality and character of the particular plant and not to the sufficiency of some other and different plant—viz., that of the Postmaster-General—to perform the function of the company's plant. The argument for the Postmaster-General had assumed that "any kind" of *plant* meant plant of any quality and not plant of any description or variety. Having made that assumption he proceeded to treat that as showing that the word "requirements" meant "needs," for "kind" had already dealt with quality. It then said the test of those needs must be what the Postmaster-General would want for the combined business of the Post Office and the company. It then arrived at the conclusion that any plant of the company could be excluded from the purchase if the Postmaster-General had become possessed of the other plant of a similar description sufficient to serve the purpose. So that, however necessary the plant objected to might have been to the service of the company, however high its quality and modern its type, the Postmaster-General could reject it. That seemed to him not very wise or very likely bargain for even a licensee to enter into seven years before the expiration of his licence. But laying that consideration aside, it was not construction at all. When individual words might have two or more meanings one must not begin by assuming one meaning because it happened to suit him and disregard all others. Further, one must not treat as pedantic and technical a reference to the exact meaning of other words in the sentence merely because they rendered the assumption impossible. That was what the argument did: it said "the actual requirements of the telephone service of the Post Office on Dec. 31, 1911 meant "the prospective needs of the combined business of the company and the Post Office on the following day." No reason was assigned why that transposition should be made: but allusions to the public purse and the propriety of economy were gracefully substituted. With that provision the words of sec. 9 (1) of the London Agreement should be compared: There the date taken was "after" the determination of the licence, not before. Even then he did not think that any idea of excluding duplicate or surplus plant was shown, but there was in the section no in dispute a clear change of language, and that should in itself have some intention attributed to it unless that could be clearly negatived by reference to other parts of the agreement. It was admitted that, as applied to sub-clause (*a*), "suitable" referred to quality and not to quantity and that was clearly so, for in non-competitive areas, however excessive its quantity, all plant must be taken over if made according to schedule *i.e.*, according to the "requirements" as then formulated. No satisfactory explanation was afforded why, if that were so under (*a*) the should be a grouping of (*a*) and (*b*) together and an application of the same words but with a different meaning to (*b*); such grouping was only sensible and proper when it was made in order to apply one and the same proposition to both branches of the group. It was clear that when the parties had in mind any question of a surplus quantity they knew how to express their intentions in the plainest language, as could be seen from sec. 2 (1) (*d*) as to stores and (2) as to spare parts.

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The next matter for consideration was the alleged invalidity of the notices of objection served upon the company by the Postmaster-General. There was no prescribed form of notice, and a notice was only bad upon the face of it when it failed to perform the functions for which it was required by the statute or agreement. The purpose which a notice was in the agreement under consideration designed to serve was to inform the company that the Postmaster-General considered certain property unsuitable and that he proposed to exclude it from the purchase. The mere notice effected its exclusion, unless the company within six months obtained an award that it was suitable. Any form of words which would enable the company to take into consideration the question and to decide whether it agreed with the Postmaster-General or differed from him would be sufficient. So long as the notice was sufficiently specific to enable the company and the Court to come to a conclusion upon the matter, it would be sufficient. That the property which it was proposed to exclude should be identified by the notice seemed to him to follow from the fact that it was a part which it suggested should be excluded from the whole; and that was supported by the language used in clauses 3 (1) and 3 (2). It was "such plant," &c., "as he considers will be unsuitable," and the award was to deal with that which had been "specified" in the notice of objection. The London notice (Part I.) seemed to him to comply with those requirements, though it might be that before the question of fact as to whether the property mentioned therein was or was not suitable some further particulars might be necessary. The same thing was true of the Abergavenny notice and of other notices. But when he turned to Part II. of the London notice, insofar as it purported to apply to plant other than that included in Part I., it seemed to him to be bad: it did not give one any idea of what plant it was or where it was situate, except that it was in the London area. It gave grounds of objection without stating the property to which they were alleged to apply. It was one thing to specify a piece of property and another to specify a quality to which one objected. Whether any particular piece of property was open to one or more of those grounds of objection was a matter about which opinions differed, and until the property was identified the question could neither be considered nor determined. The notice relating to non-competitive areas was bad for those reasons. It was no answer to say that it would have been difficult and troublesome to give a notice mentioning the plant objected to. The difficulty of duly exercising a power was no excuse for not doing so if the rights of other parties were affected thereby. The company disputed that any of its property was open to those objections. That form of notice would exclude it all from the purchase unless and until the company proved to the Court that each particular part had not the defect. That was to change the onus in a manner not justified by anything in the agreement, and to read "such plant as he considers unsuitable" as satisfied by a notice which was so framed because he did not know the facts and did not desire the trouble of ascertaining them—that although the Postmaster-General had the right under the agreement to make the company furnish him with all the information he might reasonably require.

Mr. Cathorne-Hardy delivered a judgment to the same effect.

Sir James Woodhouse dissented, and gave reasons for holding that the notices given by the Postmaster-General sufficiently described the property he did not desire to take, and that the agreement did not require him to purchase duplicate plant if he considered that the telephone service could be carried on efficiently with the buildings and plant already at his disposal. He thought that from the business point of view it would be misreading the true intention of this agreement to hold that that notice was so imperfect as to render it invalid, and that complete justice could be done between the parties on the merits without placing that strict interpretation upon it. He thought the word "unsuitable" when taken in collocation with the words which followed had, and according to the scheme of the agreement was intended to have, a quantitative as well as a qualitative meaning. The test was the Postmaster-General's requirements—in other words, his "needs"; and the standard of suitability for his actual requirements in the circumstances of these areas is the character or quality of the plant. He thought "requirements" and "needs," and "actual" referred to those at the time of award in contradistinction to the requirements of the future. He also thought that the form of the notice was valid, and he thought the Postmaster-General was entitled to judgment on both points.

Sir Alfred Cripps, K.C., said that, in substance, the order that was to be drawn would be one granting the application asked for by the company under 2c, and under another clause the company asked that any plant of suitable character for the actual requirements of the telephonic service of the Post Office on Dec. 31, 1911, should be taken over by the Postmaster-General.

Mr. Justice A. T. Lawrence: That is the point upon which Sir Jas. Woodhouse differs from the rest of the Court.

Sir Alfred Cripps: I am anxious that we should have our argument directed to it, in which we ask for a declaration that

"That plant of the company suitable in character for the telephonic service of the Post Office on Dec. 31, 1911, is not rendered unsuitable for such requirement because the Postmaster-General on that date had in his possession other plant suitable for such service."

Mr. Justice A. T. Lawrence: Is there any objection to that, Mr. Isaacs?

Sir Rufus Isaacs: We have your lordships' judgment. We know what the agreement was.

Sir Alfred Cripps pointed out that under the agreement between the parties it was necessary to have a decision of that Court upon the question submitted to them by the end of June.

Sir Rufus Isaacs said the Government would extend the time provisionally to the end of July. He intimated that it was his intention to appeal against the decision just recorded.

Sir Alfred Cripps asked that the appeal should be expedited as far as possible, as there were many matters to come before that Court before the extended period of July 31, and, so far as he could see, the discussion of those matters would occupy perhaps a fortnight.

Mr. Justice A. T. Lawrence: We will give you as early a date as possible after you have obtained the judgment of the Court of Appeal. I am certain the Court of Appeal will give you the earliest day possible, and I hope you will endeavour to classify the matters in dispute so closely that we may be able to dispose of them rapidly.

Upon the application of the Attorney-General the Court of Appeal (the Master of the Rolls and Lord Justices Buckley and Kennedy) yesterday (Thursday) agreed to expedite the hearing of the appeal from the above decision of the Railway and Canal Commission and June 14 was fixed for the hearing.

"Z" Electric Lamp Mfg. Co. (Ltd.) v. Osram Lamp Works (Ltd.)

On Friday an application was made to Mr. Justice Neville by plaintiffs for an interim injunction to restrain defendants from threatening by circulars, letters or otherwise, plaintiffs (or any other person or persons whereby plaintiffs might be aggrieved) with legal proceedings or liability in respect of any alleged infringements of defendants' letters patent in respect of the manufacture, use, sale or purchase of incandescent electric lamps manufactured or sold by plaintiffs.

Mr. T. Terrell, K.C., for plaintiffs, contended that defendants were not acting with bona fides. They had commenced actions against purchasers and users of other lamps, alleging infringements of their patent Osram lamps, but would not bring an action against plaintiffs, who were willing to fight such an action and to contest the validity of defendants' patents.

Mr. Astbury, K.C., for defendants, submitted that the action could not be maintained. Defendants were within the proviso of sec. 36 of the 1907 Act. What they were doing was to tell the world that plaintiffs' lamps were an infringement of their patent, and that, he submitted, they not only had a right to do but was what they ought to do. They had commenced actions against several persons and firms who were selling or using lamps manufactured or sold by plaintiffs on the ground that such lamps were infringements of the patents under which defendants manufactured and sold Osram lamps, and were prosecuting the actions with diligence. There was no foundation for the allegation of want of bona fides. The several actions were being defended and the solicitors on the record for defendants in those actions were the solicitors on the record for plaintiffs in the present action. If plaintiffs would waive the question of retainer of Mr. Walter, K.C., defendants would issue a writ for infringement against plaintiffs at once.

Mr. Terrell said his submission was that these actions were not brought for the purpose of trying the question between the parties, but were brought against persons who were not likely to defend them. These lamps were made in Germany from 1905 to 1908 and subsequently in England. It was not until plaintiffs' alleged infringement of their patents that defendants commenced the threats complained of. They had challenged the defendants to bring an action against them and they had not done so.

Mr. Justice Neville said he saw no ground for supposing that the actions which defendants had commenced were not bona-fide actions or that defendants would not prosecute them diligently. No case of prejudice had been made out, and the motion must be dismissed with costs.

Humphreys v City of London Electric Co. (Ltd.)

On Wednesday the Court of Appeal (the Master of the Rolls and Lords Justices Buckley and Kennedy) heard this appeal of the applicant from the award of the judge of the City of London Court under the Workmen's Compensation Act.

Mr. Boxall, K.C. (for appellant), said that applicant was employed by respondents as an electrical fitter, and in November, 1908, he had an accident, his thumb being cut by an electric arc lamp which resulted in several operations, and finally half his thumb was amputated and he had now lost the entire use of his right hand. For some time applicant was permanently incapacitated from work, but at the time of the arbitration he had obtained employment with respondents in a different capacity and was now employed by them as a watchman, which involved day and night work. In his former employment the applicant's wages were 32s. 6d. a week for 50½ hours work a week. As a watchman he had to work 68½ hours a week and his wages were 25s. a week. Applicant's contention was that the judge in the court below should have made an award in his favour for 7s. 6d., the amount he had lost by reason of the accident, but the judge only awarded him half that amount. He (counsel) contended that applicant was entitled to an award for 7s. 6d.

Without calling upon counsel for respondents their lordships dismissed the appeal, holding that there was no point of law involved upon the appeal and that they could not interfere with the finding of fact of the learned judge in the court below.

Glasgow Tramways Assessment.

On Monday Sheriff Gardner Millar delivered his reserved judgment in the appeal of Glasgow Tramways Committee against the assessment of their undertaking.

In the course of his judgment the Sheriff said that he had found great difficulty in the case. It was an appeal by the tramways department

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against the assessment of their undertaking under six heads (police, sanitary, statute labour, sewage, roads and bridges, and parks), and involved rates amounting in all to the yearly value of £12,514. 8s. 3d. After referring to the statutes imposing the rates he said there was no doubt appellants' undertaking, so far as it consisted of the lines upon the street, fell under the description of "lands or heritages," but the question was whether it was a railway within the meaning of the statute, so that its yearly rent or value should be deemed to be one-fourth of the amount entered upon the valuation roll of the city. It did not seem to be of much importance to trace the derivation of the words "railway" and "tramway," because in the course of time these undertakings might be so differentiated in character as to deprive the original terms of any significance. Nor did he think that the fact that for the last 39 years appellants' undertaking had been considered by the assessor to be a railway, and so entitled to the restriction applicable to a railway. Appellants' counsel maintained that a practice so long continued was not lightly to be set aside, as it showed the meaning that by common consent all parties put on the words. He referred to the decision in Laird & Sons v. Clyde Navigation Trustees and compared the physical characteristics of railways and tramways. The ordinary citizen knew perfectly well the distinction between a tramway and a railway, and, in ordinary language, would never think of confusing the two, and if it was competent to consider the ordinary use of the words in common parlance, that seemed to the Sheriff a strong point in respondents' favour. Another consideration arose with regard to the reason why the restriction of valuation should be allowed in favour of railways, and whether the reason for it was equally applicable to tramways. The question had arisen in England in connection with a statute expressed in similar terms to that of the statutes which they were now considering—in the case of the South Wales Railway Co. *v.* Swansea Local Board of Health, and in that case it was said that the general scheme of the enactment was that the occupiers of the classes of property most benefited by the expenditure of the district rates should be liable to be rated at a higher rate than the occupiers of the classes less benefited at the lower rate. It was plain that the railway company, in so far as the road upon which their line was laid was concerned, got less benefit from the rates applied to such matters as police, lighting, maintenance of roads, &c., than other classes of heritage, and accordingly they were only assessed at one-fourth of their yearly valuation for those purposes. But it was difficult to see why a tramway line did not get the same benefit as other heritages from the expenditure of the rates upon lighting, police, maintenance of roads, and even sewage. If they did get the benefits like any other heritage from the expenditure of the rates there was no reason why the Legislature should have granted a particular exemption in their favour as compared with other ratepayers in the district. After considering those arguments, he should be inclined to hold, apart from authority, that the words in the statute "the line of any railway constructed under the powers of an Act of Parliament for public conveyance" did not apply to the case of a tramway, and, therefore, appellants had failed. He referred to English and Scottish decisions, and concluded by saying that upon the whole matter he was of opinion that the appeal should be dismissed and the assessment affirmed, but without costs.

Conolly Bros. Ltd.; Wood v. The Company.

On Tuesday Mr. Justice Warrington heard a motion for judgment in default of defence in this case. Plaintiff was a debenture holder, and in giving formal judgment in a debenture holder's action his lordship directed a special enquiry as to priority of encumbrances.

PARLIAMENTARY INTELLIGENCE.

ROTHERHAM CORPORATION BILL.

This Bill came before the Local Legislation Committee of the House of Commons on Tuesday.

Mr. RAM, K.C., for the Corporation, explained that the bill dealt with a variety of subjects, and he proposed first to deal with the tramways scheme. The Corporation proposed to lay down a tramway. They also asked power to provide and run motor omnibuses over specified routes. There were also alternate proposals for motor buses or trackless trolley vehicles. The buses would not pay rates, but the trackless trolleys would upon the apparatus which would have to be laid down. The outside authorities were not opposing the scheme.

Ald. D. L. WINTER said their tramway system showed a net profit of £3,000 on a capital of £150,000.

Mr. H. CROSS, borough electrical engineer and tramways manager, gave estimates of the cost of the trolley equipment as follows:—Kimberworth to Thorpe, £11,004. 19s.; borough boundary to Maltby, £20,340. 19s.; Canklow terminus to Treeton, £6,368. 9s.; total, £37,714. 7s. He estimated the profits at £20,317.

On Wednesday the evidence for the Corporation closed and the Committee ordered the room to be cleared, and, on the parties being readmitted, the Chairman (Mr. Helme) announced that the Committee approved of the provisions relating to the proposed tramways, trackless trolley service and omnibuses.

Mr. LLOYD, K.C., who appeared for the Great Central Railway Co. against the Bill, protested that the Committee had heard neither him nor Mr. Bidder, for the Midland Railway Co., in opposition. They would reserve their right to oppose the Bill in the House of Lords.

Ultimately the Committee decided to give powers for trackless trolleys either from Jan. 1, 1912, or six months after the issue of the Board of Trade certificate to Leeds Corporation for their trackless trolley service.

COAL MINES BILL.

Further progress with this Bill was made during the week by Standing Committee B of the House of Commons.

On Tuesday the Committee considered clause 32, which provides that only locked safety lamps shall be used in seams where the air-current in the main return airway is found to contain more than one-half per cent. of inflammable gas.

Col. HUCKMAN moved to permit the use of electric lamps in such seams, but the amendment was withdrawn on the understanding that the question of lamps in main haulage roads would be reconsidered.

Mr. MARKHAM moved that the section should be amended so as to read that only locked safety lamps should be used in any mine.

After discussion the amendment was negatived without a division.

National Telephone Staff.—In reply to a question in the House of Commons on Friday, the Postmaster-General stated that on the transfer of the National Telephone Co.'s undertaking members of the staff would enjoy the advantages and be subject to the conditions of the rank or grade in the Post Office service to which they were admitted. It followed from that that transferred officers would obtain pensionable status if they were placed, either at once or at some subsequent date, in positions which were pensionable under the ordinary rules of the Civil Service. The fact that an officer contributed to the Company's pension fund would not affect the question of this status in the Post Office, but he anticipated that almost all the officers pensionable by the Company would, on transfer, be placed in pensionable offices, while a large number of officers whose posts under the Company were not pensionable, would be transferred to grades in the Post Office service which enjoy pension rights.

Mica Condensers.—In a recent issue of the Bulletin of the Bureau of standards Mr. H. L. Curtis discusses the use of mica condensers as standards of capacity. The following is a summary of the points dealt with: (1) The various methods for measuring capacity with alternating current and continuous current are discussed, and the best methods to use when mica condensers are to be measured are indicated. (2) A method is given by which the temperature coefficient of a mica condenser may be made very small, at most a few parts in a hundred thousand per degree. (3) The effect of changes of the atmospheric pressure upon the capacity are shown to be small though in some cases they are not negligible. (4) An explanation of the change of capacity with voltage, which is observed in the case of silvered-mica condensers, is offered. (5) Condensers which are kept in a vacuum and maintained at constant temperature can be relied upon to a few parts in a hundred thousand. Such condensers are somewhat more stable than condensers which are maintained at constant temperature, but subjected to the ordinary fluctuations of atmospheric pressure. Condensers exposed to the ordinary changes of room temperature show unaccountable variations of the capacity of two or three parts in ten thousand. (6) It is shown that, taking the measured values of the specific resistances of mica and paraffin Maxwell's theory of a stratified dielectric does not account for the absorption actually observed in the case of a mica condenser. This theory is then applied to alternating current measurements, and it is shown that, according to this theory the loss of energy per *second* in the dielectric is nearly independent of the frequency, whereas measurements show that the loss of energy per *cycle* is almost independent of the frequency. The conclusion is drawn that this theory alone will alone not explain the phenomena of absorption. (7) The capacity of a condenser with alternating current of infinite frequency is shown to be the same as the capacity with continuous current when the time of discharge is infinitely short. This capacity is called the geometric capacity, since it is a function of the dimensions and dielectric constants of the dielectrics.

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COMMERCIAL AND INDUSTRIAL SECTION.

MUNICIPAL, FOREIGN & GENERAL NOTES.

BRITISH NOTES.

Aberdeen.—The report of the city electrical engineer (Mr. J. Alex. Bell) on the recent stoppage of supply was presented to the Electricity Committee last week.

Mr. BELL stated that the breakdown was due to the following three causes:—(1.) The drawing of a heavy current to a faulty cable in Union-street due to a pickhole in the cable; (2.) The overloading of the boiler plant at the time; (3.) Owing to one of the mechanical stokers failing to operate, the steam was reduced to such a degree that it was found necessary to shut down the station until the mechanical stoker could be put right, and steam pressure brought up again.

Accrington.—Some time ago the assessment of the electric tramways was increased from £800 to £1,650, by Haslingden Union Assessment Committee, but the dispute was referred to the arbitration of Mr. Thos. Wainwright, who has now issued his award, fixing the assessment at £2,544.

Barking.—Application has been made for sanction to a loan of £11,000 for the electricity undertaking.

Beckenham.—At the last Council meeting the Electricity Committee reported that the L.G. Board had sanctioned the raising of a further £5,000 for "free" wiring.

As 11 months had elapsed since tenders for that class of work were raised, they recommended that fresh tenders be issued; and in the meantime the work to be continued through local contractors at revised prices, subject to the resident engineer, Mr. J. E. Tapper.

The Clerk submitted tables showing the effect of the expenditure of the sum of £5,000, and, arising out of the report, the Committee recommended that in future the Council, in both new free wired installations and on changes of tenancy, provide the equivalent of carbon lamps only, the consumer being required to pay the difference between 9d. (the value of a carbon lamp) and the price of the particular metallic lamp selected.

Mr. A. H. Dykes said that as he had felt it his duty to severely criticise some of the figures which had been put before them by the Committee during the past two or three years, he was now pleased to say that they were all making a small profit. He thought that that was exceedingly satisfactory, and a great improvement on what they had been doing, and that everyone concerned should be congratulated upon it. He considered it right, however, that it should be pointed out that those figures were based upon the first cost of free wiring, which was 25 per cent. below what they had been paying: and those figures showed that had they continued to pay the old price, instead of making a profit for the remaining eight years, they would have made a loss of £150 a year.

Belfast.—The agreement for the taking over of the undertaking of the Cavehill and Whitewell Tramways Co. has been approved. On and from to-day (Friday) the Corporation will manage the tramways. There will be a through connection between the city system and the new lines.

Bradford.—An inquiry was held on Tuesday into the application of the Corporation for sanction to borrow £60,000 for extensions of the electricity undertaking.

There was no opposition and evidence was given by the town clerk (Mr. F. Stevens) and the city electrical engineer (Mr. T. Roles). It was explained that the loan was required chiefly for mains and for the extinction of debt already contracted. An appeal was made for the longest possible period for repayment.

Bridlington.—It was reported to the Council on Wednesday that the report on the past year's working of the electricity department showed a profit of £1,000, an increase of £369.

Bromby and Frodingham.—An inquiry was held on Tuesday into the Council's application for sanction to borrow £1,100 for street lighting.

It was stated that the streets were at present lighted by oil lamps, and as this would be too costly, a scheme for supplying electricity for street lighting had been prepared, although a former project for public and private supply had been rejected. It was now proposed to take electricity from the Frodingham Iron & Steel Co.

Coronation Illuminations.—Fulham (London) Council will charge 2d. per unit for Coronation illuminations, plus 5s. inspection fee.—Ilkeston Electricity Committee have decided to illuminate Sunnyside Wood in Coronation week.—Warmley Rural Council will celebrate the Coronation by inaugurating electric lighting in the Kingswood district.

Islington (London) electricity department have issued a folding card on which they offer to supply current for Coronation illumination purposes at a fixed rate equivalent to 1d. per unit, dependent upon the number of lamps installed and the hours of illumination, plus a fee of 5s. for connection, &c.

Crayford (Kent).—The Parish Council have asked Bexley, Erith and Dartford Councils to quote terms for supply of electricity for street lighting.

Croydon Corporation Tramways.—At the meeting of Croydon Council on Monday the Tramways Committee submitted a lengthy report from the tramways manager (Mr. T. B. Goodyer) on the subject of fares generally, and the following recommendations of the committee were, after full discussion, unanimously adopted:—

(*a*) That no system of ½d. fare stages be adopted, (*b*) that no alteration be made in the present ordinary fares, (*c*) that the workpeople's fares remain as at present, (*d*) that the 1½d. fare stages be not adopted, and (*e*) that the fare stage distances remain as at present.

The recommendation of the Tramways Committee, against the views of Mr. Goodyer, to re-open the Whitehorse-road route (which, from previous operation, had resulted in an annual loss of over £2,000) was, on an amendment that the line should not be worked until the rates had been reduced, lost by 24 to 21 votes.

Doncaster.—The L.G. Board have approved a scheme of sewerage and sewage disposal prepared by Messrs. D. Balfour & Son, of London and Newcastle-on-Tyne, for the parish of Adwick-le-Street, in which is included the model village of Woodlands. The sewage from a portion of the district is to be pumped from a storage tank by means of electric motors and pumps to the disposal works where it is to be treated.

Edinburgh.—The Electric Light Committee are considering a request of the Merchants' Association for a reduction in the charge for electric current for industrial purposes.

The Electric Lighting Committee recommend the Council to reduce the price of electrical energy to 2¾d. per unit (a reduction of ¼d. for private lighting.

Electricity in Gas Works.—At a meeting of Dundee Gas Committee on Monday Convener Clark gave an explanation of the introduction of electrical stoking plant at the gas works.

The cost of the plant is estimated at £3,900, and in order that the members of the Council might make themselves familiar with the matter Mr. Clark said he had arranged to furnish them with information regarding the latest types of stoking plant.

It was also reported to the Electricity Committee that the cost of the second instalment of the mechanical stoking plant for the electricity works would be £396.

Fulham (London).—Mains are to be extended to the Crabtree Farm estate at a cost of £1,164.

Heston and Isleworth.—The Electricity Committee, acting on the advice of their electrical engineer (Mr. P. E. Rycroft), have decided not to enter into a contract for the supply of metal filament lamps for the present owing to the unsteadiness of quotations, but to buy in the open market.

Three 50 c.p. lamps, from each of seven different makers, had been tested and none had failed. The contract with the British Economical Lamp Co. for maintenance of street lamps, would expire on June 30 Hitherto maintenance had cost £165 per annum. Two fresh quotations had been received which showed that the cost for the 400 posts would be only £115, and it was agreed to invite further tenders when the present contract expired.

Hull.—An inquiry was held on Wednesday into the application of the Corporation for sanction to borrow £99,000 for extension of the electricity works.

The city electrical engineer (Mr. H. BELL) gave evidence and stated that the total capacity of the existing plant was 6,500 kw. and there was need for extensions to anticipate the increasing demand, especially for power.

Ilford.—An unopposed inquiry was held last week into the application of the Council for sanction to borrow £8,070 for their electricity undertaking.

Light Railways.—Hertford County Council are applying for an order to authorise the construction of about ¾ mile of tramways in Watford, as a deviation of railway No. 1 authorised by their 1908 order.

Birmingham Corporation are applying for an order to authorise the construction of a line commencing partly in Worley (Oldbury) and partly in the City of Birmingham and ending in Smethwick.

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Newport (Mon.)—The Council propose to equip offices, showrooms and stores for the electricity and tramways departments at a cost of about £2,000.

Overhead Telephone Wires in the City.—At the meeting of the Court of Common Council last week the Streets Committee reported the receipt of a letter from the solicitor of the General Post Office (Sir R. Hunter) on the subject of the acquisition of the plant of the National Telephone Co.

The letter stated that the Postmaster-General had objected to purchase the overhead plant connected with certain exchanges in the City, and the Corporation was asked to support the case of the Post Office before the Railway and Canal Commissioners.

The committee recommended that Mr. Deputy MORTON, M.P., should be requested to give evidence in favour of an underground system of telephones.

Ald. Sir GEORGE WOODMAN asked whether Mr. Morton's evidence would be confined to expressing the opinion of the Corporation upon the merits of the underground system as compared with the overhead one, or whether he would have an opportunity of expressing any other views. It seemed extravagant and expensive that the whole of the overhead system should be scrapped at once. Would Mr. Morton express any view on behalf of the Corporation as to the dispute between the National Telephone Co. and the Post Office? There were many questions involved, though probably the Court would agree that the underground system, if it could be installed with the minimum of discomfort to the City, would be far superior. Would Mr. Morton have an opportunity of getting an undertaking from the Post Office on the question of rating? At the moment Government departments paid only what they cared to pay, whereas the National Co. was assessed as a trading company upon its profits. Would it be possible to obtain some assurance that the matter would be dealt with equitably? Then there was the damage which would accrue by the pulling down of the overhead wires. He was by no means certain that the matters could be raised upon the report, but he wanted an assurance that the whole of the interests of the Corporation and of telephone users would be safeguarded.

Mr. JOSIAH GUNTON, chairman of the committee, said Mr. Morton was conversant with the whole matter.

Mr. W. W. GREEN thought the question should be watched by the Special Committee. Owners of property would be greatly affected. He moved accordingly.

Mr. Deputy MORTON did not think that many of the points mentioned arose in connection with the evidence he was asked to give. He was simply to express the view at which the Corporation arrived in 1905 to the effect that, subject to conditions, it was in favour of an underground system because it was the only one that could be properly worked. The Corporation had always submitted that there should be conditions, and that the price for the flat rate should not be above £10 per annum. That he had put in his proof of evidence. The Streets Committee had always been anxious to get an efficient telephone service for the City at a fair rate.

Mr. Deputy WALLACE seconded Mr. Green's amendment that the whole question should go to the Special Committee.

On the suggestion of the LORD MAYOR, the Streets Committee were added by the mover and seconder to the reference. The matter was left with the Streets Committee, with instructions to confer with the Special Committee. Mr. Ernest Lamb and Mr. Green were added to the committee.

Petrol-Electric Car on Great Central Railway.—The Great Central Railway Co. have recently placed an order with the British Westinghouse Co. for a "petrol-electric" car, which will shortly be put on the tracks in the London district for its trials under the direct observation of the general manager (Mr. Sam Fay), preparatory to going into service on a branch line.

The car is of the general type developed successfully by the Westinghouse companies on the Continent, will seat 50 persons, and will be capable of hauling two trailers, seating 50 more, at an average speed of 30 miles per hour on the level.

Pontardawe.—The Council have asked Mr. John Morgan to prepare a fresh report on the question of electricity supply in the district.

Reeth (Yorks.).—Next winter this village will be lighted electrically, as Mr. Burton, of Askrigg, Wensleydale, has contracted to light the village with metal filament lamps totalling 1,050 c.p. for five years at £20 per year. Water power is to be utilised in generating electrical energy.

St. Pancras (London).—The question of the charge for outside shop lighting has been under the consideration of the Electricity Committee.

The chief electrical engineer (Mr. S. W. BAYNES) reported to the committee that at present the approximate revenue from outside private lighting is £,5000 per annum, but he thought that, unless the charges were lowered, this sum would decrease. The committee have, therefore, decided, subject to the usual sanction, that the flat rate charge for current supplied for outside frontage lighting be 3d. per unit as from the June quarter, and that rentals be charged for separate meters required to register the supply.

Stepney (London).—St. George's town hall is to be wired during the summer vacation at a cost of £250. Application is to be made to the Board of Trade for a provisional order scheduling the sites of the Council's generating and sub-stations as "statutory" sites.

Stoke-on-Trent.—An inquiry will shortly be held into the Council's application for sanction to a loan of £60,000 for the erection of a new power station, and application has been made to the Board of Trade for consent to supply electricity on the e.h.t. three-phase system in the borough.

Warmley.—The Rural Council will inaugurate in Coronation week a scheme of electricity supply for the Bitton district.

Mr. King Smith (owner of Bitton Mill) will supply current and provide lamps and wires for an annual sum, and sufficient money has been voluntarily subscribed to pay for seven years' lighting. Overhead wires on poles will be used.

Wireless Telegraph Notes.—A very circumstantial statement has again appeared in one of the London morning papers as to communication being effected between the Eiffel Tower, Paris, and the Glace Bay station of the Marconi Company in Canada. It will be remembered that previously statements of this kind have been made, only to be categorically denied the following day. The particular statement published this week is to the effect that the Marconi station at Glace Bay has been in communication with the Eiffel Tower in Paris. The message from the Eiffel Tower to Glace Bay was also picked up by the station at Dakar, West Africa, and was said to have been relayed from this point direct to Glace Bay. Finally it is stated that the two stations were in perfect communication for fully an hour. This entire circumstantially stated piece of news was denied in toto in a few hours by the Marconi Company.

A correspondent of the "Financial Times" has been writing on the subject of wireless telegraphy with special reference to an installation in one of the potash mines of the Harz mountains in Germany, where for 1½ miles a service of wireless communication is established at a depth of about 1,600 ft. below the surface with satisfactory results. Our contemporary's contributor suggests that such a system might easily be adopted in many of the coal mines in Great Britain, where he considers the advantage is important and involves so little cost that "its general adoption should be considered."

COLONIAL AND FOREIGN NOTES.

Canada.—The Canadian Light and Power Co. have placed before the Dominion Government a project for the erection of hydro-electric works at Cedar and Coteau Rapids, on the St. Lawrence river, about 25 miles above Montreal, at a cost of from $15,000,000 to $20,000,000. It is estimated that 500,000 H.P. can be obtained.

Canary Islands.—An application for a concession for an electric tramway between the Barrio de San José and the centre of Las Palmas has been lodged with the Spanish Government by the Soc. Anon. Banco di Castilla.

Customs Duties.—According to recent decisions, car fittings for tramway and railway carriages (blinds, rattan seating, &c.) imported into British South Africa are subject to a duty of 15 per cent., and insulating paper, leatheroid and cloth for eletrical purposes are subjects to 3 per cent. In both cases British goods have a rebate of 3 per cent.

Egypt.—Imports of electrical machinery into Egypt in 1910 were valued at £113,771, of which £51,929 was from the United Kingdom, compared with £62,949 and £22,479 respectively in 1909.

Hayti.—Port-au-Prince is now lighted by electricity, the first time artificial lighting has been adopted.

A concession has been granted for the construction of a narrow-gauge electric tramway from Port-au-Prince to La Coupe, but construction work has not yet commenced.

Holland.—Exports from Flushing to the United Kingdom in 1910 included 11 million brass caps for incandescent electric lamps, compared with 7 million in 1909 and an average of 7,400,000 per annum for the five years 1906–1910.

Italy.—The report of Consul de Zuccato on the trade of Venice for the year 1909–10 states that the Germans continue to hold the trade they have captured and which was formerly in British hands, chiefly in machinery, electrical appliances, &c. The hydro-electric industry for long-distance transmission continues to develop, and several fresh schemes are under consideration.

The Soc. Varesina per Imprese Ellettriche have secured a concession for an electric tramway from Varese to Bobbiate.

Java.—M. Huber has applied for concessions for electric tramways from Groedo to Sourabaya and from Willemsplein to Sourabaya harbour.

Norway.—The following information is given in reports for 1910 by British Consuls in Norway:—

There was a brisk importation from Germany of porcelain insulators, zinc plates, copper wire, water-power machinery, dynamos and electric

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cables. The export of a consignment of electrically-smelted copper is reported from the Birtavarra mines.

Several works for the electric smelting of iron ore and one for the electric production of steel from broken-up vessels, &c., have been either under construction or planned in 1910. At Arendal there are a number of iron mines yielding excellent ore, and the Arendals Fossekompagni has been started by Mr. S. Eyde, with a capital of about £225,000, for the manufacture of steel electrically. Near Arendal there is also a factory called the Electrum Metallurgisk for making ferro-silicium. About 100 tons of excellent steel were electrically produced in a 1,000 H.P. furnace by the Alb. Hoerth process at Jössingfjord, between Flekkefjord and Egersund. About 800 tons of aluminium were produced in 1910 at Vigeland's Works, near Christiansand, where imported aluminium oxide is reduced by an electrical process. The Norwegian export of ferro-silicium was about 5,000 tons. The Sundlökken electrothermic zinc factory near Hatslund produced about 4,000 tons of electrically refined zinc, the raw material being partly foreign raw zinc and partly ore imported chiefly from Australia and Greece. The total export of calcium carbide was only about 50,000 tons, manufacture being reduced owing to over-production abroad, while the export of cyanamide was some 4,500 tons. The value of these products was estimated at about £650,000.

Another new development is the Electric Ore Smelting Co., in Tyssedal, near Odda, on the Hardangerfjord. The concern is expected to be in working order about the spring of 1912. Besides the electric smelting of iron ore, which it will commence with 2,500 H.P., the company will erect a station for smelting zinc ore, for which 3,000 to 4,000 H.P. will be used.

In the early part of the year Aktieselskabet Svælgfos ordered the entire electrical outfit for the Lienfos power plant for the production of nitrate of calcium. The order comprised four three-phase generators of about 9,500 E.H.P. each, and two exciters of about 500 H.P. each, with switch-gear, &c.

The outstanding feature of 1910 was the starting of the electro-steel industry by the Tinfos Papirfabrik, Notodden, which possesses, besides its two wood-pulp mills and an electrical power plant for 8,500 H.P., together with a saw and planing mill, electrical smelting works for smelting iron ore. By way of experiment, they started in January, 1910, with 500 H.P., and during the year they produced about 450 tons of pig iron. A separate limited company has now been formed, under the style of Tinfos Jernverk, with a capital of £56,250, to continue the smelting works, which are the first of their kind in Norway. It is intended during 1911 to build and start smelting furnaces for 5,000 H.P., which are expected to be in full swing in the course of the summer. During 1912, when the next 5,000 H.P. will be available, the smelting furnaces will be increased and the rolling mill and steel works erected. Another 5,000 H.P. may eventually be added. The ore is brought from the Langö, near Kragerö. At the Ulefos Jernverk the owner (Mr. D. Cappelen) has an electric furnace for iron smelting, and the accessories for a second furnace have been ordered.

Porto Rico.—A consular report states that plans are being prepared for doubling the electric tramway between San Juan and Rio Piedras.

Russia.—Chernikov municipal authorities have applied to the Council of Ministers for permission to borrow about £10,500 for the purchase of electrical machinery, &c.

South Africa.—The raising of £120,000 by Salisbury (Rhodesia) Municipality for the provision of electricity and water supplies, &c., has been authorised.

Spain.—A consular report on the provinces of the Asturias, Galicia and Leon states that the last negotiations for electrifying the Corunna tramways have fallen through, but a British firm is examining the scheme. The Vigo city electric tramway scheme has been given up. At Vigo harbour an electric crane capable of dealing with 130 tons of coal per hour has been erected.

Spain.—The Soc. Anon. Iberia Concessionaria have applied to the Public Works Department, Madrid, for a 60 years' concession for an electric tramway from Porrino to Vigo.

Switzerland.—An 80 years' concession has been granted to Herr Frederic Hoffmann and Dr. F. Volmer for constructing a narrow gauge electric railway from Worblaufen to the railway at Worb or to the Berne and Thorne line, with a branch from Schermen to Berne. The cost is estimated at £64,552.

E. Frote & Co. of Zurich have a concession for a narrow gauge electric railway, 50 miles in length, from Coire to Bivio. The cost is given at £340,000.

Transvaal Power Scheme.—At the meeting of the Tweenfontein Colliery, Ltd., last week the chairman (Lord Oranmore and Browne) referred to the arrangement with the Transvaal Hydraulic Power Syndicate by which the latter were to erect an electric power station and certain factory and to purchase from the colliery about 25,000 tons per month of different classes of coal.

He said that it was only on Oct. 27 last that the Transvaal Hydraulic Power Syndicate obtained a licence from the Transvaal Government for the erection of the power station and the grant of a definite area of supply. The scheme was a large one, involving the expenditure of about £1,000,000 and the arrangements in connection with it were of an onerous character. These arrangements were, however, proceeding, and they believed that ere long they would be definitely concluded. While the arrangement between the companies could not be other than a good one for the Hydraulic Syndicate, inasmuch as they would obtain their coal at a price which did not obtain in Europe, it would be satisfactory to the colliery company, not only on account of the profit that might arise from it directly, but also from the increased profit on their general trade through the spreading of their costs over so greatly enhanced an output. A not unimportant factor in connection with this contract was that they only mined a limited width of the 20 ft. seam of coal on the property. Under their contract at least half the amount to be supplied to the Hydraulic Syndicate was to be taken from the remaining portion of the seam—that was the portion now left in the mine. The quantity of such coal already developed by the operations of the last three years to Dec. 31 last was no less than 1,043,391 tons, which of itself would enable them to supply the Hydraulic Syndicate for some years. The contract being for a long period, the directors thought it right to have an estimate made of the tonnage contents of coal on the property. Taking the main seam alone, the quantity was estimated at 34,000,000 tons, and that by itself would enable them to maintain their present output to the general trade and meet their contract with the Hydraulic Syndicate for over 60 years. Beyond that they had seams of coal both above and below the main seam which were not taken into calculation. They were now prepared not only to fulfil the contract for the supply of the large tonnage referred to, but they looked forward to the supply of a greatly increased tonnage from the expansion which they believed must inevitably take place in the demand of power from the new power station.

United States.—A chain hoist operated by a 150 H.P. electric motor is being fitted at the shipyard of Booz Bros., Baltimore, for hauling vessels up on to a marine railway. It is anticipated that a vessel of 2,000 tons will be hauled out in 30 minutes.

On the steamer "Pilot," belonging to the Maryland Pilots' Association, lying off the Virginia capes, has been placed aloft an electric light which is used for signalling to an observing station at Cape Henry, by the Morse system, the name of any vessel passing in or out of Chesapeake Bay. The system has proved very successful.

The construction of the Susquehanna river dam at McCall's ferry, which ceased in 1908 owing to financial difficulties, was resumed in 1909 after the works and undertaking had been sold by auction for $2,000,000 to the Pennsylvania Water & Power Co., and the work was completed in September last. The company have erected a power house containing 10 large water wheels and two dynamos of about 10,000 kw. each. The contract for the supply of electricity made by the original company with the Consolidated Gas, Electric Light & Power Co. of Baltimore, has been carried out by the present company, and supply was commenced on Oct. 14, 1910. The Baltimore Co. controls the lighting by electricity from this source of eight counties in Maryland. The United Railways Co., with whom the original promoters of the water conservation scheme also had a contract, have not yet taken a supply of current.

The chief engineer of the Sewage Commission proposes, as soon as the sewage disposal plant at Back River—the point of the final discharge of the sewage into the Chesapeake Bay—is completed, to use the fall of the water after it has passed through the various tanks, which will be 18 ft., to operate turbines for the generation of electricity. It is expected that about 455 H.P. will be obtained. The intention is to light and provide current for power at the disposal works, and the chief engineer believes that the surplus will be sufficient to light the City Hall and Court House in Baltimore.

The construction of underground conduits for electric wires at Baltimore goes rapidly forward. There had been constructed to Dec. 1, 1910, 9,463,650 duct feet, which, with manholes, junction and service bases, buildings connected, &c., cost £526,755. The rentals received for the use of the conduits average £20,576 a year. The police and fire-alarm telegraph occupies 103,000 ft. of the conduits, and there are several thousand feet occupied by the municipal and Government cables, for which no rental is received.

An electric iron smelter on the Pitt River, Shasta County (Cal.), has been pronounced a success, and five more furnaces are in course of construction. The cost of production is said to average £2. 10s. per ton, and the product can be sold for £6. 5s. per ton. The pig iron produced is of high quality.

An aqueduct is being constructed to bring the waters of the Owens river to Los Angeles, the main object being to supply water to the city, but the use of the water power for generating electrical energy is also contemplated. It is expected that sufficient power for factories employing 500,000 workers will be obtained, the estimated maximum power obtainable being 120,000 H.P.

The total mileage of electric tramways in the city of Los Angeles is reported to be 350 miles, and on the suburban electric railways over 770 miles of track.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Bolton.—The accounts of the electricity department for the year to March last show capital expenditure £380,611 (increase £20,921), of which £117,501 has been repaid.

The income was £70,942 (£73,579 in 1910), working expenses £35,554 (£38,637), and gross profit £35,388 (£34,941). After providing for interest and instalment for repayment of loans, setting aside £3,504 (£4,664) for renewals, contributing £2,980 (£13,780) to capital, and placing £113 (nil) to reserve, £6,500 (as in previous year) has been voted in aid of rates, and £357 (£619) carried forward. Works costs were 0·456d. (0·436d.) per unit, and total costs 0·570d. (0·535d.), or 1·173d.

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(1·125d.) including capital charges. The increase in the cost per unit is mainly due to the decrease in the power demand (4,904,527 units compared with 6,013,928),and of the power consumers who have ceased taking current some had a good load factor. The total quantity generated was 13,753,232 (14,257,251), and the total sold 11,156,084 (11,993,271) units. There are 2,851 (2,628) consumers, with 456,986 (434,561) (equivalent) 8 c.p. lamps connected, and the motors connected are 1,029 (915), with an aggregate of 10,584 (10,017) H.P. The average price obtained was 1·23d. (1·18d.) per unit.

Brighton.—The total revenue of the tramways department for the year ended March 31 was £50,747 and working expenses were £37,669.

Out of the gross profit of £13,078 interest absorbed £7,918 and sinking fund £5,023, leaving a net profit of £137. Power expenses were £10,116, against £10,903, traffic expenses £13,253 (£13,119), repairs and renewals £10,386 (£9,249) and management and general expenses £3,007 (£2,889). Car-miles run were 1,126,676 (1,130,685), and the number of units of electricity used 2,023,109 (1·79 per car-mile) (1,938,305) 1·71 per car-mile. The number of passengers were 10,708,184 compared with 10,759,947. In his report the manager (Mr. Marsh) states that the cost of repairs and renewals to permanent way had been increasing somewhat rapidly of late, and the maximum had not been reached. The cost during last year was £5,554 against £4,005.

Coventry.—The report of the electricity department for the year ended March 31 states that the net surplus is £16,414, against £10,070 in 1909-10.

It is proposed to devote £3,500 to relief of rates, and the employés of the department are to get £237 as bonus. It has also been decided to increase the salary of the manager (Mr. G. Tough) from £450 to £550 per annum. The report and accounts were adopted by the Council on Wednesday, when meter rents were reduced and a revised scale of charges adopted.

Dundee.—The accounts of the electricity department for the past year show a total revenue of £46,047, compared with £39,908 for 1909-10.

The generating cost was £13,595; distribution, £2,919; rents, rates and taxes, £4,640; and administration, £1,816. The net profit was £22,957 and the balance brought forward £1,259. The present capital debt is £241,885. The number of units sold during the year was 7,720,018, against 6,144,957.

Hastings.—The income of the electricity department for the year ended March was £18,398, including £13,296 from the sale of current (at average price of 5·385d. per unit), £3,677 from public lighting, £690 interest and sinking fund charges upon loans chargeable to Public Lighting Committee and £679 meter rental.

The total expenditure was £9,138, including £5,293 for generation, £735 for distribution, £819 for public lamp maintenance, £471 rent, rates and taxes, £1,492 management and £328 special charges. The gross profit was £9,260, and after providing interest (£5,167), loans and sinking funds (£5,711) and bad debts (£59) there was a deficit of £1,677, against £2,919. The outstanding debt is £113,840. 915,097 units were generated, against 846,546, and 812,397 units were sold, against 731,914. There are 115 arcs and 320 incandescent lamps, against 115 and 1,357 respectively in 1910. The total maximum supply demanded was 580 kw. (530 kw.); there are 1,153 (1,067) consumers, with the equivalent of 40,697 (39,823) 30-watt lamps connected. The load factor was 15·98 (15·76) per cent. The total costs were 2·44d. (2·86d.) per unit, and coal and other fuel cost 0·86d. (1·06d.).

Kettering.—The accounts of the electric lighting department for the year ended March show total receipts £10,140, including £7,124 nett from sale of current for private lighting, £877 from public lighting and £1,420 from rental of motors, meters and arc lamps.

Total expenditure was £4,912, and included £2,718 for generation, £744 for distribution, £254 for public-lamp maintenance, £137 for rent, rates and taxes, £812 for management and £246 special charges. Gross profit was £5,228, and after paying interest (£1,751), instalments of money borrowed (£2,477) and taking into account £444 brought forward, the balance carried forward was £1,476. The existing debt is £46,270, against £47,747; 1,048,314 units were generated; 917,952 were sold to private consumers and 1,100 by contract and 62,042 units were supplied to the public lamps (30 arc lamps combined with 60 incandescents, 229 half-night and 19 all-night lamps.) The total maximum supply demanded was 624 kw.

South Shields.—The annual report of the tramways manager (Mr. L. E. Harvey) for the year ended March 31 has been issued.

Traffic revenue was £29,046 (8·627d. per car-mile), and after paying expenses (including interest and sinking fund) there was a profit of £2,344, an increase of £693 compared with 1909-10. The improvement is due almost entirely to economies effected in the current bill. Working expenses (£18,493) were practically the same as last year, except for the saving in cost of power and the increase in permanent way expenses. The number of units consumed was 914,046, from which had to be deducted 11,026 sold to power consumers, 1,310 used by the watering car and 2,654 used in the workshop, leaving 899,056 units for traction purposes. In the previous year the figure was 1,070,343, the total saving in traction current being 171,319 (or 16 per cent.). The cost of current for the past 12 months was £5,367. 14s. 5d., an average of 1·411d. per unit, and the cost of the units used for traction was £5,282. 11s. 8d., a reduction of £906. 11s. 7d. The number of miles run was 808,062·12, an average of 1·113 units per car-mile used, against 1·326, a reduction of 16·06 per cent. Those results were due to use of meters on the cars, which had taught the drivers to economise in the use of the current. The operating costs for the year were the fifth lowest in the kingdom, exclusive of costs for power, over which the tramway undertaking had no control. The number of passengers carried was 9·01 per car-mile, against 9·94 for the whole of the kingdom. Owing to the reduced consumption, the average price per unit had increased to 1·409d., against 1·388d. Passengers carried was 7,275,818. The capital expenditure is £172,255. 1s. 6d.

West Hartlepool.—The accounts of the electricity department show capital expenditure £92,548 (increase £457), of which £31,770 has been repaid or placed to credit of sinking fund or reserve.

Revenue during the year to March last was £15,974 (against £15,538 in previous year): working expenses £8,506 (£8,650), gross profit £7,468 (£6,888), and net surplus, after providing for capital charges, £1,506 (£1,128). This has been carried to reserve. Fuel cost 0·39d. per unit sold (against 0·41d. in previous year), works costs were 0·73d. (0·75d.), and total costs 0·88d. (0·94d.), or 1·54d. (1·61d.) including capital charges. Average prices obtained were 1·62d. (1·67d.) for private supply and 1·86d. (1·57d.) for public lighting. The maximum supply demanded was 1,088 kw. (1,070 kw.). 2,496,142 (2,387,222) units were generated, 2,113,558 (1,998,508) supplied to private consumers by meter and 60,329 (59,686) to public lamps.

TRADE NOTES AND NOTICES.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1911 Edition of the Big Blue Book is READY, price 15s., post free in the United Kingdom, 15s. 9d. The volume brings a great mass of very valuable statistical and technical data quite up to date, and the Directorial Division has been thoroughly revised and amplified up to February 24th.

All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters receive every attention in the new volume, which aggregates more than 2,000 pages. The Directory Division is complete and thoroughly accurate, and has been completely revised. The Big Blue Book contains more names of live electrical firms and persons than any other Directory published, and this notwithstanding that all mere lists of members of Societies and Institutions (so easily and cheaply available) are excluded, as unreliable and of little value for Manufacturers' and Dealers' purposes. The full set of valuable Statistical and Engineering Tables, &c., have been very carefully revised and extended, and are now issued in a handy form. These are included in the 1911 Big Blue Book, making it the most complete work of the kind ever published.

TENDERS INVITED.

The Secretary of H.M. OFFICE OF WORKS invites tenders for providing and erecting at the South Kensington generating station complete surface-condensing plant, capable of dealing with 15,000 lb. of steam per hour, together with the necessary gantry and stanchions. Forms of tender and further information may be obtained at H.M. Office of Works, Engineering Division, 55, Whitehall, London, S.W., and tenders addressed to the Secretary must be delivered by 11 a.m. of Friday, June 30, at Storey's Gate, London, S.W. See also an advertisement.

The Commissioners of H.M. WORKS AND PUBLIC BUILDINGS also invite tenders for the supply of hemp and steel wire lift ropes during three years from July 1. Forms of tender, conditions of contract, &c., from the Storekeeper, H.M. Office of Works Stores, 12, Lambeth-Palace-road, London, S.E. Tenders by 11 a.m. of Monday, June 12, to the Secretary, H.M. Office of Works, Storey's Gate, London, S.W. See also an advertisement.

KETTERING Urban District Council invite tenders for the supply, delivery and erection at their electricity generating station of extension pipework, oil eliminating plant, &c. Copies of specification and general conditions of contract from the Clerk of the Council, Mr. John Bond, Council Offices, Kettering, where tenders must be delivered by June 19. Specifications, general conditions and drawings can be seen at, but not obtained from, the offices of the consulting engineers, Messrs. Kennedy & Jenkin, 17, Victoria-street, Westminster, S.W. See also an advertisement.

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Tenders are invited up to July 19 for the supply of insulators, telephones, copper and iron wire to the Postmaster-General's Department in QUEENSLAND. Tender forms and specifications from the Commonwealth office, 72, Victoria-street, London, S.W. See an advertisement.

The Council of the Metropolitan Borough of POPLAR invite tenders for supply, delivery and erection of one 3,000 kw. turbine alternator, complete with surface condensing plant; two water-tube boilers with superheaters, air heaters, fans and chimneys; one 30-ton electric overhead travelling crane and water softening plant. Specification and form of tender from the borough electrical engineer and manager (Mr. J. Horace Bowden), Glaucus-street, Bromley-by-Bow, E. Tenders to the town clerk (Mr. L. Potts), Council Offices, High-street, Poplar, London, E., by 10 a.m. Monday, June 19.

OLDHAM Corporation Electricity Committee invite tenders for the supply, erection and delivery of one 1,200 kw. mixed-pressure steam turbine, coupled direct to two d.c. generators in tandem, together with barometric condenser, pumps, &c. Copies of specification, general conditions, &c., from the borough electrical engineer, Mr. S. Wilmott Newington, Greenhill, Oldham.

STEPNEY (London) Borough Council invite tenders for 12 months' supply of ampere-hour meters, demand indicators and time switches and arc-lamp carbons. Specifications, general conditions and forms of tender from the borough electrical engineer and manager (Mr. W. C. P. Tapper). Tenders to 27, Osborn-street, London, E., by noon June 8.

BARNES Council require tenders by noon June 9 for supply of pilework, 600 kw. generator panel and 1 mile of three-core, paper-insulated lead-sheathed and steel-armoured cable. Specification, &c., from the engineer.

DEVONPORT Electricity Committee want tenders by noon June 8 for 12 months' supply of d.c. meters, paper-insulated cables and rubber-covered wires. Forms of tender, &c., from the Borough Electrical Engineer.

SWINDON Corporation require tenders by noon June 20 for the supply and erection of a 220-cell battery, an automatic reversible traction booster, a three-wire hand-regulated booster, and switchgear. Specifications, &c., from the Borough Electrical Engineer.

STEPNEY (London) Council require tenders by noon June 15 for the constructional steel work of a sub-station at Wapping. Form of tender, &c., from the Borough Engineer.

SWANSEA Corporation require tenders by noon June 13 for the supply of c.c. motors and starting switches. Forms of tender, &c., from the Borough Electrical Engineer.

BELFAST Asylum Committee require tenders by noon June 12 for the electric lighting of two villas at Purdysburn. Specifications, &c., from the Town Clerk.

BECKENHAM Council want tenders by 4 p.m. June 12 for the wiring of houses. Forms of tender, &c., from the engineer, Electricity Works, Beckenham.

HESTON and ISLEWORTH Council require tenders by noon June 14 for supply of metallic filament lamps for street lighting. Particulars from the Engineer, Electricity Works, Hounslow.

WORTHING Corporation require tenders by noon June 12 for supply and erection of two Diesel oil engines and c.c. generators, sub-station, &c., from the Borough Electrical Engineer.

STRETFORD Council want tenders by June 10 for supply of booster booster set. Specification, &c., from the Electrical Engineer.

STOCKPORT Electricity and Tramways Committees require tenders by noon June 14 for supply of overhead material, ironmongery, insulators, paints, waste, &c. Forms of tender from the Engineer.

LONDON County Council require tenders by 11 a.m. July 4 for four electric traversers for car-sheds. Specification, &c., from the Clerk.

Tenders are invited up to July 25 for the supply of 12 sections for switching multiple magneto lamp signalling switchboard, &c., for automatic or semi-automatic switchboard, &c., and up to for supply of 1,400 protectors for use on main distributing of magneto exchanges to the Postmaster-General's Department, Victoria, Tender forms, &c., from 72, Victoria-street, London, S.W.

The Town Clerk, WANGANUI, N.Z., will receive tenders until July 12 for of generating plant, gas-producing plant and battery and for the Corporation tramways. Specification can be seen at Broughall-street, London, E.C. Local representation is necessary.

The American State Railways Department, LEMBURG, will receive tenders to June 15 for supply of electric carbons, &c.

CALARSHI (Roumania) municipal authorities invite tenders for a 35 years' concession for electricity supply in Calarshi. Provisional deposit of £480 will be required with tenders.

The Chairman of the Board of Control, WINNIPEG (Canada), will receive tenders until 11 a.m. July 3 for supply and installation of a police patrol telegraph system.

NAPLES Municipal Authorities require tenders by July 9 for supply and installation of the following plant in connection with the supply of electric power to Naples from the river Volturno:

1. Tubing and accessories for harnessing the water at rate of 7,000 litres a second and for the fall of 190 meters; upset price 702,900 lire (£28,116.)

2. Machinery and apparatus for hydro-electric power station, transmission line (about 57 miles), and transforming station; upset price 1,000,000 lire (£40,000.)

Tenders to Presidente del Consiglio Generale dell' Ente Autonomo Volturno, Naples.

Manufacturers who are prepared to supply 600 km. (372 miles) copper wire 8 mm. dia. are invited to communicate with the Direzione dell' Ente Autonomo Volturno, Naples, who after two months from April 10 will send invitations to tender to firms whom they consider suitable.

Conditions of tender, &c. (*in* Italian) may be seen at 73, Basinghall-street, London, E.C.

TENDERS RECEIVED AND ACCEPTED.

St. Pancras (London) Council received the following tenders for supply of a 1,000 kw. generator to King's-road generating station:—

Bruce Peebles & Co. (*accepted*) **£2,500.** Crompton & Co. £2,236, Siemens Bros. Dynamo Works £2,240, British Westinghouse Co. £2,232, £2,390 and £3,163, Brush Co. £2,625, Electric Construction Co. £2,775, General Electric Co. £2,896, Dick, Kerr & Co. £3,140, J. H. Holmes & Co. £3,150, British Thomson-Houston Co. £3,191, Lancashire Dynamo and Motor Co. £3,207. 10s., Vickers Limited £3,754, Ernest Scott & Mountain £3,845, Rees Roturbo Mfg. Co. £4,020.

The electrical engineer (Mr. S. W. Baynes), in a report on the tenders, stated that the two best offers were those of Bruce Peebles & Co. and the second alternative of the British Westinghouse Co. Although the efficiencies of the British Westinghouse rotary would represent a saving in cost of running so far as coal consumption was concerned, the Bruce Peebles set would require fewer auxiliaries, and would consequently be less expensive to maintain, and would also be easier to manipulate. In comparing the cash prices of the two offers, extras to the switchgear to the value of £180 would have to be provided by the Council in the case of the British Westinghouse Co.'s offer, so that the two tenders would work out as follows: Bruce Peebles & Co. £2,500, British Westinghouse Co. £2,570

St. Pancras (London) Council have received the following tenders for supply of high-tension cables:—

Western Electric Co. (*accepted*) **£904. 2s.**, Standard Cable Co. £829. 19s., Aubert, Grenier & Co. £891, Johnson & Phillips £919. 12s., W. T. Henley's Co. £925, Siemens Bros. & Co. £933, British Insulated & Helsby Cables £941. 12s., Union Cable Co. £950. 19s., Felten & Guilleaume Carlswerke £955, W. T. Glover & Co. £957, Callender's Co. £968, General Electric Co. £1,053. 8s. 4d.

The Electricity and Public Lighting Committee, reporting on the tenders, stated that the works of the two lowest-mentioned tenders are situated abroad, and if either of the offers were accepted it would involve loss of time and expense for the electrical engineer to attend and test the cable before delivery.

St. Pancras (London) Council have also accepted the tender of the Albion Clay Co. for supply of stoneware ducts, at £297. 1s. 5d.

On Tuesday the London County Council were recommended to accept the tender of Walter Scott (Ltd.) for tramway rails at £9,700.

Some particulars of the other tenders received appeared in our issue of May 19 (page 232), and Mr. H. Ward moved that the recommendation be referred back so that the question of the acceptance of the lowest tender (for German rails) should be taken into consideration. He said that although half a dozen English firms were invited to tender, only one submitted a tender. After discussion the amendment was defeated and the Committee's recommendation adopted.

Hammersmith (London) Council have accepted the following tenders:—

Dorman, Long & Co., foundations for new turbo-generator, £36.0s.8d.; Ferranti (Ltd.), equipment of turbo-panel, £180; Pontifex & Co., street lanterns for metal filament lamps, £268. 15s.; British Thomson-Houston Co., "Tirrel" regulator, £105.

Ilford Council have accepted the tender of the Union Cable Co. for foreign-made cable at £1,304. There were seven tenders for British and four for foreign-made cable, and the lowest tender for British-made cable was stated to be £400 higher than the amount of the accepted tender.

Margate Council has accepted the tender of Kingston & Co. for wiring the new pavilion at £729. 15s. (There were 24 tenders, varying from £729. 15s. to £1,250.) The Council also has accepted the tender of Stuart & Moore for fire alarms at £32. 15s.

Kingston-on-Thames Council have accepted the tender of Siemens Bros. & Co. for 880 yd. 0·1 sq. in. l.t. cable at £185; and that of the Craigpark Electric Cable Co. for 440 yd. of 0·05 sq. in. h.t. cable at £73. 2s. 6d.

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The D.P. Battery Co. (Ltd.), of Bakewell, have secured the contract for the new storage battery at Aldershot.

Bristol Docks Committee have accepted the following tenders:—Railway & General Eng. Co., permanent way requirements; Johnson & Phillips, cables and wiring for new sheds at Royal Edward Dock; J. H. Tucker & Co., main switchboard, &c.; Simplex Conduits (Ltd.), conduits.

Rochdale Tramways Committee have accepted the tender of the J. G. Brill Co. for 10 pairs of tramcar trucks; that of the British Westinghouse Co. for magnetic brakes; and that of the Brush Co. for car bodies.

Stoke-on-Trent Council have accepted the tender of Siemens Bros. Dynamo Works for two 600 kw. motor generators at £2,385; and that of Callender's Co. for mains and feeders at £14,185.

Hull Electricity Committee have accepted the tender of J. T. Levitt (at £10,999) for extensions of the electricity station buildings and that of G. H. Panton & Son £799) for sub-station.

Bolton Tramways Committee have placed an order with E. Dewhurst for automatic tramway signals.

Barnstaple Council have accepted the tender of H. R. Williams & Co. for wiring the Rock Park bandstand at £29.

Blackpool Council have placed an order with J. W. Fielding & Co. for wiring the new Carnegie library.

Eccles Council have accepted the tender of Matthews & Yates for three cyclone electric fans for the Town Hall, with wiring, at £63.

Maidstone Council have placed an order with the Bambridge Patent Flexible Shaft Co. for a rail grinder at £54. 11s. 6d.

Barking Council have accepted the tender of A. E. Synes for the erection of extensions to the electricity station buildings, at £2,497.

Mixed-Pressure Turbine.—Queensland Railway Commissioners have placed an order with Willans & Robinson, of Rugby, for a 750kw Willans impulse-disc and drum turbine, with a General Electric Co.'s two-phase alternator and surface-condensing plant. The turbine will be capable of giving its normal full load with high-pressure steam or with any mixture of high-pressure and exhaust steam, and is intended for the Ipswich locomotive works of the Government railways.

Government Contracts.—The following tenders were accepted by British Government Departments during April:—

Admiralty.—Evered & Co., Gabriel & Co., General Electric Co., Ingram & Kemp, Sir J. Laing & Sons, W. McGeoch & Co. and Player & Mitchell, brackets, pendants, &c.; British Insulated & Helsby Cables, Edison & Swan Co., Evered & Co., India Rubber, Gutta Percha & Telegraph Works Co., W. McGeoch & Co., Sterling Telephone & Electric Co., Veritys Limited, A. Watson & Co. and Westminster Engineering Co., switches, sockets, &c.

War Office.—Tudor Accumulator Co., storage batteries; Brotherton Tubes & Conduits, Eureka Conduit & Fittings Co., Nettlefold & Sons, Perfecta Seamless Steel Tube & Conduits Co. and Simplex Conduits, conduit fittings.

India Office.—D.P. Battery Co., accumulators; British Insulated & Helsby Cables, cable; India Rubber, Gutta Percha & Telegraph Works Co., cable core, &c.; Veritys Limited, fans; Bullers Limited & Taylor, Tunnicliff & Co., insulators; British Westinghouse Co., motor, &c.

Crown Agents for the Colonies.—General Electric Co., electrical materials.

Office of Works.—J. C. Christie, electric bellhangers' work.

General Post Office.—Western Electric Co., telephone apparatus; Houghton's Limited, battery boxes; British Insulated & Helsby Cables and Johnson & Phillips, paper-core cables; Western Electric Co., s. & c. core cable; Siemens Bros. & Co. and Telegraph Construction & Maintenance Co., submarine cable; J. R. Crompton & Bros., tinfoiled condenser paper; J. C. Fuller & Son, flameproof wire; W. J. Furse & Co., electric lighting of new money order office, Holloway, London; British Insulated & Helsby Cables, local telephone exchange equipment at Wimbledon; Marconi's Wireless Telegraph Co., wireless telegraph power plant for Crookhaven.

BUSINESS NOTICES.

Messrs. W. T. Glover & Co. ask us to state that, owing to the resignation of Mr. Scott, of Glasgow, who has represented them for many years, they have appointed Mr. McEwan (who has for a considerable period represented them in the East of Scotland) as their sole resident representative for the whole of Scotland. They will continue to carry large stocks of rubber-insulated cables at Glasgow (196, St. Vincent-street) and Edinburgh (9, Clyde-street).

Walter Trevelyan Wright and Jas. Miller (trading as the Electric and Automatic Engineering Co. and the New Enterprise Co.), George-street and 1, Watts-place, Chatham, have dissolved partnership. Debts by Mr. Wright.

Geo. Bradwell, the younger, and Matt Jennison, electrical engineers, formerly of 4, St. Ann's-square, Manchester, and 77, Victoria-street South, Grimsby, have dissolved partnership. Debts by Mr. Jennison.

The Globe Electric Co. have taken up the manufacture of signs and have acquired additional space at 11, Farringdon-avenue, London, E.C.

General Electric and Westinghouse Interests.—It is announced that, as from April 30, the agreement relating to overlapping patents entered into in 1896 between the General Electric Co. of New York and the Westinghouse Electric & Mfg. Co. of America has expired, and, being considered no longer necessary, will not be renewed.

Sale by Auction.—By order of the receiver (Mr. G. E. Corfield) of the Ferabin Lamp and Electrical Accessories Co. (Ltd.), Mr. Frank G. Bowen will sell by auction on the premises, 41, New-street Mews, Dorset-square, London, W., on Wednesday, June 14, at 1 o'clock, the extensive stock, plant and machinery of electrical accessory manufacturers, including 3,000 battery cases, pendants, brackets and lanterns, glass shades and globes, electric bells and pushes, wire, casings, electric fittings, switches, lamps, lamp-carriers, eight electric motors, seven drilling machines, tools, &c. On view day prior to sale. Catalogues of Messrs. Corfield & Cripwell, Balfour House, Finsbury-pavement, London, E.C., on the premises; and of the Auctioneers, 62A, Aldersgate-street, London, E.C. See advertisement.

BANKRUPTCIES, LIQUIDATIONS, &c.

The first meeting of creditors of John D. Carlmark, electrical engineer, West Bromwich, was held at Birmingham on Friday.

The statement of affairs showed liabilities expected to rank £442.19s.6d. assets estimated £51. 15s. 6d., deficiency £391. 4s. Debtor began business without capital as an electrical engineer and electro-plater in 1899 partnership, which traded at first as the West Bromwich Electric Light & Power Co., and later as Richardson & Carlmark. No balance-sheets or profit and loss accounts were ever prepared beyond rough estimates, which were not retained. The partnership was dissolved in May, 1910, there being at that date a deficiency of assets to meet the firm's liabilities of about £280. Debtor had also private liabilities amounting to £80. The matter was left with the O.R.

A dividend is to be paid to creditors of A. C. A. Wampach, electrical engineer, Formby Lodge, Seabrook-road, Hythe. Claims to Mr. J. O. Morris, 68A, Castle-street, Canterbury, by June 10.

A meeting will be held at 10, Walbrook, London, E.C., on June 26 to receive an account of the winding-up of the Brockie-Pell Arc Lamp (Ltd.)

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked* are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application, an asterisk is affixed.*

April 5, 1911.

8,446 ELEV. Batteries.
8,460 BARTON & CARTER. Earthing device.
8,484 MARTYN. Bonding devices for electric cables and electric fittings. (Divide application on 9,921/10. April 23.)
8,489 BARDOUR. Control of alternating-current electric motors.
8,515 JOHNSON. Switches.
8,524 MACKU. Arrangement for producing slightly damped electric oscillations. (Convention date, 2/5/10, Austria.)*
8,530 STEVENS. Means for economically charging batteries from a supply at constant potential.

April 6, 1911.

8,585 CHIGER. Time switches.
8,589 CARRICK & GREENWOOD & BATLEY. Direct-current machines.
8,591 SIEMENS BROS. DYNAMO WORKS & LYDALL. Speed control of electric motors.
8,592 SIEMENS BROS. DYNAMO WORKS & KLOSS. Starting of alternating-current electric motors.

April 7, 1911.

8,656 ENGISCH. Brush for electric engines.
8,665 BARRON. Electrical toasting and like heating apparatus.
8,688 ROBINS & WALFORD-GROUT. Method of providing temporary auxiliary electric current in case of failure or partial failure of the main source of supply, and apparatus and appliances connected therewith.
8,710 WERNER. Sparking plugs.
8,712 GES. FUR DRAHTLOSE TELEGRAPHIE M.B.H. Arrangement for producing slightly damped electric oscillations. (Convention date, 2/11/10, Austria.)*
8,720 PECHIN. Rotary electric contacts.*

April 8, 1911.

8,767 DRUSEIDT. Switches. (Addition to 9,399/10.)*
8,783 LEWIS. Control systems for alternating-current electric motors. (Convention date, 9/4/10, United States.)*
8,798 BRULL. Electrically controlled grab hoisting gear. (Convention date, 10/10/10, Germany.)*
8,806 LODGE & ROBINSON. Wireless telegraphy.

April 10, 1911.

8,846 THOMSON. Hand and belt electric lamps.
8,853 TAYLOR. Changing the frequency of alternating-current systems.
8,890 DAVEY & CO. & TOWLER. Controlling gear for or connected with electrical driven hydraulic pumps.*
8,899 NICHOLSON & BROOKING. Electrically-controlled valves.
8,943 WOODS. Driving of alternating-current motors.

April 11, 1911.

8,951 STEEL, PEECH & TOZER & BOWEN. Electric magnetic lifting-appliances used with cranes. (Addition to 30,075/10.)
8,978 GOLDSCHMIDT. Intensifying of weak alternating currents. (Convention date, 11/4/10, Germany.)*

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Welch. Electrical indicators for railway signal lamps.
Mansbridge. Supporting shades or globes of electric or like lamps.
Luecke & Imperial Lamp Works (Brimsdown). Electric furnaces for treating metal filaments and method of manufacturing same.*
Lake. (Jacob Esdaile Florence, U.S.) Electric furnaces.*
Lake. (Weston Electrical Instrument Co., U.S.) Electrical measuring instruments.*
Pritchett's Patent Lighting Co., & Vidal. Electric switches.*
Chesswick & Bentham. Cartridge fuses for electrical purposes.*
Lebel & British Ever Ready Electrical Co. Portable electric lamps.*

April 12, 1911.

Fischer. Electric furnaces and the like.
Hecht & Dowdell. Arc lamps.
Midgley & Vanderveell. Dynamo-electric machinery.
Stone & Co. & Darker. Suspension devices for dynamo-electric machines.
Jensen. (Clement International Eng. Corpn., U.S.) Telephone exchange systems.*

SPECIFICATIONS PUBLISHED.

1910 Specifications.

Martin. Telephone systems.
Keith. Telephone systems.
Fales. Telephone systems.
Dicker. (Automatic Electric Co.) Telephone systems.
Hirst & Brook. Electric motor starting and controlling apparatus.
Booth & Booth. Installations of electric incandescent lamps connected in series.
Hatfield. Tramway points.
Sefton-Jones (Soc. pour l'exploitation des Brevets d'Aoguillage Samaia). Actuating the points of tramways.
B.T.-H. Co. & Gray. Electric incandescent lamps.
Crystal & British Vitrite Works. Manufacture of bases for electric lamps.
Cowper-Coles. Electro-deposition of iron.
Adams Mfg. Co. (Cutler Hammer Mfg. Co.) Controllers for electric motors.
Walker & Seaman. Apparatus for electro-plating.
Tree. Switches, cut-outs, and the like.
& 4,276 Adams Mfg. Co. (Cutler Hammer Mfg. Co.) Control systems for electric motors.
& 4,278 Adams Mfg. Co. (Cutler Hammer Mfg. Co.) Controlling electric motors.
Balachowsky & Caire. Regulation of dynamo-electric machines. (26/4/09. Addition to 23,742/02.)
Hasluck & Faye-Hansen. Protective apparatus for alternating-current distribution systems.
Gray. Electric ovens.
Barnell. Incandescent electric lamps. (21/4/09.)
Reil. Material for electrical insulation.

1911 Specifications.

Fischer. Connecting electric wires to lamp-holders.
Sievens Bros. Dynamo Works, Kieffer & Kloss. Ventilation of dynamo-electric machines. (Addition to 5,118/10.)
B.T.-H. Co. (G.E. Co., U.S.) Vapour electric devices.
7,877 & 7,878 Fales. Telephone systems. (Divided Application on 1,422/10.)
Breuasz. Arrangement for electrically transmitting compass positions to a distance. (31/3/10.)

COMPANIES' MEETINGS AND REPORTS.

ANGLO-PORTUGUESE TELEPHONE CO. (LTD.)—At the meeting on Tuesday Mr. H. Allen said that was the fourth time in succession they had paid 8 per cent. dividend with a closed capital account and a very progressive business. Having regard to the general position of affairs in Portugal it behoved them at the present time to keep their eyes on their resources. In their last 10 years their gross income had increased from £19,223 to £54,391; their gross profit from £4,967 to £21,614, and their net profit from £3,519 to £17,330. Their income in the last 10 years had increased nearly 200 per cent. and their profit nearly 500 per cent., and in the last five years their income had increased about 80 per cent. and their profit about the same. If they were given a little more latitude under their concession in the management of their business in Portugal, they could do even better. They had in common with other employers of labour in Portugal one or two strikes to trouble them. At Oporto in particular it looked at one time as if they should have serious trouble. Thanks, however, to the courageous and firm handling of the situation by the local manager (Mr. Street) the strike was effectually stamped out and their business in Oporto was now working normally. At Lisbon, he was given to understand, they had been rather more fortunate than some other employers of labour. They were carrying a larger sum to reserve (£ against £7,500), but they carried forward about £500 less.

BANBURY & DISTRICT ELECTRIC SUPPLY CO. (LTD.)—It was reported at the meeting last week that the total capital expenditure at Dec. 31 was £29,952. 12s. 5d. The year's revenue was £3,075. 15s. 10d., and after deducting expenditure (£1,968. 16s. 8d.) and adding balance forward there remained £1,113. 1s. 2d. The directors recommend a dividend of per cent. on the ordinary shares. The demand for electrical energy for lighting and power continues to increase, the equivalent of 20,867 8 c.p. lamps being connected, against 18,173 8 c.p. in 1909.

BIRMINGHAM & MIDLAND TRAMWAYS (LTD.)—The total revenue for 1910 was £102,618, compared with £99,713 for 1909. The expenses were £ against £48,710. After providing for all expenses chargeable to revenue, including repairs, maintenance, sums payable to corporations and £3,000 to renewals, there remains £45,915, added to £149 brought forward, making £46,064. Deducting interest on loans (£6,812) and interest on debenture stock (£15,178) the balance was £24,072. After providing £4,228 for debenture sinking fund and the preference dividend there remains £8,306. The directors recommend a dividend of per cent. on the preferred ordinary shares (£7,000), in placing £1,000 to depreciation and reserve, and to carry forward £306. The gross receipts from tramways were £48,025, against £46,477; and gross receipts from lighting and power £26,737, increase £6,942. The capital expenditure during 1910 was £31,017 (£444 on tramways and £30,573 on lighting). At the meeting on Wednesday the Chairman (Mr. C. S. B. Hilton) said they had made distinct progress and were able to recommend a slightly increased dividend. They had now turned the corner, and they looked forward to the future with a certain amount of confidence. The loan from the Shropshire Power Co. remained practically at the same figure, and the directors had decided to write down the investment in the Motor Omnibus Co. The traction section during the past four years had, in spite of all drawbacks, shown steady if somewhat slow growth, while the lighting section had more than justified the hopes he expressed last year, and shows largely-increased gross receipts and a satisfactory ratio of expenses. The electric light section had also increased from £8,303 to £26,737. The expenses of both sections had decreased, and the position generally showed good progress. That those improved results were not reflected in improved dividends to the extent they should like was chiefly due to the lower returns on their investments in other companies. He had to announce with much regret that their general manager (Mr. Cramp) had retired. He has been with the company for over 16 years, and during that period he had rendered valuable and ungrudging service to the company. They had parted with him with very great regret, but they had been fortunate in obtaining the services of Mr. W. G. Bond to replace him. Mr. Bond, until he took the position, was one of the directors, and therefore well known to them all. He had a knowledge of the business and an interest in it, and he was in every way qualified to succeed Mr. Cramp.

BRUSH ELECTRICAL ENGINEERING CO. (LTD.)—The directors' report for 1910 shows gross profit £28,200, but debiting general charges and maintenance, and debenture and other interest, there is an adverse balance of £10,800. The amount now standing to debit of profit and loss account (£61,100) and the fact that depreciation not yet provided for has taken place in certain of the company's investments point to the nesessity of an early re-organisation of the share capital.

CALLENDER'S CABLE & CONSTRUCTION CO. (LTD.)—The accounts for 1910 show a balance of £55,838. 11s. 10d., making, with £42,202. 9s. 10d. from 1909, £98,041. 1s. 8d. Deducting debenture interest (£13,500), preference dividend (£10,000) and depreciation of buildings, plant and machinery (£8,217. 12s. 7d.), the available balance is £66,323. An ordinary dividend of 10 per cent. (less tax) or 10s. per share (5s. paid in November) requires £17,500, and a bonus of 5s. per share (less tax) £8,750, carrying forward £40,073. 9s. 1d.

DEVONPORT & DISTRICT TRAMWAYS CO.—During 1910 £79. 14s. 5d. was expended on capital account, making the total £162,467. 14s. 11d. The total revenue for the year was £22,902. 1s. 1d., an increase of £3,155. 18s. over 1909, but expenses increased £1,401. 14s. 2d. Deducting all expenses, the surplus is £571. 17s. 11d., which is carried forward. The increase in receipts and expenses is partly due to the fact that the company is again working the lines leased from Devonport Corporation. The inspector appointed by the Board of Trade to test the meters measuring the energy purchased from the Corporation reported in November last that the meters were reading fast and ordered certain adjustments. Meters have been fixed on all the company's cars, and as a result of the more careful driving there is a substantial reduction in the amount of electrical energy consumed.

HONG KONG ELECTRIC CO. (LTD.)—At the recent meeting, Mr. J. W. C. Bonnar said the result of the past year's working had been satisfactory, showing a balance of $177,716·10, compared with $169,595·48. In view of the increased use of metal filament lamps and of the rebates given to large consumers that result must be gratifying to them. That had led the directors to consider the advisability of purchasing another Diesel engine to meet the increasing demand for current, and they expected shortly to place an order for a larger engine than those at the station. They proposed to pay a dividend of 12 per cent. and a bonus of 1 per cent. The sum set aside for depreciation was large, but it was necessary. The efficiency of the company depended largely on their keeping up to date.

JOHNSON & PHILLIPS (LTD.)—Mr. Robt. W. Blackwell, presiding at the meeting last week, said the balance-sheet marked a distinct advance over the position to which the company was brought by the bad business of several succeeding years. They suggested that a considerable sum should be written off for depreciations during the present year, owing to the fact that during the period of their greatest depression, some three years ago, some question arose as to whether they had properly and sufficiently seen to those items. As to the general business of the company, he thought they could fairly say that the corner had been well and safely turned, and if the conditions of business in the country continued as seemed likely, he thought Johnson & Phillips could look forward to a substantial business year by year. During the whole time of the depression nothing had been neglected to strengthen the position of the company's works. They had done everything that was required to maintain them, to throw out old machinery and to bring in new and better materials, and their shops and works in general were in a better condition to-day than they had been since be became connected with the board. In their cable works, and in the shops where they made machinery for the manufacture of cables, they had been practically full all the year round, and the turnover of the business had only been exceeded once during its existence as a company The amount of business in hand at present was very large. They had in hand in the works in uncompleted orders a sum of £77,508, which was some £30,000 more than they had in the same month last year. He referred with regret to the death of Mr. Bonner, and announced that Sir Henry Benbow, who had also been a member of the board since the registration of the company, had resigned.

Mr. Thos. Dence, who seconded the motion for the adoption of the report and accounts, said that the company enjoyed a splendid reputation, equal, for the quality of their manufactures, to that of any of their competitors. They had amongst their customers practically all depart-

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ments of the British Government and many foreign Governments, as well as British and foreign railways, electric lighting companies and other first-class companies and firms, from whom they received regular orders, and amongst whom their reputation stood unquestioned. During the first three months of the present year the amount of business done constituted a record, and they had at present sufficient orders and contracts in hand to keep the various manufacturing departments employed for the next six months. They should have further working capital to enable them to carry out to the best advantage the numerous orders and contracts on hand, but they were unable to raise it by any fresh issue of stock which would have to rank behind their debentures. Therefore they used the net profit to strengthen their financial position. Had the average annual profits of Johnson & Phillips (Ltd.) during the first few years of the company's history been equal to the last years of the firm from whom they purchased, the burden could have been borne without serious detriment, but, unfortunately, there came a period of depression in the electrical trade, and their company had felt the effects most severely.

KALGOORLIE ELECTRIC POWER & LIGHTING CORPN. (LTD.)—At the meeting on Wednesday the chairman (Mr. R. W. Wallace, K.C.) said that during the past year there had been one or two drawbacks. There had been a fire at the Great Boulder Perseverance Co.'s mine. That company was their principal customer, and owing to the fire the supply of electricity to the mine was stopped. Nevertheless, they had succeeded in increasing their revenue, and that was largely due to the board's policy of putting down new plant and maintaining the old plant from the first in an efficient condition. The new unit was working satisfactorily, and now that the Great Boulder Perseverance mine was being operated again they were supplying a larger load than during any previous month. For April last their profit was double that for the corresponding month of 1910, and their prospects for the current year were extremely good.

LEWES & DISTRICT ELECTRIC SUPPLY CO. (LTD.)—Capital expenditure during 1910 was £314. 18s. 10d., making, with £31,054. 15s. 8d. previously expended, a total of £31,369. 14s. 6d. Revenue amounted to £2,633. 9s. (an increase of £231. 5s. 7d. over 1909), and all expenses to £2,030. 9s. 1d., leaving £602. 19s. 11d. The demand for electrical energy for lighting and power continues to increase steadily, and the equivalent of 15,457 8 c.p. was connected, against 14,116 8 c.p. in 1909.

POTTERIES ELECTRIC TRACTION CO. (LTD.)—At the meeting on Monday Mr. G. F. M. Cornwallis-West said that the net result of the year's working was that they had increased their profits by £164 compared with 1909. Traffic receipts increased £418, parcels receipts £250, advertising receipts £23, sundry receipts £451, and interest on their holding in the North Staffordshire Tramways Co. £1,156. The total increase in receipts was £2,298. They had carried 524,162 fewer passengers, but had received a slightly higher fare per passenger (1·24d. against 1·2d.) The "fair fare" system was not a success from the point of view either of the public or of the company. They ran 29,800 miles more than last year. Repairs and maintenance increased by £1,690, over 81,000 of which was accounted for by the increased expenditure on permanent way.

RIO DE JANEIRO TRAMWAYS, LIGHT & POWER CO. (LTD).—The gross earnings of the company's tramway, electric light and power, gas and telephone undertakings in April were £211,667 (increase £42,098). The aggregate from Jan. 1 was £809,356 (increase £155,765).

URBAN ELECTRIC SUPPLY CO. (LTD.)—At the meeting on Wednesday Mr. P. D. Tuckett said that in a year in which few electric supply undertakings had shown any marked increase in profits there was no occasion to be dissatisfied with an increase of £2,403. The profits earned by the various undertakings amounted to £47,253, against £44,849, and the net balance was £44,911. During the year, instead of the estimated output of 5,800,000 units at 5½d. per unit, they had sold less than half that number for private lighting, whilst the 6,100,000 units which they had sold for power only realised an average of 1·07d. per unit. With regard to the tramway load, they would have been better off without it.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES, &c,

NEW COMPANIES.

A. L. P. SYND. (LTD.) (116,021.)—Reg. May 25, capital £20,000 in £1 shares (10,000 preference), to construct, maintain and work tramways and railways in Buenos Aires and La Plata. Private company.

ASSOCIATED FIRE ALARMS (LTD.) (116,004.)—Reg. May 24, capital £160,000 in 60,000 preference shares of £1 each and 400,009 ordinary shares of 5s. each, to carry on the business of manufacturers of fire indicators, extinguishers, escapes and engines, and other implements and machinery, &c., and to acquire and amalgamate the undertakings of the Pearson Fire Alarm (Ltd.) and the May-Oatway Fire Appliances (Ltd.) First directors, G. H. Brown, J. Heal, E. W. Elliott, H. C. Hall, A. Hair and A. D. Fairbairn. Reg. office, Jewin House, Redcross-street, London, E.C.

ELECTRO-FLEX STEEL CO. (LTD.) (115,987.)—Reg. May 23, capital £25,000 in £1 shares, to acquire any inventions relating to electric furnaces, the electrical smelting of ores and the refining of metals or to electric batteries, electro-chemical or electro-thermal processes, &c. Private company. Reg. office, 86, Collingwood Buildings, Collingwood-street, Newcastle-on-Tyne.

ENGINEERING & ARC LAMPS (LTD.) (116,030.)—Reg. May 25, capital £3,000 in £1 shares, to take over the arc lamp manufacturing and engineering businesses carried on at Chingford and St. Albans, together with certain rights and properties connected therewith, and to adopt agreements with the Gilbert Arc Lamp Co. (Ltd.) and J. S. Hecht. Private company. First directors, J. S. Hecht (chairman), C. E. Gilbert and W. J. Davy.

JAMES J. GUEST & CO. (LTD.) (115,993.)—Reg. May 23, capital £20,000 in £1 shares, to adopt an agreement with J. J. Guest for the acquisition of the business of a mechanical and electrical engineer and manufacturer of grinding machines. Private company.

PATENT SERIES LIGHTING CO. (LTD.) (115,997.)—Reg. May 23, capital £5,000 in £1 shares, to carry on the business of an electric light company, &c. Private company. First directors, E Booth and N. R. Booth.

TELEPHONE DISINFECTING CO. (LTD.) (116,001.)—Reg. May 23, capital £2,000 in 1,980 ordinary shares of £1 each and 400 deferred shares of 1s. each, to carry on the business indicated by the title. Private company. First directors, C. E. Evans and A. E. Withers. Reg. offices Finsbury Chambers, Finsbury-pavement, London, E.C.

STATUTORY RETURN.

METROPOLITAN ELECTRIC SUPPLY) CO. (LTD.)—In the return to March 28 capital is £1,500,000 in £5 shares (100,000 preference). 200,000 ordinary and 76,121 preference shares taken up. £5 per share called up on 195,936 ordinary and 76,121 preference. £1,360,285 paid, £20,320 considered as paid on 4,064 shares. Mortgages and charges, £498,000.

MORTGAGES AND CHARGES.

DAVIS ELECTRICAL CO. (LTD.)—Particulars of £2,000 debentures, created May 16, have been filed, amount of present issue being £1,100. Property charged, company's undertaking and property, present and future, including uncalled capital (subject to £2,000 first mortgage debentures). No trustees.

ENGLISH ELECTRICAL CO. (LTD.)—Issue on May 11 of £1,000 debentures, part of a series of which particulars have been filed.

CITY NOTES.

MEMORANDA (June 1).—**Bank rate 3 per cent. (March 9, 1911). Price of silver, 24 ⅝d. per oz. Consols 81⅛—81⅛ for money and 81⅛—81⅜ for account. Consols Pay Day, July 3; Stock and Shares Continuation Days, June 13 and 28; Ticket Days, June 14 and 29; Pay Days June 15 and 30; Mining Shares Carry Over Day, June 12.**

PRICES OF METALS (London).—*Copper*, cash, 55⅞; three months 55⅛. *Lead*, English, 13⅜—13⅝; foreign, 13⅛—13⅜. *Spelter*, 24⅛—24⅜. *Tin*, English, 196½—197½; foreign, 210 cash, 190 three months. *Iron*, Cleveland, cash, 46/5, three months, 47/2.

ADELAIDE ELECTRIC SUPPLY CO. (LTD.)—The directors have declared an interim dividend of 3s. 6d. per share, less tax, on the ordinary shares.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—The number of units delivered to consumers during the five weeks ended March 31 were 801,705 compared with 743,651 units in the corresponding period of 1910. For the four weeks to April 28 the units were 787,233, against 780,51 in 1910.

COMPANIES TO BE STRUCK OFF THE REGISTER.—The following will b struck off the Register of Joint Stock Companies unless cause is shown t the contrary before Aug. 30:—

Amalgamated Dry Batteries, Edison-Gower Bell Telephone Co. (reg Sept. 1, 1898), Elmore's American and Canadian Patent Copper Deposit ing Co. Elmore's Foreign and Colonial Patent Copper Depositing Co Elmore's Patent Copper Depositing Co., Elmore's Wire Mfg. Co., South Western Electrical Co.

MACKAY COMPANIES.—The regular quarterly dividends of 1 per cent on the preferred and of 1¼ per cent. on the common shares in the Macka Companies will be paid on July 1 to shareholders of record as they appe at the close of business June 10. The transfer books will not be closed.

METROPOLITAN RAILWAY CO.—Mr. F. McLaren, M.P., has bee elected a director in succession to the late Sir Wm. Birt.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee hav appointed June 15 a special settling day in and have granted a quotatio to a further issue of £600,000 5 per cent. 50-year mortgage bonds of th *Rio de Janeiro Tramway, Light & Power Co.*, and have granted quotation to a further issue of £50,000 4½ per cent. debenture stock of the *County London Electric Supply Co. (Ltd.)*, $1,847,000 additional consolidate mortgage 5 per cent. 50-year coupon bonds of 1952 of the *Havana Electr Railway Co.*, and a further issue of £27,000 4½ per cent. first mortga prior lien gold bonds of the *Montreal Water & Power Co.* The com mittee have been asked to appoint a special settling day in, and granted quotation to £61,400 4¼ per cent. debentures, 1934, of the *Christchur Tramway Board*, and also to allow a further issue of £205,480 4½ per cen perpetual consolidated mortgage debenture stock of the *Shawinig Water & Power Co.* to be quoted.

WESTERN TELEGRAPH CO. (LTD.)—The directors have declared th third quarterly interim dividend of 3s. per share (tax free) for th year ending 30th inst., being at rate of 6 per cent. per annum. Th transfer books will be closed from June 14 to 20 inclusive, and t dividend will be payable on June 21.

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ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	May 24	1,435	— 4	51	70,976	+ 2,120
Airdrie	„ 19	221	— 18	20	4,222	— 56
Anglo-Argentine	„ 27	49,532	— 1,849	21	1,041,367	+ 113,484
Ashton-under-Lyne	„ 27	425	+ 15	9	3,733	+ 282
Ayr Corporation	„ 27	298	+ 19	2	496	+ 23
Barnsley	„ 19	188	— 16	20	3,502	+ 96
Barrow	„ 19	272	— 95	20	4,893	+ 205
Bath Electric Trams, Ltd...	„ 24	882	— 189	21	15,469	— 173
Birmingham Corporation ..	..	..	..	..	..	..
Birmingham & Midland.....	„ 19	896	— 347	20	17,452	+ 984
Blackpool and Fleetwood ..	„ 27	454	+ 296	..	..	..
Blackburn Corporation	„ 24	1,217	— 22	†9	10,085	+ 613
Bolton Corporation.....	„ 28	2,617	+ 314	9	21,396	+ 1,715
Bombay	April 28	2,862	+ 75	17	48,623	+ 2,528
Bournemouth Corporation..	May 24	1,570	— 136	‡8	13,088	+ 96
Bradford Corporation.....	„ 27	5,525	+ 414	8	44,648	+ 2,685
Brighton Corporation.....	„ 28	1,190	+ 275	¶8	8,039	+ 493
Bristol Trams & Carriage ..	„ 26	6,399	+ 270	8	49,963	+ 2,951
Burnley Corporation	„ 27	1,418	+ 210	8	11,001	+ 1,008
Burton Corporation	„ 28	268	+ 29	8	2,198	+ 27
Bury Corporation	„ 28	1,302	+ 69	¶8	10,584	+ 689
Calcutta Tramways Co.....	„ 27	₹53,666	+ ₹4,610	21	₹1,212,132	+ ₹33,826
Camborne-Redruth	„ 27	120	— 22	21	2,513	— 110
Cardiff Corporation.....	„ 20	2,335	— 301	7	16,689	+ 815
Carnforth.....	„ 19	82	— 76	20	1,444	— 83
Central London Railway ..	„ 27	5,011	— 1,047	21	109,668	— 8,245
Chatham & Dist. Lt. Rys. ..	„ 25	829	— 151	21	16,258	— 230
City & South London Rly...	„ 28	2,990	+ 31	21	70,834	+ 2,503
City of Birmingham	„ 19	3,049	— 514	20	57,215	+ 732
Clyde Electric Trams Co.....	„ 25	582	— 30	21	9,535	— 8
Devonport & Dist. Trams ..	„ 19	471	— 42	20	8,738	+ 674
Dover Corporation	„ 27	241	+ 49	8	1,859	+ 240
Dublin & Lucan Railway ..	„ 26	155	+ 2	21	2,502	— 90
Dublin United	„ 26	6,133	— 110	21	109,450	+ 842
Dudley-Stourbridge	„ 19	832	— 521	20	15,269	+ 707
Dundee Corporation	..	..	..	..	..	..
East Ham Council	„ 27	1,100	+ 75	8	8,679	+ 319
Exeter Corporation.....	„ 26	352	+ 29	8	2,607	+ 73
Gateshead & Dist. Trams ..	„ 19	1,024	— 24	20	19,832	+ 926
Glasgow Corporation	„ 27	20,953	+ 2,151	52	935,180	+ 52,025
Grimsby Trams.....	„ 27	123	— 2	21	2,449	+ 112
Gloucester Corpn.....	..	..	..	..	..	..
Gravesend-Northfleet.....	„ 19	201	— 95	20	3,729	— 82
Great Northern & City Rly..	„ 27	1,436	+ 79	21	32,499	+ 1,329
Greenock & Port Glasgow ..	„ 19	782	+ 29	20	12,759	+ 1,720
Halifax Corporation	„ 23	1,939	— 67	†8	14,508	+ 946
Hartlepool Tramways	„ 19	247	— 55	20	4 423	+ 170
Hastings Elec. Trams Co..	„ 25	929	— 117	..	..	..
Hong Kong	„ 27	$8,074	— $969	21	$191,097	— $4,106
Huddersfield Corpn.	„ 27	1,931	— 271	8	15,393	+ 1,455
Hull Corporation.....	„ 27	2,757	+ 169	8	23,003	+ 951
Ilford District Council.....	„ 27	551	+ 14	8	4,523	+ 150
Ilkeston District Council ..	„ 24	133	— 5	8	1,048	+ 50
Ipswich Corporation	„ 27	423	+ 42	8	3,345	+ 246
Isle of Thanet Co.	„ 27	573	+ 86	34	11,457	+ 255
Jarrow	„ 19	142	— 23	20	2,380	+ 120
Keighley Corporation.....	„ 25	201	+ 12	8	1,902	+ 101
Kidderminster & District ..	„ 19	101	— 143	20	1,812	+ 51
Kilmarnock Corporation ..	„ 27	157	+ 16	2	277	— 15
Lancaster Corporation	„ 24	289	+ 26	8	2,372	+ 281
Lancashire Trams Co.	„ 25	1,478	— 71	21	28,582	+ 212
Lancashire United	„ 24	1,393	— 380	21	26,497	+ 191
Leamington	„ 19	156	— 93	20	2,760	— 175
Leeds Corporation	„ 27	7,632	+ 654	8	60,720	+ 4,104
Leicester Corporation.....	„ 27	2,639	+ 382	8	20,223	+ 1,481
Leith Corporation	„ 27	694	+ 45	¶2	1,149	+ 48
Lincoln Corporation	„ 27	124	+ 13	8	1,073	+ 61
Liverpool Corporation	„ 20	11,524	— 717	20	220.793	+ 6,254
Liverpool Overhead Rly. ..	„ 23	1,435	+ 45	21	29,595	+ 1,515
Llandudno&Colwyn Bay Ry.	„ 26	213	— 95	¶25	3,908	— 217
Lancs. County Council	„ 17	44,138	— 3,803	‡7	224,633	+ 16,170
London Elec. Ry. Co.....	„ 27	13,305	+ 590	21	294,185	+ 13,450
London United	„ 27	7,449	+ 115	21	123,307	— 1,307
Lowestoft Corporation	„ 27	173	+ 5	34	5,229	+ 161
Manchester Corporation...	„ 27	16,588	+ 371	8	131,817	+ 8,000
Mansfield	..	..	..	..	..	..
Metropolitan Dist. Railway..	„ 19	201	— 112	20	3,853	— 24
Metropolitan Elec. Trams ..	„ 27	11,912	+ 1,074	21	246.342	+ 16,207
Middleton	„ 19	8,771	— 2,598	20	160,512	+ 20,833
Midland Corporation.....	„ 19	334	— 91	20	6,018	+ 366
Middlesbrough-Tees Corp. ..	„ 27	188	+ 49	$8	1,481	+ 327
Newport (Mon.)	„ 29	4,105	+ 355	8	33,716	+ 2,357
New Brighton Corporation..	„ 27	709	+ 42	8	5,899	+ 225
Nelson, Colne & Hyde	„ 26	526	+ 40	8	4,123	+ 196
Nelson Corporation	„ 19	566	— 110	20	10,827	+ 256
North (W.A.) Elec. Trams ..	„ 28	2,030	+ 182	9	18,202	+ 836
North (W.A.) Elec. Trams ..	„ 24	182	+ 1	1	228	— 18
Nottingham	„ 26	1,513	+ 47	21	34,413	+ 1,670
Oldham Corporation	„ 19	110	— 80	20	2,110	+ 46
Paisley	„ 27	2,102	+ 29	8	16,333	+ 573
Perth Corporation	„ 19	1,940	— 67	20	37,760	+ 3,320
Portsmouth Corporation...	„ 24	751	+ 14	8	6,009	+ 201
Railway	„ 25	659	+ 69	8	5,307	+ 416
Rawtenstall Corporation	„ 19	141	— 23	20	1,525	— 43
Rhyl Trams	„ 29	5,039	+ 603	$8	40,850	+ 2,126
Rochdale Corporation	„ 19	46	— 11	20	884	— 8
Rotherham Trams	„ 27	6,533	+ 823	9	58,151	+ 3,059
Salford Metropolitan	„ 27	$9,191	— $79	21	$217,497	+ $9,614
Sheffield	„ 19	872	— 477	20	14,955	— 182
Shrewsbury Corporation	„ 19	883	— 333	20	17,309	+ 1,040
Southend Corporation	„ 24	1,098	— 72	8	8,654	+ 370
Southport Tramways	„ 24	570	— 8	8	4,263	+ 432
South Staffs Hyde &c., Jt. Bd.	„ 19	313	— 205	20	5,007	— 79
Southampton Corporation...	„ 27	809	+ 11	8	6,539	+ 694
Southend District	„ 28	1,283	+ 194	8	9,938	+ 778
Stockport Trams	„ 24	438	+ 12	30	13,227	+ 831
Sunderland Corporation	„ 19	1,070	— 375	20	21,066	+ 1,008
Swansea Trams	„ 24	147	— 6	8	1,145	+ 71
Todmorden and District....	„ 19	43	— 10	20	773	— 15
Torquay Trams Co.	„ 19	197	— 249	20	3,296	— 90
Tynemouth Corporation	„ 24	469	+ 3	21	8,750	+ 527
Wallasey Corporation.....	„ 27	1,118	+ 212	8	8,778	+ 1,319
Warrington Corporation	„ 27	555	+ 60	21	11,415	+ 183
Wednesbury Corporation	„ 25	396	+ 25	8	3,116	+ 129
Weymouth-Maree	„ 25	2,659	+ 133	8	21,351	+ 1,920
Wigan Corporation	„ 19	107	— 240	20	909	— 285
Wimbledon Corpn.	„ 19	440	— 249	20	8,427	+ 203
Wisbech	„ 24	940	+ 39	8	7,619	+ 365
Wolverhampton W.R. Trams ..	„ 19	289	— 134	20	5,042	— 35
Worcester Corporation	„ 19	98	— 43	20	1,852	— 21
Yorkshire Woollen District ..	„ 28	1,272	+ 131	22	27,464	+ 415
	19	1,068	— 258	20	19,955	+ 1,033

These comparisons are with the corresponding period last year. * Partly electrical.
† Minus 3 days. ‡ Minus 2 days. ‖ Plus 3 days. ¶ Plus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Share	Last Dividend	NAME.	Price Wed., May 31.	*Rate per cent. Yielded.	Dividend Due.	Business Week to May 31. Highest.	Business Week to May 31. Lowest.
		Electricity Supply.		£ s. d.			
10	6/0	Bournemouth & Poole Elec. Sup. Ord.	8 —9	6 9 6	Mar, Sep	8½	
10	4/6	Do. 4½ per Cent. Cum. Pref.	9 —10	4 14 6	Feb, Aug	9½	
10	6/0	Do. 6 per Cent. Cum. Second Pref.	10½—10¾	5 6 6	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	102 —104	4 6 6	Jan, July	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	7¼—8¼	6 1 6	March....	8¼	..
5	3/6	Do. 7 per Cent. Pref.	7¼—8	4 1 3	Mar, Sept	..	..
St.	4%	†Central Elec. Sup. Co. 4% Guar. Deb. Stock	98 —101	4 0 6	June, Dec	100½	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	3¾—4⅜	5 2 6	Feb, Aug	4 1/16	..
5	2/3	Do. 4½ per Cent. Pref.	4¼—4½	5 0 0	Feb., Aug	4 1/16	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	96 —98	4 1 6	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101½—103½	4 7 0	..	102½	..
St.	5%	Do. City Undertaking 4½% Cum. Pref.	3⅞—4⅜	5 3 0	Jan, July	3 31/32	..
5	3/0	Chelsea Electric Supply Ord.	4 —4⅜	5 11 0	March	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	100 —102	4 8 6	June, Dec	..	..
10	8/0	City of London Electric Lighting Ord.	11¾—12¼	4 15 0	Feb, Aug	12⅜	11
10	6/0	Do. 6 per Cent. Cum. Pref.	12 —13	4 12 3	Jan, July	..	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	120 —124	4 2 0	June, Dec	123	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	101 —104	4 6 6	Jan, July	..	..
St.	5%	County of Durham Elec. P. D. 5% 1st Mort. Deb. Stk.	92 —94	5 5 3	Jan, July	..	..
10	6/0	County of London Elec. Supply Ord.	7⅛—8⅛	6 3 0	Feb, Aug	7⅛	7
10	6/0	Do. 6 per Cent. Cum. Pref.	10⅞—11⅜	5 5 6	Mar, Sept	11 5/16	11
St.	4½%	Do. 4½ per Cent. Deb Stock (red.)	109 —111	4 2 0	Jan, July	..	..
St.	4½%	Do. Second Deb. Stock	99 —102	4 8 0	May, Nov	..	..
5	4/0	Folkestone Electricity Supply Co. Ord.	4⅛—4⅜	5 19 0	April, Oct	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅛—5⅛	4 15 3	Mar, Sept	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red)	97 —100	4 10 0	Feb, Aug	..	..
5	5/0	Hove Electric Lighting Ord.	6⅞—7⅛	6 4 0	April, Oct	..	..
St.	4½%	Isle of Wight E. L. & P. Co. Deb. Stk.	88 —91	4 19 0	..	..	..
5	5/0	Kensington & Knightsbridge Ord.	7 —7⅛	5 16 0	Feb, Aug	..	..
5	6%	Do. 6 per Cent. 1st Pref.	5⅞—6	5 0 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	93 —95	4 4 0	..	..	..
St.	4%	Kensington & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	96 —99	4 1 0	April, Oct	..	..
St.	4½%	Kent Elec. Power Co. Irred Deb. Stk.	80 —84	5 7 0	Jan, July	..	..
3	1/2⅓	London Electric Supply Ord.	1⅞—2⅛	2 17 0	Mar, Sept	..	..
5	3/0	Do. 6 per Cent. Pref.	4⅛—5⅛	5 17 0	Mar, Sept	4⅛	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb	91 —94	4 5 0	Jan, July	92	..
5	3/0	Metropolitan Electric Sup. Ord.	3⅜—4⅛	5 14 0	April, Oct	3⅛	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	4⅛—4⅜	5 14 9	Jan, July	4 1/16	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	101 —104	4 6 6	June, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	86 —89	3 18 6	Jan, July	..	..
..	4½%	Midland Elec. Corp. for Power Dist. 4½ 1st Mort. Debs.	97 —99	4 11 0	..	..	..
5	2/6	Newcastle Elec. Supply Ord.	3¾—4⅛	4 14 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non Cum. Pref.	4 —4½	5 11 0	Feb, Aug	..	..
100	4½%	Do. 4½ per Cent. 1st Mort. Deb.	98 —100	4 10 0	Jan, July	..	..
100	5%	North Metro. Elec. Power Sup. 5 Morts.	99 —102	5 0 6	..	100	..
1	6%	Northampton Elec. Lt. & P. Ord.	1¼—1⅝	4 11 6	Feb, Aug	..	..
1	5%	Do. 5% Pref.	1⅜—1⅝	4 6 0	Feb, Aug	..	..
St.	4%	Do. 4% Debs.	99 —101	3 19 0	June, Dec	..	..
10	10/0	Notting Hill Electric Ord.	12 —12½	5 17 6	March	12	..
5	4/3	Oxford Electric Ord.	6 —6½	5 11 6	March	7⅛	..
St.	4%	Do. 4% Deb. Stk.	93 —96	..	..	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	8¼—9¼	5 8 0	Feb, Aug	..	..
5	3/6	Do. 7 per Cent. Pref.	6¼—7¼	4 16 6	Feb, Aug	7 1/16	..
St.	3½%	Do 3½ per Cent. Deb. Stock (red.)	86 —88	3 19 6	Jan, July	..	..
5	..	Smithfield Markets Electric Sup. Ord.	1⅜—1⅝	..	Feb.	..	..
5	4/0	South London Electric Supply Ord.	3 —3⅛	6 3 0	April	3	..
St.	5%	Do 5 % 1st Mort. Stock (red.)	101 —104	4 16 0	..	..	..
1	8⅓	South Metrop'n Elec. Lt & Power 7% 1st Pref	1¼—1½	5 18 0	Feb, Aug	..	..
1	7½	Do. 6 per Cent. 2nd Pref.	⅝—¾	6 17 0	Feb, Aug	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	97 —100	4 11 6	April, Oct	..	..
5	1/3	Urban Electric Supply Ord.	¾—1	..	April, Oct	..	..
5	1/3	Do. 5 per Cent. Cum. Pref.	2⅓—3	8⅓ 6 0	April, Oct	2⅜	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	87 —89	5 2 3	April, Oct	88½	87
5	5/0	Westminster Elec. Sup. Ord.	7⅛—8⅛	6 5 0	Mar, Sept	8	7⅛
5	2/3	Do. 4½ per Cent. Cum. Pref.	5 —5⅛	4 3 6	Jan, July	5 1/16	5⅛
		Electric Railways and Tramways.					
1	..	Bath Elec. Trams Pref. Ord.	⅛—¼	..	April	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	⅛—¼	6 13 6	Jan, July	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	79 —83	5 8 6	April, Oct	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Deb. Stock.	90½—92½	4 17 3	Jan, July	92½	91
10	4%	Bristol Tramways & Carriage Ord.	7 —7⅛	5 10 3	Feb, Aug	..	..
10	4%	Do. Cum. Pref.	7⅛—7⅛	5 6 9	..	..	..
St.	4%	Do. 4 per Cent. Debs.	101 —102	3 18 3	Feb, Aug	..	..
10	..	British Electric Traction Ord.	1⅛—1⅜	..	June, Dec	1⅛	1
10	..	Do. 6 per Cent. Cum. Pref.	4 —4½	..	Feb, Aug	4⅛	4
St.	5%	Do. 5 per Cent. Perpetual Debs.	94 —98	5 2 0	April, Oct	96½	96
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock.	75 —80	5 12 3	May, Nov	..	..
St.	3%	Central London Ordinary Stock	73 —75	4 1 0	Feb, Aug	75½	73
St.	4%	Do. 4 per Cent. Pref. Stock	87 —89	4 10 0	Feb, Aug	88½	..
St.	2%	Do. Deferred Stock	62 —64	3 3 6	Feb.	66½	62
100	4%	Do. 4 per Cent. Debs.	104 —105	3 16 0	Jan, July	..	..
5	2/6	City of Birmingham Trams, 5 % Cum. Pref.	4¾—5	5 0 0	April, Oct	..	..
100	4%	Do 4 per Cent. 1st Mort. Debs.	99 —102	3 18 9	April, Oct	..	..
St.	1½%	City & South London Rly. Con. Ord.	33 —3⅛	4 9 6	Feb, Aug	3⅛	32
St.	5%	Do. 5 per cent. Perp. Pref. (1891)	109 —111	4 10 0	Feb, Aug	111	..
St.	5%	Do. (1896)	104 —106	4 12 6	Feb, Aug	..	..
St.	5%	Do. (1901)	103 —106	4 15 6	Feb, Aug	..	..
St.	5%	Do. (1903)	103 —105	4 15 6	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	101 —103	3 18 6	May, Nov	..	..
10	6/0	Dublin United Trams, 6 per Cent. Pref.	12½—13½	4 10 6	Feb, Aug	..	..
10	12/0	Gateshead and District Trams Ord.	8⅛—8⅜	6 19 6	..	..	..
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	¾—1⅛	..	Feb, Aug	..	..
5	..	Hastings & District Elec. Trams, 6% C. P.	1⅝—2	..	Mar. Sept	..	..
St.	4½%	Do. 4½ Deb. Stock	75 —80	5 10 0	April, Oct	..	..
10	..	Imperial Tramways Ord.	3 —3⅛	..	Mar, Sept	..	..
10	..	‡Do. 6 per Cent. Pref.	4⅛—4⅜	..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Debs.	71 —73	6 5 0	Jan, July	..	..
..	2/6	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	2¼—2⅜	5 5 0	Mar, Sept.	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	79 —84	4 15 0	Jan, July	..	..
10	6/0	Lanarkshire Tramways	9⅞—10⅛	5 12 3	Feb, Aug	..	..
St.	5%	Lancs Utd. Trams, 5% Prior Lien Deb. Stk.	82 —84	5 19 0	Jan, July	..	..
St.	4%	London Electric 4% Deb. St.	98 —100	4 0 0	..	..	..
St.	4%	Do. 4% Pref.	84 —85	4 14 0	..	99½	99
10	..	London United Trams, 5% Cum. Pref.	3¾—4⅛	..	..	85½	84½
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock.	76 —79	5 3 0	Jan, July	4 1/16	4
St.	..	Mersey Con. Ord. Stock	6 —8	..	Jan, July	77½	76
1	1/1⅓	Metropolitan Elec. Tramways Ord.	⅝—1 1/16	6 0 0	Feb, Aug	..	..
1	..	Do. Deferred	⅛—⅜	..	..	1	..
1	0/6	Do. 5 per Cent. Cum. Pref.	⅜—1 1/16	5 0 0	April	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock.	102½—104½	4 7 0	Feb, Aug	1 1/16	..
St.	5%	Do 5 per Cent. Db. Stk	103½—103¾	4 18 0	Jan, July	104	102
St.	1½%	Metropolitan Railway Consolidated	51 —51½	2 13 3	..	103½	..
St.	2½%	Do. Surplus Lands Stocks	68 —70	3 19 6	Feb, Aug	51½	51
St.	3½%	Do. 3½ per Cent. Preference	90 —92	3 16 0	Feb, Aug	69½	67
St.	3½%	Do. 3½ per Cent. "A" Preference	89 —91	3 17 0	Feb, Aug	90½	..
St.	3½%	Do. 3½ per Cent. Convertible Pref.	89 —91	3 17 0	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Debenture Stock	93 —95	3 13 6	Feb, Aug	95½	90
						94½	..

* No allowance has been made for accrued interest or redemption.
† Ex Dividend ‡ The London Stock Exchange Committee have declined to quote these.

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ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

NAME.	Price Wed., May 31.	*Rate per cent. Yielded.	Dividend Due.	Business Week to May 31. High-est.	Low-est.	Shs	Last Dividend
Electric Railways and Tramways— *Continued.*		£ s. d.					
Met. Rly. 3½ per Cent. "A" Deb. Stock..	92 –94	3 14 6	Jan, July	93½	93	100	2$
Metropolitan District Railway Ord.....	32 –32½	..	Feb, Aug	32⅝	32	..	4%
Do. 4½% First Pref.	89 –91	4 19 0	Feb, Aug	–	..	St.	4%
Do. Assented Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	75 –77	4 11 0	Feb, Aug	76½	..	5	5%
Do. 3 per Cent. Consoltd. Rent-charge	77 –79	3 16 0	Jan, July	78	77½	1	3/0
Do. 4 per Cent. Midland Rent-charge	103 –105	3 16 0	Jan, July	..	–	1	0/7½
Do. 6 per Cent. Perp. Deb. Stock.....	148 –150	4 0 0	Jan, July	149½	..	1	0/6
Do. 4 per Cent. Ditto.....	98 –100	4 0 0	Jan, July	99	..	St.	6%
Potteries Electric Traction Ord.	¼ –⅜	5 6 9	April, Oct	⅜	..	St.	6%
Do. 5 per Cent. Cum. Pref.....	⅜ –½	7 5 0	Feb, Aug	⅜	..	10	6/0
Do. 4½ per Cent, Deb. Stock.....	85 –89	5 1 0	May, Nov	88½	88	10	6/0
S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	⅛ –¼	10 2 0	..	..	..	5	2/6
Do. 4 per Cent. Deb. Stock.....	75 –80	5 0 0	Jan, July	..	..	St.	3½%
Sunderland Dist. Elec. Trms. 5% 1stMtDb.	..	8 4 0	Jan, July	..	..	St.	4%
Undergd E. Rys. Lon. 6% In. bds with coup 7	63 –65	1 10 9	June, Dec	65⅛	63	1	4½%
Do. 5% Prior Lien Bonds.....	100 –101	4 19 0	..	100⅛	100⅛	1	1/0
Do. 4½% Bonds with coup. 7	99 –101	4 9 3	..	100¼	99½	1	0/7½
Do. 4 per Cent. 1st Power Ho. Dbs. ..	100 –102	3 18 3	..	..	..	St.	4%
Yorkshire (W.R.) Elec. Trams. Ord.....	⅛ ⅛	..	March ..	..	..	St.	4½%
Do. 6 per Cent. Cum. Pref.....	2⅛ –2⅛	..	..	..	..	5	3/0
Do. 4½ per Cent. 1st Debs.....	84 –87	5 3 3	Jan, July	..	..	5	4½%
						St.	2/6
						St.	4½%
Electric Manufacturing, &c.							
Anchor Cable Co. 4½ % Deb. Stock	99 –101	4 9 0		–	..	..	
Aron Electricity Meter Ord.....	⅛ –⅜	..		..	..	5	3/0
Do. 6% Cum. Pf.	⅛ –¼	7 4 0	April, Oct	⅛	..	10	2/0
Babcock & Wilcox Ord.	5⅛ –5½	4 14 6	April, Oct	5⅛	5⅛	10	3/0
Do. Pref.....	1⅛ –1½	4 0 0	..	..	..	10	6%
British Insulated & Helsby Cables Ord..	6¼ –7⅛	6 18 6	July, Feb	..	..	**Colonial and Foreign Electric Railways, Tramways, &c.**	
Do. 6 per Cent. Pref.....	6 –6½	4 12 3	Jan, July	..	..	5	2/6
Do. 4½ per Cent. 1st Mort. Deb. (red.)..	102 –104	4 6 6	Jan, July	..	..	5	2/6
British Thoms'n-Houst'n 4½% 1st Mt.Db.	96 –99	4 11 0	Mar, Sept	..	..	St.	4%
British Westinghouse 6 per Cent. Pref....	⅜ –½	..	Feb, Aug	..	..	St.	4½%
Do. 6 per Cent Prior Lien Dbs. (rd.)..	103 –103	5 16 3	..	..	..	St.	5%
Do. 4 per Cent. Mort. Deb. Stock.....	61 –64	6 5 0	Jan, July	64	..	5	4/0
BrushE. Eng. Co. 4½% Perp. 1st Deb. Stock	59 –64	7 0 6	Mar, Sept	..	..	5	2/6
Do. Perpetual 2nd Deb. Stock.....	41 –46	9 16 0	Jan, July	..	..	St.	4½%
Callender's Cable Con. Ord.....	9⅜ –9⅝	7 12 0	Jan, July	..	..	St.	8%
Do. 5 per Cent. Cum. Pref.....	4⅝ –5⅛	4 17 6	Jan, July	9⅜	..	St.	6%
Do. 4½ per Cent. 1st Mort Debs. (red.)..	102 –104	4 6 6	Nov, May	..	..	St.	5%
Castner-Kellner Alkali Co.....	3⅛ –3⅜	5 1 9	May, Nov	3⅛	3⅛	40	4½%
Do. 4½ per Cent. 1st Mort. Deb. (red.)..	103 –106	4 3 6	Feb, Aug	103⅛	..	100	4½%
Chadburn's (Ship) Telegraph Ord.	1⅛ –1⅜	5 19 0	March ..	..	..	St.	4½%
Consolidated Electrical Co.....	⅜ –½	10 0 0	August ..	..	..	St.	5%
Consolidated Signal Co.....	⅛ –¼	5 0 0	April, Oct	⅛	..	St.	6%
Do. 6 per cent. Cum. Pref.....	⅛ –⅜	6 8 0	April, Oct	..	..	**Financial, Investment, &c.**	
Crompton & Co (Nos. 1 to 85,000)	⅛ –¼	..	Jan, July	..	..	5	3/6
Do. 5 per Cent. 1st Mort. Debs. (red.)..	70 –80	6 5 0	Jan, July	..	..	100	2/6
Dick, Kerr & Co. Ord.....	¾ –1	5 0 0	Sept.	1⅛	..	1	4½%
Do. 6 per Cent. Cum. Pref.....	1 –1⅛	5 6 6	Sept	..	..	St.	..
Do. 4½ per Cent. Deb. Stock.....	97 –100	4 10 0	Jan, July	..	..	5	1/3
Edison & Swan United ("A" Sh.) (£3 pd.)	⅞ –⅞	..	Feb, Aug	⅞	⅞	St.	4%
Do. (£5 paid)	1¼ –2⅛	9 3 0	Feb. Aug	..	..	..	5%
Do 4 per Cent. Mort. Deb. Stock (red.)	69 –73	5 9 9	June, Dec	..	..	1	5%
Do 5 per Cent. 2nd Deb. Stock.....	78 –81	6 3 6	Mar, Sept	..	..		
Edmundson's Elec. Corp. Ord.....	⅛ –⅜	..	Jan, July	..	..	100	5%
Do. 6 per Cent. Cum. Pref.....	2⅛ –3⅛	..	May, Nov	2⅛	..		
Do 4½ per cent. 1st Mort. Deb. (red.)..	86 –89	5 1 0	Jan, July	..	..	1	..
Electric Construction Co.....	¾ –1	..	Jan, July	..	..	100	5%
Do. 7 per Cent. Cum. Pref.....	1⅛ –2	7 0 0	July	..	..	5	6%
Do. 4 per Cent. Perp. 1st Mort. Debs..	70 –73	5 8 0	Jan, July	71½	..	5	0/6
General Electric (1900) 5% Cum. Pref. ..	8¼ –9½	5 9 0	June, Dec	..	..	100	0/7½
Do. 4 per Cent. 1st Mort. Debs.....	88 –93	4 8 6	Mar, Sept	92½	92	St.	5%
Henley's Telegraph Works Ord.....	12⅛ –12⅝	5 16 6	Feb, Aug	12⅛	..	St.	5%
Do. 4½ per Cent. Pref.	4⅛ –5⅛	4 7 0	Feb, Aug	4⅛	..	100	5%
†Do. 4½ per Cent. 1st Mort. Deb. Stock	105 –108	4 4 6	Mar, Sept	..	..	100	5%
India Rubber, Gut. Per., &c., Works....	16 –16½	5 18 6	Feb, Aug	16⅞	16	100	$1½
Do 5 per Cent. Cum. Pref.	10⅜ –10⅝	4 14 0	..	10⅜	10⅜	100	5%
Do. 4 per Cent. Debs. (red.)	96 –98	4 1 6	April. Oct	..	..	St.	6%
National Elec. Construction Co.	⅛ –⅜	..	April ...	..	..	St.	4½%
Richardsons, Westgarth & Co., Ltd. Ord.	⅜ –½	..	Nov.	..	..		
Do. 6 per Cent. Cum. Pref.	⅜ –½	..	May, Nov	..	..	St.	4½%
Do. 4½ per Cent. Perp. Deb. Stock....	78 –82	5 10 0	Jan, July	..	..	1	0/6
Simplex Conduits 6 per Cent. Cum. Pref.	4½ –5	..	..	..	..	St.	5%
Telegraph Construction & Maintenance..	35½ –38½	5 16 3	Mar, July	38⅛	37¼	5	3/0
Do. 4 per Cent. Deb. Bonds (1909)	100 –102	3 18 6	Jan, July	..	..		
Vickers, Sons & Maxim, Ltd., Ord.....	2⅛ –2⅜	4 15 0	..	2⅛	2		
Do. 5 per Cent. non-Cum. Preference..	1⅛ –1⅛	4 3 0	..	1⅛	..	St.	4½%
Do. 5 per Cent. non-Cum. Preferred ..	110 –113	4 8 6	..	110¼	..	100	$1¼
Do. 4 per Cent. 1st Mort. Db. Sk. (red)	100 –102	4 0 0	June, Dec	102	101⅜	..	5%
Do. 4½ per Cent. 2nd Mort. Deb. (red.)	104 –106	4 5 0	June, Dec	..	..	100	5%
Do. 5 per Cent. 3rd Mort. Debs Scrip...	105 –107	4 13 6	..	..	..	..	$2½
J. G. White & Co. 6% Cum. Pref.	14½ –15½	6 11 0	..	..	..		
Willans & Robinson Ord.....	⅛ –⅜	..	Apr, Oct	..	..	..	5%
Do. 6 per Cent. Cum. Pref.....	½ –1	..	Apr, Oct	..	..	100	4½%
†Do. 4 per Cent. 1st Mort. Debs.....	55 –65	6 3 0	May, Nov	..	..	**Colonial and Foreign Electricity Supply, &c.**	
						5	3/0
Telegraphs.						10	6/0
Amazon Telegraph	7⅛ –7⅜	..	June, Dec	..	..	St.	4½%
Do. 5 per Cent. Debs. (red.)	99½ –101½	4 19 6	Jan, July	101	..	..	5%
Anglo-American	69 –71	4 4 6	F,My,Ag,N	..	..	5	5/0
Do Preferred	113¼ –114½	5 5 0	F,My,Ag,N	114	113	5	2/6
Do. Deferred	25½ –27	5 7 0	F,My,Ag,N	26⅜	26½	100	5%
Commercial Cable 4 per Cent. Deb. Stk...	83 –90	4 9 0	Jn,Ap,Jy,O	88½	88½	100	7/2½
Cuba Submarine Ord.	9⅞ –10½	6 0 0	Feb, Aug	10⅛	..	100	$3½
Do. Preference 10 per Cent.	17½ –18½	5 13 0	Feb, Aug	..	..	100	5%
Direct Spanish Ord.	3⅛ –4	5 0 0	April, Oct	..	..	500	5%
Do. 10 per Cent. Cum. Pref.....	8⅛ –8⅜	5 16 0	April, Oct	..	..	St.	5%
Do. 4½ per Cent. Deb.	101 –103	4 8 3	Jan, July	..	..		
Direct United States Cable.....	7⅞ –8⅛	6 3 6	Ja,Ap,Jy,O	7⅞	..	5	..
Direct West India Cable 4½%Rg.Db.(rd.).	100 –102	4 9 0	June, Dec	..	..	10s	..
Eastern Ordinary xd and bonus	137 –140	5 1 0	Ja,My,Jy,O	140⅞	133½	1	0/7½
†Do. 3½ per Cent. Pref. Stock.....	84 –89	4 2 6	Ja,My,Jy,O	85⅜	85¼	..	5%
Do. 4 per Cent. Mort. Deb. Stk. (red.)..	100½ –102½	3 18 6	May, Nov	102	..	5	..
Eastern Extension xd and bonus	13¾ –14	5 2 0	Ja, Ap, Jy, O	14⅛	13⅜	St.	..
Do. 4 per Cent. Deb. Stock	101 –103	3 18 6	Feb, Aug	104	100½	St.	5%
Eastern and S.Af., 4% Mauritius Sub.Debs	99½ –101½	3 19 0	May, Nov	99⅜	..	500	5%
G.N (of Copenhagen), with Coupon 82 ..	31⅛ –32½	5 8 0	Jan, July	32	31⅜		
Indo-European xd and bonus	55½ –56½	5 6 6	May, Nov	..	..	St.	$1
Mackay Companies Common	93 –95	5 4 0	Ja,Ap,Jy,O	94½	..	St.	$3½
Do. Preference	78 –80	5 0 0	Ja,Ap,Jy,O	..	..	500	5%
Marconi's Wireless Teleg. Co.	1⅜ –1½	..	April	1⅜	1½	St	5%
Pacific & Europe'n Tel. 4% Guar. Dbs. (red.)	100 –102	3 18 3	June, Dec	..	..	100	8½
†West Coast of America	1⅛ –1⅜	4 0 0	May	1⅛	..	100	5%
Do. 4 per Cent. Debs.	99½ –101½	3 18 9	Jan, July	99½	..	St.	£10
†West India & Panama	2⅜ –2⅝	1 18 9	May, Nov	2⅜	..	St.	6%
†Do. 6 per Cent. 1st Pref.	10¼ –10⅜	5 16 0	May, Nov	..	..	St.	5%
†Do. 6% 2nd Pref.	9⅛ –9⅜	6 5 0	May, Nov	9⅛	9⅛	100	$1¼
Do. 5 per Cent. Debs.	102 –104	4 16 0	Jan, July	..	..	..	5%
Western Telegraph	13⅜ –14½	5 3 0	Mr,Jn,O,D	14⅛	13⅜	St.	4½%
Do. 4 per Cent. Deb. Stock (red.)	101 –103	3 17 6	June, Dec	–	..	St.	£4½
Western Union Telegraph, $1,000 4% Bds	105 –108	3 14 0	–	–	–	–	6d.
Do. $1,000 4½% Fdg. & Rl. Est. Gd. Bnds	99½ –102½	4 9 3	–	–	–	1	–

NAME.	Price Wed., May 31.	*Rate per cent. Yielded.	Dividend Due.	Business Week May 3 Highest.
Telephones.		£ s. d.		
Amer. Telephn. & Telegh. Cap. St.	152½ –154½	5 4 0	..	..
Do. Coll. Trust $1,000 4 per Cent. Bds.	95½ –97½	4 3 0	Jan. July	..
Do. 4% Cons. Bonds 1936	113½ –115½	3 10 0	..	114
Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101 –103	4 17 0	Mar, Sept	..
Chili Telephone	7 –7⅛	5 11 6	August ..	..
Monte Video Telephone Ord.....	⅛ –1	6 0 0	Nov	..
Do. 5 per Cent. Pref.	⅞ –1	5 11 0	May, Nov	..
National Co. Pref. Stock.....	104 –105	5 14 3	Feb, Aug	104½
Do. Def. Stock	127 –129	4 13 9	Feb, Aug	132
Do. 6 per Cent. Cum. 1st Pref.....	10 –10½	5 11 6	Feb. Aug	..
Do. 6 per Cent. Cum. 2nd Pref.....	10 –10½	5 11 6	Feb, Aug	..
Do. 5 per Cent. non-Cum. 3rd Pref.....	5⅛ –5⅜	4 9 0	Feb, Aug	5⅜
Do. Deb. Stock 3½ per Cent. (red.).....	99 –101	3 9 3	June, Dec	99½
Do. 4 per Cent. Deb. Stock (red.).....	99 –101	3 19 3	Jan, July	99½
New York Telephone Co. 30 yr. Bnds....	99½ –100½	4 10 3	..	99⅝
Oriental	1⅛ –1⅛	4 18 0	April, Oct	1⅛
Do 6 per Cent. Cum. Pref.	1⅛ –1½	4 16 0	April, Oct	..
Do. 4 per Cent. Red. Deb. Stock.....	87½ –89½	4 9 6	Jan, July	..
Telephone Co. of Egypt 4½%Db.Stk.(red.)	100 –102	4 9 0	Jan, July	102
United River Plate Ord. (1 –150.000) ...	7⅜ –7⅝	5 3 0	July	7⅝
Do. (150,001—190,000).....	7⅛ –7⅜	..	..	..
Do. 5 per Cent. Cum. Pref.	5⅛ –5⅜	4 9 0	Jure, Dec	..
Do. 4½ Deb. St. Red.....	103 –105	4 5 9	Jan, July	..
Financial, Investment, &c.				
Elec. & Gen. Investment 6% Cum. Pref...	4 –4½	7 1 0	Jan, July	..
Globe Telegraph & Trust	11½ –11¾	5 2 6	Sp,DcMrJu	11
Do. 6 per Cent. Pref.	13½ –13⅝	4 10 0	Sp,DcMrJu	..
Submarine Cables Trust (Cert.)	131 –134	4 9 6	April, Oct	..
Colonial and Foreign Electric Railways, Tramways, &c.				
Anglo-Argentine 5% Cum. 1st Pref.	5 –5⅛	4 15 3	April, Oct	5
Do. 5% Cum. 2nd Pref.....	4⅛ –5⅛	4 17 6	Jan, July	..
Do. 4% Deb. Stock	96 –98	4 2 6	June, Dec	9
Do. 4½% Deb. Stock	101 –103	4 8 3	..	10
†Do. 5% Deb Stock	100½ –102½	4 18 6	..	10
Auckland Elec. Trams. 5% Deb. (red.)....	104½ –106½	4 14 6	Jan, July	..
Brisbane Electric Trams. Invest. Ord	6¼ –6½	6 3 0	May	..
Do. 5 per Cent. Cum. Pref.	5 –5⅛	4 17 6	May, Nov	..
Do. 4½ per Cent. Db. Prov. Certs.....	102 –105	4 6 0	Jan, July	..
British Columbia El. Rly. Df. Ord.	146 –150	5 6 9	Mar, Sept	..
Do. Pref. Ord. Stock	126 –129	4 14 0	May, Nov	..
Do. 5% Cum. Perp. Pref. Stock.....	109 –112	4 10 6	Jan, July	11
Do. 4½ per Cent. 1st Mort. Debs.....	100 –103	4 7 6	April, Oct	..
Do. Vancouver Power Debs.	102 –105	4 5 9	Jan, July	..
Do. 4½% Perp. Con. Deb. St.	101½ –103½	4 2 6	..	10
Buenos Ayres Lacroze Trams 1st Mt. Db.	99¼ –101¼	4 19 6	Mar, Sept	10
Buenos Ayres Port & City Tram, 1st Mt. Deb. Stock	93 –98	6 2 6	Feb, Aug	9
Calcutta Tramways (1 to 137,610).....	5½ –6	5 0 0	Mar, Sept	..
Do. 5 per Cent. Cum. Pref.	5⅜ –5⅝	4 13 0	Jan, July	..
Do. 4½% 1st Deb. Stock (red).....	101 –104	4 6 6	Jan, July	..
Cape Electric Tram Shares	⅛ –¼	..	..	..
City of Buenos Ayres Trams Co. (1904) Sh.	5⅜ –5½	4 5 0	F,My,A,N	..
Do 4 per Cent. Deb. Stock.....	96 –97	4 0 9	June, Dec	..
Colombo Tr. & Ltg. 5% 1st Mt. Db.....	95 –98	5 2 0	May, Nov	..
Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	100½ –102½	4 18 6	Feb, Aug	..
†Hong Kong Tramways Co. 5 per Cent. 1st Mort. Debs.	76½ –79½	6 8 0	June, Dec	..
Kalgoorlie Elec. Trams Sh.	⅜ –½	..	..	..
Do. 5 per Cent. "A" Deb. Stock.....	94 –97	5 3 0	Jan, July	..
Do. 6 per Cent. "B" Ditto	66 –70	4 5 9	Jan, July	..
†Lisbon Elec. Trams. Ord.	1 –1⅛	4 16 0	July	..
Do. 6 per Cent. Cum. Pref.	1 –1⅛	4 16 0	Jan, July	..
Do. 5 per Cent. Reg. Mort. Debs.....	98 –102	4 18 0	Jan, July	..
Madras Elec. Trams. 5% Deb. Stk.	96 –98	5 2 0	Jan, July	..
Manaos Trams and Lt. Co. 5% Debs	94 –97	5 4 6	..	..
Manila Elec. Ry. $1,000 Gold Bonds.....	100 –102	4 18 0	Feb, Aug	..
Mexico Trams Co. Com. St.	124½ –129½	5 11 6	..	..
Do. Gen. Con. 1st Mort. 5% Gold Bds.	96 –97	5 3 6	..	..
Do. 6% 50 yr. Mort. Bds.....	100¼ –101¼	5 19 0	..	..
Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922) (Nos. 601 to 2,000)	101 –103	4 7 6	Feb, Aug	..
Do. do. (Nos. 1 to 4,600)	102 –104	4 7 6	..	..
Perth Elec. Trams Ord.	⅛ –⅜	2 13 6	May	..
Do 1st Mt. Db. Stock	104 –106	4 14 3	Jan, July	..
Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	5⅛ –5⅜	5 4 6	..	..
Do. 4½% 1st Mort. Deb. Stk.	99 –102	4 8 0	..	..
Rio Janeiro Tram, Lt. & P. Co.....	114 –115	4 7 3	..	..
Do. 30 yr. Gold Bnds.	103 –104	4 16 0	..	..
Do. 50 yr. Mt. Bnds	96 –97	5 3 6	..	..
Sao Paulo Tramway, Light & Power Co. $100 Stock	178 –180	5 12 0	..	..
Do. 5 per Cent. 1st Mt. $500 Db.	105 –107	4 13 6	June, Dec	..
Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	98 –100	4 10 0	Feb, Aug	..
Colonial and Foreign Electricity Supply, &c.				
Adelaide Elec. S'ply Co. 6% Cu. Pr.....	5⅛ –5⅜	5 8 0	Mar, Sept	..
Bombay E.S. & T. 6% Cm. Pf.....	10¼ –11¼	5 5 6	..	..
Do. 4½ per Cent. Deb. Stk. (red).....	98 –100	4 11 0	Jan, July	..
Do. 5 per Cent. 2nd Mort. Deb. Stock..	98 –100	5 1 0	..	..
Calcutta Elec. Supply Ord.	6¼ –7¼	6 1 3	April, Oct	..
Do. 5% Cum. Pref	4⅛ –5⅜	4 13 0	..	..
Calgary Power Co. 5% 1st Mort. Bnds....	96 –98	5 2 0	..	..
Canadian Gen. Elec. Co. Com. St.....	111 –114	6 3 0	..	..
Do. 7% Cm. Pf. Stock	121 –124	5 5 0	..	..
Castner Electrolytic Alkali Co.(of U.S.A.) 1st Mort. Stl. Debs.	97 –102	4 18 0	Jan, July	..
Elect Development Co. of Ontario.....	83½ –85½	5 18 6	..	..
Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	87 –90	5 11 0	Jan, July	..
Indian Elec. Sup. & Trac. Co.	1 –1⅛	..	..	..
Kalgoorlie Elec. Power & Ltg. Ord.	⅛ –¼	..	..	..
†Do. 6 per Cent. Cum. Pref.	⅛ –¼	8 6 6	April, Oct	..
Kaministiquia Power Co. 5% Gold Bnds...	103 –105	4 15 0	..	..
Madras E. S. Corp. Ord.	3 –3⅛	..	..	..
Melbourne E. S. Co. Cons. Ord. St.	23 –33	..	..	..
Do. 5% 1st Mortg Deb. Stock.....	94 –96	5 4 0	..	..
Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	87 –90	5 12 0	..	..
Mexican Lt. & Power Co. Com. St.	84½ –85½	4 13 6	..	..
Do. 7% Cum. Pref. St.	107 –109	6 9 6	..	..
Do. 5% 1st Mort. Gold Bnds.	94 –95	5 6 0	..	..
Monterey Rly. L. & P. Co. 1st Mort. Db. Sk	89½ –91½	5 10 6	..	..
Montreal Lt. Ht. & Power Co. Cap. St.	157 –162	5 0 0	F,My,A,N	..
Northern Lt. Power & Coal 5% Gd. Bds ..	70 –72	7 1 0	..	..
River Plate Electricity Co. Ord. Stk.	218 –223	4 7 9	April	..
Do. 6 per Cent. non-Cum. Pref. Stk. ..	107 –114	5 5 0	May	..
Do. 5 per Cent. Deb. Stock	104 –106	4 14 3	Jan, July	..
Shawinigan Water & Power Co. Ca.....	115 –118	4 6 0	..	..
Do. 5 per Cent. Debs.	109 –111	4 11 0	Jan, July	..
Do. 4½ Per Con. Mt. Db. St.	102 –104	4 6 6	..	..
Toronto Power Co. 4½% Db. St.	101 –103	4 7 6	..	..
Victoria Falls Power Co. Pref. (1 to 805,000)	⅛ –¼	4 17 0	Jan, July	..
Do. (805,081 to 1,700,000)	¾ –1	–		

* No allowance has been made for accrued interest or redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

A Lesson from Bolton.

A POWER load is always liable to show considerable fluctuations from year to year owing to the varying condition of manufacturing industries, but fortunately it is not often that such a serious decrease has to be recorded as that experienced by the Bolton electricity department during the past year. The accounts of this department for the year ended March 31st last, which were abstracted in our last issue, show that owing to several large power consumers, representing a load of 1,500 kw., no longer taking a supply from the undertaking, the output for power had decreased by over 1,000,000 units, or 18·4 per cent. The loss of these consumers has been due to the Electricity Committee being unwilling, in spite of a favourable report by the engineer, to offer a supply at a sufficiently low rate. In view of the success that has attended Mr. A. A. DAY's efforts in the past to develop cheap power supply, it is to be regretted that the diminished output on the present occasion has resulted in a check to the reduction in the working expenses which it has been our pleasure to chronicle from year to year. As, however, the department quickly weathered a slight set-back two years ago, due to trade depression and strikes, we hope that the present check will be as rapidly surmounted. A satisfactory portent in this direction is that the number of motors connected to the mains has increased during the past 12 months by 114, equivalent to 567 H.P.

ALTHOUGH the loss of the large power consumers at Bolton is unfortunate, it may, nevertheless, serve a useful purpose by drawing attention to the fact that "cheap power supply" is by no means unprofitable to the supply authority, as is sometimes stated to be the case. The reduction in the output at Bolton is largely of low-priced units, as is evident from the fact that the average price per unit received for motive power has increased from 0·812d. a year ago to 0·896d. in the present accounts, and it has resulted in the total cost per unit (excluding capital charges) increasing from 0·535d. to 0·570d., and in the profit shown on the year's working falling from £7,119 to £6,857. The effect, however, is much greater than is shown by the last-mentioned figures, since they include the profit on the fittings department. This profit was £2,829 as against £1,163 in the previous year, so that the profit on the supply undertaking has really decreased by £1,928. It has, nevertheless, been decided to allocate £6,500 to the relief of the rates, a similar contribution to that made in the two preceding years.

American Telephony and the Post Office.

FROM the "Daily Mail" we learn that a party of engineers on the staff of the British General Post Office recently paid a visit to the U.S.A. to investigate the development of American telephony and that a report giving the results of this investigation has been printed for circulation among the heads of departments. We do not question the desirability of such a course; but as to the details of the investigation we are unable to say very much, because it appears that the report is not available—at least to the technical press. The "Daily Mail," however, is evidently in a more favoured position, and publishes an interview with one of the officials concerned, who gives some account of the

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more important telephonic differences between this country and the United States, as embodied in the report. To most people this will seem an unusual procedure. If information was to be given to the public we should have expected it to be given by the Engineer-in-chief, though perhaps the present method is in keeping with the desire for publicity sometimes evident in other branches of the public service. Further, we should have expected information of this kind to be given to the technical press rather than to any one of our daily contemporaries, for such matters are essentially within the province of the technical journal.

Turning to the few technical details which are given, it appears that the telephone service in America is more flexible than in this country, in that any telephone exchange can be used as a sort of bureau of general information. The local service is also somewhat quicker, which is purely a matter of training the staff, as the equipment is the same. Trunk services are also quicker; this seems to be due to the fact that trunk lines have been laid down on a much more lavish scale, and consequently the tariff for long distance messages is much higher than in this country. To most subscribers here this will, doubtless, appear a disadvantage which more than counterbalances the speed of obtaining the desired connection. Finally, the British Post Office engineers appear to have been very favourably impressed by the automatic telephone exchanges. There is no question that working by means of automatic instruments can be more rapid than manual working, as any delay on the part of the operator is avoided. This, however, is not the only point to be taken into consideration, as became apparent in the recent discussion at the Institution of Electrical Engineers. Perhaps the semi-automatic method of handling telephonic traffic, as described in another column, may meet the conditions in this country better than automatic working pure and simple. In any case there seems to be no question that the automatic telephone now demands serious consideration.

Progress at Last.

The selfish attitude of a number of local authorities towards applications for provisional electric lighting orders in the early days of electricity supply retarded the normal development of the industry in many towns. In some cases the municipalities prevented companies from coming in and establishing electricity undertakings, and in not a few instances where Local Authorities obtained provisional orders no attempts were made to carry out the provisions of the orders. During the last year or two, however, the Board of Trade has shown increased vigilance in regard to the intentions of applicants for powers to supply electricity, and many of the long outstanding orders have been revoked. The case of Macclesfield is typical of many, and the fact that this town of about 35,000 inhabitants is still unprovided with a supply of electricity illustrates the backward state of the industry in this country. The Corporation obtained an electric lighting order so long ago as 1901, but as no undertaking had been established the Board of Trade revoked the order last year. Unable themselves to supply the ratepayers with electrical energy, the Corporation recently refused their consent to the granting of an order to a company. As the Corporation did not assign any reasons for their objections, it is satisfactory to note that the Board has decided to dispense with the consent of the Corporation, and to grant the order. The position, however, is somewhat complicated by the fact that a Bill of the Macclesfield & District Rail-less Electric Traction & Electricity Supply Co. is also before Parliament, and the question as to which of these companies shall obtain powers to supply electrical energy in the borough will be considered by a Select Committee of the House of Lords at the end of this month.

Illumination Risks.

The popularity of the phrase "It is supposed that the fire was caused by the fusing of an electric wire" shows no signs of waning, and in this respect the enterprise and originality of the British journalist is seriously open to question, though possibly the explanation is that compositors have instructions to insert this time-honoured sentence in all accounts of fires. We have suspicions that lack of "copy" owing to the Whitsuntide holidays is responsible for the prominence that has been given to several fires during the last few days and to their supposed electrical origin. A drapery establishment, premises occupied by licensed victuallers and a "joy wheel" are all involved but the grounds on which blame is attached to the electri circuits are, as usual, not stated. A member of the sta of the youngest of London's evening dailies has been inte viewing a Fire Brigade official as to possible dangers fro Coronation illuminations, and has learnt that "in mos cases the fusing of wires is almost impossible to prevent. This is news indeed! The fact that the regulations issu by the Corporation of London as to illuminations on refer to electrical apparatus, perhaps implies that they e pect electrical devices alone to be in evidence, as at prese seems probable; but in any case it is desirable to emphas the necessity of running no risks of electric lamps comi into contact with inflammable decorations. That fires more likely to originate in that manner than from defecti circuits is undoubtedly the case, and it is noteworthy th the Fire Brigade official referred to above, mentioned Japanese lamp as a possible cause of the recent fire at Edinburgh Empire Music Hall. We would suggest to daily contemporaries the use of some such alternat during the next few weeks.

Concrete Pole Construction in Oklahoma.—According the "Electric Railway Journal," one of the inter-urban lin the Oklahoma Railway is equipped with reinforced conc centre poles with semi-ornamental pipe brackets. This i experimental equipment of 20 poles installed late in 1 These poles are of the hexagonal type, 30 ft. high with tops and reinforced walls 3½in. thick. The manufactu cost per pole was 34s.

Cable Interruptions.	Date of Interru
Assab—Perim	July 8, 190
Malta—Tripoli	April 20, 191
Latakia—Palura	May 26, 191

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Personal.—We offer our congratulations to Sir Oliver Lodge on his 60th birthday, which we understand will be celebrated on the 12th inst.

University of Oxford.—In Convocation, on June 20th, it is proposed to confer the honorary degree of Doctor of Science on Prof. T. W. Richards, of Harvard University.

Steel for Magnets.—According to the "Electrical Review and Western Electrician," an alloy containing 8 per cent. of molybdenum, 0·3 of 1 per cent. of vanadium and 0·6 of 1 per cent. of carbon makes good permanent magnets, which retain their magnetism up to a temperature above 1,000°C. Four per cent. of tungsten with 0·4 of 1 per cent. of vanadium has also been found to be a good combination.

Electric Propulsion for Ships.—Trial runs took place last week of the new experimental boat, the "Electric Arc," which has been equipped by Messrs. Mavor & Coulson with electrical transmission between the prime mover and the propeller shaft. The most interesting feature of the vessel, perhaps, is that alternating-current plant is employed, the system being that of Mr. H. A. Mavor. The ease with which stopping, starting, speed-changing and reversing can be carried out was demonstrated and the trials proved very satisfactory.

"The Self-Discharge of Planté and Faure Storage Batteries."—In a Paper on this subject read before the American Electrochemical Society by Messrs. O. W. Brown and W. G. Rowe, the authors gave some data showing that the Planté type of cell loses its charge when allowed to remain on open circuit for periods of 10 to 20 days. The Faure cell, when made from pure materials, suffered only very slight loss in capacity when left on open circuit. In every test the self-discharge of the Faure cell was much less than in cells of the Planté type. The data also showed that the Planté cell suffered permanent injury when considerable periods of time were allowed to elapse between the charges, while one or two re-charges of a Faure cell restored it to its original capacity. In the light of these results, the Faure type of cell was, the authors considered, best suited for all service where intervals of a week to a month or more must elapse between charges. This condition was found in some telephone plants, in isolated lighting plants, and these cells were used for ignition purposes and for the operation of signal systems.

Macclesfield Electric Lighting Order, 1911.—The Board of Trade have made a special report under sec. 1 of the Electric Lighting Act, 1888, on the application of the New Electricity Co. of Macclesfield for a provisional order to supply electricity in Macclesfield.

Macclesfield Corporation refused their consent to the order and lodged objections without assigning any reasons for their objections. The Corporation themselves obtained an electric lighting order in respect of the borough in 1901, but as they failed to establish an undertaking, the Board of Trade revoked the order in 1910. The order applied for this year was also opposed by the promoters of the Macclesfield and District Rail-less Electric Traction and Electricity Supply Bill now before Parliament. Under this Bill powers are sought to establish a system of electric traction in the borough and certain adjoining districts, and to supply electricity for public and private purposes in Macclesfield. The Board invited representatives of the promoters of the provisional order and the objectors to attend at the office of the Board to discuss the matter, and after carefully considering all the circumstances, the Board decided to dispense with the consent of the Corporation and to grant the order, leaving to Parliament the question of determining whether powers for the supply of electricity within the borough of Macclesfield should be vested in the promoters of the order or in the promoters of the Macclesfield and District Rail-less Electric Traction and Electricity Supply Bill.

Mr. Marconi on Wireless Telegraphy.—In the course of a lecture delivered at the Royal Institution on Friday evening last Mr. Marconi made a number of interesting statements regarding the present position of wireless telegraphy. He stated that the arrangement at Clifden which gave the best results was based substantially on his syntonic system of 1900. Air condensers were now used, greatly reducing the loss of energy which took place by dielectric hysteresis. In his opinion it was neither economical nor efficient when utilising the best receivers to make the waves too continuous. Much better results were obtained when groups of waves were emitted at regular intervals in such a manner that their cumulative effect produced a clear musical note in the receiver, which was tuned not only to the frequency of the electric waves transmitted, but also to their group frequency. The lecturer also dealt with the employment of direct current, the propagation of waves during daylight and the importance of the earth connection. The concluding part of the lecture was devoted to a consideration of the distance over which wireless messages could be transmitted. Over the sea a distance of 4,000 miles had been covered, and Mr. Marconi did not think he was too bold in saying that wireless telegraphy was tending to revolutionise our means of communication.

We hope to deal further with this interesting lecture when the full report is available.

Constantinople Telephone System.—Messrs. F. Gill and W. W. Cook, engineer-in-chief and assistant engineer-in-chief of the National Telephone Co., have been appointed consulting engineers to the Constantinople telephone scheme, the formal agreement for which was executed between Djavid Bey, then Minister of Finance, and Mr. Herbert Laws Webb, at Constantinople on May 6. We are informed that a staff of engineers left London last week to make a telephonic survey of Constantinople and to prepare plans and specifications for the system, which is to have an original capacity of 10,000 lines and to be ready to start service in July, 1913. Mr. John Scott is in charge of the engineering force, and left London last week for Constantinople.

The work Mr. Scott has in hand is one of many difficulties, as Constantinople is the most peculiarly situated of all European capitals. The city is divided by the Bosphorus, which is deep and has swift and variable currents, and, moreover, is much used as an anchorage. The European section is again divided by the Golden Horn, an arm of the sea over which there is no permanent bridge. In all parts of the city the streets are extremely primitive, narrow, winding and ill-paved, and many of them are precipitous hills. As no telephone service yet exists in Turkey, all modern facilities having been debarred by the ex-Sultan, there are no available data whereby to gauge the probable use of the service or the probable traffic which the system will be called upon to carry. The peculiar composition of the population of Constantinople, about one-half of which consists of non-Moslem races, Greek, Armenian, Jewish and so on, makes the business part of the engineering problem one of much complexity. Three languages are current—Turkish, Greek and French—while many more are spoken, and the variety of local customs and practices is probably greater than in any other large city in the world. No exact statistics exist, but the population of the area is estimated at between 1,000,000 and 1,250,000 inhabitants. Means of communication are at present so primitive and expensive that a large demand for the telephone service may be anticipated. The Telephone Development Co. (Ltd.) has been formed for the purpose of carrying on the necessary work pending the organisation of the Ottoman Telephone Co., which will construct the plant and operate the service.

Annual Tables of Constants and Numerical Data.—At the International Congress of Applied Chemistry held in London in 1909 an International Commission was appointed for the purpose of compiling and publishing annual tables of constants and numerical data. This Commission was subsequently accorded the patronage of the Association of Academies at the meeting of that body held in Rome in 1910. According to the programme drawn up by the Commission the tables published in any one year are intended to contain all the numerical data likely to be of interest in connection with chemistry, physics and allied sciences, pure and applied, which have found a place in the literature published during the previous year. The data are to be accompanied by full bibliographic references. This programme has now so far matured that portions of the volume for 1910 are, we understand, already in the press, while the manuscript of the remaining portions is approaching completion. Owing to the immense volume of scientific and technical literature which is continually being produced, the difficulties in the way of finding out whether any given measurement has been made or not are increasing year by year. Existing systems of indexing and abstracting are only a limited help, since a large number of measurements are made in the course of researches to which they are purely subsidiary, so that their existence cannot be inferred from the titles and sub-titles of the Papers in which they are recorded. Also tables which appear only at long intervals, such as those of Landolt and Börnstein, can of necessity cover only a small part of the ground; and,

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moreover, in most cases they are hampered by the limitations of private enterprise. The annual tables should, therefore, the compilers feel, fill a serious gap which has hitherto existed in the systematic indexing of scientific and technical results. It is hoped that the enterprise may ultimately become self-supporting; but, obviously, this cannot be the case for some time to come. The Commission has been greatly assisted by grants from various societies—for example, in this country from the British Association, Chemical Society, Faraday Society, Royal Dublin Society, Royal Irish Academy, Royal Society of Edinburgh, and the Society of Chemical Industry. Donations have also been received from a few private persons, notably from the Right Hon. the Earl of Berkeley, F.R.S. The financial position, however, is still far from satisfactory, and further help from societies and private donors is urgently needed. In this connection it may be mentioned that neither the general secretary, nor the members of the Commission receive payment for their services, except in so far as they may perform actual compiling or abstracting. The organisation of the Commission is sufficiently complete to deal effectively with periodical literature, but it happens occasionally that data are published only in non-periodical publications, such as books or monographs; and such data may easily be overlooked. Accordingly, in order that the annual tables may be as complete as possible, the authors of such books, monographs, &c., are requested to communicate with one or other of the members of the Commission. In cases where the data are numerous, specimen copies or corrected proofs of the tables containing the data would be very acceptable. The members of the International Commission for the United Kingdom are: Dr. Alex. Findlay (The University, Edgbaston, Birmingham); Dr. R. T. Glazebrook, C.B., F.R.S. (The National Physical Laboratory, Teddington, Middlesex); and Dr. N. T. M. Wilsmore (University College, Gower-street, London, W.C.). The general secretary is Dr. Charles Marie (98, Rue du Cherche-Midi, Paris, VI.).

Current Topics.

Subjects of current interest dealt with in this issue include the following:—

Dr. R. Beattie contributes an article on "Harmonic Analysis Diagrams."

Mr. C. C. Hawkins contributes an article on "The Principle of the Static Balancer."

We give an abstract of a Paper by Mr. P. Longmuir on "The Corrosion of Metals," read at the recent meeting of the Iron and Steel Institute. The subject of corrosion is also discussed in our Leading Article.

At a recent meeting of the American Institute of Electrical Engineers, Mr. E. E. Clement read a Paper on "The Semi-automatic Method of Handling Telephone Traffic."

Messrs. G. J. Hooghwinkel and F. Thursfield contributed a Paper to the Staffordshire Iron and Steel Institute on "The Electric Driving of Light Rolling Mills."

The first annual conference of the Electric Supply Publicity Committee was held last week in London, when an interesting discussion took place on methods of advertising electricity supply undertakings.

In a recent report the Postmaster-General gave particulars of the progress made with the work of laying underground telegraph cables throughout the kingdom.

Legal.—On Tuesday Lord Ormidale commenced the hearing of the action by Johannesburg Municipal Council against D. Stewart & Co., 1902 (Ltd.) and their guarantors for, *inter alia*, damages for alleged breach of contract in connection with the supply of gas producer plant for the electricity department of the Council.

Companies' Meetings and Reports.—The directors' report of the Victoria Falls & Transvaal Power Co. gives particulars of the progress during 1910. Arrangements have been made to issue further debentures to the amount of £1,300,000.

The report of the directors of the British Electric Traction Co. gives particulars of the progress made during the year by the various undertakings in which the Company is interested.

At the meeting of Callender's Cable & Construction Co. yesterday (Thursday), the managing director (Mr. Tom O. Callender) gave interesting particulars of the past year's trade and particularly of the development of the foreign department.

OBITUARY.

J. W. Boucher.—We regret to record the death of Mr. Jas. W. Boucher, Dublin branch manager of the Edison & Swan United Electric Light Co., which occurred on the 2nd inst. Deceased, who had been in ill-health for some time, was found dead in his office with a bullet-wound through his forehead and a six-chambered revolver in his right hand.

Baron d'Erlanger.—In our issue of June 2nd (p. 235) we published a statement that the death had occurred of the chairman of the General Traction Co., Baron E. B. d'Erlanger. This is not the case, the deceased gentleman being Baron Frederic Emile d'Erlanger, father of Baron E. B. d'Erlanger.

PERSONAL NOTE.

We regret to have to announce that Prof. D. Capper, of King's College, London, has sustained a serious accident. He was riding in Rotten Row, Hyde Park, London, on Tuesday morning when his horse fell and he was thrown heavily upon his head. He was taken to St. George's Hospital in an unconscious condition, but recovered consciousness in the course of the day. He has sustained a fractured skull, but the latest news of his condition is satisfactory.

APPOINTMENTS VACANT AND FILLED.

Sunderland Corporation require a superintendent to take charge of mains and sub-stations on power, lighting and traction systems, and operating upon the three-phase and c.c. systems. Salary £182 per annum. Applications to the engineer and manager, Mr. Alfred Blackman, M.I.M.E., M.I.E.E., Electricity Offices, Dunning-street, Sunderland. See advertisement.

A first class mechanical and electrical engineer is required, with thorough experience in modern manufacture of c.c. and a.c. machinery. See advertisement.

A demonstrator in physics is required for Armstrong College Newcastle-on-Tyne. Salary £100 rising to £120. Applications to Mr. F. H. Pruen, secretary, by June 23.

Mr. Jas. A. Wishart, mains superintendent at Motherwell Corporation electricity works, has been appointed electrical engineer to the burgh of Motherwell, at a commencing salary of £250 per annum.

Mr. W. C. Bexon, of Croydon electricity works, has been appointed mains assistant engineer at Kilmarnock.

Mr. L. W. Ballard, who has recently been engaged with the British Westinghouse Co., has been appointed assistant engineer on the staff of Messrs. May & Hawes, Westminster.

Mr. S. Janson, who was manager of the hire and repair business of S. F. Edge (Ltd.) for some years, has been appointed manager of the Electromobile Co. and of the Hertford-street Motor Hiring Co.

Mr. W. Dundas, senior shift engineer at the Neasden power station of the Metropolitan Railway Co., has been appointed shift engineer at the Stuart-street works, Manchester.

Mr. A. G. Low, late switchboard attendant at Tynemouth Corporation electricity works, has been appointed switchboard attendant at the "Chronicle Office" sub-station, and Mr. H. Lister, shift engineer, Middlesbrough Corporation electricity works, has been appointed shift engineer at the Close power station of the Newcastle & District Electric Lighting Co.

Mr. Chas. Brown, engineer to the North British Railway Co., has been appointed chief engineer to the Great Northern Railway Co. in succession to Mr. Alex. Ross.

INSTITUTIONS AND SOCIETIES.

Tramways and Light Railways Association.—The Papers to be read at the annual congress at Edinburgh on July 13 and 14 are as follows:—"Transfer Fares," by Mr. C. W. Shepherd (general manager, Edinburgh Corporation Tramways); "A Few Reasons why Electric Traction in England remains Stationary," by Mr. G. H. Hooghwinkel; "Notes on Tramway Problems," by Mr. C. V. Mallins (general manager, Liverpool Corporation Tramways); and "Tramways and Light Railways Legislation of the Future," by Alderman W. Ivey (West Ham Tramways Committee).

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Institution of Civil Engineers.—CONFERENCE ON EDUCATION AND TRAINING OF ENGINEERS.—At the Conference to be held on June 28th and 29th the following discussions will take place: "The extent to which mathematical and scientific subjects should share with other subjects of literate education the attention of schoolboys who intend to enter later the engineering profession," introduced by Dr. J. Gow and Prof. S. P. Thompson; "The question of specialised entrance examinations for university or college courses of study in engineering science with a view to the curricula to be followed, and also of the inclusion in the latter of courses in modern languages," introduced by Prof. A. K. Schwartz; "The requirements of practical training and of scientific study and the apportionment of time to them," introduced by Mr. A. F. Yarrow and members of his staff and Mr. W. H. Allen; "Practical training in workshops or on works of construction, with special reference to training in the engineer's office," introduced by Mr. W. B. Worthington and Mr. H. F. Donaldson; "The value of a university degree in engineering science in relation to professional competence," introduced by Prof. S. M. Dixon and Prof. C. F. Jenkin; "The position and uses of engineering laboratories in relation to education at college," introduced by Prof. W. E. Dalby, Prof. John Goodman and Prof. Bertram Hopkinson; "The relation of engineering employers and colleges from the point of view of the practical training of college students," introduced by Prof. J. E. Petavel and Mr. J. W. Horne: "The relation of practical training to college study; whether or to what extent, before, sandwiched, or after its conclusion," introduced by Prof. Archibald Barr and Prof. Henry Louis; "Workshop training as a preliminary to practical training in other branches of engineering," introduced by Mr. J. A. Brodie, Mr. J. M. Monteith and Prof. J. J. Welch.

Physical Society.—On the occasion of the visit to the National Physical Laboratory on May 26th, all departments of the Laboratory were open for inspection, and a number of special demonstrations were arranged. One of the most interesting was the *Silica Standard Metre Bar*, recently constructed as a primary standard of length. This was shown by Mr. J. E. SEARS and Dr. KAYE. The remarkably low coefficient of expansion of fused silica, and its practical freedom from thermal hysteresis, render it a specially suitable material for the construction of permanent length standards of the highest class. Such standards are always handled by trained and skilled observers, so that its comparative fragility is of small import. It is only recently, however, that sufficient progress has been made in methods of manufacture to render possible the construction of a metre standard in silica. The present bar, the first of its kind, consists of a silica tube into which are fused at its two ends optically worked plane parallel slabs of silica that serve to carry the graduations. The under sides of these slabs are platinised, and the graduations made by cutting through the platinum film with a diamond point. The readings are viewed from above through the thickness of the silica end-slabs, so avoiding any apparent alteration of length which might be caused by the shifting of the cover slips that are used to protect the platinum film. The bar is supported at two points, one of which is formed by a trunnion of silica fused into the tube and the other by a wire etched round it. In this way the conditions of support can be easily reproduced whenever the bar is under examination. The thickness and position of the end-slabs are so arranged that the apparent image of the ruling, when the bar is immersed in water, lies in the neutral axis.

Faraday Society.—At a meeting of the Faraday Society, which will be held on Tuesday next at the Institution of Electrical Engineers, Prof. Ernst Cohen, of Utrecht, will deliver a lecture on "Allotropic Forms of Metals." Prof. T. W. Richards, of Harvard University, will preside.

Röntgen Society.—At the annual general meeting of this society, which was held on Thursday, June 1st, at 20, Hanover-square, the following addition was made to the laws of the society—"The name of the society must not be used for purposes of advertising, and the council will not countenance in the slightest degree any conduct of a member tending to use the membership of the society as a qualification for practice."

Institution of Electrical Engineers.—The annual conversazione will be held at the Natural History Museum, South Kensington, on Thursday, July 6th, at 9 p.m., when Mr. and Mrs. S. Z. de Ferranti will receive the guests.

Institution of Gas Engineers.—The annual general meeting of the Institution will be held at the Glasgow and West of Scotland Technical College, Montrose-street, Glasgow, on Tuesday, Wednesday and Thursday next, June 13 to 15, under the presidency of Mr. Alex. Wilson, engineer and general manager, Glasgow Corporation Gas Department. A number of interesting communications will be presented, including one on "Public Lighting," by Mr. S. B. Langlands, of Glasgow, and on Friday, June 16, a steamer excursion on the Firth of Clyde has been arranged. On Tuesday evening, at 8 p.m. a lecture (with experiments) on "Surface Combustion," will be delivered by Prof. W. A. Bone, F.R.S.

Association of Mining Electrical Engineers, West of Scotland Branch.—The election of the following office bearers for the session 1911-12 is announced: *Branch President*: Mr. Alex. Anderson. *Branch Vice-President*: Mr. Matt. Brown. *Hon. Treasurer*: Mr. D. L. Frew. *Hon. Auditor*: Mr. A. B. Muirhead. *Hon. Secretary*: Mr. D. Martin. *Council*: Messrs. F. Anslow, Wm. Brown, J. R. Benson, R. Robertson, A. Power, W. Cairns, J. B. Thomson, W. H. Telfer, H. A. McGuffie, S. A. Simon, C. W. Holman, and J. C. McCullum. The strength of the branch is now 122, and suitable arrangements are being made by the local council for the annual meeting of the parent association to be held in Glasgow on October 6th and 7th next, among the functions being a reception by the Corporation.

EDUCATIONAL NOTICE.

City and Guilds Technical College.—This college provides a scientific training for students preparing to become electrical and mechanical engineers or chemists and for engineering pupils who desire to supplement their practical training by a two years' course of instruction in the principles of engineering science. The instruction is mainly given in the various laboratories, most of which have been recently re-equipped. The college does not prepare students to pass external examinations, but a certificate of proficiency is awarded by the Institute to students who complete a satisfactory course of instruction. The subjects of the entrance examination are mathematics and English, but the matriculation of any British University is accepted instead. The courses in electrical and mechanical engineering cover a period of two years and those in chemistry three years. There are also arrangements for three year courses in engineering. Particulars at the college, Leonard-street, City-road, London, E.C., or from the City and Guilds of London Institute, Gresham College, Basinghall-street, London, E.C.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, June 9th (to-day).

PHYSICAL SOCIETY.

8 p.m. Meeting at the Imperial College of Science. Agenda: "The Lüders Lines on Mild Steel," by Mr. W. Mason; "Exhibition of a Model illustrating the Passage of a Light Wave through Quartz," by Dr. H. S. Allen; "Tables of Circular and Hyperbolic Functions for Complex Values of the Argument," by Mr. A. Johnstone; "On the Measurement of Contact Differences of Potential," by Prof. A. Anderson and J. G. Bowen; "Exhibition of Gyroscopic Apparatus," by Sir G. Greenhill, F.R.S., and "A New Method of Approximate Harmonic Analysis by Selected Ordinates," by Prof. S. P. Thompson, F.R.S.

ROYAL INSTITUTION.

9 p.m. Meeting at Albemarle-street. Discourse on "Applications of Physical Chemistry to the Doctrine of Immunity," by Prof. Svante Arrhenius.

TUESDAY, June 13th.

FARADAY SOCIETY.

8 p.m. Meeting at the Institution of Electrical Engineers, Victoria Embankment. Lecture on "Allotropic Forms of Metals," by Prof. E. Cohen.

WEDNESDAY, June 14th.

ROYAL METEOROLOGICAL SOCIETY.

4·30 p.m. Meeting at 70, Victoria-street, S.W. Paper on "Investigation of the Electrical State of the Upper Atmosphere," by Dr. W. Makower and Messrs. A. J. Makower, W. M. Gregory and H. Robinson.

THE LONDON ELECTRICAL ENGINEERS.

Officer Commanding, Col. H. M. Leaf.

The following orders have been issued for the current week:—

Monday, June 12th, "A" Company.—Technical Drill, 7 to 9 p.m.
Tuesday, June 13th, "B" Company.—Technical Drill, 7 to 9 p.m.
Wednesday, June 14th.—Gymnastic Classes, 7 to 10 p.m.
Thursday, June 15th, "C" Company.—Technical Drill, 7 to 10 p.m. Recruits' Drill, 7 to 8 p.m.
Friday, June 16th, "D" Company.—Technical Drill, 7 to 10 p.m. Recruits' Drill, 7 to 8 p.m.
Saturday, June 17th.—No parades.

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HARMONIC ANALYSIS DIAGRAMS.*

BY R. BEATTIE, D.Sc.

According to Fourier's theorem, if y is any single-valued periodic function of θ, we can always represent y as the sum of a series of sines and cosines of multiples of θ in the form

$$y = A_0 + A_1 \sin\theta + A_2 \sin 2\theta + A_3 \sin 3\theta + \ldots\ldots + B_1 \cos\theta + B_2 \cos 2\theta + B_3 \cos 3\theta + \ldots\ldots \quad (1)$$

where A_0, A_1, A_2..... B_1, B_2.....are constants. The constants A_1, A_2... ..B_1, B_2..... are the coefficients of the so-called harmonic components of the periodic variable or its graph; and the variable or its graph is said to be harmonically analysed once these coefficients have been determined.

By writers on harmonic analysis much attention has at various times been directed to simplifying the labour involved in calculating these sine and cosine coefficients, and to this end many abbreviated arithmetical rules and ingenious graphical constructions have been suggested.† For our present purpose it will suffice to remind the reader of the direct or unshortened arithmetical method which is based on the following considerations:—

In the first place, by taking the average over a whole period of equation (1) as it stands, we have

$$A_0 = \text{average value of } y \quad (2)$$

a result which is obvious if we remember that the average value over a whole period of $\sin p\theta$ or $\cos p\theta$, where p is an integer, is necessarily zero.

Again, to determine the coefficient A_n of the sine component of the nth order, multiply both sides of (1) by $\sin n\theta$ and take the average over a whole period of the resulting equation. Remembering that the average value over a whole period of $\sin p\theta \sin q\theta$ or $\cos p\theta \cos q\theta$ where p and q are integers is zero except when $p = q$, when it is $\frac{1}{2}$, and that the average value over a whole period of $\sin p\theta \cos q\theta$ is always zero, we readily see that

$$A_n = 2 \times \text{average value of } y \sin n\theta \quad (3)$$

Similarly, to determine the coefficient B_n of the nth cosine component, multiply both sides of (1) by $\cos n\theta$ and take the average of the resulting equation as before. We thus get

$$B_n = 2 \times \text{average value of } y \cos n\theta \quad (4)$$

In order to prepare the way for subsequent explanation, let it be supposed for the moment that the actual determination by this process of the harmonic components of a given periodic function is carried out with the help of a diagram consisting of a number of parallel scales, as shown in Fig. 1. The base, K_1K_2, of this diagram is taken to represent a complete period, or 360 deg. in angular measure, and is divided up into a convenient number of equal parts, say, m. Through the centre of each part a vertical line is drawn and on each of these verticals a scale of equal divisions is marked off, the scales being the same for all the verticals and all the scales having their zeros on the base line. The scales extend on both sides of the base line and the divisions are marked positive above and negative below.

In using the diagram one complete period of the y-θ graph to be analysed is first drawn in rectangular co ordinates. This must be done on tracing paper and the wave-length or angular period of the graph made exactly equal to K_1K_2. The tracing paper carrying the curve to be analysed is then placed on the diagram, as shown in Fig. 1, so that the base of the curve coincides with K_1K_2.

To find A_0 read off on the several scales of the diagram the intercepts y_1, y_2, y_3, &c., between the curve and its base. Then by (2)

$$A_0 = \frac{1}{m}(y_1 + y_2 + y_3 + \ldots\ldots) \quad (5)$$

To find A_n read off the intercepts y_1, y_2, y_3, &c., as before, and note at the same time the angular distances θ_1, θ_2, θ_3, &c. of the respective ordinates from K_1. Having done this, form

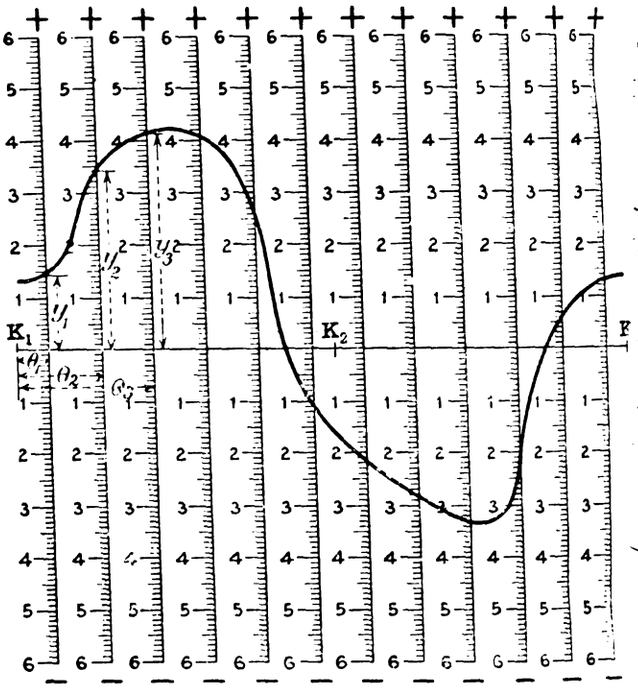

FIG. 1.—DIAGRAM OF UNIFORM SCALES FOR DETERMINING THE CONSTANT TERM IN THE FOURIER SERIES FOR A GIVEN CURVE.

the products $y_1 \sin n\theta_1$, $y_2 \sin n\theta_2$, $y_3 \sin n\theta_3$, &c., add them together and divide by m to get the mean. Introducing this mean into (3) we have

$$A_n = \frac{2}{m}(y_1 \sin n\theta_1 + y_2 \sin n\theta_2 + y_3 \sin n\theta_3 + \ldots\ldots) \quad (6$$

Lastly, to find B_n form the several products $y_1 \cos n\theta_1$, $y_2 \cos n\theta_2$, $y_3 \cos n\theta_3$, &c. Take the mean of these and introduce into (4) which gives

$$B_n = \frac{2}{m}(y_1 \cos n\theta_1 + y_2 \cos n\theta_2 + y_3 \cos n\theta_3 + \ldots\ldots) \quad (7$$

Reciprocal-sine and Reciprocal-cosine Scales.— Apart from inevitable restrictions on the attainable accuracy due to the limited number of ordinates employed, the only objection to the foregoing process is its laboriousness. This arises chiefly from the necessity of performing the various multiplications which are an essential feature of the method. If the necessity for these multiplications could by any means be done away with, and the operations reduced to additions and subtractions the arithmetical method would compare favourably with even the best of the shorter methods that have been proposed.

The suggestion here made is one by which multiplications are entirely avoided by adopting the very obvious expedient of performing them once for all on the respective scales of the diagram of Fig. 1. For this purpose we have but to alter the units of these scales in a suitable manner. Thus, suppose we wish to construct a diagram to enable the coefficient A_n of the nth sine component to be determined. The unit of the first scale would then be made equal to $1/\sin n\theta_1$, that of the second scale equal to $1/\sin n\theta_2$, that of the third scale equal

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* Manuscript received Jan. 17th, 1911.—ED. *E.*

† For an exceptionally complete list of references to the very extensive literature connected with the theory and practice of harmonic analysis, the article of Burkhardt, "Trigonometrische Interpolation: Mathematische Behandlung periodischer Naturerscheinungen," in the "Encyklopädie der mathematischen Wissenschaften," Band II., Theil 1., p. 642 (Leipzig: B. G. Teubner, 1904), may be consulted. The following references are intended to fill up some of the very few gaps in Burkhardt's list and bring it up to date so far as simplified arithmetical and graphical methods of harmonic analysis are concerned:—Perry (THE ELECTRICIAN, XXVIII., p. 362, 1892; *ibid*, XXXV., p. 285, 1895); Sharpe (THE ELECTRICIAN, XXXV., p. 123, 1895); Berson ("Ecl. Elec.," XV., p. 287, 1898); Houston and Kennelly ("Elec. World," XXXI., p. 580, 1898); Fischer-Hinnen ("Electro. Zeit.," XXII., p. 422, 1901); Langsdorf ("Phys. Rev.," XII., p. 184, 1901); Prentiss ("Phys. Rev.," XV., p. 257, 1902); Loppé ("Ecl. Elec.," XXXI., p. 449, 1902; *ibid*, XXXII., p. 287, 1902); Runge ("Zeit. Math.," LII., p. 117, 1905; "Elektro. Zeit.," XXVI., p. 247, 1905); Thompson ("Proc." Phys. Soc., XIX., p. 443, 1905; THE ELECTRICIAN, LV., p. 78, 1905); Lyle ("Phil. Mag.," (6) XI., p, 25, 1906); Harrison ("Engineering," LXXXI., p. 201, 1906); Haga ("Elektrotechnik u. Maschenenbau," XXIV., p. 762, 1906; "Arch. d. Math.," XI., p. 239, 1907); Orlich ("Arch. d. Math.," XII., p. 159, 1907); Hazeltine ("Elec. Rev." (N.Y.), L., p. 235, 1907); Vavreska ("Elektro. Zeit., XXVIII., p. 482, 1907); Slichter ("Elec. World," LIV., p. 146, 1909); Martens ("Ber. der Deutschen Physikal Ges., XI., p. 63, 1909; "Arch. d. Math.," XVII., p. 117, 1910); Fischer-Hinnen ("Elektrotechnik u. Maschinenbau," XXVII., p. 335. 1909); Hermann ("Elektro. Zeit.," XXXI., pp. 56 and 94, 1910); Schleiermacher ("Elektro. Zeit.," XXXI., p. 1,246, 1910).

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$1 \cdot \sin n\theta_2$, and so on, the scales lying above the base being marked with the signs (+ or − as the case may be) of $\sin n\theta_1$, $\sin n\theta_2$ $\sin n\theta_3$, &c., and those lying below the base with the opposite signs. Fig. 2 shows a diagram constructed in this manner. It is clear that if we apply the curve to be analysed to this diagram and read off the intercepts y_1', y_2', y_3', &c., due regard being paid to sign, then from the method of constructing the scales $y_1' = y_1 \sin n\theta_1$, $y_2' = y_2 \sin n\theta_2$, $y_3' = y_3 \sin n\theta_3$, &c. Hence from (6)

$$A_n = \frac{2}{m}(y_1' + y_2' + y_3' + \ldots\ldots) \quad . \quad . \quad . \quad . \quad (8)$$

To construct a diagram to determine B_n, the coefficient of the nth cosine component, we have only to make the units of the scales for the first, second, third, &c., ordinates equal to $1 \cos n\theta_1$, $1/\cos n\theta_2$, $1/\cos n\theta_3$, &c., marking them with the corresponding positive or negative signs above the base, and with the opposite signs below. Fig. 3 shows such a diagram. Applying the curve to be analysed to this and reading off the successive intercepts y_1'', y_2'', y_3'', &c., each with its proper sign attached, then $y_1'' = y_1 \cos n\theta$, $y_2'' = y_2 \cos n\theta_2$, $y_3'' = y_3 \cos n\theta_3$, &c. Hence

$$B_n = \frac{2}{m}(y_1'' + y_2'' + y_3'' + \ldots\ldots) \quad . \quad . \quad . \quad . \quad (9)$$

From their method of construction diagrams like Figs. 2 and 3 might be called "diagrams of reciprocal-sine scales," and "diagrams of reciprocal-cosine scales" respectively. As many of these diagrams would be required as there are coefficients to be determined. A "diagram of uniform scales," like Fig. 1, would also be required to enable the constant term A_0 to be found. A set of diagrams of this kind with scales accurately divided and carefully printed would enable any chosen harmonic component within the range of the diagrams to be evaluated in a straightforward manner and with comparatively little labour, the degree of accuracy attainable depending on the number of scales in the diagram. The curve to be analysed would have to be drawn on tracing paper to the right scale in the first instance. By placing it on the appropriate diagram, reading off on the several scales the successive intercepts between the curve and its base, adding these together algebraically and dividing the sum by $m/2$ (half the number of scales in the diagram), the required sine or cosine component for which the diagram is constructed would be obtained at once and with no more trouble than is involved in the measuring up of an indicator diagram.

If the diagrams used for determining the several sine and cosine components of a curve are all constructed on a uniform plan—that is to say, with the same number of scales in each diagram—then the operation of dividing the sum of the intercepts by $m/2$ could usually be dispensed with, since what is required is not, as a rule, the absolute values of the components, but their relative values only. In these circumstances harmonic analysis would be reduced to a mere matter of addition and subtraction. Circumstances requiring the use of diagrams having a larger number of scales than the normal might arise, however, as when a harmonic of extra high order has to be picked out accurately. In such cases, when the diagrams employed do not all have the same number of scales, the operation of dividing by $m/2$ cannot, of course, be omitted.

Figs. 2 and 3 are correctly drawn 12-ordinate diagrams * for determining the 5th sine and cosine components respectively, the unit of a scale situated at a distance θ from the origin being made equal to $\pm 1/\sin 5\theta$ in Fig. 2, and $\pm 1/\cos 5\theta$ in Fig. 3. In other words, the units of the first, second, third, &c., scales are made numerically equal to $1/\sin(5 \times 15°)$, $1/\sin(5 \times 45°)$, $1/\sin(5 \times 75°)$, &c., in Fig. 2, and $1/\cos(5 \times 15°)$, $1/\cos(5 \times 45°)$, $1/\cos(5 \times 75°)$, &c., in Fig. 3. Besides illustrating the character of the scales, these diagrams provide the reader with a means of estimating for himself the time required to compute a given harmonic. In Fig. 2 the successive intercepts between the curve represented and the base are:— +1·40, −2·32, +1·06, +1·04, −1·93, −1·22, +2·18, −2·08, +0·86, +0·54, +0·40, −1·20, the sum of which is −2·27. Dividing this by 6 (half the number of ordinates in the diagram) we get −0·38 as the required sine component. For convenience in adding, the positive and negative intercepts would in practice be set down in two separate columns as they are read off, and the whole process need not occupy more than about 1 minute.

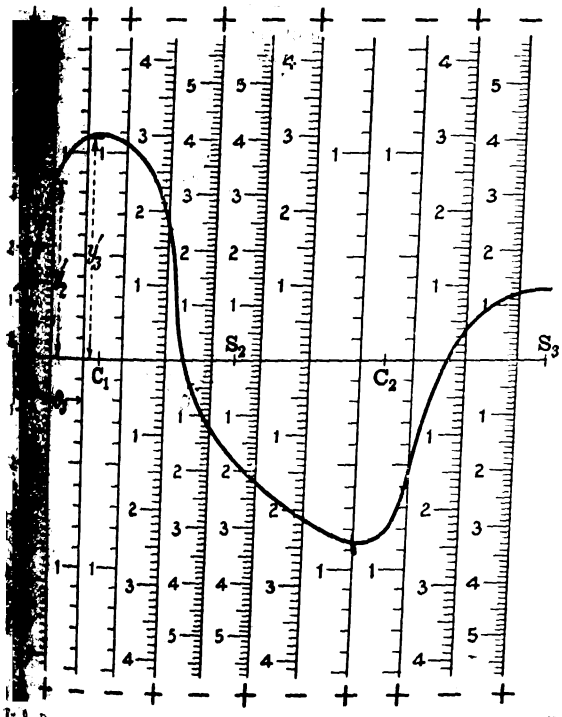

Fig. 2.—Diagram of Reciprocal-Sine Scales for Determining the Coefficient of the Fifth Sine Term.

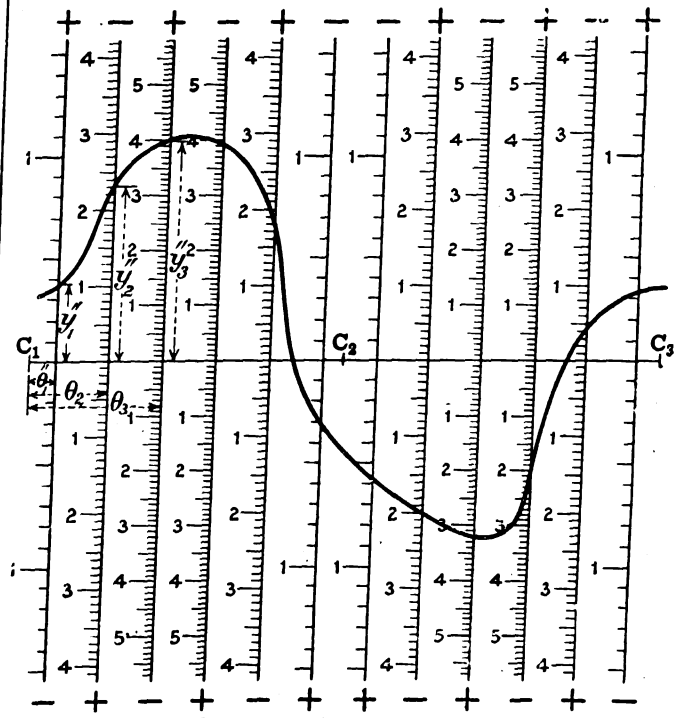

Fig. 3.—Diagram of Reciprocal-Cosine Scales for Determining the Coefficient of the Fifth Cosine Term.

The cosine component, found from Fig. 3 in the same way, is −0·07 and takes an equal space of time to arrive at. If we wish to find the magnitude and phase of the resultant harmonic, we must add a further interval of, say, 1 minute, required to evaluate $\sqrt{(0{\cdot}38)^2 + (0{\cdot}07)^2}$, which is the magnitude, and $\tan^{-1}(-0{\cdot}17/-0{\cdot}38)$, which is the phase, of the resultant. We may therefore put down the total time required to find the magnitude and phase of a single resultant harmonic at, say, 3 minutes. Using 12-ordinate diagrams like Figs. 2 and 3, all the harmonics, both even and odd, up to the sixth order, could thus be determined in about 20 minutes. If diagrams with more than 12 ordinates are used, the time would, of course, have to be increased in proportion.

* These 12-ordinate diagrams are intended for illustrative purposes only; actual diagrams should have at least 24 ordinates, and when greater accuracy is required, or when the higher harmonics are at all prominent, 36 or even 48 ordinates.

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When using reciprocal sine scales to analyse alternating-current or other wave-forms which contain odd harmonics only, and in which the second half of the wave is therefore similar to the first, it is unnecessary to employ the whole diagram for a complete wave. In such cases it suffices to take the graph of half the wave to be analysed and place it on the initial half of the diagram—that is, on S_1S_2 (Fig. 2), or C_1C_2 (Fig. 3). The sum of the intercepts divided by half their number still gives, it will be seen, the value of the sine or cosine component for which the diagram is constructed. In certain circumstances the sine diagram can be used for determining the cosine component as well as the sine component. This can be done in the diagram of Fig. 2, for instance, where the part of the diagram lying between C_1 and C_2 is evidently identical with the part of the diagram lying between C_1 and C_2 in Fig. 3. It is only for harmonics of certain orders and for diagrams constructed with a certain number of scales that this holds good, however, and as a general rule it is necessary to employ two separate diagrams, one for the sine component and another and different one for the cosine component.

(*To be concluded.*)

THE CORROSION OF METALS.*

BY P. LONGMUIR, B.MET.

Theories of Corrosion.—The acid theory depends on the presence of oxygen, moisture and an acid, and mere traces of acidity are sufficient to start the reaction. As generally understood, the primary attack is due to carbonic acid, a ferrous salt resulting, which in turn is acted upon by oxygen and water with the formation of rust and the liberation of the acid. In this manner the process is continuous, and a comparatively small amount of acid may exercise a vast influence. The acid theory has been studied in detail by Friend.† Friend also gives an excellent *résumé* of results obtained by other workers in this direction. The electrolytic theory depends upon the solubility of iron in pure water, or, expressed in another form, upon the presence of free hydrogen ions in the purest water. A large amount of experimental work has been done in this direction, and it has been shown that the rusting of iron is principally due to attack by hydrogen ions. Cushman and Walker have respectively presented the case from the electrolytic point of view in two admirable memoirs.‡ Taking the whole of the work done, the balance of evidence appears to be in favour of the electrolytic theory. However, from an ordinary point of view this is of little moment, for the fundamental differences between the acid and electrolytic theories are theoretical rather than practical.

Consideration of Results.—In discussing problems of corrosion it is frequently stated that the examination of corroded residues is inconclusive. So far as chemical constitution is concerned there may be truth in this, but in the majority of cases of exceptional corrosion a detailed examination of the residue will give some clue as to the cause. Results given in the Paper represent instances noted over a long period of time and a diversity of geographical position, yet one characteristic feature is maintained throughout, and that is the distinct content of sulphur in the residues. To some extent corroded deposits may be taken as an index of the sulphurous character of the surrounding atmosphere. In no problem of corrosion can local conditions be ignored, and in most instances they are of equal importance to the character of the metal which has been corroded.

The Real Problem of Corrosion.—The problem of corrosion does not lie in the amount of metal lost by rust or decay, but on the influence exerted on the metal remaining intact and apparently unaffected. Deterioration is found which is not explained by mere loss in weight or by change in the ordinary composition of the metal. In the case of non-ferrous alloys Arnold§ showed in 1898 the possibility of failure due to deterioration or dezincification of brazing solders and Muntz metal. In 1903 Milton and Larke,‖ in a Paper on the decay of metals, gave many instances of deterioration in non-ferrous alloys and also in cast-iron. Generally speaking these examples represent definite chemical change in the composition induced by external causes. With steels any evidence of chemical change is not easily found, and although physical changes are apparent these cannot be explained on the ground of definite change in composition. It is not easy to follow the brittleness induced in steel when subject to corrosive action, for not infrequently a series of factors may be operating together, and it then becomes difficult to isolate one single factor. This aspect is of particular interest in the case of rails, and in order to get a good starting-point a number of new and unused rails have been tested in various ways. Results obtained from two rails are given here, and it is hoped to publish others when later stages of the work have been further advanced.

Tensile Properties.—The method followed was to cut an 8 in. length of rail in order to obtain values corresponding to different zones. This was known as rail No. 11. Another rail (No. 6) of a slightly different character was cut for tensile tests. The adjoining piece of rail No. 6, from which the tensiles were cut, was machined up into bars of $\frac{3}{8}$ in. diameter. These bars were tested for (1) resistivity, (2) alternating stress, (3) a complete analysis of each bar, and (4) a microscopical examination. By the kindness of Prof. Arnold the alternating stress tests were made on his machine at the Sheffield University.

Sections were examined in detail under varying magnifications, but in each instance the structures were quite normal, and are not therefore reproduced. The extent of variation found in rail No. 6 is summarised as follows:—

Table I.—*Summary.—Rail No.* 6.

—	Maximum stress.	Elongation per cent. on 4 in.	Reduction of area per cent.	Alternation of stress reversals.	Specific resistivity. Microhms per cubic cm.
Highest	44·25	20·5	49·0	342	18·5
Lowest	41·75	16·5	43·0	202	17·8
Range	2·50	4·0	7·0	140	0·7

In view of the distribution of metal in the regular rail section the foregoing highest and lowest values are remarkably near to each other, and the range between highest and lowest is comparatively small except in the case of alternation of stress. Here the range is represented by 140, or from 202 to 342 reversals. From many tests the author believes the foregoing summary to very fairly represent maximum and minimum variations in good quality unused acid rails of British manufacture as made in 1910.

Rail fractures in service may be due to initial defects in the steel, or to faults developed by track conditions, by service, or by environment. Experience in this direction tends to support Dudley's observation, that rail failures are a question of geography rather than one of steel-making. A series of fractured rails have been examined, and two of these may be quoted here. Rail No. 11 gives the following summary:—

Table II —*Summary.—Rail No.* 11.

—	Maximum stress.	Elongation, per cent. on 4 in.	Reduction of area, per cent.
Highest	50·25	21·0	42·0
Lowest	49·24	18·0	39·2
Range	1·01	3·0	2·8

Another fractured rail of the same type gives the following range:

Table III.—*Summary.—Rail No.* 13.

—	Maximum stress.	Elongation, per cent. on 4 in.	Reduction of area, per cent.
Highest	50·58	21·0	45·6
Lowest	48·82	17·5	39·0
Range	1·76	3·5	6·6

Nos. 12 and 13 had developed cracks through defective track conditions, and in both cases the cracks led from the bolt holes of the fish plate. Under such conditions, apart from the actual defect developed, the rail shows no sign of decay or deterioration. Under other conditions rails become seriously embrittled, and observation has shown this to be specially so in the case of tunnel rails, and the effect is intensified in damp tunnels. Rail No. 4 which had been in tunnel service is included for comparison with Rail No. 6. The summary is as follows:—

Table IV.—*Summary—Rail. No.* 4.

—	Maximum stress.	Elongation per cent. on 4 in.	Reduction of area. per cent.	Alternation of stress. reversals.	Specific resistivity. Microhms per cubic cm.
Highest	59·25	15·0	32·5	276	21·9
Lowest .	42·50	1·5	2·0	4	19·5
Range	16·75	13·5	30·5	272	2·4

* Abstract of a Paper read before the Iron and Steel Institute.

† "Journal" of the Iron and Steel Institute," 1908, No. II., p. 5; and 1909, No. II., p. 257.

‡ *Ibid*, 1909, No. I., pp. 33 and 69.

§ "On the Failure of a Steam-pipe of the ss. Prodano, "Engineering," Vol. LXXXV., p. 363.

‖ "The Decay of Metals," "Proceedings" of the Institution of Civil Engineers, Vol. CLIV., part IV.

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The previous history of this rail is not known to the author, but it presented no steel-making flaws or defects, and so far as can be judged is comparable, except in the matter of service, with rail No. 6. The hardening effect, as shown by the highest maximum stress and lowest elongation, is readily apparent. The rail has been rendered decidedly brittle by its environment and service conditions. Other similar instances have been noted, but it has not yet been ascertained how the brittleness progresses into the interior of the rail. Whilst the whole of the results show the embrittling effect, no two samples are precisely alike, and the author has not been able to trace any regularity in the order of development of brittleness. So far, it can only be said that the deterioration of the uncorroded metal, whilst erratic in intensity, is still certain in effect.

The embrittling effect induced by immersion in fairly strong acids is more or less recognised. In many industries, especially that of wire-drawing, acid cleaning is followed by heating in order to remove scale formed. The following tests were made on rail steel rolled down to ⅜ in. rod for convenience in testing. Each result represents the mean of several tests, and unless otherwise stated the rods were immersed only until the scale was removed, then washed in running water and dipped into lime water. The results are given in the following table:—

Table V.—*The Effect of Acid Cleaning on Steel as Judged by the Arnold Alternating Stress Test.*

No.	Treatment.	Alternating stress test reversals.
10	Cleaned by sand blast	200
11	„ in pure sulphuric acid, 1·5 per cent. water	58
12	„ in pure hydrochloric acid, 2·5 per cent. water	47
13	„ in pure acetic acid	59
14	„ commercial spirits	101
14A	„ „ „ and blued	200
14B	„ „ „ and heated to 800 deg.	225
15	„ „ salts	102
15A	„ „ „ and blued	190
16	„ „ „ twice normal time	80
16A	„ „ „ twice normal time and blued	140
16	„ „ „ thrice normal time	53
17A	„ „ „ thrice normal time and blued	100

Nos. 10 to 13 represent laboratory results, and Nos. 14 to 17A were cleaned in an ordinary wire-cleaning house. Bluing represents stoving overnight at a temperature of from 100°C. to 150°C.; and in the case of No. 14A this treatment has sufficed to eliminate absorbed hydrogen, and to restore the material to its original properties. That permanent injury has not followed is shown by the slight improvement following normalising at 800°C. In the other cases permanent injury follows. From a study of many cases it has been found that even slight over-cleaning results in permanent injury. These results have a certain bearing on those shown in the summary of rail No. 4. The degree of acidity is immaterial provided the time of attack is sufficiently prolonged. A slightly acidulated and moist atmosphere will, in course of two or three years, be sufficient to develop brittleness corresponding to that obtained by immersion for a short time in strong acid.

THEORY AND CONSTRUCTION OF PARTIAL-SLOT WINDINGS FOR POLYPHASE GENERATORS.*

BY DR. M. SEIDNER.

Summary.—An account is given of a graphical method of developing the windings on various types of polyphase machines. This is designed to act as a useful aid in the construction of such windings as employed in practice. The theory is applied to a number of different types of commercial machines.

Modern alternators are, in general, constructed with two, three or four-slot windings; that is, they have two, three or four teeth per pole per phase. When erecting new machines in a systematic and rational way it may, however, happen that the builder, in order to employ the dies which he has in stock, is forced to use a solution which, while combining the number of poles, frequency and speed, leads to a dissymmetry in the number of slots per pole per phase. That machine is wound on the partial-slot system, and such cases are often met with. A partial-slot wound machine is obtained when a three-slot three-phase alternator is converted into a two-phase alternator, the number of poles remaining the same; when a generator with a specific speed is adapted for a different number of poles or another frequency; or when a generator is required to run at different speeds with the same frequency and number of poles. It may also happen that, in a certain type of machine, two teeth per pole per phase are not sufficient, while three are too many. In such cases it is advantageous to use 2·5 teeth per pole per phase. Lastly, partial windings can be used in all cases where machines have to be built with one to two teeth per pole per phase in order to cheapen the manufacture or for other special reasons. Partial-slot windings have also the property, as will be shown later, that the E.M.F. induced in them follows more closely the laws of harmonic motion than does that in an ordinary winding with the same total number of teeth.

In the usual full-slot winding the topographical distribution of the teeth belonging to the respective phases and poles is identical. The winding factors of the respective phases and the angle and size of the vectors of the E.M.F.'s induced in each phase are equal. The system is therefore symmetrical. With the partial-slot winding, on the other hand, the topographical distribution under the respective poles and phases is not consequently identical, so that the vectors of the E.M.F. in the phases may differ both in value and phase. The distribution of the teeth has now so to be combined that the phase voltages and angles are as nearly as possible equal. Another problem is so to distribute the teeth that the winding is simple, and that with former windings as few patterns as possible are necessary. With former windings, too, attention must be paid to the possibility of separating the machine.

Researches on the counterbalancing of the phases, the determination of the winding factor of the single coils, and the settlement of the time relations of the resulting phase voltages can be made mathematically. By calculation, the projections of the vectors of the induced E.M.F.'s in the corresponding teeth can be resolved along two orthogonal axes. In this way their vector sum can be obtained, whose ratio to the absolute value of the vectors gives the winding factor of the fundamental harmonic. In the same way the winding factors of the third, fifth, &c., harmonics can be obtained with the

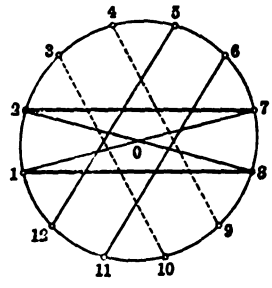

Fig. 1.

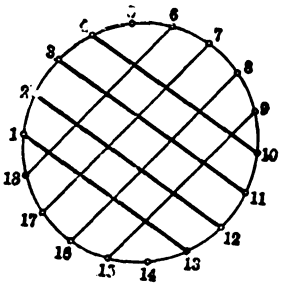

Fig. 2.

difference that the angle of inclination between the components which it is desired to add is three, five, &c., times the angle employed when calculating the fundamental harmonic.

Graphical Representation of the Windings.

In this way, therefore, it is possible to determine accurately and to analyse the winding mathematically. Mathematics is, however, primarily an absolutely indispensable aid to the critical analysis of actual windings. The constructor uses graphical methods with more success, for they make it possible for him to construct a picture of the actual winding, thus facilitating and developing the combination. Having regard to this circumstance, the author has worked out a graphical arrangement to act as a useful aid in the construction of such windings as are employed in practice.

In Fig. 1 is shown the circumference of a three-phase generator wound on the two-slot method. It is thus divided into twelve equal parts. Teeth 1, 2 and 7, 8 belong to phase I., 3, 4 and 9, 10 to phase II., and 5, 6 and 11, 12 to phase III. If the radius of the circle represents the maximum value of the E.M.F. induced in one tooth, then the diameter drawn between the points of division represents the corresponding E.M.F. from which the momentary value may be determined. The diameters are also the vectors of the corresponding E.M.F.'s, and the sum of the E.M.F.'s in any one phase can thus be determined from the corresponding vectors. The resultant of any two vectors can be determined, and taking this property into account the division points of opposite polarity in the respective phases can be connected up as desired. These connections should be made with a view to obtaining the best results.

In the foregoing case a general picture can be obtained when the corresponding points of opposite polarity in the respective phases are connected by means of parallel chords, as shown in Fig. 1. Vectors 1 to 8 and 2 to 7 are in phase I., 3 to 10 and 4 to 9 in phase II., and 5 to 12 and 6 to 11. in phase III. Hence it is clear that the resultant vectors of the respective phases are at an angle of 120 deg. to each

* Abstract of a Paper in the "Elektrotechnik und Maschinenbau."

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other. Further, the resulting vectors belonging to the respective phases are equal in value. These windings are therefore symmetrical.

The vector diagrams given apply only to two poles. With full slot winding the distribution of the teeth under the respective poles is identical, so that the diagram exhibits the phase relations of the winding for the whole machine. When, however, in multipolar machines, the distribution of the teeth is such that the same tooth arrangement is only repeated after more than one pair of poles, it becomes necessary, in order to determine the vector values proportionate to the resultant phase voltages, to take into account as many circuits as there are pairs of poles, until the original tooth distribution is repeated. It is then possible to sum vectorially the resultants obtained from the respective calculations. These circles can now be superposed, or, in other words, the whole operation is identical to arranging the teeth under different poles, as if they were under two poles in accordance with their topographical position.

If the number of teeth per pole per phase is z, under p poles per phase there will be zp teeth, and the total number of teeth in q phases will be zpq. The same tooth arrangement is therefore repeated after that number of poles for which the product $zpq = c$ is the least whole number. This gives:

$$zpq = c \text{ min.}$$

The winding and vector diagram can naturally be completed only for even-numbered poles, so that in the equation

$$zq = \frac{c}{p}$$

the value of p is always an even number. The vector circle is divided into c parts. The diagram contains the total number of teeth, zpq, under p poles, which, however, should be reduced to that under two poles, so that in the two-pole vector diagram $zp/2$ teeth per pole per phase occur. Each division corresponds to one tooth. With full-slot winding the vector circle must be divided in a corresponding

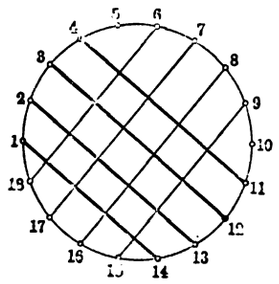

Fig. 3.

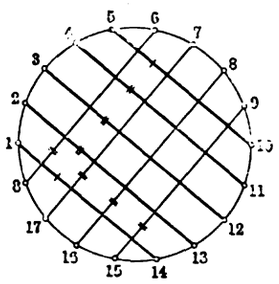

Fig. 4.

manner to the number of teeth from two poles. On the other hand, with partial-slot winding the vector circle must be divided into as many parts as there are teeth under each repeated group of poles. The number of divisions is in most cases greater than with the full-slot winding. For this reason the induced E.M.F. curve with partial-slot winding corresponds more nearly to sine form than does a full-slot winding with an equal number of teeth.

When, however, the number of poles in which the slot distribution is repeated is employed as the minimum number of poles, there is no guarantee that the induced phase voltages and phase angles will be equal. Such equality is only certain when $zp/2$ is a whole number. In this case the vector diagram in all three phases will be completely symmetrical.

If the number of teeth per pole per phase of the machine $zp/2$, when reduced to two poles is an odd number, the division points of the vector diagram can be no longer joined. In this case the winding can only be effected when each phase has not an equal number of teeth, or when certain slots are left empty. In order to make possible the connection when there are an equal number of teeth in each phase without leaving certain slots unwound, the smallest value of n must be found for which

$$\frac{zp}{2}n = \frac{z}{2}\mathrm{P}$$

is a whole number. This means that the vector diagram will be completed when the number of poles is $np = \mathrm{P}$, so that each division of the diagram will represent n teeth. The divisions of the vector diagram may then contain the teeth of the two different phases. The original vector diagram will then be again analysed.

After the diagram, reduced to two poles, has been drawn out and the division points relating to the respective phases have been connected together by suitable means, the vectorial sum of these vectors must be determined, and the resulting vectors equalised with regard to length and direction. If these latter correspond, the p pole winding arrangement can be found from the two-pole diagram. For this purpose the dividing points of the diagram are numbered, each dividing point receiving n numbers. The number of each $np/2$th point is now noted progressively with its phase. In this way the tooth arrangement for a machine with p poles is arrived at.

If the number of slots for a machine with q phases is written down in q horizontal rows, so that the vertical columns give the division of the slots per phase lying under the respective poles, it is then possible to obtain a very clear picture of the winding.

Practical Partial-Slot Windings.

Two-phase 4·5 Slot Windings.—A two-phase winding with nine teeth per pole is known as a 4·5 slot winding. Such a winding is obtained when a three-phase three-slot-wound machine is changed into a two-phase machine without altering the number of poles. In this winding the number of teeth per pole per phase, $z = 4{\cdot}5$, the number of phases $q = 2$; so that $qz = c$ $p = 4{\cdot}5 \times 2 = 9$. Now c, the number of teeth, and p, the number of poles, must be so arranged that with p the smallest even number the value of c is a whole number. If $p = 2$, then $c = 18$. The vector diagram, when $p = 2$, is therefore drawn out, and

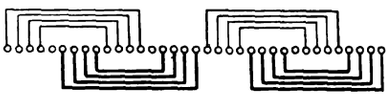

Fig. 5.—Diagram of a 4-Pole Two-Phase 4·5 Slot Winding with Four Empty Slots.

the circle divided into 18 parts, c being 18. In a two-pole vector diagram there are $zp/2 = 4{\cdot}5$ teeth per pole per phase, which is a whole number when $n = 2$. It follows that the minimum number of poles for which the winding can be completed without leaving any slots free is $np = 4$.

It may not be without interest to analyse this winding first in the case when some slots are left free. The circle in Fig. 2 is divided into 18 parts for two poles. The connections for two poles can be differently arranged. It is, however, quite clear that the vector of the two phases neither correspond in value nor in angle. If slots 5 and 14 are left empty, and the then remaining divisions connected, the resulting vectors of both phases will be truly equal but will not be at right angles to one another. If the phase angle is made 90 deg., the values of the two vectors will be very different the one from the other (Fig. 3). If a bipolar solution only is required, the latter is the more suitable. In this case the difference between the resulting vectors is not large, when slots 5—10 are left empty. The difference between the phases is about 1·5 per cent.

In the other case the vectors of both phases are equal but the angles differ by about 10 deg. Naturally, so great a difference is not permissible. In the four-pole arrangement in the diagram in Fig. 4 each division represents two teeth, one tooth in each of the divisions 5, 10, 14 and 1 being left free. Between the resultant values of the phases stands the relation $\cos(10°) = 0{\cdot}98481$, that is the second phase is about 1·52 per cent. greater than the first, as in the former case. The winding diagram for this case is given in Fig. 5.

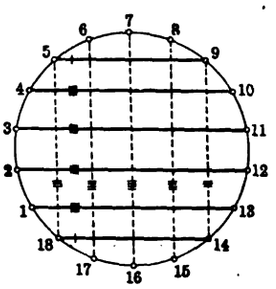

Fig. 6.

By using eight poles the difference between the phases can be reduced practically to zero. With eight poles each point of division represents four teeth, and the divisions 5, 10, 14 and 1 each contain two teeth. It is known that the resultants of the second phase is greater than the resultant of the first phase. If the free slots are so filled up that the shorter vectors 1 to 5 and 10 to 4 and the shorter first phase contain the longer vectors 5 to 10 and 1 to 14, the difference between the phases can be shown by calculation to be only 0·15 per cent. (Fig. 6). A diagram of the eight-pole winding is given in Fig. 7.

To sum up, it will be seen that the two-pole two-phase 4·5 slot winding for two poles can be arranged in such a way that one slot is left free under every pole. In this case the angle between the phases is 90 deg., while between the vectors of the phases there is a difference of 1·5 per cent. With an eight-pole arrangement, all the slots can be used, and there is practically coincidence between the phases. The head connection of the windings can be effected in two planes, and the machine is therefore divisible into two parts.

2⅔-Slot Winding.—The opposite problem to that given above is presented by the three-phase 2⅔-slot winding which is obtained when a two-phase machine with a four-slot winding is converted into

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three-phase machine with an equal number of poles. In this winding $z=2\frac{2}{3}$ and $q=3$, so that $c/p=3\times 2\frac{2}{3}=8=16/2$, and the tooth distribution is repeated every pole. The vector diagram is divided into 16 parts. Only when $n=3$ is $\frac{1}{2}nzp$ a whole number, and each division will then represent three teeth. The difference between the vectors is shown by calculation to be about 1 per cent. Such a difference between the angles is permissible in a machine with a large voltage drop. The winding scheme is given in Fig. 8, the main connections being arranged in three planes.

It follows, therefore, that a $2\frac{2}{3}$-slot winding can only have an equal number of teeth per phase when there are at least six poles. With

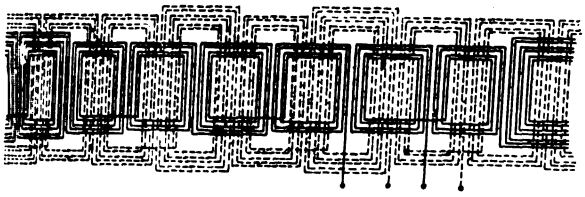

Fig. 7.—Diagram of an 8-Pole Two-Phase 4·5 Slot Winding.

the six-pole arrangement neither the E.M.F. induced per phase nor the phase angles are equal. With an 18-pole arrangement the difference between the phases is reduced to a very small value, so that they are practically symmetrical.

Three-phase 2·5-Slot Winding.—A very frequently used partial-slot winding is the 2·5-slot winding. It occurs in cases where a 42-frequency generator has to be turned into a 50 frequency generator, keeping the number of poles and speed the same. The number of teeth per pole per phase must be altered in the ratio 42/50, so that a three-slot winding becomes a 2·5 winding. The number of teeth per pole per phase is $z=2·5$, the number of phases $q=3$, so that $c/q=7·5=15/2$, so that the teeth distribution is repeated every pair of poles. As, however, $zpn/2=5n/2$, only when $n=2$ is this factor a whole number. It follows that a winding without empty slots can only be arranged on this system with more than four poles.

The three-phase 2·5 tooth winding can be arranged by leaving every third slot in the two-pole arrangement free. To have every slot filled the lowest number of poles is four or some multiple thereof. The winding is in every case absolutely symmetrical.

4·5 Three-Phase Slot Winding.—If the machine speed is altered in such a way that the number of poles must be changed from 12 to 8, a 4·5 wound machine is obtained from a three-slot winding. In this winding $z=4·5$ and $q=3$, so that $c/p=13·5=27/2$. That is the vector diagram must be divided into 27 parts. As, however, $zpn/2$ is only a whole number when $n=2$, it is clear that such a winding can only be arranged for a machine with four or more poles.

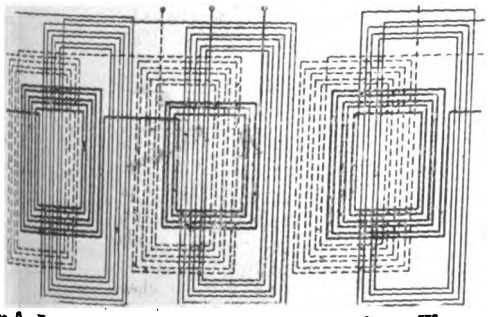

Fig. 8.—Diagram of a 6-Pole Three-Phase $2\frac{4}{5}$ Slot Winding.

Three-Phase 2·4-Slot Winding.—This winding seems very complicated, but is in reality very simple. In this case $z=2·4$ and $q=3$, so that $c/p=7·2=72/10$. That is the same slot distribution is repeated every fifth pole, and the vector diagram must be divided into 72 parts. As $zpn/2=12$ is a whole number when $n=1$, it is clear that this winding is symmetrical for all three phases, that is, the voltages induced in the single phases are equal while the phase angles are 120 deg. With 10 poles this arrangement gives absolute equality between the phases.

THE SEMI-AUTOMATIC METHOD OF HANDLING TELEPHONE TRAFFIC.*

BY E. E. CLEMENT.

Summary.—The author describes a semi-automatic system of telephony which is in use in several towns in America. The subscriber asks for a number in the usual way and the connection is then made automatically by an exchange operator pressing appropriate keys. A comparison of the results obtained by this system and the ordinary manual arrangement is given.

The author begins his Paper by comparing the automatic and manual systems and shows that when a large amount of junction line work is necessary, the cost of the latter system as compared with the former is unnecessarily high. Further, in the full automatic system, though certain advantages are obtained, certain other disadvantages are introduced; it substitutes the untrained subscriber for the highly-trained operator without saving more than 50 per cent. of the running costs under the most favourable conditions and allows certain faulty calls to go through which would be prevented on the manual system.

The fundamental principal underlying the Clement auto-manual system is that the calling subscriber should be met at once by the response of a human intelligence which can direct the proper automatic agencies to satisfy his wants; or, in other words, that the correct method of handling telephone traffic is to sell service and

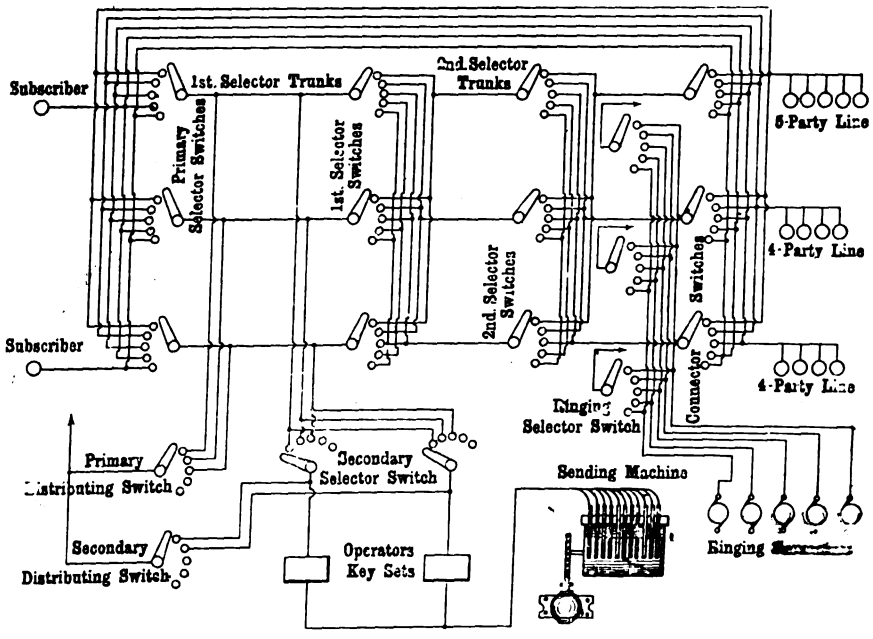

Fig. 1.—General Arrangement of Auto-manual Exchange.

not rent apparatus. Stated broadly, the auto-manual is a combination of the manual and automatic methods which contemplates the centralisation of automatic apparatus; the employment and concentration of operators; and the correct sub-division of a system for traffic handling.

The apparatus is all concentrated at exchange centres, the subscribers' lines and telephones being reduced to the common battery type. The sub-station construction, and the connection and distribution of lines at the exchange centres are the same in the auto-manual system as they are in any modern standard common battery system. With regard to the operators they are restricted to the only function requiring intelligence, that is, ascertaining the subscriber's want and setting up a signal by which automatic apparatus may be caused to supply that want. It is possible to concentrate all the operators at a single operating centre, which can take care of all the switching or exchange centres in a district or even in an entire city, handling all calls with maximum efficiency, and giving uniform service, 24 hours per day, regardless of the nature of the calls or the time of calling.

The accompanying illustration (Fig. 1) is a simplified skeleton diagram showing the general lay-out of an auto-manual exchange equipment having a capacity up to 10,000 lines. In this diagram, five subscribers' lines are shown, one of which is a five-party line, two others are four-party lines and the remaining two are individual lines. Ringing is supposed to be five-party selective. For the sake

* Abstract of a Paper read before the American Institute of Electrical Engineers.

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of clearness only the most elementary forms of apparatus are shown. The switches, however, are supposed to represent two-motion, 100-point, electromagnetically-driven, step-by-step automatic units, of uniform type. Percentage trunking is employed throughout the system shown, and the switches are equipped with banks containing 10 vertical rows of 10 contact pairs each. The motion is around and up, this precedence of the rotary motion affording certain advantages. The entire system is built up of interchangeable units. The individual or unit switch is composed of a certain number of interchangeable units, such as the spindle with its wipers, the frame, and the interchangeable operating magnets; each switch or trunk circuit, such as the primary and first selector, the second selector and the connector equipment, is assembled complete as a unit, the latest designs having steel mounting plates upon which the unit switches with their relays, condensers, &c., are mounted and wired up complete, previous to being assembled on the racks; a sufficient number of switch plates, with the line and cut-off relays, lamp strips and other accessories, are mounted on a frame section to form a 100-line unit; and finally these 100-line unit frames are aggregated to build up the full exchange equipment, adding thereto, of course, the operators' and wire chief's desks, power plant, &c.

In Fig. 1 the circuits have been laid out so as to show in a simple way the analogy between this system and a manual switchboard system, the same operations being performed in the same manner throughout, but automatically instead of manually. For example, the subscribers' lines terminate on primary selector bank contacts which correspond to the answering jacks of the manual board, and they are also multipled to calling contacts in the banks of the connector switches, which correspond to the multiple jacks on the manual board. The wipers of the primary selector switches constitute the equivalents of plugs which co-operate with the subscribers' answering jacks, but are mechanically driven instead of by the hand of an operator. The first selector switches similarly correspond to the calling plugs of manual pairs, and the first selector trunks extending between the primary and the first selector switches are the equivalents of the cord circuits. The second selector and connector trunks are the same as trunk lines between different positions on a switchboard, the method of switching at each step corresponding to the selective insertion of another plug to add another link in the connection by a manual operator. The secondary selector switches constitute the equivalents of the operators' keys associated with the cord circuits, and the sending machine operated thereby sends impulses to work the selector and connector switches, instead of spoken words to direct an equivalent number of successive operators. The primary distributing switch performs the function of the operator's mind in selecting an idle cord circuit for any given connection, and the secondary distributing switch is the equivalent of a monitor distributing calls among the operators, by directing each one of them when to answer. The ringing selector switches take the place of the selective buttons of "B" or trunk operators so that the selection of the desired generator to ring a particular subscriber is directed by impulses from the sending machine, instead of by spoken words proceeding from the original or "A" operator. To complete the analogy, the releasing means for all the switches when in service are controlled by the connected subscribers, thus corresponding to the supervisory signals, by which in a manual system the subscribers can instruct the operators to clear out. All subscribers' lines are represented by terminals in the primary selectors and in the connector banks.

The progress of a call is from the calling subscriber through an idle primary selector, which becomes automatically attracted to his line, and thence through a secondary selector, similarly attracted, to an idle operator. Under no conditions is this departed from. The principle is that the operator should be brought into direct touch with the subscriber at the very outset, precisely as in a manual system. Having ascertained the number, the operator sets up this number on her key set (Fig. 2) and sends impulses through her circuit to the first selector, second selector, connector, and ringing selector switches, thus establishing the wanted connection, and also starting agencies in the connector circuit which continue thereafter automatically to ring until the called subscriber answers or the calling subscriber hangs up the receiver. After initiating the call, the calling subscriber's line is connected through the primary and secondary selector switches to the operator in every case, and further movement of a subscriber's hook or the repeated opening and closing of the circuit will not reach more than one operator, and cannot disturb general traffic conditions. This happens sometimes through change of purpose or the like, and it is highly essential that the auto-manual operator should not experience the slightest delay, nor pay attention to anything except the rigid rule of getting the number and setting it up. After the operator has answered, the calling subscriber is given full control of the connection, and can clear out and release all the apparatus at any time up to the moment when the called subscriber answers. Thereafter, the called subscriber assumes control of the connector switch, which he can release so as to clear his line by merely hanging up his receiver. This prevents tying up the called line.

When the operator connects the sending machine to the switches, through her key set, impulses are sent in groups corresponding to the several keys depressed, that is to the number wanted, as well as to the number of the generator required to ring the wanted party, if it be a party line. The first group of impulses steps around the first selector switch to pick out a group of second selector trunks, and an idle trunk in that group, leading to the wipers of the second selector switch. The second group of impulses works this second selector switch and picks out a group of connector trunks, and an idle trunk in that group, terminating on the wipers of a connector switch in whose banks appear the terminals of the wanted line. Successive groups of impulses are then transmitted to step the connector wipers round and up to the wanted line terminals.

Associated with each connector switch is an auxiliary or ringing selector, having a wiper sweeping over terminals which are connected to several ringing generators, as shown, each of which supplies current at a distinctive frequency.

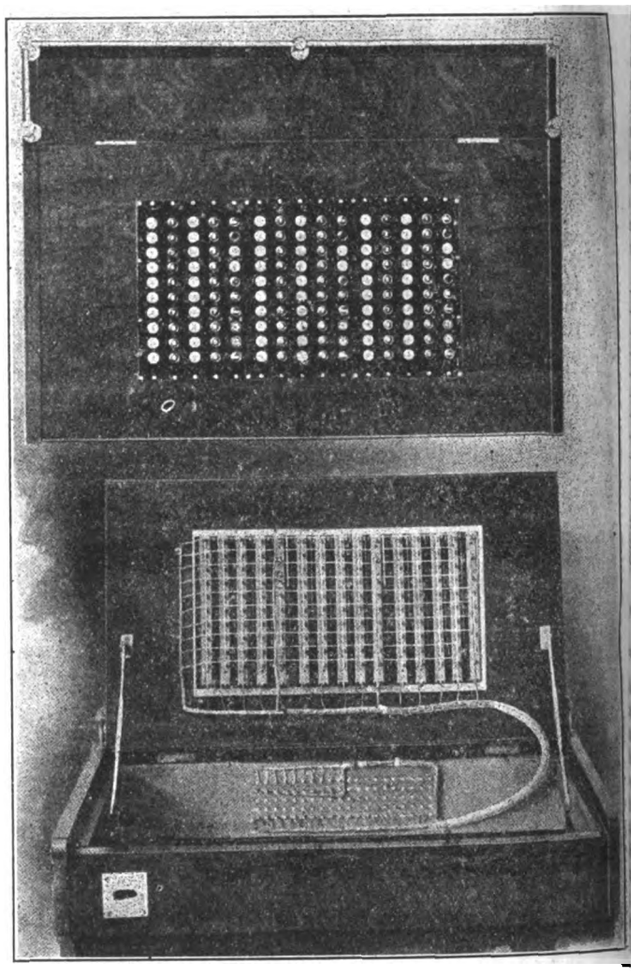

FIG. 2.—KEYBOARD OF CLEMENT AUTO-MANUAL SYSTEM.

At the last stage in a connection, when the wanted subscriber's line has been picked out by the connector switch, and the ringing selector has been set so as to bring into service the proper generator, that generator is then automatically connected by a ringing relay to the subscriber's line to ring his bell. At all other times the ringing selector remains disconnected.

The control of the primary selector switches is through relays on the switch racks, responsive to line current. These relays complete local circuits to place test potential on the test contacts of the primary selector switches, and at the same time close starting circuits for the idle trunks and operators. A type of relay is employed both for the lines and switches, which is the result of much thought and experiment. This relay has its armature bent over at both ends, the inner end being screwed to the rack, and the outer end carrying the adjustment for the magnet core. The bell crank armature is dropped through a slot punched in the main armature near the rack end, and the springs are mounted on this same end, so that both the armature

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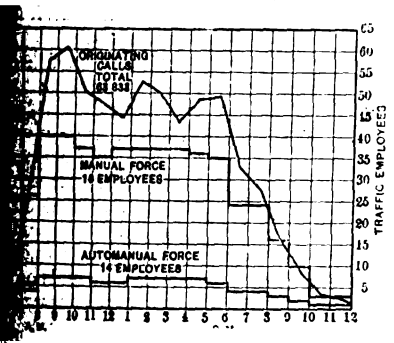
lever and the springs extend forwardly. This construction gives a long leverage with a very small air gap which is essential for this class of work, and also exposes the core adjustment and spring contacts.

The operation of the secondary selector switches is essentially the same as that of the primaries. As soon as the primary distributing switch has determined the primary trunk to be connected to the calling line, the secondary or operator's switch tests until it reaches the trunk, where it stops, and remains connected to the trunk until finally released, which may be by the calling subscriber hanging up after the operator has answered, or at the conclusion of a cycle of impulses, whereby a complete connection is established. The interrupters and sending machine are timed so as to deliver at the rate of about 1,000 impulses per minute, with the battery voltage normal. Any drop in the battery which would affect the switches is compensated by a corresponding drop in speed of the sending machine. At the normal speed stated, however, a high number line in the calling group and a high number trunk in the corresponding group, can both be found and connected in less than one second and a half. Where the numbers are low the action is practically instantaneous.

Each operator has three key-sets mounted on a suitable desk, each associated with it certain signals which guide the operator in the discharge of her duties. The key-set in general appearance is quite similar to the keyboard of an adding writer, consisting of a number of strips of 10 keys from 1 to 0 in each vertical row. One of the keys with these keys is a calling lamp, which is lighted when the key-set becomes connected through switch to a first selector trunk already connected to a call. Observing the signal, the operator asks the subscriber number wanted, and proceeds to depress the corresponding buttons. She then presses a separate starting key,



...SON BETWEEN THE OPERATION OF A MANUAL AND AUTO-MANUAL SYSTEM.

...employees in manual force should apparently be 61.—ED. *E.*]

...impulses, corresponding to the buttons depressed, will be transmitted as already stated. The wanted subscriber's bell is automatically rung at intervals until the call is answered, but in the meantime it is both unnecessary and undesirable to hold the operator, and so the secondary switch is cut off from the line by the sending machine as soon as the ringing starts. The duplicate sending machines are arranged with changeover gear enabling either to be thrown in or out in case of breakdown. Each machine comprises a cam drum working 10 pairs of contacts, with separate controlling contacts and a commutator. On one side the commutator is earthed and on the other is connected to all of the number spring sets, and the number cams are so arranged that in the rotation of the drum they make and break at the zero potential on the commutator, thereby avoiding sparking at the collective terminals. The operator's key set is normally disconnected from the sending machine, but is connected thereto when the starting button is pressed, by means of a switch or relay, after the whole number of groups of impulses has been transmitted. The secondary selector is released automatically. The operation is the same when junction lines have to be used.

A comparison between a manual and an auto-manual operating system handling a traffic load is shown in Fig. 3. This traffic load is that of 4,162 working lines connected with a main and a branch exchange located in a western city. About 21 per cent. of all calls originated are trunked. The calls handled during the busy hour in the busiest months average about 185 per manual operator.

	THE AUTO-MANUAL FORCE.
...ation.	2 chief operators
...erator	1 relief operator
...tors	11 operators
61 employés	14 employés.

It will be noted that the manual "B" or trunk operators and the trunk calls are omitted from this chart. The auto-manual makes its greatest saving where branch exchanges are employed; the heavier the trunking, the greater the saving with auto-manual because it eliminates trunk operators. Notwithstanding that the chart deals only with "A" operators, a reduction in employés in favour of auto-manual amounting to 77 per cent. is nevertheless effected.

THE DETERMINATION OF LONGITUDE BY RADIO-TELEGRAPHIC TIME SIGNALS.*

BY M. TISSOT.

The constant care of the navigator is to know at each instant his position. Observations of the stars easily furnish the latitude; but the longitude may only be obtained from the difference of two angles, and its determination necessitates a knowledge of the local time and the time of the meridian origin—Paris, for example. It is this last determination which gives the difficulty, as local time is furnished by observations of the stars with the same facility as latitude.

As everyone knows, the time of the meridian origin is obtained by means of a chronometer which the navigator carries with him. Everything depends on the quality of this chronometer and the more frequently it is checked the greater will be the confidence one may have in its indications. If these checks can be obtained at sufficiently short intervals the *quality* of the chronometer will have lost its importance.

During the course of experiments undertaken by the Commission Centrale de la Marine, in November, 1907, it appeared, amongst other results, that our ships received with perfect regularity the signals emitted by the Eiffel Tower, in the Mediterranean and on the Atlantic coast of Morocco. From this I thought of proceeding to a series of systematic trials in order to find out under what conditions it was possible to utilise the Eiffel Tower station

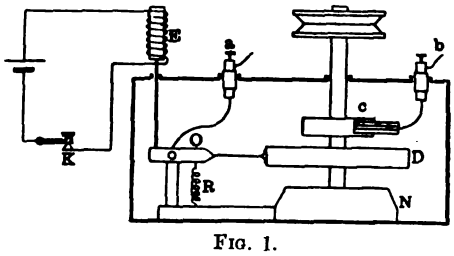


FIG. 1.

for the transmission of time signals. Thanks to the collaboration of Commandant Ferrié, it was possible to execute these experiments between the Eiffel Tower and Brest in December 1907.

The trials consisted in obtaining by the aid of "dots" sent from the Tower, the comparison of chronometers of known rates, placed at each of these stations. Very concordant values were obtained, agreeing to 0·5 sec.; an approximation amply sufficient for ships. As a result of these experiments, a service of regular time signals was commenced in May, 1910.

The signal consists of a "dot" emitted at midnight—Paris mean time—preceded by a *call* signal. This is repeated at 2 min. and 4 min. past midnight. The call signal is sufficiently characteristic to render confusion impossible and is actuated by hand with a Morse key; but the real time signal is controlled automatically by a clock at the Observatory of Paris.

The emission from the Tower necessitates the making and breaking of a current of 50 amperes by means of a device actuated by a relay controlled from the Observatory. This is done by a mercury jet interrupter designed by Commandant Ferrié. A small turbine forces mercury under pressure through a tube pivotted on a horizontal axis O (Fig. 1). By means of a spring, R, this tube is, normally, directed towards the fixed part, N, of the turbine. On closing the key, K, a current in the coil, E, attracts a plunger causing the tube to turn, so that the stream of mercury impinges on an amalgamated copper disc keyed to the axis of the turbine. The main current is thus closed through the mercury jet. On opening K, the jet falls and the current is broken without the production of an arc. To secure a quick break, it should be produced in a liquid dielectric, by filling the turbine with paraffin or alcohol.

With the assistance of M. F. Pellier, I have produced a very easily managed receiver, suitable for small ships, the low cost of which enables it to supplant an expensive chronometer.

* Abstract of an article in "La Technique Moderne."

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It consists of an Oudin resonator (Fig. 2) of rectangular form, the secondary of which is fixed and constitutes, with a condenser, C, also invariable, a resonating circuit, tuned once for all to the period of the waves emitted from the Eiffel Tower. A detector is inserted in this circuit with a telephone across its terminals. The primary is inserted between the antenna and the earth and consists of the part of this solenoid between M and the sliding contact, A. This sliding contact is moved until the sound in the telephone is a maximum. The detector, which is of the solid contact type and requires no auxiliary battery, consists of a fixed electrode (Fig. 3) which is a small piece of sulphide of copper, or galena, and an adjustable electrode consisting of a fragment of zinc oxide; the whole being enclosed in a protecting brass cylinder.

As the time signals make it possible to obtain Paris time every 24 hours, it is sufficient for a ship furnished with receiving apparatus, to possess a good watch to act as daily timekeeper. With the present installation at the Tower, the reception of radiotelegraphic time signals may be considered certain within a radius of 2,000 km.; and this distance will be considerably increased when the new more powerful station is working.

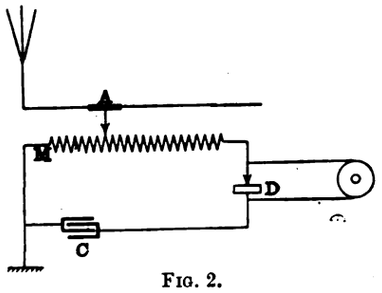

FIG. 2.

The observation of a single "dot" is not sufficient to fix the precise value of a difference of longitude. In order to use the *method of coincidences* a series of periodic signals is necessary. For this purpose M. Claude has adapted the Lippmann pendulum, electromagnetically maintained, in the following manner. Two silver wire circles, *a* and *b* (Fig. 4) are fixed to two supports, *m* and *n*, and are inserted in the circuit containing the cell, P, and relay, R. A small piece of silver carried by the pendulum closes the circuit as the pendulum passes through the vertical. The duration of contact is long enough to secure the working of the relay; this can be regulated by micrometer screws which allow the supports, *m* and *n*, to be displaced. At each beat of the pendulum, the relay is actuated and closes the circuit, E (Fig 1), so that a spark is produced. The successive beats thus gave rise, in the receiving telephone, to a series of ticks.

It is then easy to compare two pendulums placed at any two stations, A and B, by using as intermediary a pendulum at a third station, C. In order to apply the *method of coincidences* the length of the pendulum at C is adjusted so that its time of vibration is slightly greater than that of either of the pendulums to be compared.

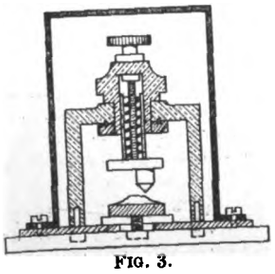

FIG. 3.

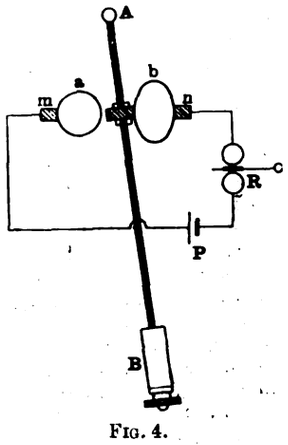

FIG. 4.

This method has been applied to the determination of the difference of longitude between Paris and Brest; the pendulum C being at the Eiffel Tower, A and B at the Observatory at Montsouris and the radiotelegraphic station at Brest respectively.

By the aid of a microphone the beats of a local chronometer were observed in the receiving telephone together with the signals from C.

The microphone is inserted in the primary of an induction coil, the secondary of which is connected to the receiving telephone; adjustable resistances in both primary and secondary make it possible to equalise the intensity of the beats from the chronometer with that of the signals transmitted by wireless telegraphy.

The object of the experiments was not the determination of a difference of longitude already known, but to test the radiotelegraphic method, by comparing two chronometers, one at Paris, the other at Brest, on the one hand by the telephone, on the other, by the beats transmitted from the Tower by wireless telegraphy.

The results were perfectly satisfactory, the difference, if there be one, between the telephonic and radiotelegraphic comparisons being certainly less than 0·01 sec.

THE ELECTRIC DRIVING OF LIGHT ROLLING MILLS.*

BY G. J. HOOGHWINKEL AND F. THURSFIELD.

As compared with heavy reversible mills the problem of light mills is an easy one, although the electric drive for reversible mills is even more advantageous, but the usual bugbears, such as high installation cost and complicated equalising plant, do not enter into the comparison to the same extent. On the other hand, the various applications of electric driving offer a much wider field to the electrical expert if more economy and simplicity is to be obtained.

The question of final economy is a very complicated one, and the case is not quite so clear as in the analogous case of the electric-driven winding engine, because, in the case of the reversing rolling mill, the stored energy of the system cannot be utilised for starting again. The flywheel masses of rolling mills and the radius of gyration are small, and there is no question of direct electric braking, giving energy back into the system, but the mill comes to a standstill almost immediately the current supply is cut off.

The authors indicate how economy in many of the existing steam-driven plants could be obtained by the use of exhaust steam turbines, and then pass on to the consideration of gas engines for this purpose. The first engines in this class of prime mover were invariably too small, and now they are more expensive in first cost than steam engines, though the running costs are about the same, if the value of the furnace gases be taken to be ½d. per 1,000 cubic ft. It is practically certain, however, that the cost of gas is much higher.

From their peculiar properties, electric motors are particularly applicable to mill driving, as compared with steam engines. Until recently the difficulty of speed variation was regarded as an objection to the motor, elaborate arrangements of stepped rope pulleys and screw traversing gears being adopted in some cases. In the last year or two several methods of overcoming these difficulties have been perfected, and satisfactory arrangements for producing three or four different speeds quite economically are now available.

The question of economy entirely depends on circumstances. A large majority of the mills in the Black Country are driven by steam generated from the waste heat of the coal-fired furnaces. With this system ample steam is produced for driving the mill, and the cost of power consists of the attendance and stores, plus the capital and maintenance charges on the engines, the numerous small scattered boilers, and the ramification of steam pipes needed to combine them. Though these upkeep charges are undoubtedly heavy for the power of the plant, they are small as compared with the cost of electrical energy for the work they perform. If, however, the cost of fuel used is taken into consideration, it will be seen that it is a very large item in the production of, say, a ton of rails as compared with the cost of the electrical energy needed for rolling. A ton of rails can be rolled from the ingot for about 60 units, or for, say, 2s., taking current at 0·4d. per unit. With improved regenerative furnaces it should be possible to save at least 2s. per ton of metal in the fuel required for puddling, re-heating, &c.

As to the capital cost, this will not be a very serious item when both electric power and gas can be obtained from a supply company. Taking 10 per cent. on the capital cost of the motors, switchboards, starters, flywheels, couplings, foundations, &c., it should not work out at more than 3d. per ton of finished material, provided the plant is kept fully loaded. This small charge would be more than covered by the saving on the upkeep of boilers, pipes and engines, without taking into account the saving in space effected by the change.

As a guide to the relative cost of upkeep of the two classes of machinery under severe usages, the experience of the Mersey Railway Co. may be quoted, where the upkeep of the generating station plant, conductor rails, motor and all electrical gear is 6 per cent. less per train-mile than the maintenance of the steam locomotives.

It is now generally admitted that an increased output may be obtained from a given mill when electrically driven. This is due to two causes: (*a*) The more even turning moment, resulting in fewer hot bearings, breaking of couplings, &c., and (*b*) the more uniform speed, permitting the average speed to approach more nearly to the maximum. Both these causes favourably influence the quality of material produced.

* Abstract of a Paper read before the Staffordshire Iron and Steel Institute.

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The economy to be obtained from electric driving will depend very materially not only on the proportioning of the various passes, but on the actual usage of the plant. Where power is supplied by meter from a power company, idle running must be avoided at all costs. The power required to run a mill light is very considerable, and close supervision will be needed to see that the roll train is continuously fed with pieces. Care is also needed to see that not more than the correct number of pieces is allowed in the mill simultaneously, as the consequent overload can only be supplied at some expense in economy.

With reference to the power supply, four cases need only be considered: (1) A supply from a municipality or power company. (2) a supply from the Mond Gas Co., (3) a turbine supplied from existing puddling furnaces or coal-fed boilers, (4) an exhaust turbine supplied from an existing large mill engine to generate electricity for smaller mills and auxiliary plant.

At about 0·4d. per unit the electric drive will be cheaper than the steam drive with modern non-condensing compound engines, taking into consideration repairs, maintenance, wages, 10 per cent. for interest and depreciation, oil, waste, &c. The steam consumption must be taken over 24 hours or over a year, and include all auxiliary machinery. It is this point which is so often lost sight of by the advocates of the steam drive. The writers have found that with modern engines of the best types 35 lb. of steam at 150 lb. pressure per brake horse-power-hour taken over the whole year is a fair average. Taking an 8 ft. and 10 ft. merchant mill rolling rounds and squares at 20 B.H.P.-hours per ton, with coal at 6s. per ton, the fuel costs would be 6·5d., and the total costs, including interest and depreciation, wages, &c., but no repairs and maintenance of boilers and engine, would be, with an output of 30,000 tons, 13·6d. per ton, and with an output of 15,000 tons, 19·2d. per ton.

With electric power at 0·4d. a unit and an overall efficiency of 62 per cent. we get the following: With an output of 30,000 tons, 12d. per ton, and with an output of 15,000 tons, 18·6d. per ton. The repairs and maintenance of the electric motor are, of course, quite small, and the total maintenance, including gearropes, &c., is quite out of proportion to the repairs and maintenance, costs of engine, boilers, pumps, belts, gearing, &c. The corresponding figures for the heavy rail mill at the Hildegarde works is 10·4d. per ton, not including wages. The increased production, and other advantages which have been proved in actual practice, and which have been enumerated before, will turn the scale still further to the advantage of electric driving.

The installation of gas engines to drive the electrical equipment in cases where no electric supply at low rates is obtainable, but where the mains of the Mond Gas Co. are within easy reach, is more or less a special case, and need only be considered in this particular (Staffordshire) district. The first cost of gas engines, dynamos and motor is higher than steam engines and boilers, and, therefore, the capital charges also increase. The full costs are about half and maintenance and repairs are higher than with steam drive. Altogether it will be found that this method of driving does not present any specific advantages in general cases.

By far the most important system of driving in this district, which is bound to engage the attention of works managers in the near future, is the utilisation of the low-pressure steam from the puddling furnaces in steam turbines coupled to electric generators, enabling the larger works to produce their own electric power required for the rolling mills and auxiliary plant. In most works the mill-engines are old and highly uneconomical, the gearing is worn, and last, but not least, there is a general desire to speed up the mills and increase the production per mill. As already explained, the electric drive is inherently adapted to give this increased production, and this more homogeneous product, and the old steam engine is unable to go. The low steam pressure prevents in any case the installation of the more modern but costly compound condensing mill engine, even should this be desirable. The turbine, however, adapts readily of the utilisation of low-pressure steam; it possesses practically unlimited overload capacity, and can be easily regulated.

It is incorrect to say that as steam is a bye-product of the puddling plant it costs nothing, and can be wasted in the old mill engines. This also used to be the colliery engineers' argument when electric winding came to be discussed, and the waste of the old steam winders was pointed out, because slack at the pit mouth would cost nothing. The fallacy of this argument is now readily admitted, and steam at the colliery has been given its true value. The same applies to the waste heat of the puddling plant, especially if puddled bars are produced and sold at a loss in order to keep the waste heat.

A system which will prove to be a considerable advance on existing methods, and which has been worked out for electric-winding engines, consists in driving a single turbine coupled to two generators, one direct current for driving the direct-current motor of two mill trains, and the other a three-phase current generator to drive the auxiliary plant at the works. Only the steam turbine allows such an arrangement owing to its splendid regulation and overload capacity, the boilers acting as the storage system or flywheel in this case. This is a cheap and very efficient arrangement, as the load factor on the turbine is very high. The authors then give details of the various methods employed in applying the electric motor to the driving of

List of Electrically Driven Rolling Mills.

Company.	Output. Tons per annum.	Speed, r.p.m.	Type of mill.	Drive.
Cargo Fleet Iron Co.	1,000	150/75	Merchant, var. speed	...
English McKenna P. Co.	500	392	Rail	...
	350	250/125	Merchant, var. speed. 3-ph. motor	
Baldwins	600	150	Hot tinplate rolls	...
	300	250	Cold rolls	...
	440	150	,,	...
Darlington Rolling Mills Co.	600	450/260	Rail	...
	450	247/110	Merchant	...
	250	450/300	Forge train	...
David Colville & Sons	400	200/100	Guide	...
Tregoning & Co.	200	200	Cold tinplate	...
Monkbridge Ironworks	600	500	Tyre rolls	...
	300	500	,,	...
Willans & Robinson	275	360	Tube	...
District Iron & Steel Co.	150	365	Hot	...
John Brown & Co.	200	200/450	Bar	...
Henry Wiggin & Co.	200	300	Sheet nickel	...
	150	375	Bar nickel	...
	215	300	Sheet nickel	...
Barker & Allen	120	500	,,	...
	50	375	,,	...
Redbrook Tinplate Co.	125	240	Cold tinplate	...
John Hands	150	375	Sheet rolls	...
George Jones	100	500	Copper	...
John Wood	125	490	...	...
Davey Bros.	200	600	Plate	...
Wilkes, Son & Mapplebeck	150	485	Copper rolling	...
	120	485	...	...
	75	485	...	...
Perry & Co.	100	300	...	...
E. Lloyd & Co.	50	500	Sheet	...
Crown Galvanising Co.	55	480	,,	...
Richard Neville	Various	live roll	motors	
William Bain (Ltd.)	350	300/100	Guide	...
Dugard Bros.	275	375	...	...
	100	500	...	...
William Bayliss	120	500	...	...
Bolckow, Vaughan	Various	small	motors	
S. Riper	30/60	900	Metal	...
Trees (Ltd.)	80	600/700	Tube	...
Pather Iron & Steel Co.	500–1,000	375	Merchant	Ropes
Etna Iron & Steel Co.	500–1,000	375	,,	,,
	250	485	,,	,,
Excelsior Iron & Steel Co.	200	...	Sheet	,,
Redheugh Mills	350	375	,,	,,
Sir Theodore Fry	400	330	Forge	Geared
	250	385	,,	,,
	250	385	,,	,,
	250	385	,,	,,
	250	385	Rail	,,
John Summers	325	570	Merchant	Ropes
J. Brown & Co.	200	200/450	,,	Geared
	200	200/450	,,	,,
W. H. Moore & Co.	200	240	Sheet brass	,,
G. Johnson & Co.	250	240	,,	,,
The Mint, Birmingham	325	365	...	,,
	235	...	...	,,
	235	...	...	,,
Birmingham Metal & Munitions	110	360	Sheet brass	,,
	160	360	,,	,,
Jonas & Cohen	200	500	Bar	Belted
British Insulated & Helsby	250	350/380	Copper rod	...
Newcastle	130	388	Wire rod	Geared
	130	770	,,	,,
	130	580	,,	,,
Motherwell Iron & Steel Wks	500	...	...	...
Thomas Firth & Sons	400/800	300	Hoop	Rope
	300/600	300	Rod	,,
	200/400	500	,,	,,
	200/400	500	,,	,,
	250/500	215	,,	,,
	700/1,400	150	Plate	Gear
	150/300	500	,,	Rope
Sanderson Bros & Newbould	30/60	750	Cold	...
	30/60	750	,,	...
Morfa Copper Works	22/44	120	Copper plate	Rope

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rolling mills. These include both rope, belt and direct drive with flywheels, or gearing may be used. Rope driving is at present the most commonly met, though it has the disadvantage that fluffy matter is given off, while no very great speed reduction can be obtained.

As regards the construction of rolling-mill motors, they should be made with ample bearing surface and with a substantial shaft. Live pressure should be guarded against by the provision of thrust bearings. Commutating poles should be used on direct-current motors.

The Paper concludes with a table giving a list of electrically-driven rolling mills, which we reproduce herewith.

ELECTRIC SMELTING FURNACES AND THEIR APPLICATION.*

BY M. RUTHENBURG.

Electric smelting has emerged from the realm of mere scientific investigation, and has taken a firm foothold in the commercial production of metallurgical and other products, which can be produced either more cheaply or of greater purity from base starting products than by other means; or in some cases it does work or makes products that cannot be produced in any other way. Of furnaces there are many. Their claims to radical superiority, one over the other, except in mechanical detail, may be at once dismissed as existing only in the minds of the inventors and those interested in exploiting them.

The first practical furnace operating under modern conditions was that of Siemens, and all the details of current regulation necessary in an arc furnace, typical of some modern examples, are clearly shown in Siemens' furnace of 35 years ago. It has been well said that "the time has arrived at which the furnace man and the metallurgist should take a hand in the development of the electric furnace." This being so, along what lines should that development be? Whether the furnace be used for refining steel, smelting pig iron, smelting copper ore, smelting complex ores of lead and zinc, smelting zinc, smelting nickel-cobalt arsenides, smelting nickeliferous pyrrhotite, smelting tin ore and tin slags, making alloys of manganese, chrome, titanium, vanadium or silicon, the furnace does not depart from being a mere receptacle or container for holding the raw material to be operated on—the molten product—and means for minimising the radiation of the electrically produced heat.

It may differ in form, in lining, in the means of introducing raw material, the means for removal of product, and means and facility of repair—all of which are of vital importance. The kind of current used, and the means of applying it, are also important. Direct current, on account of commutator troubles, is not used, except for electrolytic work, and the furnaces for such work are of the very simplest description. Single and multi-phase currents are most extensively used, the advantage for electrical and heat distribution being with the three-phase current.

Constant voltage is almost universally used, simply because lighting and power supply demand such regulation, and the smelting supply is taken from the same source, or from a generator that has been designed on the same lines. The latest and best work is done with constant current with automatically regulated non-arcing voltage, using a slag as resistances, the electrodes operating merely as conductors to deliver the current to the slag. The electrodes are usually held by heavy clamps, to which are also attached the flexible leads for supplying them with current. When in the course of use the clamps reach the roof of the furnace, the electrodes can be fed no further and must be replaced by new ones.

The heaviest consumption of electrode is not at the end, and useful; but along the body, and useless. Water jackets around the electrodes remedy this wasteful consumption of carbon. It is quite safe to carry them clean down to the slag, and though the current notion may be to speculate on what will happen if a jacket be cut, long experience shows that absolutely nothing will happen other than chilling the furnace.

The hearth is accessible in all parts for repair, and may be replaced in a few minutes by a spare one. For experimental work, hearths with acid, basic or other lining, may be kept ready, and used in the same furnace at a few minutes' notice for the change.

Other important points in an electric furnace supplied with alternating current are to minimise joints and contacts; have no heavy solid conductors, but split them up. When joints are unavoidable, see that contact is good and of ample area. Conductors should be ample for maximum current—err, if at all, in making them over what is needed. They are bought but once, and their scrap value is high.

The smelting of iron ore electrically is an accomplished fact, and if the same principles that apply to the selection of a proper site for a blast furnace are used, the electrical proposition stands or falls in the same way. Either case resolves itself largely into one of transportation, the items being ore, fuel (power), flux and finished product. That furnace which can gather fuel, flux and ore, and deliver finished product to market with the least *mile tons*, other things being equal, wins. Therefore, every proposition must be worked out on its own basis. Power in Norway may be dear at *any* price if raw material and finished product must be carried in and out, unless electric current is the chief item of expense, and the product cannot be made otherwise.

Copper ores, both carbonate and sulphide, are shipped half around the globe, when, after paying freight, but a small portion of their value remains to pay for the mining and profit. Water power or coal, and in some cases, both, occur in close proximity to the mines; instead of shipping a 20 per cent. to 40 per cent. ore, it should be smelted at the mine to finished anode metal, making much better recoveries than a blast furnace, and doing it more cheaply. In a recent case, the difference in slags made in the electric furnace and the blast furnace amounted to 4s. a ton on 100 tons a day—making a saving of £7,000 a year.

In smelting nickel-cobalt arsenides, great trouble is experienced in roasting, and, if not roasted, an inordinate amount of speiss is made. Electrically smelted, without roasting, the last traces of arsenic are removed, no speiss is formed, and clean slags are made. A second melt delivers the finished alloy ready for sale. In making nickeliferous pig iron, pyrrhotite, carrying 40 per cent. of sulphur and 2 per cent. of nickel, is roasted to get rid of sulphur. This is never complete, and is a laborious job. Electrical smelting drops the sulphur at once to a fraction of one per cent. and a second melting delivers finished pig iron with 3·25 nickel which finds a ready sale among steel makers. That complex mixture of lead-zinc-iron sulphides carrying gold and silver, which has been the basis of more metallurgical schemes than any other, is a beautiful example of the electrical furnace doing what cannot be done otherwise. If the ores occur crystalline, they may be crushed and dressed, the lead separating by gravity, the iron and zinc by magnetic separation. But even with the best of work, the lead has some zinc and iron, the zinc some lead and iron, and the iron some lead and zinc. Only one metal is paid for, and any other value it carries is lost. In the electric furnace the raw ores from the mine, coarse and fine alike, are smelted without admixture of any kind whatever. Lead, zinc and sulphur volatilise and are caught and separated in condensing towers; copper, silver, gold, iron and silica form matte and slag. The matte is bessemerised to anode metal; the lead and zinc, with a second smelting, are made into finished metal.

Tin ores present many difficulties. The ores as they come to market contain many impurities, which, in being slagged, carry a lot of tin with them. The case is complicated by the fact that tin acts as an acid to bases and as base to acids. Besides, the temperature of reduction of stannous oxide by carbon is high, and at this temperature tin volatilises. The first ordinary smelting produces very rich slags, which, after being re-smelted five times, still contain 3 to 5 per cent. of tin. If these slags be smelted in the electric furnace, slags result that carry but 0·25 per cent. tin, recovering the tin as metal, and besides, as a separate product, any other values. Many ores of tungsten, manganese and chromium are low grade, their impurities being mostly iron and silica, frequently chemically combined. These may be separated and the fractions smelted, resulting in pig iron carrying a little of the other metal, and a high grade ferro-alloy of the more valuable metal.

Some of the more fusible metals volatilise badly at the temperature of reduction of their oxides by carbon. Late improvements enable these metals to be reduced at low temperatures with no volatilisation. For this work, the electric furnace is essential.

Central power stations are realising the desirability of an equalising load, and those who fully realise the situation will sell at very low figures, and still profit largely through serving electric furnaces. If the undertaking be of sufficient magnitude, an individual installation is desirable, and may consist of steam turbo-generator sets, or gas engine units.

DISCUSSION.

Dr. J. W. RICHARDS said he hardly liked the statement that Mr. Ruthenburg had made, in regard to using the slag as a resistance, that the furnace should be built with a non-arcing voltage. In using slag as a resistance the current actually went through the metal and practically only met the resistance of the thickness of the slag above the metal. In all the furnaces where electrodes were used, apparently dipping in the slag, there was always an arc beneath both electrodes, and the major part of the heat energy was generated by the arcs at the electrodes.

Mr. F. T. SNYDER thought this was a good time to call attention to the fact that the electric furnace load was not a desirable load for the central station.

* Abstract of a Paper read before the American Electrochemical Society.

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FARADAY SOCIETY.

The meeting of the Faraday Society held on May 23rd, at the Institution of Electrical Engineers, Dr. R. T. Glazebrook, C.B., F.R.S., vice-president, in the chair, took the form of a general discussion on high-temperature work. Previous to the meeting, the Society visited the National Physical Laboratory, by the kind invitation of the Director, and inspected the high-temperature equipment described in Dr. J. A. Harker's Paper. Mr. H. C. Greenwood also gave a demonstration of his method for determining the boiling points of metals mentioned in the Paper below.

Dr. A. L. Day, Director of the Geophysical Laboratory, Carnegie Institution, Washington, contributed the first Paper, entitled

"Recent Advances in High-Temperature Gas Thermometry."

The Paper reviews the work done in recent years to increase the range and accuracy of the temperature scale upon which the various methods of measuring high temperatures depend for their calibration. It is very essential to emphasise the limitations of the gas thermometer, on which the fundamental measurements have to be made, because the ease with which relative temperatures are now measured electrically may lead the inaccuracies of the standard scale to be overlooked and the readings of the secondary instrument to be regarded with unwarranted confidence. The gas thermometer, moreover, is limited in range, and in using radiation-pyrometers, or even thermo-elements, for the higher temperatures, there is a temptation to extrapolation of a somewhat irresponsible kind.

The four attempts which have been made during the past few years to measure temperatures above 1,000°C. with the gas thermometer are next described briefly. Harker in 1904 used a porcelain bulb and nitrogen, but 1,150°C. was the upper limit of temperature attained. Jacquerod and Perrot in 1905 used a bulb of quartz glass, whose expansion coefficient is very small, and various gases, which gave concordant figures for the melting point of gold. But all of these were higher than other recent results, and again the absolute measurements did not extend beyond 1,150 deg. Holborn and Valentiner in 1906, using bulbs of platinum-iridium and pure iridium, with nitrogen for the gas, were the first to extend the scale to beyond 1,600 deg., and their work has been continued by Day and Clement (1909) and Day and Sosman (1910) using nitrogen in bulbs of platinum containing 10 per cent. iridium and 20 per cent. rhodium respectively.

The principal features of the modern constant volume gas thermometer are next discussed. *The Gas.*—Nitrogen is now used exclusively, and even at 1,600 deg. there is no irregularity in its expansion or evidence of dissociation. *The Bulb.*—The abandonment of metal for porcelain by Deville and Troost in 1857 was a retrograde step. Porcelain at high temperatures cannot hold the gas, and it does not expand uniformly. The author now uses platinum stiffened with 20 per cent. rhodium, as it is not safe to use iridium in conjunction with thermo-elements at high temperatures. Such bulbs cannot be used above 1,100 deg. *The Furnace.*—Two essential improvements are noteworthy: electrical heating and the author's device of enclosing bulb and heating coils in an air-tight bomb, so that the gas pressure outside bulb may be kept equal to that of the expanding gas, thus preventing diffusion, minimising mechanical strain, and increasing sensitiveness. Electrical heating, while giving a constant temperature, does not necessitate a uniform temperature over the bulb. Below 700 deg. baths can be used to equalise the bulb temperature—it would be worth while to search for a liquid bath that could be used up to 1,550 deg. *The Manometer.*—The open U-tube type is usually adopted. The capillary connection between bulb and manometer may be made so small that errors due to ignorance of its temperature, once of formidable importance, are now negligible. *The Auxiliary Thermo-element.*—As the gas thermometer can only be occasionally employed, a thermo-element graduated in terms of the gas thermometer is usually employed as a secondary standard. As the E.M.F. temperature curve approximates to a parabola, interpolation can safely be employed, and now that direct measurements with the gas thermometer have been made up to 1,550 C., thermo-elements can be relied upon to the same limit of temperature. The Paper contains a table of standard fixed temperatures ranging from 320 deg. to 1,575 deg., which, being the melting or freezing points of metals, minerals or salts, are available for general use. Direct and accurate calibration of radiation pyrometers between 900 deg. and 1,550 deg. is now possible.

An estimate of the melting point of platinum, based on the temperature interval obtained by radiation methods between the melting points of palladium and platinum, gives 1,755°C. ±5°. Extrapolation on a thermal E.M.F. curve gives a mean value of 1,752 deg. for the same point.

The next Paper was by Dr. J. A. Harker, F.R.S., on

"The High-Temperature Equipment of the National Physical Laboratory."

The Paper dealt with the methods of construction and the use of the various forms of apparatus for the attainment of temperatures above 100°C. which have been designed at the laboratory during the past 10 years. For liquid baths the general system adopted throughout, both for these and lower temperatures, consisted in the use of a vessel made up of two parallel vertical tubes, cross connected above and below. In one of these tubes is placed a continuous rotary stirrer, and in the other the apparatus to be heated. The heating may be by gas or electric current. The baths are so designed that the work to be accomplished by the stirrer in equalising the temperature of the different parts is a minimum, and great uniformity of temperature in the working tube is thus attained. Common olive oil is employed between 50 deg. and 220°C., and above that temperature mixtures of fused salts are used, one of the most convenient being equal molecules of KNO_3 and $NaNO_3$, which melts at 219°C., gives off no fumes, and can be used in an iron vessel as high as about 650°C.

The construction of electric furnaces for various temperature regimes formed the subject of the second half of the Paper.

Mr. H. C. Greenwood, M.Sc., then read a Paper entitled

"The Boiling-points of Metals."

In view of the scanty and uncertain nature of our knowledge of these important constants, a general investigation of the question was greatly needed. The present experiments may be divided into three sections:—

1. A study at atmospheric pressure of the boiling points of a number of metals which are unaffected by carbon at high temperatures (antimony 1,440°C., bismuth 1,420°C., copper 2,310°C., lead 1,525°C., magnesium 1,120°C., silver 1,955°C., tin 2,275°C.).

2. A study at atmospheric pressure of the boiling points of some metals which readily combine with carbon (aluminium 1,800°C., chromium 2,200°C., iron 2,450°C., manganese 1,900°C.).

3. The influence of pressures varying from 10 cms. of mercury to 50 atmospheres on the boiling points of bismuth, copper, lead, silver tin and zinc.

The metals were contained in graphite crucibles ("brasqued" with fused magnesia for the metals attacked by carbon) and were heated in vertical carbon tube electric resistance furnaces. For the experiments at pressures other than atmospheric the furnaces were arranged inside suitable enclosures. From the boiling point pressure curves the latent heats of vaporisation were calculated.

Mr. A. Blackie, B.A., communicated a Paper

"On the Behaviour of Silica at High Temperatures."

This communication gives an account of some experiments made to determine the effect of heat on the strength and devitrification of the opaque and transparent varieties of fused silica. A determination was also made of their relative coefficients of expansion at high temperatures.

The test selected as a criterion of strength was the transverse fracture of a small rectangular beam. The figures obtained for the modulus of transverse fracture showed that in the unheated condition the transparent material was considerably stronger than the opaque. When heated, it was found that a few hours at from 1,100°C. to 1,200°C. materially increased the strength of certain types of the opaque silica owing to an annealing action taking place. After more prolonged heating at 1,200°C. all types, both transparent and opaque, exhibited a loss of strength due to devitrification. This became much more serious and rapid at temperatures above 1,300°C. Heat treatment for four hours at 1,350 deg., for instance, may reduce the strength by from 40 per cent. to 60 per cent., according to the type of the material.

A microscopic examination in polarised light showed that the devitrification and loss of strength proceeded *pari passu*. The minute crystals of tridymite which are formed increase very greatly in numbers at the higher temperatures. They began to form chiefly at the surface of the specimens and from the walls of bubbles in the material. Other interesting phenomena affecting the strength of the material were also observed.

As is well known, the thermal coefficient of expansion of fused silica is very small, less than one-fortieth part of that of brass. In fact, it is smaller than that of any known substance excepting the best Invar. The difference in the coefficients of expansion of the transparent and opaque silica was determined over the range 0°C. to 900°C. The experiments showed that at no temperature in this range did the relative lengths of the two materials differ by more than 30-millionths of their length at room temperature. Assuming the total increase of length of a clear silica rod between 0°C. and

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800° C. to be about 440-millionths of its original length, these experiments show that the increase of length of a similar rod of the opaque material does not differ from this by more than 7 per cent. The majority of the experiments gave differences of less than 5 per cent. Several interesting phenomena connected with the lagging of the expansion and contraction of the materials after heating and cooling were also observed. The experiments were carried out at the National Physical Laboratory at the request of the Thermal Syndicate, Ltd.

Prof. MAX BODENSTEIN, of Hanover, sent in a communication on

"Methods of Maintaining Constant High Temperatures."

Three general methods are in use.

1. By means of a vapour in equilibrium with its liquid. Suitable substances are only available for a moderate range of temperature, but a uniform temperature over a large volume is easily maintained. On the other hand, constancy of temperature over a long period cannot be relied upon.

2. A liquid heating bath controlled by a thermostat. For high temperatures the method is restricted by the difficulty in obtaining a suitable substance, although for moderate temperatures oil or paraffin in a suitably constructed bath are fairly satisfactory, and temperatures up to 350 deg. can be maintained within 0·05 deg. for several months if a sensitive gas regulator be employed.

3. For high temperatures air baths only can be employed. Tube furnaces heated electrically, either directly or by means of coils, are now exclusively used, but although a constant temperature is easily maintained, uniformity of temperature is more difficult of attainment. Usually the spiral heating coil is wound more closely at the ends of the tube, where the heat insulation should also be better, or additional resistances may be placed in front of the ends, and thus the heating of the middle portion of the tube is kept uniform. If there are any fluctuations in the current, it is necessary to employ a thermo-regulator. In the form recommended by the author the expansion of a confined volume of gas moves a column of mercury against a constant gas pressure. The motion of the mercury actuates, by means of a relay, a secondary current superimposed upon the primary heating current. Various modifications of the method are suggested, and it is stated that its use will render possible the maintenance of temperatures up to 1,500° C.

M. CHARLES FÉRY contributed to the discussion a short note on

"Stellar Pyrometry."

The temperatures of incandescent terrestrial bodies can be measured by reference to the laws of radiation, either the law of Stefan or the law of monochromatic radiations, but these cannot be applied in the case of stars, owing to the small amount of radiation. The author has therefore devised an instrument based on Weiss' displacement law, according to which temperature is measured by an appreciation of the colour tint of the star. In the instrument described, the colour of an image of the star is compared with that of a standard lamp whose tint can be varied. The pyrometer is standardised by reference to an electric furnace, an arc (3,500° C.) and the sun (6,500° C.).

In the course of the general discussion which followed the reading of the Papers—

Dr. T. M. LOWRY suggested the use of helium or argon in high-temperature gas thermometers instead of nitrogen.

Dr. J. A. HARKER agreed that a substitute would have to be found for nitrogen, which was not inactive in the electric furnace. Helium was impracticable, but he thought argon promising. The difficulty was a suitable containing material; they were trying to find one at the National Physical Laboratory.

Dr. ARTHUR DAY threw out the suggestion that tungsten might be found a possible material.

Prof. A. K. HUNTINGTON commented on the distinction which should be drawn between the diffusion of gases through metals, which depended on affinity, and through porcelain, which was merely a matter of porosity.

"The Central."—The current number of this journal is an "overseas" issue, though the editors point out that it is only a partial realisation of their hopes to publish a number entirely devoted to "Centralians" in India. Nevertheless, two of the articles do deal with Indian affairs, these being "Indian Industrial problems," by Mr. A. Chatterton, and "Life in India," by Mr. A. Marshall. In other articles Mr. C. S. Hainsworth describes the "Selina Cruz Port Works," and Mr. A. B. Jones the "Central Cordoba Extension Railway," which allows this system an independent entrance into Buenos Aires. Besides the illustrations in the articles there is an excellent photograph of Prof. M. O. Forster, F.R.S.

PREPARATION AND PROPERTIES OF THE HEUSLER ALLOYS.*

BY A. A. KNOWLTON.

Summary.—The method of preparing the alloys is first described. The magnetic examination shows the favourable effect of annealing at the upper limit of transformation. The transformation temperature depends upon the composition. Photographic examination shows the close dependence of the magnetic properties upon the crystalline structure.

Since the discovery by Heusler in 1903 that it is possible to prepare strongly ferro-magnetic alloys of the non-magnetic metals copper, manganese and aluminium, important papers concerning the properties of these alloys have been published by Heusler, Starck, Take, Gumlich, Guthe and Austin, McLennan, and others. The most important facts as developed by these investigators may be briefly summarised as follows:—(1) The magnetic permeability of the best specimens is about that of cast iron. (2) The permeability is often greatly increased by annealing for some time at a temperature a little above 100° C. At higher temperatures the alloys become non-magnetic and this transformation may be irreversible. (3) The most strongly magnetic alloys were found by Heusler and Starck to be those containing manganese and aluminium in atomic proportions, *i.e.*, in the ratio of two parts by weight of manganese to one of aluminium. Largely upon this ground it has been quite generally assumed that the copper plays no part in the alloy except as a solvent for a magnetic manganese-aluminium alloy, which would otherwise be too hard and brittle for experimental use. (4) Other trivalent metals as arsenic, antimony, or tin may be substituted for the aluminium, but the alloys thus obtained are much inferior to those containing aluminium. (5) Zahm and Schmidt have found a Hall effect in these alloys of the same sign as in iron, but larger than in any substance previously studied. (6) Ingersoll has found that these alloys do not show the Kerr effect. This is of special importance, both on account of the theoretical importance of the phenomenon itself and because it is the only way in which the magnetic properties of these alloys are strikingly different from those of iron.

As nearly all observers had found occasion to complain of the poor mechanical quality of their specimens, it seemed best at the outset to undertake such a study of their preparation as should, if possible, overcome this difficulty. The first stage of the preparation consisted in dissolving manganese in molten copper. On account of the great affinity of manganese for silicon a graphite crucible must be used, and it is even then impossible to employ any flux without causing the metal to eat rapidly into the crucible. To secure a uniform mixture the melt must be kept hot for several hours and stirred frequently—or the same result may be obtained with less loss by oxidation if the bath is cast and remelted several times. The materials used were ordinary electrolytic copper and, at first, chemically pure manganese. Later commercial manganese was used with apparently equally good results. To the copper-manganese alumi-nium in slightly more than the calculated amount was added, and the bath cast and remelted several times to ensure a uniform mixture. Stirring should be avoided during this part of the operation because of rapid oxidation of the aluminium. Even under the best conditions of working with small quantities of material the loss in this way is considerable and uncertain, so that the proportions by analysis may vary widely from those of mixing. After several remeltings the alloy was cast in graphite moulds made by boring a ⅝ in. hole in an arc furnace electrode. To provide for a uniform rate of cooling in all parts of the casting these moulds were heated before use to a temperature slightly above the melting point of the alloys, which was about 850° C. The very heavy slag which forms instantly over any exposed surface makes it essential that the metal be poured rapidly in an unbroken stream. The moulds were covered over with a layer of asbestos wool of such thickness as to allow the temperature to fall to 250° C. in about an hour. When this temperature was reached, as indicated by a thermocouple, the casting was quenched by immersion in cold water. Specimens prepared in this way were of excellent mechanical quality, free from flaws and blow-holes and, in many cases, malleable to a considerable degree. The magnetic test appears to indicate that a somewhat slower rate of cooling and a slightly higher temperature of quenching might have been advantageous. Fourteen specimens were selected at random for examination. These were wet ground with emery to a uniform diameter of 6 mm. and tested as hereafter described. The chemical composition and density (which ranged from 6·72 to 7·17) of each specimen is given by the author. In general the density was found to increase slightly on annealing at 120° C. This increase never exceeded ½ of 1 per cent. although it appeared to take place in all cases.

* Abstract of an article in the "Physical Review."

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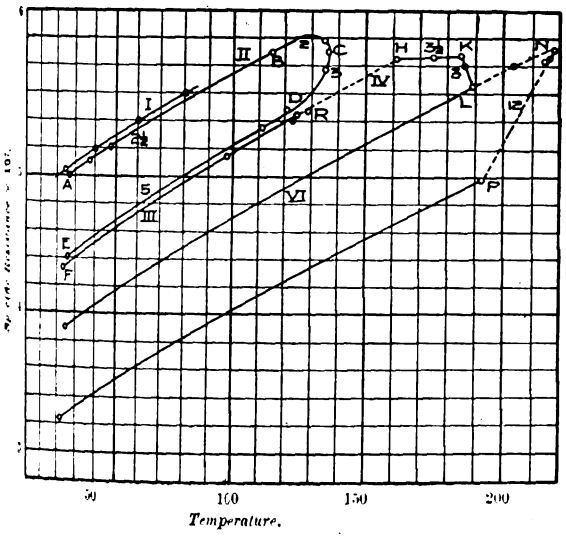
Electrical Resistance and Temperature Coefficient of Resistance.—For measuring the resistance a Thomson double bridge was used. The external field was constant and equal to 80 lines/cm.^{2} during these tests.

The variation in the value of the specific resistance (σ) for different specimens was larger than can be accounted for by differences in composition. Later work indicates that a slower rate of cooling would have given more uniform results. The variation of σ with temperature, shown in the figure, refers to only one specimen, but it is typical of what happens in every case. The curves are straight lines differing from those for a pure metal only in slope, and in that at certain temperatures the resistance undergoes a permanent decrease with time, a process of artificial ageing frequently met in alloys. The numbers given in the diagram indicate the time which elapsed between the lettered readings; *e.g.*, in curve II. the reading at C was taken two hours after that at B. The microscopic examination which was carried on in connection with this part of the work showed that each decrease in resistivity accompanied an improvement in crystalline structure, and that any treatment, such as quenching from a comparatively high temperature, which impaired the crystallisation was accompanied by a corresponding increase in resistivity. There was no indication that the resistance depended at all upon the kind of crystals. The temperature coefficient (α) which was originally very low and lowest for the specimens of highest resistivity (varying from $9{\cdot}1\times10^{-4}$ to $27{\cdot}3\times10^{-4}$) increased as the resistance at zero decreased and in nearly the same ratio, as is shown by the fact that the successive curves are parallel. It will be noticed that after five hours at 140 deg. the succeeding heatings represented by III. and IV. (both of which began at 28 deg.) produced no effect, but that above 160 deg. a second rapid decrease in resistivity took place until a second condition of stability was reached, which persisted until the



temperature was raised above 225 deg. In some later work it has been found that these three temperatures are important transition points for many specimens. The only way in which these alloys are different from many others in respect to their conductivity is in the degree of their sensibility to annealing processes, and this is altogether due to the ease with which their crystalline structure undergoes modification.

Relation of Magnetic Quality to Crystalline Structure.—Several of the specimens were subjected to extensive cycles of heating, magnetic measurements being made before and after each cycle, and at such other temperatures as seemed desirable. Before and after each cycle one end of the specimen was polished and etched with a mixture of hydrochloric acid and ferric chloride. This mixture was adopted after experiments with many etching agents because it was found to give more uniform results than any other, and also because the colouring action of the ferric chloride greatly increased the contrast between the different crystals. An outline of the treatment to which a single specimen was subjected and the results obtained are given in the Paper. The total time of annealing in this case was somewhat more than 100 hours, and the value of the magnetisation reached varied from about 400 C.G.S. units to zero, with corresponding variations in crystalline structure, as is shown in a set of microphotographs in the Paper.

A comparison of the value of the intensity of magnetisation I, with its original value, shows an increase from 212 to 298 for the same field strength. This increase took place at ordinary temperatures during a period of 16 months. Heating to temperatures up to 160 deg. apparently completed in something less than 20 hours the transformation which had been going on slowly at room temperatures. Heating at 225 deg. for five hours caused a 25 per cent. decrease in the value of I, while two hours at 290 deg. restored the specimen nearly to its best condition. Subsequent heatings at temperatures below 225 deg. produced no effect. Even a short time at 225 deg., however, produced a marked change, and the loss of magnetic quality continued on further heating at 225 deg. and 250 deg. Partial recovery again followed heating to 300 deg. Nine and one-half hours between 225 deg. and 250 deg. left the specimen very poor magnetically with the expected recovery at 300 deg. or slightly above. After this heating to 350 deg. it was noticed that the alloy reacted to the etching agent very differently from its previous behaviour. Up to this point there had been no tendency to deposit copper, even when the etching was continued for from five to eight minutes, but on attempting to etch following this heating a coating of copper so thick as entirely to conceal the structure was deposited in less than half a minute. This, of course, indicates a breaking-up of some of the crystals. Chilling from this temperature left the alloy non-magnetic, and it was not found possible to render it magnetic again by any thermal treatment, although after some months at ordinary temperatures it was found to have become appreciably magnetic again.

These results are in good accord with those of Asteroth who states that he found it possible to control hysteresis losses by the rate at which his specimens were cooled through the transformation temperature. The writer's interpretation of the phenomena is, however, somewhat different. Transformation from the magnetic to the non-magnetic state takes place over a range of about 50 deg., the lower limit for this particular specimen being 225 deg., where the loss of magnetic quality begins to take place rapidly, and the upper limit being 275 deg., where the specimen is totally non-magnetic. Annealing at the lower limit leaves the alloy very hard and with a low maximum induction, while annealing at the upper limit, followed by moderately rapid cooling, softens the specimen and increases the maximum induction. This was found to be the case with all specimens examined.

So far as the permanent changes that take place on heating are concerned, they may be explained if we assume that the magnetic properties belong to molecular groups which are constituents of a certain type of crystals that form at temperatures in the neighbourhood of 300 deg. and are stable at ordinary temperatures, but pass through a meta-stable condition between 225 deg. and 275 deg., while the non-magnetic crystals, which constitute the stable form within this range, are meta-stable both at 300 deg. and at room temperatures. An examination of the micro-photographs appears to verify this assumption.

The micro-photographic examination which was carried on in connection with the magnetic testing showed that the alloys contain crystalline masses of three distinct sorts. Of the three sorts of crystalline masses (white, dark grey and black) those which are unaffected by the reagent, and consequently appear white in the prints, are by far the most striking and show the widest range of variation. The area of the photograph covered by these crystals is large in all cases where the specimen was highly magnetic and decreases with loss of magnetic quality. So marked was the relation between structure and magnetic quality that after some experience it was found possible to make a fairly accurate estimate of the value of I at saturation from a visual examination of the structure. The areas covered by the white crystals on a number of photographs were estimated by means of squared paper, and within the limits of error (which are naturally large) these areas appear to be proportional to the values of I at saturation.

Although the differences in chemical composition did not appear sufficient to account for the observed differences in the transformation temperature, no other cause could be assigned, since in no case did the heat treatment appear to produce any change in this regard. An attempt to reproduce the alloys of low transformation temperature by making specimens having a high ratio of copper to manganese (Cu 72, Mn 18, Al 10) was successful. This result is in line with the work of Ross and Gray in indicating that the copper plays a part of much greater importance than a mere solvent.

Since the white crystals are always present in magnetic specimens and are never found in specimens which are not, under proper conditions, magnetic, and since there seems to be a simple relation between the quantity of crystals of this kind and the magnetic quality, it seems fair to assume that they contain the magnetic constituents of the alloy. Attempts to isolate these crystals were unsuccessful. A surprising feature is the apparently slight difference between the magnetic and non-magnetic states as indicated by the fact that careful experiments with an apparatus of great sensitiveness failed to show positive evidence of any evolution of heat on passing through the transformation range.

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"THE ELECTRICIAN" INDUSTRIAL SUPPLEMENT.

With "THE ELECTRICIAN" for Sept. 14, 1906, was issued the first of a series of "Industrial Supplements," to be published from time to time with "THE ELECTRICIAN." The fifty-third issue of the Supplement published (Gratis) with the number of "THE ELECTRICIAN" for September 23, 1910, was the last of the monthly issues. "THE COMMERCIAL AND INDUSTRIAL SUPPLEMENT" to "THE ELECTRICIAN" is now issued weekly (Gratis). It will be found towards the end of the present issue.

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SPECIAL NOTICE FOR CORONATION WEEK.

"THE ELECTRICIAN" will be published on Saturday instead of on Friday in Coronation Week.

As it will be necessary for the Publisher to have the paper practically completed by Wednesday night (Friday being a holiday in London), Contributors and Advertisers will please send their copy for Contributions and for new Advertisements and changes in running Advertisements not later than first post Wednesday in Coronation Week.

THE CORROSION OF IRON AND STEEL.

The annual London meetings of the Iron and Steel Institute appeal in point of interest not only to the iron founder and to the metallurgist, but to the engineering community at large, which owes so many of its achievements to the improved products from foundries and rolling mills. Every year iron and steel enter more and more into our daily lives, and user and producer find their identity of interest to be more intimate. From the user's point of view, perhaps, the outstanding feature of general interest in the recent meeting of the Institute lay in the three Papers dealing directly with corrosion. As the annual outlay of the world on account of liability to corrosion now reaches an enormous sum, not only through the cost of preventive measures, but through the actual loss of metal in cases where preventive measures cannot be applied, to say nothing of accidents arising through corrosion, we make no apology for referring to the main points of these Papers.

At the present time the mechanism of corrosion is warmly debated by two schools, which have been respectively labelled the chemical and the electrolytic. The former regards all corrosion as primarily a matter of oxidation produced through the action of acids upon the metal. The latter regards corrosion as in the main due to local galvanic

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action between different metallic impurities in the presence of a suitable electrolyte.

Now of the three Papers presented, that by Messrs. J. Newton Friend and Joseph H. Brown upon "The Action of Aqueous Solutions of Single and Mixed Electrolytes upon Iron" must be regarded, despite the use of the word "electrolyte" in its title, as identified mainly with the chemical school. The experiments were all conducted upon what is nominally a single metal—namely, "relatively pure iron." (It is to be regretted that the authors did not give an analysis of this.) Plates of this iron were immersed in various saline solutions, with the result that in each case the corrosion was found to be a minimum for dense solutions. Employing solutions of different salts containing 0·1 gramme of potassium bichromate per litre, it was found that corrosion was retarded and that potassium chromate gave even better results. We have spoken of "relatively pure iron" as nominally a single metal, but pure iron, in the sense that electrolytic copper is pure, is not known to the metallurgist. Commercial iron and steel are relatively impure, and therefore the electrolytic school must regard this Paper as academically valuable rather than as conclusively practical.

The second Paper, by Mr. John W. Cobb, on "The Influence of Impurities on the Corrosion of Iron," represents a research conducted wholly from the point of view of the electrolytic school. The Paper covers observations of the colour reactions observed in the Walker and Cushman "ferroxyl" cell between iron and the sulphides, phosphides and silicates. This very sensitive device indicates by respective blue and pink colouration whether metals, or portions of them, are electro-positive or electro-negative to other metals or to parts of the same metallic plate. Mr. Cobb clearly shows that in the ferroxyl solutions iron is electro-positive to slag—that is to say, that a current will flow (if the conditions of a closed electrical circuit are secured) from the iron to the slag, and the iron tend to pass into solution. It must, however, be remembered by all who study this interesting and valuable Paper in detail that it does not necessarily follow that what is true of the ferroxyl cell is true of all conditions in which other electrolytes occur in contact with dissimilar metals. Metals which are electro-positive to other metals in one solution are known to be electro-negative in another solution. Also, too, the method followed by Mr. Cobb in the measurement of the E.M.F. between dissimilar metals by using a galvanometer calibrated as a millivoltmeter only affords relative measurements which are not scientifically comparable with those obtained by other observers using either a millivoltmeter of different internal resistance or electrodes of different area, or a cell with the same electrolyte but with a different length of path between the electrodes. The only really reliable method is the potentiometer.

The third Paper, by Mr. Percy Longmuir, on "The Corrosion of Metals," is at once wide in its scope, and distinguished in many of its conclusions. It commences with the action of tomato juice on the domestic table knife, it discusses variations in the composition of the atmosphere and rain water in various districts, as well as that of the soot in domestic and locomotive chimneys and in tunnels, and concludes with some striking work on the relation between rail failure and corrosion. Mr. Longmuir's Paper should be read in detail by those interested. On the whole he considers that "the balance of evidence appears to be in favour of the electrolytic theory." But "purity of composition alone is not the clue to immunity from, or retardation of corrosion." There are "numberless cases in which composition of metal has been of considerably less moment than its environment."

Mr. Longmuir regards sulphur in soot and in the atmosphere as a most important factor, and records many cases of sulphur in excessive quantity in rust and in tunnel water. His chief contention is that the problem of corrosion does not lie in the amount of metal lost by rust or decay, but in the influence exerted on the metal remaining intact and apparently unaffected. Deterioration is found which is not explained by mere loss in weight or change in the ordinary condition of the metal. This theory is illustrated by the case of a steel rail from a damp tunnel. No rail is absolutely homogeneous, and this is well shown by a case of a normal rail from which tensile test pieces cut from different parts of the cross section, which had been mapped out, showed large variations as compared with a rail from a tunnel. From these results the author deduces that the rail from the tunnel had been rendered decidedly brittle by its environment and service conditions; and, instancing the well-known parallel of acid cleaning causing brittleness in wire, he urges that under working conditions "the degree of acidity is immaterial provided the time of attack is sufficiently prolonged." The railway engineer will naturally demand from metallurgists more evidence in support of this seemingly well-founded theory. Apart from railway interests in this section of the subject, the general concern about corrosion is very deep.

This is not the occasion on which to discuss protective coatings. It must be remembered that cases are inevitable in which protective coatings either cannot be applied, or, if applied, are difficult of uniform maintenance. It is right, therefore, that the metallurgist, the chemist, and the physicist should continue to concern themselves with the study both of the mechanism of corrosion and of its effects. From their efforts we may hope to obtain metals as superior in their resistance to corrosion to those now in everyday use as a good mild-steel casting is superior to good cast iron.

REVIEWS.

(Copies of the undermentioned works can be had from The Electrician Office, post free, on receipt of published price, adding 3d. for books published under 3s. Add 10 per cent. for abroad or for foreign books.)

Diagram for the Easy Calculation of Shaft or Beam Deflections.

By R. Livingstone. (London: "The Electrician" Printing & Publishing Co.) 2s. 6d. net. Postage in tube 4d. extra.

This sheet has two diagrams, of which the former consists of a series of curves plotted on rectangular co-ordinates so that the lengths of a beam supported at each end form one side, and certain coefficients "k" are plotted as ordinates with this side as base.

It can be shown that a concentrated load so placed as to divide a beam into segments "a" and "b" produces a deflection "δ" at a distance, x, from one end given by the expression

$$\delta = \frac{Wbx}{EI(a+b)} \cdot \frac{x^2 - a^2 - 2ab}{6} \cdot L^3 = k \cdot \frac{WL^3}{EI}.$$

(Morley's "Strength of Materials," p. 161.)

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The values of "k" obtained in this way and plotted as described enable the deflection for a series of loads to be obtained by summing the values of "k" for each load. The second diagram for distributed loads is a single curve connecting the deflection at a point with the position of this latter on the beam.

A brief description of the method, including an example of a calculation, is printed on the diagram, and this shows very clearly that an otherwise laborious calculation can be performed with ease and accuracy. E. G. Coker.

Several questions have come to hand regarding the accuracy of Mr. Livingstone's, recently issued diagram to which the above review refers. One of these questions was: "Could you guarantee a Livingstone diagram to give the deflection accurately to 0·0001 in the case of shafts about 6 ft. span and, say, four concentrated loads?"

The following reply by Mr. Livingstone will be of general interest:—

1st. As the total deflection at any point is the *sum* of the deflections at that point, due to the individual loads, the percentage error due to inaccurate drawing of the curve will be less for a number of loads than for a single load, since such errors tend to cancel each other.

2nd. The accuracy of drawing of the curve is good, as the following comparison between carefully integrated and calculated values of "K" and the values read from the curves will show.

Deflection considered at 0·3 of the Span.

Position of load.	Actual value of "K."	K from curve.	Error.
0·1	0·00583	0·00580	0·57 of 1%
0·2	0·01096	0·01100	0·305 of 1%
0·3	0·01470	0·01470	0
0·4	0·01650	0·01650	0
0·5	0·01650	0·01650	0
0·6	0·01500	0·01500	0
0·7	0·01230	0·01230	0
0·8	0·0087	0·00870	0
0·9	0·0045	0·00445	1·1%

3rd. From the above table we may assume that the average error is much less than 1 per cent., and as the value of the deflection in a 6 ft. span would be about 0·020 in., an error of $\frac{1}{2}$ of 1 per cent. would be an error in value of 0·0001, which is what your correspondent wishes.

4th. In actual practice such accuracy is not required. The most accurate test is a case of three or four bearing spans, where the deflection at a point is found from the difference between the vertical loads and upward reactions. In such cases an error exceeding 5 per cent. is not admissible.

5th. The preceding is based on the assumption that $\frac{L^3}{E \cdot I}$ is accurately determined. Now E may vary between 28×10^6 and 30×10^6, which is a possible error of 7 per cent.

6th. In conclusion, (*a*) we cannot guarantee that the error will be 0·0001 in., as the whole deflection might be too large to make this appreciable percentage of the total. (*b*) But with average deflections of, say, 0·01 in. to 0·02 in. we can guarantee the accuracy of the deflections calculated from the curves within 0·0001 in. when $\frac{L^3}{E \cdot I}$ is correctly obtained and the shaft is homogeneous. (*c*) Or we can guarantee the accuracy of the values of the constants within 1 per cent.

Practical Telephony. By G. Bell and S. Wilson. 5th edition. (London: S. Rentell & Co.) Pp. xiv. + 309. 3s. 6d. net.

This book is written to meet the requirements of students preparing for the examinations of the City and Guilds of London Institute and the Post Office departmental examinations. It deals for the greater part with the systems and methods adopted by the British Post Office, and only somewhat sparingly with the practice of other administrations.

In the first half of the book where they deal with exchange systems, signalling apparatus, instruments and circuits, &c., the authors seem to have been on unfamiliar ground, and in not a few instances "at sea" altogether, as for example on page 83 where the operator's transmitter, shown in Fig. 81, is referred to as a "supplemental resistance of 55 ohms," and on page 104 where the main ringing machine shown in Fig. 101 in connection with the night bell circuit is described as "a generator for the operator's use when the motor generator is not running." This part of the book contains an extraordinary number of inaccuracies, loosely worded descriptions, and discrepancies between diagrams and letterpress, which render it of little value to students, who are frequently not in a position to detect such errors.

Although there is no direct reference to the Daniell cell in the book, the authors seem to have experienced some difficulty in abandoning what has evidently been an old friend, and we find the positive pole of subscribers' batteries frequently referred to as the "copper" pole, and the negative pole of the main battery in a CB exchange as the "zinc" pole.

Although numerous diagrams of circuits are given, none of them carry titles, and to find out what circuit is illustrated one is compelled to search about in the text for the corresponding figure number. Reference to diagrams would be much facilitated if each one bore a title, and, in the same way the text would be considerably improved by a more liberal use of sub-headings.

In view of the great importance of the subject one would expect to find in a modern work at least one chapter devoted to traffic matters, and it is disappointing to find that in the present volume the subject is practically ignored.

The last half of the book deals with methods of testing and localising faults, overhead construction and telephone cables, the latter portion including a description of the loaded cable recently laid across the channel at Dover. These chapters form, perhaps, the best part of the book.

The final chapter contains the syllabus upon which the City and Guilds examination papers are based, and the questions set during the last seven years in both the Ordinary and Honours Grades. These will be useful to prospective candidates. H. S. T.

Logarithms for Beginners. By C. N. Pickworth. (London: Whittaker & Co.) 3rd edition. Pp. 42. 1s.

We do not appear to have had the pleasure of reviewing former editions of this book, and it is therefore rather difficu for us to tell exactly how it has been improved, or whether it ha been improved at all. From the preface to the first edition i appears that its purpose is to give a more detailed and prac tical explanation of logarithms and their various application than is to be found in text books on algebra and trigonometry From this point of view the book is well done, though we can not subscribe to the author's argument that it is necessar There is, however, evidently a demand for the book, since it ha reached a third edition.

THE PRINCIPLE OF THE STATIC BALANCER.

BY C. C. HAWKINS.

Summary.—The theory of the static balancer is here developed simple lines by the superposition of the component currents. An actu case is worked out numerically.

The general idea of a static balancer as a means of obtaini a point of connection for the middle wire of a three-w system with a single generating dynamo is not difficult follow. If two or more slip-rings are connected at proj intervals to the armature winding of a continuous-curre dynamo, then from each brush pressing on a slip-ring a le can be taken to one end of a coil forming part of a stationa inductive resistance or "static balancer" which has as ma limbs or coils as there are slip-rings; the other end of each c is connected to a common junction, and this forms a cen point to which the middle wire of the three-wire network m be attached when only a single dynamo is feeding the outs Yet though this general idea is readily grasped, a thorou

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understanding of the inner working of the apparatus requires that its fundamental principles should be very clearly understood. It is, therefore, proposed here to examine these principles, beginning from an elementary standpoint.

The static balancer is essentially and fundamentally a *choking coil*, and the lower its ohmic resistance, the more nearly for a given difference of resistance on the two sides of the network and a given armature resistance is the potential of the third wire brought to a value midway between the potentials of the outers. Each limb or coil of the balancer is to be regarded as a "phase," so that there are as many phases as there are slip-rings. What is often called the single-phase balancer is, therefore, strictly speaking, two-phase.* If the one coil, A, carries current, say, towards the centre of the balancer, and the same current continues onwards, then the other coil, B, even though it is merely a continuation of the same winding, is carrying this current away from the centre and so forms the second phase, displaced by 180 electrical degrees relatively to A. The sign of the current in any coil is thus to be regarded as fixed by its direction relatively to the central or junction point, inwards towards it being regarded as negative, and outwards, away from it, as positive. If the above two-phase balancer has its two coils on a common core, its actual construction closely resembles that of a one-to-one transformer with its primary and secondary coils, preferably

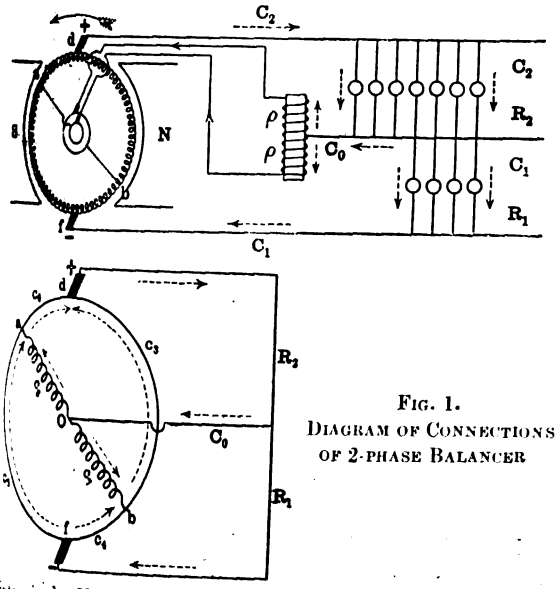

FIG. 1.
DIAGRAM OF CONNECTIONS OF 2-PHASE BALANCER

intermixed. Yet if the coils of the static balancer were not wound on a common magnetic core but were kept entirely distinct, although the arrangement would not for other reasons be nearly so good, its essential action would remain unimpaired; the fluxes of the phases do not, therefore, necessarily have a common magnetic circuit, which suffices to prove that the function of the balancer is that of a choking coil and not that of a transformer.

Taking the simplest case of two slip-rings and two coils or phases, the connections are as shown in Fig. 1. Below is shown diagrammatically the various portions of the system of armature, network and balancer, lettered with corresponding symbols to agree with the upper portion of the figure.

The resistances and impressed E.M.F.'s are given in a still more simple form in Fig. 2. Each leg of the balancer has a resistance of ρ ohms, and except when the balancer tappings pass the brushes, the balancer divides each half of the armature into two portions, *fb*, *bd*, which are fractions q and $(1-q)$ of the length between *f* and *d*. If R_a = the joint resistance of all paths in the armature winding from + to − brushes, one-half of the armature (which may itself consist of several parallel paths) will have a resistance of $2R_a$ ohms, and the resistance of the portions *fb* and *bd* will be respectively $2R_a.q$ and $2R_a.(1-q)$.†

* A true single-phase arrangement is theoretically possible, but gives a strongly pulsating middle wire current.

† The same symbols are here used as in the writer's original communication on the "Theory of the Static Balancer," Journal I.E.E., Vol. XLV., p. 704, for the convenience of any reader who might wish to pursue the matter further.

If E_3, E_4, E_5, E_6 are the instantaneous E.M.F.'s induced in each of the four portions into which the armature is divided, the two E.M.F.'s on one and the same side of the balancer act differentially against each other, and their varying difference, *i.e.*, E_3-E_6 or E_5-E_4, yields an E.M.F. alternating with respect to the balancer, and having a frequency $f=\frac{pN}{60}$, equal to that of the machine, where p is the number of pairs of poles and N is the number of revolutions per minute.

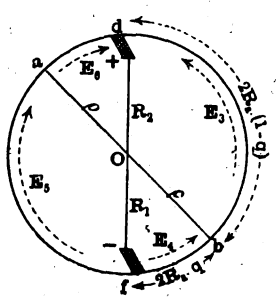

FIG. 2.—SIMPLIFIED FORM.

In the first place, let the third wire be completely disconnected from the centre of the balancer, and also let the network be balanced so that $R_1=R_2=R$. The alternating E.M.F. above described causes an alternating current, i, to flow through the two limbs of the balancer in series, and considered by itself this current would divide equally at the points *a* and *b*, $i/2$ flowing through each of the halves into which the armature is divided (Fig. 3*a*). Upon this distribution of current must be superposed the direct-current balanced system of Fig. 3*b*, so that when the two are added together, having regard to their directions in the several portions, Fig. 3*c* is obtained. It will be seen that the armature currents are divided (except at the moment when the balancer tappings pass the brushes) into *two similar pairs*, viz.,

$$i_2=i_5=\frac{C_b}{2}+\frac{i}{2},$$

and

$$i_4=i_6=\frac{C_b}{2}-\frac{i}{2},$$

just as in a single phase rotary converter. The iron in the trailing portions of the poles being influenced by one pair of circuits and so also that in the leading sides by the other pair,

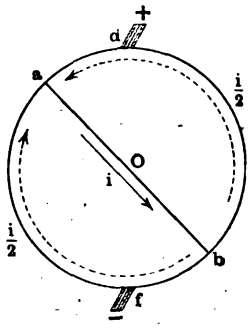

FIG. 3*a*.

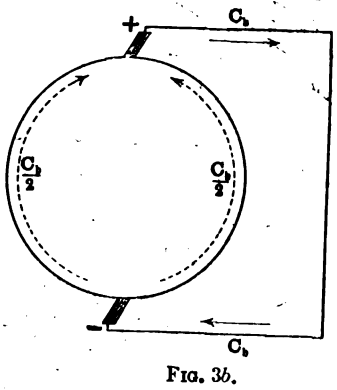

FIG. 3*b*.

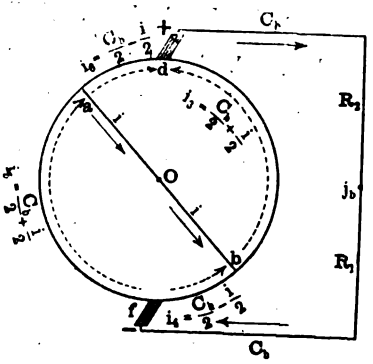

FIG. 3*c*.—THE SYSTEM WITH THIRD WIRE REMOVED.

the arrangement is so far symmetrical, and in relation to the induced and self-induced E.M.F.'s we are also correct in taking at each moment $E_3=E_5$, $E_4=E_6$, $L_3=L_5$, and $L_4=L_6$, where L_3, L_4, &c., are the instantaneous inductances of the several portions.

The principle of all such superpositions of current is the same, viz., that the actual total induced E.M.F.'s may be split up into any components that we please, so long as their

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algebraic sum is correct, but that if this is done, each component E.M.F. will always produce its own corresponding currents throughout the whole system, and the algebraic sum of these in any portion will yield the actual current in that portion.

But, now, if we wish to divide the actual distribution of currents into the above alternating and direct-current sets, the proportions into which the total E.M.F. is divided must be correctly taken in order to secure the required result.

One might at first sight suppose that it would only be necessary to take a direct current of value in the external circuit,

$$C = \frac{E_a}{2R + R_x}$$

(the shunt current being for simplicity neglected), and upon it to superpose an alternating current of value in the balancer,

$$i = \frac{E_3 - E_4 - \frac{1}{2}(L_3 + L_4)\frac{di}{dt} - 2L\frac{di}{dt}}{2\rho + R_a},$$

where L is the inductance of one limb of the balancer. But such a superposition would be incorrect, since the two component E.M.F.'s which must be used are in reality dependent upon one another. The former expression would hold for the instant when $q = \frac{1}{2}$, and also when $i = 0$ (*i.e.*, for the instant when the alternating current is passing through its zero value), but not at any other moments; the latter expression only when $q = \frac{1}{2}$ or when $C = 0$, the last alternative being no-load when only the alternating-current exists.

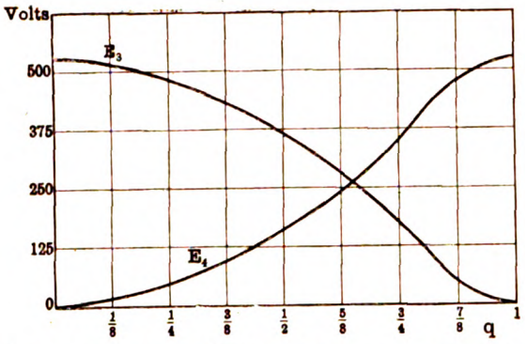

FIG. 4.—RISE AND FALL OF E.M.F. IN THE TWO PARTS OF THE ARMATURE.

To obtain the true direct current component C_b, the total impressed E.M.F. E_a must be reduced by the difference between the alternating-current ohmic losses in the two parts of the armature, *i.e.*, by $\frac{i}{2}\cdot 2R_a(1-q) - \frac{i}{2}\cdot 2R_a q = iR_a(1-2q)$, and also by the difference between the self-induced E.M.F.'s in the the two portions, *i.e.*, by $L_3\frac{di_3}{dt} - L_4\frac{di_4}{dt}$. Similarly, the whole of the differential E.M.F. $E_3 - E_4$ is not available as an impressed E.M.F. to cause an alternating current, but only this amount less the difference between the direct-current losses in the two parts of the armature or $C_b \cdot R_a(1-2q)$.

The true expressions for the instantaneous values of C_b and i need not here be examined, so long as the consequences of their interaction are clearly understood. The important fact to be remembered is that by the connection of the balancer across the armature, C_b is rendered slightly pulsating, and only coincides in value with C at the particular moment when $q = \frac{1}{2}$, or the tappings stand at right angles to the brushes. So also the instantaneous terminal voltage, v_{eb} is rendered pulsating about a mean value. Thus if the letters *a*, *b*, *d*, *f* (Fig. 3*c*) also represent the actual potentials at these points, the difference of potential between the brushes or v_{eb} is

$$d - f = E_3 + E_4 - \left(\frac{C_b}{2} + \frac{i}{2}\right)2R_a(1-q) - \left(\frac{C_b}{2} - \frac{i}{2}\right)2R_a q - L_3\frac{di_3}{dt} + L_4\frac{di_4}{dt},$$

$$i.e., \quad v_{eb} = E_a - C_b \cdot R_a - iR_a(1-2q) - \left(L_3\frac{di_3}{dt} - L_4\frac{di_4}{dt}\right) \quad . \quad (1)$$

By the varying values of the last two terms v_{eb} is caused to pulsate slightly, whether C_b have any value or not, *i.e.*, whether on no-load or full load. When $q = \frac{1}{2}$, $L_3 = L_4$ and $\frac{di_3}{dt} = \frac{di_4}{dt}$; further, whatever alternating current may then be flowing raises the ohmic drop in one quadrant as much as it lessens it in another quadrant, so that neither of the two last terms affects the terminal voltage, and at this moment we return to $v_{eb} = E_a - CR_a$, as if there were no balancer.

When $q = 0$, $\frac{di_3}{dt}$ is positive and acts on L_3, which now is the inductance of one half of the armature $= L_a$, while i is positive. Hence v_{eb} is reduced to a lower value $= E_a - C_b R_a - iR_a - L_a\frac{di_3}{dt}$, and this same value also holds when $q = 1$, since, then, both i and $(1-2q)$ have changed sign, while $\frac{di_4}{dt}$ of negative sign acts on $-L_4$ in equation (1).

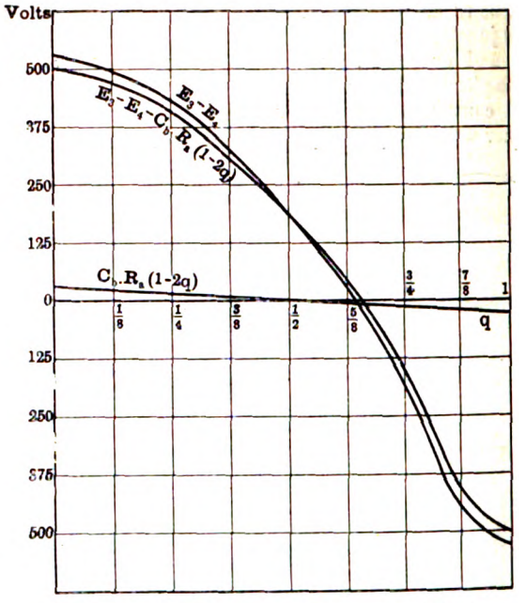

FIG. 5.—THE TRUE ALTERNATING E.M.F

In the intermediate stages there would have to be considere not only the changes of $\frac{di_3}{dt}$ and $\frac{di_4}{dt}$, but also the varying pr portions of L_3 and L_4.

But the whole effect from the self-induced E.M.F.'s in th armature is small as compared with that from the inductanc of the balancer itself. It only needs to be emphasised that b reason of the high inductance that is given to the balancer, th phase of the alternating current through it lags very greatl behind the impressed E.M.F.; the latter is a maximum whe $q = 0$ or 1, *i.e.*, when the tappings pass the brushes, and th current is then but little removed from zero, so that it is ver far from changing its direction when $q = \frac{1}{2}$. On external n load, when the tappings pass the centre of the poles and $q =$ $E_3 = E_4$, and the impressed E.M.F. is zero, but under loa owing to the field being distorted forwards by armature r action (Fig. 4), E_3 does not become $= E_4$ until much later, a this delaying action is also reinforced slightly by the fact th the impressed alternating E.M.F. is not simply $E_3 - E_4$, b $E_3 - E_4 - C_b \cdot R_a(1-2q)$, as shown in Fig. 5. The alternati current will then be nearly at its maximum and $\frac{di}{dt} = 0$, p haps later than $q = \frac{1}{2}$. The two half-waves of E.M.F. will dissimilar, and the current-waves owing to the presence of ir will be further distorted, but beyond the above general stat ment their exact shape need not further be more particular considered.

The network being so far assumed to be balanced, the sa current flows in series through the two limbs of the balanc and since these are assumed to be similar in both winding a magnetic data, even if they are on separate cores, it is evid

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that the potential of the centre point of the balancer is at every moment exactly midway between the potentials of the points a and b, or is equal to $\frac{a+b}{2}$. Further, from the symmetrical distribution of the currents the potential of the brush d is always as much above that of point a as the potential of brush f is below that of point b. For example, by Fig. 3c,

$$d = a + E_3 - i_3 . 2R_a q + L_3 \frac{di_3}{dt},$$

$$f = b - E_4 + i_4 . 2R_a q - L_4 \frac{di_4}{dt},$$

and, therefore, since $E_4 = E_3$, $i_4 = i_3$ and $L_4 \frac{di_4}{dt} = L_3 \frac{di_3}{dt}$, $d + f = a + b$.

Or the potential of brush d might have been obtained from that of b as a starting point, and the potential of brush f from that of a with the same result as above.

Thus the network being balanced, the midway value between d and f is the same as the midway value between a and b. The potential of the middle of the network is also $\frac{d+f}{2}$, so that if the third wire is connected to the centre of the balancer, no current passes and the entire system is unchanged.

Let the load on the two sides of the network now be unbalanced, the effective resistances (whether from lamps or motors) on the two sides being R_1 and R_2, and R_1 being the resistance of the negative side. If the balancer were absent, the potential of the middle wire instead of being $\frac{d+f}{2}$ would be $\frac{d+f}{2} + J_0$, or the initial divergence of the centre potential from its true value midway between those of the brushes is $J = (R_1 - R_2)\frac{C}{2}$, *i.e.*,

$$J_0 = \frac{R_1 - R_2}{R_1 + R_2} \cdot \frac{V_e}{2} = \frac{R_1 - R_2}{2} \cdot \frac{E_a}{R_1 + R_2 + R_a} \quad . \quad . \quad . \quad (2)$$

where V_e is the initial terminal voltage.

The third-wire potential is thus above the mean, or J_0 is *positive*, when $R_1 > R_2$, or the *positive* side is the *more heavily loaded* and has the lower resistance.

Take the case of a dynamo of normal output 250 kw. at 500 volts; let $R_a = 0{\cdot}05$ ohm, and the induced E.M.F. of the armature be $E_a = 525$ volts. When the dynamo is well loaded, $R_1 + R_2$ must not be very far different from the balanced resistance which would give full load, *i.e.*, in our case 1 ohm. Let it be assumed that R_1 on the negative side is 0·55 ohm, and R_2 on the positive side 0·45 ohm. Then without any balancer, the output would be 500 amperes and 500 volts at the terminals, the latter being divided between the two sides of the network in the proportion of 275 volts on the negative side to 225 volts on the positive side, or

$$J_0 = \frac{R_1 - R_2}{R_1 + R_2} \cdot \frac{V_e}{2} = \frac{0{\cdot}1}{1} \cdot 250 = 25 \text{ volts},$$

i.e., on either side an initial divergence from the mean of 25 volts = 10 per cent. above or below the correct amount.

Now, let the balancer be joined across the armature so that an alternating current flows through it, but let the middle wire be still left unconnected to the centre of the balancer. As before, the direct current flowing through the two sides of the network in series, *i.e.*,

$$C_b = \frac{v_{eb}}{R_1 + R_2}$$

is rendered pulsating, and the new initial divergence, like v_{eb}, is also a pulsating quantity. Its instantaneous value is

$$j_b = (R_1 - R_2)\frac{C_b}{2} = \frac{R_1 - R_2}{R_1 + R_2} \cdot \frac{v_{eb}}{2} \quad . \quad . \quad . \quad . \quad (3)$$

which only becomes identical with J_0 at the particular moment when C_b becomes identical with C, *i.e.*, when $q = \frac{1}{2}$.

But the centre point of the balancer would always be at every moment at its true midway value, $\frac{d+f}{2}$. The consequence, therefore, of connecting the third wire to the centre must be an increased current on the side of the network of lower resistance and a decreased current on the other side, *i.e.*, a flow of an out-of-balance current through the middle wire of value $C_0 = C_2 - C_1$, and a consequent re-adjustment of the potentials so that j_b falls to some lower value j_0, and the voltages on the two sides of the network are more nearly equalised.

It remains, then, to examine the redistribution of potentials which results when the third wire is connected, and in the first place to consider in what way the magnetic conditions of the armature will be altered. It will be found that as soon as the middle wire is connected, and the out-of-balance components flow, the armature currents c_3, c_4, c_5, c_6, are no longer divisible into similar pairs, but are rendered *all dissimilar* except at certain instants. Yet, in spite of this, *in the drum armature*, since the windings carrying c_2 and c_5 are situated side by side, and so also those carrying c_1 and c_6, the iron of the armature and pole-pieces is similarly affected in parts 3 and 5, and also in 4 and 6, so that

$$E_3 = E_5, \; E_4 = E_6,$$
$$L_3 = L_5, \; L_4 = L_6,$$

is still completely true.

Further, when the two phases of the balancer are wound on one core and are interlaced, even though the out-of-balance currents which they respectively carry diverge in amount, yet L_7 remains $= L_8 = L$. It is only, therefore, necessary to make use of the final resultant instantaneous values for E_3, E_4, L_3, L_4 and L for insertion in our previous expressions, and they still remain true.

Thus the joint system of C_b and i is only affected by the superposition of the out of-balance components in virtue of alteration of the iron inductances.

The correct principle of superposition is, however, often wrongly stated. To superpose $C_0/2$ in different directions upon C_b in the external network is quite erroneous; to superpose $C_0/2$ in different directions upon the mean of the new final currents in the network, *i.e.*, upon $\frac{C_1 + C_2}{2}$, is, of course, right externally, but leads to an incorrect result in the armature.

Lastly, to treat the actual current in each limb of the balancer as composed of the alternating current i and a fixed proportion of the out-of-balance current $= C_0 n$, where n is the number of limbs or phases, is found to be only approximately correct.

(To be continued.)

CORRESPONDENCE.

THE NOMENCLATURE OF PRIMARY AND SECONDARY SOURCES OF LIGHT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The very interesting articles by Mr. Trotter and Mr. Harrison in your issues of May 19th and 26th make it perfectly clear that the science of photometry is in great need of clearly defined and universally recognised units. While one must strongly support Mr. Trotter's desire for a system of units which will appeal to the engineer rather than to the mathematical scientist, if we are to follow the excellent example set in the other branches of electrical engineering we must reach the practical engineering units through the scientific ones.

To my mind the confusion arises largely from the loose use of the regularly accepted term candle-power. This is a unit dating from the barbaric times when one gazed directly at a light source in order to estimate its illuminating power. Now, we turn our backs to the light and judge the illumination directly.

Candle-power, as Mr. Trotter states, is the English expression for luminous intensity, and I think most engineers regard it as a measure of the penetrating power of a point source of light in one direction. Thus, in a polar diagram, *candle-power is represented by a definite length or magnitude in a definite direction.*

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This idea is based upon the law of *point* radiation—*i.e.*, the law of inverse squares.

Next, we have intrinsic brilliance defined as candle-power per unit area of light source. This quantity, apparently easily understood, seems to me an anomaly. If the light source has area it cannot (except by a conventional licence) be measured in candle-power; therefore, we may have candle-power or area, but we cannot have both together. In magnetism the unit pole is the basis of the system of measurements, or in electro-statics the unit charge. Both these systems bear a close analogy to the one under consideration, but, fortunately for the practical engineer, unit poles or unit charges do *not* exist; while, unfortunately, sources of light, which will obey the inverse square law experimentally, may readily be obtained.

The pole of a dynamo, for example, is referred to as producing a certain total magnetic flux and no attempt is made to compare it with the strength of a unit pole in one direction. A projector lamp, on the contrary, is usually absurdly rated as so many candle-power, the expression being absolutely meaningless. The correct method of stating the output of such a lamp would be in lumens, and would be found by measuring the mean illumination at any place along the beam of light and multiplying this by the area of the section of the beam. Mr. Trotter seems to object to illumination being defined as luminous flux per square centimetre; would he prefer to measure the density of a magnetic field in terms of feet and unit poles?

It therefore appears to me that, while candle-power is a very useful term for describing the luminous intensity in a definite direction of a light source of small dimensions, it should be reserved entirely for use in this relation. As at present employed, it sometimes means intensity and sometimes flux.

Mr. Harrison's remarks with regard to shadow-effect were of particular interest to me, as I have recently been working on somewhat similar lines. It seems, however, that there will be greater difficulty of definition than he imagines since there are "hard" and "soft" shadows, and while both help to define the outline of an object, and so, within limits, add to the effectiveness of the illumination, there is no doubt that the former is usually much more objectionable than the latter. The diversity of the illumination on opposite sides of a solid body would give no indication with regard to this most important point.—I am, &c.,

East London College, June 3. LEONARD MURPHY.

SOME NOTES ON THE USE OF TURBINE PUMPS IN COLLIERIES.*

BY R. H. WILLIS.

Turbine pumps for the unwatering of colliery and mine workings bid fair to oust the ram and other forms from colliery work altogether. Both the turbine pump and the electric motor are essentially high-speed machines, and therefore they can be direct-coupled. Running at comparatively high speed the combination takes up little space, and is easily handled, thus making it specially valuable for dip pumping, shaft sinking, &c. This type is, however, not confined to small quantities and low heads, but by adopting the multi-stage principle, it can tackle anything in the way of pumping water, however great the quantity or the height. For example, at the Powell Duffryn Steam Coal Co.'s Colliery, South Wales, there is a 900 H.P. electrically driven turbine pump in successful operation.

All turbine pumps have the following features:—One or more impellers, mounted on a shaft, revolving in suitable chambers, each delivering the water through a diffusion vane into the succeeding impellers, and finally into an annular space from which the water escapes into the delivery pipe. The chief improvement of recent years has been the provision of diffusion vanes. These take hold of the water after it leaves the impeller at a high velocity, and guide it into suitable passages until the velocity is comparatively reduced; the kinetic energy due to the velocity being thus converted into static energy. In the turbine pump there is no actual displacement of water as in a ram pump, as the action depends on the velocity imparted to the water, due to the revolving impeller, which velocity is ultimately changed into pressure head. Owing to this feature there is no necessity to provide relief valves on a turbine pump, as the pressure can never rise above that due to the velocity set up by the speed of the impellers. Consequently, the pumps can be started up with the delivery valve closed, and this is a great advantage as there is no chance of accidents happening.

The water always passes through turbine pumps in one direction, and is acted on equally by the impellers at all parts. Therefore, the water comes from the pump in a constant stream, and there is no need to provide air vessels as in a ram pump. This feature is a distinct advantage, as it prevents shocks to the pipe system and gives a steady uniform flow of water, allowing the use of the minimum size of delivery pipes.

One point in connection with turbine pumps of some designs, is the possibility of the motor being overloaded if working against a lower head than that for which the pump was designed. This is due to the fact that the surplus head expends its energy in increasing the velocity of flow of the water (consequently the quantity) in all parts of the piping and pump. The friction head is thereby increased and the efficiency decreased, and this artificial and inefficient load may exceed the normal power of the motor. It is general practice to make the motor some 10 per cent. larger than is normally required. Turbine pumps can be provided with special impellers, so designed that the variation of horse-power due to the variation in head is only a very small percentage. This is not altogether an advantage, as it often results in reduced efficiency.

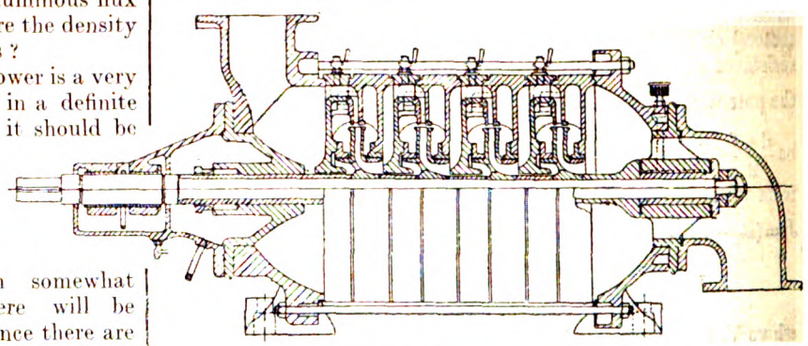

FIG. 1.—SECTION OF SELF-BALANCING TURBINE PUMP.

The greatest obstacle in the way of the satisfactory performance of turbine pumps has, in the past, been the difficulty of suitably overcoming the end thrust set up. In the earlier pumps, a ball thrust bearing or horse-shoe type thrust bearing was largely adopted, but these invariably gave trouble sooner or later. They were discarded in favour of what is known as the balance piston or plate. This device has held the field up to quite recently, but it is now in turn likely to be ousted. Instead of endeavouring, as was done in the older designs of pumps, to use the balance piston to balance the whole end thrust at once, the newer method is to destroy or neutralise the cause of end thrust where it is set up at each impeller. This is done by maintaining equilibrium on either side of each impeller by specially-designed passages connecting the chamber at each side of each impeller. This arrangement has been in satisfactory operation for some considerable time, and is, no doubt, the ultimate solution of the difficulty.

Another method of overcoming end thrust was to place the impellers back to back in pairs. Still another was to cause the water to flow in one direction through one-half the number of impellers and in the opposite direction through the other half. The thrusts set up in the halves of the pump are thus equal in value but opposite in direction, with the result that these two thrusts neutralise one another. Both these arrangements necessitate the use of an even number of impellers, which is not always convenient for the conditions under which the pump has to work. Their effectiveness also depends on equal leakage from all impellers to maintain the balance, and the castings are complicated and costly.

The author proceeds to describe and illustrate various types of turbine pumps. In his opinion there is no advantage in having an external casing, as it not only makes it more difficult to dismantle and re-erect the pump, but also adds very materially to the weight. For colliery work this additional weight is objectionable.

Fig. 1 herewith shows a self-balancing pump in which the end thrust is destroyed by equalising the pressure on each side of each impeller by means of the spiral passages connecting the chambers on the two sides of the impeller. This arrangement is very simple, and yet is very effective in operation. The reduction of the parts is a desirable feature, and simplifies and cheapens the design. A disad-

* Abstract of a Paper read before the West of Scotland branch of the Association of Mining Electrical Engineers.

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vantage of the balance piston or plate is that as the wear increases in the neck rings of the impellers the leakage water tends to increase. The out-of-balance thus becomes greater, consequently more water has to flow from the interior of the balance piston, and as a result the efficiency of the pump falls off. If grit is present in the water this rapidly increases the wear of the rubbing parts and consequently the leakage.

Comparison of Ram and Turbine Pumps.—A great advantage that the ram pump has over the turbine pump is its ability to pump air and water. It can therefore be used in connection with unwatering a working, close to the face, where the supply of water is more or less intermittent. The turbine pump would be unsuitable under these conditions, as the presence of air in the suction side of a turbine pump is detrimental. It would constantly require to be re-primed.

If a very small amount of water has to be lifted against a very high head, then the turbine pump, while it is, of course, capable of doing the work, compares unfavourably with the ram pump. The number of chambers becomes excessive and the efficiency is low. With this exception, turbine pumps can be used for any work in connection with collieries.

Dip Pumping.—A condition which is very often met with in colliery practice is the unwatering of the "dook." Some engineers are of the opinion that this problem is unsuitable for turbine pumps. All difficulties can, however, be overcome, and the author's firm have several pumps installed for the purpose. The pump is mounted on a trolley which is so designed as to keep the pump horizontal. The pump starts against the minimum head, and as is the feature of all turbine pumps, it would, under these conditions, deliver more water

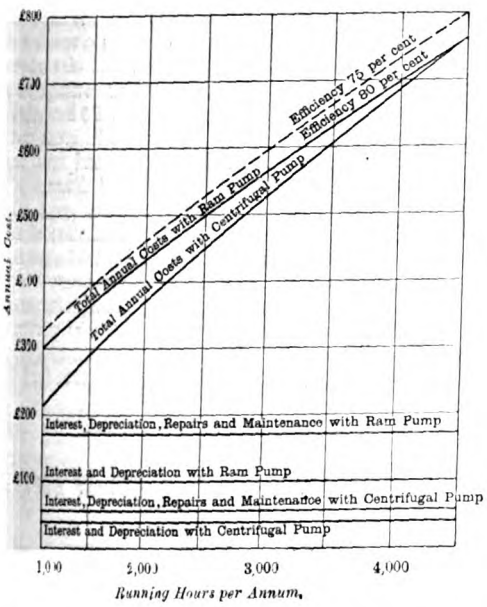

FIG. 2.—DIAGRAM SHOWING ANNUAL COSTS OF TURBINE PUMPS AND THREE-THROW RAM PUMPS FOR A FIXED OUTPUT OF 500 G.P.M. AGAINST A 600 FEET HEAD.

than the quantity for which it was designed. Consequently the motor would be overloaded unless some special steps were taken to prevent this happening. It is, of course, possible to throttle the discharge by means of a valve on the delivery pipe and produce an artificial head equal to the head for which the pump is designed, but this is obviously a wasteful arrangement.

The method followed by the author's firm (the British Electric Plant Co.) is as follows:—The pump is so designed that a varying number of impellers can be brought into operation, the chambers not required being replaced by dummy stages, which are removed as required. Only one impeller, say, in a four-stage pump need be in operation, all the remaining chambers in the pump being dummies, with, of course, a clear waterway through. The motor is some 10 per cent. larger than is actually required, and is of the variable-speed type. As the pump is lowered down, a shunt resistance is inserted in the motor field, and the motor speeded up until a point is reached when the head dealt with is equal to that of two impellers when running at the lowest speed of the motor. Two impellers are then put in the pump and the motor worked at its lowest speed. The same cycle of operations is followed until, ultimately, the pump has its full number of impellers. By this method the maximum of water is obtained with the minimum amount of current throughout the whole period, and the total result compares most favourably with ram pumps which have hitherto been always used for this purpose.

The same arrangement can be followed when the pump is driven with a three-phase motor, but it is not quite so flexible as with a direct-current motor. Consequently, use has to be made of a throttle valve on the delivery side, immediately after changing the impellers, so as to prevent the motor overloading itself at this point of the operations.

Sinking.—The turbine pump also lends itself very readily to the unwatering of vertical shafts. In this case the pump and motor are mounted with vertical-spindle motors and carried in a suitable cage, arranged so that the whole combination can be lowered down the shaft to follow the water as the level is reduced. In this case it is usual to prevent overloading of the motor by screwing down the valve on the delivery side so as to add an artificial head to the pump until it reaches a depth equal to that for which it is designed.

Relative Costs.—The following estimates for pumps to deliver 500 galls. per minute against 600 ft. head may be found of interest:

Specification of Turbine Pump.—Six-stage with 7 in. suction and 6 in. delivery branches. Internal parts of cast-iron and shaft of mild steel. Renewable cast-iron bushes at all internal rubbing surfaces. Direct-coupled by flexible coupling to three-phase squirrel-cage induction motor, 150 H.P., 50 cycles, 500 volts, speed 1,460 revs. per min. Both machines on one bedplate.

Specification of Ram Pump.—Horizontal three-throw, with cast-iron rams, 10 in. diameter by 15 in. stroke. Speed 41 revs. per min. with double reduction gearing, three-phase slip-ring type motor with interlocked short-circuiting and brush-raising device to give 120 H.P., 970 revs. per min., 50 cycles, 500 volts. Both machines on one bedplate.

With the above specifications as a basis, the following are the power calculations. It is assumed that the pumps run for 8 hours per day, and 365 days per year, so the total number of running hours per annum is 2,920:—

	Turbine.	Ram.
Output in gallons per minute	500	500
Head in feet	600	600
Water H.P.	91	91
Motor, B.H.P.	138	114
Input, electric H.P.	151	125
Kilowatts	113	93
No. of kw.-hours per annum	329,960	268,540

The life of the turbine pump may be taken as 10 years; that of the ram pump as 20 years.

Repairs and Maintenance.—7½ per cent. on the first cost of the turbine pump will allow for three complete sets of internal parts during the life of 10 years, also for renewing the cast-iron neck ring bushes every 18 months.

Efficiency (per cent.)

	Turbine.	Ram.
Pump	66	80
Motor	91	91
Combined	60·1	72·8

These efficiencies are lower than what may be obtained from new pumps as tested under favourable conditions, but they are considered fair average values for mining practice. When new, the makers would guarantee, probably, 70 per cent. and 85 per cent. respectively for the pumps alone.

	Turbine pump.	Horizontal treble-ram pump.
Net first cost of pump and motor, exclusive of control gear	£200	£750
Estimated cost of brick-built pump house with concrete foundations for pumps	40	115
Interest—5 per cent. on totals as above	12	43¼
Depreciation—		
Turbine, 10 per cent.	20	—
Ram, 5 per cent.	—	37½
Pump room, 2½ per cent.	5	18¾
Repairs and maintenance—		
Turbine, 7½ per cent.	15	—
Ram, 7½ per cent.	—	56¼
Pump room, 1¼ per cent.	2½	9½
Running costs for 2,920 hours at 0·33d. per kw.-hour, delivered at the terminals	458¼	373
Lubrication and packing glands	4	15
	£516¾	£553¼
Balance in favour of turbine pump	£36½	

If after running some time the efficiency of the ram pump comes down to 75 per cent., the balance in favour of the turbine pump on the above basis would be £67 per annum. The weight of the pump

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and motor complete would be 3½ tons, and 18 tons for the turbine and ram pump respectively.

The cost in one case of preparing chambers, foundations, &c., for the two types of pumps was £240 and £900 respectively.

The number of hours during which pumping is carried on has considerable bearing on the question of relative costs between the two types of pumps. The curves given in Fig. 2 show the effect on the annual running cost of the turbine and a ram pump, according to the number of hours worked. The curves embody data relative to the 500-gallon pumps already considered, and the basis of comparison is the total annual cost inclusive of running and fixed or establishment charges. While the charge for interest is independent of the number of hours per annum during which the plant is in operation, this is not strictly true of depreciation, and still less accurate for repairs and maintenance. The error introduced by treating them as constant is nor great, and does not affect the value of the curves for comparative purposes. The vertical distance between the total cost and the total standing charge in each case represents the annual cost for power and supplies. It will at once be appreciated by a study of the diagram in what manner the comparatively expensive ram pump is handicapped. In fact, not until the pumps have run for at least 4,400 hours per annum (in this particular case) does the greater cost of power for the turbine pump outweigh its other advantages.

When considering the installation of a turbine pumping plant, the following features should be carefully considered :-(*a*) The pump should be capable of being easily dismantled and easily re-erected ; (*b*) all wearing parts should be made renewable, and all similar parts of similar pumps should be made interchangeable ; (*c*) effective methods should be adopted to obviate end thrust.

When the type of pump has been decided upon, the following points should be observed in fixing the same : (*a*) The pump should be fixed on solid foundations and set carefully in line ; (*b*) the suction pipe should be absolutely air-tight ; (*c*) an efficient foot-valve should be provided ; (*d*) the pump should be placed as close to the water to be lifted as possible.

DISCUSSION.

Mr. J. A. RUDD regretted that the author, instead of comparing points of similarity, had not dealt with the points of difference. Between the balance piston and the balance plate there was a very wide distinction. The omission of that distinction showed up weakness in Mr. Willis's design, which was practically the same as that now being abandoned on the Continent. The retention of thrust bearings also raised doubt in the author's mind as to the balance being effective. Then phosphor-bronze was admittedly better than cast-iron for impellers. Further, all makes of pumps were not equally efficient when new. He thought the author had made a slip surely in his figures in only allowing £50 for the pump. The Swiss undoubtedly showed the way for the method of dip sinking instanced by Mr. Willis. He criticised severely the difficulty of dismantling the type shown in case of repairs.

Mr. W. L. SPENCE thought Mr. Willis had treated the matter of end thrust—a very important point in turbine pumps—rather airily. Absolute balance was unattainable, to his mind, with varying loads such as in emptying a lodgment, and the increased vacuum developing on the suction side. So far as the sketches showed, the author had also no device for the balance being preserved on the outer casings. Such absence would inevitably, he thought, lead to destruction of the pump. Then he observed the author's pump alone had the motor at the pressure end. The tendency was to keep it away from the squirting water. To have a bearing as indicated inside the suction end casting seemed a bad engineering proposition.

Mr. S. A. SIMON remarked, as to the author's statement that 1,500 revs. per min. for alternating-current motors was the limit, that he knew of at least five motors in the district of 20 to 100 H.P. of the two-pole alternating-current 50-cycle type running at 2,950 revs. per min. satisfactorily for the past three or four years. He knew one firm had manufactured an aggregate capacity of 16,000 B.H.P. of two-pole motors varying from 100 to 1,000 H.P., running at 3,000 revs. per min.

Mr. WILLIS, in reply, said both Mr. Rudd and Mr. Spence had fallen into the same error. The small holes in the impeller—a feature of all makes of turbine pumps—had nothing whatever to do with the balance. Frankly he thought also the name balance-piston was a mis-nomer. In pumps of the turbine type forces were present to the extent of several tons in whichever style was used, either the piston or plate, and the potential danger attached thereto appealed to the engineer in a very disconcerting fashion. In the pump described these forces were balanced over the neck rings round the impellers, allowing the pressure on each side of the impellers to be equalised. This was how he arrived at a balance irrespective of load. As to the bearing at the suction end, there was no flow of water through the bearing as it was dead-ended, therefore no grit troubles could arise. Being surrounded by water little lubrication was necessary. As to ease of dismantling, he thought the spigot and socket arrangement simpler than the Swiss arrangement. The cast-iron was perfectly satisfactory, but he could give phosphor bronze if customers would pay for increased cost. He admitted Mr. Simon's point as to the two-pole alternating-current machines for 3,000 revs. per min.

WIRELESS TELEGRAPH INSTALLATIONS.

Messrs. Siemens Bros. & Co., Caxton House, Westminster, S.W., announce that, as they anticipate in the near future there will be an extensive field in wireless telegraph apparatus, they have acquired the British rights of the "Telefunken" system. This decision has, Messrs. Siemens state, been come to after mature consideration, as they have deemed it inadvisable to expend time and money in carrying out tedious experiments. The Company, however, have made a careful study of all the known systems of wireless telegraphy, and have come to the conclusion that the "Telefunken" system, introduced by the Gesellschaft für Drahtlose Telegraphie, of Berlin, offers the greatest advantages. They have, therefore, entered into arrangements by which they have secured the exclusive rights for the use of this system for the United Kingdom and for some of the British colonies.

The A.E.G. Electrical Co. of South Africa have acquired the rights of the system for the Union of South Africa.

Messrs. Siemens Bros. & Co. further inform us that they are now prepared to give estimates for the erection and equipment of wireless telegraph stations suitable for all purposes and also to contract for supplying complete telegraphic services under their own control on board ships.

At the same time Messrs. Siemens have issued a well-printed and profusely illustrated "pamphlet" of some 70 pages, which gives particulars of the origin and development of the "Telefunken" system. In Part I. a brief history of the system is given, and Part II. contains a sketch of its development up to a recent date. Excellent portraits of Profs. Slaby and Braun and of Graf Arco are included. Part III., which gives a fully-illustrated description of the new "Singing Quenched Spark" Telefunken system, contains a number of clear illustrations of instruments and apparatus, and also curves, &c., as well as particulars of the types of stations constructed on the new system, figures as to the efficiency of a 1·5 kw. station, &c. In Part IV. the chief advantages of the new Telefunken system are set out, and among these are small apparatus and small antennæ, large ranges, high speed, increased selection and decrease of atmospheric and other disturbances, tone resonance, great efficiency, noiselessness, large wave length, complete utilisation of the total energy in the receiver in consequence of singleness of wave, increased freedom from disturbance with loose receiver coupling owing to the slight damping, and complete utilisation of the high-frequency resonance owing to wave constancy. In Parts V. and VI. particulars are given of the stations erected, their locality, &c., and some interesting records of the new "Telefunken" system are set out in Part VII.

FIRST PUBLICITY CONFERENCE OF SUPPLY AUTHORITIES.

The Electricity Supply Publicity Committee held its first annual conference at the Institution of Electrical Engineers, Victoria Embankment, London, on Tuesday, May 30th. Mr. H. B. Renwick, chairman of the Committee, presided.

The CHAIRMAN briefly touched on the facts connected with the formation of the Committee, its aims and objects. He particularly emphasised the fact that this was the first time the officials of municipal undertakings and the officials of company undertakings had met together for the purpose of carrying on business in their mutual interest, and he hoped to see the principle of co-operation extended in other directions. The constitution of the committee was a particularly representative one. Its 17 members represented some of the most influential undertakings of the country, as would be noted from the following: Representing London municipal supply: St. Marylebone, Croydon, Hampstead, Hammersmith, Hackney, Hornsey, Beckenham, Representing the London companies: City of London Co., Charing Cross Co., Metropolitan Co., St. James' & Pall Mall Co., Kensington & Knightsbridge Co., Notting Hill Co., County of London Co. Representing the provincial undertakings: Brighton, Ipswich, Newcastle-on-Tyne.

The CHAIRMAN then ran through the leading features of the past work of the Committee. Successive issues of publicity literature had been made at frequent intervals throughout the year. These issues comprised posters, showcards, booklets, pamphlets, circulars, folders, leaflets, mail cards, postcards and adhesive labels, covering practically the whole of the field of electric supply. Further, the issues had been arranged so as to be appropriate to the various seasons of the year, and the shape and size of the publications had been carefully arranged so as to fall in with the general office arrangements of supply undertakings. The total sales during the year numbered nearly one million and a half. The entire result was perfectly satisfactory from every point of view, the Committee having supplied literature throughout the whole of the United Kingdom in addition to the colonies and abroad. The Committee had also done signal service in connection with newspapers, and the

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various erroneous reports which had been given currency to in the Press in regard to the causes of fires. Corrections had been arranged in the Press wherever necessary, and the interests of electricity supply generally upheld. The chairman then invited suggestions from any of the members, chairmen or committeemen present.

Mr. W. A. Nicholes, of Great Grimsby, spoke strongly in support of a systematic advertising campaign, and of the considerable results which he had experienced in his own area. He also spoke very highly of the Committee's productions. He thought the time had now come when electric cooking should be energetically pushed.

Mr. H. R. Burnett, of Barrow-in-Furness, congratulated the Committee on the work they had done and the actual results which had been facilitated in so extraordinarily short a time, and said the whole of the industry was beginning to feel the benefit. He thought that the inclusion of an information bureau would be a good thing.

Mr. A. H. Shaw, of Ilford, suggested that the Committee should in the coming year issue large sized posters, as he thought there would be a great opening for same.

The Chairman, in reply, thanked the members for the various suggestions and criticisms, which, he said, should have the careful consideration of the Committee, and in reply to Mr. Shaw's suggestion said he hoped very soon to have some large sized posters to put at their service.

Mr. A. C. Cramb, of Croydon, on behalf of the municipalities, said how much they were indebted to the companies for the large share of the work which they had taken on their shoulders, particularly in this initial stage. He suggested that it would be very useful to have some arrangement for the registration of canvassers, to ensure being able to get hold of good men as representatives.

Col. Hopkins, of St. Marylebone, proposed a vote of thanks to the chairman, vice-chairman and hon. secretary, and spoke enthusiastically of the results which from his own experience had been obtained through the advertising propaganda. He thought there was a good deal to be said for Mr. Burnett's suggestion as to an information bureau. He suggested that competitive prizes should be offered for designs for posters, &c.

Dr. Mansfield Robinson, of Shoreditch, seconded, and spoke very appreciatively of the work done by the Committee. He thought it was the immediate duty of all the municipalities who had not yet joined the Committee to do so at once. He said that in the whole of his 20 years' municipal experience he had never seen in any department of municipal or public work such a record as that shown by this Committee.

The Chairman thanked Col. Hopkins and Dr. Mansfield Robinson for their vote of thanks, and the various members who had supported the Committee by their presence. He also mentioned the considerable assistance which had been given to the Committee by Mr. Cramb as vice-chairman and Mr. Walker as hon. secretary.

Mr. F. J. Walker (St. James' & Pall Mall Co.) spoke of the pleasure which his association with the Committee had given him, and hoped that the spirit of co-ordination between the municipalities and companies would be carried into the forthcoming Electrical Exhibition, as this would considerably help to impress the public.

ELECTRIC COOKING DEMONSTRATION AT HAMPSTEAD.

On Wednesday, Thursday and Friday last week special cooking demonstrations took place at the newly-opened showrooms of the Hampstead Corporation Electricity Department, 283, Finchley-road, N.W. These showrooms have been fitted up very attractively, and the attention of passers-by was drawn last week by laundry operations carried on in one window, electric irons being employed, and by a demonstration of the capabilities of a vacuum cleaner in another window.

The upstairs showroom has been fitted up for cooking demonstrations, and a lady attendant is to introduce in a practical manner electric cooking to the electricity supply consumers of Hampstead. The neighbourhood should certainly provide an excellent field for an extensive heating and cooking load.

The cooking demonstrations last week were given by Mr. F. Grogan, of the Berry Construction Co., and were undoubtedly the most interesting at which we have been present. Our only regret was that Mr. Grogan's audience was so small, for the convincing manner in which he substantiated the various claims made for electric cooking and for the "Tricity" apparatus in particular, could not fail to have won many converts. We understand that Mr. Grogan has during the last three months given a series of electric cooking demonstrations throughout the country with the most satisfactory results, the sales of "Tricity" apparatus during April being double those of March, whilst the turnover in May has more than quadrupled the total of the March sales. Such a result is convincing testimony that the public only require to have practical demonstrations of what electric cooking means and they will quickly see its advantages.

The "Tricity" cooker is already well known to our readers, as is also the extension cooker by which a top heat is provided for the oven; but we may draw attention to the fact that a two-gallon "Tricity" urn is obtainable and is usually fitted on the second hot plate of the duplex cooker. This provides a plentiful supply of hot water. Moreover, the two heats provided for each cooker enables two gallons of water to be raised to boiling point in about 70 minutes with an input of 800 watts, and to be maintained at that temperature by using only $\frac{1}{2}$ unit per hour. On the other hand, by filling up the urn the last thing at night and leaving the switch in the "low" position, the water will be ready at boiling point early next morning.

Other "Tricity" accessories to which attention may be called are a ham boiler, a fish kettle and an egg stand. This last mentioned fits inside the 3½ pint saucepan. By using only ¾ pint of water in this saucepan the eggs are steamed instead of boiled, and time and current are saved.

In connection with his demonstrations last week Mr. Grogan explained the importance of having flat bottoms to the utensils fitted over the "Tricity" hot plates if satisfactory results are to be obtained, and also the object of keeping the surfaces bright. This point was emphasised by means of a 4 lb. flat iron; although this was at the required temperature for ironing, no heat could be felt when the hand was placed at ¼ in. from the surface of the iron, provided it was bright. Moreover, the iron was still too hot to touch after standing for over one hour, due to the small radiation losses. The iron was heated in the first place in 4½ minutes by being placed on the hot plate. The ordinary black and rough surfaced flat irons besides being inefficient, owing to being excellent radiators, are also uncomfortable to use owing to the heat radiated on to the knuckles.

A striking demonstration of the capabilities of the "Tricity" oven was also given. A feature of this oven is that the heat is distributed evenly over the whole horizontal area, deflectors placed opposite the hot plates bringing about this result. As figures are of interest, we may mention that the oven was brought to a working temperature of 340 deg. in 20 minutes for an energy consumption of ¼ unit, which with current at 1d. per unit is equivalent to ½d. This result, the Company claim, cannot be obtained with any other form of oven.

A great feature of electric cooking, in addition to the improved flavour of the food, is the considerable saving in meat. This is emphasised by the following figures recorded in one test on a "Tricity" oven and for a coal range. The joint was a top side of beef:—

	Coal.	"Tricity."
Weight uncooked	5 lb. 4 oz.	4 lb. 0 oz.
,, cooked	3 lb. 6 oz.	3 lb. 8 oz.
Loss in cooking	35·7%	11·5%

This indicates that with electric cooking a 4 lb. joint is equivalent to a 5¼ lb. joint where an ordinary oven is used.

LEGAL INTELLIGENCE.

Johannesburg Municipal Council v. D. Stewart & Co. (1902) (Ltd.) and Others.

At Edinburgh on Tuesday Lord Ormidale commenced the hearing of this action, which was brought by pursuers against Messrs. D. Stewart & Co., Mr. Beardmore, and another for a declaration that they were entitled to reject certain gas producer plant, gas engines, two-phase alternators, direct-current dynamos, balancers and machinery and other goods contracted to be supplied by defenders, Messrs. D. Stewart & Co., to pursuers. Pursuers also claimed payment from Messrs. Stewart & Co. of certain sums, amounting to £418,694, as damages for breach of contract, and from the other defenders £115,134, being the principal sum contained in a bond dated April 13, 1907, granted by William Beardmore and the late Joseph Beardmore, as cautioners for D. Stewart & Co.

It appeared that in 1904 pursuers were desirous of introducing a system of electricity supply and tramways in the city of Johannesburg, and in May, 1905, entered into a contract with the defenders, Stewart & Co., to supply and erect the goods, plant, &c., necessary for the purpose, at a total cost of over £210,000. Messrs. W. and J. Beardmore were their sureties for the fulfilment of the contract. During 1905, 1906 and 1907 Messrs. Stewart & Co. delivered certain portions of the plant, and proceeded to erect them on the site at Johannesburg. The plant is alleged not to have been to specification. In 1906 Stewart & Co. were in financial difficulties, and in May of that year they intimated to pursuers that they were unable to perform the work, and abandoned it entirely on May 15, 1906. The portions of the plant erected on the site were of little or no value to pursuers, who in July, 1907, rejected the goods, plant and machinery, and claimed from Stewart & Co. repayment of the instalments of the price which they had paid (£143,095) and damages for breach of contract. Messrs. Stewart & Co. pleaded that the matter should be dealt with by arbitration, and also that in terms of the contract the matter should be decided by English law and in England. They denied breach of contract, and pleaded that the installation was according to the specification of pursuers, and that any failure of the installation to reach the prescribed tests was due to unsuitability of coal supplied by pursuers for gas-producing purposes.

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A preliminary point of law led to an appeal to the House of Lords, who remitted the case to the Court of Session for proof on the grounds (1) that there being an averment that the whole contract had been repudiated by defenders, it was for the Court of Session to determine whether that was so, and whether, therefore, the arbitration clause could still be appealed to by them; and (2) that in any event, as English law would not compel an English Court to refer the matters falling under these clauses to arbitration, the Court of Session was not bound to refer such matters to arbitration, but had jurisdiction to entertain the whole case. In regard to the claim against the guarantors, the House of Lords reversed the judgment of the First Division, holding that as the bond bore that it was to be regarded as an English bond, it fell to be construed by English law, and that under that law the action was competently laid against the guarantors.

The first witness was the Town Clerk of Johannesburg, whose evidence occupied the whole of the opening day.

The case is expected to extend over three weeks, as numerous letters and other documents have to be produced.

PARLIAMENTARY INTELLIGENCE.

Telephones in Rural Areas.—The Assistant Postmaster-General (Capt. Norton) stated, in reply to questions in the House of Commons last week, that no distinction would be made in the provision of telephone party lines in rural districts or in the conditions of such provision between any part of the United Kingdom and any other part. Of course, those cheap party lines could only be provided in districts in the vicinity of existing telephone exchanges, or where there was enough telephone business to justify the establishment of new exchanges and their connection with the general telephone system of the country. No doubt this limitation would prevent to some extent the extension of telephones to farmers in England. The system could only be extended gradually. Those facilities could not be given throughout the country in places where the telephone did not, to some extent, exist at present. They could not cover the whole face of the United Kingdom with a network of telephones at tremendous cost.

New Acts of Parliament.—On June 2 the Royal Assent was given to the following Acts:—London United Tramways, Dover Corporation, London Electric Railways, Metropolitan District Railway.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

*NOTE.—The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application, an asterisk is affixed.*

April 13, 1911.

9,176 BREWERTON. Device for starting, controlling, and protecting electric motors.
9,186 ELECTRIC CONSTRUCTION CO. & PENSABENE. Cooling commutators of high velocity continuous-current dynamos and motors.
9,201 RAILING & BARTLETT. Cooling the commutators of dynamo-electric machines.*
9,231 AYRES. Wave motors.*
9,232 RAWLINGS & NICHOLSON. Ditionof electrical energy.
9,255 BRULL. Electrical auxiliary motor for reversing.

April 15, 1911.

9,352 GEIPEL & CO. Fixing resistance wires or conductors on porcelain or other insulating supports.
9,375 SIEMENS BROS. & CO. (Siemens & Halske Akt.-Ges., Germany.) Telephone intercommunication sets.*

April 18, 1911.

9,406 WYNDHAM. Telegraphic transmission of pictures and the like.
9,422 SALISBURY & MILLS. Regulating and maintaining pressure and power on an electric supply circuit.
9,475 SHEARS. Brake electro-magnet for tramway and like vehicles.

April 19, 1911.

9,492 AITKEN & BRITISH INSULATED & HELSBY CABLES. Telephone switchboards. (Addition to 1,050/10.)
9,493 TAYLOR. Changing the frequency of an alternating-current circuit.
9,514 TAYLOR. Continuous currents from alternating current circuits. (Addition to 20,867/09.)
9,523 BEAVER & CLAREMONT. Twin or multicore electric cables.*
9,528 SANDRINI & SANGUINETI. Generators of electrical energy.*
9,573 BACHELET. Electro-maenetic levitating and transmitting apparatus.*
9,575 MENNS. Electro-magnetic instruments.*
9,577 DICKER. (Automatic Electric Co., U.S.) Telephone systems.

April 20, 1911.

9,595 STEVENS. Regulation for electric motors with series field windings.
9,598 BODDAM. Electrically-driven hydraulic lifts.
9,606 SIEMENS BROS. DYNAMO WORKS & SCHUPP. Controllers.*
9,625 LAKE. (Kelley Electric Machine Co., U.S.) Wood working or routing machines.*
9,633 IMRAY. (Shawinigan Carbide Co., Ltd., Canada.) Electrodes for electric furnaces.
9,649 BENKO. Carbon electrode for galvanic batteries.
9,652 BUSSEY. Planiawerke Akt.-Ges. für Kohlenfabrikation Ratibor, Germany.) Carbon electrode.*

April 21, 1911.

9,686 WHITE. Electrical switches.
9,717 MERRYWEATHER. Electrically-driven pumps.
9,719 SCHALLER. Electric incandescent lamp. (Convention date, 21/4/10, Germany.)*
9,725 ORLING & ORLING'S TELEGRAPH INSTRUMENTS SYNDICATE. Electro-capillary contrivances.*
9,739 LAKE. (Soc. Anon. le Carbone, France.) Connections for electrical uses.
9,745 GILES. Indicating an earth or ground connection of an electric line. (Convention date, 21/4/10, Switzerland.)*

April 22, 1911.

9,806 BOOTH & BOOTH. Reflectors for incandescent electric lamps.
9,815 SCHALLER. Electric incandescent lamp. (Convention date, 22/4/10, Germany.)*
9,816 SCHALLER. Electric incandescent lamp with liquid incandescing body. (Convention date, 22/4/10, Germany.)*
9,819 NORTH. Electrical measuring instruments.
9,840 BOSCH. Producing electric ignition in internal-combustion engines. (Convention date, 27/3/11, Germany.)*
9,847 & 9,848 BEST, PONSONBY & BEST'S CONTRACT CO. Miners' safety lamps.

April 24, 1911.

9,856 ELECTRIC & ORDNANCE ACCESSORIES CO. & BOWEN. Electric motor generators.
9,941 SPEZIALFABRIK FUR ALUMINIUM SPULEN UND-LEITUNGEN G.M.B.H. Electrically insulating layers or coatings on metal. (Addition to 20,634/10. Convention date, 25/4/10, Germany.)*
9,945 & 9,946 PORSCKE & ACHENBACH. Electrodes for secondary galvanic cells. (Convention date, 9/5/10, Germany.)*
9,948 SOCIETE RENE GILLET ET CIE. Timing electro-magneto machines for explosion motors. (Convention date, 25/11/10, France.)*

April 25, 1911.

9,957 HAIGH. Single-phase commutator motors.
9,965 SMITH. Holders for incandescent electric lamps.
9,995 GRAHAM. Supporting or carrying fuses for electric circuits.*
10,038 PINTHER. Trolley wheels for electrically-driven vehicles. (Convention date, 4/8/10, Austria.)*
10,043 & 10,044 MACKENZIE. (American Transmitter & Mfg. Co., U.S.). Telegraph transmitters.*
10,045 GRAHAM & RICKETS. Impedance coils for telephony and like systems.*
10,056 HARTMANN & BRAUN AKT.-GES. Electric measuring instruments. (Convention date, 3/6/10, Germany.)*

April 26, 1911.

10,065 SCOTT & CROFT. Automatic gear for isolating faulty feeder cables by means of electrostatic apparatus.
10,080 CHAMBERLAIN & HOOKHAM & HOLDEN. Electricity meters.*
10,085 SMITHSON & SHARPE. Open-type arc lamps.
10,101 WATERHOUSE. Wiring buildings and the like for the distribution of electricity.
10,105 ORLING & ORLINGS TELEGRAPH INSTRUMENTS SYND. Relay device.
10,113 SIEMENS BROS. DYNAMO WORKS. (Siemens Schuckertwerke G.m.b.H., Germany.) Non-interchangeable electric fuses.*
10,128 COBBETT & DALMAINE. Cable sling.
10,142 THRELFALL. Electrolytic cells.*
10,156 BENKO. Electrolytic cells.*
10,162 B.T.-H. CO. (G.E. Co., U.S.). Electric switches.
10,166 BOULT. (Frank W. Van Ness, U.S.). Electric switch for use with a vacuum pump or for other purposes.

April 27, 1911.

10,180 LEON. Electrified steel tool.
10,186 POORE. Electric pump.
10,205 STOCKWELL. Electric plugs.
10,219 SMITH. Controllers for electric motors.
10,231 ROCHLING'SCHE EISEN UND STAHLWERKE G.M.B.H., & RODENHAUSER. Electric furnaces. (Convention date, 13/12/10, Germany.)*
10,238 TELEPHON APPARAT FABRIK E. ZWIETUSCH & CO. G.M.B.H. Connection of lines in automatic telephone exchanges. (Convention date, 27/4/10, Germany.)*
10,245 STEEL & STEEL. Time control for electric alarm.
10,254 B.T.-H. CO. (G.E. Co., U.S.). Electric switches.
10,264 PÖRSCKE & ACHENBACH. Electrodes for secondary galvanic cells. (Convention date, 12/7/10, Germany.)*
10,265 BELLINI & TOSI. Spark-gap devices for wireless telegraphic and telephonic apparatus.*

SPECIFICATIONS PUBLISHED.

1910 SPECIFICATIONS.

2,088 ELECTRIC & ORDNANCE ACCESSORIES CO. & SEAL. Electric lighting of railway carriages and other vehicles.
9,837 HARDEN. Electric furnaces.
9,921 MARTYN. Bonding devices for electric cables and electric fittings.
10,041 MALACHOWSKI. Electric glow lamps. (3/9/09.)
10,048 HARRIS. Electric measuring instruments having movable coils.
10,160 TORCHIO. Making insulated electric conductors. (4/5/09.)
10,191 ADAMS MFG. CO. (Cutler Hammer Mfg. Co.) Electric motor starters.
10,334 KRETZ. Coin-operated mechanism for supplying electricity.
10,693 KOOPMAN & PONTELEC WELDING PATENTS. Supports for electric conductors.
10,694 KOOPMAN & PONTELEC WELDING PATENTS. Electric heating machines.
10,745 HURD. Means for facilitating the transcription of telegraphic messages.
10,871 HARRISON. Filaments for incandescent electric lamps.
10,872 HARRISON. Exhaustion of incandescent electric lamps.
11,602 FESSENDEN. Telephone transmitters and relays.
11,707 B.T.-H. Co., & WEDMORE. Electric switch mechanism.
12,261 LAYTON. Electric generating systems.
12,651 LEHMANN, ROSS-HARVEY & INRIG. Variable-speed dynamo.
12,701 ADAMS & ADAMS MFG. CO. Electric change-over switches.
13,274 MARTYN. Wall plugs.
13,528 MOUL. Arc lamps.
14,476 REYROLLE & Co., & SCHUIL. Lightning arresters.
14,496 PINDTERSHOFEN. Electric cables. (Addition to 6,757/08.)
14,512 B.T.-H. Co. (G.E. Co., U.S.) Protective devices for electric distribution systems.
15,165 FITZGERALD. Electric furnaces. (1/9/09.)
15,343 SMITH & LARSEN. Electric motor controllers. (30/9/09.)
15,422 MONEY. Electromagnetic apparatus for the transmission of power.
15,482 WINTERHALDER. Cut-out switches for electric tramway systems and the like.
15,684 DEAN. Armoured or protected electric switches and fuses.
15,807 JANDUS ARC LAMP & ELECTRIC CO. & JONES. Arc lamps.
15,873 BULLIMORE & COSSER, LTD. High-tension electrical condenser.
16,333 GOLDSTEIN. Signalling system.
18,307 WARBURTON. Combined reciprocating engines and turbo-electric generator and motors for driving steamships and machinery.
18,821 GILL. Sheath for electric lamps.
18,850 COOPER. Driving connection for electrically-propelled vehicles. (10/9/09.)
19,044 BENTLEY. Electrically-driven clocks.
19,093 HARDINGHAM. (Hartmann & Braun Akt.-Ges.). Electrical measuring instruments.
19,125 SCOTT. Switches.
19,835 EEID. Regulating electrodes in electric furnaces.
19,866 GEB. SIEMENS & CO. Process for the manufacture of fireproof electrically-conductive materials. (4/10/09.)
20,968 ROBERT BOSCH. Electric ignition of internal-combustion engines. (1/11/09.)
22,368 PUGH & GAMBLEE. Electric time switches.
22,380 BERRY & MARKHAM. Insulating parts of electric switches.
22,482 LUCAS & EDWARDS. Electro-magnets.
23,634 SIEMENS BROS. DYNAMO WORKS. (Siemens-Schuckerwerke, Ges.) Polyphase electric induction generators.
24,439 HOPE. Electric switches.
24,548 KRAUSE. Incandescent metal filament lamps. (8/7/10.)
27,712 DORMAN, SMITH & BAGGS. Fusible cut-outs.
28,888 MICHOTTE. Arc lamps. (15/7/10.)
28,940 SIEMENS BROS. DYNAMO WORKS (Siemens-Schuckertwerke Ges.) Electrodynamical couplings.
29,271 SOC. DES TELEGRAPHES MULTIPLEX (SYSTEM E. MERCADIER). Mono-telephonic relays. (26/1/10. Addition to 6,767/08.)

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COMMERCIAL AND INDUSTRIAL SECTION.

MUNICIPAL, FOREIGN & GENERAL NOTES.

BRITISH NOTES.

Association of Teachers in Technical Institutions.—The conference of this association was held at Southport on Monday and Tuesday. The president (Mr. Barker North, of Bradford) in the chair. About 100 delegates were present, 12 branches being represented.

A series of resolutions relating to various aspects of technical education and the work of technical teachers were discussed.

The President, in the course of his address, said that the more one inquired into the various reasons given for England's failure to take the lead in industrial developments, the more one was driven to the conclusion that lack of the spirit of organisation and system, in both industrial and educational matters, was the root of the evil. The provision of an adequate number of preliminary trade schools and secondary schools with a technical bias was of the utmost importance. A characteristic feature of the present secondary system was that the education was too literary in character, with the result that youths were frequently pitchforked later into pursuits for which they were not adapted, or into professions which were overcrowded. Out of 157 holders of London County Council senior scholarships, only two were ultimately trained for industrial pursuits. They had to recognise clearly that provision must be made in the future for two distinct types of students—the first, the rank and file of the industrial army, and the second, the officers, who would have to organise and direct. Other questions were also of pressing importance—namely, (1) the necessity for the institution of a national "course" system, which should replace the present haphazard arrangement, and so that this might lead up systematically to the day work of the highest institutions; (2) the institution of a national system of examinations; (3) the necessity for placing the general organisation of evening schools on a more business-like footing.

Resolutions were passed in favour of an advisory council on technical education, the formation of consultative committees of teachers, the representation of teachers on education committees, advisory committees for juvenile employment, &c.

Mr. J. H. Reynolds, director of higher education for Manchester, said that as a nation we were spending £20,000,000 a year on elementary education, and it was a crime that a large proportion of that vast sum should go to waste. They had to lay hold of every boy and girl leaving school at 14 and carry on their education in some way or another to at least the age of 17.

Bangor.—On Wednesday the Council adopted a recommendation of the Lighting Committee to put in a Diesel oil engine and dynamo at the electricity works, instead of the present steam generating plant, at a cost of £2,000.

It was explained that the adoption of the recommendation would result in a total saving to the Corporation of £343 yearly. Application has been made to the L.G. Board for sanction to borrow £2,000 for the plant.

Darlington.—The salary of the engineer and manager of the electricity and light railways departments (Mr. Lunn) has been increased to £600 per annum, by three annual increments of £50.

Dudley.—The Council are recommended to apply for a loan of £5,500 for feeder and distributing cables and £1,080 for services, &c.

It is also proposed to increase the size of the condensing plant, fix a mechanical stoker to one of the boilers and replace an engine to enable the station to cope with the anticipated demand for the forthcoming winter. The cost of the work (£1,560) will be charged to revenue, and payment be extended over a number of years.

Imperial Conference.—At the sitting of the Imperial Conference on Friday various questions of importance to commercial men were discussed.

Arbitration Awards.—The following resolution, by Mr. S. Buxton, M.P., was referred to a committee: "That the Imperial Government should consider, in concert with the Dominion Governments, whether and to what extent and under what conditions it is practicable and desirable to make mutual arrangements with a view to the enforcement in one part of the Empire of commercial arbitration awards given in another part."

Uniformity of Patent Laws.—A resolution by Sir Joseph Ward, "That it is in the best interest of the Empire that there should be more uniformity throughout its centres and Dependencies in the law of Copyrights, Patents, Trade Marks and Companies" was agreed to.

Weights and Measures.—A resolution in favour of the decimal system was withdrawn.

International Exhibitions.—Mr. S. Buxton moved "That in view of the International Conference to be held at Berlin in 1912, with a view to the regulation of the conditions under which International Exhibitions should receive support, it is desirable that the Imperial and Dominion Governments shall consider the matter in conjunction so as to arrange if possible for concerted action on this subject." After discussion, this was agreed to.

Inland Telegraph Charges.—In matters relating to land telegraphy Belgium has always been in a foremost position. The development of land line telegraphy has, ever since the days of Van Rysselberghe, been a subject for which the world has much to thank the Belgium telegraphic department. "The Times" correspondent at Brussels, under date May 24, refers to negotiations regarding reductions in telegraph rates, subject to special conditions, between Belgium, on the one hand, and Great Britain, France and Germany on the other. The Belgium authorities have inaugurated a system of telegraphic subscriptions. Newspapers, business houses and other large users of the telegraph day by day, by payment of a subscription representing about one-half the ordinary rates, are enabled to transmit their telegraphic messages. The only condition attaching to this arrangement, which Belgium is the first country to adopt, is that there shall be a minimum of 250 words per day to be paid for, and that the messages shall be transmitted between stated hours. Belgium is endeavouring to obtain the consent of Great Britain, France and Germany in order that the arrangement may be applied to telegraphic traffic between these countries.

Inquests.—Adjourned inquiries were held last week into the deaths of two men who were recently killed at the Sherburn Hill colliery and the Lumley Third Pit of the Lambton Collieries Co.

At Sherburn Hill the inquiry related to a hand putter named Laverick, who met his death on April 28. Mr. Robt. Nelson, H.M. electrical inspector of mines, and Mr. A. D. Nicholson, chief inspector of mines, were present.

WM. WALKER, coal filler, said that on April 28, after Laverick had brought out his full tub and taken the empty one in he sat down on the rails. Witness was standing beside the empty tub (3½ yds. away), and whilst talking to Laverick and to a man named Ashworth, the latter shouted out to Laverick, "Keep back, the tub's off the way." Just as he shouted, and when Ashworth was getting round the turn, the place where Laverick stood lit up. A man named Nutter switched off the current. Several men applied artificial respiration upon both Ashworth and Laverick. They succeeded in reviving Ashworth, but not Laverick. When Ashworth's tub was off the way it was quite clear of the cable, but where deceased sat he thought he caught his head against the cable. He had not heard of anything like that happening before, but he had had many a shock before when he was pulling tubs through catching the cable in a bare place. He had not reported those matters because he never thought anything of them until this accident occurred.

By Mr. NICHOLSON: He had never observed that in the haulage roads the cables caught the tubs. He could see the blue light on the plates when the place lighted up. It was five minutes after the accident before current was switched off.

In answer to the foreman (Mr. Errington) witness said he had had a few shocks, and others had more shocks, but he did not frequently come across places where the cable was worn. He had never seen the timber set on fire by any flashes.

GEORGE TURNBULL, driver of the coal cutter, said that on the morning in question Walker shouted that someone was caught in the face. He stopped the coal-cutting machine at once and went along the face to see what had occurred. He saw deceased lying face downwards, his face touching the side of the rail. He used artificial respiration to try to bring him round, and was so engaged close upon half-an-hour, but without result. Prior to that he had given orders for the current to be cut off at the out-bye switch box. There was no flash when he was there, and he did not see any defect. He could not give any explanation of the accident. He had had some trifling shocks from the cutter, but not from the main cable.

Mr. NELSON said cases had been known of life having been restored after two hours' treatment. He did not want to cast any reflection on Turnbull, but the more widely this was known the better, because efforts ought not to be stopped so soon.

Mr. BELL (for the Colliery Co.) said that the cables had been greatly improved of late years.

Mr. NELSON: I understand you to say that you repair worn cables with black tape. Are you satisfied that you can make a good job of it?—Turnbull: Yes.

Do you consider it a satisfactory job to cover up a bare part with black tape alone?—It is quite safe for a time, just with black tape.

For the time being?—Yes; and I report the matter to the electrician.

By Mr. HEATH (for the Miners' Association): The rails were still electrified, but Laverick was not touching the cable then. There must have been some connection between the cable and the rail.

PATTERSON, a foreman electrician, said he examined the electric apparatus at 10:30 a.m. on April 28, shortly before the accident. He

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examined the cables and switch boxes in the second east district and found all was safe and in order. The cables were properly insulated. When he heard of the accident he went straight to the scene and saw Turnbull, who told him what had taken place, and showed him the exact spot. On the way he met deceased and Laverick being taken out-bye. He examined the cables, and found one damaged. The insulation had split about ¾ in. He found the copper was not bare, and he had to probe with his screwdriver to find it. The cable had been jambed, probably by a tub, and that caused it to split. The tub that jambed it would act as a conductor, and form a connection. That was what he should say was the cause of the accident. He thought it would be the empty tub that Ashworth was putting that caused it. Ashworth would not get so severe a shock, as he would be standing on the ground, whilst Laverick was actually sitting on the rails.

In reply to Mr. NELSON, witness said the cable seemed to be in the same position after the accident as it was before. His private theory was that the empty tub coming in-bye got off the way, and in putting it on again it must have jumped and struck the cable. He knew there was a rule about cables and tubs, but in that case the cable was closer to the tub than it should be, because they were going to shoot the canch down.

By Mr. HEATH: He did not agree that the electrical system adopted at the colliery was dangerous, although personally he preferred the alternating system. He thought armoured cables were safer than rubber cables.

Other evidence having been given, the Coroner summed up. He did not think the matter had been definitely cleared up. There was no evidence to show that the empty tub was off the way. There was no evidence of negligence on the part of the management. The report of the local inspectors was to the effect that they, as practical working men, had examined the place and found the cables in good order.

The Foreman expressed surprise that the defect in the cable was not discovered.

The jury then returned a verdict that Laverick's death was caused by injuries accidentally sustained from an electric shock through coming in contact with an electrified rail whilst following his employment.

In the second inquiry, the deceased was John McPherson, who had been an electric conveyor operator at Lumley Third Pit.

After medical evidence had been given to the effect that death was due to paralysis of the brain due to electric shock,

Mr. NELSON asked Dr. J. R. Hall, a medical witness: Is this the first post-mortem you have held in a case of this kind?—Yes.

And you are not able to say from the condition of deceased whether it was a case of death from high or low pressure?—No.

But the indications were so marked as to show that the man died from electric shock?—Yes, in my opinion.

GEO. COULSON, deputy overman, said McPherson seemed to understand his work. He last saw McPherson alive at 10 a.m. on May 13. He was then at the motor, but no conversation passed. Witness went to the other end of the conveyor, and subsequently returned to the motor end. When he got to the switch box he heard the motor humming, which meant there was something wrong with it. He at once switched off the current, and going to the motor found McPherson lying on his left breast, with his nose and mouth to the ground. There was some water between the sleepers and the rails, and his face was in it. He tried artificial respiration and continued it for an hour and a half, and meanwhile the doctor came. Witness was first to McPherson, but he seemed lifeless when he picked him up. That morning witness and deceased had got slight shocks off the motor, and he reported the matter to the foreoverman, who had the machine stopped, and the electrician was sent for. In the morning he received a shock through touching the motor with his elbow when he was on a canch. He had heard another man say he had had a slight shock from the fan. He did not know whether McPherson had any shock. There was no necessity for deceased to touch the motor.

LAWSON, an apprentice electrician, said that on May 13 he got a message that the electrician was wanted down the pit. He could not find the chief electrician, so he went himself. He met deceased, who told him the motor was a bit "tickley." Current was shut off, and witness went to the three leads from the cable into the motor. He took the top one off first, and found the small strands had been catching the side of the framework of the motor, and had been burnt away. He tightened the strands up and put some rubber tape and black tape around them. The other two leads were found to be all right. He then switched on the current, and found everything was right. He got no shock, although he stayed there a quarter of an hour.

By Mr. NELSON: The machine frame had never been alive before when it was running. He had several times made those connections, and thought that what he did was an effective way of making the connections.

By Mr. HEATH: The leads were fixed to the cables. The risk would be obviated if the leads fitted into the holes of the motor, and without having to pare off the strands.

Mr. R. DOBBING, chief electrician, said that Lawson reported to him the result of his examination of the motor and leads. He considered that what he had done was quite right and proper. When witness went down the pit artificial respiration was being applied to deceased. He examined the motor the previous night, and found everything all right.

By Mr. NELSON: There was a previous case reported of a shock from a cutter, but that was the first time he had had a report of a shock from a motor frame. That would indicate a fault in the machine, and also that the earth connection was imperfect.

By Mr. HEATH: He had been at the colliery three years, and with the exception of one shock from a coal-cutter had never heard of another shock.

Mr. H. J. FISHER, engineer to the Lambton Collieries Co., said he examined the motor and machinery about three weeks previous to the accident. He had not heard of any shocks previous to the accident. He made an examination of the machinery after the accident to see if it was properly earthed, and he also examined the continuity of the earth to bank. Tests were taken and they were entirely satisfactory. That proved that it was impossible to get a shock from the framework of the motor. He knew of the repairs done to the motor, and thought that confirmed the impossibility of getting a shock. He thought there must have been an intermittent break in the earth. The humming of the machine was intermittent, and that was proved by it not humming one day, but doing so on another day after the accident. The earth plates at bank had been tested, and found satisfactory. The earthing of a portable machine like the motor was not compulsory.

By Mr. NELSON: The boy might have inserted his fingers in the terminal box, and thus have got a shock. The motor was humming when he made the test. He did not regard the terminal box as an ideal method of connection with the motor, but it had been in operation there and elsewhere for several years without an accident. He did not think it necessary to alter it, but they were doing away with the terminal box and putting in a plug box and automatic switch.

By Mr. HEATH: There was a great deal of vibration with the motor, which might easily slacken the nut in the motor frame, and thus weaken the connection. The boy would only have to slide the terminal cover to one side in order to put his fingers in.

Other evidence having been given, the jury came to the conclusion that McPherson was killed by an electric shock accidentally received, and recommended that experienced men only be employed to attend to electrical machinery.

L.B. and S. Coast Electric Train Service.—The improved service of trains on the London, Brighton and South Coast Railway came into full operation on the 1st inst. by the opening of the complete electric service between Victoria and the Crystal Palace.

By the electric train service displacing the steam trains on certain journeys there are 97 down trains daily instead of 72, and 113 up trains instead of 82, running from Victoria to Wandsworth Common. There are also a number of through business trains from London Bridge to Wandsworth Common morning and evening. During the day the only change necessary for residents in that district is at the Crystal Palace, and in a few months' time through electric trains will be running between London Bridge and Wandsworth Common, as the electrification of this road is nearing completion.

London Electricity Supply.—A return prepared by the assistant statistical officer of London County Council (Mr. J. J. C. Spensley) has been issued, giving particulars of the electricity undertakings in and around London.

The return shows the various authorities under the Electric Lighting Acts, with their areas of supply, and an analysis of the accounts of each undertaking for the year ended March 31, 1910, or December 31, 1909, and also various miscellaneous statistics relating to capacity, output, average prices obtained for current, assessments, &c. The publication, although somewhat belated, is interesting, inasmuch as it contains a number of tables, which enable a ready comparison of the figures of one undertaking with another. In addition to the undertakings in the metropolitan boroughs, statistics are given of those in Greater London and a few places on the outskirts of the metropolis, such as Grays, Gravesend, Chislehurst, Watford and Weybridge. Figures relating to the North Metropolitan Electric Power Supply and the South Metropolitan Electric Tramways & Lighting Co. and undertakings taking electricity in bulk are also included.

Miners' Safety Lamps.—In his monthly circular to the Northumberland Miners' Association Mr. Thos. Burt, M.P., makes reference to the prize of £1,000 recently offered by a colliery proprietor (through the Home Secretary) for the best electric safety lamp fulfilling certain specified requirements. Particulars of the prize were given in the ELECTRICIAN for June 22 (p. 283).

Mr. Burt points out that some years ago it was thought that electrical engineers would supply a greatly improved safety lamp. Many portable lamps were invented and exhibited from time to time. Some of the initial difficulties, such as the too great size and weight of the lamp, were overcome. One of the drawbacks, however, which remained unsolved was that the electric lamp could not be used for testing the presence of gas. That difficulty, he was told, was likely to be surmounted. Owing to the very imperfect light afforded by many of the ordinary safety lamps, the miner was always under a temptation to work with a naked light. It should be borne in mind, too, that insufficiency of light was often itself a source of danger. Hence a genuine safety lamp, giving a good, serviceable light, would be a great boon to the miner, and would be likely to largely diminish the number of accidents.

In reference to this matter, the Dalkeith miners, on Saturday, passed a resolution calling for the deletion of the sub-section of the Mines Bill making the use of safety lamps compulsory. It was considered that the imperfect illumination by safety lamps would increase accidents when open lights could reasonably be used.

Provisional Order Revocation.—The Board of Trade have revoked the Stevenage Electric Lighting Order, 1902, as from May 30.

St. Pancras (London).—Last week the Council approved the recommendation to reduce the charge for current for outside shop lighting to 3d. per unit.

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South Shields.—The L.G. Board have now sanctioned the borrowing of £7,580 for providing additional plant at the electricity works.

Three inquiries were held by the L.G. Board with regard to the Corporation's application for permission to borrow money, and in February the Corporation revised their schemes, and the Board's inspector held an inquiry last month, when the application was opposed by the N.E. Railway Co. and Smith's Dock Co. The estimated cost of the new plant is £10,080, of which amount it is proposed to borrow £7,580, the balance (£2,500) being taken from reserve fund.

Spennymoor (Durham).—The Council have invited the local electricity supply and gas companies to tender for the public lighting of the district for 12 months.

Stoke-on-Trent.—An inquiry will be held on Wednesday next into the application of the Council for sanction to borrow £60,000 for the erection and equipment of a new generating station.

Submarine Cable Rates.—Following on the very specific statement made by the Postmaster-General in Parliament and by the Chairman of the Eastern and Associated Telegraph Companies to the shareholders of these undertakings, "The Times" correspondent in Paris, under date June 4, informs us that "a reduction of 50 per cent. is recommended to be made in the charges for long-distance telegrams transmitted by submarine cables in clear language." This is, we think, exactly the rate mentioned by the P.M.G. and Sir John Wolfe-Barry.

Tramcar Accident.—On Monday morning an accident occurred on the tramways of the Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board, and several persons were injured. At a sharp curve at the foot of an incline the car left the rails and was overturned.

Lieut.-Col. von Donop opened a Board of Trade inquiry into the accident on Wednesday.

John Napper, driver of the car, in reply to the Inspector, said he had never lost control of a car before that accident. On previous runs he had had no trouble in running down Millbrook. He brought the car to a stand at the top of the Millbrook-hill, and in doing so used the hand-brake. He did not use the magnetic brake in making the stop.

The Inspector: That is different from what you told me last night?—Yes, sir.

You told me distinctly that you stopped the car by means of the Westinghouse brake, that is, the magnetic brake, and then applied the hand-brake?—No. I said I used nothing but the hand-brake.

Witness added that he waited at the top until he got the signal from the conductor. Describing the journey down hill, he said: "I had released the hand-brake, and simultaneously applied power to the third notch. The car moved forward, and gradually gained speed. When I had sufficient speed to generate current to bring the magnetic brake into action, I dropped some sand and applied the magnetic brake by degrees, on account of the rails being very moist. I noticed that when the brake was on the second notch the car was gaining speed quicker than I expected. I continued to drop sand, but the car did not retard at all. I gave the magnetic brake another two notches, but I could not make the first stop before getting round the first curve. I could not pull up at the second Board of Trade stopping place, and I put that down to the wheels skidding. Then, when I got out straight again, I put on the magnetic brake until the highest point was reached, but as the car kept going, and gaining speed, I came to the conclusion that the magnetic brake had failed. So I shut it off, and applied the hand brake to go round the curve at the bottom. Though the speed was high I thought as we kept the rails we should clear the curve, but the passengers on the top were excited and did not keep their seats. Instead, they got on the right-hand side. The car lurched at the curve and the heavy side weight turned it over on its side."

The Inspector: When you started downhill did you think the wheels were skidding or did you know where they began to skid?—Witness: I don't know, but when I put on the magnetic brake the car gained speed. I thought the wheels were skidding owing to the bad state of the rails. I am sure the magnetic brake did not act going down the hill."

Did you try the magnetic brake at the last stop before starting down Millbrook-hill?—No, sir.

Frank Shaw, the conductor, said the car carried 42 passengers on the journey, and the usual stop was made at the top of Millbrook-hill. Several passengers, who travelled by the car, denied that the car was brought to a stand-still at the top of Millbrook-hill.

The inquiry was adjourned.

Underground Telegraph Cables.—In a recent report by the Postmaster-General it was stated that the main underground telegraph line to the west had been completed, and the wires between London and the landing places of the important cables starting from the west coast had been diverted to the underground route.

The northern underground line had been completed to Edinburgh: a considerable underground work from Aylesbury to Coventry had been laid completing the second London-Birmingham underground cable. Pipes and cables had been laid down between Manchester and Liverpool, Manchester and Ashton, and Manchester and Stockport; cables had been laid between Leeds and Stockton, Chatham and Canterbury, and Berkeley and the city boundary of Gloucester. During the current year it was hoped to lay pipes from Gloucester to Worcester, from Leeds to Hull, and from Canterbury to St. Margaret's Bay and Abbot's Cliff, the landing places of Continental cables, and cables from Berkeley to Worcester. The cable from Stockton to Leeds was practically finished, and would complete the line from Warrington to Newcastle. The pipe work from Gloucester to Worcester and the cable from Berkeley to Worcester would complete the underground connection between Bristol and Birmingham. There would then be a triangle of underground lines with the angles at London, Birmingham and Bristol, the underground lines to the south-east, the north and the south-west being extensions from these three towns.

Wanstead.—On the invitation of the Council, West Ham Corporation are considering the question of constructing a tramway along the centre road across Wanstead Flats.

It is suggested that West Ham should promote a bill for a double line across the Flats and round Bushwood to Leytonstone, with inter-running powers over the new section with the East Ham, Leyton and Walthamstow Councils.

Wrexham.—An enquiry was held here on Friday into the application of the Council for sanction to borrow £4,145 for the electricity undertaking.

The town clerk (Mr. Lawson Taylor) gave particulars of outstanding loans, &c. There was, he said, an overdraft of £728 on the electricity account, but while debit balances in connection with the undertaking had affected the rates to the extent of £3,353, £290 had been credited out of subsequent profits, the latter totalling £1,134 in addition, which at present was placed to reserve. The total loans sanctioned for electricity works amounted to £41,856, of which £10,459 had been paid off. Last year the profit was £503 (against £343 in the previous year).

The Inspector (Mr. T. C. Ekin) observed that the undertaking owed £3,060 to the rates. They started off very well by putting their first profit of £270 to relief of rates, but after that they stopped. Why?

The Town Clerk replied that receipts from the rates were not regarded as a debt. The reserve fund was started in compliance with a strong representation from the L.G. inspector who held an enquiry into a like application three years ago.

The borough accountant (Mr. Rogers) and the borough electrical engineer (Mr. W. G. Pickvance) also gave evidence. Mr. Pickvance stated that there had been a progressive increase in the consumption of electrical current from 306,268 units in 1903-4 to 646,883 in 1910-11.

Mr. Hugh Jones (for the local gas and water companies) tried to ascertain the proportion of the profits from wiring to the aggregate profits, which, he alleged, constituted an illegal source of income; but the Inspector said the question had nothing to do with the enquiry.

By agreement, £130. 6s. 4d. was eliminated from the total applied for.

COLONIAL AND FOREIGN NOTES.

Argentina.—The "Review of the River Plate" says the Electric Light Council of Montevideo have finished their study of the project for acquiring all existing electric light stations by the Government and the erection of further stations in important towns. The administration of all the stations will be under the control of the Council of the Electric Light Stations of the Uruguayan Republic.

Mr. McClelland, consulting engineer for the electrification of the Central Argentine Railway line to the Tigre, left Argentina for England on April 21 to order the necessary material.

Campana Council have been authorised to place a contract for the electric lighting of the town.

San Fernando Municipality have cancelled the concession granted to the Compania Argentina de Electricidad for public lighting, and will shortly call for tenders for the erection and equipment of a generating station.

The Cia Franco-Argentina de Electricidad, who recently obtained a controlling interest in the Anglo-Argentine Electric Light Co., have decided to increase their capital to $10,000,000.

Canada.—The Alberta Electric Railway Co., which was formed last October with a capital of $10,000,000, will commence work on the construction of an electric railway from Medicine Hat to Banff, via Calgary, with branch lines extending to Taber and Macleod.

The construction work of the electric railway from Guelph to Berlin has been completed, and the line will ultimately extend from Toronto to Detroit (U.S.A.). The company will take its motive energy from the Government's Hydro-Electric Power Commission.

Canary Islands.—An electric tramway between Las Palmas and Puerto de la Luz (four miles in length) was completed last August, and an excellent service of cars has since been running.

Engines, boilers, iron chimney, cranes, machinery and tools which have been imported in connection with this undertaking are all British, the pumps are American, rails and iron work for buildings are Belgian, batteries Spanish, cables French, and dynamos, switchboards posts and cars German.

France.—The electric lighting of the port of Pallice, for which current is at present supplied direct from the Rochelle station, is to come into the hands of the Chamber of Commerce, which will have a transforming station at the dock to supply the quays and warehouses.

India.—"Indian Engineering" states that arrangements were recently made for fitting 45 ceiling fans and 107 pendant electric lamps in the four blocks of buildings occupied by the engineering and

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traffic employés of the East Indian Railway at Howrah station. The remainder of the staff quarters had already been provided with electric light and electric fans.

On the Burma railways a trial is to be made with Stone's electric train lighting system. Some carriages on the line are fitted with the Vicarino-Crawford electric lighting system, but nearly all trains are lighted with oil.

A tender has been received for the electric lighting of the public offices of Lahore, and a contract will probably result. The contracting company will also have the right to supply private consumers.

A new power house has been built for the North-Western Railway at Lahore, and authority has been given for the purchase of plant. The plant in the old power house (and which will be removed to the new power house) includes two 125 kw. and one 250 kw. sets with two Stirling boilers and a Babcock boiler. The station as completed will contain four 400 kw. Browett-Westinghouse, and two 250 kw. and two 125 kw. Howden-Lancashire steam turbine sets; five Babcock and five Stirling boilers, with Babcock & Wilcox chain grate stokers. Weir three feed pumps, one Hayward-Tyler three-throw electrically-driven pump (Lancashire dynamo motor), one centrifugal Worthington pump (Lancashire Dynamo motor); one Leblanc type central low level jet condensing plant for 41,000 lb. steam per hour with rotary air and water pumps; enclosed assisted draft type cooling tower and main switchboard (by Whipp & Bourne). The transmission is overhead, and the internal wiring is carried out with v.i.r. cable on porcelain cleats except where leads have to be taken along floors or in other places where mechanical protection is necessary. In such cases heavy gauge screwed conduit with insulated lining is employed.

At the workshops are also a number of electrically-operated overhead travelling cranes and traversers, the equipment for which was supplied by the British Thomson-Houston Co., the Lancashire Dynamo & Motor Co., and the British Westinghouse Co.

Italy.—Concessions for the construction of electric tramways have recently been granted to the Soc. Anon. Tranvi di Mestre for lines from Mestre to Carpenedo and Mestre to Treviso and Sant' Artemio, with branch from Piazza dei Noli to Port Cavour station; to the Soc. Varinese par Imprese Elettriche for extensions to Monte Tre Croci, and to Santa Maria del Monte; and to other concessionaires for a line from Como to Erba Incino.

A consular report on the Genoa district for 1910 states that the new electric railway from Genoa to Busalla, on the way to Turin and Milan, is now working.

A new direct bronze telephone wire is working very satisfactorily between Genoa and Rome.

In Genoa there are 94 miles of tramways, with 304 electric cars and 147 trailers in use; 7,951,592 car-miles were run in 1910, and 61,152,935 passengers carried. Receipts were £333,636, and gross profit was £146,873. The employés number 1,518.

The two electric tramway companies in Turin have constructed two new lines to Borgata, Lingatto and Pozza Strada, both extending about two miles from Turin.

The Società Elettrica Riviera di Ponente Ing. Negri, which was formed to utilise the water power of the Roia, has found it necessary to build at Savona a steam-driven generating station as a reserve for emergencies. The company supplies power to the Soc. Siderurgica of Savona, to the local gas company and to several small towns and villages, including Albisola and Celle.

Japanese Submarine Cable.—A consular report on the trade of Nagasaki for 1910 states that the total imports at Nagasaki showed a decrease of £40,198 compared with 1909, although there was an increase of about £85,000 in submarine cable, the cable being for the new telegraph line from Mogi to Tamsui (Formosa), 655 miles in length, which was supplied from the United Kingdom, and was put into service in October, 1910. The total imports of submarine cable (all from the U.K.) were valued at £102,254.

Russia.—The municipal authorities of Ekaterinoslav propose to raise a loan of 2,600,000 roubles (about £274,000), of which about £105,000 is to be spent on tramway and other works. The Council of Ministers has agreed not to oppose the proposal.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Brighton.—The accounts of the electricity works for the year ended March 31 were presented to and approved by the Council last week.

The total amount borrowed is £816,848, an increase of £24,000 during the year. The total income was £98,821, including £60,188 from lighting supplies, £6,568 from power, £4,558 from special contract supplies, £407 from bulk supply, £10,116 from tramway supply and £12,044 from public lighting, sundry revenue being £4,940. The total expenses (£49,555) included £28,683 for generation, £4,291 distribution, £4,500 public lamp maintenance, £4,084 rent, rates and taxes, £6,606 for management and £1,225 special charges. The gross profit was £49,266, and after paying interest (£18,931) and sinking fund (£25,584) there was a net profit of £4,752, against £6,252. The total works costs were 0·73d. per unit sold (against 0·7d.) and the total costs, including loan charges, 2·05d. (against 2·19d.). The weight of coal consumed per unit sold was 5·26 lb. (against 5·95 lb.), and the average cost was 13s. 3¾d. (against 12s. 4¾d.). 10,285,680 units were sold (4,193,701 lighting, 1,478,200 power, 2,023,109 tramways and 1,034,681 public lamps), against 9,041,844; there are 5,239 consumers, against 5,020, and the number of 8 c.p. lamps connected was 375,099, against 363,124. The maximum load was 5,140 kw., against 4,727 kw., and the load factor was 22·8 per cent., against 21·8 per cent. There are 2,220 public electric lamps (arc and incandescent), an increase of 20.

In an interesting report the engineer and manager (Mr. John Christie) gives particulars of the plant and mains extensions during the year. The total amount provided for redemption of debt by sinking fund is £265,558, or 33 per cent. of the capital. They sold 1,243,836 more units (13½ per cent.) than in the previous year, and owing to the better load factor and various economies in the operation of the steam generating plant, they had been able to reduce substantially the weight of the coal consumed per unit sold, and thus, in spite of the considerable increase in the price per ton, they had been able to generate the additional output for an extra expenditure of only £1,195, thus neutralising the increased price, and the cost under this heading per unit generated had fallen from 0·40d. to 0·38d. Repairs and maintenance showed a considerable increase of £3,510 (equivalent to 0·06d. per unit), due to the alterations to the high-tension switchgear, oil cooling, hot well and circulating water pipe systems, and repairs to sea defences. These would not be recurring charges, and when completed would have brought their plant thoroughly up to date. There was an increase in the units sold under every head. For private lighting the increase was 100,880 units and he (Mr. Christie) considered they could now fairly assume that they had passed the low water mark in their progress brought about through the general use of the metallic filament lamp, and with the additional business, which they might reasonably count on obtaining, their sales under that heading should in future years show steady annual increments. The output for power showed the substantial increase of 336,800 units. During the year 21 additional motors (94 H.P.) had been hired to consumers. The number now let out is 210, representing a total of 1,041 H.P., and the demand from these, together with the extra electrobuses which the company had added to their fleet was responsible for the increase. With the great improvements which were being effected in heating and cooking apparatus, however, a fresh field was opened up for development, and it would shortly be necessary to consider what steps they should take to meet the probable requirements of the consumers in that direction. The sales to public lamps showed a small increase of 19,575 units, due to a few additional lamps having been erected, and to the 60-watt standard metallic filament lamps being now universally used throughout the whole area for side street lighting. The average candle-power per post during the past few years had been increased by at least 50 per cent., while the total cost to the town for street lighting furnished by their department showed a saving of £80 over last year. The output to the trams had increased by 84,804 units, and the reduction in the price of current from 1·35d. to 1·2d. per unit had further benefited that department to the extent of £1,264. The bulk supply to Aldrington showed the satisfactory increase of 12,046 units, and they had now 152 consumers with an equivalent of 6,247 8 c.p. lamps connected. The Aldrington revenue was £407, or 24 per cent. increase. The railway company had also put down more electrically-driven plant, and the quantity sold to them under special contract now approached the estimated maximum for which provision was made. The power supply to Messrs. Smith & Son's mill, Portslade, was started up in February last, and the results so far had proved most satisfactory. The substantial increase in output had not proportionately increased the maximum demand on their generating plant, the load factor having increased 22·8 per cent., as the result of more economical operation. During the year they had connected 219 new services with an equivalent of 11,975 lamps.

The Lighting Committee recommended that out of the profit of £4,751. 12s. 10d., the sum of £4,626. 12s. 10d. be placed to reserve or renewals fund account, and that the balance (£125) be transferred to District Fund. The accounts were approved and the Committee's recommendations adopted.

Bury (Lancs.)—The accounts of the electricity supply department for the year ended March last show capital expenditure £26,[illegible] making a total of £143,824, of which £23,520 has been repaid, and the sinking and reserve funds amount to £17,332.

Revenue was £19,215, working and general expenses were £9,108, profit was £10,107, plus £415 interest on investments. Capital charges were £8,574, leaving £1,948 net profit. £1,000 has been devoted to relief of rates and £656 placed to reserve. 4,180,280 units were generated, 65,393 supplied to public lamps and clocks (against 62,496 in previous year), 1,421,355 to tramways (against 1,771,718), and 2,527,499 (against 2,077,624) to private consumers by meter. The total maximum supply demanded was 2,022 kw.

The report of the borough electrical engineer (Mr. S. J. Watson) states that there were 607 consumers at March 31, with 117,551 (equivalent 8 c.p. lamps (increases of 42 and 10,238 during the year). The combined lighting and power load factor improved from 21·8 to 24 per cent., the tramway load factor decreased from 21·4 to 20·5 per cent. In January last it was decided to substitute groups of high c.p. metallic filament lamps for all the old open-type arc lamps for street lighting. 14 had been altered by March 31. The increase of hired and privately owned motors connected was 15 (296 H.P.), making a total of (2,802 H.P.). Generating costs per unit were 0·51d. (as in previous year), of which the cost of coal was 0·20d. (0·19d.), and total costs, including capital charges, were 1·01d. (0·92d.). Average prices received were 2·81d. (as in previous year) for private lighting, 1d. (against 1·[illegible]d. for public lighting, 0·744d. (0·765d.) for power, and 1d. (as in previous year) for tramway supply, the average for the total output being 1·14d. (1·14d.). Although a slight falling off in the units sold for lighting

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pass has had to be recorded for two years through the use of metallic filament lamps, the past year shows an increase in that direction. A large reduction in consumption of current in the tramways has been effected by the use of car meters, and the income of the electricity department for the supply of current to the tramways is reduced by £1,416.

Cardiff.—At a recent meeting of the Tramways and Lighting Committee the engineer and manager (Mr. A. Ellis) reported on the principle of supplying electric power from the Roath station to the electric lighting department.

The accounts for the year to March 31 were also presented, and the report stated that the system had proved very satisfactory to both departments, showing that the principle of combining the load was a wise one. The total cost of generating at Roath was £16,726, and the total number of units generated was 10,604,299, an increase of 1,360,002 units on the year. The charge for supply to the lighting department was £6,352, an increase of £2,164. The lighting department benefited to the extent of obtaining energy at 0·72d. per unit, against 0·75d. If the power station was taken as a separate undertaking, and the tramways and lighting department as consumers at the same figure that the lighting department was being charged, the revenues from the tramways department to the power station would amount to £12,243. Deducting the cost of production for the whole of the output (£16,726), there was a surplus of £11,886 with which to pay capital charges, or 6 per cent. upon £20,000 capital, and 8 per cent. on a capital of £150,000; and as the capital expended upon the power station, lands, &c., was well under £20,000, it would be seen that the tramways were provided with ample funds from the lighting department with which to pay their proper proportion of such capital charges, and, further, that the tramways had everything to gain.

The chairman (Ald. CURTIS) said the report was highly satisfactory, and it was decided to enter it upon the minutes.

Coventry.—The total revenue for the year ended March 31 was £46,423 (including £13,561 from sale of current by meter, £29,840 from power supply and £800 for public lighting), against £36,920 in 1909-10.

Total works costs were £12,495 (0·378d. per unit) and total expenditure £34,187, against £11,380), the gross profit being £32,237 (against £25,540). With £10,238 brought forward and £23 bank interest, the available balance was £42,498. Interest absorbed £7,413 and sinking fund £7,932, a total of £15,822 (0·477d. per unit) for capital charges, and after paying property tax on interest (£458), placing £7,469 to reserve, applying £2,500 for relief of rates and paying bonus (£205) to employés, the balance £16,478 was carried forward.

This balance has now been applied as follows: £3,500 in aid of rates, £8,212 to meet cost of services, part cost of destructor and remaining value of plant superseded, &c., £1,150 for providing new workshop, tools, and other fittings and for replacing condensing plant for pumps, £3,000 to reserve, £237 as additional bonus to employés and £379 was carried forward. The total capital expended at March 31 was £271,201, an increase of £20,103 during the year. 8,822,170 units were generated; 7,732,024 were sold to private consumers and 211,913 supplied to public lamps (111 arc and 118 incandescent lamps); and the total maximum supply demanded was 4,769 kw. The total of works costs and capital charges was 0·855d. per unit.

Croydon.—The total revenue of the electricity department for the year ended March 31 was £61,489, including £52,884 net from sale of current for private lighting and traction, £6,964 from public lighting and £1,230 meter rent.

The total expenditure (£30,797) included £15,793 for generation, £733 for distribution, £1,638 public lamp maintenance, £2,575 rent, rates and taxes, £3,275 management expenses, and £4,774 for new services, meters and other charges. The gross profit was £30,691, and after paying £23,205 for sinking fund and interest on stock and loans and £1,149 for income tax, there was a net profit of £6,978, making, with £2,440 brought forward, a total of £19,388, of which £7,000 was placed to reserve and renewals fund, £12,015 voted to relief of rates, and the balance (£373) carried forward. The total capital expenditure is £351,251, an increase of £2,910 during the past year. 7,306,305 units were generated; 2,580,949 units were supplied to private consumers by meter (against 2,349,646), 2,787,244 supplied for traction (against 3,600,941), and 57,800 for public lighting (against 621,008). There are 420 arc and 425 incandescent lamps for street lighting (against 419 and 317), and the total maximum supply demanded was 3,613 kw. (against 3,319 kw.).

In the annual report of the borough electrical engineer (Mr. A. C. Cossor) it is stated that there was a considerable decrease in the output for public lighting and traction. Although the number of public lamps was increased, the cost of public lighting has been considerably reduced. The reduction in the energy sold for traction amounted to 813,697 units, representing £5,372 (or 20·6 per cent.). The saving by consumers changing over to metal filament lamps has continued, but in future will not have such a marked effect on sales. There was a satisfactory increase of 240,303 units sold for power and for heating and cooking. The average price per unit sold for general supply was 2·98d. per unit (against 3·01d.) and for total supply 1·92d. (against 2·25d.). There are 3,949 consumers (against 3,593), and the load factor was 21·13 per cent. (against 22·87 per cent.). In the last 10 years the reduction in the cost of producing electrical energy is equal to 46·06 per cent., or, on present output, £23,490 per annum.

Glasgow.—For the year ended May 31 the traffic receipts of the tramways department amounted to £946,021. 5s. 11d., an increase of £52,430. 4s. over 1909-10. The number of passengers carried was 237,967,307, an increase of 15,236,736.

There was a decrease of 2,409,941 in the total of penny fares, due to the fact that for the past four months two-stage fares have been in operation. The other stages, particularly halfpenny stages, showed increases. During the year a number of extensions were opened for traffic, including the Crow-road, Clincart-road, London-road and Kelvingrove-street routes, of a total length of six miles of route. The average track mileage open during year was 194¼ miles (single), an increase of 5¾ miles. The car-mileage was 21,704,237 miles, increase 730,221 miles; traffic receipts per car-mile were 10·461d., increase 0·236d.

Kingston-on-Thames.—The accounts of the electricity department for the year ended March 31 show capital expenditure £108,239, an increase of £2,795 (mainly on mains, transformers and services) during the year.

Revenue from sale of current by meter was £8,855 (against £8,520) and from public lighting £2,576 (against £1,929), meter rental, &c., making up a total of £11,983 (£10,907). Expenses were £6,555, or 2·137d. per unit sold (against £6,259, or 2·118d.), of which coal and other fuel represented £2,861, or 0·932d. per unit (against £2,546, or 0·859d.) Interest on loans and repayment of principal absorbed £6,621, or 2·158d. per unit (£6,292, or 2·125d.), and the debit balance was £1,193 (£1,644). There are 1,336 consumers (1,209) and the equivalent of 61,712 32-watt lamps is connected to the mains (55,814), of which 686 lamps were taking current through prepayment meters. 736,140 units were sold (710,704), including 579,652 to private consumers (574,610.)

In his report, Mr. J. E. Edgcome states that there is a further satisfactory increase in the number of motors connected and small motors have maintained their popularity. The number of radiators connected also shows a satisfactory increase. During the year 140 public incandescent lamps were erected. Several new consumers took advantage of the deferred payment system of wiring. The undertaking has suffered, though in a less degree than during the previous two or three years, from the continued substitution of metal filament lamps.

Lincoln.—In moving the minutes of the Electricity Works Committee at the Council meeting on Tuesday, the chairman (Mr. W. S. White) said that the accounts for the year ended March 31 had proved a record.

Mr. WHITE said that never before had they supplied so much current or carried so many passengers on their tramcars. The gross profit on the electricity department was £7,292, and deducting £3,969 for interest and sinking fund, the net profit was £3,323, an increase of £820 over 1909-10.

On the tramway undertaking the gross profit was £2,447. 10s. 11d., but after deducting £2,600 for repayment of loan and interest, the deficiency was £152. 16s. 3d., which had been provided for out of the profit on the electricity undertaking. The reserve fund amounted to £8,628, and although 1,649,090 passengers had been carried there had been no accident.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Tenders are invited for the supply of 150 miles insulated wire and 5 miles of telegraph cable to the Postmaster-General's Department in Victoria. Tender forms and specifications from the Commonwealth Office, 72, Victoria-street, London, S.W. See also an advertisement.

Tenders are invited up to July 19 for the supply of insulators, telephones, copper and iron wire to the Postmaster-General's Department in QUEENSLAND. Tender forms and specifications from the Commonwealth office, 72, Victoria-street, London, S.W. See an advertisement.

The Secretary of H.M. OFFICE OF WORKS invites tenders for providing and erecting at the South Kensington generating station complete surface-condensing plant, capable of dealing with 15,000 lb. of steam per hour, together with the necessary gantry and stanchions. Forms of tender and further information may be obtained at H.M. Office of Works, Engineering Division, 55, Whitehall, London, S.W., and tenders addressed to the Secretary must be delivered by 11 a.m. of Friday, June 30, at Storey's Gate, London, S.W.

The Commissioners of H.M. WORKS AND PUBLIC BUILDINGS also invite tenders for the supply of hemp and steel wire lift ropes during three years from July 1. Forms of tender, conditions of contract, &c., from the Storekeeper, H.M. Office of Works Stores, 12, Lambeth-Palace-road, London, S.E. Tenders by 11 a.m. of Monday, June 12, to the Secretary, H.M. Office of Works, Storey's Gate, London, S.W.

KETTERING Urban District Council invite tenders for the supply, delivery and erection at their electricity generating station of extension pipework, oil eliminating plant, &c. Copies of specification and general conditions of contract from the Clerk of the Council, Mr. John Bond, Council Offices, Kettering, where tenders must be delivered by June 19. Specifications, general conditions and draw-

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ings can be seen at, but not obtained from, the consulting engineers, Messrs. Kennedy & Jenkin, 17, Victoria-street, Westminster, S.W.

The Council of the Metropolitan Borough of POPLAR invite tenders for supply, delivery and erection of one 3,000 kw. turbine alternator, complete with surface condensing plant; two water-tube boilers with superheaters, air heaters, fans and chimneys; one 30-ton electric overhead travelling crane and water softening plant. Specification and form of tender from the borough electrical engineer and manager (Mr. J. Horace Bowden), Glaucus-street, Bromley-by-Bow, E. Tenders to the town clerk (Mr. L. Potts), Council Offices, High-street, Poplar, London, E., by 10 a.m. Monday, June 19.

SWINDON Corporation require tenders by noon June 20 for the supply and erection of a 220-cell battery, an automatic reversible traction booster, a three-wire hand-regulated booster, and switchgear. Specifications, &c., from the Borough Electrical Engineer.

MANCHESTER Electricity Committee invite tenders for supply and erection of two water-tube boilers, superheaters, coal chutes, ash conveyors and fuel economisers. Tenders to Chairman of Committee, Town Hall, Manchester, by 27th inst.

SWANSEA Corporation require tenders by noon June 13 for the supply of c.c. motors and starting switches. Forms of tender, &c., from the Borough Electrical Engineer.

HESTON and ISLEWORTH Council require tenders by noon June 14 for supply of metallic filament lamps for street lighting. Particulars from the Engineer, Electricity Works, Hounslow.

STOCKPORT Electricity and Tramways Committees require tenders by noon June 14 for supply of overhead material, ironmongery, castings, oils, paints, waste, &c. Forms of tender from the Engineer.

HULL Education Committee require tenders by 10 a.m., June 20 for supply of electric fans and wiring and fitting for electric light at the new Sculcoates-lane school. Specification, from City Architect.

LONDON County Council require tenders by 11 a.m. July 4 for four electric traversers for car-sheds. Specification, &c., from the Clerk.

The Metropolitan Water and Sewerage Board, Albert-street, BRISBANE, Queensland, want tenders by noon Jan. 30 next for supply and erection, of one, two or three complete units, each consisting of power generating plant and pump or pumps to lift not less than 6,000,000 gallons per day. Particulars from the Secretary.

Tenders are invited up to July 25 for the supply of 12 sections of a branching multiple magneto lamp signalling switchboard, &c., or one automatic or semi-automatic switchboard, &c., and up to June 27 for supply of 1,400 protectors for use on main distributing frame at magneto exchanges to the Postmaster-General's Department, VICTORIA. Tender forms, &c., from 72, Victoria-street, London, S.W.

The Town Clerk, WANGANUI, N.Z., will receive tenders until July 12 for supply of generating plant, gas-producing plant and battery and booster for the Corporation tramways. Specification can be seen at 73, Basinghall-street, London, E.C. Local representation is necessary.

CALARSHI (Roumania) municipal authorities invite tenders for a 35 years' concession for electricity supply in Calarshi. Provisional deposit of £480 will be required with tenders.

The Chairman of the Board of Control, WINNIPEG (Canada), will receive tenders until 11 a.m. July 3 for supply and installation of a police patrol telegraph system.

NAPLES Municipal Authorities require tenders by July 9 for supply and installation of the following plant in connection with the supply of electric power to Naples from the river Volturno:

1. Tubing and accessories for harnessing the water at rate of 7,000 litres a second and for the fall of 190 meters; upset price 702,900 lire (£28,116.)

2. Machinery and apparatus for hydro-electric power station, transmission line (about 57 miles), and transforming station; upset price 1,000,000 Frs (£40,000.)

Tenders to Presidente del Consiglio Generale dell' Ente Autonomo Volturno, Naples.

Manufacturers who are prepared to supply 600 km. (372 miles) copper wire 8 mm. dia. are invited to communicate with the Direzione dell' Ente Autonomo Volturno, Naples, who after two months from April 10 will send invitations to tender to firms whom they consider suitable.

Conditions of tender, &c. (in Italian) may be seen at 73, Basinghall-street, London, E.C.

The Egyptian Ministry of Public Works, CAIRO, will receive tenders until noon June 15 for supply and erection of an electric pumping installation with electric motors, switchboards, &c. Stamped paper for tenders can be obtained from Mr. A. L. Webb, C.M.G., Queen Anne's Chambers, London, S.W.

The Turkish Ministry of War, CONSTANTINOPLE, require tenders by June 26 for electric accumulators for the fez factory at Eyouband the tailoring workshop at the Ahir Capou. Particulars from the Administration Générale des Fournitures, at the Ministry of War, Constantinople.

TENDERS RECEIVED AND ACCEPTED.

Siemens Bros. Dynamo Works (Ltd.) have obtained the contract for the supply of "Tantalum" and "Onewatt" metal filament lamps of various voltages and candle powers, for the G.P.O. for the ensuing six months.

Blackburn Council have accepted the tender of the British Westinghouse Co. for the supply of a 2,000 kw. turbo-generator and two rotary converters.

York Electricity Committee have accepted the tender of the Tudor Accumulator Co. for replating the battery and supplying an automatic reversible booster, switchboard, cables, &c., at £1,625.

Caversham Council have accepted the tender of the Reading Electric Supply Co. for public lighting for 10 years.

The terms are as follows: (*a*) For 213 lanterns each equipped with two 55-watt lamps, alight till 11 p.m., £1. 17s. 3d. per lamp per annum; (*b*) 34 lanterns each with two 55-watt lamps till 11 a.m. from April 1 to Sept. 30, and all night from Oct. 1 to March 31, £2. 3s. 6d.; (*c*) four lanterns each with two 80-watt lamps till 11 p.m. from April 1 to Sept. 30, and all night from Oct. 1 to March 31, £2. 13s.; (*d*) seven lanterns each with two 80-watt lamps, alight all night throughout year, £3. 2s. 6d. per lamp per annum.

Leyton Council have accepted the following tenders:—

Mordey, Fricker & Co., for the annual supply of prepayment meters; Measures Bros., for wrought steel work for additional flue dampers (£27); Cottis & Sons, c.i. work for ditto (£17); Tudor Accumulator Co., battery to test tramway meters, £29.

Croydon Corporation have placed an order with Johnson & Phillips for 51 magazine arc lamps.

Derby Council have accepted the tender of John Spencer (Ltd.) for 35 trolley standards at £187. 5s.

Marylebone (London) Council have accepted the tender of W. Geipel & Co. for annual supply of arc lamp carbons.

BUSINESS NOTICES.

After the 10th inst. the registered offices of Vickers Limited will be Vickers House, Broadway, Westminster, S.W. Telephone 10110 Gerrard (Nat., 8 lines). The telegraphic address will remain "Vickers London."

Messrs. E. M. Evans & Sons, electric lighting and power engineers, have removed to 1 and 5, Lever-street, Manchester. Telephone, 4,250 City.

John McIvor Lambie and Chas. Robt. Wrigley, electrical engineers, 116, City-road, London, E.C., have dissolved partnership.

Sales by Auction.—Messrs. Fuller, Horsey, Sons & Cassell have been instructed to sell by auction at H.M. Dockyard, Devonport, on Tuesday, July 11 and following days some old and surplus stores, including 180 tons scrap brass and mixed metal, 10 tons manganese bronze, 8 tons lead skimmings and packing, 900 tons mild scrap steel, 900 tons scrap iron, 30 tons zinc ashes and bottoms, &c.; also 65 tons electric cable, electrical gear and various stores, 4 motors, gas and steam engines, overhead traveller, crane, pumps, machine tools, lamps, furniture and fittings, &c. May be viewed three working days prior to and on mornings of sale, and catalogues (6d each) had at the Dockyard, or of the Auctioneers, 11, Billiter-square, London, E.C., and 100, King-street, Manchester. See also an advertisement.

Messrs. Horne & Co., 35, Old Queen-street, Westminster, S.W., will sell by auction at the Royal Arsenal, Woolwich, at 11 a.m. on Tuesday, June 20, unserviceable and obsolete stores, including iron and steel scrap, brass, copper, gunmetal, lead and tin alloy, zinc &c., electric cable, tools, pumps, electrical instruments, lamps, &c. May be viewed at the Royal Arsenal, Woolwich, on Friday and Monday, prior to and on morning of sale. Catalogues at the War Office, Whitehall, the Ordnance Office, Tower, and the Ordnance Office, Royal Arsenal, Woolwich. See also an advertisement.

Patent Development.—The proprietor of British patent No. 11,861 1905, relating to "Improvements in galvanic battery plates," desires to make arrangements for developing and working same in this country. Applications to Messrs. W. P. Thompson & Co., patent agents, 285, High Holborn, London, W.C.

The proprietors of the following patents also desire to enter into negotiations for the grant of licences to manufacture under royalty in Great Britain;—

No. 18,245/1907, relating to "Electrically-driven vehicles."
No. 17,852/1908, relating to "Continuous-current motors."
Nos. 24,211 and 24,212/1908, relating to "Incandescent electric lamps."

Inquiries to Messrs. Carpmael & Co., Patent Agents, 24, Southampton buildings, London, W.C.

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BANKRUPTCIES, LIQUIDATIONS, &c.

The trustee in the bankruptcy of Alfd. E. Felgate and Wm. Storey, electrical engineers, 10, Queen Victoria-street, Reading, has been released.

A first and final dividend of 10¾d. will be payable on June 12 at the offices of Messrs. Brittain & Brittain, North-Eastern Bank-chambers, Stockton-on-Tees, to creditors of Ernest F. Jones, electrical engineer, &c., 132, York-road, West Hartlepool.

An application for the discharge of Geo. Montague Sellick, electrical accessories manufacturer, 466, Romford-road, London, E., will be heard on June 27 at Bankruptcy Buildings, London, W.C.

Creditors of Arc Lamps (Ltd.) (in liq.) must send particulars of claims, &c., to the liquidators, H. B. Clark and G. E. Corfield, 3 and 5, Crown-court, Old Broad-street, London, E.C., by July 7.

Improved Electric Traction (Ltd.) is being wound up voluntarily. Claims to the liquidator, Mr. H. M. Gower, 428, Birkbeck Bank-chambers, London, W.C., by July 15. A meeting of creditors will be held at Mr. Gower's offices on June 15.

A meeting to receive an account of the winding-up of the Telewriter Synd. (Ltd.) will be held on July 4 at 3, London Wall-buildings, London, E.C.

COMPANIES' MEETINGS AND REPORTS.

Callender's Cable & Construction Co. (Ltd.)

The annual general meeting was held yesterday (Thursday), Mr. Hy. Drake presiding.

The CHAIRMAN referred with regret to the deaths of the secretary, Mr Harrison, and one of the founders of the company, Mr. D. P. McEuen. As stated in the report (which was abstracted in our last issue) the undertaking of the Uxbridge & District Electric Supply Co. was acquired during the year, and debenture stock had been issued to cover the cost. He also gave particulars of the various items in the accounts. Anchor Cable Co.'s shares were valued at £57,500 (as last year). St. Helens Cable & Rubber Co. (against this £35,280 in shares and debentures [illegible]), £38,376 (£38,829), shares and investments in other companies [illegible] (£228,611), the total assets being £1,124,133 (£1,049,422). Profits for the year, after deducting all charges on manufacturing accounts and contracts, including salaries, &c., at Erith, were £93,204 (£98,135). After providing £8,217 for depreciation and paying interest on the debentures and dividend on preference shares, it was proposed to dispose of the balance of £66,323 (£68,422) by payment of the dividends and bonus shown in the report, and carrying forward £40,073 (£42,202).

Mr. T. O. CALLENDER (managing director) said that during 1910 the condition of the company's business, and he believed of all heavy construction businesses in this country, was bad. He was afraid they had not seen any of the alleged boom in trade, and others with whom he had discussed the outlook were of his opinion, that the boom had not come into the engineering world. The signs observed at the end of last year of a lightening in the dark cloud had unfortunately passed away, and again they had been in the doldrums, absolutely nothing being done. They had, however, managed to maintain, and to improve upon, the position they had in the previous year. Since Easter, however, there had been a distinct improvement, and the factories at Erith and Leigh were busy and running full time. The position of the supply and power companies had materially improved during the last few years. They were getting over their "childhood's maladies," and electrical supply in this country was settling down to a steady business on the lines of their competitors, the gas companies, and he might say the railway companies. They were now finding in every case that the anticipations they had when they entered the power business some years ago were being fulfilled, and he hoped the company would, therefore, get better orders from the supply companies than they had in the past. They had pushed energetically abroad work, and one could hardly enter a port without seeing Callender's drums. The idea in some people's minds that English manufacturers were remiss in pushing trade abroad might be true in some instances, but his experience was that foreign trade could not be got in the easy way newspaper critics would lead one to believe. They had a hard battle to fight. A few days ago the engineer of a large electric company who was over here told him that a certain order had not been given to Callender's Co. because the German Ambassador intervened and brought pressure to bear, and that led to the order being placed in Germany. He (Mr. Callender) and others had discussed the necessity of the formation of some bank or financial association to put them into a position to fight those heavy influences which were now acting against them. One of these days (it might be this year or next) the board would ask the shareholders to assist them in backing up such an institution, which would be the only way in which British trade could be secured in the foreign portions of the world. The last field the company had tackled was South Africa, and they had already most important contracts. They were strengthening their position, and they were getting some of the trade that was going. In reply to questions by shareholders, he said they had written a very large amount off plant and [illegible], and he was satisfied that the amount written off this year was ample. He did not think it advisable to state the value of land separately. They had had some of their ideas and schemes seriously damaged by having brought them too prominently before the shareholders, and at the same time before their competitors. The shares held in other companies had been amply depreciated where necessary.

The report and accounts were adopted and the dividends and bonus approved.

ALUMINIUM CORPN. (LTD.)—The directors' report from the date of incorporation (Dec. 14, 1909) to Dec. 31, 1910, states that aluminium is now being made on a commercial scale, the metal produced being of a high grade. The works are being extended to their full capacity, and it is anticipated that the output will find a ready market. The dam at Eigiau Lake, Dolgarrog, is on the point of completion, the Cowlyd Leet has been put into operation, and the necessary water rights of the Dulyn river have been acquired. The serious problem of traffic in connection with the supply of raw materials for the Dolgarrog works and the dispatch of the manufactured metal has been solved. The company's liability in connection with the shares of the Bauxite Refining Co. has been paid up in full, enabling the Bauxite works to be completed to a capacity sufficient to supply the corporation with alumina of first quality. It is proposed to convert the preference shares into preference stock, and the ordinary shares are to be sub-divided and converted into preference and ordinary stock.

BRITISH ELECTRIC TRACTION CO. (LTD.)—The directors in their report for the year ended March 31, state that there is a general improvement in the position and prospects of the Company. The traffic receipts of the associated companies for year show a marked improvement, which promises to be maintained in the current year. The net profits of these companies show a substantial increase for 1910. For the most part, however, these increased profits have been added to reserve and renewal funds, or have been otherwise applied in strengthening the position of the companies. The profit of the B. E. T. Co. from this source has, therefore, not increased by so large an amount as would otherwise have been the case. No increase of dividend is recommended by the directors for the past year, but they recommend placing £25,000 to reserve out of profits, compared with £15,000. The opportunities of promoting new electrical undertakings in this country with a prospect of reasonable profit under present conditions continue to be restricted, but whenever the conditions justify extensions of electrical business in this country the resources of the Company will enable it to participate in them. Meanwhile, the directors hope that some of the foreign enterprises which have engaged their attention will mature during the current year. Further successful efforts have been made to reduce expenses, but in view of the large economies already effected the reductions cannot now be carried much further. The directors consider the time has now arrived when the interests of the company will best be served by a re-organisation of the capital dealing with the arrears of dividend on the preference shares, and equitably adjusting the relations between the two classes of shares. The directors will place their proposals before the shareholders at an early date. In March, 1910, the reserve was £633,581. 17s. 3d. This account has since been debited with £6,318. 19s. 7d. loss on sale of Consols and credited with £1,675. 4s. 8d. net profit on sale of other investments, and adding £12,393. 9s. 9d. (the difference between the nominal value and purchase price of certain debenture stock); the reserve at March 31, 1911 stands at £641,331. 12s. 1d. It will be further increased by £25,000 proposed to be transferred out of the profits of the year. In addition, reserves amounting to £4,052. 14s. 7d. have been made out of profits of the year against loss and depreciation of specific assets. The total of these reserves is £63,787. 0s. 7d. The associated companies have created depreciation and other reserve funds of their own, which amounted at Dec. 31, 1910 (including balances carried forward), to £1,228,127. During the year the directors sold part of the large amount of Consols held by the company and re-invested the proceeds in India 2½ per cent. stock and other securities yielding a larger return than is obtainable from Consols. The item, Investments and Undertakings stands at £5,204,667. 8s. 9d., and consists of shares and debentures in associated tramway, electricity supply, manufacturing and other companies, Consols and sundry securities and undertakings, of which debentures in various companies of the nominal value of £563,950 stand in the books at £527,596. 4s. 8d. and shares in various companies of the nominal value of £4,523,490. 18s. 4d. stand at £4,360,299. 9s. 6d. The year's net profit, after applying £5,947. 5s. 5d. to writing down expenditure on Acts of Parliament, &c., and after reserving £4,052. 14s. 7d. against depreciation of undertakings worked by the company, buildings and freehold land, and doubtful debts, is £139,512. 19s. 10d., to which must be added £14,067. 9s. 6d. brought forward, making a total of £153,580. 9s. 4d. After deducting interest on the 5 per cent. perpetual debenture stock and the 4½ per cent. second debenture stock for the year, amounting to £93,533. 2s. 7d., there remains a balance of £60,047. 6s. 9d., out of which it is proposed to pay a dividend of 3s. per share on the preference shares, amounting to £24,215. 11s., and to transfer £25,000 to reserve, leaving a net balance of £10,831. 15s. 9d. to be carried forward. This dividend will bring the payment of the full dividend on the 6 per cent. cumulative preference shares to Sept. 30, 1908, and the reserve will be increased from £641,331. 12s. 1d. to £666,331 12s. 1d. The yield for the past year on the total investments and undertakings standing in the books at £5,204,667 was 2·7 per cent., compared with 2·63 per cent. for the preceding year on £4,997,845. Since March 31 last Mr. E. Garcke has acted as sole managing director. Mr. C. Shirreff Hilton and Mr. W. L. Madgen have resigned the positions of joint managing directors, but they remain directors of the Company, and they have agreed to continue to act as chairmen and directors of various associated

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companies and to perform other special services. Mr. George Cornwallis-West has been appointed a director of the Company. The members of the board who act as chairmen or directors of associated companies receive special remuneration therefore in addition to the remuneration paid to them for their ordinary services as directors of the B. E. T. Co., but they pay to that company all fees received by them from the associated companies. Sir Charles-Rivers Wilson proposes to vacate the position of chairman of the board after the general meeting, but will remain a director, and Mr. E. Garcke has been appointed to succeed him as chairman.

BRUSH ELECTRICAL ENGINEERING CO. (LTD.)—At the meeting on Wednesday the Chairman (Mr. E. Garcke) said that the results of the business for the past year were better than for the preceding year. The gross profits were £28,159, compared with £14,349. After paying debenture interest, the loss was £10,780 against a loss of £21,230. The causes of the loss were insufficient volume of business and consequent keenness of competition for such orders as were placed, resulting in unremunerative prices. There was probably no business or trade in which the expenses were relatively so heavy, the responsibility so great and the reward so insignificant as in the electrical industry. The conditions were constantly changing—new inventions and discoveries succeeding each other with disconcerting rapidity, and making it almost impossible, speaking generally, to standardise or to settle down to economical production of manufactures in large quantities. Those conditions necessitated the retention of experts who were specially skilled in their various departments. The establishment expenses of the business were, therefore, always high, and could not, without crippling the organisation, be reduced below a certain minimum, whether trade be good or bad. The new Invalidity and Unemployment Bill would probably increase their expenses by over £2,000 per annum, a heavy charge for a business not clearing its charges. During the last few months there had been a decided revival of business in the electrical engineering industry. Many of the central power stations had now recovered the temporary loss of load which they had to face owing to the general adoption of the current-saving metal filament lamp, and had found it necessary to place orders for additional plant. Of these orders they had secured their share, and it was gratifying that their turbo-generators and other power house plant were held in such excellent reputation. They entered the current year with a much larger volume of unexecuted orders in the factory than was the case in the previous year, and that circumstance, coupled with the fact that the new orders secured this year were above the average, justified the hope that they might this year turn the corner. The directors proposed to formulate a scheme for the reorganisation of the capital.

CAPE TOWN CONSOLIDATED TRAMWAYS & LAND CO. (LTD.)—The accounts for 1910 show a balance of £1,045. 11s. 1d. to debit of profit and loss account, which, added to balance brought forward (£2,169. 16s. 1d.), makes the total debit £3,215. 7s. 2d. to be carried forward. The result of the operations of the Camps Bay tramways shows a loss on working of £375. 18s., compared with a loss for 1909 of £1,559. 13s. 4d., and of £2,232. 11s. 3d. in 1908. A continued further improvement is anticipated.

DIESEL ENGINE CO. (LTD.)—The report for the year ended March 31 states that the gross profit was £12,376 (£11,564 in 1910). The net profit was £2,147. The total at credit of profit and loss account is £5,240. Out of this the directors recommend payment of the preference dividend (absorbing £938) and carrying forward £4,302. As the expenses of further pioneering work are likely to be heavy, it has been deemed prudent not to pay an ordinary dividend. Mr. S. Furness, M.P., has joined the board.

PEEL-CONNER TELEPHONE WORKS (LTD.)—The directors' report states that the net profit from the commencement of the working of the company, after writing off preliminary expenses (£527. 5s. 3d.) and placing £2,151. 7s. 1d. to reserve, was £7,276. 11s. 3d. This balance will enable the directors to pay the full preference dividend at the rate of 5 per cent. from date of issue (£6,956. 9s. 5d.), and to carry forward £320. 1s. 10d. The directors are gratified with the result of the first year's trading. The difficulties of training efficient labour are gradually being overcome. A number of contracts recently obtained ensure full employment for the works for a considerable time.

UNITED ELECTRIC TRAMWAYS OF MONTEVIDEO (LTD.)—The gross receipts for the year ended Oct. 31, 1910, were $1,315,955, against $1,190,310 in the previous year; the operating expenses $731,994, against $694,588; and the net receipts $583,961 against $495,722. 32,474,355 passengers were carried, against 29,293,804, and 6,185,737 car-miles run, against 6,282,240. The extensions to the main car and store sheds and the enlargement of the company's hotel at Pocitos have been nearly completed. The extension of the lines to the suburb of Maldonado (approximately 3 miles) is in course of construction and is expected to be open for public service during the next few months. During the past month there has been a general strike in Montevideo, including the tramway employées. Owing to the absence of adequate protection for the men who were willing to work, the services were entirely suspended for several days. The terms upon which the strike has been ended will involve a permanent additional charge upon future revenue. £2,555 has been set aside for debenture stock redemption fund and £20,000 transferred to renewals and contingency account. Interim dividends of 6 per cent. on the preference and ordinary shares for the half-year to Sept. 30, 1910, have been paid and the directors now recommend payment of a dividend at the rate of 6 per cent. per annum (less tax) on the preference shares and at the rate of 8 per cent. per annum (making 7 per cent. for year), leaving £13,754. 19s. 8d. to be carried forward.

VICTORIA FALLS & TRANSVAAL POWER CO. (LTD.)—In the directors' report for the year ended Dec. 31 it is stated that during 1911 the balance of the preference shares has been issued, bringing the total issued capital up to £3,000,000. The total share and debenture capital at the date of the report stood at £4,700,000. An agreement has been entered into with the Dresdner Bank and the Deutsche Bank to take up a further £1,000,000 5 per cent. first mortgage debentures, leaving a balance of £300,000 out of the authorised amount of £3,000,000. The year's business has resulted in a profit of £157,749, to which is added the balance of £135,398 from 1909. After providing for debenture interest, income tax, depreciation for 1907, 1908 and 1909 (£75,887) and for the year 1910 (£38,964), the balance is £95,747, out of which the directors declared a preference dividend at the rate of 6 per cent. per annum on the amount paid on the shares, from Jan. 1 to Oct. 14, 1909. These payments will absorb £58,347, leaving £37,400 to be carried forward. The profit shown in the accounts has been secured from sale of power from the Brakpan and Simmer Pan stations only. An agreement has been entered into between the company and the Rand Mines Power Supply Co. by which the entire management of the latter is placed in the hands of this company.

NEW COMPANIES REGISTERED.

BIRMINGHAM MICA CO. (LTD.) (116,048.)—Reg. May 26, capital £2,000 in £1 shares, to take over the business of workers of and dealers in mica and other insulating materials carried on as the Birmingham Mica Co. Private company. Reg. office, 250, Icknield-street, Birmingham.

T. CLEMMONS & CO. (LTD.) (116,092.)—Reg. May 29, capital £5,000 in £1 shares, to take over the business of aluminium goods and castings manufacturers carried on by T. Clemmons & Co. Private company. First directors, H. W. Tomlinson and M. B. Wild.

SAMUEL HARTFORD & CO. (LTD.) (116,148.)—Reg. May 31, capital £10,000 in £1 shares, to carry on the business of manufacturers of and dealers in wires, cables and lines of all kinds, electricians, electrical engineers and contractors, &c., and to adopt agreements with S. Hartford and D. Woolfright. Private company. First directors, S. Hartford and P. Woolfright (both permanent).

WOODHOUSE STEEL CASING CO. (LTD.) (116,097.)—Reg. May 29, capital £6,000 in 4,000 6 per cent. participating non-cumulative A preference shares of £1 each, and 4,000 A ordinary shares of 10s. each, to take over the business of the Woodhouse Steel Casing Co., and to carry on the business of manufacturers and sellers of electrical appliances, engineers, founders, &c. Private company. First directors, A. E. Woodhouse and W. W. Little, both permanent. Reg. office, Craven House, Kingsway, London, W.C.

CITY NOTES.

MEMORANDA (June 8).—**Bank rate 3 per cent. (March 9, 1911)** Price of silver, 24 $\frac{7}{8}$d. per oz. Consols 80$\frac{5}{8}$—80$\frac{3}{4}$ for money and 80$\frac{7}{8}$—80$\frac{1}{2}$ for account. Consols Pay Day, July 5; Stock and Shares Continuation Days, June 13 and 28; Ticket Days, June 14 and 29; Pay Days June 15 and 30; Mining Shares Carry Over Day, June 12.

PRICES OF METALS (London).—*Copper*, cash, 55$\frac{1}{8}$; three month 56. *Lead*, English, 13$\frac{3}{4}$—13$\frac{3}{4}$; foreign, 13$\frac{7}{8}$—13$\frac{1}{8}$. *Spelter*, 24$\frac{1}{2}$-24$\frac{3}{4}$. *Tin*, English, 201—202; foreign, 209 cash, 192$\frac{3}{4}$ three months *Iron*, Cleveland, cash, 46/2, three months, 46/11.

ARON ELECTRICITY METER (LTD.)—The transfer books and register of members will be closed from 12th to 24th inst., inclusive.

BRISBANE ELECTRIC TRAMWAYS INVESTMENT CO. (LTD.)—The traffic receipts for May were £21,099 (increase £2,609).

CANADIAN GENERAL ELECTRIC CO.—A quarterly dividend of 1$\frac{1}{4}$ per cent. on the common stock has been declared.

ELECTRIC SUPPLY CO. OF VICTORIA.—The tramway and lighting receipts for February were £5,719.

MADRAS ELECTRIC TRAMWAYS (1904) (LTD.)—Traffic receipts for the fortnight ended May 31 were R.20,251 (increase 8427). Aggregate from Jan. 1, R.220,851 (increase R.15,100).

MANILA ELECTRIC RAILROAD & LIGHTING CORPN.—Revenue for May was $118,250 (increase $16,908).

NORTHERN COUNTIES ELECTRICITY SUPPLY CO. (LTD.)—The accounts for 1910 show, after debiting interest and bad debts, a loss £2,777, making a total debit balance of £5,756 to be carried forward.

SAO PAULO TRAMWAYS, LIGHT & POWER CO.—A quarterly dividend of 2$\frac{1}{2}$ per cent. has been declared.

SIEMENS BROS. & CO. (LTD.)—The directors announce a dividend of 4 per cent. (4s. per share) for the past year, writing off £7,500 from Woolwich buildings, £5,000 off s.s. "Faraday," and appropriating £4,000 for pensions and carrying £575 forward.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed June 21 a special settling day in fully-paid scrip for £300,000 5 per cent. perpetual consolidated debenture stock of the *Sao Paulo Tramway, Light & Power Co.* (*Ltd.*) and have granted a quotation to 250,000 fully-paid ordinary shares of *La Plata Electric Tramways Co.* (*Ltd.*). The committee have been asked to appoint a special settling day in order to grant a quotation to a further issue of 11,850 £1 fully-paid ordinary shares of *Marconi's Wireless Telegraph Co.*

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ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	May 31	1,557	+ 346	52	72,406	+ 2,330
Airdrie	" 26	230	+ 1	21	4,451	− 55
Anglo-Argentine	June 3	48,632	+ 4,730	22	1,089,999	+ 118,214
Ashton-under-Lyne	" 3	432	+ 72	10	4,165	+ 353
Ayr Corporation	" 2	320	+ 33	3	816	+ 9
Barnsley	May 26	190	+ 33	21	3,692	+ 130
Barrow	" 26	283	− 8	21	5,176	+ 197
Bath Electric Trams, Ltd.	" 31	923	+ 154	22	16,392	− 20
Birmingham Corporation	" 27	7,217	+ 671	8	59,317	+ 3,139
Birmingham & Midland	" 26	898	+ 103	21	18,351	+ 1,086
Blackpool and Fleetwood	..	..	..	..	..	..
Blackburn Corporation	" 31	1,221	+ 279	†10	11,306	+ 882
Bolton Corporation	June 4	2,640	+ 312	10	24,036	+ 2,027
Bombay	May 5	3,031	+ 183	18	51,654	+ 2,711
Bournemouth Corporation	" 31	1,654	+ 121	‡9	14,741	+ 217
Bradford Corporation	..	..	..	..	..	..
Brighton Corporation	June 4	1,112	+ 208	¶9	9,151	+ 701
Bristol Trams & Carriage	" 3	6,725	+ 1,093	9	56,688	+ 4,014
Burnley Corporation	" 3	1,419	+ 236	9	12,420	+ 1,244
Burton Corporation	" 4	307	+ 40	9	2,505	+ 66
Bury Corporation	" 4	1,349	+ 166	¶9	11,933	+ 854
Calcutta Tramways Co.	" 3	R52,725	+ R2,886	22	R1,264,858	+ R36,712
Camborne-Redruth	" 3	143	+ 31	22	2,546	− 79
Cardiff Corporation	May 27	2,381	+ 142	8	19,070	+ 957
Cavehill	" 26	109	− 6	21	1,554	− 90
Central London Railway	June 3	4,906	− 1,138	22	114,574	− 9,383
Chatham & Dist. Lt. Rys.	" 1	943	+ 34	22	17,201	− 196
City & South London Rly.	" 4	3,068	− 147	22	73,902	+ 2,356
City of Birmingham	May 25	3,049	+ 242	21	60,265	+ 974
Cork Electric Trams Co.	June 1	601	+ 85	22	10,136	+ 77
Devonport & Dist. Trams	May 26	500	+ 89	21	9,238	+ 762
Dover Corporation	June 3	251	+ 39	9	2,111	+ 279
Dublin & Lucan Railway	" 2	164	+ 25	22	2,666	− 65
Dublin United	" 2	6,795	+ 1,414	22	116,246	+ 2,313
Dudley-Stourbridge	May 26	846	+ 79	21	16,115	+ 785
Dundee Corporation	" 31	1,243	+ 32	¶2	2,745	− 48
East Ham Council	June 3	1,101	+ 83	9	9,780	+ 396
Exeter Corporation	" 2	365	+ 48	9	2,972	+ 121
Gateshead & Dist. Trams	May 26	1,048	+ 93	21	20,881	+ 1,016
Glasgow Corporation	June 3	20,947	+ 2,523	1	20,947	+ 2,523
Glossop Trams	" 3	129	+ 16	22	2,578	+ 128
Gloucester Corpn.	May 31	304	+ 130	..	..	..
Gravesend-Northfleet	" 26	205	+ 9	21	2,934	− 73
Great Northern & City Rly.	June 3	1,444	+ 18	22	33,943	+ 1,347
Greenock & Port Glasgow	May 26	829	+ 54	21	13,586	+ 1,774
Halifax Corporation	" 30	2,095	+ 406	†9	16,604	+ 1,352
Hartlepool Tramways	" 26	275	+ 40	21	4,703	+ 210
Hastings Elec. Trams Co.	June 1	1,072	+ 178	..	..	..
Hong Kong	" 3	$9,621	+ $1,390	22	$200,718	− $2,716
…dersfield Corpn.	..	..	..	..	..	..
…l Corporation	" 3	2,787	+ 106	9	25,790	+ 1,057
…d District Council	" 3	568	+ 44	9	5,091	+ 194
…on District Council	May 31	135	+ 14	9	1,184	+ 65
…ch Corporation	June 3	536	+ 127	9	3,881	+ 378
…of Thanet Co.	" 3	659	+ 133	35	12,116	+ 383
…	May 26	144	+ 25	21	2,524	+ 145
…ley Corporation	June 1	203	+ 36	9	1,706	+ 138
…ster & District	May 26	110	+ 9	21	1,923	− 42
…nock Corporation	..	..	..	..	..	..
…lty Corporation	" 31	284	+ 42	9	2,606	+ 323
…shire Trams Co.	June 1	1,473	+ 95	22	30,054	+ 306
…shire United	May 31	1,402	+ 187	22	27,916	+ 374
…	" 25	158	+ 11	21	2,918	− 176
…Corporation	June 3	7,856	+ 988	9	68,576	+ 5,175
…Corporation	" 3	2,721	+ 403	9	22,944	+ 1,887
…Corporation	" 3	682	+ 73	¶3	1,830	+ 122
…Corporation	..	..	..	..	..	..
…Corporation	May 27	11,738	+ 713	21	232,532	+ 6,968
…pool Overhead Rly.	June 4	1,523	+ 180	22	31,118	+ 1,765
…& Colwyn Bay Ry.	" 2	226	+ 12	¶26	4,134	− 205
…County Council	May 24	43,984	− 482	‡8	338,619	+ 15,687
…Elec. Ry. Co.	June 3	13,165	+ 655	22	307,350	+ 14,115
…United	" 3	7,704	+ 1,037	22	131,011	− 270
…Corporation	..	..	..	..	..	..
…r Corporation	..	..	..	..	..	..
…Railway	..	..	..	..	..	..
…y	" 3	1,942	− 44	22	45,218	+ 934
…	May 26	200	− 9	21	4,053	− 34
…tan Dist. Railway	June 3	11,580	+ 715	22	257,922	+ 16,922
…tan Elec. Trams	May 26	9,024	+ 1,403	21	169,536	+ 22,286
…	" 26	383	− 112	21	6,401	+ 254
…Corporation	June 3	184	+ 49	§9	1,668	+ 352
…e-on-Tyne Corp.	" 3	4,257	+ 432	9	37,972	+ 2,783
…rt (Mon.)	" 3	753	+ 81	9	6,564	+ 308
…ton Corporation	" 2	573	+ 80	9	4,696	+ 276
…, Ashton & Hyde	May 26	594	− 42	21	11,422	+ 215
…Corporation	June 4	2,100	+ 324	10	20,303	+ 1,160
…) Corporation	May 31	181	+ 22	2	410	+ 4
…) Elec. Trams	June 2	1,631	+ 137	22	36,044	+ 1,810
…gh	May 26	119	+ 14	21	2,229	+ 60
…Corporation	June 3	2,289	+ 254	9	18,622	+ 826
…	May 26	1,944	+ 311	21	39,703	+ 3,631
…Corporation	" 31	774	+ 84	9	6,783	+ 284
…Corporation	June 1	668	+ 110	9	5,976	+ 516
…y	May 26	211	+ 5	21	1,737	− 38
…Corporation	June 5	5,273	+ 650	§9	46,123	+ 2,786
…	May 25	50	+ 5	21	915	+ 15
…Corporation	June 4	6,665	+ 891	10	64,806	+ 3,944
…Trams	" 3	$10,274	+ $1,194	22	$227,753	+ $10,803
…politan	May 26	885	+ 26	21	15,841	− 156
…	" 26	878	+ 103	21	18,187	+ 1,143
…ton	" 31	1,201	+ 118	9	9,855	+ 512
…Corporation	" 31	635	+ 113	9	4,899	+ 515
…Tramways	" 26	303	− 78	21	5,316	− 157
…Hyde &c., Jt. Bd.	June 3	823	+ 149	9	7,367	+ 893
…Corporation	" 4	1,370	+ 237	9	11,309	+ 1,015
…District	May 31	471	+ 64	31	13,698	+ 894
…Trams	" 26	1,111	+ 72	21	22,177	+ 1,031
…Corporation	..	..	..	..	..	..
…	" 26	40	..	21	814	− 15
…and District	" 25	230	− 11	21	3,526	− 102
…Trams Co.	" 31	510	+ 110	22	9,260	+ 637
…Corporation	June 3	1,191	+ 283	9	9,969	+ 1,602
…Corporation	" 3	582	+ 87	22	11,996	+ 270
…Corporation	..	..	..	..	..	..
…Corporation	" 1	2,892	+ 276	9	24,243	+ 2,396
…per-Mare	May 25	118	− 10	21	1,027	− 295
…Co.	" 26	433	+ 56	21	8,861	+ 260
…Corpn.	" 31	967	+ 133	9	8,585	+ 498
…	" 25	306	+ 24	21	5,349	+ 59
…	" 26	102	+ 6	21	1,954	− 15
…W.R. Trams	June 4	1,315	+ 173	23	28,779	+ 588
…Woollen District	May 26	1,086	+ 147	21	21,041	+ 1,180

(a) Comparisons are with the corresponding period last year. * Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 3 days. ¶ Plus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Shrs	Last Dividend	Name.	Price Wed., June 7.	*Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Week to June 7. Highest.	Business Week to June 7. Lowest.
		Electricity Supply.					
10	6/0	Bournemouth & Poole Elec. Sup. Ord.	8—9	6 9 6	Mar, Sep	..	—
10	4/6	Do. 4½ per Cent. Cum. Pref.	9—10	4 14 6	Feb, Aug	9⅝	—
10	6/0	Do. 6 per Cent. Cum. Second Pref.	10⅜—10⅞	5 6 6	Feb, Aug	..	—
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	102—104	4 6 6	Jan, July	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	7¾—8¼	6 1 6	March....	8⅛	8
5	3/6	Do. 7 per Cent. Pref.	7½—8	4 1 3	Mar, Sept	..	..
St.	4%	†Central Elec. Sup. Co. 4% Guar. Deb. Stock	98—101	4 0 6	June, Dec	..	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	3⅞—4⅜	5 2 6	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	4⅝—4⅞	4 17 3	Feb., Aug	4¾	—
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	96—98	4 1 6	Jan, July	97½	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101½—103½	4 7 0	..	102½	..
5	2/3	Do. City Undertaking 4½% Cum. Pref.	3⅞—4⅜	5 3 0	Jan, July	4 7/16	..
5	3/0	Chelsea Electric Supply Ord.	4—4½	5 11 0	March	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	100—102	4 8 6	June, Dec	..	..
10	8/0	City of London Electric Lighting Ord.	11¾—12¼	4 15 0	Feb, Aug	12 1/16	11 15/16
10	6/0	Do. 6 per Cent. Cum. Pref.	12—13	4 12 3	Jan, July	..	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	120—124	4 2 0	June, Dec	..	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	101—104	4 6 6	Jan, July	..	..
St.	5%	County of Durham Elec. P. D. 5% 1st Mort. Deb. Stk.	92—94	5 5 3	Jan, July	..	—
10	6/0	County of London Elec. Supply Ord.	7⅝—8⅛	6 3 0	Feb, Aug	7 13/16	..
10	6/0	Do. 6 per Cent. Cum. Pref.	10¾—11¼	5 5 6	Mar, Sept	11⅛	..
St.	4½%	Do. 4½ per Cent. Deb Stock (red.)	109—111	4 2 0	Jan, July	..	..
St.	4½%	Do. Second Deb. Stock	99—102	4 8 0	May, Nov	101½	101¼
5	4/0	Folkestone Electricity Supply Co. Ord.	4½—4⅞	5 19 0	April, Oct	..	—
5	2/6	Do. 5 per Cent. Cum. Pref.	4¾—5¼	4 15 3	Mar, Sept	..	—
St.	4½%	Do. 4½ 1st Deb. Stock (red)	97—100	4 10 0	Feb, Aug	..	..
5	5/0	Hove Electric Lighting Ord.	6¾—7¼	6 4 0	April, Oct	7	—
St.	4½%	Isle of Wight E. L. & P. Co. Deb. Stk.	88—91	4 19 0	..	..	—
5	5/0	Kensington & Knightsbridge Ord	7—7½	5 16 0	Feb, Aug	—	..
5	6%	Do. 6 per Cent. 1st Pref.	5¾—6	5 0 0	Jan, July	..	—
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	93—95	4 4 0	..	—	—
St.	4%	Kensington & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	96—99	4 1 0	April, Oct	—	—
St.	4½%	Kent Elec. Power Co. Irred Deb. Stk.	80—84	5 7 0	Jan, July	—	—
3	1/2⅖	London Electric Supply Ord.	1¾—2¼	2 17 0	Mar, Sept	..	—
5	3/0	Do. 6 per Cent. Pref.	4¾—5¼	5 17 0	Mar, Sept	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb	91—94	4 5 0	Jan, July	..	..
5	3/0	Metropolitan Electric Sup. Ord.	3½—4	6 13 4	April, Oct	..	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	4½—4¾	4 14 9	Jan, July	..	—
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	101—104	4 6 6	June, Dec	..	—
St.	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	86—89	3 18 6	Jan, July	..	—
..	4½%	Midland Elec. Corp. for Power Dist, 4½ 1st Mort. Debs.	93—100	4 11 0	..	—	—
5	2/6	Newcastle Elec. Supply Ord.	3¾—4¼	4 14 0	Feb, Aug	..	—
5	2/6	Do. 5 per Cent. non Cum. Pref.	4—4½	5 11 0	Feb, Aug	—	..
100	4½%	Do. 4½ per Cent. 1st Mort. Deb.	98—100	4 10 0	Jan, July	..	..
100	5%	North Metro. Elec. Power Sup. 5 Morts.	99—102	5 0 6	..	..	..
1	6%	Northampton Elec. Lt. & P. Ord.	1¼—1 5/16	4 11 6	Feb, Aug	..	..
1	5%	Do. 5% Pref.	1 3/32—1 5/32	4 6 0	Feb, Aug	..	..
St.	4%	Do. 4% Debs.	99—101	3 19 0	June, Dec	..	—
10	10/0	Notting Hill Electric Ord.	12—12½	5 17 6	March	12	..
5	4/3	Oxford Electric Ord.	6⅛—6⅝	5 13 9	March	..	..
St.	4%	Do. 4% Deb. Stk.	93—96	..	..	..	—
5	5/0	St. James' & Pall Mall Elec. Ord.	8¾—9¼	5 8 0	Feb, Aug	8⅞	..
5	3/6	Do. 7 per Cent. Pref.	6¾—7¼	4 16 6	Feb, Aug	..	..
St.	3½%	Do 3½ per Cent. Deb. Stock (red.)	86—88	3 19 6	Jan, July	..	—
5	..	Smithfield Markets Electric Sup. Ord.	1⅜—1⅞	..	Feb.	..	—
5	4/0	South London Electric Supply Ord.	3—3½	6 3 0	April	..	—
St.	5%	Do. 5% 1st Mort. Stock (red.)	101—104	4 16 0	..	..	—
1	0/8⅖	South Metrop'n Elec. Lt & Power 7% 1st Pref	1⅛—1¼	5 18 0	Feb, Aug	—	—
1	0/7⅕	Do. 6 per Cent. 2nd Pref.	⅞—⅞	6 17 0	Feb, Aug	1 3/32	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	97—100	4 11 6	April, Oct	..	—
5	1/3	Urban Electric Supply Ord.	½—1	..	April, Oct	..	—
5	1/3	Do. 5 per Cent. Cum. Pref.	2½—3	8 6 0	April, Oct	..	—
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	87—89	5 2 3	April, Oct	—	..
5	5/0	Westminster Elec. Sup. Ord.	7¾—8¼	6 5 0	Mar, Sept	..	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	5—5¼	4 3 6	Jan, July	5¼	..
		Electric Railways and Tramways.					
1	..	Bath Elec. Trams Pref. Ord.	⅜—7/16	..	April	..	—
1	0/6	Do. 5 per Cent. Cum. Pref.	⅝—⅞	6 13 6	Jan, July	—	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	79—83	5 8 6	April, Oct	..	—
St.	4½%	B'ham & Midland Trams 4½ 1st Deb. Stock.	90½—92½	4 17 3	Jan, July	..	..
10	4%	Bristol Tramways & Carriage Ord.	7—7½	5 10 3	Feb, Aug	..	—
10	4%	Do. Cum. Pref.	7¼—7½	5 6 9	..	..	—
St.	4%	Do. 4 per Cent. Debs.	101—102	3 18 3	Feb, Aug	..	..
10	..	British Electric Traction Ord.	1⅜—1⅝	..	June, Dec	1 9/32	—
10	..	Do. 6 per Cent. Cum. Pref.	4—4½	..	Feb, Aug	4¼	.
St.	5%	Do. 5 per Cent. Perpetual Debs.	94—98	5 2 0	April, Oct	96⅛	96¼
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	75—80	5 12 3	May, Nov	..	..
St.	3%	Central London Ordinary Stock	73—75	4 1 0	Feb, Aug	74	73
St.	4%	Do. 4 per Cent. Pref. Stock	87—89	4 10 0	Feb, Aug	88¼	88¼
St.	2%	Do. Deferred Stock	62—64	3 3 6	Feb.	63½	62½
100	4%	Do. 4 per Cent. Debs.	104—106	3 16 0	Jan, July	..	—
5	2/6	City of Birmingham Trams, 5% Cum. Pref.	4¾—5	5 0 0	April, Oct	..	—
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99—102	3 18 9	April, Oct	..	—
St.	1¼%	City & South London Rly. Con. Ord.	32½—33½	4 11 0	Feb, Aug	33½	33
St.	5%	Do. 5 per cent. Perp. Pref. (1891)	109—111	4 10 0	Feb, Aug	..	—
St.	5%	Do. (1896)	104—106	4 12 6	Feb, Aug	..	..
St.	5%	Do. (1901)	103—106	4 15 6	Feb, Aug	..	..
St.	5%	Do. (1903)	103—106	4 15 6	Feb, Aug	104½	104½
St.	4%	Do. 4 per Cent. Perpetual Debs.	101—103	3 18 6	May, Nov	101¾	101½
10	6/0	Dublin United Trams, 6 per Cent. Pref.	12½—13½	4 10 6	Feb, Aug	..	—
10	12/0	Gateshead and District Trams Ord.	8½—9½	6 19 6	..	..	..
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	⅞—1⅛	..	Feb, Aug	31/32	..
5	..	Hastings & District Elec. Trams, 6% C. P.	1½—2	..	Mar. Sept	..	..
St.	4½%	Do. 4½ Deb. Stock	75—80	5 10 0	April, Oct	..	..
10	..	Imperial Tramways Ord.	3—3½	..	Mar, Sept	..	..
10	..	‡Do. 6 per Cent. Pref.	4¼—4¾	..	Mar, Sept	..	—
St.	4½%	Do. 4½ per Cent. Debs.	71—73	6 5 0	Jan, July	..	—
..	2/6	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	2¼—2¾	5 0 0	Mar, Sept.	..	—
St.	4%	Do. 4 per Cent. Deb. Stock	79—84	4 15 0	Jan, July	..	—
10	6/0	Lanarkshire Tramways	10—10½	5 12 3	Feb, Aug	..	..
St.	5%	Lancs Utd. Trams, 5% Prior Lien Deb. Stk.	82—84	5 19 0	Jan. July	..	..
St.	4%	London Electric 4% Deb. St.	98—100	4 0 0	..	99¼	99¼
St.	4%	Do. 4% Pref.	84—85	4 14 0	..	85¼	84½
10	..	London United Trams, 5% Cum. Pref.	3¾—4¼	..	Jan, July	4	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	76—79	5 3 0	Jan, July	—	..
St.	..	Mersey Con. Ord. Stock	6—8	..	Feb, Aug	—	..
1	1/1⅕	Metropolitan Elec. Tramways Ord.	31/32—1 1/32	6 0 0	..	1	..
1	..	Do. Deferred	⅛—3/16	..	April	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	31/32—1 1/16	5 0 0	Feb, Aug	31/32	15/16
St.	4½%	Do. 4½ per Cent. Deb. Stock	102½—104½	4 7 0	Jan, July	103½	102½
St.	5%	Do. 5 per Cent. Db. Stk	100½—103½	4 18 0	—	102½	..
St.	1¼%	Metropolitan Railway Consolidated	50¼—50¾	2 15 0	Feb, Aug	51¼	50½
St.	2¾%	Do. Surplus Lands Stocks	68—70	3 19 6	Feb, Aug	69½	68½
St.	3½%	Do. 3½ per Cent. Preference	90½—92	3 16 0	Feb, Aug	91¼	90¼
St.	3½%	Do. 3½ per Cent. "A" Preference	89—91	3 17 0	Feb, Aug	90	..
St.	3½%	Do. 3½ per Cent. Convertible Pref.	89—91	3 17 0	Feb, Aug	90¼	—
St.	3½%	Do. 3½ per Cent. Debenture Stock	93—95	3 13 6	Jan, July	94½	93½

* No allowance has been made for accrued interest or redemption.
† Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Share	Last Dividend	Name	Price Wed., June 7.	*Rate per cent. Yielded.	Dividend Due.	Business Week to June 7. Highest.	Lowest.
		Electric Railways and Tramways—*Continued.*		£ s. d.			
St.	3½%	Met. Rly. 3½ per Cent. "A" Deb. Stock..	92 —94	3 14 6	Jan, July	..	..
St.	..	Metropolitan District Railway Ord.....	32 —32½	..	Feb, Aug	..	..
St.	3½%	Do. 4½% First Pref.	89 —91	4 19 0	Feb, Aug	90½	89½
St.	3½%	Do. Assented Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	75 —77	4 11 0	Feb, Aug	..	..
St.	3%	Do. 3 per Cent. Consoltd. Rent-charge	77 —79	3 16 0	Jan, July	78	..
St.	4%	Do. 4 per Cent. Midland Rent-charge	104 —106	3 16 0	Jan, July	..	..
St.	6%	Do. 6 per Cent. Perp. Deb. Stock.....	148 —150	4 0 0	Jan, July	149½	148½
St.	4%	Do. 4 per Cent. Ditto.....	98 —100	4 0 0	Jan, July	100	..
1	4d.	†Potteries Electric Traction Ord.	¼ —⅜	5 6 9	April, Oct	⅜	..
1	0/6	Do. 5 per Cent. Cum. Pref.....	⅜ —½	7 5 0	Feb, Aug	⅜	..
St.	4½%	Do. 4½ per Cent, Deb. Stock.....	86 —89	5 1 0	May, Nov	88½	88
1	1/2½	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	½ —⅝	10 2 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock.....	75 —80	5 0 0	Jan, July	..	..
100	5%	Sunderland Dist. Elec. Trms. 5% 1stMtDb.	..	8 4 0	Jan, July	..	..
..	10/0	UndergdE.Rys.Lon.6% In. bds with coup 7	63 —65	1 10 9	June, Dec	64½	63
..	5%	Do. 5% Prior Lien Bonds.....	100 —101	4 19 0	..	100½	99½
..	4½%	Do. 4½% Bonds with coup. 7	99 —101	4 9 3	..	..	..
5	4%	Do. 4 per Cent. 1st Power Ho. Dbs. ..	100 —102	3 18 3	..	..	..
5	..	Yorkshire (W.R.) Elec. Trams. Ord.....	½ —¾	..	March ..	..	..
St.	..	Do. 6 per Cent. Cum. Pref.....	2½—2¾	..	..	..	..
St.	4½	Do. 4½ per Cent. 1st Debs.....	84 —87	5 3 3	Jan, July	..	..
		Electric Manufacturing, &c.					
St.	4½%	Anchor Cable Co. 4½ % Deb. Stock	99 —101	4 9 0	—	..	..
1	..	Aron Electricity Meter Ord.....	⅜—⅝	..	..	..	..
1	0/7½	Do. 6% Cum. Pf.	⅝—¾	7 4 0	April, Oct	⅝	..
1	3/2½	Babcock & Wilcox Ord.	5⅜—5⅝	4 14 6	April, Oct	5⅜	5½
1	0/7½	Do. Pref.....	1⅜—1½	4 0 0	..	..	..
5	6/0	British Insulated & Helsby Cables Ord..	6½—7⅜	6 15 6	July, Feb	7⅛	..
100	3/0	Do. 6 per Cent. Pref.....	6 —6½	4 12 3	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)..	102 —104	4 6 6	Jan, July	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt.Db.	96 —99	4 11 0	Mar, Sept	..	..
100	..	British Westinghouse 6 per Cent. Pref....	⅜—½	..	Feb, Aug	..	..
St.	6%	Do. 6 per Cent. Prior Lien Dbs. (rd.)..	100 —103	5 16 3	..	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock.....	61 —64	6 5 0	Jan, July	60½	..
St.	4½%	BrushE.Eng. Co. 4½% Perp. 1st Deb.Stock	59 —64	7 0 6	Mar, Sept	..	..
St	4½%	Do. Perpetual 2nd Deb. Stock.....	41 —46	9 16 0	Jan, July	..	..
5	5/0	Callender's Cable Con. Ord.....	9⅛—9⅝	7 12 0	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.....	4⅞—5⅛	4 17 6	Jan, July	5⅜	..
St.	4½%	Do. 4½ per Cent. 1st Mort Debs. (red.)..	102 —104	4 6 6	Nov, May	103½	..
1	1/6	Castner-Kellner Alkali Co.....	3⅛—3⅜	5 1 9	May, Nov	3⅛	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)..	103 —106	4 3 6	Feb. Aug	105	..
1	7½d.	Chadburn's (Ship) Telegraph Ord.	1⅛—1⅛	5 19 0	March ..	..	..
1	0/8½	Consolidated Electrical Co.....	⅛—¼	10 0 0	August ..	..	..
1	0/6	Consolidated Signal Co.....	¼—½	5 0 0	April, Oct	..	..
1	0/7½	Do. 6 per cent. Cum. Pref.	⅛—⅛	6 8 0	April, Oct	..	..
3	..	Crompton & Co (Nos. 1 to 85,000)	⅛—¼	..	Jan, July	..	..
100	5%	Do. 5 per Cent. 1st Mort. Debs. (red.)..	70 —80	6 5 0	Jan, July	..	..
5	1/0	Dick, Kerr & Co. Ord.....	½—1	5 0 0	Sept.	..	..
5	0/7½	Do. 6 per Cent. Cum. Pref.....	1 —1⅛	5 6 6	Sept	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock.....	97 —100	4 10 0	Jan, July	..	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	⅛—⅛	..	Feb, Aug	..	..
..	..	Do. (£5 paid)	1½—2½	9 3 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (red.)	69 —73	5 9 9	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock.....	78 —81	6 3 6	Mar, Sept	..	..
..	..	Edmundson's Elec. Corp. Ord.....	⅛—⅛	..	Jan, July	..	..
5	..	Do. 6 per Cent. Cum. Pref.....	2⅜—3⅛	..	May, Nov	..	..
St.	4½%	Do 4½ per cent. 1st Mort. Deb. (red.)..	86 —89	5 1 0	Jan, July	..	..
2	..	Electric Construction Co.....	¾—1	..	Jan, July	..	..
2	2/9	Do. 7 per Cent. Cum. Pref.....	1½—2	7 0 0	July	..	..
St.	4%	Do. 4 per Cent. Perp. 1st Mort. Debs...	70 —73	5 8 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref. ..	8½—9½	5 9 0	June, Dec	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.....	88 —93	4 8 6	Mar, Sept	92½	92
5	10/0	Henley's Telegraph Works Ord.....	12½—12⅝	5 16 6	Feb, Aug	13½	..
St.	2/3	Do. 4½ per Cent. Pref.	4⅛—5⅛	4 7 0	Feb, Aug	5¼	4⅛
10	15/0	†Do. 4½ per Cent. 1st Mort. Deb. Stock	105 —108	4 4 6	Mar, Sept	..	..
10	5/0	India Rubber, Gut. Per., &c., Works....	16 —16½	5 18 6	Feb, Aug	16⅞	..
100	4%	Do 5 per Cent. Cum. Pref.	10½—10¾	4 14 0	..	10⅛	10½
1	..	Do 4 per Cent. Debs. (red.)	96 —98	4 1 6	April. Oct	..	..
1	..	National Elec. Construction Co.....	⅛—¼	..	April	..	..
1	..	Richardsons, Westgarth & Co., Ltd. Ord.	⅜—½	..	Nov.	..	..
St.	4½%	Do. 6 per Cent. Cum. Pref.	⅝—¾	..	May, Nov	..	..
5	..	Do. 4½ per Cent. Perp. Deb. Stock....	78 —82	5 10 0	Jan, July	..	..
12	36/0	Simplex Conduits 6 per Cent. Cum. Pref.	4½—5	..	..	..	..
100	4%	Telegraph Construction & Maintenance..	35¼—38½	5 16 3	Mar, July	33	37½
1	0/0	Do. 4 per Cent. Deb. Bonds (1909)	100 —102	3 18 6	Jan, July	..	..
1	0/6	Vickers, Sons & Maxim, Ltd., Ord.....	2⅛—2⅜	4 15 0	..	2⅛	2⅛
St.	5%	Do. 5 per Cent. non-Cum. Preference..	1⅛—1⅜	4 3 0	..	..	..
St.	4%	Do. 5 per Cent. non-Cum. Preferred ..	110 —113	4 8 6	..	..	..
100	4½%	Do. 4 per Cent. 1st Mort. Db. Sk. (red)	100 —102	4 0 0	June, Dec	100½	..
100	5%	†Do. 4½ per Cent. 2nd Mort. Deb. (red.)	102 —104	4 7 6	June, Dec	..	..
10	10%	†Do. 5 per Cent. 3rd Mort. Debs Scrip...	103 —105	4 16 0	..	102½	..
1	..	J. G. White & Co. 6% Cum. Pref.	14½—15½	6 11 0	..	..	..
5	..	Willans & Robinson Ord.....	⅛—¼	..	Apr, Oct	..	..
St.	4%	Do. 6 per Cent. Cum. Pref.....	⅛—¼	..	Apr, Oct	..	..
		†Do. 4 per Cent. 1st Mort. Debs.....	55 —65	6 3 0	May, Nov	..	..
		Telegraphs.					
10	..	Amazon Telegraph	7⅛—7⅜	..	June, Dec	7¼	..
100	5%	Do. 5 per Cent. Debs. (red.)	99½—101½	4 19 6	Jan, July	101	..
St.	15/0	Anglo-American	69 —71	4 4 6	F,My,Ag,N	..	..
St.	30/0	Do Preferred	113½—114½	5 5 0	F,My,Ag,N	114½	113
St.	30/0	Do. Deferred	26½—27	5 7 0	F,My,Ag,N	..	..
St.	4%	Commercial Cable 4 per Cent. Deb. Stk...	88 —90	4 9 0	Jn,Ap,Jy,O	89½	88½
10	6/0	Cuba Submarine Ord.	9½—10½	6 0 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	17½—18½	5 13 0	Feb, Aug	..	..
5	2/0	Direct Spanish Ord.....	3½—4	5 0 0	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.....	8½—8¾	5 16 0	April, Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	101 —103	4 8 3	Jan, July	..	..
10	2/0	Direct United States Cable.....	7⅛—8½	6 3 6	Ja,Ap,Jy,O	7⅜	..
100	4½%	Direct West India Cable 4½% Rg.Db.(rd.).	100 —102	4 9 0	June, Dec	..	..
St.	65/0	Eastern Ordinary xd and bonus	137 —140	5 1 0	Ja,My,Jy,O	139½	137½
St.	17/6	Do. 3½ per Cent. Pref. Stock.....	84 —85	4 2 6	Ja,My,Jy,O	85½	84½
St.	4%	†Do. 3½ per Cent. Mort. Deb. Stk. (red.)..	100½—102½	3 18 6	May, Nov	101½	101½
St.	6/6	Do. 4 per Cent. Deb. Stock	13½—14	5 2 0	Ja, Ap, Jy, O	13⅜	13⅝
10	4%	Eastern Extension xd and bonus	101 —103	3 18 6	Feb, Aug	..	..
25	4%	Do. 4 per Cent. Deb. Stock	99½—101½	3 19 0	May, Nov	..	..
10	26/0	Eastern and S.Af., 4% Mauritius Sub.Debs	31½—32½	5 8 0	Jan, July	31⅝	..
25	52/6	G.N. (of Copenhagen), with Coupon 82 ..	52½—53½	5 6 6	May, Nov	..	..
100	5%	Indo-European xd and bonus	93 —95	5 4 0	Ja,Ap,Jy,O	94½	..
100	4%	Mackay Companies Common	78 —80	5 0 0	Ja,Ap,Jy,O	..	..
1	..	Do. Preference	1¼—1¾	..	April	1⅛	..
100	4%	Marconi's Wireless Teleg. Co.	100 —102	3 18 3	June, Dec	..	..
1	..	Pacific & Europe'n Tel.4%Guar.Dbs.(red.)	1½—1⅝	5 0 0	May	..	..
100	4%	†West Coast of America	99½—101½	3 18 9	Jan, July	..	..
2½	1/3	Do. 4 per Cent. Debs.....	2⅜—2⅝	1 18 9	May, Nov	2½	..
100	4%	†West India & Panama	10½—10⅝	5 16 0	May, Nov	10½	10½
10	1/6	†Do. 6 per Cent. 1st Pref.	9⅜—9⅝	6 5 0	May, Nov	..	..
10	6/0	†Do. 6% 2nd Pref.	102 —104	4 16 0	Jan, July	..	..
10	6/0	Do. 5 per Cent. Debs.....	13½—14½	5 3 0	Mr,Jn,O,D	14½	..
100	5%	Western Telegraph.....	101 —103	3 17 6	June, Dec	..	..
10	3/0	Do. 4 per Cent. Deb. Stock (red.).....	105 —108	3 14 0			
St	4%	Western Union Telegraph, $1,000 4% Bds	92½				
..	4%	Do. $1,000 4½% Fdg. & Rl. Est. Gd. Bnds					
—	4½%						

Share	Last Dividend	Name	Price Wed., June 7.	*Rate per cent. Yielded.	Dividend Due.	Business Week to June 7. Highest.	Lowest.
		Telephones.		£ s. d.			
100	2$	Amer. Telephn. & Telegh. Cap. St.	155 —157	5 2 6	..	..	..
..	4%	Do. Coll. Trust $1,000 4 per Cent. Bds.	95½—97½	4 3 0	Jan, July	..	..
St.	4%	Do. 4% Cons. Bonds 1936	115½—116½	3 9 0	..	..	..
5	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101 —103	4 17 0	Mar, Sept	..	..
1	3/0	Chili Telephone	7⅛—7⅜	5 11 6	August ..	..	..
1	0/6	Monte Video Telephone Ord.....	⅞—1	6 0 0	Nov	..	..
..	..	Do. 5 per Cent. Pref.	¾—⅞	5 11 0	May, Nov	..	..
St.	6%	National Co. Pref. Stock.....	104 —105	5 14 3	Feb, Aug	..	..
St.	6%	Do. Def. Stock	127 —129	4 13 9	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 1st Pref.....	10 —10½	5 11 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.....	10 —10½	5 11 6	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.....	5½—5¾	4 9 0	June, Dec	..	..
St.	3½%	Do. Deb. Stock 3½ per Cent. (red.).....	99 —101	3 9 3	Jan, July	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.).....	99 —101	3 19 3	..	..	..
..	4½%	New York Telephone Co. 30 yr. Bnds.....	99½—100½	4 10 0	April, Oct	..	..
1	1/0	Oriental	1⅜—1⅝	4 18 0	April, Oct	..	..
..	0/7½	Do 6 per Cent. Cum. Pref.	1⅛—1¼	4 16 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Red. Deb. Stock.....	87½—89½	4 9 6	Jan, July	..	..
St.	4½%	Telephone Co. of Egypt 4½% Db.Stk.(red.)	100 —102	4 9 0	Jan, July	..	..
5	3/0	United River Plate Ord. (1—150,000) ...	7⅛—7⅜	5 3 0	July	..	..
5	4½%	Do. (150,001—190,000).....	7⅛—7⅜	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅛—5⅜	4 9 0	June, Dec	..	..
St.	4½%	Do. 4½ Deb. St. Red.....	103 —105	4 5 9	Jan, July	..	..
		Financial, Investment, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref...	4 —4½	7 1 0	Jan, July	..	..
10	2/0	Globe Telegraph & Trust	11½—11¾	5 2 6	Sp,DcMrJu	..	..
10	3/0	Do. 6 per Cent. Pref.	13½—13¾	4 10 0	Sp,DcMrJu	..	..
10	6%	Submarine Cables Trust (Cert.).....	131 —134	4 9 6	April, Oct	..	..
		Colonial and Foreign Electric Railways, Tramways, &c.					
5	2/6	Anglo-Argentine 5% Cum. 1st Pref.	5⅛—5⅜	4 16 3	April, Oct	..	..
5	2/6	Do. 5% Cum. 2nd Pref.....	4⅛—5⅜	4 19 0	Jan, July	..	..
St.	4%	Do. 4% Deb. Stock	96 —98	4 2 6	June, Dec	..	..
St.	4½%	Do. 4½% Deb. Stock	101 —103	4 8 3	..	..	..
St.	5%	†Do. 5% Deb' Stock	100½—102½	4 13 6	..	..	..
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)....	104½—106½	4 14 6	Jan, July	..	..
5	4/0	Brisbane Electric Trams. Invest. Ord	6½—6¾	6 3 0	May	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5⅛	4 17 6	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Certs.....	102 —105	4 6 0	Jan, July	..	..
St.	8%	British Columbia El..Rly. Df.Ord.	146 —150	5 6 9	Mar, Sept	..	..
St.	6%	Do. Pref. Ord. Stock	127 —130	4 13 3	May, Nov	..	..
St.	5%	Do. 5% Cum. Perp. Pref. Stock.....	110 —112	4 10 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs.....	100 —103	4 7 6	April, Oct	..	..
100	4½%	Do. Vancouver Power Debs.	102 —105	4 5 9	Jan, July	..	..
St.	4½%	Do. 4½% Perp. Con. Deb. St.	101½—103½	4 2 6	..	..	..
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	99½—101½	4 19 6	Mar, Sept	..	..
St.	6%	Buenos Ayres Port & City Tram, 1st Mt. Debt Stock	93 —98	6 2 6	Feb, Aug	..	..
5	3/6	Calcutta Tramways (1 to 137,610).....	5½—6	5 0 0	Mar, Sept	..	..
100	2/6	Do. 5 per Cent. Cum. Pref.	5¼—5⅝	4 13 0	Jan, July	..	..
1	4½%	Do. 4½% 1st Deb. Stock (red).....	10. —104	4 6 6	Jan, July	..	..
St.	1⅞	Cape Electric Tram Shares	⅛—¼	..	..	..	..
5	1/3	City of Buenos Ayres Trams Co. (1904) Sh.	5⅛—5⅜	4 5 0	F,My,A,N	..	..
St.	4%	Do 4 per Cent. Deb. Stock.....	96 —99	4 0 9	June, Dec	..	..
St.	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.....	95 —98	5 2 0	May, Nov	..	..
1	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	100½—102½	4 18 6	Feb, Aug	..	..
2	..	†Hong Kong Tramways Co. 5 per Cent. 1st Mort. Debs.	76½—79½	6 8 0	June, Dec	..	..
100	5%	Kalgoorlie Elec. Trams Sh.	⅜—⅝	..	..	..	..
5	6%	Do. 5 per Cent. "A" Deb. Stock.....	94 —97	5 3 0	Jan, July	..	..
5	0/6	Do. 6 per Cent. "B" Ditto	66 —70	4 5 9	Jan, July	..	..
100	0/7½	†Lisbon Elec. Trams. Ord.	1 —1¼	4 16 0	July	..	..
St.	5%	Do. 6 per Cent. Cum. Pref.	1 —1¼	4 16 0	Jan, July	..	..
St.	5%	Do. 5 per Cent. Reg. Mort. Debs.	98 —102	4 18 0	Jan, July	..	..
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	96 —98	5 2 0	Jan, July	..	..
100	5%	Manaos Trams and Lt. Co. 5% Debs	91 —97	5 4 6	..	..	..
100	$1¼	Manila Elec. Ry. $1,000 Gold Bonds.....	100 —102	4 18 0	Feb, Aug	..	..
St.	5%	Mexico Trams Co. Com. St.	123½—125½	5 12 0	..	..	..
St.	6%	Do. Gen. Con 1st Mort. 5% Gold Bds.	96 —97	5 3 6	..	..	..
St.	4½%	Do. 6% 50 yr. Mort. Bds.....	100½—101½	5 18 6	—	..	..
100	$2½	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922) (Nos. 601 to 2,000)	101 —103	4 7 6	Feb, Aug	..	..
St.	5%	Do. do. (Nos. 1 to 4,600)	102 —104	4 7 6	..	..	..
5	3/0	Perth Elec. Trams Ord.	⅛—⅛	2 13 6	May	..	..
5	3/0	Do 1st Mt. Db. Stock	104 —106	4 14 3	Jan, July	..	..
100	5%	Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	5¼—5½	5 4 6	—	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. Stk.	99 —102	4 8 0	..	..	..
100	$1½	Rio Janeiro Tram, Lt. & P. Co.....	116 —117	4 6 0	..	..	..
100	5%	Do. 30 yr. Gold Bnds.	102½—104½	4 16 3	..	..	..
100	$2½	Do. 50 yr. Mt. Bnds	96 —97	5 3 6	—	..	..
100	5%	Sao Paulo Tramway, Light & Power Co. $100 Stock	184½—186½	5 8 0	..	..	..
10	10%	Do. 5 per Cent. 1st Mt. $500 Db.	102 —104	4 17 0	June, Dec	..	..
1	..	Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	93 —100	4 10 0	Feb, Aug	..	..
5	..						
St.	4%	**Colonial and Foreign Electricity Supply, &c.**					
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.....	5½—5¾	5 8 0	Mar, Sept	..	..
10	6/0	Bombay E.S. & T. 6% Cm. Pf.....	10¾—11½	5 5 6	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stk. (red).....	98 —100	4 11 0	Jan, July	..	..
..	5%	Do. 5 per Cent. 2nd Mort. Deb. Stock..	98 —100	5 1 0	..	..	..
5	5/0	Calcutta Elec. Supply Ord.	6¼—7½	6 1 3	April, Oct	..	..
5	2/6	Do. 5% Cum. Pref	4⅛—5⅜	4 13 0	..	..	..
100	5%	Calgary Power Co. 5% 1st Mort. Bnds....	96 —98	5 2 0	..	..	..
100	7/2½	Canadian Gen. Elec. Co. Com. St.....	108 —111	6 8 0	..	..	..
100	$3½	Do. 7% Cm. Pf. Stock	121 —124	5 5 0	..	..	..
100	5%	Castner Electrolytic Alkali Co.(of U.S.A.) 1st Mort. Stl. Debs.	97 —102	4 18 0	Jan, July	..	..
500	5%	Elect Development Co. of Ontario.....	83½—85½	5 18 6	..	..	..
St.	5%	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	87 —90	5 11 0	Jan, July	..	..
5	..	Indian Elec. Sup. & Trac. Co.	1 —1¼	..	..	..	..
10s	..	Kalgoorlie Elec. Power & Lig. Ord.	⅛—¼	..	..	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	⅛—¼	8 6 6	April, Oct	..	..
5	5%	Kaministiquia Power Co.5% Gold Bnds...	103½—105½	4 15 6	..	..	..
5	..	Madras E. S. Corp. Ord.	3 —3½	..	..	..	..
100	5%	Melbourne E. S. Co. Cons. Ord. St.....	23 —33	..	..	..	..
St.	5%	Do. 5% 1st Mortg Deb. Stock	94 —96	5 4 0	..	..	..
500	5%	Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	89 —90	5 12 0	..	..	..
St.	$1	Mexican Lt. & Power Co. Com. St.	84½—86½	4 13 6	..	..	..
500	5%	Do. 7% Cum. Pref. St.	107 —109	6 9 6	..	..	..
100	8/2½	Do 5% 1st Mort. Gold Bnds.	94½—95½	5 5 0	..	..	..
100	5%	Monterey Ry. L. & P. Co. 1st Mort. Db. Sk.	84½—91½	5 10 6	F,My,A,N	..	..
100	5%	Montreal Lt. Ht. & Power Co. Cap. St.	162 —165	5 0 0	..	..	..
100	5%	Northern Lt. Power & Coal 5% Gd. Bds ..	70 —72	7 1 0	April	..	..
St.	£10	River Plate Electricity Co. Ord. Stk.	218 —228	4 7 9	May	..	..
St.	6%	Do. 6 per Cent. non-Cum. Pref. Stk. ..	107 —114	5 5 0	Jan, July	..	..
St.	5%	Do. 5 per Cent. Deb. Stock	104 —106	4 14 3	..	..	..
100	$1½	Shawinigan Water & Power Co.Ca.....	115 —118	4 6 0	..	..	..
100	5%	Do. 5 per Cent. Bds.	109 —111	4 11 0	Jan, July	..	..
St.	4½%	Do. 4½ Per Con. Mt. Db. St.	102 —104	4 6 6	—	..	..

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NOTES.

End of the Metal Filament Depression.

It is now becoming evident that the pessimistic opinions held a year or two ago by some central station engineers as to the effect of metal filament lamps on the prospects of the supply industry are not likely to be justified. Indeed, many reports show that considerable progress is again being made in private lighting, and the normal growth of the output seems likely to be resumed. The annual report of Mr. S. J. WATSON, borough electrical engineer at Bury, may be cited as a case in point. The sales for private lighting, after a slight falling off during the last two years, have for the 12 months just ended increased by no less than 12·3 per cent., whilst 42 new consumers have been obtained, a larger number than during any of the last seven years. When it is also mentioned that the output for power has increased by 24 per cent., a very satisfactory state of affairs might be anticipated. The introduction of meters on the tramcars, however, has resulted in the revenue received from the sale of current to the tramways being £1,406 less than in the previous year, the output for traction having declined by no less than 19·7 per cent. Whilst this result is, of course, unfortunate for the electricity department, the economy introduced by adopting meters should encourage other tramway undertakings to experiment in this direction. Attention may also be called to the fact that Mr. WATSON anticipates a considerable increase in the power load when the new three-phase station now under construction is completed. In erecting this station Bury is following the policy which has proved most satisfactory in other towns.

The Advancement of the Telephone.

AT the annual meeting of the Peel-Conner Telephone Works (Ltd.), this week, the chairman of the Company, Mr. HUGO HIRST, threw out the suggestion that when the General Post Office have the telephones in their hands they should work along similar lines to an electricity supply undertaking. In other words the Post Office should bring their lines to a house, and the installation of the telephone, on whatever system might be necessary, should be carried out by independent contractors engaged by the owner or occupier of the premises. Mr. HIRST pointed out that a staff of inspectors in the service of the General Post Office would be necessary, but under such a system the Post Office would have the advantage of the services and enterprise of the whole electrical trade for obtaining subscribers and for extending their business.

AT first sight this seems to be an excellent suggestion, but we fear that it would not be altogether feasible, because there is a very distinct difference between a telephone service and one for electricity supply. If anything goes wrong with the telephone installation the subscriber turns instinctively to the National Telephone Co. or the General Post Office, as the case may be, but if the installation were carried out by a contractor the telephone authority might very well feel disinclined to accept the responsibility of putting right any subsequent troubles free of charge. The subscriber, on his part, would find it very inconvenient to call in a contractor to put right anything that might be wrong. Apart from this, however, we need scarcely point out that the connecting up of a telephone service is by no means so simple a matter as connecting up a service for

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light or power. In the case of the telephone service a very definite connection has to be made to the exchange before messages can be handled, and thus it is more necessary for the telephone authority to have the matter in hand than it is for the supply authority in the case of electric lighting or power, where it is merely a question of connecting up to mains so long as the station is not overloaded. Nevertheless, we fully sympathise with Mr. HIRST in his desire to popularise the telephone, and we hope that all that can be done without making matters really more complicated when the General Post Office enter into possession of the field will be done in due course.

Strenuous Opposition.

STRIKING testimony of the anxiety with which gas companies regard the progress of electric supply undertakings, and of the determination of the companies to offer still greater opposition to the development of these undertakings, is afforded by the recent action of the Wrexham Gas Co. A little more than two months ago we referred to the petty complaints of the chairman of the Company as to the canvassing by the electricity department of the Gas Company's customers. Not content with protests, however, the Company recently strenuously opposed, at a Local Government Board inquiry, the Council's application for further loans for extensions of the electricity undertaking. The counsel for the opposition undoubtedly put the matter in a nutshell when he stated that his clients' case was "that the electricity concern was going ahead too fast." Such candour is to be welcomed. The Gas Company are particularly disturbed because the Council are proposing to convert more gas lamps to electric lighting; and as a reply to the electrical engineer's statement that he could light and maintain electric lamps of 50 c.p. for 14s. per lamp less than the cost of gas lighting, the Company stated that the gas lamps in Wrexham each gave 140 c.p. We understand, however, that the makers of these particular lamps only claim 75 c.p. per lamp, doubtless under the most favourable conditions, so that the Company's statement seems rather a figure of speech than anything else; but perhaps we ought not to expect much more than 50 per cent. accuracy under these circumstances.

Wanted—A Policy.

THE inquiry just referred to has drawn attention to the absence of any definite policy on the part of the Local Government Board in regard to certain aspects of municipal trading in general and electricity supply in particular. It is in the highest degree desirable that the Board's inspectors should be animated by a uniform policy, but this appears to be far from the actual state of affairs. Thus, when Mr. Ross HOOPER held an inquiry at Wrexham on the occasion of a previous application by the Council for a loan for electricity supply extensions, he strongly advised that all profits made by the electricity undertaking should be allocated to a reserve fund. This advice, which we think was decidedly sound, has been followed by the Council; but now Mr. T. C EKIN, at the recent inquiry, wants to know why certain profits have been paid to the reserve fund and not to the relief of the rates. The confusion which must result from such conflicting advice on the part of Government officials will tend to make municipal authorities regard Local Government Board inquiries with even less favour than in the past, whilst the claims of certain sections of ratepayers that all profits should be handed over for the relief of the rates will be strengthened. That a reserve fund is essential for any electricity undertaking is opportunely emphasised by the Inspector's report on the recent inquiry at York referred to elsewhere in this issue. It is therefore to be regretted that another of the Board's officials should have said anything that can be regarded as discounting the present policy in providing for unforeseen expenditure.

Annual Report of the Chief Inspector of Factories and Workshops.—The annual report for the year 1910 of Dr. B. A. Whitelegge, C.B., H.M. Chief Inspector of Factories, was issued this week. In their report in February last the Accidents Committee regarded the increase in the number of reported accidents up to 1907 as almost entirely due to improvement in reporting, which since that date has been less marked. The statistics given in the present report show that the total number of accidents in 1910 was 129,550, as against 117,500 in 1909, 122,154 in 1908 and 124,325 in 1907. The increase shown in 1910 is attributed by Dr. Whitelegge to improved trade and more employment. The number of accidents attributable to electrical apparatus shows little change, notwithstanding the increased use of electricity for light and power. In summarising the sectional reports, Mr. H. M. Robinson, deputy Chief Inspector, says a further advance in the use of electrical energy for power purposes in factories has again to be recorded, as is shown by the returns issued by THE ELECTRICIAN. Owing to the technical nature of the requirements set out in the revised regulations for the use of electricity, it has been found that occupiers are inclined to await instructions from the inspector before taking steps to comply with these regulations, but the explanatory memorandum of Mr. G. Scott Ram, H.M. Electrical Inspector of Factories, has proved of great service. We hope to give in our next issue an abstract of Mr. Ram's report.

Enlargement of the Cos Cob Power Station of the New Haven Railroad.—According to the "Electric Railway Journal," the New York, New Haven & Hartford Railroad is more than doubling the size of its Cos Cob power station. Orders have been placed for four Westinghouse-Parsons single phase turbo-generators, each of 4,000 kw. capacity. These will supply energy at an 80 per cent. power factor, thus increasing the generating capacity of the station from 12,000 kw to 28,000 kw. The present boiler equipment will be increased proportionately, and the coal-handling plant will be rearranged and enlarged.

Large Telephone Installation.—In the McAlpin Hotel which is now being built in New York, the telephone installation will consist of 100 trunk lines and 1,800 stations. It is estimated that there will be transmitted from these stations 500,000 messages annually at a service cost of £5,666. The main telephone switchboard will contain 16 regular operating positions. There will be three sub-switchboards, as follows: One two-position switchboard with 17 booths in the main corridor; one with 16 stations in the engineering department and one with 12 extensions for the use of the office staff. There will also be a complete telautographic equipment of 1 instruments.

Cable Interruptions.

	Date of Interruption
Assab—Perim	July 8, 1909
Malta—Tripoli	April 20, 1910
Latakia—Palura	May 26, 1910

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New Electric Travelling Facilities.—The British Electrical Federation, which comprises numerous tramway and electric supply undertakings in Greater London and the provinces, has been making inquiries extending over some months regarding "trackless trolley" methods of construction. The method most favoured is that known as the Bremen system (see THE ELECTRICIAN, April 28th, 1911, p. 93) which was first put into use in that city. It is hoped that in this manner improved traffic facilities may be provided in rural and extra-suburban districts, where the greater expense of laying tramway tracks would not be justified.

Electric Locomotives for the Panama Canal.—A note in "The Engineer" states that tenders have been invited for electric locomotives of a special type for service on the Panama Canal. They will run on a rack railway, and will be employed for towing vessels through the waterway. In the design formulated by the Isthmian Commission these towing locomotives are to be constructed in three sections, of which the front and rear are to be mounted on rigid four-wheel trucks, each driven by an independent motor, while the middle section is connected to the two tractive elements by universal joints, and is to be equipped with a slip-drum towing windlass and hawser, so that the line may be veered and hauled at pleasure without any motion of the locomotive along the track. The current for the operation of the locomotives will be taken from underground circuits. The maximum pull on the tow line is fixed at 25 tons, at which force a friction coupling will relieve further stress. The central racks are to be provided only on the towing tracks and inclines. On the level portion of the return tracks the locomotives will run by friction on the side rails as on an ordinary electric railway.

100,000 Volts Transmission Line in Canada.—The Canadian "Electrical News" states that work has just been commenced by the Shawinigan Water & Power Co. on the construction of an electrical transmission line from Shawinigan Falls to Montreal, a distance of about 85 miles. This line will consist of two three-phase circuits. A new receiving and distributing station is now being erected by the Company near their other east-end station at Maisonneuve. This will be the Montreal terminal of the new line. The cable will be worked at 100,000 volts and be capable of carrying the equivalent of 50,000 H.P. This load will constitute the first instalment of a contract made by the Shawinigan Company to furnish the Montreal Light, Heat & Power Co. with 60,000 H.P. The new line between Shawinigan and Montreal will follow closely the route of the Canadian Pacific Railway between those points, and for the greater part of the distance will be about 10 miles from the line built a few years ago, which lies close to the Canadian Northern Railway. The construction work will be done entirely by the Company's own staff. When this line is completed the Company will be ready to build another line to furnish the balance of the power required by the Montreal Light, Heat & Power Co.

Protecting Gas Pipes against Electrolysis.—In the correspondence columns of a recent issue of the "Electrical World" Mr. J. L. Fitzhugh describes how, after a number of experiments to protect its service pipes against electrolysis, the Laclede Gas Co., of St. Louis, is now covering its wrought-iron piping with layers of pitch and paper. This method seems to be proving successful. The wrought-iron pipe is first coated with a tar-and-pitch mixture, heated and thinned sufficiently to flow easily, and on to this a 4 in. paper ribbon is wrapped spirally, its edges overlapping. This paper covering is then tar-painted and again wrapped with paper, the process being repeated until four successive coats of tar and paper have been applied. Pieces of pipe thus insulated have been placed in the ground under conditions distinctly favourable to electrolysis, together with other lengths not so treated, and after being taken up at the end of two years the unprotected pipes were badly pitted and almost completely destroyed, while the insulated piping was virtually in the same condition as when laid. It is believed that pipes so treated will have their life at least doubled. Only service runs are being so treated, the cast-iron mains being less subject to corrosion and electrolysis than the service pipes. The tar and paper coating is very hard when cooled, and the pipe lengths need be handled with no more care than bare pipe.

Wireless Telegraphy and Aeroplanes.—At a meeting of the Royal Institution last week Mr. T. Thorne Baker delivered a lecture on this subject. The airship was, he said, easy to deal with on account of its comparatively large carrying capacity which enabled accumulators or a small dynamo to be carried for supplying electrical energy to the wireless apparatus. In the case of the aeroplane, however, weight was an all-important factor. Mr. Farman had obtained satisfactory results with his biplane by using two trailing aerials, each one consisting of rather thin wire about 100 metres in length. A similar Hertz arrangement had been applied by the lecturer (*see* THE ELECTRICIAN, March 17, 1911, p. 902) to a Bristol biplane, no loose wires being used. In receiving wireless messages on aeroplanes the chief difficulty was noise. Visible methods of receiving the wireless message had therefore to be adopted. Vibration was also a difficulty if the ordinary coherer was used, and an anti-vibration holder might be necessary. In the case of the Beta military airship wireless signals had been transmitted a distance of 50 miles. One of the most useful advances in wireless work was the conduction wireless telephone of Mr. A. W. Sharman; and remarkable possibilities were suggested by the attempt to employ the surface of water in place of the ether as a transmitting medium.

The Direct Measurement of the Attenuation and Characteristic of Telephone Lines.—The direct measurement of the attenuation and characteristic of telephone lines is a subject of the greatest interest, for all the phenomena which occur on such lines depend on these two factors. The first is a coefficient that gives the exponential law according to which the current varies during its propagation; the second is analogous to the impedance, and governs the phenomena which occur at the junction of two differently constituted lines. These two factors may be calculated from the line constants, though the lines are never homogeneous, and in consequence the theoretical formulæ are not rigorously applicable. It is, therefore, absolutely necessary to find some means of direct measurement. M. Devaux-Charbonnel, in a recent issue of "La Lumière Electrique" shows that this operation can be easily accomplished, whatever the length of the line under test, if the line be connected through an impedance exactly equal to its characteristic. In this case no reflection phenomena arise. Measuring the impedance at the sending end at once gives the characteristic, and the ratio of the sent to the received current gives the attenuation in the form of a simple exponential. This method, the author considers, should be of great use owing to the ease and precision with which it enables measurements hitherto considered difficult and inaccurate to be made.

Verband Deutscher Elektrotechniker.—The annual general meeting of this Institution began on Monday, May 29th, the meeting place this year being Munich. According to the "Elektrotechnischer Anzeiger," the president, Prof. E. Budde, after replying to the speeches of welcome made by Oberbürgermeister von Borscht, of Munich, and Prof. Schröter, delivered an address in which he referred to the development of electrotechnical work during the last twelve months. Fresh capital had been invested and the amalgamation of large firms had made further progress. The proposed tax on electricity was likely to bring in about £400,000. Heavy current work had made steady progress, while the erection of "overland" stations was being continued. The necessity for such stations would become more and more pressing as the use of the electrical plough developed. As regards transmission, pressures of 110,000 volts were already in use and even higher voltages were being considered. Street railways would celebrate their jubilee during the present year, and it was already 30 years ago since Werner Siemens had set the first electric railway to work. The use of underground railways in large towns, thus avoiding congestion in the streets, was becoming more and more extended, and the employment of electric traction for

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main-line working was also making steady headway. In conclusion, the president referred briefly to telegraphy and telephony, and mentioned the work of the International Electrotechnical Commission.

International Congress at Turin.—Further particulars in connection with the International Congress of the Applications of Electricity to be held at Turin in September have come to hand and include a list of the Papers so far arranged and the official subjects for discussion with the names of the respective reporters. In view of the support that has already been received, the Organising Committee feel sure that the Congress will prove of considerable importance to the electrical world. The final programme is to be sent to all members of the Congress who apply to the Executive Committee for it. Applications for membership and any request for information should be sent to the secretaries at the following address: Congresso di Elettricità, Politecnico, Torino, Italy.

Engineering Standards' Committee.—The Engineering Standards' Committee have just issued a copy of the "Report on British Standard Threads, Nuts and Bolt Heads for Automobile Construction" (No. 54). The sub-committee which was entrusted with the drafting of this report was a very representative one, its membership comprising delegates from the leading technical institutions and societies associated with the automobile industry. To supply the great want of interchangeability in the smaller component parts of automobiles the Committee have decided to recommend the use of the British Standard Fine (B.S.F.) Threads, but they have found it desirable to alter the pitch of the ¼ in. size from 25 to 26 threads per inch, and to introduce a new standard size of $\frac{3}{32}$ in., with 28 threads per inch. While recommending these threads for general use the Committee anticipate that there will be cases in which a special thread may be required, and here they have recommended the adoption of the Whitworth form with a uniform pitch of 16 threads per inch irrespective of the diameter. With regard to the standard nuts and bolt heads the British standard widths across the flats have been adhered to, but in order to save weight and space they are applied to a larger size of bolt. The report is published by Messrs. Crosby, Lockwood & Son, and is obtainable either from them or at the offices of the Committee at a price of 2s. 6d. net.

Hydro-Electric Power in the French Alps.—According to a statement recently made in "L'Industrie Electrique," the total capacity of the hydro-electric stations at present working in the region bounded by the Alps, the Rhone and the Mediterranean is 475,000 H.P. This region covers rather over 2,000 sq. miles and 10 departments, namely: Basses-Alpes, Hautes-Alpes, Alpes-Maritimes, Bouches du Rhône, the Sère, Savoie, Haute-Savoie, Var and Varcluse. The power is at present used in the following ways: Metallurgy 200,000 H.P., power and light 32,000 H.P., chemical products 60,000 H.P., paper and wood works 25,000 H.P., traction 10,000 H.P., and various 8,000 H.P. The minimum power at low water is at least 180,000 H.P., while the capacity of stations under construction is 80,000 H.P. and of proposed stations 600,000 H.P. The following table gives details of the various stations:—

Watersheds.	Horse-power. Minimum.	Total installed.
Dranse	600	1,100
Arol	14,000	54,880
Fier	4,000	14,760
Rhône (Jonage)	12,000	22,000
Isère	105,000	26,000
Drôme	570	670
Lez	—	90
Durance	30,500	93,000
Argens	750	3,800
Siagne	3,500	8,600
Loup	2,000	3,200
Var	4,800	8,350
Roya	150	275
Total (in round figures)	180,000	475,000

National Physical Laboratory—Collected Researches. Vol. VII.—This volume, which has recently come to hand, contains an account of numerous researches which have been carried out by members of the staff of the National Physical Laboratory. They appeared in various publications during 1910, and are as follows:—

"Some Phenomena of Magnetic Disturbances at Kew," by Dr. C. Chree, F.R.S. ("Philosophical Transactions of the Royal Society," series A, Vol. CCX, 1910); abstract in THE ELECTRICIAN, Vol. LXV., p. 607. "Discussion of Results obtained at Kew Observatory with an Elster and Geitel Electrical Dissipation Apparatus from 1907 to 1909," by Dr. C. Chree, F.R.S. ("Philosophical Magazine," September, 1910) "On the Properties of some Alloys of Copper, Aluminium and Manganese (with an Appendix on the Corrosion of Alloys of Copper and Aluminium when exposed to the Sea), being the Ninth Report to the Alloys Research Committee of the Institution of Mechanical Engineers," by Dr. W. Rosenhain and Mr. F. C. A. H. Lantsberry ("Proceedings" of the Institution of Mechanical Engineers. 1910). "Report on the Progress of the National Experimental Tank," by Dr. R. T. Glazebrook C.B., F.R.S. (The "Transactions" of the Institution of Naval Architects, Vol. LII., 1910). "On the Use of Mutual Inductometers," by Mr. A. Campbell ("Proceedings" of the Physical Society of London Vol. XXII.; also "Phil. Mag.," April, 1910; abstract in THE ELECTRICIAN, Vol. LXIV., p. 728). "Comparative Life Tests on Glow Lamps," by Messrs. C. C. Paterson and E. H. Rayner (THE ELECTRICIAN Vol. LXV., p. 983. September 9, 1910). "On a Method of Counting the Rulings of a Diffraction Grating," by Dr. G. W. C. Kaye ("Philosophical Magazine," October, 1910). "The Expansion and Thermal Hysteresis of Fused Silica," by Dr. G. W. C. Kaye ("Philosophical Magazine, October, 1910).

Current Topics.

Subjects of current interest dealt with in this issue include the following:—

Dr. R. Beattie concludes his article on "Harmonic Analysis Diagrams."

Mr. C. C. Hawkins concludes his article on "The Principle of the Static Balancer."

At a recent meeting of the National Association of British and Irish Millers, Messrs. W. Cramp and B. E. Stott read a Paper on "Flour Mill Power Schemes."

In a Paper read before the American Institute of Electrical Engineers on "Electrification Analysed and its Practical Application to Trunk Line Roads, inclusive of Freight and Passenger Operation," Mr. W. S. Murray describes the results of single-phase traction on the New Haven Railroad. The subject of electrification of trunk lines is discussed in our Leading Article.

Mr. J. Miller recently read a Paper before the Rugby Engineering Society on "Electric Power in Collieries."

A letter of some interest, from the pen of Mr. C. Pfeffer, general manager of the A.E.G. Electric Co., on the subject of German tariffs on electrical machinery and materials, appears on another page.

The rail-less trolley sections of the Leeds and Bradford tramways will be opened on Tuesday next.

Particulars are given of the R.A.C. Report on the recent trials of the "Thomas" electromechanical transmission.

A special Committee of Holborn Council have recommended the acceptance of the joint tender of the Gas Light & Coke Co. and the Metropolitan Electric Supply Co. for lighting the streets of the borough for 10 years for £7,645 per annum.

Municipal Loans.—An inquiry was held on Wednesday into the application of Stoke-on-Trent Corporation for permission to borrow £60,000 for the erection of new three-phase plant.

An inquiry was held at Manchester on Tuesday into the application of the Corporation to borrow £12,186 for additional generating plant and to divert £50,000 from a previously authorised loan for street lighting to extension of mains and services.

Walsall Council have received sanction to a loan of £14,510, and Wimbledon and Newcastle (Staffs.) Councils have applied for permission to borrow £5,970 and £54,000 respectively, for their electricity departments.

In forwarding sanction to a loan for extensions of the electricity undertaking, the Board of Trade point out the necessity for providing an adequate reserve or depreciation fund to meet renewals of plant, &c.

Parliamentary.—Further consideration of the Coal Mines Bill in a Standing Committee of the House of Commons was resumed on Wednesday, when clause 32 was added.

The Corporation of London (Bridges) Bill was re-committed on Wednesday.

A Select Committee of the House of Commons has resumed consideration of the Greater London Railway Bill.

Legal.—On Wednesday the Court of Appeal commenced hearing the cross appeals in the case of the National Telephone Co. v. the Postmaster-General in regard to the sufficiency of the notices given by the Postmaster-General rejecting certain portions of the Company's plant, &c.

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The action brought by Hartlepool Electric Tramways (Ltd.) against the Corporation of West Hartlepool in regard to the purchase by the Corporation of two of the Company's tramway routes was again before Mr. Justice Bray on Wednesday, and, after further argument, his lordship reserved judgment.

Companies' Meetings.—At the first meeting of the shareholders of the Peel-Conner Telephone Co. the chairman (Mr. Hugo Hirst) had an agreeable story to tell of the Company's progress. Mr. Hirst claimed that the outlook for the Company is excellent.

The report of the Aron Electricity Meter (Ltd.) gives particulars of the progress made during the past year. Extensions of the factories have been made in order to cope with the increased business.

The report of the Westinghouse Electric & Mfg. Co. gives particulars of the work undertaken by the Company and its subsidiaries during the year ended March 31.

OBITUARY.

J. J. Marr.—We regret to record the death of Mr. J. J. Marr, electrical engineer, which took place at Seacombe on the 11th inst. Mr. Marr, who was in his 72nd year, was born in Edinburgh. In 1868 he moved to Liverpool and entered the service of Messrs. Chadwick, ships' telegraph engineers, Bootle, subsequently joining the staff of Messrs. Edison & Swan. In 1874 he started on his own account in Moorfields, Liverpool, where he continued until his death.

PERSONAL NOTE.

We understand that Prof. D. S. Capper, though still confined to his bed, is making satisfactory progress.

APPOINTMENTS VACANT AND FILLED.

Hammersmith (London) Borough Council invite applications for the appointment of a fourth assistant engineer at the electricity works to act as junior engineer-in-charge. Salary £130, rising by annual increments of £5 to £150. Forms of application, &c., from the engineer and manager (Mr. G. G. Bell), 85, Fulham Palace-road, W., to whom applications by 10 a.m. Friday, June 30. See an advertisement.

A junior assistant electrical engineer is required by a firm of consulting engineers in Westminster. See an advertisement.

A capable engineer, with knowledge of meters and instruments, is wanted for indoor commercial work. See advertisement.

Teachers of experimental physics and chemistry are required for Government Schools, Cairo and Alexandria. Salary £369. Two years' engagement. For further particulars apply (by June 20) to Mr. J. W. Crowfoot, care of Director of Egyptian Educational Mission, 36, Victoria-street, London, S.W.

A demonstrator in electrotechnology (£100 a year) and a visiting teacher of telegraphy and telephony (one evening per week, 10s. 6d.) are required at L.C.C. Paddington Technical Institute. Application form (T. 17) can be obtained from the Education Officer, Victoria Embankment, W.C. Applications by 11 a.m. June 26.

A demonstrator in physics is required for Armstrong College, Newcastle-on-Tyne. Salary £100, rising to £120. Applications to Mr. F. H. Pruen, secretary, by June 23.

London County Council require a teacher of practical electric wiring. Form of application (T. 17) from the Education Offices. Applications by 11 a.m. June 19.

In connection with the organisation of the new department of heating and ventilating engineering at University College, London, towards which London County Council have made a grant in aid, Mr. Arthur H. Barker, B.A., B.Sc., vice-president of the Institution of Heating and Ventilating Engineers, has been appointed lecturer for the session 1911-12. Mr. E. Kilburn Scott has been appointed lecturer in electrical design for the session, in succession to Mr. H. M. Hobart resigned.

Mr. W. W. Mayne of Rutherford College, Newcastle-on-Tyne, has been appointed director of the technical schools of the Cheltenham Local Higher Education Committee at a salary of £220, rising to £250.

Mr. Stephen H. Piper, B.Sc., has been appointed assistant lecturer and demonstrator in physics at University College, Nottingham.

Mr. H. W. Turner, of the Imperial College of Science and Technology, has been appointed chief assistant lecturer in the engineering department of the Borough Polytechnic Institute.

INSTITUTIONS AND SOCIETIES.

Electrical Contractors' Association.—The annual dinner of this Association will be held on Monday, July 3rd, at Frascati's Restaurant, under the chairmanship of Mr. Geo. Harland Bowden.

Physical Society.—The meeting of this Society, previously announced to be held on Friday, June 23rd, has been postponed to Friday, June 30th, at 5 p.m., the meeting place being the Imperial College of Science.

Royal Society.—At the conversazione held on Wednesday the exhibits, generally speaking, were not of particular physical interest, or at least they were not particularly novel, as they were mostly shown at the conversazione held last month. One of the most interesting exhibits was that by Prof. S. P. Thompson, F.R.S., and Prof. E. G. Coker, and consisted of experiments with polarised light showing transparent objects in a state of strain. This method is particularly valuable as a means of showing students easily how the stresses are distributed when the object is put into a state of strain, and it is found that quantitative results can also be obtained. This exhibit also included a remarkably fine quarter wave plate of mica cut from clear sheets of mica supplied by Messrs. Wiggins, the diameter of the plate being 19 in. Sir James Dewar, F.R.S., showed how the motion of a radiometer is stopped by a very high vacuum, charcoal cooled in liquid air being used for the purpose. The limiting pressure is about one fifty-millionth of an atmosphere. Messrs. Elliott Bros. showed experiments illustrating the application of the gyrostat to the mariners' compass, and Dr. Deane Butcher showed interesting examples of osmetic growth as on the last occasion.

University of London.—At a meeting of the Senate on Wednesday last Sir Wm. Collins was elected Vice-Chancellor of the University for the year 1911-12 in succession to Prof. M. J. M. Hill, F.R.S.

Institution of Gas Engineers.—In connection with the annual conference of this institution, which was held at Glasgow this week, an exceedingly pleasing incident at the luncheon in the City Chambers, over which the Lord Provost, the Hon. A. McInnes Shaw, presided, was the presentation of a beautifully designed and mounted president's hammer and striking board sent by the German Association of Gas and Water Engineers with a letter, expressing the feeling of friendly relationship existing not only between the members of the two societies but also between the citizens of the two nations. The gift was received with great appreciation and was suitably acknowledged.

Royal Meteorological Society.—At a meeting of this society held on Wednesday June 14th, Dr. C. Chree, F.R.S., read a Paper giving the results of a discussion of the barograph records kept by the late Mr. R. Bell at Castle O'er, Dumfriesshire, during the seven years 1902 to 1908. These results show a well-marked principal maximum and minimum at 10 p.m. and 5 a.m. respectively. Every single year agrees in this except 1908, which puts the maximum at 7 a.m. The existence of a secondary maximum and minimum is unmistakable, but while the hour of occurrence of the former is clearly 11 a.m. that of the latter is less distinct. It seems to be 4 p.m., but a longer series of observations would have been necessary to confirm this. Mr. Spencer C. Russell gave an account of a number of interesting experiments which he had carried out at Epsom during the last two years in order to obtain a permanent record of the variations in the size of raindrops as and when they occurred. The most satisfactory results were obtained by using plaster of paris; slate covered with oil caused the drops to be broken when the rain was very heavy and was therefore not very suitable. A joint Paper by Dr. W. Makower and Messrs. A. J. Makower, W. M. Gregory and H. Robinson was read describing the experiments which they carried out last August at Ditcham Park, near Petersfield, in Hampshire, to investigate the electrical state of the air at different heights above the ground.

ARRANGEMENTS FOR THE WEEK.

THE LONDON ELECTRICAL ENGINEERS.

Officer Commanding, Col. H. M. Leaf.

The following orders have been issued for the coming week:—

Monday, 19th, "A" Company.—No parades.

Tuesday, 20th, "B" Company.—No parades.

Wednesday, 21st.—Detachments for the "Coronation and Royal Progress" will parade at headquarters for ceremonial drill at 7 p.m. Dress, blue clothing, drill order, with water-bottle and haversack. Special orders will be sent to each concerned.

Thursday, 22nd, "C" Company.—No parades.

Friday, 23rd, "D" Company.—No parades.

Saturday, 24th—No parades.

NOTE.—Headquarters will be closed during Coronation Week for all purposes except Coronation duty.

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ELECTRIFICATION ANALYSED, AND ITS PRACTICAL APPLICATION TO TRUNK LINE ROADS, INCLUSIVE OF FREIGHT AND PASSENGER OPERATION.*

BY W. S. MURRAY.

Summary.—The author advocates the standardisation of 11,000 volts, 25 cycles single-phase for all trunk lines. A description is given in detail of the operation of the New Haven equipment, and data as to delays, performance of locomotives, &c. The development of the present equipment and full particulars of the work now under construction are also included in the Paper.

Succinctly, the object of this Paper is to place before the practical engineer and railroad man the facts concerning trunk line electrification, and bring home to him the simple truth that it can be treated in a class of its own. I venture the opinion that there is no trunk line situation that exists to-day, but what there is a construction drawing in the New Haven engineering files that would have immediate application. The religion of the Paper is to preach the doctrine of universal use of single-phase current on trunk-line roads, inclusive of suburban and terminal territory, as applied to freight and passenger operation, and I offer for consideration the standardisation of 11,000 volts on the contact wire and a system frequency of 25 cycles. In recommending 25 cycles, the author has in mind that the future will undoubtedly see single-phase locomotive induction motors and probably single-phase current received at the terminals of the locomotive and transformed into direct current without the use of any rotating element within the locomotive.

In the generosity of his heart, the practical railroad man has looked with some commiseration, some kindness, and lately with some real interest upon those electrical engineers who are truly endeavouring, while engrossed in the principles of their own electrical art, not to forget in their studies to take into consideration the principles now of such long standing that have placed the art of steam railroading on its present sound basis. With that in mind there follows in this Paper a series of studies of a steam locomotive as it appears in its four classes on a typical trunk-line property. The whole problem of electrification, if viewed from the point of whether it is to pay, settles down to how much it costs to produce the necessary tractive effort required in (1) The passenger express locomotive; (2) the passenger local locomotive; (3) the freight road engine; (4) the freight switch engine; together with such other costs incident to the electrical system.

Steam Passenger Locomotive.—In a discussion of a Paper by Messrs. Stillwell and Putnam†, the writer presented a tabulated set of figures with reference to the fuel required for the operation of steam passenger and freight locomotives, and the yearly cost of their maintenance and repairs. He was obliged to omit, however, the actual data from which the results were obtained. A very fair express and local trunk-line service is offered in the trains of these respective classes between New Haven and New York City; and, as explained in the discussion previously referred to, a month was devoted to the study of the capacity of engines required and the coal consumed in such services over the 61·5 miles of route between New Haven and Woodlawn. In the present Paper are set out the information with reference to average cut-off, boiler pressure, water consumption, indicated horse-power and grade—all referred to stations along the route.

The averages of five tests over the route are as follows:—

Express runs.	Train 63.	Train 16.
Average weight of train with engine	328 tons	414½ tons
Time	73 min. 17 sec.	75 min. 5 sec.
Average I.H.P.	833	845·6
Average I.H.P. per ton	2·54	2·04
Water consumption per ton-mile	1·367 lb.	1·194 lb.
Local runs.		Train 284
Average weight of train with engine		294·3 tons
Time		127¼ min.
Average I.H.P.		626·8
Average I.H.P. per ton		2·13
Water consumption per ton-mile		2·034 lb.

The analysis of the steam engine under operation for trunk-line conditions incident to the New Haven road caused us to choose for our passenger unit a locomotive the normal capacity of which was 1,000 H.P. at the rim of the locomotive wheels, and this size in practice has borne out our estimate of the capacity required

Steam Freight Locomotive.—A series of tests was carried out, the runs being over a distance of 55½ miles, and in this case trains in the regular log of the New Haven operation varying in weights between 720 and 1,500 tons, including weight of engine, were used. The average of 10 tests showed the evaporation of water per pound of coal to be 6·9 lb., also the average indicated horse-power varied from a minimum of 655 to a maximum of 892, the average speed varying from 23·5 miles per hour minimum to 31·5 miles per hour maximum.

The electric locomotive we have designed to handle our general class of freight service has a normal horse-power rating of approximately 1,400 H.P. This capacity provides a margin above the requirements indicated in the tests, but is highly desirable in virtue of its affording the electriclocomotive an opportunity to operate heavier trains and at a higher schedule speed than the steam locomotive it replaces.

Fig. 1 shows the motor characteristics of our electric road freight engine "071." Not uninteresting is the flexibility offered by the electric over a steam locomotive, in noting that its limit ation of service is not absolutely confined to one class. When the same locomotive (071) made a local schedule in passenger service, handling a total weight of 500 tons, the watt-hours per ton-mile were under 60.

Steam Locomotive Switcher.—By far the most interesting investigation of the four types of steam engines employed in trunk-line service was that of the steam-switching locomotive. In the many yards of the New Haven lines none afforded a better opportunity to study this type of engine than at Harlem River, where the duty imposed upon the switching locomotive, beside that of classification, included also float work, calling into account the necessity of heavy drafts of power and sustained for periods longer than usual to other

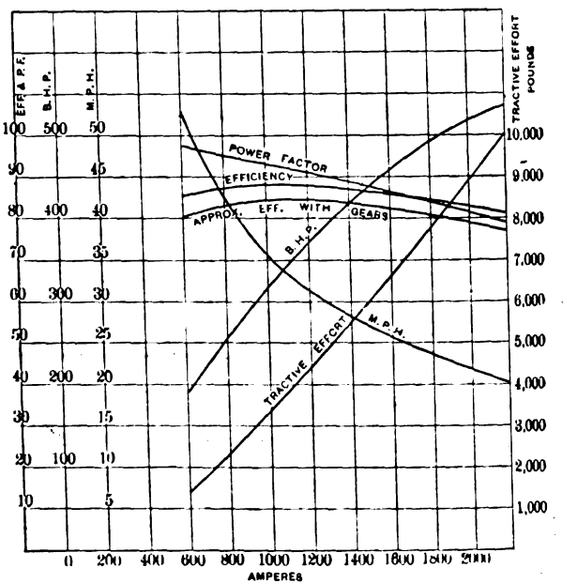

FIG. 1.—SPEED-TORQUE CHARACTERISTICS OF 25-CYCLE RAILWAY MOTOR

switching yards; but even with this additional duty to perform, th relatively small amount of energy required for this work yielded great surprise. Careful observations for 12 days of switching move ments were made on switch engine 2,392, and showed the following averages:

Total time of throttle open	.....	36·7 per cent.
Total time engine in motion	.....	62·65 per cent.
Total time engine standing	.....	37·5 per cent.
Rate of water used per hour	.....	12,633 lb.
Total water used—7·5 hours	.....	37,603 lb.

Assuming 40 lb. of water evaporated per horse-power hour, whic is probably much lower than the actual, it is seen that the averag horse-power during the time the throttle is open is approximatel 313 H.P.; but it is noted that the engine is developing power for onl 36·7 per cent. of the time, and thus the average energy develope during the hour is approximately 115 H.P.

The reduction of the energy developed by a switching engine to a average of 115 H.P. has been something of a revelation to the write and the two most important things it suggests are: (1) That i switching, yard speeds can be greatly increased by the use of an ele tric switcher of very much less engine capacity than that used in th steam switcher. (2) On account of the low average rate of energ required for their operation, a central power station will deliver at f higher efficiency the power necessary to the electric switching engin than that obtained from the power plant individual to the stea switching engine itself.

Immediate application of this statement is seen in the ratio of th pounds of coal burned to the number of horse-power hours develope which averaged 6·4. Increasing this by the coal burned during th idle hours of the engine, this ratio approximates 8. It has be demonstrated that the ratio between the coal burned for operati

* Abstract of a Paper read before the American Institute of Electrical Engineers.

† THE ELECTRICIAN, Vol. LVIII., p. 758.

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passenger trains by electric rather than steam locomotives is one to two. In the case of switching engines this rate is much greater; a figure of one to three being conservative.

Record of Single-phase Trunk Line Operation.—In the Paper entitled "The Log of the New Haven Electrification,"* there was given a table of train minute delays with their causes. Similar data covering a consecutive period of six months—one year later—are given in the present Paper. The most interesting point is the disappearance of delays, with the exception of one amounting to over 300 train minutes. The total delays for the six months' consecutive operation in 1908 were 10,373 train minutes; and for the six months' consecutive operation in 1909 the train minute delays were 2,076, or one-fifth of those for 1908.

A diagram in the Paper shows that whilst the electric locomotive failures were nine per 100,000 electric engine miles, the steam locomotive average for all the divisions of the New Haven was 21. Thus, the electric locomotive service is 133 per cent. better than the steam.

Power House.—Our experience with three-phase generators indicates that their choice, as against single-phase, is the proper one. The three-phase star winding offers at all times a spare leg in any of the generators in the event of any trouble with the two other legs, and at the same time permits simultaneous supply of current from the same generating system for the operation of either three-phase or single-phase apparatus. In the case of the Cos Cob station, this is instanced in the fact that we are supplying three-phase current for our Greenwich lighting plant and are now arranging for the supply of power for the operation of sub-stations at White Plains, Mamaroneck, Porchester, Stamford, South Norwalk and Bridgeport; in which sub-stations there will be operated motor-generator or synchronous converter outfits for the supply of direct current for railway purposes at the above-mentioned places. By the installation of copper-clad rotating fields in our generators, the unbalanced voltage between phases is reduced to a minimum, and such as remains is easily compensated for by arrangement of transformer taps in the sub-stations reducing the three-phase current from high to low voltage for motor or synchronous converter application.

Distribution System.—This is a unit system comprehending the main line of the New York, New Haven and Hartford road between Stamford and Woodlawn, the six-track Harlem River freight and passenger connection from New Rochelle to the Harlem River terminal, New York City and the New York, Westchester and Boston line running from the West Farms connection to the Harlem River branch up to White Plains, New York. Throughout this extensive area, embracing in all over 300 miles of single track, there is not a single sub-station, and no electrical pressure higher than 11,000 volts is used. Also, all of the copper installed over the tracks, just above the steel contact wire, is in the same phase, unaugmented by any feeders other than the by-pass wires installed on the lower cross-arms of the catenary posts to permit sectionalisation of anchor bridges.

Of interest, also, is the very successful control system common to all the sectionalising breakers throughout this triple arrangement of distribution, the function of which is to ensure a reliable selective action of circuit breakers to confine any line trouble to its specific locality. Briefly described, the control consists of a single wire, upon which is impressed the normal voltage of the system when a short-circuit occurs anywhere, but not until the automatic resistance at the power station has been cut in series with the line; at which moment the control wire by means of transformers passes current through the tripping coils of the sectionalising breakers, and the two breakers that are directly feeding the short circuit are immediately opened. The resistance, thus inserted, however, has reduced the short-circuiting current to a minimum and relieved greatly the duty of opening the breakers. This resistance scheme has proved itself to be a most valuable acquisition to the system, serving at once to lessen the duty on both generating and distributing apparatus.

The maximum pressure drop on the system during the 5:30 p.m. suburban load peak is such that the voltage at Harlem River station, which is 25·6 miles from Cos Cob, is 9,151 volts—entirely sufficient to maintain all passenger and freight trains on schedule.

Storage batteries for trunk line electrifications are not economical. This is true whether the propulsion current be direct or alternating. The efficiency of electric energy production is higher with than without the battery, on account of the greater constancy of load for the former conditions, but the difference is so small that it is, at least for trunk line conditions, offset by the increase of output required and the cost of maintenance of the battery. In this connection should be noted the great importance of the added freight and switching loads in improving the station load factor, due both to the exclusion of freight trains from main tracks during the hours of passenger peaks and to the latitude of operation afforded in fixing freight schedules; thus discharging the functions of a battery while escaping the penalties of battery losses and maintenance charges.

* THE ELECTRICIAN, Vol. LXII., p. 493.

Insulation.—There are points in the overhead system where the factor of insulation should be higher than at others. In the order of their higher degree of insulation requirements, I would mention: (1) Sectionalising switches; (2) Sectionalising 'bus bars; (3) Dead-end catenary insulators; (4) Intermediate catenary insulators.

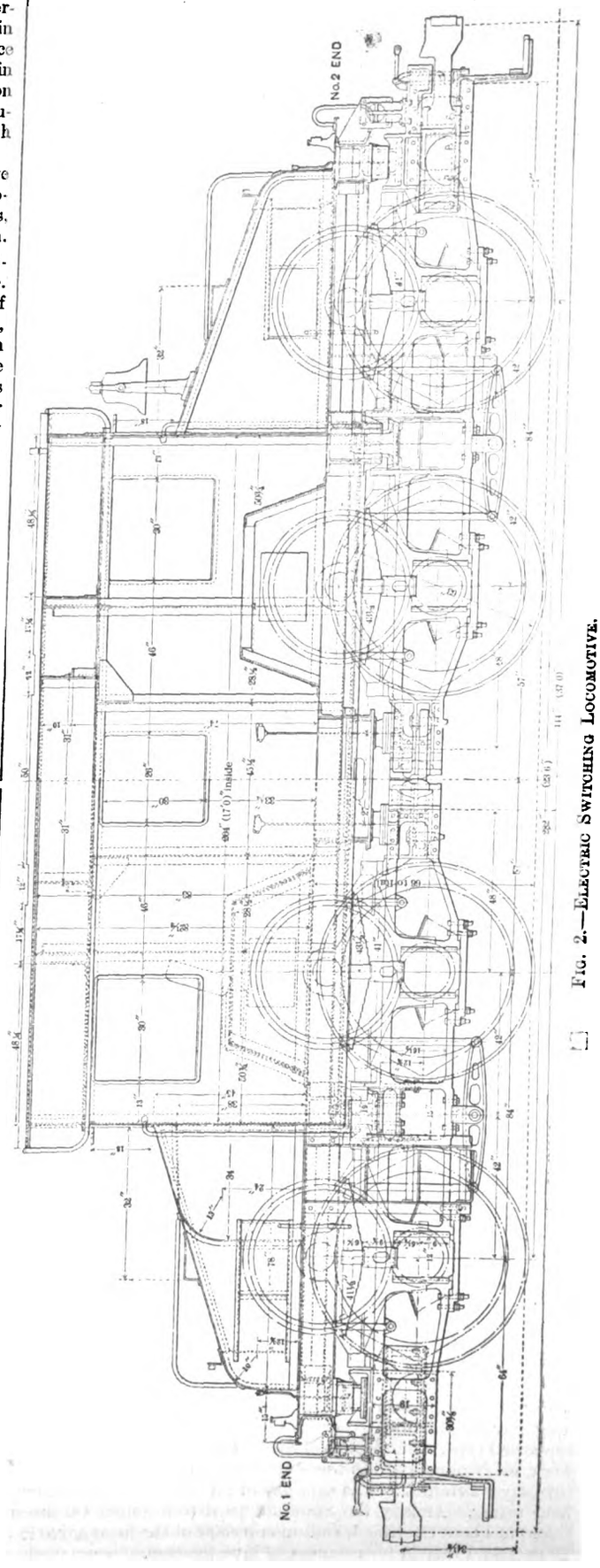

FIG. 2.—ELECTRIC SWITCHING LOCOMOTIVE.

When the New Haven electrification was completed in 1908, the best dead-end insulator then on the market was one rated at 7,000 lb. mehcanically and 40,000 volts electrically, and cost $27. We found

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in a very short time that two of these had to be used in series, which with the yoke harness made the cost $61. To-day we have placed orders for dead-end (or strain) insulators, every one of which is tested before shipment, for 110,000 volts under a mechanical strain of 35,000 lb., and they have an ultimate mechanical tensile strength of 50,000 lb. The cost is now $7 as against $61.

Steel Contact Wire.—It is difficult to place sufficient emphasis on the importance and value of the steel contact wire which was put in service on the New Haven lines in 1908. Micrometer measurements of the steel wire taken at a point of maximum wear directly in front of one of our low highway bridges where the steel wire is on a gradient of 2 per cent. show that the actual vertical wear of the wire since its first installation 30 months ago is 0·028 in., *i.e.*, practically 4·5 per cent. per year of the half diameter of the wire (one-half taken to permit wire to be held in clips). Even on this vertical diameter basis, it indicates a life of over 20 years; but as a matter of fact the life will be much more, for the reason that as the vertical diameter lessens the breadth of contact increases throughout, thus diminishing the rate of vertical wear. Of further interest, too, is the fact that there is practically no corrosion on the wire; for, like the traffic rails in service (only much more so) the wire is constantly covered by a film of grease– due to a generous amount of this material being placed on the pantagraph shoe.

It was thought, due to the coefficient of expansion of steel being less than that of copper, that the extreme variations in temperature might cause the contact wire to break; but this feature has not manifested itself. Our experience with this steel wire justifies its presence and it will be used throughout our catenary construction over the New York, New Haven and Hartford, Harlem River branch and the New York, Westchester and Boston electrification; thus serving something over 300 miles of single track.

Electric Locomotives.—In a previous Paper* there was given a list of mechanical and electrical changes that were being made in the passenger type of locomotive. The introduction of a completely cushioned locomotive (with the exception of the wheels and axis) on heavy trunk line rails was of keen interest to the maintenance-of-way department, and a careful study of its effect is being made. They have already reported a decided improvement of rail life and alignment.

The initial installation of the New Haven road provided for locomotive propulsion of all trains. During the past two years close attention has been given to the development of three other classes of equipment, namely: the multiple-unit train, the road freight engine and the switching engine. The future will see the gradual replacement of the locomotives by multiple-unit cars for suburban service, and the continued use of the locomotives thus replaced in the express service.

The electrical characteristics of the freight locomotive have been referred to in connection with Fig. 1. One of the impressive characteristics of this engine is its ability to start very heavy trailing loads, *e.g.*, 2,160 tons. This, the largest load we were able to assemble, was easily accelerated. The locomotive is of the quill-geared type, entirely spring supported (except wheels and axle), with pony wheels leading and trailing; and four propulsion motors are provided, each with a normal hourly rating of 396 H.P.

This type of locomotive is of higher power and differs from our present passenger engine in the arrangement of its apparatus, it being fitted with a central truck over super-imposed motors, with the control apparatus arranged in the middle of the cab and a full passage on each side, giving excellent light for inspection of the various items of equipment. This is a marked improvement over the previous type of locomotive, the apparatus and control of which is arranged on the sides of the locomotive with a central aisle.

Besides the above-described type of electric road engine, there is being built for the New Haven road two other types of equivalent hauling capacity; one of the side-rod design with four-motor equipment, the other having its power divided between eight motors. All these locomotives have been designed to operate both on alternating and direct current. In every instance this condition has increased weight and complicated control.

Fig. 2 gives an outline elevation drawing of our switching locomotive. This engine is coming to us as this paper goes to press. To the writer, it is the most interesting of all, though small and apparently insignificant. Like its larger brothers, it too is of the quill spring-supported type. On account of the buffing strains incidental to yard work, its framing and the assemblement of equipment is made particularly substantial. The capacity of its motors is 600 H.P. on the hour rating. Already the Stamford yard (containing 4·2 miles of track) has been electrified, and upon receipt of the locomotive it will be exercised therein for commercial investigation.

In connection with our alternating-current multiple-unit train development, we have had in operation a multiple-unit equipment consisting of four motor cars and six trailers. Again the requirement of direct-current operation has super-imposed upon this equipment the handicap of extra weight and complication of control. In spite of great strides in the simplification of the alternating-current-direct-current apparatus, the weight of the equipment is 55,405 lb., as against 47,250 lb. for a straight single-phase equipment.

Catenary Construction.—A number of drawings showing the work are reproduced in the Paper, and include the Hoosac Tunnel catenary construction. While the electrification of the tunnel and its approaches is not yet complete, it is rapidly nearing this stage.

The Hoosac Tunnel electrification is characteristic for its simplicity. In the case of its power house, two turbo-generators each of 3,000 kw. capacity are installed. Fig. 3 shows the arrangement of the supports in the tunnel. Four insulators, each capable of resisting 150,000 volts to earth, are installed on the bracket, two for each track. They are arranged in series, so as to give a combined strength of 300,000 volts. The outside insulator holds the track messenger, to which is pendent the contact wires below. Some criticism might be offered in using a 150,000-volt insulator, where 40,000 might have sufficed, but it has been forcibly impressed upon the writer that it is *good* engineering to spend money on insulation. All of the insulators purchased for the Hoosac Tunnel electrification, inclusive of the tunnel itself and its outside approaches, did not total one-half of one per cent. of the total expenditure.

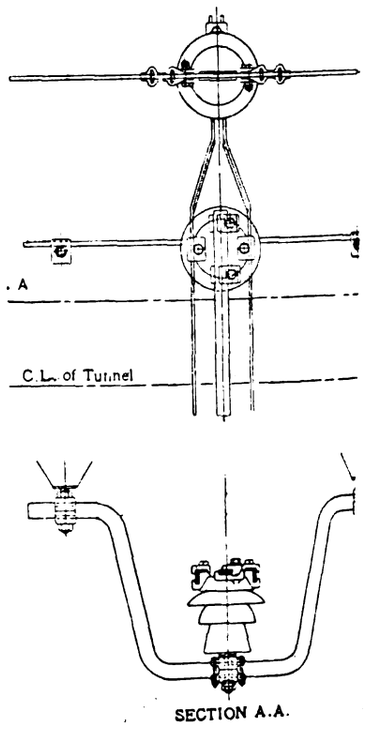

FIG. 3.—HOOSAC TUNNEL CATENARY BRACKET.

Electrification Costs.—Not until the electrical system of the New Haven road is a unit in itself rather than a mixed service of steam and electricity can its true economies of electrical traction be discussed. Suffice it to say that the two great departments of economy be in the saving of fuel and repairs to rolling equipment.

In writing this Paper I have endeavoured to avoid a discrimination between systems; I wish, however, to state very plainly that I am not at all in sympathy with the attitude on the part of some who claim some recognition in the field of railroad engineering when they suggest the advisability of not advocating any particular system of electrification. To discuss electricity v. steam without a recommendation of system in the specific cases of trunk line work, in my judgment, is to launch a ship upon a rough and windy sea without a rudder. My experience with the single-phase system v. other competitive systems, affords me the sincere conviction that, under practically all conditions of trunk line consideration where the traffic is of the same amount and character, or indeed much less than that which is comprehended in the mileage that this Paper covers, its first cost is, at the greatest, not more than 85 per cent. of its next best competitor, and its operating costs less than the above percentage.

The above statements should not be taken to mean that all trunk line railroads considering electrification can electrify and save money; indeed, its general application is prohibitive.

In conclusion, this Paper is not an argument for the single-phase system. Statistical records of the first cost and operating expense make such a course unnecessary. It has been written with the purpose of placing in the hands of those interested in the electrification of railroads the facts concerning the application of single-phase current to nearly 500 miles of trunk line property and to make a specific recommendation that for the sake of simplicity and economy it be the adopted system for other trunk line properties which the future will see electrified.

The Paper with its appendix contains 76 illustrations, including drawings of the overhead catenary construction for the New York, New Haven and Hartford Harlem River branch; the New York, Westchester and Boston Railroad; and the Hoosac Tunnel electrification.

* THE ELECTRICIAN, Vol. LXII., p. 493.

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ELECTRIC POWER IN COLLIERIES.*

BY JAS. MILLER.

On deciding to utilise electrical energy in a colliery, the engineer has to determine whether it is more economical to instal his own generating plant, or to take a supply of energy from a local power company when available. This obviously depends to a great extent on local conditions, but it is probable that in most cases it is more profitable to instal generating plant at the colliery. To begin with, coal is much cheaper at a colliery than elsewhere, and at those collieries where the coal is not used for coking purposes, and therefore generally washed, there is usually an overabundant supply of washings or smudge for which there is practically no market, and which provides a sufficiently good fuel for steam raising. These coal washings if not used at the colliery have to be stored away somewhere, and usually rent paid for the ground. This means a great saving in the coal bill of a colliery power station over that of a power company, who for the purposes of efficient steam raising have to burn coal of much better quality.

A great deal depends on the nature of the work for which the power is to be used. If the load is to consist mainly of pumping, coal-cutting and ventilation, then the load factor on the plant will probably be very high, and so the generating plant can be run very economically, but if the load consists mainly of haulage, especially of the "main" or "main and tail" type or electric winding, then the load factor may be very low indeed, possibly as low as 5 per cent., in which case the plant would necessarily be run at a very low efficiency, and thus it might possibly be cheaper to take power from some supply company when available.

The question of generating plant depends entirely upon the conditions existing at the particular colliery. Of recent years a new prime mover has become available, and is now used on a large scale at collieries. This is the exhaust steam turbine. At many collieries there is a very large quantity of exhaust steam from winding, haulage and fan engines, which, before the introduction of the exhaust steam turbine, was discharged to the atmosphere and lost. Obviously, by installing exhaust steam turbines, a great saving can be effected by utilising the energy in this steam, and it has been found that some installations of this type save their own cost after they have been running for three or four years. As the supply of exhaust steam from winding engines is intermittent, it is generally essential to instal a mixed-pressure turbine, unless there is a continuous supply of exhaust steam from some other source. Also it is necessary to instal a heat accumulator as the exhaust steam from the windings comes in rushes which, without an accumulator, would be lost through the relief valves.

The electrical side of the generating plant is, almost without exception, three-phase. The generating voltage varies between about 3,300 and 3,400, according to the requirements. Where the amount of energy to be transmitted is comparatively small and the distances not very great, it is usually found most economical to generate at about 500 volts, as the cost of transmission would be considerably less for the low voltage than for the high. Again, this saves transforming down for motors working at the coal face where high voltage cannot be used. If the amount of energy to be transmitted is large, then high-tension transmission is nearly always adopted.

With the introduction of electricity, pumping in mines has undergone a radical change. The type of pump most commonly in use for underground work is the reciprocating pump, generally of the three or four ram type. This type of pump can be made in a very compact form, and the torque on the motor is practically constant, as is also the flow of water. Again, pumps of this type can be constructed for pumping against any head. The motor generally used with this form of pump is the squirrel-cage type, as it can easily be arranged that the motor starts on light load only, a bye-pass valve being provided on the pump. This valve is opened on starting and is gradually closed as the motor speeds up. In most cases these pumps are driven direct through gearing, but in some cases belt driving is used. Another class of pump which has been used very extensively in the last few years is the turbine pump. This pump is generally placed along with the driving motor on a common base plate, and it has several distinct advantages over its rival, the reciprocating pump, viz., the space and cost are less and no heavy foundations are necessary. On the other hand where the head is very large it may be necessary to do the pumping in several stages, thus increasing the initial cost and the turbine pump is only efficient at the particular head for which it was designed.

An interesting example of the great advantage of the electrically-driven pumps over the old method of shaft pumping is to be seen at the Cowie Colliery, Stirlingshire. A steam engine was erected, operating pumps at three stages in the shaft, by means of a column of oak beams. The quantity of water pumped is 1,000 gallons per min. against a head of 340 yds. The weight of the plant is probably about 200 tons, and the initial cost, excluding boilers, was about £7,750. This plant gave great trouble, due to the breaking of pump rods and spur wheels, with a consequent great loss of time. Recently turbine pumps were installed for the same service. These pumps are arranged to pump in three stages. The bottom stage consists of a multi-stage turbo-pump direct, driven by a direct-current motor running at 1,100 revs. per min., and capable of pumping 600 gallons per min. against a head of 78 yds., and taking 80 B.H.P. The middle stage consists of a turbo-pump capable of pumping 740 gallons per min. against a head of 118 yds., when driven by a motor running at 1,000 revs. per min., and taking 86 B.H.P. The top lift pump runs at 900 revs. per min., and discharges 900 gallons per min. against a head of 144 yds., and takes 236 B.H.P. This means that the power absorbed is about 400 B.H.P., and the total cost of the plant was about £1,000, exclusive of the cost of the pipes, which were not included in the cost of the old set. When the cost of the generating plant was added to this there would still be a saving of probably £3,000, and there would be a considerable saving in the pipes as a much higher velocity would be used, hence much smaller pipes.

Another branch of pumping where the electric motor has made itself invaluable is in the driving of sinking pumps. Previously, the class of pump most commonly used was the pulsometer type. This meant running steam pipes down the shaft, with the usual trouble from leaky joints, especially as the sinking pump has to be hung in the shaft, hence a considerable amount of vibration. The pump almost invariably used where a supply of electric energy is available, is the vertical spindle turbo-type, direct coupled to a motor. This pump is hung by wire ropes from a drum on the surface, and is lowered as the shaft gets deeper, the cable for the motor being lowered at the same time. For this service a totally-enclosed motor would be almost essential, as the atmosphere is very wet.

The cutting of coal by machinery has been in operation for the last 40 years, but until a comparatively recent date it was only carried out on a very small scale. At first only direct current was used for driving coal-cutters, as it was essential for the older form of coal-cutter that the motor should be able to start up on load, that is in case the machine should be shut down on load, but at the present time there are coal-cutters which are driven by squirrel-cage induction motors, and, for the other types, induction motors with wound rotors are extensively used with great success. Current is supplied to the coal-cutter motors through flexible armoured cable wound on a drum, which is unwound to follow up the machine. A plug connector is attached to this cable which fits into a socket on the machine. This plug must be arranged with an interlocking device, so that it is impossible to remove the plug without first opening the switch, as otherwise it might be pulled out when the motor was running, thus causing a spark, and possibly an explosion if done in the presence of gas.

The motors for coal-cutters are always of the totally-enclosed flame-proof type, and the power used varies between 20 H.P. and 40 H.P. according to the size of coal-cutter used. Great care must be taken that the frame of the motor is well earthed, since there is a possibility of the motor case becoming "live," due to a breakdown in the motor, which works under very severe conditions. In some cases a protective device is installed so that the switch can only be closed if the earth connection is made, but as this device is rather complicated and delicate, it is doubtful whether it would operate well under the severe conditions existing.

There is no doubt that the judicious use of properly selected coal-cutting machinery makes possible the profitable working of the very thin seams, which could not possibly show a profit when worked by hand. An interesting example of this is shown in a Paper read by Mr. Kirkup to the Colliery Managers' Association. The seam referred to is a very hard seam of steam coal, about 26 in. thick, with a fairly bad roof. When worked by hand the underground cost of production was 5s. 1½d. per ton, while when worked by a coal-cutter the cost was reduced to 4s. 6½d. per ton, including capital charges and repairs on the cutter. This shows a clear saving of 7d. per ton, besides the fact that the value of the coal was increased enormously, due to the much larger percentage of round coal produced.

Another branch of the mining industry into which electricity enters very largely is the hauling of the coal from the inner workings to the pit bottom. The two methods generally used before underground haulage gears were installed were haulage ropes underground driven by steam gears on the surface, and haulage by horses, hundreds of which were sometimes to be found in one pit, representing a great outlay of capital. Neither of these systems was found to be economical; the first because of the enormous wear and tear on ropes and the great lengths of rope in the shaft doing no useful work, and the

*Abstract of a Paper read before the Rugby Engineering Society.

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second because of the additional cost of keeping roads at a height of at least 5 ft. to allow the horses the necessary head room.

Three types of haulage gear are used to suit the different conditions existing. These are :—*Main Rope Haulage.*—This system is adopted where the road to be worked is a single one, and where there is sufficient gradient to allow of the tubs running back by gravity. The type of motor which is used for this class of gear is the compound motor if the supply is direct current, or the slip-ring motor if alternating current is in use. The motor has always to start up against a considerable load, and it is essential that motors used for a main-rope haulage should be capable of starting up slowly, since, if the gear is started quickly, the rope and the tub couplings will be subject to severe shocks—thus the cost of maintenance would be heavy. For large gears, the maximum speed of the rope would probably be from 8 to 12 miles per hour. *Main and Tail Haulage.*—This type of gear is used frequently for fairly level loads, where the empty tubs will not run back by gravity. The arrangement is that the rope, which is run round a loose pulley at the end of the haulage road, has one end attached to the train of tubs for pulling, while the other end is attached to the back of the train, so that where there is a down gradient at any point the tubs can be retarded. Here again a considerable starting torque may be required and slip-ring motors are generally installed. Both types of haulages are frequently driven direct through gearing from the motor, but many engineers prefer belt or rope drives, which, to a great extent, absorb severe shocks on the gear, due to the tubs becoming derailed. Liquid starters are frequently used for this work, and are found to be very satisfactory, as it is possible to speed up gradually, thus reducing the shock on the rope. *Endless Haulage.*—This type of gear is used very extensively on long double roads. It is generally arranged to run at $1\frac{1}{4}$ to $2\frac{1}{2}$ miles per hour, according to circumstances, and has the great advantage over the other two systems that it provides a practically steady load all day while the other types take a very varying load. Another advantage is that with this type of gear a squirrel-cage motor may be used. This is usually arranged to drive the gear through a friction clutch, so that the motor may be run up to speed on light load only, the friction clutch being gradually tightened, and the gear started afterwards.

The following figures may serve to show the great economy which can be effected by the installation of electric haulage gears underground over the surface haulage system. The length of road is 500 yds. the haulage is of the endless type with a rope speed of $1\frac{1}{8}$ miles per hour, and the power absorbed is about 33 H.P. The total output is 300 tons per day, and the cost of working it is found to be 0·39d. per ton. Originally this road was worked by a steam haulage gear on the surface, and the working cost was found to be 1·77d. per ton. This shows a clear gain of 1·38d. per ton, which with this output means a saving of about £500 per annum. Electric locomotives are used to some considerable extent on the Continent for underground work, but there are very few in operation in this country, probably because of the stringent mines regulations existing. They are only suitable for use in roads exceeding 6 ft. in height, and, of course, can only be used in roads which are ventilated with fresh air, that is for roads near the downcast shaft, on account of the considerable amount of sparking at the collector.

HARMONIC ANALYSIS DIAGRAMS.

BY R. BEATTIE, D.Sc.

(*Concluded from page 328.*)

Accurate Determination of Higher Harmonics.—Diagrams of reciprocal-sine scales with a limited number of ordinates—say 12 for instance—cannot, of course, give the higher harmonics with the same degree of accuracy as the lower. To do this the diagrams for the higher harmonics would have to be constructed with an increased number of ordinates to correspond to the order of the harmonic sought; whilst this is in general inexpedient, it may be pointed out that by the expenditure of a little extra labour a diagram of few ordinates can always be used in such a way as to be practically equivalent to a diagram of many ordinates.

Thus, let it be desired to determine accurately the resultant 5th component by means of the 12-ordinate diagrams of Figs. 2 and 3. The curve to be analysed is supposed to be drawn on tracing paper as before, but it must now be extended to the left of the origin for a distance of at least one-twelfth the wave length. This tracing is first placed on the diagrams, Figs. 2 and 3, so that the origin coincides with S_1 or C_1 as the case may be. The intercepts are then read off on the several scales, added up, and the sum divided by half the number of ordinates, precisely as already described. Let the values so obtained for the sine and cosine components be denoted by A_5 and B_5 respectively.

The tracing of the curve is next shifted to the right, and parallel to the base, through a small distance x, where x is some aliquot part—say, one-quarter—of the distance between successive scales, so that $x = S_1S_3/48$. As before, the intercepts are read off and added, the new values thus deduced being denoted by A_5' and B_5'.

Similarly, let A_5'', B_5'' denote the respective values obtained for the sine and cosine coefficients when the tracing is shifted a total distance $2x$ to the right, and A_5''', B_5''', the values when the tracing is shifted a distance $3x$ to the right.

We have thus four independent determinations of the sine and cosine coefficients at our disposal. The corresponding resultant components deduced from these are, $\sqrt{(A_5)^2+(B_5)^2}$, $\sqrt{(A_5')^2+(B_5')^2}$, $\sqrt{(A_5'')^2+(B_5'')^2}$ and $\sqrt{(A_5''')^2+(B_5''')^2}$, respectively, the mean of which may be taken as the most probable value of the resultant component.

To deduce the phase of the resultant component, it should be observed that $\tan^{-1}(B_5/A_5)$ gives one value of this, $\tan^{-1}(B_5'/A_5')+x$* a second, $\tan^{-1}(B_5''/A_5'')+2x$ a third, and $\tan^{-1}(B_5'''/A_5''')+3x$ a fourth. The mean of these four quantities is certain to be nearer the correct value of the phase than any one of the individual determinations.

Used in this way a diagram of 12 ordinates is substantially equivalent to one of 48 ordinates.

Reciprocal-sine Curves.—A wider degree of generality, though possibly a somewhat less practical character, may be given to the diagram of reciprocal-sine scales in the following way. Imagine a large number of scales to be introduced (say, into Fig. 2, for example) each scale being graduated on the reciprocal-sine principle. Let the corresponding points of division on these scales be joined by continuous curves, the linear scales being at the same time omitted and the curves numbered instead. The loci thus obtained have the shape shown in Fig. 4, and constitute a family of "reciprocal-sine" curves corresponding to the general equation $y = \pm k/\sin n\theta$. Fig. 4† is, in fact, the graph of this equation obtained by giving the parameter k the successive values 0·2, 0·4, 0·6, &c., up to 3·8, the distance S_1S_3 being taken to represent 360 deg. and n being put equal to 2.

Obviously such a diagram can be used for the purposes of harmonic analysis in place of a diagram of reciprocal-sine scales—Fig. 4, for instance, gives the second sine component—and it has the advantage over a diagram of reciprocal-sine scales of being applicable for just as few or just as many ordinates as circumstances may demand. The curve to be analysed is first drawn on tracing paper so that the wave-length is equal to S_1S_3. The base of the curve so drawn is next divided up into any convenient number of equal parts according to the degree of accuracy required, and ordinates are erected at the middle points of the several divisions. The tracing paper carrying the curve and its ordinates is then placed on the diagram of reciprocal-sine curves, as in Fig. 4, so that its base coincides with S_1S_3, and the lengths of the various ordinates (shown dotted) are read off by help of the curves. Thus, in Fig. 4, the successive ordinates are: +0·16, +1·32, +1·85, −1·45, −2·96, −1·57, +1·00, −0·50, −1·45, +1·25, +1·50, +0·20. The algebraical sum of these, divided by half the number of ordinates, is −0·19, which is, therefore, the value of the second sine component of the curve represented. To obtain the value of the cosine component it is only necessary to shift the tracing paper parallel to the base through a distance S_1C_1 (representing 90 deg. on the scale of the second harmonic) and proceed as before. In analysing symmetrical curves, such as alternating-current wave-forms, the half-wave trace is placed on S_1S_2 to get the sine component, and on C_1C_2 to get the cosine component.

* The displacement x must be expressed in angular measure on the scale of the 5th harmonic; thus, in degrees, $x = 5 \times 360/48$.

† For preparing Fig. 4 I am indebted to Mr. Harold Gerrard, M.Sc.

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Whilst being a distinct improvement from the point of view of general adaptability, diagrams of reciprocal-sine curves are, it must be admitted, inferior to diagrams of reciprocal-sine scales in most other respects. They are more troublesome to construct, less easy to read, and to be accurate the diagrams must contain so many curves that they become overcrowded to an impracticable degree, more especially the diagrams for the higher harmonics. As an aid to analysis, the use of diagrams of reciprocal-sine curves can hardly be recommended therefore. It is hoped, however, that a set of diagrams of reciprocal-sine and reciprocal-cosine scales may prove of some general utility as a simple kind of harmonic analyser when the services of one of the more elaborate forms of mechanical analysers are not available.

Modified Diagrams of Reciprocal-sine Scales.—Certain modifications of the reciprocal-sine diagrams will probably suggest themselves to the reader. Thus we might wish to render the diagrams applicable when the function y is not in the first instance obtained as a continuous curve, but only the numerical values of the function at a number of regular intervals throughout the period are given. To save the labour of actually plotting the graph of y from these numbers we might employ a diagram like Fig. 5. This is a combination of Figs. 1 and 2, each ordinate being provided on one side with graduations on the reciprocal-sine (or reciprocal-cosine) principle, and on the other side with a normal scale. To illustrate the method of using this composite type of diagram, suppose that the successive mean monthly values of a certain variable with a yearly period are, +3·4, +4·1, +3·3, +1·1, +1·8, +3·0, +3·8, +3·6, +2·7, +1·5, +1·7, +3·2. Then we have only to read off these respective values on the right-hand scales of the first, second, third, &c., ordinates of Fig. 5 (reckoning from S_1 to S_3), and note at the same time the corresponding readings on the left-hand scales, viz., +3·81, +2·95, +0·87, +0·30, −1·29, +2·88, −3·68, +2·64, −0·70, −0·40, +1·20, −3·10. The sum of these latter numbers when divided by 6 gives −0·18, which is therefore the value of the fifth sine component of the variable under consideration.

Sine-scale Diagrams.—Another possible construction for a harmonic analysis diagram may also be mentioned, in which the unit of a vertical scale at a distance θ from the origin instead of being made equal to $\pm 1/\sin n\theta$ (or $\pm 1/\cos n\theta$) is made equal to $\pm \sin n\theta$ (or $\pm \cos n\theta$). A diagram of this kind—such as that shown in Fig. 6, which represents a "sine scale" diagram for determining the fundamental sine component—is evidently adapted for use in conjunction with a planimeter. Thus, take a wave-form whose true shape as ordinarily drawn in rectangular co-ordinates is that of the curve in Fig. 1. To prepare this curve for analysis it must be re-drawn on the diagram of Fig. 6, when it becomes distorted in the manner shown. If we now measure the area of the closed loop $S_1LS_2MS_3S_2S_1$ by means of a planimeter and divide by half the base-length of the diagram, the quotient obtained is clearly equal to twice the mean value of $y \sin\theta$, and is, therefore, the required coefficient of the fundamental sine component.

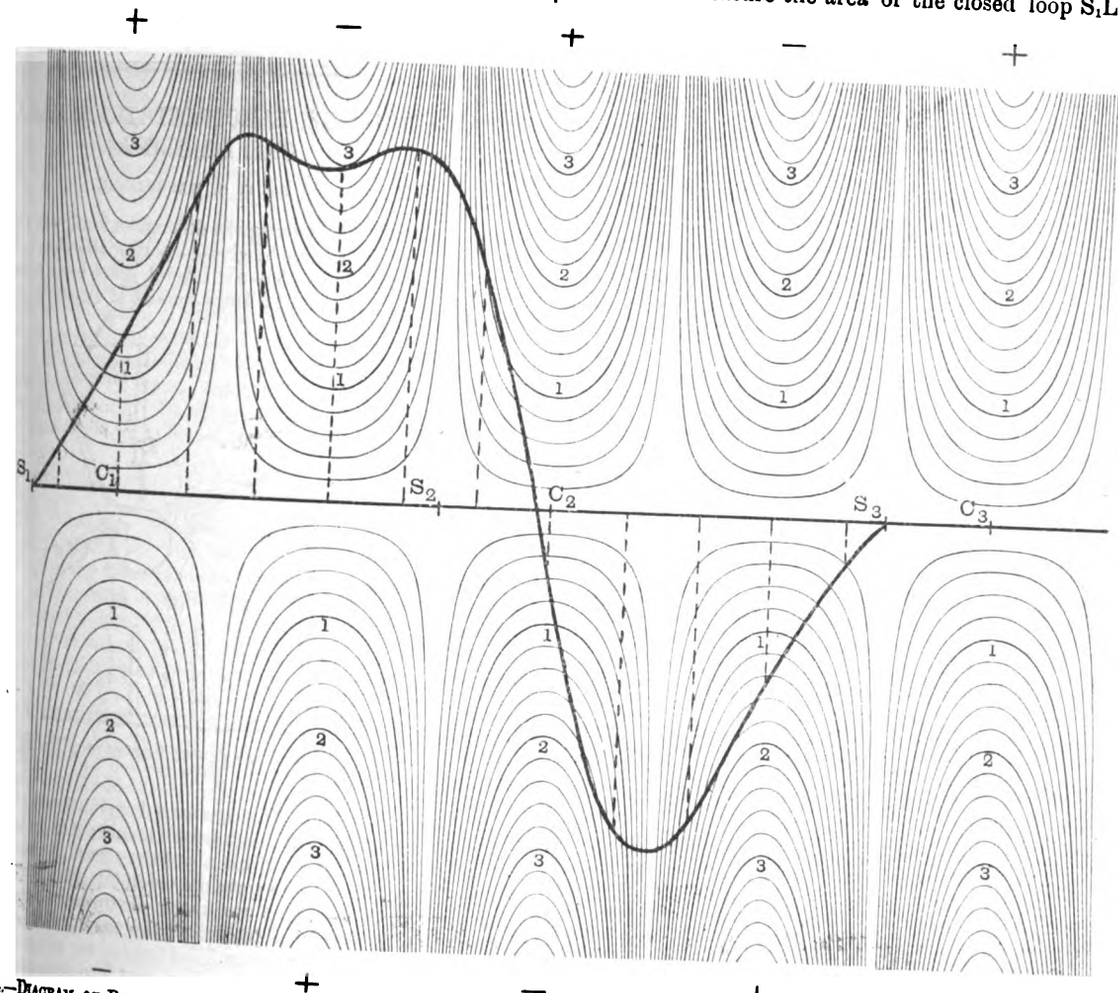

Fig. 4.—Diagram of Reciprocal-sine Curves for Determining the Coefficients of the Fifth Sine and Fifth Cosine Terms.

This type of harmonic analysis diagram has been referred to, not because it is likely to prove more useful than diagrams like Figs. 2 and 3, but because it is the complementary construction to that employed by Slichter,* whose diagram consists of a series of vertical ordinates normally divided but spaced at irregular intervals, the distance between any two consecutive ordinates at a mean distance θ from the origin being made proportional to $\sin\theta$. Both Slichter's method and that requiring the use of diagrams like Fig. 6 are tedious, however, because they involve the re-drawing of the curve to be analysed just as often as there are components to be determined. Hence, although the sine-scale diagram can be made to yield results of con-

* *Loc. cit.*

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siderable accuracy, the time required in using it is likely to militate against its general adoption. For this reason it has been given no more than a passing mention, and it is left to the ingenuity of the interested reader to work out for himself the

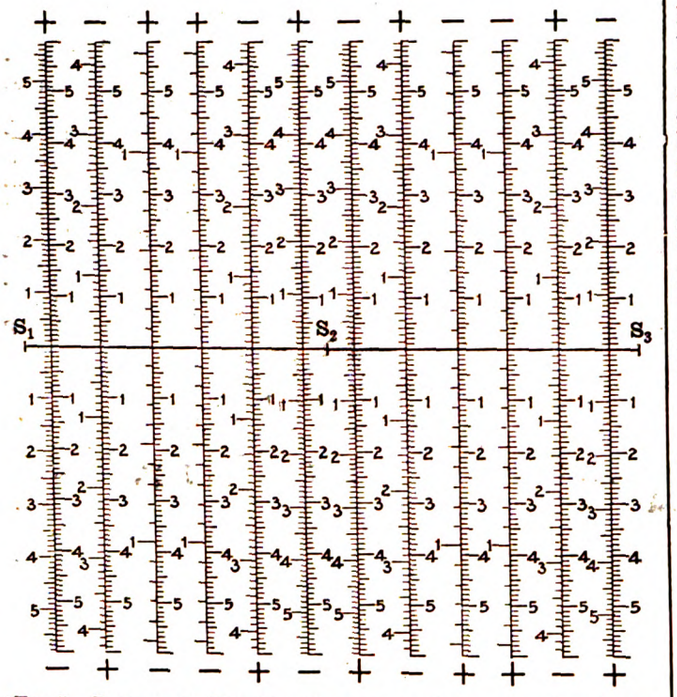

FIG. 5.—DIAGRAM OF COMBINED UNIFORM AND RECIPROCAL SINE SCALES FOR DETERMINING THE COEFFICIENT OF THE FIFTH SINE TERM.

The attached signs refer to the left-hand scales; the right-hand scales are to be taken as positive above the base line and negative below.

details of the various adaptations of which the diagram is capable. It will be seen at once, for example, that it is unnecessary to employ the complete diagram as drawn in Fig. 6.

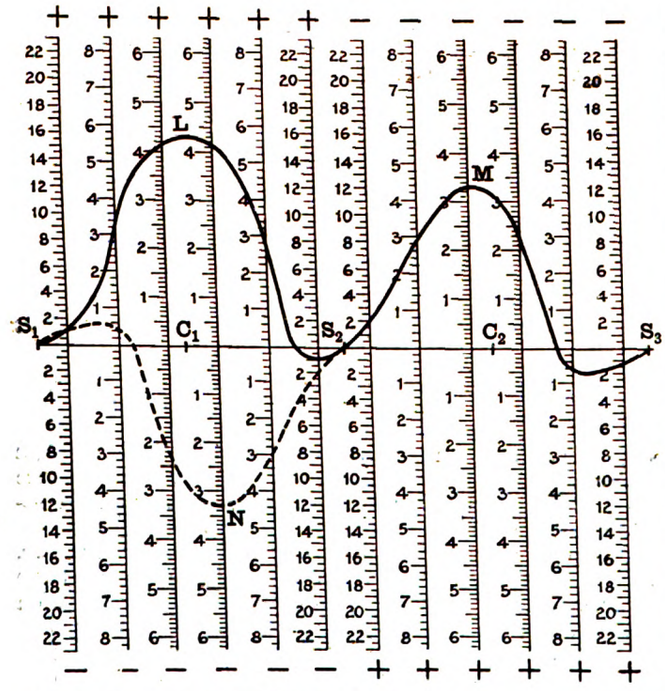

FIG. 6.—DIAGRAM OF SINE SCALES FOR DETERMINING THE COEFFICIENT OF THE FUNDAMENTAL SINE TERM.

For if we employ the first half of the diagram only, and plot on this the first half of the curve to be analysed, going forward from left to right, and the remaining half of the curve coming backward from right to left, then the result of carrying the tracing point of the planimeter round $S_1LS_2NS_1$ (the closed loop obtained by this method of plotting) is the same as carrying it round $S_1LS_2MS_3S_2S_1$.

Further, the half diagram S_1S_2, Fig. 6, suffices for any given higher sine harmonic as well as for the fundamental. Thus, if we wish to obtain, say, the 3rd sine component, let the base of the curve to be analysed be divided up into 6 equal parts, and let the first section of the curve be plotted on the half-diagram S_1S_2 from left to right, the second section of the curve being plotted backwards from right to left, the third section from left to right, and so on. The reading of the planimeter after it has been carried round the closed curve thus traced gives, when divided by three times the length of the base S_1S_2, the required 3rd sine component. The corresponding 3rd cosine component is found by using the part of the diagram lying between C_1 and C_2 instead of that lying between S_1 and S_2.

It is instructive to compare a diagram of sine-scales employed in this way with the Clifford-Perry,* Clifford-Finsterwalder† and Wedmore‡ diagrams.

APPLICATIONS OF ELECTROSTATIC SEPARATION TO ORE DRESSING.§

BY F. S. MACGREGOR.

The possibility of utilising the differences in the electrical conductivity of various minerals by giving a part or all of the particles of ore an electrostatic charge has for several years been recognised as a means of separation, and a large amount of experimenting has been

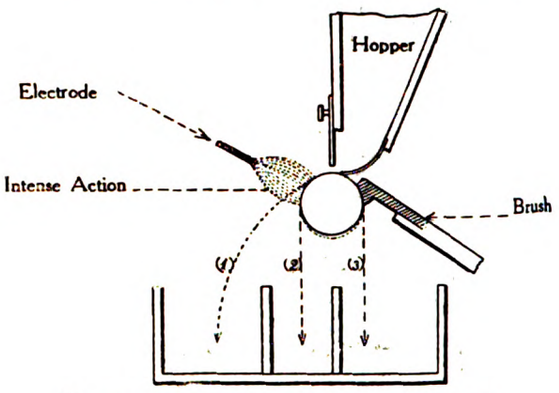

DIAGRAM OF ELECTRICAL SEPARATING MACHINE.

done along this line. The commercial application of the art of ele trostatic separation has been tried a number of times within the la decade, but until only within about three years has success attend the efforts. Two factors contributed to this want of success—a la of the proper means of continuous electrification, and a practic machine and system of treatment designed to meet the rigorous r quirements of mill operation.

Several types of separators have now been perfected, and in th Paper is described a means of electrification which has been a co mercial success from its first installation.

The type of machine employed is shown in the accompanyi diagram. It consists of a series of separating electrodes placed c above the other. The frame is cast-iron, built in sections, with t electrodes to each section, which facilitates easy shipment and a flexibility in the number of treatments which can be given the c A three-section machine (the usual type) is 6 ft. high, 6 ft. 6 in. l and 18 in. wide. A feed hopper on the top distributes the ore acr the first electrode, and it passes by gravity to each succeeding o The mineral particles receive their charge while passing throug concentrated static field formed by two electrodes—one an earth rotated shaft, and the other an insulated metal rod. The elect static charging of the electrodes is accomplished by a special e trical apparatus (using commercial dynamos and transforme which gives either a continuous and steady potential of several th

* Perry, THE ELECTRICIAN, XXXV., p. 285, 1895.
† Finsterwalder, "Zeitschr. Math. Phys.," XLIII., p. 85, 1898.
‡ Wedmore, "Jour." Inst. Elec. Engineers, XXV., p. 234, 1896.
§ Abstract of a Paper read before the American Electrochem Society.

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sand volts, or an intermittent charge of great regularity. The strength of the field can be altered at will, according to the conductivities of various ores treated. The figure shows the scheme of separation, the dotted lines indicating the path of the conductors and non-conductors.

The separating plant at Platteville was started in March, 1908, and was the first plant to be equipped with Huff separators. Although originally built as an experimental plant, it has been in practically continuous operation since then, and is used to separate, without roasting, the iron pyrites from the zinc blende, which occur together in varying proportions in south-western Wisconsin. The ores are milled in ordinary jigs and the lead and lime rock removed. Owing to the nearness in specific gravity of the blende and pyrites, they are recovered in the jigs as middlings, containing from 10 to 45 per cent. zinc, according to the grade of the crude ore, the remainder being iron and the sulphur in combination. Iron above a few per cent. interferes with the smelting of the blende, and the function of this plant is to remove this impurity, making the low-grade ores into high-grade smelting ores.

The plant consists of a wooden frame building, 30 ft. by 40 ft., and three stories high. On the first floor are the bins for collecting the finished products as they are delivered from the separators. The second and third floors are separator floors, and in the tower is located the screening system. A spur railroad track runs on either side of the mill, one for cars of raw ore, allowing them to be unloaded either directly into the mill or into storage bins across the track. The other track, which is below the mill level, permits at the same time the loading of empty cars with finished products.

The course of the ore through the plant is as follows: It is shovelled into a wheel-barrow in the freight car, wheeled to scales and weighed, then dumped into the feed hopper of the dryer. The top of this hopper is on a level with the car floors to facilitate the easy handling of the ore, and at the bottom of this hopper is an adjustable plunger feeder. The dryer is of the cylindrical type, and the shell is 16 ft. long and 30 in. in diameter, rotating about 4½ revs. per min. Being set at a slight pitch, the ore travels gradually to the discharge end, where it emerges bone dry. As the separation depends on the difference in conductivity of the minerals, it is necessary that all moisture should be removed.

A short drag conveyor carries the dried ore to the foot of a bucket elevator, which raises it to the top of the tower and discharges it into a set of screens. There are four giving an oversize, and four other sizes, called A, B, C and D. The oversize passes through a short trommel to remove any foreign materials, and is spouted to the first roll to a set of rolls, which crush it and deliver it to the boot of the elevator carrying the original feed.

The location of the screens in a tower permits the different sizes to flow by gravity through an iron pipe 2 in. diameter to the top machine floor. On this floor are placed the rougher machines, where the ore is given a rough split, that is, two products are made, one a product higher in zinc than the original feed, and the other higher in iron. Thus, no matter what the grade of the feed to the mill may be (and it varies within wide limits), a fairly uniform mixture is sent to the finishing machines on the floor below.

These finishing machines give the final cleaning to the ore, one set giving a finished iron product, and the other a finished zinc product. The middlings from these cleaners return by gravity to the boot of the elevator and mix with the fresh ore, so that no ore leaves the system that is not separated into its proper grades of product. The finished zinc product and finished iron product fall into separate bins on the first floor. These bins are V-bottomed, and constructed of two thicknesses of wood flooring with heavy building paper between. They are elevated from the floor so that they may conveniently be drawn off into a 1,600 lb. capacity push-car for loading. The car is then wheeled to a small elevator and dumped into a hopper on the floor level. This feeds the ore into the boot of a small elevator, which discharges either into a freight car by means of a goose-neck spout, or may be allowed to discharge to a second elevator in the storage bins. From these bins a car may be loaded whenever convenient.

Two products of marketable value are obtained: the iron pyrites, heretofore valueless in these Wisconsin ores, is sold for its sulphur content, and by reason of its free-burning qualities, makes a very desirable product for the acid manufacturer; and a zinc product which, of course, sold for spelter. The pyrite is sold by contract, but the blende is sold to the smelters on the open market. With a penalty for excess of iron or lead it is evidently necessary for such a plant to turn out consistently high-grade products in order to command a satisfactory market price.

As a result of the excellent showing of this electrostatic plant, the United States Smelting, Mining and Refining Co. decided to put in a plant at their works at Midvale, Utah. The function of an electrostatic plant there is different from that in Platteville, for the ore from the mine of the United States Company at Bingham, Utah, contains about 9 per cent. of zinc in addition to the gold, silver and lead values. This ore is shipped to the concentrator at Midvale, where it is crushed and milled by the usual methods of jigs and tables. In this concentration there were formerly two products, one a lead-pyrite product carrying the iron and considerable zinc, and a tailings carrying zinc and some gold and silver values, the object being to keep the zinc as low as possible in the lead concentrate, and yet at the same time make the maximum recovery of the gold, silver, lead and copper values. The zinc added materially to the difficulty and cost of smelting the lead concentrates, and, at the same time, was a total loss. In order to recover this zinc, three products were made in the concentrator, lead-pyrites carrying practically no zinc, tailings free from zinc, and middlings containing about 22 per cent. zinc, the balance pyrite and some copper, lead, gold and silver.

To treat these middlings, an electrostatic plant was built near the concentrator as shown. It is a wooden frame building, 40 ft. by 40ft., and covered with corrugated sheet-iron. In general plan it is the same as the Platteville plant—finished ore bins on the ground floors, and two floors of separators. The method of handling the ore is somewhat different. The middlings are shovelled from the table hutches in the wet concentrator into tramcars, which are pushed by hand to the platform elevator at the electrostatic plant. The cars are raised to the third floor level, and, after weighing, are dumped into a 40-ton hopper. This is built over the dryer, and feeds automatically. After drying, the ore is screened. The oversize is small in amount and very low in zinc, so instead of re-crushing, it is put directly into the finished pyrites. The three sizes are separated, and the products drawn from the bins on the first floor into tramcars. These are run out of the mill to the loading trestle and dumped into freight cars. The pyrite product is smelted near by, and the zinc product is shipped to the Kansas zinc smelters.

The plant is electrically-driven by a 20 H.P. motor, the 15 Huff separators requiring about ⅓ H.P. each. The generating apparatus for the electrostatic field is located in a small room on the finishing floor. A 3 H.P. motor is direct-coupled to a generator, and the strength of field is controlled from a small switchboard. This electrostatic plant not only removes the objectionable zinc from the lead-pyrites concentrate, but makes it a marketable product, and, instead of being a total loss, it is made to produce a profit. The electrostatic process in these two plants demonstrates two applications in ore dressing, one the custom plant making low-grade ores profitable, and the other as an adjunct to a wet concentrator for the recovery of zinc. Besides these plants, there is being installed in Nevada a plant working on crude silver ores, wherein the ore goes through no concentrating machinery prior to its electrostatic treatment.

EXPERIMENTS IN IMPACT EXCITATION.*

BY G. W. NASMYTH.

Summary.—In the first section of this article the author shows that the Lepel arc has a falling characteristic much steeper than those of the Duddell and Poulsen arcs and operates on smaller currents. By plotting P.D. against arc length a resonance phenomenon was suggested, and the maxima observed in the voltage were found to be due indirectly to the changing capacity of the arc itself, being caused by corresponding minima in the oscillations produced by the arc. In the succeeding sections, on the intensity and frequency of the oscillations, it is shown that the minima in the oscillations occur at larger values of the direct current through the arc as the capacity in the shunt circuit is increased or the inductance diminished, and that the intensity of the oscillations increases. It is also shown that the frequency of the oscillations increases with the arc current and decreases with the arc length, and that the formula derived by the author for the frequency of the singing arc holds true also for the frequency of the oscillations produced by the new short arcs between metal electrodes.

The Characteristics of Short Arcs between Metal Electrodes.

The author first reviews briefly the history of "impact excitation" since October, 1906, when Wien published a short account of his experiments. In the same year Lepel† began his work on the discharge between metal electrodes. By September, 1907, Lepel's apparatus had been so perfected that he was able to transmit mes-

* Abstract of three articles in the "Physical Review."

† The best descriptions of Baron von Lepel's system and apparatus are to be found in THE ELECTRICIAN (London), Vol. LXIII., pp. 142, 157, 174, 345, 376, 1909; Vol. LXIV., pp. 153, 386, 1909-10. Abstracts from his German patent No. 24,757, filed August 20, 1907, are given in Vol. LXIII., p. 374, 1909.

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sages and musical tones from Slough to Scheveningen, 160 miles, using an E.M.F. of 440 volts and 1·5 amperes of direct current.

The first public announcement of any of the short spark methods of generating oscillations was made by von Arco* in April, 1909. The Telefunken Co. had experimented with Lepel's apparatus early in 1907, but finding it unsatisfactory in its form at that time proceeded to develop its own system. Recently Prof. W. Peukert† has announced the invention of a short spark generator in 1906, for which a patent application was filed February, 1907, prior to either the Lepel or Telefunken Co. applications.

These three short spark generators constitute the chief means at present available for producing high-frequency oscillations of the impact excitation type. In principle the three spark generators have much in common, and experiments and theory dealing with any one will have a measure of value for each of the others. The author's experiments have been made on the Lepel generator. This is the simplest of the three, since it uses direct current instead of alternating, as in the case of the Telefunken generator, and it has no moving parts, as in the case of Peukert's apparatus.

Arc or Spark.—The discharge between the electrodes of all three generators is intermediate in character between the ordinary arc and spark discharges, and in the absence of exact definitions for the two terms it is difficult to decide in which class they should be placed. From the arc point of view, Lepel's generator is a direct-current arc between metal electrodes, the Telefunken arrangement is an alternating-current arc, and Peukert's generator is an arc between relatively rotating electrodes. But in general, when the capacity circuit is connected, the discharge of all three generators becomes discontinuous, and corresponds to a spark-gap. This condition also arises in the Poulsen arc, although to a less extent. Von Arco has suggested the following definitions: "By arc excitation one might understand that method of producing oscillations by which the rate of condenser discharges is equal to or about the frequency of the oscillations; by spark excitations, that method by which this rate is considerably less." This definition makes the type of discharge depend upon the constants of the circuit, and the same generator might be an arc or a spark-gap under different conditions. The author's experiments on the Lepel generator have demonstrated that in many of its general characteristics it bears a marked simi-

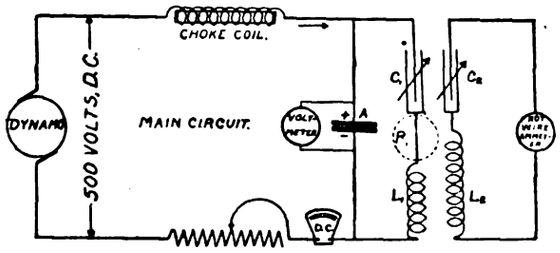

FIG. 1.—DIAGRAM OF CONNECTIONS.

larity to the Poulsen arc, and for the present it will be called an arc whenever the applied voltage would be sufficient to maintain the current through the gap if the condenser circuit were disconnected.

Besides the familiar damped discharge of the ordinary spark-gap, three distinct types of arc oscillations have been recognised quite generally by investigators in this field. For convenience the author has named these types after the experimenters who first produced them—viz., Duddell, Poulsen and Wien. The characteristic of the first class of oscillations is that the maximum value of the condenser current is less than that of the direct current through the arc, so that the arc remains lighted. In the second the maximum value of the condenser current is greater than that of the direct current through the arc, so that the arc is extinguished and re-lighted at each oscillation, whilst in the Wien oscillations the maximum value of the condenser current is so great that the arc is not only extinguished, but is re-lighted in the opposite sense. It is with these oscillations that this investigation is chiefly concerned.

Arrangement of Experimental Apparatus.—In the author's experiments on the Lepel arc the arrangement of apparatus is shown in Fig. 1. The source of E.M.F. was a 500-volt shunt-wound dynamo, direct connected to a two-phase 900 revs. per min. induction motor. A large water rheostat made from an old oil barrel, together with two Cutler-Hammer rheostats arranged for connection in series or parallel, each having a maximum resistance of 200 ohms and a current capacity of 1·5 to 2·5 amperes, constituted the resistance in the circuit. The choke coils were two solenoids, each of 0·0296 henry. In the condenser circuit a variable number of Leyden jars, having a capacity of 0·00188 mfd. each, were connected in parallel. A Weston direct-current voltmeter of the d'Arsonval galvanometer type, with a 600-volt and 150-volt scales, was connected across the arc, and a Weston millivoltmeter, with a 5-ampere shunt, was connected in series with the main circuit, as shown. The intensity of the oscillations was measured by an unshunted hot-wire ammeter containing no iron and giving a maximum deflection at 7 amperes of direct current. The position of the ammeter when used for measuring the oscillations is shown by the dotted circle in the primary circuit.

After experimenting with various forms of the Lepel apparatus, it was found that with flat copper plates water cooling of the electrodes was unnecessary, as the radiation to the air was large, and the generator seemed to work better, if anything, as it became heated by the discharge. The author's first experiments were made with brass and copper plates. The results obtained when either metal was used as cathode were fairly satisfactory, but the pitting of the brass plate, due possibly to the volatilisation of the zinc, was found to be a source of great annoyance and to make the oscillations inconstant by changing the arc length. Two electrodes of sheet

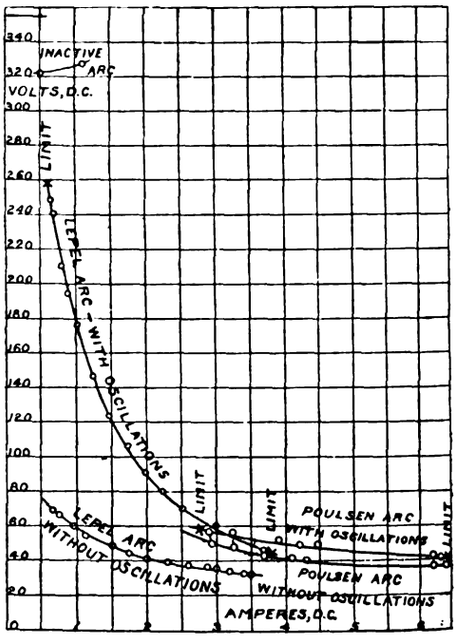

FIG. 2.—COMPARISON OF LEPEL AND POULSEN ARC CHARACTERISTICS.

copper ¼ in. thick and 6 in. in diameter were then obtained. These were carefully surfaced in a lathe with a sharp tool set at an acute angle, and were then rubbed with sandpaper and oil. The connecting wires were at first soldered to the copper plates, but after they had been melted off two or three times they were fastened to screws set into the edges of the plates. These electrodes were found very satisfactory. The oscillations are more irregular when the surfaces of the electrodes have been rubbed with emery cloth than when oil and a sandpaper block are used. On the other hand, the vapour of the oil (ordinary machine lubricating oil was used) seemed to have a marked effect in steadying the arc conditions.

Very good electrodes may be made from the hard rolled copper plate used in the photo-engraving processes. The surface of this copper is very smooth and flat, and it holds its shape well on account of its hardness. If this copper sheeting is used, it is unnecessary to turn the plates to a flat surface in a lathe. The plates need only be rubbed with fine pumice stone and oil, and then with a piece of wood carbon and oil, and the surface is almost perfect. Contact with the connecting wires may be made by means of a piece of tinfoil held down by a small weight.

Any kind of paper seems to work well as an insulator and as a source, when disintegrated by the discharge, of the hydrogen and carbon atmosphere which the arc requires for satisfactory working. For the sake of uniformity in conditions, W.S. & B. Paragon typewriter paper in legal size sheets was used in all the quantitative experiments. In thickness this paper is very closely 0·05 mm. per sheet. Mica rings were tried without success, as the discharge occurred either at the edge of the mica, or, if this were prevented by cutting a sufficiently deep groove in the plates, the discharge took

* THE ELECTRICIAN, Vol. LXIII., p. 89. See also pp. 332, 370, 461 and 720. For the relation and comparison of the Lepel and Arco systems, see also Vol. LXIII., pp. 228, 325, 617, 661; Vol. LXIV., pp. 726, 768 and 947.

† THE ELECTRICIAN, Vol. LXIV., p. 361. See also p. 550.

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place through the mica instead of across the air-gap. To start the arc various devices may be used, the most convenient one being to short-circuit the arc and then suddenly break the short-circuit with an oil switch, thus bringing the full pressure of the inductive kick of the choke coils to bear on the gap. If the edge of the hole in the paper has been charred, by a match or some other means, the discharge will start as soon as the P.D. is applied.

As in the case of the Poulsen arc, the Lepel generator may be made to give increased power by connecting several arcs in series. By starting the arcs one at a time separately and then connecting them together in series the author has been able to make as many as three arcs run on 500 volts impressed E.M.F. This was only possible at relatively large currents, however. A better way to obtain increased power at a given impressed E.M.F. is to connect two arcs in parallel, each with its own choke coil and resistance in series.

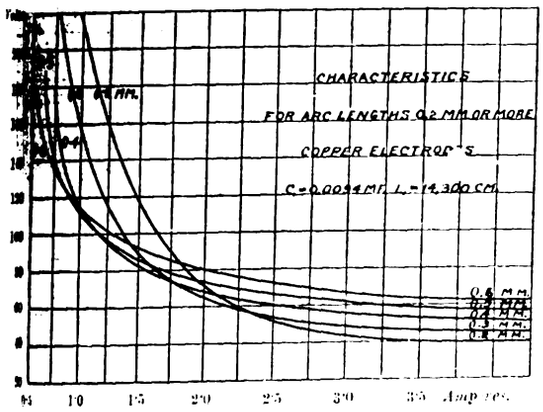

FIG. 3.

The method of generating oscillations by connecting arcs in parallel in this way was discovered by the author in 1907, set forth under the title "An Improved Form of the Duddell Singing Arc."* Later the attention of the author was called by Mr. Duddell† to a lecture given in England before the Institution of Electrical Engineers, in which practically the same principle had been used. The author had overlooked the reference to the earlier work, and is glad to take this opportunity of acknowledging the priority of Duddell in discovering the method of generating oscillations by connecting arcs in parallel.

The characteristic Lepel curve for an arc length of 0·15 mm. when the arc is generating oscillations is shown in Fig. 2. For currents much larger than 4 amperes the arc becomes inactive and the oscillations cease, probably on account of the flatness of the curve for large currents. For currents less than 0·7 ampere it is difficult to obtain steady conditions on account of the steepness of the curve. The readings of the direct-current instruments are, of course, average or integrated values.

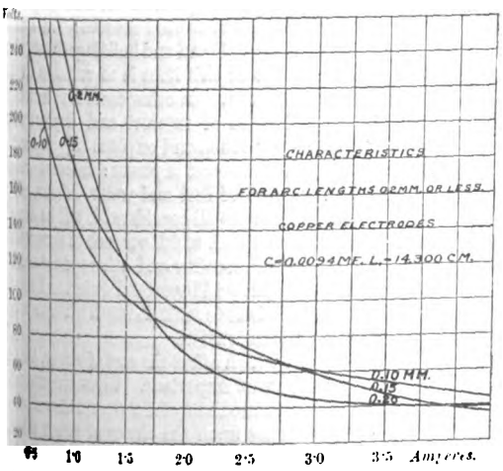

FIG. 4.—LEPEL ARC CHARACTERISTICS FOR DIFFERENT ARC LENGTHS.

The relation of the Lepel arc characteristics to those of the Poulsen arc are also shown in Fig. 2. The lower curve for the Lepel arc gives the corresponding characteristic when the condenser circuit is disconnected. One reason for the greater effectiveness of the Lepel arc is due to the steepness of the characteristic in the region of small currents in which it operates. Even at larger currents, however, the Lepel characteristic seems to be much steeper than that for the Poulsen arc. The separation of the two curves is also seen to be much greater than that for the Poulsen arc. The product of the difference of the voltages of the two characteristics by the corresponding amperes may be taken as a measure of the power converted into oscillations. Since the characteristic "without oscillations" varies but little for the different arc lengths, a comparison of the characteristics "with oscillations" will furnish a means of finding the arc length and current which will transform most power into oscillations and give the greater efficiency. It was found that with the author's apparatus the maximum power and efficiency are obtained at an arc length of 0·2 mm. and with a current between 1·0 and 1·5 amperes.

In attempting to find the change in the characteristic curve when the arc length was varied, apparently discordant results were obtained. For large currents the voltage increased with increasing arc length, as in the case of the Poulsen arc, but for small currents the voltage sometimes increased and sometimes decreased with increase of arc length. It was then decided to make a systematic exploration of the whole characteristic field, taking a hundred or more observations at each arc length under different conditions and at different times, and drawing a smooth curve through the observations. The results of these experiments are shown in Figs. 3 and 4, representing more than a thousand single observations. It is evident from these curves that for small currents (*e.g.*, 1 ampere) as

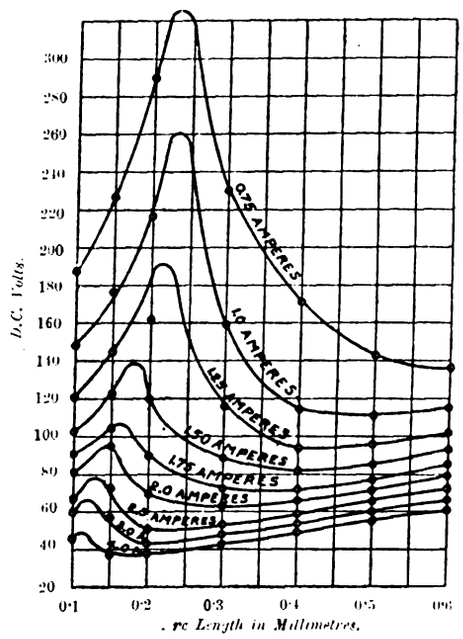

FIG. 5.—P.D. ACROSS ARC FOR CONSTANT CURRENT AND VARYING ARC LENGTH.

the arc length is increased from 0·1 mm. to 0·2 mm. the voltage increases; then as the arc length is increased to 0·5 mm. the voltage falls off rapidly at first, then more slowly, and begins to rise again as the length is increased to 0·6 mm. If cross-sections of the curves are taken in this way at constant currents, and the P.D. across the arc plotted against the arc length, the family of curves shown in Fig. 5 is obtained.

This suggested a resonance phenomenon, and tests were at once made to determine whether the effect was a true one corresponding to something inherent in the short spark form of excitation, or a false effect due to some peculiarity in the measuring instruments. The substitution of another voltmeter, and, moreover, its high resistance, precluded the possibility of resonant oscillations through the voltmeter. The clue to the cause of the phenomenon was obtained accidentally, and it was suspected that the curious variations in the arc voltage as the arc length was increased might be due to the change in the capacity of the arc as the distance between the plates was varied. A rough computation, using 1 as the dielectric constant of the paper and gas between the plates, showed that the capacity of the arc varied between rather wide limits, from 0·0016 mfd. at 0·10 mm. arc length to 0·00023 mfd. at 0·70 mm. Accordingly, a variable air condenser was connected directly across the arc, and the values of the arc voltage and oscillation current were read as the capacity in parallel with the arc was varied. The

* THE ELECTRICIAN, August 20, 1909, p. 747.
† THE ELECTRICIAN, August 27, 1909, p. 799.

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arc length used was 0·25 mm. and the direct-current ammeter reading was maintained constant at 2·5 amperes by varying the resistance in the main circuit. The results are shown in Fig. 6.

In Fig. 6 the variable capacity in parallel with the arc is plotted as abscissa, with the direct-current voltage across the arc and the corresponding intensity of the oscillations indicated by a hot-wire ammeter as ordinates. The capacities corresponding to arc lengths of 0·05, 0·10, 0·15 and 0·20 mm. have been marked, and the left-hand boundary of the figure, with no capacity in parallel, corresponds, of course, to the arc length of 0·25 mm. actually used. The resistances in series with the arcs have not been plotted, but the resistance curve is approximately the reciprocal of the voltage curve.

It is apparent that the voltage curve with varying arc capacity corresponds qualitatively at least with the voltage curve for varying arc length at 2·5 amperes shown in Fig. 5. The maximum in the voltage in Fig. 5 occurs at an arc length less than 0·15 mm., while in Fig. 6 the maximum occurs at a capacity equivalent to an arc-length slightly more than 0·15 mm., as calculated. The discrepancy is due in part to the manner in which the plates forming the arc electrodes were arranged in the two experiments. Further experiments showed that the maxima observed in the voltage in Fig. 5 are due chiefly to the changing capacity of the arc itself, as the arc length is varied, and that corresponding to these maxima in the voltage there are minima in the oscillations produced by the arc.

At small capacities the condensers will charge up quickly, the number of discharges per second will be great, and the sparking potential will be low, since the gas will remain ionised to a large extent. The intensity of the oscillations, as measured by a hot-wire ammeter, will be large, and the average direct-current voltmeter reading low, partly on account of the low sparking potential, and partly because the charging time, when the voltmeter reading is obtained, is relatively small compared with the discharging time,

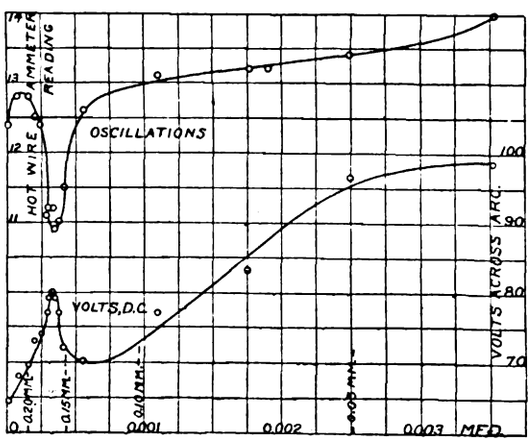

Fig. 6.—Effect of Arc Capacity on Arc Voltage and Oscillations.

when the voltmeter indication should be relatively small. At large capacities, on the other hand, the quantity of energy liberated at each discharge is large, the trains of oscillations will last a long time, and their effective value will be large even though the number of discharges per second is relatively small. A large reading of the hot-wire ammeter should, therefore, be obtained. But the resistance of the arc will be small while the large current is flowing through it, and the time of each discharge is large compared with the time of charge. In this case also, then, the average voltmeter reading will be small. Between these limiting cases a low value of the oscillations may result from a low value of the group frequency, due to high sparking potential, and a low value of effective oscillation current, due to small capacity. The time of charge will be relatively great and the time of discharge relatively small, giving a large value of the average voltmeter reading. The minimum in the oscillations should correspond with a maximum in the voltage, therefore, and this effect is observed in Fig. 6.

The reason for the shift of the maxima into the region of larger arc capacities as the current is increased is clear from this explanation. If the direct current from the generator is increased, the time required to charge the condensers will be decreased. This is the same effect as would be produced by a decrease of capacity. To neutralise this effect the actual capacity would have to be increased, thus restoring things to the same condition. In other words, as the charging current is increased the maxima should move over into the region of larger capacities or shorter arc lengths, and this is the effect found experimentally.

To test the assumption that the sparking potential required to break down the insulation increased as the arc current was diminished a Braun cathode ray oscillograph was connected across the arc, so that the maximum deflection of the ray by the electromagnetic field measured the maximum instantaneous or sparking potential across the arc. Experiment verified this.

If horizontal sections are taken through the family of curves shown in Figs. 3 and 4 the variation of the current through the arc, as read by the direct-current ammeter, is found to have maximum and minimum values as the arc length is increased while the voltage across the arc is maintained constant. This is chiefly an effect due to the capacity of the arc, and is explained in the same way as the variation in voltage at constant current was explained, the two phenomena being complementary.

An alternative interpretation may be given to the curves if we assume that the voltage across the arc depends not merely upon the direct current through the arc, but rather upon the effective arc current, or the square root of the sum of the squares of the direct current and the oscillatory current. According to this interpretation, when the oscillations are at a minimum, corresponding to a critical value of the capacity of the arc, the effective current through the arc would be small, and the voltage across the arc would rise to a maximum even though the direct-current ammeter reading is kept constant.

Investigators who have used the ordinary spark-gap as a means of producing high-frequency oscillations have long been familiar with a similar phenomenon. For a given constant applied voltage at the high-tension transformer or induction coil there is a definite spark length which will give a maximum current in all the circuits. It is possible that this effect is due in part to the influence of the capacity of the spark, but it is probable that the variation of the sparking voltage and spark resistance with the spark length plays a much more important part than in the case of the short arc between large electrodes. A more marked effect has been observed by Duddell* in the secondary current of an induction coil when a mercury interrupter was used to make and break the primary current. It is probable that the resistance of the spark-gap in Duddell's experiment plays a relatively more important part than in the phenomena of the Lepel arc.

(To be continued.)

FLOUR MILL POWER SCHEMES.†

BY W. CRAMP, M.SC., AND B. E. STOTT.

In dealing with this question the authors first consider what proportion of the total cost of a sack of flour is to be placed to the account of power. For the purposes of comparison the following items are assumed as belonging to the power capital account: The cost of the actual power plant, and the cost of land and buildings should also properly be added, but the value of this item is so variable that when included it is specially mentioned. In other cases it is omitted.

The following combined rates of interest and depreciation are assumed: On buildings 7½ per cent., and on plant 12½ per cent. The following items make up the total cost of power: Interest and depreciation on capital outlay, cost of fuel and water, labour, oil waste stores, &c. When these items are all considered it will be found that the cost of power will vary from 2d. to 6d. per sack of flour produced, depending upon the size of mill, locality and other special conditions. The saving, therefore, to be effected by careful design and running of the power plant is quite sufficient to make it worth while to watch the costs in these days of keen competition.

Of the special conditions which affect the cost of power, that of site or locality is probably the most important. Given the site of a mill the cost of each sort of fuel immediately follows, and the output of the mill has then a direct bearing upon the choice of power plant. To cover these two items, "site" and "size," all flour mills are divided into three types: (1) Large port mills, (2) large inland mills (assumed to be near an industrial centre), and (3) small country mills.

Each system of drive has its own advantages, but it so happens that there is always some part of the plant which is better driven electrically than direct. For every complete flour mill plant consists of: (*a*) Intake plant and silo, (*b*) wheat cleaning plant, (*c*) mill proper, (*d*) warehouse. Between these the total power is generally divided in the following proportions: (*a*) and (*d*) 12 to 14 per cent., (*b*) 18 to 22 per cent., (*c*) 60 to 70 per cent. Not only is there this difference, but while (*c*) has an almost constant load, and runs 140 hours per week, and (*b*) and (*d*) are also nearly constant, and run

* The Electrician, Vol. LXI., p. 796, 1908.

† Abstract of a Paper read before the National Association of British and Irish Millers.

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nearly always for the same hours, (*a*) is variable, and runs for a number of hours which depend upon the capacity of the building, the arrival of wheat and other conditions. Further, from insurance and other causes, (*b*) is always cut off from (*c*), while often (*a*) and sometimes (*d*) occupy entirely separate buildings. It thus happens that in almost all cases there is a portion of the plant which is more conveniently and economically driven by electricity. This is the more easily arranged since electric light is now the rule; and, therefore, it is only necessary to provide a larger generator and switchgear to deal with electric light and all plant that is situated at a distance, scattered as regards position or intermittent in operation.

A comparison of the schemes will make clear that the second can only be better than the first when the arrangement of the mill is such that the motor and generator losses are more than saved by improvements in the drives obtained. In the last case the boiler and generator and some of the cable losses are borne by the supply company; and when millers compare the price per unit at which they can generate with that offered by the supply company, this fact should be remembered. As a heat engine at low temperatures and pressures the turbine is more effective than the steam engine. A combination of the two, therefore, results in more power being developed per pound of steam, and if the load can be divided between turbine and engine in the proper proportions this is sometimes the best steam system.

With the exception of those items mentioned above, the power scheme may vary very considerably in its main features. There are, however, certain essentials which every such scheme must possess: (1) *Reliability.*—This point is regarded as of the very first importance. It is a *sine qua non* that the prime mover should be able to run for 140 hours per week with the minimum of attention. (2) *Regularity of Moment.*—It is essential that the speed and turning moment of the prime mover should be very regular. (3) If direct driving is to be adopted the speed of the prime mover should be such as will allow of rope drives on to the main shafts without the intervention of gears or countershafts, otherwise electrical transmission is necessary.

The authors next consider in some detail the various classes of steam plant that can be used, the advantages and disadvantages of each type being considered. Turbines are not adaptable to mill work owing to their high speed, and as regards running cost, there is little to choose between high and low-speed engines. A combined engine and turbine may often, too, be used with advantage. Gas engines, except those of the Diesel type, are not suitable for mill work.

In considering the question of electrical working the authors draw attention to the fact that if in many cases it is advantageous to transmit power electrically from steam, oil or gas, it will be much better to take power straight from convenient mains to any set of machines, and there utilise it by a motor direct connected to the line shaft. The absence of coal smoke or fumes, the small space required, the absolute regularity and ease of control, are points that should appeal to all millers; and when electricity can be obtained at a reasonable price per Board of Trade unit, doubtless it will attract the consumer. It is all a matter of disposition of plant and price per unit. In some respects flour mills are at a disadvantage as compared with other industries, since there is little or nothing to be gained by subdividing the drives of an ordinary flour mill; so little of the plant is intermittent in use, and the bulk of the machines must go as one unit. It would not pay, for instance, to drive the roller mills by independent motors, as the looms in the modern weaving shed are arranged, and the same applies to purifiers and centrifugals. On the other hand, the load factor of a flour mill is such as should tempt the most pampered supply company, since the main load is regular day and night, and by careful arrangement the auxiliary load can be put so as to avoid the central station peak. These points should not be lost sight of when millers are negotiating for a supply; nor should they forget that if the milling engineer is to get the best out of a site or ground he should be informed as to whether electrical driving is to be adopted before the buildings are even planned.

The best arrangements for a steam-driven mill are not necessarily best for one that has motors to its shafts, and there are, besides, differences in detail which must be allowed for. One of the chief of these is the speed of the line shafts. Certainly, if motors are to be used to their best advantage belts and ropes should be avoided as much as possible. This involves raising the speed of the roller mill shafts from 200 to about 350 revs. per min., and the centrifugal and purifier shafts may go even faster. All such auxiliaries as hoists, pumps, fans, &c., should be equipped with individual motors, and the machines themselves are usually most satisfactory if split up so that one or more motors take the roller mills, and other motors are arranged to take the purifiers, centrifugals, &c. There is no reason why, by proper electrical connections, the whole of the motors in the mill should not start at one time; and when the miller has his own generating plant, they may be arranged to start up all together in absolute synchronism with the engine.

As regards systems of generation, two are of importance—*i.e.*, continuous current and three-phase alternating current. Either may be used with success, but there is no question at all as to which is the better. Alternating current, besides giving steadier running and smaller speed variation with load, has great advantages from the point of view of insurance and capital cost, especially as regards transmission; while it is extremely flexible as regards pressure, and therefore very suitable where both lighting and power are required. It also lends itself particularly well to cases where a number of motors are to be started together.

Certain general conclusions are drawn from figures given in the Paper. Since electricity can rarely be supplied in large quantities (4,000,000 units per annum) at less than 0·3d. and in small quantities at less than 0·5d., it seldom enters as a competitor against steam, gas and oil. Turbo-electric drives are only of value for large mills, where, however, they stand pre-eminent. For country mills suction gas and oil are about equal, and when ground space and cleanliness are of importance the Diesel engine is to be preferred. For increasing the power and economy of existing plants the exhaust steam turbine is often of value; but it will not as a rule justify its inclusion in a new plant. Of electrical systems three-phase alternating current is to be preferred for all purposes—even where only part of the plant is driven electrically.

Suppose that at some port a number of millers were to combine their energies, and make use of one large power plant, what is the best that could be done in the cheapening of power? Suppose a case of three mills situated about 100 yds. each from the site of the central power station, and requiring altogether about 4,000 I.H.P. Steam turbines with electric drive could provide energy for about 2d. per sack in the case of a plant of 100 sacks' capacity, and since any decrease of this cost would, in the case of distribution to several mills, be more than compensated by cable losses, 2d. per sack may be taken as about the limit for the supposed case. Besides steam turbines there are only two economical ways of dealing with such a scheme: (1) Putting in Mond gas producers, leading the gas to boilers after passing through a recovery plant and burning it to produce steam which would drive the original steam engine. (2) Putting in Mond gas producers with recovery plant, leading the gas to gas engines with electric generators and distributing electrically.

If the mills are already equipped with up-to-date boilers and engines the first method would save a good deal of capital outlay and still show a small saving over individual steam plants. How much the saving would be it is impossible to say without knowing the exact conditions under which the plant worked. It is, however, safe to state that a capital outlay of £12,000 would be involved, and that the saving would only run to about ¼d. per sack. This arrangement, therefore, cannot be recommended, since it involves too many difficulties for too small a result. Of course, the above saving is nett after allowing for interest and depreciation on capital outlay. It may be stated that under such conditions the price of power per sack could not be less than 1·75d.

The second scheme would involve a greater expenditure, which, however, would be amply repaid, thus the power cost per sack produced would be, when ample margin is allowed for all eventualities, about 1⅛d., against 1¼d. by any other arrangement.

Earth Currents and the Telegraph.—A recent article in the "Elektrotechnische Zeitschrift" deals with this subject, and it is pointed out that when a single line is connected to earth at both ends it is traversed by a current not usually exceeding 1 milliamp., but this may rise considerably during magnetic storms. The following facts appear as the result of researches made on this question. Wires running north and south experience stronger currents than those running east and west; the currents are less the shorter the line; the currents undergo periodic variation, the daily and yearly fluctuations following those of the earth's magnetic field; and unusual fluctuations of the earth currents accompany unusual disturbances in the earth's magnetism. The customary earth currents do not interfere with telegraphy upon an earthed circuit, because even the most sensitive relay does not operate at such a low current. In times of severe disturbance, however, the interference may become very great, and even prevent the transmission of messages. In that case two earth-return circuits may be combined into a single unearthed circuit, or two telephone circuits may be combined to yield one telegraph circuit without interfering with its use for telephony.

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"THE ELECTRICIAN" INDUSTRIAL SUPPLEMENT.

With "THE ELECTRICIAN" for Sept. 14, 1906, was issued the first of a series of "Industrial Supplements," to be published from time to time with "THE ELECTRICIAN." The fifty-third issue of the Supplement published (Gratis) with the number of "THE ELECTRICIAN" for September 23, 1910, was the last of the monthly issues. "THE COMMERCIAL AND INDUSTRIAL SUPPLEMENT" to "THE ELECTRICIAN" is now issued weekly (Gratis). It will be found towards the end of the present issue

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SPECIAL NOTICE FOR CORONATION WEEK.

"THE ELECTRICIAN" will be published on Saturday instead on Friday next week.

As it will be necessary for the Publisher to have the paper practical completed by Wednesday night (Friday being a holiday in London Contributors and Advertisers will please send their copy for Contributions and for new Advertisements and changes in runnin Advertisements not later than first post on Wednesday next week.

ELECTRIC TRACTION ON MAIN LINES.

The position of electric traction on main lines at th present time appears to be that, although some enginee are sceptical as to the value of electrical methods in su cases, electric traction on main lines is, nevertheles making steady progress. The New York, New Haven Hartford Railway affords a fitting example of this fa and a Paper by Mr. W. S. MURRAY, of which our readers w find an abstract on another page, is an important record the results obtained on this line. It is particularly gra fying to see the very great reliability of service that has be obtained under electrical conditions of working, the authc figures showing that the electric service is now more th twice as reliable as the steam service on the line. Apa however, from recording the satisfactory results obtain Mr. MURRAY preaches the gospel of standardisation. T creed being single-phase supply at 11,000 volts and a f quency of 25. As to the last-mentioned figure, engine in this country will not cavil at the frequency suggest as this has already been adopted with satisfactory resu though Continental engineers do not seem to be so unc mous in favour of this figure, and it is quite possible t the lower frequency of 15 periods may be favoured m

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strongly. Nevertheless, a frequency of 25 has its advantages, and it is largely used.

With regard to the operating pressure, on the other hand, the position is not so clear. So far, in this country, a pressure of about 6,000 volts has been adopted for single-phase working, and therefore in all probability the tendency would be to favour this pressure unless good reason can be shown for something higher. It is certainly important that a uniform pressure should be adopted to facilitate the interchange of traffic, though this is more particularly so with suburban traffic than with main line traffic, because multiple unit equipment is likely to be used with the former whereas locomotives would find a place in the latter. It is not very feasible, however, to separate suburban from main line traffic. Probably a lower pressure than in America would be permissible, for the simple reason that there should not be any difficulty in arranging for the supply of energy in this country from large towns or from power companies along the route.

Finally, there is the question of the single-phase system being used for main line traffic. There certainly is much to be said in favour of this system for main lines, whatever may be the case on shorter lines, and Mr. MURRAY goes so far as to say that the first cost of the single-phase system is not more than 85 per cent. of its next best competitor, and its operating costs are less than this percentage.

There are one or two interesting points of detail to which Mr. MURRAY refers in the course of his Paper. One of these is in regard to the use of a subsidiary steel wire for the overhead transmission, this wire being used for the contact made by the collecting bows. In this way the copper wire can be reserved solely for the transmission of electric energy and is not subjected to any serious wear. So far, in this country, this form of construction does not seem to have been adopted. In the case of the South London branch of the London, Brighton & South Coast Railway, which is the only instance of a single-phase line in Great Britain on which there is a dense traffic, the usual copper wire is employed, and it has been found that the wear is extremely small. Theoretically, at least, it seems to be the right course to restrict the use of copper to the transmission part of the overhead construction and to use steel for supplying the contact, as the cost of renewal of the steel would be much less than that of copper. As to whether this would really be so in practice it is not so easy to say, as the additional steel wire must add something to the first cost, and if the wear is really very trifling it may not be worth while to incur this additional expenditure. It has sometimes been thought that a steel wire would not wear satisfactorily owing to corrosion, but no such difficulty seems to arise because the wire is always covered with a film of grease from the bows.

Another point on which Mr. MURRAY touches is the use of batteries for a traction system of this kind, and he gives his opinion emphatically against their use. It is well recognised that a battery enables the energy to be generated more cheaply under certain conditions by levelling up the load; and this increased cheapness may more than offset the loss due to the inefficiency of the battery. It is, however, purely a question of the character of the load, and Mr. MURRAY points out that if electric energy is used for handling freight traffic as well as passenger traffic the load can be so adjusted as to be very satisfactory from the station point of view. In this connection it is well to bear in mind that there is more than one class of locomotive used on a railway. The express locomotive is by no means inefficient, and it can be used fairly efficiently; but locomotives used for handling goods, and particularly those used for shunting, may be worked very inefficiently. Mr. MURRAY, in fact, as the result of tests, gives some very low figures and points out that the electric locomotive, when used for shunting, can be employed to advantage and may have a very high rating owing to the intermittent nature of the work. It seems not improbable that if electric traction on main lines is to justify itself, it will do so by embracing all classes of work and not by restricting itself merely to the handling of passenger traffic.

REVIEWS.

(Copies of the undermentioned works can be had from THE ELECTRICIAN Office, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.)

The Principles of Electric Wave Telegraphy and Telephony. By J. A. FLEMING, M.A., D.Sc., F.R.S. 2nd edition. (London: (Longmans, Green & Co.) Pp. xviii. + 906. 28s. nett.

Prof. Fleming's well-known treatise remains in its second edition quite its former self in style and method, though it has increased some 50 per cent. in bulk. Just as when it was first published nearly five years ago, it forms a very comprehensive, up-to-date account of all the scientific aspects of wireless telegraphy, and it still deserves to be accorded the premier place as a book of reference on the principles of the subject. The additions and improvements found in this new edition are, of course, those due mainly to natural progress; but the opportunity has been frequently taken of correcting errors of omission and commission noticeable in the first edition. Among new matter may be mentioned a good account of recent measurements of dielectric strength, and of the absorption of electric waves by the materials of the surface of the earth, the latter especially being very fully treated. The recent theory and experiments, mainly due to German writers, on the resonance phenomena in coupled circuits is given great attention. The author, though describing just as fully as before the very bad method of measuring small mutual inductances between two coils (a method consisting in measuring the total self-inductance of the two coils in series and in opposition), now, fortunately, gives prominently a description of better methods and so removes a reproach that many people must have directed against the first edition. Among other new matter worthy of mention are the interesting results of Abraham's and of Love's calculations of the field round a Hertzian oscillator.

Looked at as a whole we conclude that this second edition is even more encyclopædic than the first. It is difficult to think of any paper or publication bearing directly on wireless telegraphy that is not referred to, and in a greater or less degree discussed, in this new big volume. Perhaps the chief faults of the work will, in time to come, be accounted to arise out of its author's desire to make it an all-embracing book of reference rather than a balanced expository treatise. This criticism is only strengthened by the fact that the index, though obviously laboriously and carefully compiled, is soon found to be but an imperfect guide to the contents of the volume. Finally, though the reader may close the book with the feeling that it is here and there a little out of touch with actual practice, he must admit that it is a marvellously rich store of the book-lore of the whole subject.

W. H. ECCLES.

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Die Elektrische Fernübertragung von Bildern. By Dr. Robert Pohl. (Brunswick: F. Vieweg & Son.) Pp. viii. + 45. M.1.80.

Electricians who feel disposed to pay any attention to the telegraphy of photographs, writing, sketches, &c., will do well to study this little book, as it deals with most of the early systems and experiments of any importance, while treating in a later chapter of Prof. Korn's original method, which was the first to come into actual commercial use.

A considerable amount of space is devoted to the question of synchronising the transmitting and receiving apparatus, and, as a matter of fact, synchronism still remains the vital problem when working over long distances. In the Korn, Belin and Thorne-Baker systems, as at present arranged, the revolving drums of the apparatus make a revolution in two seconds, while the circumference of the drums is about 7 in. in each case. An error of a hundredth part of a second would thus distort the picture about a thirtieth of an inch—quite enough to deteriorate it seriously.

The most interesting process of telegraphing pictures is unquestionably that in which selenium is used to record the densities of different successive parts of a transparent photograph. Curves are given showing how Prof. Korn has overcome to a great extent the effects of inertia of the selenium cells, and his own method and Dr. Bidwell's are described in detail. On the other hand, the description of the telautographs of Bakewell and Korn can hardly be looked upon as satisfactory, as in the cursory description given of the latter it is impossible to deal with the extraordinary advance made by Prof. Korn with his Einthoven galvanometer method of reception.

THE PRINCIPLE OF THE STATIC BALANCER.

BY C. C. HAWKINS.

(*Concluded from p. 345.*)

Summary.—The theory of the static balancer is here developed on simple lines by the superposition of the component currents. An actual case is worked out numerically.

The simplest way of looking at the problem is to take the centre of the balancer as being earthed and, therefore, as remaining as a fixed datum at zero value. The third wire before

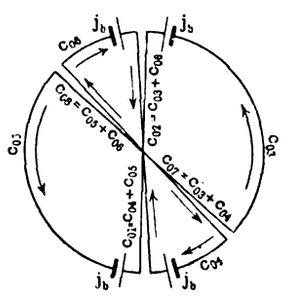

Fig. 6.—Out-of-balance Components in 2-Phase Case.

connection to the centre is at potential j_b, which may be positive or negative. We have only then to ask what currents c_{03}, c_{04}, c_{05}, c_{06}, superposed respectively on the four portions of the armature and each flowing *from* the point of low potential *to* the point of high potential, will lower or raise the potential of the middle *of the network* to zero. Each of the four portions of the armature will have its circuit completed by a share of the balancer and of the network resistances, so as to form four circuits which may be regarded as independent (Fig. 6). Thus, in R_2 there flows $c_{02}=c_{03}+c_{06}$ and in ρ_7 there flows $c_{07}=c_{03}+c_{04}$. Hence, to complete the circuit, *e.g.*, of c_{03}, we must take $R_2 \cdot \frac{c_{03}+c_{06}}{c_{03}}$, and $\rho \cdot \frac{c_{03}+c_{04}}{c_{03}}$.

The driving E.M.F.'s, which are represented by cells in Fig. 6 are in the two-phase case equal in each of the four circuits, *i.e.* $j_b = \frac{C_b}{2}(R_1 - R_2)$, or half the difference in the volts lost over the two sides of the network due to the direct current C_b; this E.M.F. is supplied by the armature induced E.M.F. in one portion and is, so to speak, saved in the adjacent portion, since the currents are in alternate directions in adjacent parts.

The coils being assumed to be wound on a common core, let $L = l + M$, where l is the leakage flux per unit current which is not linked with both coils and M is the flux due to unit current in one coil which also passes through the other coil, *i.e.*, their mutual inductance. The mutually induced E.M.F. in each coil is the same $= M\left(\frac{dc_{07}}{dt} - \frac{dc_{08}}{dt}\right)$, but in opposite directions relatively to the centre.

The principle is then shown by the four equations—

$$c_{03} \cdot 2R_a(1-q) + c_{02} \cdot R_2 + c_{07} \cdot \rho = j_b - L_3 \cdot \frac{dc_{03}}{dt} - l \cdot \frac{dc_{07}}{dt} - M\left(\frac{dc_{07}}{dt} - \frac{dc_{0}}{dt}\right.$$

$$c_{04} \cdot 2R_a \cdot q \quad + c_{01} \cdot R_1 + c_{07} \cdot \rho = j_b - L_4 \cdot \frac{dc_{04}}{dt} - l \cdot \frac{dc_{07}}{dt} - M\left(\frac{dc_{07}}{dt} - \frac{dc_{0}}{dt}\right.$$

$$c_{05} \cdot 2R_a(1-q) + c_{01} \cdot R_1 + c_{08} \cdot \rho = j_b - L_3 \cdot \frac{dc_{05}}{dt} - l \cdot \frac{dc_{08}}{dt} + M\left(\frac{dc_{07}}{dt} - \frac{dc_{0}}{dt}\right.$$

$$c_{06} \cdot 2R_a \cdot q \quad + c_{02} \cdot R_2 + c_{08} \cdot \rho = j_b - L_4 \cdot \frac{dc_{06}}{dt} - l \cdot \frac{dc_{08}}{dt} + M\left(\frac{dc_{07}}{dt} - \frac{dc}{dt}\right.$$

which would yield the numerical values of c_{03}, c_{04}, &c., and, as shown in Fig. 6, their directions are alternately clockwise and anti-clockwise.

Only one distribution of the instantaneous out-of-balance components can satisfy the conditions, and their numerical values continually alter as rotation proceeds and q changes from 0 to 1, when the process begins again. Strictly speaking, therefore, the E.M.F.'s self- and mutually-induced by the out-of-balance components would have also to be taken into account as shown above, but, being small, they may be neglected.

All the out-of-balance components are in general dissimilar, and when Fig. 6 is superposed on Fig. 3*c*, Fig. 7 is obtained, from which it follows that *all* the resultant armature currents are dissimilar so long as the tappings to the balancer and the brushes divide the armature into four portions.

The out-of-balance currents in each limb of the balancer are in the same direction relatively to the centre, *i.e.*, both outwards

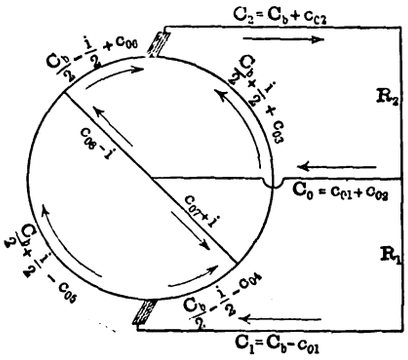

Fig. 7.—Final Distribution of Currents in System with 2-Phase Balancer.

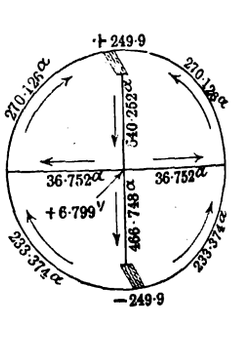

Fig. 8.—Numerical Value in Assumed Case.

or both inwards, and in Fig. 6 or 7 the outward direction is du to the fact that the positive side of the network has bee assumed to have the lesser resistance and therefore to be th more heavily loaded: if the negative side had been the mor heavily loaded, the components of Fig. 6 must be reverse The out-of-balance components in the limbs of the balance are also always dissimilar except when $q = \frac{1}{2}$.

The out-of-balance component in each section of the armatu is in the opposite direction to that of its adjacent neighbo (Fig. 6), but they are additive in each limb of the balancer an in each side of the network.

The total out-of-balance current is, therefore, numerically

$$C_0 = c_{01} + c_{02} = c_{03} + c_{04} + c_{05} + c_{06}.$$

The simple case of $q = \frac{1}{2}$ need alone be considered,* and ar E.M.F. self or mutually induced by the out-of-balance curren

* The grounds for this statement are given more fully in Jour I.E.E., *loc. cit.*, p. 714.

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themselves may be neglected; under these circumstances the shares of the total out-of-balance current are,

$$\text{In } R_1, \qquad c_{01} = c_{04} + c_{05} = \frac{C_0}{2} \cdot \frac{2R_2 + R_a}{R_1 + R_2 + R_a},$$

$$\text{In } R_2 \qquad c_{02} = c_{03} + c_{06} = \frac{C_0}{2} \cdot \frac{2R_1 + R_a}{R_1 + R_2 + R_a}.$$

The total out-of-balance current is

$$C_0 = C_2 - C_1 = (R_1 - R_2) C_b \frac{W'}{U'} \quad . \quad . \quad . \quad . \quad (4)$$

and with $q = \frac{1}{2}$ in the two-phase case,

$$W' = (R_1 + R_2 + R_a) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

$$U' = 2R_1R_2 + \rho(R_1 + R_2 + R_a) + R_a(R_1 + R_2 + \tfrac{1}{2}R_a) \quad . \quad (6)$$

The numerical values* for the case of the 250 kw. dynamo above described, if we make $\rho = 0{\cdot}16$ ohm, will be (Fig. 8),

$q = \frac{1}{2}$.

E_a	$= 525$ volts
V_a	$= 500$,,
J_a	$= 25$,,
C_b	$= 500$ amperes
W'	$= 1{\cdot}05$
U'	$= 0{\cdot}71425$
C_0	$= 73{\cdot}504$ amperes
Out-of-balance current in R_1	$= 33{\cdot}252$,,
Out-of-balance current in R_2	$= 40{\cdot}252$,,
Out-of-balance current in each limb of balancer	$= 36{\cdot}752$,,
Additional loss of terminal voltage	$= 0{\cdot}175$ volts
Resultant terminal voltage	$= 499{\cdot}825$,,
Resultant divergence of centre potential, j_c	$= 6{\cdot}8$,,

The last figure shows how much the equality of the voltage on the two sides of the network has been improved as compared with the initial J_0, and this value for the new divergence remains to be proved.

The brushes which, before the connection of the third wire to the balancer, were at potentials of equal numerical value, but the one above and the other below zero, have their potentials changed as follows. Starting from the centre, which has been assumed as earthed, by the path o, b, d, the potential of brush d is positive, or above zero by the amount

$$-\left(\frac{C_0}{2} + i\right)\rho - L_1\frac{di}{dt} - l \cdot \frac{dc_{07}}{dt} - M\left(\frac{dc_{07}}{dt} - \frac{dc_{08}}{dt}\right)$$

$$+E_3 - L_3 \cdot \frac{di_3}{dt} - L_3 \cdot \frac{dc_{03}}{dt} - \left(\frac{C_b}{2} + \frac{i}{2} + c_{03}\right)R_a \quad . \quad (7)$$

and the potential of the brush f by the path o, a, f is negative or below zero, its value being

$$-\left(\frac{C_0}{2} - i\right)\rho + L_1\frac{di}{dt} - l \cdot \frac{dc_{08}}{dt} + M\left(\frac{dc_{07}}{dt} - \frac{dc_{08}}{dt}\right)$$

$$-E_3 + L_3\frac{di_3}{dt} - L_3\frac{dc_{05}}{dt} + \left(\frac{C_b}{2} + \frac{i}{2} - c_{05}\right)R_a \quad . \quad (8)$$

Their sum gives the arithmetical *difference* between the two new brush potentials, viz,

$$-C_0\rho - (c_3 + c_{05})R_a - l\left(\frac{dc_{07}}{dt} + \frac{dc_{08}}{dt}\right) - L_3\left(\frac{dc_{03}}{dt} + \frac{dc_{05}}{dt}\right).$$

At this instant L_3 may be assumed equal to L_1 and both $= L_a$, the inductance of one-half of the armature winding; it can then be shown that

$$c_3 + c_{05} = \frac{C_0}{2} - \tfrac{1}{2}L_a\left(\frac{dc_{03}}{dt} + \frac{dc_{05}}{dt} - \frac{dc_{01}}{dt} - \frac{dc_{06}}{dt}\right) \times \frac{1}{R_a}.$$

The above sum is, therefore,

$$= -C_0\left(\rho + \frac{R_a}{2}\right) - l\left(\frac{dc_{07}}{dt} + \frac{dc_{08}}{dt}\right)$$

$$-\tfrac{1}{2}L_a\left(\frac{dc_{03}}{dt} + \frac{dc_{05}}{dt} + \frac{dc_{01}}{dt} + \frac{dc_{06}}{dt}\right).$$

The two latter terms being in any case small and negligible, this reduces

$$-C_0\left(\rho + \frac{R_a}{2}\right).$$

If, therefore, half of this sum, but of opposite sign, is added to the potential of the centre, the potential of each brush is altered similarly and they become of equal numerical value but of opposite sign. The new potential of the centre is then the required divergence that has to be found, or

$$j_c = \frac{C_0}{2}\left(\rho + \frac{R_a}{2}\right),$$

and in general for n phases, when $q = \frac{1}{2}$ it is

$$j_c = \frac{C_0}{n}\left(\rho + \frac{R_a}{2}\right). \quad . \quad . \quad . \quad . \quad . \quad (9)$$

The new terminal voltage between the brushes is the difference between the potentials of (7) and (8), *i.e.*, when $q = \frac{1}{2}$,

$$d - f = 2\left(E_3 - L_3\frac{di_3}{dt} - L_1\frac{di}{dt}\right) - i(2\rho + R_a) - C_0 \cdot R_a - (c_{03} - c_{05}) \cdot R_a$$

$$- L_3\left(\frac{dc_{03}}{dt} - \frac{dc_{05}}{dt}\right) - 2M\left(\frac{dc_{07}}{dt} - \frac{dc_{08}}{dt}\right).$$

The E.M.F.'s self- and mutually-induced by the out-of-balance currents may again be neglected, and under this assumption, when $q = \frac{1}{2}$,

$$c_{03} - c_{05} = \frac{(R_1 - R_2)j_b}{U'}.$$

Further, at this moment,

$$i(2\rho + R_a) = E_3 - E_4 - L_3\frac{di_3}{dt} - L_1\frac{di_1}{dt} - 2L\frac{di}{dt}.$$

Therefore the new terminal voltage between the brushes is

$$v_{cc} = E_3 + E_4 - L_3\frac{di_3}{dt} + L_1\frac{di_1}{dt} - C_b \cdot R_a - j_b \cdot \frac{(R_1 - R_2)R_a}{U'},$$

or since $j_b = J_0$ when $q = \frac{1}{2}$,

$$v_{cc} = E_a - \left(L_3\frac{di_3}{dt} - L_1\frac{di_1}{dt}\right) - C_b \cdot R_a - J_0 \cdot \frac{(R_1 - R_2)R_a}{U'}. \quad (10)$$

As compared with equation (1) it will be seen that the last term is an entirely additional loss due to the presence of the out-of-balance current; the terminal voltage is lowered with an assumed constant E_a, but the amperes in R_2 are raised and the total output is improved. Thus, in our case of $q = \frac{1}{2}$, the additional loss of volts is $0{\cdot}175$, making $v_{cc} = 499{\cdot}825$, divided between R_1 and R_2 in the proportion of $256{\cdot}712 : 243{\cdot}113$. The total output is, therefore,

In R_1, $256{\cdot}712$ volts $\times$ $466{\cdot}75$ amperes $= 120$ kw.
In R_2, $243{\cdot}113$ volts $\times$ $540{\cdot}25$ amperes $= 131$ kw.

Total $= 251$ kw.

From what has been stated above, it follows that a division of the actual instantaneous currents c_3 and c_4 in the two limbs of the balancer into an alternating current i and an equal share of C_0, so that

$$c_3 = \frac{C_0}{2} + i$$

$$c_4 = \frac{C_0}{2} - i$$

is only true when the self-induced and mutually-induced E.M.F.'s are neglected and $q = \frac{1}{2}$. Yet with practical values for the quantities it is at other instants sufficiently near to the truth to make it a useful approximation. If a current through one limb of the balancer directed *outwards* from the centre junction is regarded as *positive*, while a current inwards towards the centre is regarded as negative, we can then say that the alternating-current component has its sign fixed in accordance with the time, and, as it flows through two limbs in series, is + in one and − in the other. The direct-current component is half the total out-of-balance current in a two-phase balancer, or, if there are n phases, is $\frac{C_0}{n}$, and in every limb has the same sign which is fixed once and for all according to which side of the network is the more heavily loaded; it is outwards and *positive* if j_c is *positive*, or $R_1 > R_2$, and the + side of the network is the more heavily loaded, while it is inwards and negative if the divergence of the centre potential from the mean is negative.

Since

$$C_0 = C_2 - C_1 = \frac{\frac{1}{2}v_{cc} - j_c}{R_2} - \frac{\frac{1}{2}v_{cc} + j_c}{R_1}, \quad . \quad . \quad . \quad (11)$$

$$\frac{v_{cc}}{2} \cdot \frac{R_1 - R_2}{R_1 + R_2} - C_0 \cdot \frac{R_1R_2}{R_1 + R_2} = j_c = \frac{C_0}{n}\left(\rho + \frac{R_a}{2}\right),$$

* The refinement in the following figures is necessary in order that the principle may be brought to the test of numerical calculation and the value of the out-of-balance voltage in each of the four circuits may be checked. The writer is well aware that in practice the data for R_a can only be very roughly guessed.

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when $q=\frac{1}{2}$. Whence

$$C_0=\frac{v_{cc}}{2}\cdot\frac{R_1-R_2}{(R_1+R_2)\left(\frac{\rho}{n}+\frac{R_a}{2n}\right)+R_1R_2}. \quad . \quad . \quad (12)$$

and

$$j_c=\frac{v_{cc}}{2}\cdot\frac{(R_1-R_2)\left(\frac{\rho}{n}+\frac{R_a}{2n}\right)}{(R_1+R_2)\left(\frac{\rho}{n}+\frac{R_a}{2n}\right)+R_1R_2}, \quad . \quad . \quad (13)$$

where R_1 is the effective resistance of the network on the negative side, so that j_c is positive when R_1 is $>R_2$. The average *difference* between the terminal voltages on the two sides of the network is, of course, $2\,j_c$.

It must then be emphasised that the amount of the out-of-balance current or its percentage of the full-load current is not a function simply of the terminal voltage between the outers and the resistances of the network; it cannot be stated until the resistances of the balancer itself and of the armature are fixed. Further, so long as the balancer has any resistance, j_c can never disappear, and the degree of perfection of the balancing depends essentially upon the resistance of the balancer and armature.

From given values of R_1 and R_2 and of v_{cc}, it is only the maximum possible out-of-balance current with perfect balancing that can be stated, *i.e.*, the ideal when $j_c=0$ and the voltage on either side of the network is the same. This ideal value of C_0 is $\frac{v_{cc}}{2}\cdot\frac{R_1-R_2}{R_1R_2}$, whereas actually, from equations (12) and (13), we have

$$C_0=\frac{v_{cc}}{2}\cdot\frac{R_1-R_2}{R_1R_2}-j_c\cdot\frac{R_1+R_2}{R_1R_2}$$

$$=\frac{v_{cc}}{2}\cdot\frac{R_1-R_2}{R_1R_2}\left\{1-\frac{(R_1+R_2)\left(\frac{\rho}{n}+\frac{R_a}{2n}\right)}{(R_1+R_2)\left(\frac{\rho}{n}+\frac{R_a}{2n}\right)+R_1R_2}\right\}. \quad (14)$$

$$=\frac{v_{cc}}{2}\cdot\frac{R_1-R_2}{R_1R_2}(1-x). \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (15)$$

Here $(1-x)$ indicates by how much we fall short of the ideal, and the smaller the fraction x the better.

It is also evident that C_0 cannot be stated unless v_{cc} is known, and it has been shown that v_{cc} not only pulsates but is affected by j_c or C_0: hence, C_0 should be expressed in terms of an assumed constant E_{cc}. But if the excitation is raised when the balancer is connected so that v_{cc} is raised to equality with V_e when there is no balancer (and in practice V_e would be maintained at its required value across the outers), we have

$$\frac{j_c}{J_0}=\frac{(R_1+R_2)\left(\frac{\rho}{n}+\frac{R_a}{2n}\right)}{(R_1+R_2)\left(\frac{\rho}{n}+\frac{R_a}{2n}\right)+R_1R_2}, \quad . \quad . \quad . \quad (16)$$

$$=x,$$

so that x is then also the fraction which the new divergence is of the initial without any balancer for the same value of the terminal voltage at the brushes.

The complete impracticability of a non-inductive balancer is evident from a short consideration. The effective value of the alternating voltage impressed upon the balancer depends upon the wave-shape and so upon the ratio of the polar arc to the pole-pitch, just as in a rotary converter. Assuming provisionally a sinusoidal wave, the effective voltage applied to one phase of the balancer (*i.e.*, to one of the coils, not between the slip-rings) is $\frac{V_e}{2\sqrt{2}}$, whatever the number of phases; if, therefore, the balancer were a simple ohmic resistance without inductance, the effective value of the natural alternating current in any phase would be $\frac{V_e}{2\sqrt{2}\,.\,\rho}$, and its maximum value $\frac{V_e}{2\rho}$. The ratio of this to the share of the total out-of-balance current which the phase carries would be

$$\frac{I_{max.}}{C_0/n}=\frac{\frac{V_e}{2}\cdot\frac{1}{\rho}}{\frac{V_e}{2}\cdot\frac{(R_1-R_2)(1-x)}{nR_1R_2}}=\frac{n}{\rho}\cdot\frac{R_1R_2}{(R_1-R_2)(1-x)}.$$

Since the moment of maximum alternating current would, with a non-inductive balancer, coincide with passage of the phase past the brushes, the armature resistance term in equation (16) vanishes, so that

$$x=\frac{(R_1+R_2)\frac{\rho}{n}}{(R_1+R_2)\frac{\rho}{n}+R_1R_2},$$

and the ratio finally becomes

$$\frac{I_{max.}}{C_0/n}=\frac{R_1+R_2}{(R_1-R_2)x}. \quad . \quad . \quad . \quad . \quad . \quad (17)$$

It thence follows that so long as the balancer is non-inductive, $I_{max.}$ must necessarily be larger than C_0/n, or the actual current in each limb must at least, for a part of a revolution, have its direction reversed, as shown in Fig. 9, and this is always the case on light loads, when C_0/n is less than $I_{max.}$

The curve of current in either limb is therefore alternating, but with the waves symmetrical not about the zero axis but about a horizontal axis at a height equal to C_0/n.

The average alternating watts of the phases are then $n\cdot\frac{V_e^2}{8\rho}$ and $\frac{n}{\rho}\cdot\frac{(R_1+R_2)(1-x)}{xR_1R_2}$. When the generator is well loaded, the useful output is not far different from $\frac{V_e^2}{R_1+R_2}$, even if the load is unbalanced, so that the ratio $\frac{\text{alternating watts in balancer}}{\text{output in network}}$ becomes approximately $=\frac{(R_1+R_2)^2}{8R_1R_2}\cdot\frac{1-x}{x}$, and if we assume $R_1=1\frac{1}{2}R_2$, it is $=\frac{1}{2}\cdot\frac{1-x}{x}$. If, therefore, $x=0{\cdot}25$, the alternating watts would be $1\frac{1}{2}$ times the useful output, from which the impracticability of the non-inductive balancer is evident.

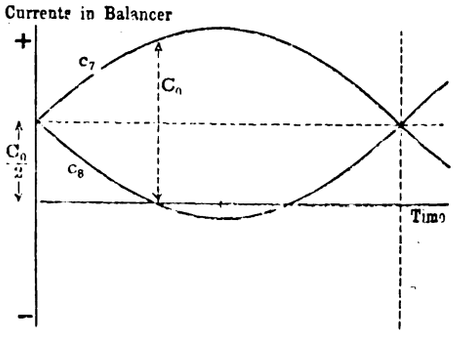

FIG. 9.

A very low ohmic resistance, such as will make the potent difference of the two sides of the network nearly equal, m therefore be combined with a counter E.M.F. to check t excessive waste of power and inefficiency of a simple resistar when the slip-ring tappings draw near to and pass under t brushes at the epoch of maximum impressed potential differen This is secured by making each limb highly inductive, so tl the natural alternating current is limited rather by the actance $2\pi fL$ than by the resistance. Its effective value n becomes $\frac{V_e}{2\sqrt{2}\sqrt{\rho^2+4\pi^2f^2L^2}}$ where L = the inductance of phase, and by making L large enough we become practic independent of ρ, and the ratio of $I_{max.}$ to C_0/n can be inc nitely reduced. One effect, as has already been mentione to alter the moments of time when the alternating curren each phase passes through zero or a maximum, but more portant is the lesser amplitude of the alternations or pu tions in the current. If the several phases or limbs are wo on entirely separate cores and have no common magn circuit, then, as L is increased, the time during which the is actually reversed becomes gradually reduced, until, f certain value of L, the flux is never reversed, but simply va from $B_{max.}$ to zero. With a still further increase of L, the varies from a maximum to a minimum, but always remain the same direction, so that we have, in effect, a constant n

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netic flux upon which is superposed an alternating flux. The greater the amount of the inductive action, the flatter becomes the curve of instantaneous current, until in the ideal case of a very high inductance, the core of each phase will carry approximately a constant flux corresponding to half of the out-of-balance current.

When the limbs are entirely separate magnetically, $\frac{C_0}{2}$ would tend to impart to the cores an initial and permanent magnetisation upon which would be superposed an alternating magnetisation; the result would be an unequal change of flux in the two limbs for the same variation of the current on either side of the mean, *i.e.*, an unsymmetrical hysteresis loop, and the simultaneous values of dB/dH in the two limbs, or, which is the same, of L_7 and L_8, would not be the same at each instant. In this case the normal division of the total out-of-balance current between the phases at any instant is altered, and adjusts itself automatically to the changing conditions, or it may be said that the imaginary division of the current in each limb into its alternating and direct-current component is no longer so true a representation of the facts. But as soon as the two limbs of the balancer are wound over a common core, if the direct-current out-of-balance components could be arranged to magnetise this common core in opposite directions, they would cause no resultant initial flux, and the alternating flux would alone remain. This can always be secured without any difficulty so long as the balancer has an even number of limbs, 2, 4, 6, &c., which can be arranged in pairs, and this has, in fact, been shown in Fig. 1, where the out-of-balance components either both outwards from or both inwards to the centre will neutralise one another magnetically. We then return to a magnetisation varying between equal positive and negative maxima of flux, giving a symmetrical hysteresis loop and equal instantaneous values of L_7 and $L_8 = L$, as originally assumed. The difference in the ampere-turns of the two limbs is now the magnetising force, and the rise and fall of this difference simply reproduces the natural alternating current which magnetises the common core and supplies the requisite counter E.M.F.

To design the static balancer it is then only necessary to remember that the winding of each of the n phases must carry $\frac{1}{n}$ of the total out-of-balance current *plus* the natural alternating current, which would arise if the effective voltage $\frac{V_e}{2\sqrt{2}}$ were applied to the phase.

The problem of design usually presents itself as follows. It is, with given resistances of the network, by what percentage may the voltage on one side be permitted to exceed the true mean voltage? If not given, the resistances of the network must be approximated. Let y = the fraction which the excess voltage on one side may be permitted to be of the true mean, $\frac{V_e}{2\sqrt{2}}$. Then from equation (13) the resistance ρ of each phase of the balancer *must* be such that

$$\frac{\rho}{n} = \frac{yR_1R_2}{R_1 - R_2 - y(R_1 + R_2)} - \frac{R_a}{2n}, \quad . \quad . \quad . \quad (18)$$

$$\rho = \frac{y \,.\, n \,.\, R_1R_2}{R_1 - R_2 - y(R_1 + R_2)} - \frac{R_a}{2}. \quad . \quad . \quad . \quad (19)$$

The value of C_0 with the shunt circuit included can also be given in simple terms when $q = \frac{1}{2}$. Without any balancer

$$C_a = \frac{E_a}{\dfrac{(R_1 + R_2)R_s}{R_1 + R_2 + R_s} + R_a}, \quad . \quad . \quad . \quad . \quad . \quad (20)$$

where R_s is the resistance of the shunt, and the current through the network is $C_b = C_a - c_s$, where c_s is the shunt current. The full expression for W' is then the denominator of (13) instead of simply $R_1 + R_2 + R_a$, and

$$C_0 = \frac{(R_1 - R_2)(C_a - c_s)\left\{\dfrac{(R_1 + R_2)R_s}{R_1 + R_2 + R_s} + R_a\right\}}{2R_1R_2 + \rho(R_1 + R_2 + R_a) + R_a(R_1 + R_2 + \frac{1}{2}R_a)}. \quad . \quad (21)$$

The inaccuracy in the denominator of C_0, due to the addition of the shunt circuit, is negligible, and allowances can be made for the resistance of the series magnet winding in the values assumed for R_1 and R_2.*

In the two-phase case one winding is placed on each limb of the closed magnetic circuit, or, preferably, half of each phase is wound on each limb, as in Fig. 10. In the four-phase case, either two separate two-phase choking coils may be employed, or, better, the two magnetic circuits have a common yoke, the section of which is approximately $\sqrt{2}$ times the section of either core (Fig. 11); in each pair of phases the coils may be wound one over the other or intermixed. The six-phase case requires a three-legged choking coil either as in Fig. 11, but with limbs of equal section, or with three limbs at the corners of a equilateral triangle, united top and bottom by three-armed stampings.

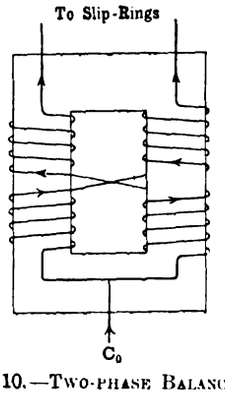

FIG. 10.—TWO-PHASE BALANCER.

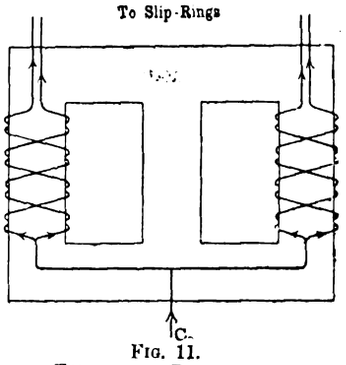

FIG. 11.
FOUR-PHASE BALANCER.

In all cases the advantage of increasing the number of phases is to distribute the out-of-balance current more uniformly over the armature winding and so to lessen the power wasted and reduce the local heating near the armature tappings just as in a rotary converter. It is not, however, worth while to go beyond six phases.

The three-phase arrangement stands quite by itself, inasmuch as it is not possible to annul the constant flux unless the middle wire connection is itself wound round each of the three cores to the amount of one-third of the number of turns on each limb of the balancer winding proper, *i.e.*, sufficient to counteract the direct-current ampere-turns of the three phases (Fig. 12). Unless this device, due to Prof. Steinmetz, is adopted, the cycle of flux-density in the iron core is carried out fairly high up on the curve of magnetisation, and, in consequence, the hysteresis loop and the hysteresis loss is greater. The extra expense of adding a fourth slip-ring is, therefore, usually warranted by the greater economy in working.

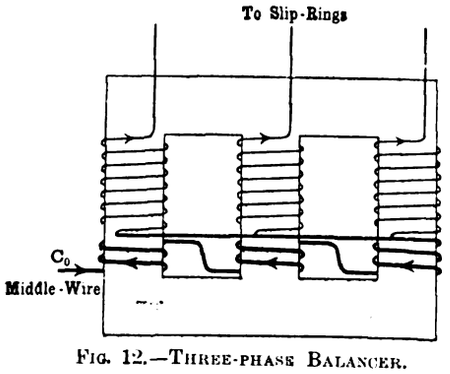

FIG. 12.—THREE-PHASE BALANCER.

An objection to the use of static balancers may finally be mentioned; it is that difficulty may arise when they are used with two or more dynamos working in parallel, unless the out-of-balance current is fairly small as compared with the current of the smallest generator. It is, therefore, best adapted to the case of a single generator in a large installation, *e.g.*, of a factory which uses appliances of low and of high voltage.

* In the three-phase case the denominator of equation (21) becomes

$$2R_1R_2 + \frac{2}{3}\rho(R_1 + R_2 + R_a) + \frac{2}{3}R_a(R_1 + R_2 + \frac{1}{6}.R_a),$$

and in the four-phase case,

$$2R_1R_2 + \frac{\rho}{2}(R_1 + R_2 + R_a) + \frac{R_a}{2}\left(R_1 + R_2 + \frac{R_a}{4}\right).$$

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CORRESPONDENCE.

THE NOMENCLATURE OF PRIMARY AND SECONDARY SOURCES OF LIGHT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: If practical units in any branch of engineering are found to differ from scientific units, it need not be assumed that there is any conflict or confusion. The measurements of pressure as a head of water in feet, or as a pressure per square inch, or in atmospheres, or even as millimetres of mercury, are all unscientific. The scientific unit is the dyne per square centimetre, and the International Physical Congress at Paris in 1900 recommended that it should be called a *barie*. Somebody else called it a *barad*, and the *megabarie* was so inviting to others that nothing was done. Meanwhile the dyne per square centimetre is modestly waiting outside the engineer's office (gossiping no doubt with a poundal), until the dyne has got taken on. We still graduate our steam gauges in pounds per square inch.

There are two primary physical quantities in photometry—the one, luminous intensity, commonly called candle-power, and the other luminous flux, the unit of which is the lumen. From a point source of I candles there is a luminous flux of $4\pi I$ lumens. One candle-power is therefore the luminous flux per steradian or unit solid angle. The secondary quantity called illumination may be defined as the illumination produced by 1 c.p. at a distance of 1 ft. on a surface facing the light, or by the lumens per square centimetre. I do not, as Mr. Murphy suggests, object to the latter mode of defining illumination, but the question is, Which is the most convenient method for engineers and borough surveyors? I agree with Mr. Murphy that the rating of a projector lamp in candle-power is generally meaningless.

In electric and magnetic units, 4π is sometimes discovered in unlikely and apparently useless places. Attempts have been made to put it in a convenient place by so-called rational systems of units. Oliver Heaviside proposed that a unit magnetic pole should be defined as the pole from which unit magnetic flux proceeds. A pole thus defined would have a strength of m units if it attracts or repels another equal pole placed at a distance d centimetres, with a force of $m^2/4\pi d^2$ dynes. The Heaviside units would all be incommensurable with our practical units. Giorgi made the ingenious proposal to eradicate 4π from the units of current magnetic flux, &c., and to plant it in the permeability or dielectric constant of ether or air where it would trouble nobody.

Mr. Murphy asks whether I would prefer to measure the density of a magnetic field in terms of feet and unit poles. Setting aside the fact that I should probably turn my rule over and use millimetres, if the measurement were feasible, I find myself debarred for the simple reason given by him, "unit poles or unit charges do not exist." Why he prefixes this statement by "fortunately for the practical engineer," is not clear. But the analogy must not be pushed too far. The trouble about magnetic poles is that the lines of force from them seldom radiate from a point in straight lines. An advantage in optics is that the radiation is in straight lines, and except in unusual circumstances, the source may be regarded as a point. In other words, the law of inverse squares applies, and when Nature is so obliging as to work to this law, engineers are generally glad to take advantage of it. In optics we may use 4π or drop it, whichever is most convenient, without affecting our units.

I have pointed out elsewhere in connection with this question that there are three ways of measuring rainfall: First, tons per acre or cubic feet per square foot—that is, three dimensions of water and two of land; second, square feet per lineal foot, as in gauging the section of a river, two dimensions of water and one of land; or, as rainfall is commonly described, inches on or at a point, one dimension of water and none of land. All three are convenient. According to the reasoning of Mr. Murphy, Mr. Carl Hering and others, the last method is an anomaly. Though the schoolmen calculated how many angels could dance on the point of a needle, no quantity of water can rest on a point. The expression of rainfall in inches is an economy of dimensions derived from measurements made with a rain-gauge. In general, an engineer does well in avoiding quantities with redundant dimensions, though at his leisure he may reflect that some have been suppressed.

The projected area of a candle-flame in a horizontal direction is about 0·4 sq. in. Since it emits 1 c.p. the specific brilliance of the flame may surely be described as 2·5 c.p. per square inch. Mr. Murphy says that "if the light source has area it cannot (except by a conventional licence) be measured in candle-power." Does this conventional licence refer to the fact that it is not a point source? This is the sort of question which often confronts an engineer. He has to determine the error involved and consider whether he is justified in neglecting it. It can be shown that at a distance of 9 in. the light from a candle-flame is about 1 per cent. smaller than from a point source. That is less than the error of observation with such a source, and 9 in. is a smaller distance than is generally used on a photometer. At 6 in. the difference would be about 2 per cent.

While in various theoretical considerations, the conception of luminous flux is a necessity and 4π must put in an appearance, I maintain that for other purposes there is nothing unscientific or illogical in using candle-power as the unit of luminous intensity, candle-power per square inch or per square millimetre as the unit of intrinsic brilliance, and the foot-candle as the unit of illumination. Two letters by Mr. Roger T. Smith in recent numbers of the "Railway Gazette" show that illumination is often a more important quantity than candle-power for the practical engineer.—I am, &c.,

Westminster, June 13. A. P. TROTTER.

IMPENETRABLE TARIFFS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have before me the copy of a speech made a few days ago by the chairman of a large electrical engineering company on the occasion of their annual meeting of shareholders. Amongst other things it contains the following statement: "It must also be remembered that in this market of free imports we have to meet the competition of most powerful continental manufacturers, who with their home markets secured to them by *impenetrable tariffs* are able to work at a good profit," &c. By "powerful continental manufacturers" I suppose the speaker means, principally, German manufacturers. If so, I cannot understand how such a statement passed unnoticed and without protest from those present at the meeting, some of whom must surely know that the German tariff is anything but impenetrable, at least as far as it applies to electrical material. The import duties levied in Germany on electrical goods of English origin work out at about 2 to 4½ per cent. of the value for motors, ¾ to 1½ per cent. of the value for glow lamps, 3 to 4 per cent. of the value for turbo-generators, whilst lead-covered cable and a few other classes of goods pay no import duty at all.—I am, &c.,

London, June 10. C. PFEFFER, General Manager A.E.G. Electric Co. (Ltd.).

A QUESTION OF IDENTITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: A post card signed "J.S.", recommending the recipient to read some article in a periodical, has been widely circulated; and those of my professional friends I have met since have asked me about it. May I use your journal to tell those I have not met that I am not the "J.S." who wrote the post card? I never recommended anybody to read anything.—I am, &c., J. SWINBURNE.

Westminster, June 15.

Electricity Supply in Italy.—According to the "Elektrotechnik und Maschinenbau," there were last year 250 gas works and 7,127 electricity supply stations in Italy; 5,148 of the latter only supplied private plants. The total gas consumption was 8,180 million cubic ft., and the total electricity consumption 113 million kw.-hours. The electricity consumption increased 18 per cent. over that of the previous year.

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TROUBLES ON OVERHEAD POWER LINES.*

BY C. W. R. CAMPBELL.

In the first instance, the geographical direction of the line has a decided influence on the effect of atmospheric disturbances, so far as I have observed in this country; here it is, I think, common experience that the most troublesome lines are those running north and south, or in wave form over high and low ground. This, unfortunately, is beyond our control commercially.

As to the spacing of the conductors on the towers. It is acknowledged, I think, that the correct arrangement of conductors is that with the apex of the triangle on top; and I think that where overhead earth wires are used, it would always be better to carry the top cross-arm out, so that the outside earth wire would be at least 18 in. clear of the outside conductor if any sag or breakage took place. This would enable the line to be kept in commission until a repair can be effected; and I have an idea that from the protective point of view this arrangement might be better.

With insulators the chief troubles experienced beyond faulty material (which is rare nowadays) have been through flashing-over caused by lightning, or by birds, and I fancy the bird trouble is the greater. I say this because of the numerous instances in which birds are found at the foot of the pole in question, with signs of burns. With regard to flashing-over caused by surges and lightning, it appears that little damage is usually caused by the actual flash-over, but a fractured insulator is nearly always caused by the arc following the flash-over.

With regard to the lines formerly in use, erected on shorter poles, a great deal of trouble used to be caused by objects being either blown over the lines and guard wires, or maliciously thrown over. A great source of trouble during high winds, which is not, by the way, confined to lines with short poles, is from long strips of gum-tree bark and branches. These are often carried quite long distances. The [illegible] wire trouble has sometimes been very serious in certain districts, more particularly so since the wire does not easily fuse and clear itself. Modern transmission tower lines are not very subject to these troubles, as they are so much higher.

With reference to lines coming down through breakage due to faulty material (which is rare), or burning through broken insulators, a point of interest is the method of binding the conductors on the insulator. From the repair-gang's point of view, and I also think from the point of view of cost, the ordinary binding wire is perhaps preferable to any form of clamp. In any case, the line has to be pulled up and repaired, but if clamps are used on long spans the strain at the moment of breaking is bound to bend over a certain number of insulator pins, which would have to be replaced; whilst with binders the copper slips through and saves the pins. Turning to the long-span construction with suspension type insulators for straining at corners and certain definite distances and pin-type intermediate, several breakages of the suspension type have occurred. It is generally very difficult to diagnose the trouble; in only one instance have we found an undoubted case of puncture. In some cases, I believe, owing to the straps not bedding properly on the bells, any extra strain during very high wind cracking the porcelain, and the shock breaking through the other insulators in series. In several instances—in fact, in most—it has been possible, after the first trip caused by the breakage, to continue to keep the line in, with the shackles on the other side of the tower supporting the conductor. It has been suggested that the loop between the two strain shackles should be carried on a pin-type insulator above the cross-arm instead of below, as is customary. I think, however, that, apart from the additional cost, the chance of being able to keep a line in service until a convenient time for repair is greater with the loop below the cross-arm. The reason for the conductor itself generally holding up is that the burning is confined to the U pieces of the suspension insulators, which clear themselves. When a line runs through a dip, trouble is sometimes caused by the line having been originally pulled up too tightly during the hot season. On the first frosty night it contracts and pulls away from the binders, in some cases even coming in contact with the cross-arm above.

With regard to pole lines in soft ground, great care has to be observed in avoiding chances of wash-outs during heavy rains. Also in such cases it is essential to put plenty of wind-stays. In any long length of straight line where poles are used, it is preferable to stay the shackle poles on all four corners to avoid the trouble spreading in cases of line-breakage. With regard to the staying of poles, an annoying source of trouble is a cow or mule rubbing itself against the stay and setting the conductors and earth wires swinging. Barbed wire is recommended by some to prevent this, but fencing round the chief danger points seems to be the only remedy.

Trouble has frequently occurred through the guy-rods not having been set in a direct line with the pull. The safest plan is to undercut the hole for the plate, and cut a slot in the ground for the rod; this disturbs the ground very little, and the guy needs little attention after.

Outside links should, of course, be avoided when possible; but seeing that they are frequently unavoidable, a few notes may be of interest. The jumpers from the main line to the branch line links are sometimes connected straight on to the metal carrying the link contacts. This is bound in time to cause trouble if the links are on a separate pole, owing to the constant movement gradually loosening the links. The jumpers should invariably be carried to a separate insulator on the link pole, and then connected by a lead as flexible as possible to the link contacts. The older type of links were usually carried on the top of pin-type insulators; these were very inconvenient to handle, and the suspended type should always be used. It is important to carry all wiring to the links on the top of the frame, so as to allow the space below them to be absolutely clear for operating safely.

* Extract of a Paper read before the South African Institute of Electrical Engineers.

DISCUSSION.

Mr. BERNARD PRICE thought it was always necessary in overhead work to have some means of curing the trouble after it had taken place, as well as endeavouring to design lines so as to prevent it. If they had a long transmission line, such as was now in use in that district, they must, in considering the effect of lightning, distinguish between two possible effects —the local effect on the line, and the effect on the sub-stations and the stations at the end of the line. The local effect was extremely difficult to avoid entirely. The earth wires over the lines were probably of some advantage, but it was still very difficult to prevent damage to insulators, especially in severe storms. It might be possible, by increasing the size of the insulators, to prevent almost entirely, if not entirely, the induced effect from a neighbouring flash, but it seemed impossible to safeguard against a direct flash on the lines, for that must cause damage to the insulators. The metallic ring around the insulators was said in America to go a long way towards safeguarding the insulators. It had not been tried here, and it would be a matter of considerable difficulty and expense. It was very unusual to find two lines damaged in the same storm on the same route, so if one arranged the network by running the lines feeding a given section or district by different routes, in a given storm no two lines at one point would be affected. Thus, local effects on the lines need not cause a stoppage of supply unless the automatic tripping gear on switches should fail, or the effect was transmitted to apparatus in the sub-stations or stations at the end of the line. His experience was that they were still very far from having an entirely satisfactory safety valve for high frequency effects at stations. There was also the question as to whether overhead line troubles would not be very much reduced when higher pressures were used. In the course of 12 months they would be running lines at 80,000 volts in that district, and judging from the published experience of companies operating at 100,000 volts, many of the present troubles might be expected to disappear. He believed that in the region of 100,000 volts they were reaching a point where the insulation provided for the lines approached that necessary to deal with the high frequency overhead effects that took place at times of lightning discharge.

Mr. A. E. GIBBS noticed that the author had omitted all mention of one cause of trouble with overhead power lines, namely, pilot cables. The birds brought the sportsman with his gun, and trouble followed. Often the shot only just penetrated the lead sheath, and the trouble did not show itself till the next rain-storm. A point of interest in a long overhead power line was that, while still dead and free at either end, quite a heavy shock could be received from it. When building a long line it was necessary to earth it at frequent intervals. The charge was not due to a lightning storm, but would be there on an absolutely fine day, more especially if there was a high wind. On a fine, dry, windy day one could get a big shock from the lines.

Mr. G. A. WEBB corroborated the point mentioned by Mr. Gibbs, and said he found that he could obtain a much heavier discharge from the lines when there was a very intense sun. He once had trouble with some guard wires owing to expansion and contraction, resulting in breakages; he got over the difficulty by using eye bolts about 2 ft. 6 in. long, and placing spiral springs of suitable dimensions between a back plate and the cross-arm. This arrangement answered perfectly. Some such method must be beneficial to the conductor, as when contraction took place (provided the springs were suitably proportioned to the length of line) there would be no elongation of the conductor, the contraction being taken up by the springs.

Mr. G. NOWLAN thought it possible to protect a line by having a non-inductive resistance always on the line. In regard to the binders, the breaking of power lines was not always caused through the binders being too tight, or the wind, but it was caused by an electrical effect, because at high voltage a long stretch of wire not supported would get up a movement depending on the frequency.

Mr. G. T. PLUMB believed that after extensive experiments in Canada it was found that 75,000 volts gave the highest commercial efficiency, and he thought that arresters gave more trouble than the inductive effects.

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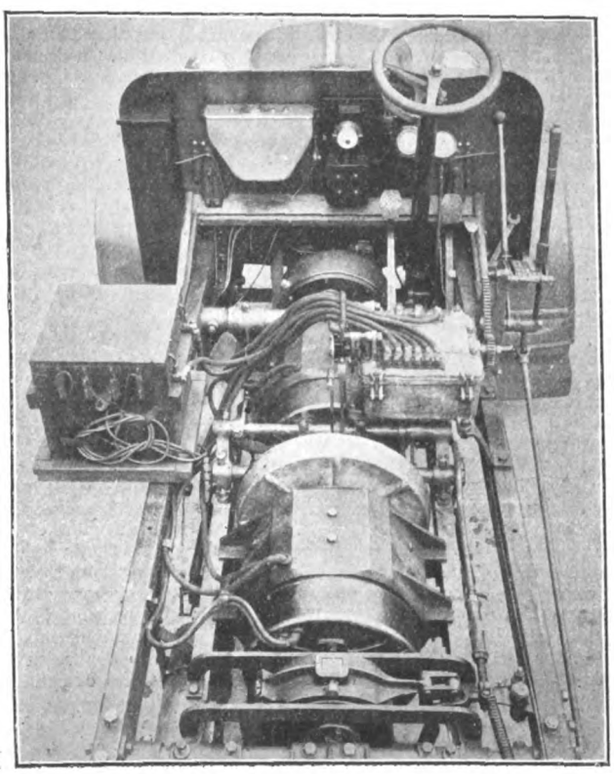
THE "THOMAS" ELECTROMECHANICAL TRANSMISSION.

In our issue of May 5th we described an electromechanical transmission system of a distinctly novel and interesting character which was installed on a 30–40 H.P. lorry. This vehicle was at that time under test by the Royal Automobile Club, a 2,000 miles' trial having been arranged over an exceptionally hilly route in Kent. We have now received a copy of the report which has been made by the club, and which shows that the vehicle came out of the tests with credit.

The illustration herewith is a top view of the transmission gear on the lorry after the R.A.C. trial. The battery seen at the left-hand side of the photograph is used for car lighting and also for starting the engine. The controller with its leads will be noticed at the right-hand side of the car.

The total weight of lorry fitted with the "Thomas" transmission was 4·5 tons; and a permanent load (sand) of 3 tons was carried, which with passengers brought the average running weight of the vehicle to 7·68 tons. Although the speed was not



Top View of Lorry after R.A.C. Trials.

allowed to exceed 12 miles per hour, the average speed worked out at 10·47 miles per hour. On a level route this speed limit would not have affected the fuel consumption, but on a hilly route such as that chosen it was a serious handicap, since it meant that it was impossible to rush any of the hills and so make use of the kinetic energy of the moving vehicle.

The report mentions that during the trial no work was done upon the transmission, except lubrication, 5½ oz. of oil being used for this purpose. The total water consumption throughout the trial was 20 gallons, or one gallon per 100 miles, whilst 265·8 gallons of fuel were used, equivalent to 7·55 miles, or 58 ton-miles, per gallon. There is no doubt that during the trials the continual strain and anxiety of the test affected the drivers to some extent, so that they could not drive as efficiently as at the commencement. A preliminary trial run over the route showed a fuel consumption equivalent to 9 miles per gallon. It should be noted that the above figure of 7·55 miles per gallon includes the charging of the battery for engine starting and car lighting.

Up Riverhill, which is ¾ mile long, the greater part of the gradient being 1 in 9·4, 1 in 10·1, 1 in 11·2 and 1 in 12·3, the fastest average speed was 7·2 miles per hour, the average of all ascents being 6·65 miles per hour. The average rise of temperature of the casings of the electrical machines after ascending the hill was 22·8°C.

The report concludes as follows:—

Condition after Trial.—The transmission was dismantled after the trial. The condition throughout (with the following specified exceptions) was found to be very good. The teeth of the double-helical planetary wheels were found to be somewhat worn. In the controller box two brushes, four sparking tips and a brush contact block were found sufficiently burned to require replacing. This was done by one man in 7 min. 57 sec.

It may be noted, however, that the planetary gear wheels had been used for 2,000 miles before the official trial commenced.

HOLBORN STREET LIGHTING.

At the meeting of the Holborn (London) Council on Wednesday the question of the improved lighting of the borough came up for consideration on reports from the whole Council sitting in Committee and from the Finance Committee.

It will be remembered that, as a result of a recommendation last year by the Works Committee in favour of the gas company's tender (£7,527) being accepted as against a tender by the electric light company at £6,602, the report was sent back, with instructions to obtain fresh tenders on a definite specification to be prepared by the borough surveyor. The gas and electric light companies then submitted a joint tender for the lighting of the borough partly by gas and partly by electric light, the disclosure of the various companies' figures for the previous tenders having made this (as the companies contended) imperative. This joint tender was then referred to the whole Council for consideration. The report now submitted that they had considered the tender of the Gas Light & Coke Co. and the Metropolitan Electric Supply Co. for the public lighting of the borough and which provided for an entire re-arrangement of the present system of lighting so that approximately one-half of the borough would be lighted by gas and the remainder by electricity. The companies undertook for £6,950 per annum to install and maintain suitable lamps and fittings and to supply electric current or gas as necessary for giving a minimum of 425,140 c.p. There would be 20 electric arc lamps of 1,800 c.p. in High Holborn, New Oxford-street, and Kingsway, 13 electric lamps of 600 c.p. in High Holborn and New Oxford-street, two 400 c.p. electric lamps in Brooke's Market and in Chancery-lane, 54 in Gray's Inn-road, 42 in Theobald's-road, four in Holborn-circus, 22 in Farringdon-road, 28 in Clerkenwell-road, 1 in Hart-street, seven in Bloomsbury-square (South), one in Vernon-place, 13 in Great Queen-street and 18 in Southampton-row (Vernon-place and Russell-square), one 300 c.p. lamp in Endell-street, and four 180 c.p. lamps in Queen-square, Bedford-row, Endell-street, and Onslow-street, and 716 90 c.p. lamps in the remaining streets of the borough, giving a total of 966 electric lamps on 957 columns, against 879 gas lamps on 879 columns. The report further stated that the present tender was made on a specification prepared by the borough surveyor which was approved by the Council on March 8 last, and provided for all new lamps and fittings and contained proper conditions for the protection of the Council in all respects, and on the basis of a 10 years' contract determinable at the end of the fifth year by the Council, on payment of £4,400 fifth and smaller sums in subsequent years. In a letter which accompanied the tender, the companies stipulated, however, for the deletion of clauses 34 and 35 in the specification, otherwise the annual payment would be increased 10 per cent. Clause 28 provided for the imposition of a fine upon the contractors in the event of the nominal candle power falling more than 10 per cent. on an average of 30 lamps taken on three successive nights. Clause 35 provided that the contractors shall adopt any subsequent improvement in burners, lamps, or appliances that may be made, without additional cost to the Council. As regards clause 34, the opinion of the Committee, the condition was too onerous, and might well be deleted. They were strongly of opinion, however, that clause 28 should be adhered to, as upon that clause it depended entirely whether the Council should retain any control over the efficiency of the lighting. Negotiations had taken place with the companies on the point, but without any satisfactory result. They concurred in the opinion of the Works and General Purposes Committee that a proposed new clause by the companies was quite unacceptable, as not only did it allow of a not reduction of no less than 20 per cent. in the candle power, but the penalty for exceeding this limit would be so trifling and difficult of enforcement as to be practically useless. They were unable to recommend any other than a general scheme for the whole borough, and they, therefore, saw no alternative but to accept the condition on which the companies were willing to be bound by clause 28 as originally drawn, *i.e.*, by making an extra payment of 10 per cent. on the contract price, which would therefore be £7,645, instead of £6,950 per annum. They recommended the joint and several tender of the Gas Light & Coke Co. and the Metropolitan Electric Supply Co. for lighting the streets of the borough for

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years for £7,645 per annum, subject to the deletion of clause 35 in the specification, and the amendment of the schedule of lighting as proposed by them, be accepted, and that the seal of the Council be affixed to the necessary contract to be prepared by the town clerk.

In a report on the subject the Finance Committee advised that before the Council adopt the recommendation of the Committee of the Council with regard to improved lighting the words "subject to the consent of the London County Council being first obtained to the form and principle of the Contract" be added to the recommendation of the Committee, or alternatively that the recommendation of the Committee be referred back for negotiations with the Companies to ascertain the cost of purchasing columns, lamps, lanterns, &c., outright.

The Mayor (Mr. HORATIO PORTER) moved the adoption of the report of the Council in Committee.

Mr. C. E. GREEN reviewed the circumstances which had led up to the present situation and said the Works Committee had lost the opportunity of a system of obtaining increased lighting for the Borough at a saving of £2,000. He thought the Council could still obtain a tender which would be more economical than the present tender, which he urged should not be accepted.

Mr. MAY CLARKE said the Committee had never asked for more than £9,000. The lighting companies sent in tenders for a light exceeding that, and the Council had either to accept or reject; they had no power to amend. He was still of opinion that the lighting of the side streets was insufficient.

Mr. N. GLAVE said the Borough was not properly lighted. The principal lighting came from the public houses and the theatres. Everybody's tendency was to give more light, and if they wanted more light it would have to be paid for. He thought the recommendation before them was the best solution of the problem. In addition it would give an excellent idea as to which was the ideal system. He thought strongly that the tender should be accepted. The increased expenditure was comparatively small as they were getting three times the light.

Mr. J. H. WRENTMORE said the report ought to be referred to the Works Committee for consideration and further report.

Mr. W. GIBBS KENT supported the suggestion that the report be referred to the Works Committee, together with the report from the Finance Committee.

Mr. W. G. COXEN said the approximate cost of lamps was £9,000 and if they made a capital expenditure to cover that item their annual expenditure would be reduced by £1,000 at least.

Mr. MAY CLARKE said the matter of the £9,000 referred to by the Finance Committee had never been before the Works Committee.

After further discussion the matter was referred to the Works and General Purposes Committee for further consideration and report.

LEGAL INTELLIGENCE.

National Telephone Co. v. H.M. Postmaster-General.

On Wednesday the Court of Appeal (the Master of the Rolls and Lords Justices Farwell and Kennedy) commenced the hearing of the cross appeals from a judgment of the Railway and Canal Commission in this case (reported in THE ELECTRICIAN for June 2, p. 308).

The Railway and Canal Commission held (by a majority) that the notices given by the Postmaster-General with regard to the three London exchanges were good but that the others were bad as being too vague, and that was no answer to say that it would have been difficult to have stated more explicitly the plant, &c., objected to.

The Attorney-General, the Solicitor-General and Mr. Branson appeared for the Postmaster-General, and Sir A. Cripps, K.C., Mr. Danckwerts, K.C., Mr. Morton, K.C., Mr. Forbes Lankester, K.C., and Mr. H. Gaine for the Telephone Company.

The ATTORNEY-GENERAL, in opening the case for the Postmaster-General, said the question their lordships had to determine was what construction to be put upon certain clauses of the agreement for the purchase of the Company's undertaking. There were substantially two points involved. One was as to the validity of certain notices of objection by the Postmaster-General and the other point was as to the meaning of certain words in the agreement, and the particular point involved in the appeal was whether the Postmaster-General was right in saying that he was not bound to take over plant which was duplicated. In other words that the Postmaster-General was not bound to take over plant which was not necessary for his requirements because he had already got plant which was sufficient to supply the wants of his subscribers. Whatever the result of the appeal was they had to go back to the Railway and Canal Commission in order to determine questions of fact of considerable complexity which were involved in the judgment of the Commission. He submitted that it was a reasonable construction to be put upon the phraseology of the agreement to say that the Postmaster-General was bound to take over the whole of the land, plant and buildings of one of the Company's exchanges when the Postmaster-General had got practically all but the corner the whole equipment necessary for the purpose of supplying his subscribers. He contended that the Postmaster-General was not bound to take over the plant, &c., in any area where the Post Office was sufficiently supplied with plant. What had to be examined were the needs of the telephone service of the Post Office at the date when the Company's business was taken over by the Post Office and not. The real point for decision was to ascertain the needs of the Post Office for carrying on the combined business of the Company and the Post Office at the date when the business of the Company was taken over by the Post Office.

The Solicitor-General followed on the same side. Sir A. Cripps opened the case for the Telephone Co., and the case was proceeding when we went to press.

Hartlepool Electric Tramways (Ltd.) v. Mayor and Corporation of West Hartlepool.

Mr. Justice Bray had this action before him again on Wednesday. The facts were reported in THE ELECTRICIAN for May 12, p. 183.

Mr. ATHERLEY JONES, K.C., for plaintiffs, said the subject-matter of the action had already been before his lordship in the form of a special case, when it was pointed out that the award of the arbitrator was not in statutory form, and a suggestion was made that some arrangement might be come to between the parties, so that the issue between them might be properly formulated. It had now been agreed that the value of the undertaking should be taken to be £12,963, and the only question remaining for decision was whether the purchase money was payable to the promoters (Messrs. Sellon and Francis Ashby), or to plaintiff company, who were the assigns of the promoters. There was no legal assignment to the company by the promoters, but there was an equitable assignment. No sanction was obtained from the Board of Trade, as required by Statute. It was contended that Messrs. Sellon and Ashby were, and still remained, promoters of the undertaking, but that they had no property whatever in the undertaking, and, therefore, could not receive payment for that which they did not possess. A second contention was that plaintiff company were mere trespassers, inasmuch as no statutory assignment had been executed to them, whatever the rights between the plaintiff company and the promoters might be.

Mr. BALFOUR BROWNE, K.C., for the Corporation, submitted that there was no one to whom the Corporation could pay the purchase price.

His LORDSHIP: I cannot order payment of the money, but I can order specific performance. Then a question will arise as to the title to the tramways.

Mr. BROWNE: We have agreed the value of the things belonging to the promoters.

His LORDSHIP: I think the payment ought to be made to the promoters. No one else has any right to bring this action.

Mr. BROWNE: The promoters were paid out by plaintiff company, and the company cannot be said to have constructed the lines for the promoters.

His LORDSHIP: To whom does the tramway belong?

Mr. BROWNE: To nobody. Plaintiffs have no title to it.

His LORDSHIP: The promoters have not lost their power to work the tramway. Whatever the rights may be between the two people one does not know; but the question in law is, who has the power to work the tramways?

Mr. BALFOUR BROWNE said he thought the promoters had lost their power to do so through not exercising their right. Neither the promoters nor plaintiff company had any property to sell. Plaintiffs might have property in the rails, if they liked to take them away. Plaintiffs ought to get a private Act of Parliament or a provisional order, and then the Corporation would pay the money.

Mr. ATHERLEY JONES: I do not think a provisional order is required. All we need is the sanction of the Board of Trade.

His LORDSHIP reserved judgment.

PARLIAMENTARY INTELLIGENCE.

COAL MINES BILL.

The Standing Committee of the House of Commons on this Bill resumed its sittings on Wednesday.

Sec. 32 (1*b*) provides that no lamp or light other than a locked safety lamp shall be allowed or used in any seam (except in the main intake airways, within 200 yd. from the bottom of the shaft) in which an explosion of inflammable gas causing any personal injury whatever has occurred within the previous 12 months.

Sir W. MENZIES moved the omission of this sub-section, and stated that the miners, mine-owners and mine-managers in Scotland were unanimously in favour of this being done.

On a division the sub-section was carried by 19 votes to 18.

Mr. MASTERMAN then proposed the following addition to the sub-section:—"unless an exemption is given by the Secretary of State on the ground that on account of the special character of the mine the use of safety lamps is not required." This exemption would embrace, among others, the thick seams in South Staffordshire and such places as the Cleveland iron mines and the shale mines in Scotland.

The amendment was agreed to, and the clause as amended added to the Bill.

Corporation of London (Bridges) Bill.—In the House of Commons on Wednesday this Bill, which provides, amongst other things, for the building of a new bridge across the Thames and the construction of a new street with tramways from North to South London, was re-committed for further consideration.

Gréater London Railway Bill.—A Select Committee of the House of Commons resumed consideration of this Bill on Wednesday, when further evidence in opposition to the scheme was given on behalf of the Finchley and Hendon Councils.

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COMMERCIAL AND INDUSTRIAL SECTION

MUNICIPAL, FOREIGN & GENERAL NOTES.

BRITISH NOTES.

Aberdeen.—The Council have decided to replace with new car bodies fitted with top covers four of the old horse cars, at a cost of £425.

Aldershot.—An inquiry will be held into the application of the Council for sanction to a loan of £2,500 for the electricity undertaking.

Application for Extension of Patents.—Application is being made for an extension of the term of the patents Nos. 1,020 and 1,022/1898, granted to Charles Hy. Stearn for "Improvements in the manufacture and production of a filamentary material and fabrics therefrom" and for "Improvements in the manufacture and production of a filament in film, sheet or web form." Objections to the chambers of Mr. Justice Parker, Royal Courts of Justice, London, by July 22.

Barnet.—The Council have asked the Board of Trade to appoint an arbitrator to deal with the dispute with the North Metropolitan Electrical Power Distribution Co. as to the price for current for lighting under the existing agreement between the parties.

Colchester.—The Electricity Supply Committee have adopted a scheme of hiring out domestic electrical apparatus, flat-irons, &c.

Coronation and Annual Holidays.—We are informed that the following arrangements have been made for Coronation and annual holidays:—

Willans & Robinson's offices and works will be closed on June 22, 23 and 24 and from Friday, Aug. 4, to Monday, Aug. 14. A small staff will remain to deal with urgent correspondence and replace parts, but the company ask that no goods be despatched to arrive during the above periods.

Pope's Electric Lamp Co. announce that their works will be closed on June 22 and 23 and (for the annual outing) on June 24.

Coronation Illuminations.—*Bristol* and *Colchester* Corporations will supply current for Coronation illuminations at 1½d. per unit.—At *Colwyn Bay* current will be supplied free for outside illuminations during the Coronation festivities.—In another column we give some particulars of tenders accepted by *Wigan* Council for material for Coronation illuminations.—Residents at *St. Anne's-on-Sea* will be supplied with current at cost price.—The sea front at *Llandudno* will be brilliantly illuminated.—The front of *Portsmouth* town hall will be outlined with coloured electric lamps.—*Walthamstow* will supply during Coronation week at 1½d. per unit or (alternatively) at 1d. per 8 c.p. lamp for "illumination" purposes.—The festoons of electric lamps along the whole of the *Brighton* sea front are to be lighted nightly for a month from June 22, the whole of the illuminations including those at the Pavilion, the Mayor's Parlour and the Old Steine comprising from 10,000 to 11,000 lamps.—At *Hove* the sea front, town hall and other places will be illuminated electrically.

Dudley.—The Corporation have adopted the recommendation of the Tramways and Lighting Committee to extend the electricity generating plant and mains at an estimated cost of £8,140.

Kilkeel (Ireland).—At a recent public meeting it was unanimously decided to form a public company for the erection of electricity works. Nearly the whole of the required capital was subscribed on the spot.

Light Railways.—The County of Hertford (Cheshunt) Light Railways Order (authorising the abandonment of part and revival of powers with respect to the remainder of the railway authorised by the 1906 order), and the Tarporley Light Railway (revival and extension of time) Order (reviving powers for purchase of land and extending period for same and for completion of works authorised by 1906 order) have been submitted to the Board of Trade for confirmation. Objections to the Board by July 7.

Manchester.—On Tuesday an inquiry was held into the application of the Corporation for sanction to borrow £12,186 for plant for the electricity department and also to expend on mains and service sums amounting to £50,000 which the Council had been authorised to borrow for certain other purposes.

The Town Clerk said that the £12,188 was the balance unborrowed at unsanctioned of £130,500, in regard to which an application was made 1908. The £50,000 was part of a sum of £75,000 authorised on June 1 1901, to be borrowed for street lighting. The Committee had not thoug it necessary to spend the £75,000 on street lighting, and they now desir to divert £50,000 for mains and services. He gave particulars of t present financial position of the electricity undertaking and said that i expansion rendered necessary the expenditure on mains and services an on the extension of the plant at the Stuart-street generating station.

Metal Filament Lamp Patent Litigation.—We have received for pu lication letters in regard to an alleged infringement of Letters Pate Nos. 23,899 of 1904 and 8,563 of 1907 owned by the Osram Lam Works (Ltd.) The letter addressed by the solicitors to the Osr Lamp Works (Ltd.) asks for an undertaking by the Corona Lam Works Co. to cease infringement and to deliver up any infring lamps in stock and also to provide full information as to the num and power of the lamps sold, in order that the amount of damage m be estimated. The reply of the solicitors to the Corona Lamp Wo Co. expresses surprise at the allegations of infringement, affirm that the Corona Co.'s lamps are manufactured by an altogether d erent method to those set out in the Osram Patents of 1904 and 1 respectively. The letter proceeds to intimate that the Corona are prepared to indemnify their customers against any proceed by the Osram Co. in regard to the "Corona" or "Mascot" lam and further that the Corona Co. will meet and defend any ac brought against them in this respect.

Newcastle (Staffs.).—Sanction to a loan of £5,400 for additi generating plant has been applied for by the Council.

Olympia Electrical Exhibition.—Announcement is made that a Electrical Exhibition at Olympia from Sept. 23 to Oct. 21 the Office telephone department is providing telephonic facilities exhibitors. Applications have to be sent in within the next few d

Penmaenmawr.—The Board of Trade have deferred the que of the revocation of the Provisional Electric Lighting Order.

Presentation.—The staff of the Lewes electricity Works have sented a barometer to Mr. J. Morris on his marriage.

Rail-less Trolley Traction in Yorkshire.—Arrangements have made for the formal opening on Tuesday next of the trackless t car services in Leeds and Bradford.

The service in Leeds will be to Farnley, and in Bradford from La dyke to Dudley, a distance of about a mile and a quarter. The ge details of the installations have been provisionally approved by Board of Trade, and the preparations are now practically compl It is intended that the opening of the lines in both Leeds and Brad shall take place at noon on Tuesday. The Lord Mayors of Leeds Bradford will open the routes in their respective cities and a joint lunc will afterwards be held in the Leeds Town Hall.

Redditch.—On the recommendation of the electrical engineer W. J. Ferguson) the Council have decided to put in a steam altern in place of two gas engines and a 100 kw. gas-driven alternator to carry out other extensions and improvements of the plant at a of £5,850.

Rotherham.—It is proposed to wire the outside market for electric light.

Stafford.—It was reported on Tuesday by the Gas and Electr Committee that the gross profit on the electricity undertaking fo past year was £2,734, and after meeting capital charges there w net profit of £607. It was decided to pay a bonus of 10·4 per c on the wages of the men employed at the electricity station.

Stoke-on-Trent.—An inquiry was held on Wednesday into the plication of the Corporation for sanction to borrow £60,000 for erection of a new three-phase generating station.

For the Corporation, Mr. THORN DRURY stated that there was an ur necessity for extensions of the electricity undertaking and the me proposed to be adopted was to erect a three-phase high-tension p station near the present Hanley electricity works, and to convert

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other four works in the area into sub-stations for transmitting the current. The details of the proposed expenditure were: Buildings £9,415, generating station plant £29,056, sub-station plant £8,435, e.h.t. mains £13,094 total £60,000. It certainly was not possible to face another winter without making provision for an increased supply, and he claimed that the course proposed to be adopted by the Corporation was the only one from the point of view of both economy and efficiency.

The Chairman of the Electricity Supply Committee (Mr. H. LEESE) and the borough electrical engineer (Mr. C. H. YEAMAN) gave evidence in support of the application. Mr. Yeaman said if the Council were going to meet their obligations an extension of plant was absolutely necessary. Extensions inside the existing works would not be economical, and he considered the scheme sound from an engineering point of view.

Mr. J. F. C. SNELL, consulting electrical engineer, also gave evidence in support of the scheme.

The North-Western Electricity & Power Gas Co., the North Staffordshire Railway Co. and others opposed the scheme.

Councillor J. S. GODDARD said a large body of ratepayers in the area were against the scheme.

Mr. C. S. VESEY BROWN, consulting engineer to the North-Western Electricity & Power Gas Co., said they were prepared to supply electricity in bulk to the Corporation. No capital outlay on the part of the Corporation would be necessary as the power company were prepared to lay mains and put down the transformer plant.

In reply to the Inspector (Mr. H. Ross HOOPER) witness said the company had no works at present. They had arranged to buy power from the Cockshead Colliery and from Messrs. Robert Heath & Sons' ironworks, but there was no legal agreement.

Mr. GRAHAM MILWARD said the borrowing of such a large sum would seriously impair the credit of the borough now and affect their future borrowing. Some parts of the borough at present were the highest rated areas in England. This loan was proposed at a time when the borough was unable to bear the pressure.

Mr. E. S. MARSHALL, for the North Staffordshire Railway Co., said the railway company viewed the financial position of the Corporation with great alarm, not only because they were the largest ratepayers in the area and had to pay large sums themselves, but because their welfare was bound up with that of the district.

Walsall.—Sanction has been received to the borrowing of £17,840 for the electricity undertaking, less £3,330 in respect of superseded plant and buildings.

Wharfedale (Yorks.).—A company is to be formed to supply electricity in the Wharfedale district, including Otley, Burley, Ilkley, Menston, Guiseley, Yeadon and Baildon.

Messrs. Newstead & Wade, solicitors, Otley, are acting for the promoters, and already two or three of the Councils interested have passed favourable resolutions. Yeadon Council have deferred the matter for a month pending receipt of further information. It is proposed that the maximum charge for current shall be 5d. per unit for lighting and from 3d. to 4d. per unit for power. The statutory notices to the Councils are to be served during the month.

Wimbledon.—Electric current will be supplied to consumers in Malden and Coombe at 6d. per unit for lighting and 2d. for power or heating with 1s. per quarter for a meter not exceeding 25 amperes and 2s. 6d. per quarter for a meter exceeding 25 amperes.

Application is to be made to the L.G. Board for sanction to borrow £50,000, the estimated amount required until March, 1914, for mains and house services (£4,225), meters (£895) and transformer sub-stations £650.

Current for external lighting will be supplied at 3d. per unit, provided consumptions for not less than 100,000 units per annum are received by July 31.

The Arc Engraving Co. offered a uniform rate of 1d. per unit for all energy supplied to their factory, with a guarantee of a minimum consumption of 30,000 units per annum. The power rate in force for the time being is to be charged for all energy supplied to the company as from July 1 last.

A subcommittee has been appointed to meet Messrs. Handcock & Dickes, representing the Fixed Price Lighting Co., to discuss an arrangement between the Corporation and the company for the supply of energy to private houses for lighting at a fixed price per annum.

Wireless Telegraph Notes.—The "British Australasian" is responsible for the following:—

Barrier to Wireless.—It has been ascertained that Cape Otway is a barrier to wireless communication with Melbourne. Mr. C. A. Hill, wireless operator on the "Themistocles," thinks that iron or other mineral deposits on the high land of the Cape intercept the messages and prevent them. On successive voyages he has been unable to call up wireless ships in the bay when on the other side of Cape Otway, but immediately the parallel was crossed he could speak to them with ease.

The Australian Commonwealth Government recently decided to appoint a wireless telegraphy expert in Australia, and we are informed that the candidates for the position are very numerous and these have now been submitted to the Commonwealth consulting engineer (Mr. Charles Bright, F.R.S.E.) for his consideration and recommendation.

York.—The L.G. Board have sanctioned a loan of £10,700 for extensions of the electricity undertaking.

In forwarding the sanction, the Board state that they are advised that the plant which it is proposed to instal will have the effect of superseding the small 74 kw. alternator sets at present in use, on which there is debt outstanding. They also learn that there is practically no reserve or depreciation fund to meet the renewals of plant which must shortly become necessary, and that, although a profit was made last year on the undertaking, the greater part of it was applied to relief of rates. In these circumstances it is with considerable hesitation that the Board have decided to sanction a loan for the full amount required for the new plant, and they urge upon the Council the necessity for the establishment of a reserve or depreciation fund in order to provide for the renewal or replacement of plant as it becomes worn out or obsolete.

Outing.—The employés of the Ealing Corporation electricity department had their annual outing last week.

The party travelled to Box Hill, where an excellent programme of sports was carried out, and at a luncheon which took place the borough electrical engineer (Mr. J. D. Knight) said the past year had been a trying one for their electricity undertaking and all their energies would be required in the coming years to make their success continuous and progressive. Mr. Knight subsequently presented the sports prizes and mentioned the impending departure of Mr. R. Golding (assistant engineer) for Australia.

COLONIAL AND FOREIGN NOTES.

Argentina.—A new concession (cancelling the concession they previously obtained) has been granted to the Buenos Ayres Western Railway Co. for an underground electric railway in Buenos Ayres from Calle Sadi Carnot to the port tramways, and two additional lines between Caballito and Moreno.

Australasia.—The "Australian Mining Standard" says Ballina (N.S.W.) electric lighting plant, which has been in operation about three months, was installed by the Provincial Electric Lighting Co., of Sydney, and consists of a 75 H.P. Crossley suction gas plant, and a 40 kw. d.c. generator giving 84 amperes at 480 volts and a battery of 264 cells

Ararat (Victoria) Council have appointed Messrs. G. B. Lincolne and J. K. MacDougall as consulting engineers for their proposed electricity undertaking.

In giving further evidence before the (Melbourne) Metropolitan Traffic Commission, Mr. R. P. Wilson said he recommended the conduit system of tramways for the city itself. The cost of the overhead system might be taken as £8,000 per mile of single track and the conduit system as £18,000. As a temporary expedient electric motors might be substituted for the present engines working the cable tramways in streets where the general traffic would not permit of the speed of the cars being accelerated. For traction and power there should be only one power house in Melbourne district, as that would give the best diversity factor. The Malvern cars (8 ft. 3 in. wide) were abnormal, 85 per cent. of the world's tramcars were 6 ft. 6 in., and in Melbourne the cars were generally 7 ft. 3 in. It would be better to sacrifice the Malvern cars for the sake of uniformity than put the £2,000,000 worth of cable cars out of commission.

Mr. Wilson, who is to submit a report to the Commissioner, has been allowed a fee of 250 guineas for the information he has given to the Commissioner and to the Railways Standing Committee.

The Tumberumba (N.S.W.) Railway League has asked the Public Works Committee not to furnish a report on the electrification of the proposed railway to Tumberumba until it has obtained a departmental report on the desirability of establishing a power station on Tumberumba Creek, as it is suggested that the larger and permanent water supply thus obtained would enable much greater power to be generated.

The city electrical engineer (Mr. H. R. Forbes Mackay) recently explained to Waverley Council a scheme for the extension of the Sydney municipal electric supply mains to Waverley, four miles from the city. The cost of laying underground mains was, he said, prohibitive, as underground mains in the city cost six times as much as overhead mains. He believed he could supply electricity in Waverley cheaper than the present gas supply. In the streets where he laid mains public lamps would be lighted at £3. 7s. 6d. per annum for light equal to the ordinary gas lights on a 10 years' agreement.

In giving evidence before the Royal Commission recently appointed to inquire into the system of letting N.S.W. Government contracts, Mr. A. Berckelman, secretary and ex-member of the Stores and Supply Department, said there was no such thing as favouring certain firms. For contracts from £20 upwards advertisements were inserted in the papers inviting tenders. In buying machinery the best expert advice was obtained, and if the experts decided that some different class of machine would suit the particular department better than the class the principal of the department had asked for, the whole matter would be placed before the Minister, and he would decide. A prime cost item was that which could not be described so as to be included in the specification. A sample room should be provided for prime cost items. He thought the Public Works Department should follow the example of the Stores Supply Department, by having the articles sent to a Government depôt and examined. Mr. Thos. Raw, assistant engineer in the Government Architect's Branch, said in contracts over which he had control the contractor obtained quotations from various firms for the article required, and these

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were submitted to witness, who passed them on to the Government architect with recommendations. It was the custom to select the lowest tender or give a good reason for not doing so. Mr. Wm. Corin, electrical engineer of the Public Works Department, said in a case like that of a contract at the Coast Hospital (which was under his supervision), which was let, say, two years before it was finished, he thought prime cost the best way to deal with items which could not be put into the original contract. Everything possible should be put into the contract, but there should be a clause with regard to some items which the Government should supply, and possibly another clause including prime cost items, and these also, in the majority of cases, might be put down to be supplied by the Government. In the Coast Hospital contract there were prime cost items for lamps. There was nothing to prevent a successful firm paying 10 per cent. discount to a contractor. If the contractor were directed to buy lamps from a firm at a price and the firm made the contractor a present the Department would know nothing about it. Mr. T. B. Cooper, secretary to the Public Works Tender Board, said tenders under £200 were managed by the departmental officers and those over that amount by the Minister, who was the final authority. It would not be possible for a firm to see the tenders and then submit a lower tender. In the case of competitive quotations, the superintendent of stores consulted a list of registered firms, and called for quotations, which, if suitable and under £10 in cost, would be accepted by him, but if over £10 would first have to be passed by the Minister. If a firm wished to become registered they approached the superintendent of stores.

Rutherglen (Victoria) Council have decided to adopt electric lighting in the streets and also to provide a supply for private consumers. The capital cost is estimated at £2,500.

To systematise the carrying out of various works necessitating the opening of roads in Sydney a conference was recently held of the authorities concerned, including representatives of municipal and Government departments dealing with public works, electricity supply, tramway, water and sewerage and postal works and the Sydney & Suburban Hydraulic Power Co.

The Municipal Council of Vaucluse (a suburb of Sydney) recently decided to light the Town Hall electrically for five years, and a company will probably be formed to light the military buildings and streets.

Brazil.—A consular report from Rio de Janeiro states that the acting Consul-General has become more and more convinced of the uselessness of a large proportion of the catalogues sent to Rio.

The majority of these (he points out) do not give sufficient information of the right sort. The article is well described (in English), but discounts, modes of payment, &c., are not mentioned. If a local house cannot give a price immediately the chance of trade is often lost. Not more than three or four catalogues in Portuguese have been received at the Consulate. Whatever trade foreign competitors have taken from British traders in Brazil has been the result of close study of the local conditions. The United Kingdom supplies about 26 per cent., Germany 15 per cent., the United States 12 per cent. and France 10 per cent. of the total imports.

Congo State.—A proposal has been made for the construction of an electric railway from Matadi to the neighbouring hills to enable the Europeans to live out of town.

Egypt.—The "Egyptian Gazette" states that the Cairo Tramways Co. carried 53,492,219 passengers during 1910 (increase 4,000,000) and the receipts were £276,866 (an increase of 8 per cent.). The length of the lines is 344 miles (increase nearly one mile).

The Sloan Electrical Co. have removed their Manchester office from 16, John Dalton-street to 16 and 16A, Jackson's-row. The head office of the company is at Conradty House, 12, Golden-lane, London, E.C.

German Consular Service.—"Engineering" states that the German Government is preparing an important reform of the German diplomatic and consular service, in the creation of new posts as technical attachés to the Empire's legations. These new offices will be filled by engineers and technical experts, and it is proposed to place these technical attachés on the same footing as the usual diplomatic attachés. Their work will be, as quickly and as thoroughly as possible, to keep themselves posted with all technical inventions and progress of any importance in the different countries, with reference to which it may be considered that they are of value in industry or commerce. The two first appointments are likely to be in connection with the German Embassies in London and Washington. It is also under consideration to attach technical experts to some of the consulates.

Japan.—The acting British Commercial Attaché for Japan (Mr. R. Boulter) says, in a communication regarding the production and manufacture of copper in Japan, that the Japanese importing houses with branches in London and New York have secured many orders for small motors, &c., and they have for the most part filled them with American and German machinery.

The reason appears to be that the initial cost of such machinery is very often cheaper than that of British machinery, although the latter would probably prove cheaper in the long run, taking into consideration the working capacity, expenses for upkeep, &c. The point of view of the Japanese mining engineer is probably that, so far as he can see, the British machinery is the most expensive of the three as regards initial cost, and he has not sufficient experience of its working to justify his recommending its purchase when makers of other nationalities offer what is apparently the same article at a lower price. Moreover, Japanese copper mining engineers when travelling abroad would naturally spend more time in America than in England, as they find in the former country the opportunities of practical study for which they are travelling; they thus become accustomed to the working of American types of machinery. Another point is that German merchants are stated to be willing to give more liberal terms as to credit than British firms give. As regards power stations, for which contracts would naturally be much larger, tenders are usually invited from engineers of various nationalities.

Paris Telephone Service.—A measure has been introduced into the French Chamber for the extension of the telephone service of Paris, at an estimated cost of Fr.11,667,000.

Roumania.—A consular report on the Braila district states that the electrical goods imported during 1910 include dynamos, motors, rotary converters, accumulators, arc lamps, telegraph and telephone apparatus, bells, batteries for medicinal and chemical purposes, switches, wire and insulated cables, &c., incandescent lamps and porcelain insulators. Ventilators are used to some extent in banks, hotels, hospitals and public institutions.

The steady development of home industries in Roumania is favourable to the import trade in electrical goods, but there is keen competition between the United Kingdom, Germany, Austria-Hungary and France. Manufacturers should be represented in Roumania. The import business in the Braila district is chiefly carried out through commission agents, who are of great assistance to commercial travellers and to the firms that they represent, but firms should send out their own representatives to establish their first connections; and it is necessary for such men to be capable of transacting their business, failing Roumanian, either in German or in French, the former for choice. The foreign agent or traveller is an expert; he speaks the business language, has circulars and price lists in that language, and will wait upon the would-be buyer at his own shop. He can further give him indulgent terms owing to being in continual and personal contact with him, visiting him several times a year.

Spain.—D. Fernando G. Gongora has been authorised to make surveys for the construction of an overhead electric tramway in Malaga.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Brighton.—For the year ended March 31 the traffic revenue of the tramways department was £49,124 and sundry revenue £1,623, a total of £50,747, against £51,358.

The working expenses were £37,609 (against £37,069) and the gross profit was £13,078 (against £14,289). After paying interest (£7,918) and sinking fund charges (£5,023) there was a balance of £137; 10,708,184 passengers (against 10,759,947) were carried and the car-miles run 1,126,676 (against 1,130,685). The number of units of electricity used was 2,023,109 (against 1,938,305), or 1·79 per car-mile (against 1·71).

Burnley.—The total capital expenditure on the tramways department for the year ended March 31 is £206,134, an increase of £7,769 over 1910.

The total revenue for the past year was £65,817, including £65,570 (against £65,295) from traffic receipts. The working expenses were £42,574, leaving £23,243 as gross profit. After paying interest, sinking fund and income tax, placing £5,000 to reserve and setting aside £1,000 for contingencies, and deducting accountant's fees, &c., the balance (£499) was placed to reserve; 13,107,830 passengers were carried, against 12,911,113, and 1,306,860 car-miles run, against 1,263,118.

Devonport.—In submitting the annual report of the Electric Power Committee at the meeting of the Council last week, the chairman (Ald. J. B. Love) said that there had been a large increase of new consumers during the past year, and also in the consumption of current.

Ald. Love said that they expected that the increasing demand would continue in the future, and should mean corresponding increases in profits. After paying all expenses, including interest (£3,624) and sinking fund (£3,014) and contributing £833 (against £445) for relief of rates there was a net balance of £26. 2s. 11d. which the Committee recommended be put to reserve fund. After paying £1,540 for the mechanical stokers, the reserve fund would stand at £8,352, which was sufficient for contingencies.

Dudley.—For the year ended March 31 the total capital expenditure was £1,877, bringing the total to £97,310.

It was reported to the Council on Tuesday that there was a decided improvement in the working of the undertaking. With the exception of the supply for traction there had been an increase in the output. The income was £13,009 against £12,991, the gross profit £5,939, an increase of £135. The undertaking had been debited with £500, the first instalment of the cost of the arbitration in reference to the price of tramway current, thereby reducing the gross profit to £5,459. Interest and repayment of loans came to £6,665, leaving an adverse balance of £1,206.

Mr. H. W. HUGHES, chairman of the Tramway and Lighting Committee, explained that if the tramway company had been supplied at the old rates and there had not been any arbitration costs to pay, the income would have been £14,018, the gross profit £6,968, and net profit £302; whilst had the conditions of traction supply remained as in preceding years the undertaking would have advanced from a net deficit of £609 to a net profit

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of £592. The arbitration expenses amounted to about £2,000, payment of which it was proposed to distribute over four years. The aim of the Committee had been directed principally towards the idea of supplying electrical energy so cheaply for lighting and power as would enable manufacturers to employ it to keep their factories going full time, thereby increasing the number of workpeople and indirectly promoting the prosperity of the town.

Dundee.—The accounts of the electricity department for the past year show a net profit of £7,254.

The report states that the cost of coal was 7 per cent. higher than in 1909-10. Units sold were 7,720,018, an increase of about 1,500,000 or 24 per cent. Units sold for power represented the largest part of the increase, units for lighting showing an increase of 170,000.

Eastbourne.—The income of the electricity department for the year ended March 31 was £24,522, against £25,144.

The working expenses were £10,969 (against £11,282) and the gross profit was £13,553 (against £13,861). Interest and sinking fund charges came to £11,340 (£11,661), leaving a nett profit of £2,213 (£2,200), out of which £1,500 has been transferred to reserve. The gross capital outlay is £220,985.

The annual report of the borough electrical engineer (Mr. J. K. Brydges) states that the equivalent of 122,000 30-watt lamps is connected (against 111,755 in 1910), an increase of 11,235, and included 97 arcs, 17 double and one three-light metal filament lamps for street lighting, 140 motors and 222 radiators. During the year 23 motors of 134 H.P. were connected, and during the past six months 74 radiators were added owing to the reduction in the price of current from 2½d. to 1½d. per unit. There are 1,758 consumers, against 1,584. The units sold for private lighting show a small increase, against a decrease of 2·6 per cent. The revenue from private lighting shows a decrease of £961, mainly due to a reduction in the price from 3d. to 5d. a unit, but the revenue from power and heating increased by £316, of which £148 was from radiators. The works cost are 1·2d. per unit, against 1·36d., and the total costs 1·79d., against 1·92d.

Epsom.—The accounts of the electricity department show capital expenditure £40,040 (increase £533), of which £11,791 has been extinguished.

Revenue was £5,954, working expenses were £2,703, and gross profit was £3,250 against £2,903 in previous year). After meeting capital charges the net profit was £510 (£185). Units generated were 321,236 (299,83), the total sold being 274,669 (250,810). The maximum supply demanded was 217 kw. (198 kw.).

The report of the engineer, Mr. A. C. Gilling, states that during the year 50 of the ordinary public lamps and 12 arcs have been changed over to metallic, leaving 96 still switched from pillars. The total number of (equivalent) 8 c.p. lamps connected is 21,828. Revenue per (mean) unit is 3s. 6s. 3¾d.), the drop being due to increased sales for heating purposes at a cheap rate. Works costs were 1·477d. (1·522d.), and total costs 2·266d. (2·177d.). Capital charges were 2·393d. (2·599d.). The figures quoted show a steady increase, and apparently the danger of loss of revenue from the adoption of metallic filament lamps is past.

At a recent meeting, the Council adopted the report and accounts, and congratulated the Committee and the officials on the result of the year's working.

Lincoln.—The accounts of the electricity supply and tramways undertakings for the year ended March 31 were approved by the Council last week.

The total income of the electricity department was £13,623, and included £7,597 from sale of current for private lighting, £638 from public lighting, £4,415 from power supply and £908 from the tramways department. The working expenses came to £6,331, leaving a gross profit of £7,292. After providing for redemption of debt (£1,945), dividends and interest £2,090, deficit on tramways (£153) and paying £2,000 in relief of rates, the balance (£1,170) has been transferred to depreciation account. The capital expenditure is £67,410 and the outstanding debt is £48,628. The units generated were 2,054,729 (against 1,918,790) and the units sold 1,830,482 (against 1,642,424). There are 34 arc and 92 metal filament lamps for street lighting, and the total maximum supply demanded was 365 kw. for lighting and 100 kw. for traction. There are 662 consumers (against 619) and the equivalent of 88,179 (against 74,253) 8 c.p. lamps connected.

The total revenue of the tramways department was £6,412 and the working expenses was £6,536. The expenses were £4,091, leaving a gross profit of £2,444. Interest and redemption of debt required £2,600, leaving a deficit of £153 which was provided out of the profit on the electricity undertakings. The capital expended is £54,049; 1,649,537 passengers were carried (against 1,599,751), 160,186 car-miles run (against 157,268), and 169,480 units of current (1·088 per car-mile) were used against 176,480 (1·123).

In the report of the city electrical engineer (Mr. S. Clegg) it is stated that there was an increase in the units sold under every head, except street lighting, the total increase being 178,058 units. There was a considerable addition under that of motors (473 H.P., of which 188 H.P. was for Clayton & Shuttleworth's) and 90,611 more units than in 1909-10 were sold. The total works costs were 0·835d. per unit (against 0·918d.) and the total costs, including interest and sinking fund, were 1·359d. (against 1·501d.) The cost of coal again showed a decrease (0·021d. per unit), this only owing to the use of automatic stokers on two low-pressure boilers. In regard to the tramways, there was a saving in traffic expenses, but there were small increases in repairs and maintenance, management and horse keep, and power, giving a total of 6·12d. per car-mile, against 5·95d. With this year's expenditure, the total amount spent since 1906 on the repairs of the "G. B" equipment is £539, an annual average of £108, or £18 a year in excess of the guarantee; but Mr. Clegg thinks that by the end of the period of the guarantee (10 years) the excess will disappear.

Manchester.—At the meeting of the Council on Wednesday it was reported there was a net profit of £27,573 on the working of the electricity undertaking for the year ended March 31, of which £15,000 has been transferred to district rate fund and the balance applied in defraying cost of special renewals.

The renewals suspense account has been augmented by £25,450. To permit of the extension of business, various additional borrowing powers amounting to £70,000 were obtained during the year. The total capital outlay is now £2,733,207, and the mortgage debt stands at £1,949,583. The annual sales total over 83,000,000 units. At the Dickinson-street and Bloom-street stations the first completed year of working with the large Tudor storage battery has resulted in a substantial reduction of the station costs. At the Stuart-street station the various works in connection with the independent water supply have been completed and put into successful operation for the major portion of the year. A contract has been entered into for a further turbo-alternator and satisfactory progress has been made with the various works. At Oldham-road, Bennett Side, Rusholme, Fallowfield, Levenshulme and Moss Side distributing stations extensions of converting plant and switchgear have been carried out. With the exception of the Bengal Mill, no extensions of note have been made on consumers' premises in connection with power supply. There was a net addition of 15 miles 858 yd. of mains and various alterations were made to the City network with the view of facilitating fault-localisation and improving the pressure balancing. The efficiency of the distributing system as a whole equalled 79·85 per cent., the quantity lost or absorbed in the mains and distributing stations being 20·15 per cent.

Middlesbrough.—In his annual report the Borough electrical engineer (Mr. H. M. Taylor) states that the net profit on the past year's working of the electricity department was £2,079, compared with £1,296 for 1909-10.

The price of coal, which increased 9d. per ton (7·5 per cent.) upon the previous year and other items including cost of repairs to boilers (£600) and labour troubles in the shipyards had been detrimental to the year's working. There was a gain through the re-adjustment of income tax, and through the reduction in the price of energy purchased from the Power Co. During the year a reduction in the price showed a decrease in revenue of over £200, but the effect was that a greater quantity of electricity was consumed. The number of consumers was 1,257, and the number of units sold was 2,021,586. The average price had been reduced from 2·24d. to 2·20d. per unit.

Nottingham.—The total revenue of the electricity department for the year ended March 31 was £94,882, including £91,915 from sale of current, £732 for public lighting and £1,748 for meter rent.

The expenditure was £52,010, including £17,739 for coals, £7,481 for wages, £4,413 salaries, £10,555 for rates and taxes, and £3,972 for repairs and maintenance. The gross profit was £42,872, of which £12,675 was paid for interest on consolidated stock and loans, £13,337 for repayment of loans, £2,416 sinking fund, and £15,350 was given as a contribution in aid of general district rate.

The report of the city electrical engineer (Mr. H. Talbot) states that the capacity of the plant at the three generating stations is 17,345 H.P., Talbot-street station, 8,925 H.P.; St. Ann's power station, 7,700 H.P. and Easteroft destructor, 720 H.P. There are 60·62 miles of distributing mains, an increase of 1·71 miles. The number of applications for a supply of electricity was 4,008, an increase of 207. The increase in the number of 32-watt lamps (or their equivalent) is 23,435, the largest for the past three years, the total at the end of the financial year being 410,322. The demand for electricity for power is maintained, 143 motors, aggregating 466 H.P., having been connected during the year, the totals being 1,183 motors and 4,635 H.P. The number of units sold was 11,944,527: for lighting 3,835,876 units, power 2,426,727 units and traction 5,681,924 units, an increase of 474,792 units; 52·02 per cent. of the units used for private lighting were at the reduced rate of 1½d. per unit. The works cost was 0·71d. (against 0·69d.), the total works cost 1·04d. (against 0·99d.) and the total costs 1·62d. (1·6d.) There was a decrease of 57,365 units used for lighting, compared with 192,204 units last year. The majority of the consumers are now using metal filament lamps, so that any further changes to this type of lamp should be compensated for by the continually increasing number of electric light users.

The receipts of the tramways department were £157,290, an increase of £2,354 (11·13d. per car-mile, as in 1910). The working expenses were £104,085. 14s. 7d., an increase of £5,922. 11s. 2d. (7·37d. per car-mile, compared with 7·06d.) Out of the balance (£53,204. 2s. 9d.) has been paid interest on stock and loans (£15,564), sinking fund (£18,823), reserve and renewal fund (£3,817) and £15,000 in aid of general district rate. The reserve and renewals fund, including interest on investments, amounts to £68,069. 12s. 8d. There was an increase in expenditure as follows: Rent, rates and taxes (£1,523), electrical energy (£1,405), wages of traffic staff (£743), maintenance (£2,641). Other items showed a decrease of £387, leaving a net increase of £5,923. Maintenance was £18,543 and included the cost of relaying the lines in Long-row and Queen-street, new junctions in Parliament-street and at the Sherwood depot, also new points and crossings of an improved design at all the passing places on St Ann's Well-road, and two passing places on Nottingham-road. The maintenance of cars includes cost of building and fitting 12 top covers and building an

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additional snow plough. Overhead equipment maintenance included cost of renewing 8 miles of copper trolley wire, nearly all being replaced with wire of a larger size. 35,259,067 passengers were carried, an increase of 611,829, and 3,388,740 car-miles run, an increase of 48,191. The consumption of electrical energy for traction, car and depot lighting, works machinery and permanent way repairs was 5,681,924 units, costing £29,593. 7s. 1d., equal to 1·68 units and 2·11d. per car-mile, increases of 0·05 units and 0·07d.

St. Helens.—The annual report of the electricity department to March 31 states that there has been a very large increase in the output of energy, the total units sold being 4,138,000 units, an increase of 1,359,000 units (49 per cent.) compared with 1909–10.

The energy supplied for lighting increased from 420,000 to 454,000 (8 per cent.), for power from 916,000 to 2,115,000 (130 per cent.), and for tramways from 1,444,000 to 1,569,000 (8¼ per cent.). The total revenue amounted to £23,827, an increase of £3,695, but owing to heavy expenditure on repairs to plant the working expenes increased by £2,500 to a total of £13,191. The gross profit was £10,636, but after paying interest and sinking fund and special charges (£1,200) the net profit was £124. The cost of production had been reduced from 0·66d. to 0·64d. per unit.

Stepney (London).—The accounts of the electricity department for the year ended March 31 show capital expenditure £397,305 (increase £41,046). Provision has been made for repayment of £41,497 and £6,955 has been provided out of revenue to meet capital expenditure.

Revenue was £57,636 (compared with £52,266), working and general expenses were £33,528 (against £31,450), gross profit was £24,108 (£20,816 to which has to be added £351 (£361) minimum guarantees and interest from bankers and from investments, and net profit was £1,769 (£1,497). Fuel cost 0·436d. (0·470d.) per unit sold, works costs were 0·631d. (0·669d.), works and administrative costs 0·805d. (0·856d.), and total cost (including capital charges) 1·396d. (1·437d.), the average income being 1·409d. (1·458d.). 96,80800 (8,014,717) units were generated, 1,053,080 (1,027,427) purchased in bulk, 3,320,303 (3,027,894) sold for private lighting, 3,821,362 (3,388,215) for power and heating, 1,151,337 (1,165,372) for public lighting and 813,291 (427,693) bulk supply. The maximum supply into feeders was 4,091 kw. (3,669 kw.), and the dynamo capacity 7,720 kw. (5,720 kw.).

The report of the borough electrical engineer (Mr. W. C. P. Tapper) states that in February, 1910, the Council entered into contracts to the value of £32,852 for machinery, boilers, &c., to fill the available space in the existing buildings at Limehouse generating station and for sub-station plant for the Whitechapel station. The installation of the plant is nearing completion. During the transition of plant from Whitechapel to Stepney the bulk supply obtained from Poplar Council was of great assistance, 1,053,080 units having been purchased in 1910. The Limehouse plant comprises 6,000 kw. of turbine-driven generators and the Whitechapel plant 1,720 kw. of reciprocating plant. The maximum load at the generators (at Christmas) was 4,274 (increase 605 kw.), which showed a margin capacity of 1,446 kw. after allowing 2,000 kw. as spare. This margin should last until Christmas, 1913. The realisation of a profit of £1,769, instead of the estimated deficit, was due to the fact that the condensing plant at Limehouse was put into operation in October last, and since that time a saving of over £3,000 in cost of coal had been effected compared with the previous year's cost at Whitechapel. £1,671 was paid to the works department for destructor steam (=1,003,041 units), and (the report says) the very large reduction in cost of generation due to condensing at Limehouse renders it necessary that the charge of 0·4d. per unit at present made by the works department should be reconsidered. The total surplus since the inception of the undertaking is £25,887. The total number of (equivalent) 30-watt lamps connected is 447,862 (an increase of 62,597 compared with 74,134 in previous year). Nearly 250 consumers are taking restricted supplies (cut off between sunset and 7 p.m. in the winter) at 1d. per unit, over half a million units being taken on this system, and the advantage of this arrangement is seen in the improved load factor (24·32 per cent. compared with 22·9, which would have been the load factor if the restricted supplies had not been given). The set back in sales for private lighting due to the use of metallic filament lamps appears now to be arrested, an advance being recorded for 1910.

Sunderland.—The annual report of the electricity department was adopted by the Council on Wednesday.

Ald. Bruce, in moving the adoption of the report, said the output for the past year was 10,208,000 units, as compared with 7,000,800 units for the previous year. There was a net profit on the year's working of £1,189.

Swansea.—The total revenue of the electricity department for the year ended March 31 was £26,320.

Expenses were £13,542, leaving gross profit £12,778. 1s. 11d., an increase of £500 over 1909-10. After paying interest, sinking fund, &c., the net profit was £2,802, an increase of £80. The amount paid in rates was £1,638, against £799. The balance in hand is £8,062.

Tunbridge Wells.—The total revenue of the electricity department for the year ended March 31 was £13,991, including £10,094 from the sale of electricity, £2,793 from public lighting, £539 from meter rents and £274 for lighting Town Hall, &c.

The total expenses (£7.713) included £4,406 for generation, £788 distribution, £653 public lamp maintenance, £374 rent, rates and taxes, and £1,386 management. The gross profit was £6,277, and after paying £4,375 as dividends on and redemption of Corporation stock and £1,423 for interest on and repayment of mortgage loan there was a net profit of £479. The stock and loans authorised amount to £90,092, of which £38,500 has been repaid. 1,113,270 units were generated (against 1,078,018 in 1909-10) and 838,500 (831,136) were sold, of which 593,500 (578,025) were supplied to private consumers and 245,000 (253,111) to public lamps. The connections to the mains are equal to 75,521 30-watt lamps (against 70,681), and the total maximum supply demanded was 560 kw. (against 569 kw.).

In an interesting report by the borough electrical engineer (Mr. J. W. Beauchamp) it is stated that the units sold to private consumers showed an increase of 3·74 per cent. over 1909-10. In the previous year there was a decrease of 11 per cent., due to the rapid introduction of metal filament lamps, but the effect of the change has been stemmed by the very considerable amount of new business obtained. The cost of fuel per unit sold was reduced from 1d. to 0·8d., and the net works costs (generation plus distribution) was 1·49d. against 1·725d. In the distribution and public lighting departments a large amount of renovation and replacement of obsolete apparatus was effected out of revenue, to which account all new meters and replacements of obsolete patterns are also debited. Old type a.c. arc lamps are being replaced by high candle-power metal filament lamps with very satisfactory results. Several extensions to supply premises situated beyond the boundaries of the borough are now being made under the provisions of the Electric Lighting Act, 1909. New connections have been made amounting to 145 kw., of which a considerable portion represents heating and cooking apparatus and single-phase motors for driving machinery. The sales of energy for heating and occasional motors increased by 22 per cent., and for industrial motors by 105 per cent.

Wednesbury.—The annual report of the electricity department was adopted by the Council on Monday.

The Electricity Committee reported that there had been an increase of 92 consumers, and in the sale of current from 433,267 units to 634,356 units. The net profit was £583, and it was proposed to write £245 off the "free" wiring account and to allocate £300 to relief of rates. Extensions of the plant and mains at a cost of £2,250 were authorised.

York.—The accounts of the electricity supply and tramways departments for the year ended March 31 have been approved by the Council.

The total revenue of the electricity department for the year was £19,591 (against £14,629), and included £12,484 from sale of current to private consumers, £1,761 from public lighting, £4,465 from the tramways department and £811 from the rental motors, &c. The total expenses were £8,480 (against £6,095), and the gross profit was £11,111 (against £6,804). After paying interest on loans (£4,627) and sinking fund (£5,326) there was a net profit of £1,260. The capital expended is £131,372, an increase of £3,948 (due to expenditure on mains and motors for hiring). 2,536,389 units were generated (against 1,789,461) and 2,200,517 (1,438,700) sold, including 257,269 (245,456) for public lighting, 1,288,529 (1,093,235) to private consumers, 47,400 (50,000) by contract and 191,109 (140,546) for traction. There are 40 open and 69 enclosed type arcs and 92 incandescents for street lighting, and the total maximum supply demanded was 1,267 kw. (against 1,035 kw.).

The total revenue of the tramways department was £17,569 (9·2d. per car-mile), including £17,096 traffic receipts. The total expenses were £11,291 (5·91d. per car-mile), leaving a gross profit of £6,278. After paying interest (£3,394) and contributing £995 to sinking fund, the balance (£1,890) has been placed to reserve fund. The capital expended is £112,900, an increase of £37,646.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Hammersmith (London) Borough Council invite tenders for supply of about 600 time switches suitable for controlling individual electric lamps for lighting side streets. The switches are required to deal with 1 ampere at a pressure of 120 volts single-phase a.c. 50 periods. Samples of switches tendered for should be addressed to the borough electrical engineer, Mr. G. G. Bell, 85, Fulham Palace-road, Hammersmith, W. Tenders to the town clerk, Mr. H. Thompson, by 4 p.m. Friday, June 30. See also an advertisement.

The Electricity Committee of Hull Corporation invite tenders for one year's supply of electric cables and for the supply of the two water-tube boilers required in connection with the extensions of plant at their Sculcoates-lane generating works. Forms of tender and specification from the city treasurer, Mr. T. G. Milner, and tenders, addressed to the Chairman of the Electricity Committee, Town Hall, Hull, must be delivered by noon of Monday, June 26. See also an advertisement.

Hull Education Committee require tenders by 10 a.m., June 20 for supply of electric fans and wiring and fitting for electric light at the new Sculcoates-lane school. Specification, from City Architect.

Hammersmith Council also invite tenders for supply of sundry wrought-iron flues. Specification and form of tender from the borough electrical engineer, Mr. G. G. Bell, and tenders to the town

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"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1911 Edition of the Big Blue Book is READY, price 15s., post free in the United Kingdom, 15s. 9d. The volume brings a great mass of very valuable statistical and technical data quite up to date, and the Directorial Division has been thoroughly revised and amplified up to February 24th.

All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters receive every attention in the new volume, which aggregates more than 2,000 pages. The Directory Division is complete and thoroughly accurate, and has been completely revised. The Big Blue Book contains more names of live electrical firms and persons than any other Directory published, and this notwithstanding that all mere lists of members of Societies and Institutions (so easily and cheaply available) are excluded, as unreliable and of little value for Manufacturers' and Dealers' purposes. The full set of valuable Statistical and Engineering Tables, &c., have been very carefully revised and extended, and are now issued in a handy form. These are included in the 1911 Big Blue Book, making it the most complete work of the kind ever published.

clerk, Mr. H. Thompson, Town Hall, Hammersmith, W., by 4 p.m. Wednesday, June 21. See also an advertisement.

Tenders are invited for supply of lead-covered and vulcanised rubber-covered cable to the City of MELBOURNE. Specifications, tender form and conditions of tender from the agents for the City Council, Messrs. Mellwraith, McEacharn & Co. Proprietory (Ltd.), Bilbter-square-buildings, London, E.C., to whom tenders by noon Friday, July 7. See also an advertisement.

Tenders are invited for the supply of 150 miles insulated wire and 5 miles of telegraph cable to the Postmaster-General's Department in Victoria. Tender forms and specifications from the Commonwealth Office, 72, Victoria-street, London, S.W. See also an advertisement.

Tenders are invited up to July 19 for the supply of insulators, telephones, copper and iron wire to the Postmaster-General's Department in QUEENSLAND. Tender forms and specifications from the Commonwealth office, 72, Victoria-street, London, S.W. See an advertisement.

The Secretary of H.M. OFFICE OF WORKS invites tenders for providing and erecting at the South Kensington generating station complete surface-condensing plant, capable of dealing with 15,000 lb. of steam per hour, together with the necessary gantry and stanchions. Forms of tender and further information may be obtained at H.M. Office of Works, Engineering Division, 55, Whitehall, London, S.W., Tenders by 11 a.m., June 30, to Secretary, Storey's Gate, London, S.W.

GOVAN Corporation require tenders by June 27 for supply and erection of steam, exhaust and water piping, boiler, mechanical stoker, coal bunkers, and cooling tower and for extension of h.t. switchboard. Specifications, &c., from the Burgh Electrical Engineer.

SWINDON Corporation require tenders by noon June 20 for the supply and erection of a 220-cell battery, an automatic reversible traction booster, a three-wire hand-regulated booster, and switchgear. Specifications, &c., from the Borough Electrical Engineer.

MANCHESTER Electricity Committee invite tenders for supply and erection of two water-tube boilers, superheaters, coal chutes, ash conveyors and fuel economisers. Tenders to Chairman of Committee, Town Hall, Manchester, by 27th inst.

IPSWICH Guardians require tenders by noon June 30 for alterations to switchboards and other electrical apparatus at the workhouse. Specifications, &c., from Mr. H. P. Girling, the Wharf, Maldon, Essex.

ROTHERHAM Corporation want tenders by July 8 for 12 months' supply of single vulcanised bitumen covered cable and electricity meters. Particulars from the Borough Electrical Engineer.

BIRMINGHAM Electric Supply Department require tenders by June 26 for 12 months' supply of electrical accessories, engineering and general stores, &c. Particulars from the City Electrical Engineer.

LONDON County Council require tenders by 11 a.m. July 4 for four electric traversers for car-sheds. Specification, &c., from the Clerk.

The Metropolitan Water and Sewerage Board, Albert-street, BRISBANE, Queensland, want tenders by noon Jan. 30 next for supply and erection, of one, two or three complete units, each consisting of power generating plant and pump or pumps to lift not less than 6,000,000 gallons per day. Particulars from the Secretary.

Tenders are invited up to July 25 for the supply of 12 sections of a branching multiple magneto lamp signalling switchboard, &c., or one automatic or semi-automatic switchboard, &c., to the Postmaster-General's Department, VICTORIA. Tender forms, &c., from 72, Victoria-street, London, S.W.

The Town Clerk, WANGANUI, N.Z., will receive tenders until July 12 for supply of generating plant, gas-producing plant and battery and booster for the Corporation tramways. Specification can be seen at 73, Basinghall-street, London, E.C. Local representation is necessary.

WELLINGTON (N.Z.) Corporation require tenders by 4 p.m. Aug. 24 for supply of a motor power wagon and accessories for the electric tramways department. Gonville and Castlecliff Tramway Board, Ridgway-street. WANGANUI (N.Z.) require tenders by 4 p.m. Aug. 14 for supply of overhead tramway material, feeders, &c. Conditions, &c., can be seen at 73, Basinghall-street, London, E.C. Representation in New Zealand is necessary.

The Chairman of the Board of Control, WINNIPEG (Canada), will receive tenders until 11 a.m. July 3 for supply and installation of a police patrol telegraph system.

NAPLES Municipal Authorities require tenders by July 9 for supply and installation of the following plant in connection with the supply of electric power to Naples from the river Volturno:

1. Tubing and accessories for harnessing the water at rate of 7,000 litres a second and for the fall of 190 meters; upset price 702,900 lire (£28,116.)

2. Machinery and apparatus for hydro-electric power station, transmission line (about 57 miles), and transforming station; upset price 1,000,000 lire (£40,000.)

Tenders to Presidente del Consiglio Generale dell' Ente Autonomo Volturno, Naples.

Manufacturers who are prepared to supply 600 km. (372 miles) copper wire 8 mm. dia. are invited to communicate with the Direzione dell' Ente Autonomo Volturno, Naples, who after two months from April 10 will send invitations to tender to firms whom they consider suitable.

Conditions of tender, &c. (in Italian) may be seen at 73, Basinghall-street, London, E.C.

The Secretary of the Works Department of the port of CADIZ will receive tenders until 5 p.m. June 20, for supply of four electric cranes. Particulars from the Public Works Department, Madrid.

Tenders will be received by Senor Alcalde, Casa Consistorial, VILLARROBLEDO (Spain) until June 26 for 10 years' supply of electric light for the town, and until June 30 for 25 years' supply of electric light to TORS (Zamora Province) Municipality.

Extension of Time.—The time for the receipt of tenders by the Egyptian Ministry of Public Works CAIRO, for an electric pumping installation (*see* p. 356 of our last issue) is extended to 10 a.m. June 24.

TENDERS RECEIVED AND ACCEPTED.

Salford Council has accepted the following tenders:—Hadfield's Steel Foundry Co., special tramway trackwork at £2,304; Berry Transformer Co., two transformers at £39. 10s. each; W. T. Glover & Co., for annual supply of single insulated cable, twin workshop flexible cable, rubber cable and bare rubber stranded wire cable at £2,000; Aubert, Grenier & Co. for multiple core cable.

Bristol Council has accepted the following tenders for annual supplies:—

Wm. Geipel & Co., are lamp carbons for open type lamps, £345. 15s.; Sloan Elec. Co., carbons for flame type lamps, £370. 11s. 4d.; Sykes & Sugden, joint boxes, £198. 17s. 1d.; British Westinghouse Co., watt-hour meters, £385. 15s.

Walsall Council has accepted the following tenders:—

British Westinghouse Co., h.t. switchgear for generating station; Johnson & Phillips, supply and fixing transformer at Bloxwich sub-station, and a design for illuminating the Council house for the Coronation; W. Kendrich & Sons, erection of Bloxwich electrical sub-station.

Wigan Council have accepted the following tenders for material for Coronation illuminations:—

General Electric Co., 1,500 yds. pixielight, 2,230 lamps, 125 gelatine lanterns, lgobes, &c.; W. T. Glover & Co. (lowest tender), for cable, £282. 10s. 9d. (Four tenders received, highest £302. 10s.)

Cheltenham Council have accepted the following tenders for annual supplies:—

British Thomson-Houston Co., meters, at 17s. 6d. each; W. Geipel & Co., open-type arc lamp carbons; Ship Carbons (Ltd.), flame carbons.

Ilford Urban Council have accepted the following tenders:—

Drake & Gorham, distribution switchboard and neutral board, £162. 15s.; Union Cable Co., feeder cable, £1,304. 8s. 10d.; Albion Clay Co., stoneware conduits, £312. 14s. 2d.

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Barrow-in-Furness Council has accepted the tender of Edgar Allen & Co. for points and crossings at £372, and that of the Barrow Hematite Steel Co. for tram rails at £6. 15s. per ton and fishplates at £8. 15s. per ton.

Richmond (Surrey) Council have accepted the tender of Beard & Co. (Richmond) for the testing and maintenance of fire alarms at £52 per annum, for connecting up the system to the houses of new members of the fire brigade at £1. 10s. each and connecting up new residences of old members at 18s. 6d. each.

Ramsgate Council have accepted the tender of the local electric supply company for an electric motor and pump for the sewage works at £44. 16s.

Leyton Council received five tenders for Coronation illuminations at the two branch libraries, varying from £190 to £203, and the tender of Boston & Co. (at £200) was accepted.

St. Helen's Council have accepted the tender of Dick, Kerr & Co. for a 2,000 kw. turbo-generator, and that of the Mirrlees-Watson Co. for condensing plant.

Tunbridge Wells Council have placed an order with Jas. Keith & Blackman Co. for an electric fan, motor, &c., for the Town Hall at £75.

Stockport Council have accepted the tender of W. A. Shaw & Co. for wiring work at the baths.

Kendal Council have placed an order for a boiler (at £323) with the Yorkshire Boiler Co.

Bacup Council have accepted the tender of Ferranti Limited for two transformers, and that of the General Electric Co. for meters.

Canterbury Council have accepted the tender of E. J. Philpot & Son for wiring the public buildings for illumination at £50.

Northampton Council has placed an order with Dick, Kerr & Co. for two new tramcars at £555 each.

We have received a notification that the Felten & Guilleaume Fabrikelektrischer Kabel, Stahl und Kupferwerke A.G., the Kabelfabrik und Drahtindustrie A.G., the Oesterreichische Bergmann-Elektrizitätswerke Ges. and the Siemens & Halske Kabelwerk have been entrusted (by Franta Ludikar, of Prague) with the whole of the contract obtained by the last-mentioned firm for three years' requirements of lead-covered cable for Prague municipality.

BUSINESS NOTICES.

Mr. J. G. Lorrain, M.I.Mech.E., M.I.E.E., &c., consulting engineer and chartered patent agent, will remove to Staple Inn-buildings, Holborn, London, W.C., on 24th inst.

Messrs. Handcock & Dykes have removed from No. 1 to No. 11, Victoria-street, London, S.W. Telephone, "231 Vicotria"; telegrams, "Rheophore London."

It is announced that the partnership hitherto existing between Mr. A. E. Woodhouse and Mr. Edgar Jones (trading as the Woodhouse Steel Casing Co.), electrical engineers and manufacturers, has been dissolved, and the business hitherto carried on by the Woodhouse Steel Casing Co. has been transferred to the Woodhouse Steel Casing Co. (Ltd.).

The Electrical Apparatus Co. have appointed Mr. Thos. G. Travis, formerly of the British Westinghouse Co., to be their Lancashire and Yorkshire representative. The company state that their business in that territory has expanded very considerably during the last 12 months, and Mr. Travis will shortly open their Manchester office.

Thos. Percy Shillcock and John Harold Payne (trading as T. P. Shillcock & Co.), electrical engineers, 10, Gothic-arcade, Snow-hill, Birmingham, have dissolved partnership. Debts by Mr. Payne, who continues.

Notice to Coronation Illumination Contractors.—Messrs. Siemens Bros. Dynamo Works (Ltd.) are issuing a post card stating that their London stores, 39, Upper Thames-street, E.C., will be open until 11 p.m. on Tuesday, 20th, and all night on Wednesday, 21st inst. Telephone, 8,270 London Wall.

Patents Development.—The owner of British patent No. 18,043/1907 for "Process for the production of Metallic Deposits," desires to sell his patent rights or to grant licences. Particulars from Messrs. Day, Davies & Hunt, patent agents, 321, High Holborn, London, W.C.

The proprietor of patent No. 16,500 of 1907 for "Improvements relating to Electric Self-winding Clocks," desires to make arrangements for exploiting same in this country. Communications to Messrs. Haseltine, Lake & Co., patent agents and consulting engineers, 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

ELECTRICITY SUPPLY TABLES AND DATA.

This Valuable Set of Tables and Engineering Data relating to Electricity Supply and to Electric Traction on Railways and Tramways in the United Kingdom, the Colonies, and some important places abroad, is now ready, and can be obtained complete in handy book form, price 6s. 6d. post free, or on very hard paper for rough or constant use, price 8s. 6d. post free. A complete Index is included.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during May, 1911, and (*b*) during the current year from Jan. 1 to May 31, with the increases or decreases compared with the corresponding periods of 1910:—

Electrical machinery (*a*) £79,380 (increase £27,887), (*b*) £461,578 (increase £228,496); telegraph and telephone cables (*a*) £40,808 (increase £32,450), (*b*) £162,425 (increase £101,146); telegraph and telephone apparatus (*a*) £12,107 (decrease £3,685), (*b*) £64,228 (decrease £10,450); other electrical wires and cables, rubber insulated (*a*) £5,423 (decrease £14,342), (*b*) £35,858 (decrease £33,134); with other insulations, (*a*) £2,492 (decrease £1,451), (*b*) £16,029 (increase £3,192); carbons (*a*) £10,435 (decrease £1,134), (*b*) £56,106 (decrease £1,754); glow lamps (*a*) £22,301 (decrease £32,555), (*b*) £138,508 (decrease £89,302); arc lamps and electric searchlights (*a*) £33 (decrease £115), (*b*) £597 (decrease £952); parts of arc lamps and searchlights (other than carbons), (*a*) £10,391 (increase £4,342), (*b*) £46,346 (increase £16,098); primary and secondary batteries (*a*) £3,948 (increase £541), (*b*) £19,893 (increase £2,645). Total of electrical goods and apparatus, other than machinery and telegraph and telephone wire (*a*) £121,356 (decrease £10,458), (*b*) £589,530 (decrease £3,002).

Exports.—The exports of electrical machinery, material, &c., (*a*) during May, 1911, and (*b*) during the current year from Jan. 1 to May 31, and the increases and decreases compared with the corresponding periods of 1910, are as follows:—

Electrical machinery (*a*) £156,332 (increase £50,117), (*b*) £698,307 (increase £129,594); telegraph and telephone cables (*a*) £56,013 (decrease £10,172), (*b*) £295,959 (decrease £574,362); telegraph and telephone apparatus (*a*) £15,188 (increase £1,805), (*b*) £109,537 (increase £43,674); other electrical wires and cables, rubber insulated (*a*) £30,930 (decrease £4,024), (*b*) £166,866 (decrease £5,514); with other insulations (*a*) £34,156 (decrease £222), (*b*) £166,453 (increase £52,944); carbons, (*a*) £1,594 (increase £371), (*b*) £8,398 (increase £985); glow lamps (*a*) £13,192 (increase £3,504), (*b*) £65,390 (increase £13,895); arc lamps and searchlights (*a*) £1,923 (increase £1,079), (*b*) £7,736 (decrease £30); parts of arc lamps and searchlights (other than carbons) (*a*) £1,540 (increase £509), (*b*) £6,276 (increase £565); primary and secondary batteries (*a*) £10,055 (increase £2,308), (*b*) £60,079 (increase £18,762). Total of electrical goods and apparatus, other than machinery and telegraph and telephone wire, (*a*) £215,466 (increase £8,917), (*b*) £1,118,146 (decrease £406,482).

PATENT RECORD.

APPLICATIONS FOR PATENTS.

*NOTE.—The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application, an asterisk is affixed.*

April 28, 1911.

10,290 KÖRTING & MATHIESEN AKT.-GES. Electric arc lamps for alternating current. (Addition to 26,706/09. Convention date, 30/4/10. Germany.)*
10,303 HANSEN. Metal filaments for electric incandescent lamps.
10,309 BENTALL, BINGHAM & GRAY. Electro-magnetically controlled throttle valve.
10,313 BARKER. Incandescent electric lamps.
10,315 RAWLINGS & NICHOLSON. Distribution of electrical energy.
10,316 RAWLINGS. Electric lighting systems and lamp holders and connecting devices for use in connection therewith, or on ordinary systems.
10,317 RAWLINGS & NICHOLSON. Distribution or supply of electrical energy.*
10,318 RAWLINGS. Electrical switsches or distributing devices.
10,341 SIEMENS BROS. & CO. (Siemens & Halske Akt.-Ges., Germany.) Subscribers' instruments for automatic telephones.*
10,342 SIEMENS BROS. DYNAMO WORKS. (Siemens-Schuckertwerke G.m.b.H., Germany.) Maintaining a constant speed in direct-current motors.*
10,358 SIEMENS BROS. & CO. & MARECHAL. Electric incandescence lamps.
10,363 REGAL. Electric jacquard apparatus. (Convention date, 17/5/10, Austria.)*
10,364 BROWN. Controllers for electric motors.

April 29, 1911.

10,375 WINTER. Electric lamp shades, screens or the like.
10,433 HUBERS. (Berliner Siriuslampen-Vertriebsges. m.b.H., Germany.). Incandescent electric lamps and the mounting of same for illumination advertisement.
10,434 HUBERS. (Berliner Siriuslampen-Vertriebsges. m.b.H., Germany.) Fastening incandescent electric lamps to sheet-metal discs.
10,435 HUBERS. (Berliner Siriuslampen-Vertriebsges m.b.H., Germany.) Holders for electric incandescent lamps.

May 1, 1911.

10,472 WILDEY & MERRETT. Electrically lighted display boards.
10,486 BARTON. Perforator for electric telegraphs.
10,527 DOWNTON & KIBBLEWHITE. Holders for electric incandescent lamps.*
10,545 ZICKEL. Electric shutter indicators. (Addition to 26,502/08. Convention date, 2/5/10, Germany.)*
10,549 B.T.-H. Co. (G.E. Co., U.S.) Electric heating devices.
10,550 & 10,551 ELEKTROMOTOREN-WERKE HERMANN GRADENWITZ. Remote control systems for electrically-driven vehicles. (Convention date, 27/5/10 and 22/9/10, Germany.) (Addition to 10,550/11.)*

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May 2, 1911.

10,624 Mitchell. Road switches for surface contact electric traction systems.
10,639 Galletti. Production of quenched electrical spark discharges. (Convention date, 3/5/10. Italy.)*
10,650 Lesty. Laying and picking up field telephone lines and the like.
10,652 Lofquist. Automatic circuit breaker.*
10,664 Brown. Variable resistance contact devices for electrical transmission purposes.

May 3, 1911.

10,668 Heenan. Masts for wireless telegraphic and other purposes.
10,689 Mountson. Electric meters of the electrolytic type.
10,694 Brownlee. Device for protecting the body from electric currents.
10,701 J. Halden & Co. & Watts. Electric photographic printing or copying machines.*
10,747 W. T. Henley's Telegraph Works Co. & Judge. Electric switches.
10,758 Newton. Dynamo-electric machines. (Addition to 15,423/10.)
10,765 Quain. Electric heaters.
10,767 Frisali & Visconti. Electrical heating apparatus.

May 4, 1911.

10,785 Spence. Differential electric rope gear.
10,792 Schott & Gen. Electrolytically measuring electricity. (Convention date, 23/5/10. Germany.)*
10,804 Shire. Leverless contact breaker for high-tension magnetos.
10,816 Chamberlain & Hookham & James. Electricity motor meters.*
10,824 Siemens Bros. & Co. (Siemens & Halske Akt.-Ges., Germany.) Alternating current block circuits.*
10,841 Lake. (U.S. Light & Heating Co., U.S.) Automatic electric switches.*
10,845 Mareyat. Electric lifts.
10,856 Kramer & Kapp. Resonating relays.
10,857 Kramer. Inductive wireless telegraphic installations.
10,858 Pearson, Zsvetaeff & Tistchenko. Electric furnaces.*
10,859 Poersche & Achenbach. Electrodes for secondary galvanic cells. (Convention date, 27/1/11, Germany.)*

May 5, 1911.

10,967 McCaffery & Klyne. Electrically-operated time switches or time mechanisms.
10,971 Bastian, Newman & London Electrical Trading Co. Preventing overheating in electrically heated boilers and the like.
10,986 Koeting & Mathiesen Akt.-Ges. Rainproof ventilator for arc lamps. (Convention date, 6/5/10. Germany.)*
10,992 Dicker. (Automatic Electric Co., U.S.) Telephone systems.

May 6, 1911.

11,048 Nell. Feedine low-voltage lamps and other low-voltage electrical devices in a high-voltage net. (Convention date, 7/7/10. France.)*
11,068 Lucas & Eppinton. Electric lamps for motor vehicles and other purposes.
11,070 Ingram. Transmitting news, reports, and the like by telegraphic or similar means.
11,075 Dawson & Buckham. Electrical apparatus for transmitting and receiving speech.

SPECIFICATIONS PUBLISHED.

1910 Specifications.

10,738 Godfree. Electro-mechanical selector. (28/5/09.)
10,758 Liddle. Electric motor-driven capstans.
10,776 Adams Mfg. Co. (Cutler Hammer Mfg. Co.) Electric circuit controllers.
10,864 Harrison. Manufacture of incandescent electric lamps.
10,870 Von Zweigbergk. Dynamo-electric machines.
10,903 Murray. System of heating interiors by means of electric radiators.
10,925 Veritys, Ltd., & Pipkin. Electrically-heated soldering iron or tool.
11,037 Mines & Rail-less Electric Traction Co. Trolley poles for electric traction systems.
11,070 Seward, Von Kugelin & Von Bidder. Electrolytic production of light metals, and particularly sodium. (10/5/09.)
11,091 Crossley & Hamer. Cord-grips for incandescent lamp holders.
11,[illegible] Kitsee. Metallic filaments for electric lamps.
11,[illegible] Walters. Stable arc lamps.
11,[illegible] Pressler. Automatic polarisation of fluid condensers in an electric welding apparatus. (Addition to 14,859/10.)
11,[illegible] Siemens Bros. Dynamo Works. (Siemens Schuckertwerke Ges.) Working electric motor and like controllers.
11,[illegible] Mines & Rail-less Electric Traction Co. Electric traction systems.
11,[illegible] Price. Switches for working with dynamos, accumulators, and the like. (6/11/10.)
11,[illegible] Waterhouse. Ceiling roses for electric light pendant fittings and the like.
11,[illegible] Salzer. Igniting magnetos of internal-combustion engines. (20/9/09.)
11,[illegible] Roberts & Prescott. Attachment devices for the shades of electric lamps and the like. (18/10/10.)
11,[illegible] Hinson & Johnson. Telephonic apparatus.
11,[illegible] Swangeon. Incandescence electric lamps. (18/9/09.)
11,[illegible] Deeke & Imperial Lamp Works (Brimsdown). Incandescent electric lamps.
24,123 Western Electric Co. (Western Electric Co.) Suspended hygroscopic shield for suspended electrical conductors.
24,[illegible] Marchant. Telephonic transmitters.
24,[illegible] Wicker. Waterproof protector for electric lamps.
24,[illegible] Mitchell & Duggeon. Section insulators for overhead wires and cables of tramway, railway, and like systems.
24,[illegible] Block. Trolleys or collectors for electric cars.
24,[illegible] Brown & Schneider. Galvanic gas cells.
24,[illegible] Aktiengesellschaft Elektricitats-Ges. Compensation of polyphase commutating dynamo-electric machines. (16/11/09.)
24,[illegible] Block. Dynamo-electric machines.
24,[illegible] Prestwich. Means for electrically igniting miners' safety lamps.
24,[illegible] Elektromechanische Werke Ges. Rectification of alternating electric currents and devices for use therein. (22/11/09.)
24,[illegible] Fauli. Overhead systems for transmitting electricity. (21/12/09.)
24,[illegible] Schneider. Verifying the operation of apparatus for distant electrical transmission and control of operations.
24,[illegible] Crompton & Co., Macfarlane, Burge & Williams. Means for regulating electrically-operated driving systems.
24,[illegible] Siemens Bros. Dynamo Works. (Siemens Schuckertwerke Ges.). Regulation of alternating current generators working in parallel.
24,[illegible] Siemens Bros. & Co. (Siemens & Halske Akt.-Ges.). Telephone exchange circuits.

1911 Specification.

[illegible] Hesse & Schultze. Electric traction on elevated cable tracks. (Divided application on 12,843/10. 26/5.)
[illegible] Pilé. Electric Storage Cells or Batteries.
[illegible] Brown & Trafagna. Switches adapted for operating the electric lamps of illuminated signs and the like.
[illegible] Aktiengesellschaft Elektricitats Ges. Electricity meter which indicates the consumption above a certain energy. (9/2/10.)
[illegible] Adams Mfg. Co. (Cutler Hammer Mfg. Co.) Electro-magnetic relay devices. (Divided application on 7,332/10. 25/4.)
[illegible] Fletcher. Magneto-electric machines.
[illegible] Fletcher. Magneto-electric machines.
[illegible] Siemens & Halske Akt.-Ges. Automatic telephone exchange circuits. (1/3/10.)
[illegible] H. Aron Elektrizitatszahlerfabrik Ges. Prepayment electric meters. (4/4/10.)
[illegible] Kjellman & Pentelec Welding Patents. Electric transformers. (Divided application on 10,694/10. 30/4.)
[illegible] Siemens Bros. & Co. (Siemens & Halske Akt.-Ges.). Electric order signalling apparatus. (Addition to 19,684/09.)

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from *The Electrician* office, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published under 2s., and 5 per cent. for books published nett. Add 10 per cent. for abroad or for foreign books.]

"Magnetismo e Elettricità." By F. Grassi. (Milan, 1911: Ulrico Hoepli.) L.7·50.

"Science Abstracts." Vol. XIV., No. 160. Part IV. Section A. Physics; Section B, Electrical Engineering. (London, 1911: E. & F. N. Spon.) 1s. 6d. each.

"Bulletin of the Bureau of Standards." Vol. VII., No. 1. (Washington, 1911: Government Printing Office.)

"The Transactions of the South African Institute of Electrical Engineers." Vol. II. Part II. 2s.

"Proceedings" of the Royal Society of Edinburgh. Vol. XXXI., part III. Session 1910–1911. (London, 1911, Williams & Norgate). 12s. 10d.

"Principles of Electrical Engineering." By H. Pender. Preliminary Edition. (New York, 1910: McGraw-Hill Book Co.) 17s. nett.

"Whittaker's Electrical Engineer's Pocket Book." Edited by Kenelm Edgcumbe. Third Edition. (London, 1911: Whittaker & Co.) 5s. nett.

COMPANIES' MEETINGS AND REPORTS.

Peel-Conner Telephone Works (Ltd.)

The first ordinary general meeting of this company took place on Monday, Mr. Hugo Hirst presiding.

The SECRETARY (Mr. P. P. Kipping) having read the notice convening the meeting and the auditor's report,

The CHAIRMAN said: It may be expected of me that, at this first meeting of shareholders of the Peel-Conner Telephone Works, I should say a few words as to the inception of the company, its past year's trading, &c. This company was started because your directors realised that there is to be a big telephone business in this country, in the colonies and in foreign countries. The development of the common battery system makes it certain that much of the existing exchange plants within a few years may have to be scrapped, and the improved service obtained by the common battery system will make telephony much more popular. Your directors (I should say, your present directors) felt that, owing to the monopoly enjoyed by the National Telephone Co., and under the practice they indulged in of buying their plant principally from foreign houses, it was not possible to establish an industry in this country earlier. But on the Post Office taking over the management, with the desire of buying its supplies from home manufacturers, and desirous of taking full advantage of the more modern system of common battery exchanges, they let it be known that they would prefer to confine their purchases to British products, if a sufficient and healthy competition of home producers could be created. Relying on our ability to manage works and men, and assisted by one of the foremost telephone experts, now our managing director, Mr. M. S. Conner, we decided to enter the field. The work during the first financial period already justifies our action. It would scarcely have been surprising to me if I had to present a balance-sheet which would not have enabled us to declare a dividend this year. At the starting of new works one has to reckon with so many problematical figures and facts. We have not followed others. We have been original right through.

Turning to the balance-sheet, the only figures which require comment are: (1) On the debit side, loans from bankers, (2) on the credit side, cash in hand and stock in hand. For the reason above explained, it has been impossible to complete all orders obtained during the financial year under review, and, as a result, our stock in hand and the work in progress amounts to some £30,000 to £40,000 of finished or nearly finished work for contracts which are being executed in this financial year, and the profit on the manufacture of this large amount of stock will show in the coming year's work. Our capital of £100,000 was not sufficient to deal with such items of stock, and in consequence we relied on our bankers to assist us to complete these contracts. After expressing his views on the subject of the ability of the Post Office to efficiently carry on the telephone business of the State, Mr. Hirst said there were ways by which the telephone service could be extended. Why should not the Post Office bring their mains to the houses and let duly qualified manufacturers and engineers instal private houses, factories, offices and the like with up-to-date telephone service at defined rates and on certain conditions and tests, exactly as electricity undertakings do? This would mean a staff of inspectors in the service of the G.P.O., but under such a method of extending the telephone business the Post Office would have at its command the service and enterprise of the whole of the electrical trade for getting subscribers. This was his own suggestion, but when the time came many more or less contentious schemes were conceivable. He now moved the adoption of the report and accounts.

Mr. JAS. FRASER seconded the motion and congratulated the shareholders on the first balance-sheet. He felt confident that the next would be much better.

The resolution was carried.

The retiring director (Mr. E. G. Byng) was re-elected, the auditor (Mr. C. S. Nicholson) was re-appointed, and the proceedings closed with a vote of thanks.

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ARON ELECTRICITY METER (LTD.)—For the year ended March 31 the profit and loss account, after providing for general charges and depreciation, shows a net profit of £27,520. 17s. 6d., making, with £5,353. 11s. 2d. brought forward, a total available profit of £32,874. 8s. 8d. Out of this the directors distributed in December a preference dividend of 3 per cent., absorbing £3,746. 17s. 7d., leaving £29,127. 11s. 1d. The directors now recommend payment of the balance 3 per cent. on the preference shares (absorbing £3,746. 17s. 7d.), a dividend of 6 per cent. on the ordinary shares (absorbing £7,500), and to transfer £5,000 to reserve towards goodwill and patents, leaving £12,880. 13s. 6d., out of which it is proposed to appropriate £7,000 towards writing off expenses of debenture issue of 1911, and to carry forward £5,880. 13s. 6d. The past year's trading has been most satisfactory, the sales having again exceeded those of any previous year. The factories have been fully employed and the necessary extensions to cope with the increased business have been carried out. The taximeter business is still progressing satisfactorily in England, Belgium and Austria.

HAVANA ELECTRIC RAILWAY CO.—The report for 1910 states that the gross earnings were $2,656,979, operating expenses $1,365,640, leaving $1,291,338. Fixed charges and taxes amounted to $448,128, leaving $843,209. Adjustments amounted to $1,549, and available surplus earnings were $844,759. Dividends were paid during the year of 6 per cent. on preferred ($300,000) and 6 per cent. on common shares ($447,821), leaving $1,114,913. after taking into account the amount brought forward from 1909.

WESTINGHOUSE ELECTRIC & MFG. CO.—The report of this company and its subsidiaries for the year ended March 31 states that the gross earnings were $38,119,000, an increase of nearly $9,000,000 over the preceding year. The net manufacturing profits are $5,609,000, making, with other income ($1,515,000) a total net income of $7,124,000. Deducting interest and other charges the surplus is $4,881,000. The surplus on March 31, 1910, was $5,669,000, which was increased by various items of profit throughout the year to $6,349,000. Adding net income for the year the surplus amounted to $11,230,000. Against this there have been charged dividends of preferred stock for year at rate of 7 per cent. per annum, plus remaining balance of dividends accumulated but unpaid in previous years ($630,000): in adjustment of account property and plant $1,193,000; to reserve for notes and accounts receivable $590,000; depreciation of investments $2,753,000. This leaves a surplus of $5,964,000.

NEW COMPANIES, MORTGAGES AND CHARGES.

NEW COMPANIES.

BENTINCK MOTOR SUPPLY CO. (LTD.) (116,155.)—Reg. June 1, capital £50,000 in £1 shares, to carry on the business of proprietors of and dealers in motor cabs, cars, &c., manufacturers of engines, dynamos, accumulators, magnetos, wheels, tyres, lamps, &c. Private company. First directors are S. Brooks (governing director and chairman), J. H. Smith and J. Nuttall. Reg. office: care of C. Lord, 13, Spring-gardens, Manchester.

FOREST-WEY TRUST CO. (LTD.) (116,161.)—Reg. June 1, capital £20,000 in £1 shares, to promote, contract, purchase, lease, or otherwise acquire, equip, work, maintain and operate railways and tramways in the U.S.A. or elsewhere and to carry on the business of rolling stock manufacturers, engineers, &c. Private company. First directors are J. Wayman and G. F. Thomson. Reg. office: 31, Lombard-street, E.C.

JACOB WHITE & CO. (LTD.) (116,217).—Reg. June 3, capital £2,000 in £1 shares, to carry on the business of electricians, manufacturers of and dealers in accessories, fittings and supplies, lighting engineers, electrical contractors, &c. Private company. First directors T. Jacob and E. W. White (both permanent). Reg. office, King's House, King-street, London, E.C.

KJELLBERG SYND. (LTD.) (116,140.)—Reg. May 31, capital £130 in £1 shares, to work and turn to account in the U.K. and colonies an invention for improvements in electric welding or soldering and for electric switches and to adopt an agreement with the Jektriska Svetsnings Aktiebolaget. Private company. First directors, G. T. H. Davidson, R. S. Prinsep, G. H. Hannay, E. G. Thormadlon, T. M. Aitken and J. B. Hamilton.

MOSCOW METROPOLITAN SYND. (LTD.) (116,059.)—Reg. May 26, capital £20,000 in £1 shares, to acquire concessions and rights, to construct or acquire any railway or tramways in Moscow or elsewhere and to equip, maintain and work same by electricity or other power, &c. Private company.

MORTGAGES AND CHARGES.

ARC LAMPS (LTD.) (70,795).—A memorandum of satisfaction in full on 27th May, of debentures dated 18th Dec., 1908, securing £4,000, has been filed.

DELHI ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.)—Issue on May 22 of £600 bearer debentures, part of a series of which particulars already filed.

ENGINEERING & ARC LAMPS (LTD.)—Particulars of £6,000 debentures created 26th May, have been filed, amount of present issue being £5,500. Property charged: Co.'s undertaking and property, present and future, including uncalled capital. No trustees.

LONDON TELEGRAPH TRAINING COLLEGE (LTD.)—Particulars of £400 debentures, created 25th May, have been filed, amount of present issue being £300. Property charged: Co.'s undertaking and property, present and future. No trustees. A memorandum of satisfaction in full on 29th May of debenture dated 24th March, 1909, securing £100, has also been filed.

CITY NOTES.

MEMORANDA (June 15).—**Bank rate 3 per cent.** (March 9, 1911) **Price of silver,** 24½d. **per oz. Consols** 79⅞—80 **for money and for account. Consols Pay Day, July 5; Stock and Shares Continuation Days, June 28 and July 12; Ticket Days, June 29 and July 13; Pay Days, June 30 and July 14; Mining Shares Carry Over Day, June 27.**

PRICES OF METALS (London).—*Copper*, **cash,** 56⅞; **three months** 57. *Lead*, **English,** 13½—13¼; **foreign,** 13¼—13⅛ **cash,** 13⅞ **three months.** *Spelter*, 24½—24⅝. *Tin*, **English,** 200—201; **foreign,** 229 **cash,** 186½ **three months.** *Iron*, **Cleveland, cash,** 46/3, **three months,** 47/0.

ALBY UNITED CARBIDE FACTORIES (LTD.) In a circular issued by the directors it is stated that the agreement entered into with the other European carbide manufacturers has been working satisfactorily and all contracts made at low rates prior to the arrangement have been executed. The price of carbide delivered since April 1 has been at an advance of about £2 per ton over that ruling during the previous year. The profits for the 12 months ending June 30 will, it is estimated, show an advance of about 40 per cent. The business of the North-Western Cyanamide Co. (in which they are largely interested) is progressing satisfactorily, and the plant is working to its fullest capacity and producing the maximum amount of cyanamide for which it was designed.

CHADBURN'S (SHIP) TELEGRAPH CO. (LTD.)—The directors recommend a dividend of 5 per cent. on the ordinary shares, making 8 per cent. for the past year.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—The transfer books and register of holders of the 5 per cent. first and 4½ per cent. second debenture stock of this company will be closed from 17th to 30th inst., inclusive.

GWYNNES (LTD.)—The accounts for the year ended Jan. 31, 1911, show, after deducting debenture interest and allowing £3,067 for depreciation on plant, &c., a debit balance of £7,432.

MANILA ELECTRIC RAILROAD & LIGHTING CO.—A dividend of 1¼ per cent. for the quarter ending June 30 has been declared, payable in New York.

METALITE (LTD.)—The following gentlemen have been added to the Board of this company: The Hon. Sir Cornthwaite H. Rason, Kt. (ex-Premier West Australia), Mr. Walter Bernard Hopkins (director of A. Darracq & Co.), and Mr. William Stewart.

NATIONAL TELEPHONE CO. (LTD.)—The transfer books of the 3½ per cent. and 4 per cent. debenture stocks will be closed from 17th to 30th inst. inclusive, for the preparation of warrants for interest due July 1.

PROVINCIAL TRAMWAYS CO.—The directors have declared an interim dividend of 8d. per share.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed June 29 a special settling day in 125,000 £1 fully-paid vendors' shares of the *Juga (Nigeria) Tin & Power Co. (Ltd.)* The Committee have been asked to grant a quotation to 500,000 £10 fully-paid shares of the *Underground Electric Railways Co. of London (Ltd.)* (special application).

UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON (LTD.)—A circular has been issued to the shareholders and to the holders of the Six per Cent. Income Bonds stating that the Lot's-road power house is now leased to the London Electric Underground and Metropolitan District Railway Companies as tenants in common for 999 years. It is provided each of the two companies being liable for and paying a moiety of the rent as part of its working expenses, the moiety attributable to each railway company being payable out of its revenues in priority to the interest on its present or future debentures and debenture stock. Under the present contracts for the supply of electrical energy to the railway companies the price paid for such energy includes a contribution to a depreciation fund which was established under the contracts. This fund at June 30, 1911, amounts to approximately £176,900, and is only applicable to payments for repairs and renewals of the generating station in so far as they are properly chargeable against depreciation. It is proposed that the price for the generating station undertaking should be £2,200,000 of power house rent-charge stock at par, or the nett proceeds thereof, and carrying a fixed perpetual dividend at the rate of 4 per cent. per annum. It is proposed that the sale and lease shall take effect on July 1, 1911, and that the dividend on the power house rent-charge stock shall commence to accrue on the same date. It is proposed to apply the balance of the purchase price remaining after payment of expenses incident to sale, first in redemption of the entire issue of £1,000,000 of first power house debentures now charged on the generating station undertaking, and then towards the redemption of the 4½ per cent. bonds of 1933 of the Company. The sale and lease of the undertaking to the two railway companies are not to take effect until the purchase price and conditions of sale and purchase and the terms and conditions of the lease have been duly approved by general meetings of the interests concerned.

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ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.		Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
			£	£		£	£
Aberdeen Corporation	June	7	1,825	+ 202	1	1,825	+ 202
Airdrie	„	2	240	+ 29	22	4,692	− 26
Anglo-Argentine	„	10	49,639	+ 4,955	23	1,139,638	+ 123,169
Ashton-under-Lyne	„	10	534	+ 147	11	4,700	+ 500
Ayr Corporation	„	10	317	..	4	1,134	+ 9
Barnsley	„	2	191	+ 32	22	3,883	+ 163
Barrow	„	2	301	+ 53	22	5,477	+ 250
Bath Electric Trams, Ltd.	„	7	1,300	+ 487	23	17,692	+ 467
Birmingham Corporation	„	3	7,278	+ 746	9	66,595	+ 3,885
Birmingham & Midland	„	2	904	+ 97	22	19,257	+ 1,183
Blackpool and Fleetwood	„	10	1,834	+ 1,279	..	..	..
Blackburn Corporation	„	7	1,639	+ 601	¶6	12,945	+ 1,493
Bolton Corporation	„	11	2,841	+ 321	11	26,878	+ 2,348
Bombay	May	12	2,948	+ 165	19	54,602	+ 2,876
Bournemouth Corporation	June	7	2,288	+ 625	10	17,279	+ 1,092
Bradford Corporation	„	10	7,262	+ 2,105	20	57,625	+ 5,513
Brighton Corporation	„	11	1,292	+ 323	¶10	10,444	+ 1,025
Bristol Trams & Carriage	„	9	9,061	+ 3.097	10	65,749	+ 7,141
Burnley Corporation	„	10	1,595	+ 320	10	13,835	+ 1,564
Burton Corporation	„	11	326	+ 54	10	2,830	+ 120
Bury Corporation	..		..	..	..	..	..
Calcutta Tramways Co.	„	10	R58,630	+ R8,976	23	R1,323,488	+ R45,688
Camborne-Redruth	„	10	183	+ 71	23	2,729	− 8
Cardiff Corporation	..		..	..	..	..	..
Cavehill	„	2	115	+ 34	22	1,669	− 60
Central London Railway	„	10	4,916	− 1,024	23	119,490	− 10,407
Chatham & Dist. Lt. Rys.	„	8	1,194	+ 288	23	18,396	+ 92
City & South London Rly.	„	11	3,081	− 20	23	76,983	+ 2,336
City of Birmingham	„	2	3,112	+ 339	22	63,376	+ 1,313
Cork Electric Trams Co.	„	8	660	+ 93	23	10,796	+ 170
Devonport & Dist. Trams	„	2	531	+ 109	22	9,769	+ 872
Dover Corporation	„	10	329	+ 112	10	2,441	+ 391
Dublin & Lucan Railway	„	9	225	+ 79	23	2,891	+ 14
Dublin United	„	9	7,914	+ 2,424	23	124,160	+ 4,743
Dudley-Stourbridge	„	2	862	+ 68	22	16,977	+ 854
Dundee Corporation	„	7	1,301	+ 85	¶3	4,046	+ 36
East Ham Council	„	10	1,323	+ 255	10	11,103	+ 668
Exeter Corporation	„	9	453	+ 129	10	3,426	+ 251
Gateshead & Dist. Trams	„	2	1,071	+ 117	22	21,952	+ 1,136
Glasgow Corporation	„	10	20,829	+ 1,842	§1	30,978	+ 4,467
Glossop Trams	„	10	140	+ 20	23	2,718	+ 148
Gloucester Corpn.	„	7	423	+ 128	..	..	..
Gravesend-Northfleet	„	2	234	+ 32	22	4,168	− 40
Great Northern & City Rly.	„	10	1,438	+ 66	23	35,381	+ 1,413
Greenock & Port Glasgow	„	2	861	+ 192	22	14,447	+ 1,965
Halifax Corporation	„	6	3,071	+ 1,315	†10	19,675	+ 2,667
Hartlepool Tramways	„	2	292	+ 55	22	4,995	+ 266
Hastings Elec. Trams Co.	„	8	1,490	+ 484	..	..	..
Hong Kong	„	10	$9,624	+ $162	23	$210,342	− $2,878
Huddersfield Corpn.	„	10	2,578	+ 825	10	19,992	+ 2,546
Hull Corporation	„	10	3,030	+ 352	10	28,821	+ 1,410
Ilford District Council	„	10	748	+ 208	10	5,839	+ 403
Ilkeston District Council	„	7	175	+ 53	10	1,360	+ 118
Ipswich Corporation	„	10	594	+ 151	10	4,476	+ 538
Isle of Thanet Co.	„	10	1,095	+ 445	36	13,211	+ 833
Jarrow	„	2	155	+ 43	22	2,679	+ 189
Keighley Corporation	„	8	260	+ 84	10	1,967	+ 221
Kidderminster & District	„	2	115	+ 25	22	2,038	− 17
Kilmarnock Corporation	„	10	155	+ 7	4	600	+ 14
Kirkcaldy Corporation	„	7	311	+ 49	10	2,917	+ 372
Lanarkshire Trams Co.	„	8	1,536	+ 101	23	31,591	+ 407
Lancashire United	„	7	1,683	+ 399	23	29,603	+ 780
*Leamington	„	2	174	+ 15	22	3,091	− 161
Leeds Corporation	„	10	9,284	+ 2,169	10	77,860	+ 7,344
Leicester Corporation	„	10	3,090	+ 711	10	26,034	+ 2,598
Leith Corporation	„	10	727	+ 84	‡4	2,558	+ 208
Lincoln Corporation	„	10	150	+ 27	10	1,367	+ 118
Liverpool Corporation	„	3	12,336	+ 1,213	22	244,868	+ 8,181
Liverpool Overhead Rly.	„	11	1,731	+ 290	23	32,849	+ 2,015
*Llandudno&ColwynBayRy.	..	9	638	+ 380	¶27	4,772	+ 175
London County Council	May	31	46,119	+ 4,194	‡9	384,738	+ 19,881
London Elec. Ry. Co.	June	10	18,420	+ 1,155	23	320,770	+ 15,270
London United	„	10	10,613	+ 3,816	23	141,624	+ 3,546
Lowestoft Corporation	..		..	..	..	..	..
Manchester Corporation	„	10	19,013	+ 3,193	11	167,684	+ 13,229
Mersey Railway	„	10	2,344	+ 130	23	47,562	+ 1,064
Merthyr	„	2	214	+ 33	22	4,268	..
Metropolitan Dist. Railway	„	10	11,593	+ 618	23	269,515	+ 17,540
Metropolitan Elec. Trams	„	2	9,832	+ 2,202	22	179,369	+ 24,448
Middleton	„	2	388	+ 93	22	6,789	+ 347
Nelson Corporation	„	10	217	+ 65	§10	1,884	+ 417
Newcastle-on-Tyne Corp.	„	10	4,542	+ 631	10	42,514	+ 3,419
Newport (Mon.)	„	10	964	+ 258	10	7,528	+ 565
Northampton Corporation	„	9	814	+ 319	10	5,510	+ 595
Oldham, Ashton & Hyde	„	2	598	+ 84	22	12,020	+ 299
Oldham Corporation	„	11	2,068	+ 156	11	22,371	+ 1,316
Perth (N.B.) Corporation	„	7	209	+ 39	3	619	+ 43
Perth (W.A.) Elec. Trams	„	9	1,520	+ 73	23	37,564	+ 1,873
[illegible]rborough	„	2	129	+ 22	22	2,359	+ 82
[illegible]mouth Corporation	„	10	2,916	+ 809	10	21,538	+ 1,635
[illegible]	„	2	1,968	+ 291	22	41,671	+ 3,922
[illegible]ton Corporation	..		..	..	..	..	..
[illegible]ham Corporation	„	8	874	+ 269	10	6,850	+ 787
[illegible]y	„	2	176	− 19	22	1,913	− 57
[illegible]rd Corporation	„	12	6,262	+ 1,266	§10	52,385	+ 4,045
[illegible]es	„	2	55	+ 5	22	970	+ 20
[illegible]ld Corporation	„	11	7,282	+ 1,198	11	72,087	+ 5,300
[illegible]pore Trams	„	10	$10,833	+ $1,196	23	$238,636	+ $12,004
[illegible] Metropolitan	„	2	1,101	+ 153	22	16,942	− 3
[illegible] Staffs	„	2	893	+ 105	22	19,080	+ 1,254
[illegible]hampton	„	7	1,607	+ 474	10	11,463	+ 979
[illegible]end Corporation	„	7	1,060	+ 498	10	5,959	+ 1,033
[illegible]port Tramways	„	2	339	+ 63	22	5,654	− 94
[illegible]bridge,Hyde,&c., Jt.Bd.	..		..	..	..	..	..
[illegible]derland Corporation	„	11	1,739	+ 457	10	13,047	+ 1,471
[illegible]derland District	„	7	714	+ 325	32	14,412	+ 1,219
[illegible]sea Trams	„	2	1,175	+ 117	22	23,353	+ 1,198
[illegible]don Corporation	„	7	216	+ 70	‡10	1,522	+ 175
[illegible]ton	„	2	44	+ 4	22	858	− 11
[illegible]mouth and District	„	2	270	+ 47	22	3,796	− 14
[illegible]e Trams Co.	„	7	765	+ 333	23	10,025	+ 970
[illegible]y Corporation	„	10	1,488	+ 509	10	11,457	+ 2,112
[illegible]ll Corporation	„	10	745	+ 245	23	12,741	+ 515
[illegible]ngton Corporation	„	8	438	+ 57	10	3,959	+ 210
[illegible]t Ham Corporation	„	8	3,454	+ 944	10	27,697	+ 13,340
[illegible]on-super-Mare	„	2	158	− 49	22	1,185	− 246
[illegible]hampton Co.	„	2	435	+ 49	22	9,296	+ 309
[illegible]hampton Corpn.	„	7	1,579	+ 712	10	10,165	+ 1,210
[illegible]ster	„	2	306	+ 29	22	5,654	+ 88
[illegible]ham	„	2	107	+ 22	22	2,062	− 9
[illegible]shire W.R. Trams	„	11	1,852	+ 588	24	30,632	+ 1,176
[illegible]shire Woollen District.	„	2	1,130	+ 180	22	22,171	+ 1,360

(a) These comparisons are with the corresponding period last year. * Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 3 days. ¶ Plus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Size	Last Dividend	NAME.	Price Wed., June 14.	*Rate per cent. Yielded. £ s. d.	Dividend Due.	Business Week to June 14. Highest.	Lowest.
		Electricity Supply.					
10	6/0	Bournemouth & Poole Elec. Sup. Ord.	8 —9	6 9 6	Mar, Sep	..	—
10	4/6	Do. 4½ per Cent. Cum. Pref.	9 —10	4 14 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Second Pref.	10⅛—10⅝	5 6 6	Feb, Aug	10 1/16	10½
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	102 —104	4 6 6	Jan, July	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	7¾—8¼	6 1 6	March....	8⅛	..
5	3/6	Do. 7 per Cent. Pref.	7⅜—8	4 1 3	Mar, Sept	..	..
St.	4%	†Central Elec. Sup. Co. 4% Guar. Deb. Stock	98 —101	4 0 6	June, Dec	..	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	3¾—4¼	5 2 6	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	4⅜—4⅞	4 17 3	Feb., Aug	..	—
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	96 —98	4 1 6	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101½—103½	4 7 0	..	..	..
5	2/3	Do. City Undertaking 4½% Cum. Pref.	3⅞—4⅜	5 3 0	Jan, July	4 1/16	..
5	3/0	Chelsea Electric Supply Ord.	4 —4½	5 11 0	March ..	—	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	100 —102	4 8 6	June, Dec	..	..
10	8/0	City of London Electric Lighting Ord.	11¾—12¼	4 15 0	Feb, Aug	12⅛	..
10	6/0	Do. 6 per Cent. Cum. Pref.	12 —13	4 12 3	Jan, July	..	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	121 —125	4 1 0	June, Dec	121½	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	101 —104	4 6 6	Jan, July	104	103½
St.	5%	County of Durham Elec. P. D. 5% 1st Mort. Deb. Stk.	92 —94	5 5 3	Jan, July	..	—
10	6/0	County of London Elec. Supply Ord.	7⅞—8⅛	6 3 0	Feb, Aug	7 3/32	7⅞
10	6/0	Do. 6 per Cent. Cum. Pref.	10⅞—11⅜	5 5 6	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Deb Stock (red.)	109 —111	4 2 0	Jan, July	..	..
St.	4½%	Do. Second Deb. Stock	99 —102	4 8 0	May, Nov	100¼	..
5	4/0	Folkestone Electricity Supply Co. Ord.	4¼—4¾	5 19 0	April, Oct	—	—
5	2/6	Do. 5 per Cent. Cum. Pref.	4¾—5¼	4 15 3	Mar, Sept	..	—
St.	4½%	Do. 4½ 1st Deb. Stock (red)	97 —100	4 10 0	Feb, Aug	—	..
5	5/0	Hove Electric Lighting Ord.	6¾—7¼	6 4 0	April, Oct	—	—
St.	4½%	Isle of Wight E. L. & P. Co. Deb. Stk.	88 —91	4 19 0	..	..	—
5	5/0	Kensington & Knightsbridge Ord.	7 —7½	5 16 0	Feb, Aug	—	—
5	6%	Do. 6 per Cent. 1st Pref.	5½—6	5 0 0	Jan, July	..	—
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	93 —95	4 4 0	..	—	—
St.	4%	Kensington & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	96 —99	4 1 0	April, Oct	—	—
St.	4½%	Kent Elec. Power Co. Irred Deb. Stk.	80 —84	5 7 0	Jan, July	—	—
3	1/2⅜	London Electric Supply Ord.	1¾—2¼	2 17 0	Mar, Sept	—	—
5	3/0	Do. 6 per Cent. Pref.	4¾—5¼	5 17 0	Mar, Sept	5	4⅞
St.	4%	Do. 4 per Cent. 1st Mort. Deb	91 —94	4 5 0	Jan, July	..	..
5	3/0	Metropolitan Electric Sup. Ord.	3⅜—3⅞	6 18 0	April, Oct	3 7/16	3½
5	2/3	Do. 4½ per Cent. Cum. Pref.	4½—4¾	4 14 9	Jan, July	4 9/16	—
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	101 —104	4 6 6	June, Dec	..	—
St.	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	86 —89	3 18 6	Jan, July	..	—
..	4½%	Midland Elec. Corp. for Power Dist, 4½ 1st Mort. Debs.	98 —100	4 11 0	..	—	..
5	2/6	Newcastle Elec. Supply Ord.	3¾—4¼	4 14 0	Feb, Aug	..	—
5	2/6	Do. 5 per Cent. non Cum. Pref.	4 —4½	5 11 0	Feb, Aug	—	..
100	4½%	Do. 4½ per Cent. 1st Mort. Deb.	99 —101	4 10 0	Jan, July	..	..
100	5%	North Metro. Elec. Power Sup. 5 Morts.	99 —102	5 0 6	..	..	..
1	6%	Northampton Elec. Lt. & P. Ord.	1¼—1 5/16	4 11 6	Feb, Aug	..	—
1	5%	Do. 5% Pref.	[illegible]—[illegible]	4 6 0	Feb, Aug	..	—
St.	4%	Do. 4% Debs.	99 —101	3 19 0	June, Dec	..	—
10	10/0	Notting Hill Electric Ord.	12 —12½	5 17 6	March	12	..
5	4/3	Oxford Electric Ord.	6¼—6⅝	5 13 9	March	..	..
St.	4%	Do. 4% Deb. Stk.	93 —96	..	..	..	—
5	5/0	St. James' & Pall Mall Elec. Ord.	8¾—9¼	5 8 0	Feb, Aug	9 1/16	8⅞
5	3/6	Do. 7 per Cent. Pref.	6¾—7¼	4 16 6	Feb, Aug	..	..
St.	3½%	Do 3½ per Cent. Deb. Stock (red.)	86 —88	3 19 6	Jan, July	..	—
5	..	Smithfield Markets Electric Sup. Ord.	1⅜—1⅞	..	Feb.	..	—
5	4/0	South London Electric Supply Ord.	3 —3½	6 3 0	April	..	—
St.	5%	Do. 5% 1st Mort. Stock (red.)	101 —104	4 16 0	..	101	—
1	0 8¾	South Metrop'n Elec. Lt & Power 7% 1st Pref	1⅛—1¼	5 18 0	Feb, Aug	—	—
1	0/7½	Do. 6 per Cent. 2nd Pref.	⅞—⅞	6 17 0	Feb, Aug	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	97 —100	4 11 6	April, Oct	..	—
5	1/3	Urban Electric Supply Ord.	½—1	..	April, Oct	..	—
5	1/3	Do. 5 per Cent. Cum. Pref.	2½—3	8 6 0	April, Oct	2⅜	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	87 —89	5 2 3	April, Oct	88¼	87½
5	5/0	Westminster Elec. Sup. Ord.	7¼—8¼	6 5 0	Mar, Sept	8	7 15/16
5	2/3	Do. 4½ per Cent. Cum. Pref.	5 —5½	4 3 6	Jan, July	—	..
		Electric Railways and Tramways.					
1	..	Bath Elec. Trams Pref. Ord.	⅜—7/16	..	April	..	—
1	0/6	Do. 5 per Cent. Cum. Pref.	⅜—½	6 13 6	Jan, July	[illegible]	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	79 —83	5 8 6	April, Oct	..	—
St.	4½%	B'ham & Midland Trams 4½ 1st Deb. Stock.	90½—92½	4 17 3	Jan, July	90½	..
10	4%	Bristol Tramways & Carriage Ord.	7 —7½	5 10 3	Feb, Aug	—	—
10	4%	Do. Cum. Pref.	7¼—7¾	5 6 9	..	..	—
St.	4%	Do. 4 per Cent. Debs.	101 —102	3 18 3	Feb, Aug	..	..
10	..	British Electric Traction Ord.	1¼—1⅜	..	June, Dec	1⅜	—
10	..	Do. 6 per Cent. Cum. Pref.	4¼—4⅝	..	Feb, Aug	4¼	4⅛
St.	5%	Do. 5 per Cent. Perpetual Debs.	96 —99	5 2 6	April, Oct	97½	96¼
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	76 —81	5 14 6	May, Nov	78½	..
St.	3%	Central London Ordinary Stock	72 —74	4 2 0	Feb, Aug	73½	72
St.	4%	Do. 4 per Cent. Pref. Stock	87 —89	4 10 0	Feb, Aug	88¼	87½
St.	2%	Do. Deferred Stock	62 —64	3 3 6	Feb.	62½	62¼
100	4%	Do. 4 per Cent. Debs.	104 —106	3 16 0	Jan, July	..	..
5	2/6	City of Birmingham Trams, 5% Cum. Pref.	4¼—5	5 0 0	April, Oct	..	—
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 18 9	April, Oct	..	—
St.	1½%	City & South London Rly. Con. Ord.	31½—32½	4 14 0	Feb, Aug	33	32¼
St.	5%	Do. 5 per cent. Perp. Pref. (1891)	109 —111	4 10 0	Feb, Aug	..	—
St.	5%	Do. (1896)	105 —108	4 13 0	Feb, Aug	..	—
St.	5%	Do. (1901)	104 —107	4 15 0	Feb, Aug	104½	—
St.	5%	Do. (1903)	103 —106	4 15 6	Feb, Aug	..	—
St.	4%	Do. 4 per Cent. Perpetual Debs.	102 —104	3 17 9	May, Nov	104½	..
10	6/0	Dublin United Trams. 6 per Cent. Pref.	12½—13½	4 10 6	Feb, Aug	..	—
10	12/0	Gateshead and District Trams Ord.	8½—8¾	6 19 6	..	8½	..
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	¾—1½	..	Feb, Aug	..	..
5	..	Hastings & District Elec. Trams, 6% C. P.	1½—2	..	Mar, Sept	..	..
St.	4½%	Do. 4½ Deb. Stock	75 —80	5 10 0	April, Oct	..	—
10	..	Imperial Tramways Ord.	3 —3½	..	Mar, Sept	..	..
10	..	‡Do. 6 per Cent. Pref.	4¼—4¾	..	Mar, Sept	..	—
St.	4½%	Do. 4½ per Cent. Debs.	72 —74	6 3 6	Jan, July	..	—
..	2/6	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	2¼—2¾	5 0 0	Mar, Sept.	..	—
St.	4%	Do. 4 per Cent. Deb. Stock	79 —84	4 15 0	Jan, July	—	—
10	6/0	Lanarkshire Tramways	10 —10½	5 12 3	Feb, Aug	..	—
St.	5%	Lancs Utd. Trams. 5% Prior Lien Deb. Stk.	82 —84	5 19 0	Jan. July	..	—
St.	4%	London Electric 4% Deb. St.	98 —100	4 0 0	..	99½	99¼
St.	4%	Do. 4% Pref.	85 —86	4 14 0	..	85½	84¾
10	..	London United Trams, 5% Cum. Pref.	4 —4½	..	Jan, July	4 1/16	3⅞
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	77 —80	5 3 0	Jan, July	77½	76
St.	..	Mersey Con. Ord. Stock	6 —8	..	Feb, Aug	—	..
1	1/1⅕	Metropolitan Elec. Tramways Ord.	15/16—1 1/16	6 0 0	..	1	..
1	..	Do. Deferred	⅛—3/16	..	April	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	[illegible]—1 1/16	5 0 0	Feb, Aug	[illegible]	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	102½—104½	4 7 0	Jan, July	103	—
St.	5%	Do. 5 per Cent. Db. Stk	100½—103½	4 18 0	..	103	10[illegible]
St.	1½%	Metropolitan Railway Consolidated	47½—48	2 16 3	Feb, Aug	50½	[illegible]
St.	2½%	Do. Surplus Lands Stocks	68 —70	3 19 6	Feb, Aug	[illegible]	[illegible]
St.	3½%	Do. 3½ per Cent. Preference	90 —92	3 16 0	[illegible]	[illegible]	[illegible]
St.	3½%	Do. 3½ per Cent. "A" Preference	89 —91	[illegible]	[illegible]	[illegible]	[illegible]
St.	3½%	Do. 3½ per Cent. Convertible Pref.	89 —91	[illegible]	[illegible]	[illegible]	[illegible]
St.	3½%	Do. 3½ per Cent. Debenture Stock	93 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]

* No allowance has been [illegible]
† Ex Dividend. ‡ The [illegible]

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ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shre	Last Dividend	Name.	Price Wed., June 14.	*Rate per cent. Yielded.	Dividend Due.	Business Week to June 14. Highest.	Lowest.
		Electric Railways and Tramways— *Continued.*		£ s. d.			
St.	3½%	Met. Rly. 3½ per Cent. "A" Deb. Stock	92 —94	3 14 6	Jan, July	93⅜	92
St.	..	Metropolitan District Railway Ord.	29¼—29⅝	..	Feb, Aug	32⅝	29
St.	3½%	Do. 4½% First Pref.	89 —91	4 19 0	Feb, Aug	90½	90
St.	3½%	Do. Assented Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	75 —77	4 11 0	Feb, Aug	75⅛	..
St.	3%	Do. 3 per Cent. Consoltd. Rent-charge	77 —79	3 16 0	Jan, July	77⅛	..
St.	4%	Do. 4 per Cent. Midland Rent-charge	104 —106	3 16 0	Jan, July	..	..
St.	6%	Do. 6 per Cent. Perp. Deb. Stock	148 —150	4 0 0	Jan, July	149⅜	149
St.	4%	Do. 4 per Cent. Ditto	98 —100	4 0 0	Jan, July	99¼	99
1	4½d.	†Potteries Electric Traction Ord.	⅛ —⅜	5 6 9	April, Oct	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	3/16—5/16	7 5 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent, Deb. Stock	89 —90	5 0 6	May, Nov	..	..
1	1/2½	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	1/32—3/32	10 2 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	75 —80	5 0 0	Jan, July	..	..
100	5%	Sunderland Dist. Elec. Trms. 5% 1stMtDb.	..	8 4 0	Jan, July	68½	63½
..	10/0	Undergd E. Rys. Lon. 6% In. bds with coup 7	67 —69	1 13 0	June, Dec	..	..
—	5%	Do. 5% Prior Lien Bonds	100 —101	4 19 0	..	101	99½
—	4½%	Do. 4½% Bonds with coup. 7	100 —102	4 9 0	..	..	..
—	4%	Do. 4 per Cent. 1st Power Ho. Dbs.	100 —102	3 18 3	..	..	..
5	..	Yorkshire (W.R.) Elec. Trams. Ord.	⅛ —⅜	..	March ..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	2⅛—2⅞	..	..	..	..
St.	4½	Do. 4½ per Cent. 1st Debs.	84 —87	5 3 3	Jan, July	..	..
		Electric Manufacturing, &c.					
St.	4½%	Anchor Cable Co. 4½ % Deb. Stock	99 —101	4 9 0	—	..	..
1	..	Aron Electricity Meter Ord.	3/32—5/32	..	..	..	..
1	0/7½	Do. 6% Cum. Pf.	7/32—9/32	7 4 0	April, Oct	5/16	5/16
1	3/2½	Babcock & Wilcox Ord.	5⅛—5⅝	4 11 0	April, Oct	..	..
1	0/7½	Do. Pref.	1⅛—1⅜	4 0 0	..	..	..
5	6/0	British Insulated & Helsby Cables Ord.	6⅛—7⅛	6 15 6	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	6 —6⅛	4 12 3	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (rcd.)	102 —104	4 6 6	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mt. Db.	96 —99	4 11 0	Mar, Sept	..	..
5	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	⅜—½	..	Feb, Aug	1	2½
100	6%	British Westinghouse 6 per Cent. Pref.	100 —103	5 16 3	..	62⅜	62
St.	4%	Do. 6 per Cent. Prior Lien Dbs. (rd.)	61 —64	6 5 0	Jan, July	60⅛	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	59 —64	7 0 6	Mar, Sept	41⅛	..
St.	4½%	Brush E. Eng. Co. 4½% Perp. 1st Deb. Stock	41 —46	9 16 0	Jan, July	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	9⅛—9⅞	7 12 0	Jan, July	4⅜	..
5	5/0	Callender's Cable Con. Ord.	4⅛—5⅛	4 17 6	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	102 —104	4 6 6	Nov, May	3 1/16	3 7/16
St.	4½%	Do. 4½ per Cent. 1st Mort Debs. (red.)	3⅞—3⅞	5 1 9	May, Nov	..	..
1	1/6	Castner-Kellner Alkali Co.	103 —106	4 3 6	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	1⅛—1⅛	5 19 0	March ..	..	..
1	7½d.	Chadburn's (Ship) Telegraph Ord.	⅜—½	10 0 0	August ..	..	..
1	0/8½	Consolidated Electrical Co.	1/16—1/16	5 14 0	April, Oct	..	..
1	0/6	Consolidated Signal Co.	1/16—1/16	6 8 0	April, Oct	..	..
3	0/7½	Do. 6 per cent. Cum. Pref.	⅛—⅜	..	Jan, July	..	..
100	..	Crompton & Co (Nos. 1 to 85,000)	60 —70	7 14 0	Jan, July	..	..
5	5%	Do. 5 per Cent. 1st Mort. Debs. (red.)	1/32—1/32	5 14 0	Sept. ..	..	..
5	1/0	Dick, Kerr & Co. Ord.	1 —1⅛	5 6 6	Sept ..	..	..
St.	0/7½	Do. 6 per Cent. Cum. Pref.	97 —100	4 10 0	Jan, July	98	..
5	4½%	Do. 4½ per Cent. Deb. Stock	1/32—1/32	..	Feb, Aug	..	..
..	..	Edison & Swan United ("A" Sh.) (£3 pd.)	1/16—2/16	9 3 0	Feb, Aug	..	..
St.	4%	Do. (£5 paid)	69 —73	5 9 9	June, Dec	..	..
St.	5%	Do 4 per Cent. Mort. Deb. Stock (red.)	78 —81	6 3 6	Mar, Sept	..	..
..	..	Do 5 per Cent. 2nd Deb. Stock	1/16—1/16	..	Jan, July	..	..
5	..	Edmundson's Elec. Corp. Ord.	2⅛—3	..	May, Nov	..	..
St.	4½%	Do. 6 per Cent. Cum. Pref.	86 —89	5 1 0	Jan, July	..	..
2	..	Do 4½ per cent. 1st Mort. Deb. (red.)	¾—1	..	Jan, July	..	..
2	2/9⅜	Electric Construction Co.	1⅞—2	7 0 0	July	..	..
St.	4%	Do. 7 per Cent. Cum. Pref.	70 —73	5 8 0	Jan, July	..	..
10	5/0	Do. 4 per Cent. Perp. 1st Mort. Debs.	8⅛—9⅛	5 9 0	June, Dec	..	..
St.	15/0	General Electric (1900) 5% Cum. Pref.	88 —93	4 8 6	Mar, Sept	12⅛	..
5	10/0	Do. 4 per Cent. 1st Mort. Debs.	12⅛—12⅞	5 16 6	Feb, Aug	..	..
5	2/3	Henley's Telegraph Works Ord.	4⅛—5⅛	4 10 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Pref.	105 —108	4 4 6	Mar, Sept	..	..
10	15/0	Do. 4½ per Cent. 1st Mort. Deb. Stock	15⅜—16⅛	5 18 6	Feb, Aug	..	..
10	5/0	India Rubber, Gut. Per., &c., Works	10⅜—10⅞	4 14 0	..	..	..
100	4%	Do 5 per Cent. Cum. Pref.	96 —98	4 1 6	April, Oct	..	..
1	..	Do. 4 per Cent. Debs. (red.)	⅛ —⅜	..	April	..	..
1	..	National Elec. Construction Co.	3/32—1/8	..	Nov	..	..
1	..	Richardsons, Westgarth & Co., Ltd. Ord.	3/32—1/8	..	May, Nov	..	..
St.	4½%	Do. 6 per Cent. Cum. Pref.	78 —82	5 10 0	Jan, July	..	..
5	..	Do. 4½ per Cent. Perp. Deb. Stock	4⅞—5	..	..	37⅛	36½
12	36/0	Simplex Conduits 6 per Cent. Cum. Pref.	36½—38½	5 16 3	Mar, July	..	5
100	4%	Telegraph Construction & Maintenance	100 —102	3 18 6	Jan, July	..	..
1	1/0	Do. 4 per Cent. Deb. Bonds (1909)	2⅛—2⅜	4 15 0	..	2⅛	2
1	0/6	Vickers, Sons & Maxim, Ltd., Ord.	1⅛—1⅜	4 3 0	..	..	..
St.	5%	Do. 5 per Cent. non-Cum. Preference	108 —112	4 11 0	..	..	..
St.	4%	Do. 5 per Cent. non-Cum. Preferred	100 —102	4 0 0	June, Dec	101⅛	100
100	4½%	Do. 4 per Cent. 1st Mort. Db. Sk. (red)	102 —104	4 7 6	June, Dec	103⅛	..
100	5%	†Do. 4½ per Cent. 2nd Mort. Deb. (red.)	103 —105	4 16 0	..	103⅛	..
10	10%	†Do. 5 per Cent. 3rd Mort. Debs Scrip	14⅛—15⅛	6 11 0	..	14⅛	14⅛
5	..	J. G. White & Co. 6% Cum. Pref.	⅛—⅜	..	Apr, Oct	..	..
St.	4%	Willans & Robinson Ord.	⅛—1	..	Apr, Oct	..	..
		Do. 6 per Cent. Cum. Pref.	55 —65	6 3 0	May, Nov	..	..
		†Do. 4 per Cent. 1st Mort. Debs.					
		Telegraphs.					
10	..	Amazon Telegraph	7⅜—7⅞	..	June, Dec	..	..
100	5%	Do. 5 per Cent. Debs. (red.)	99½—101½	4 19 6	Jan, July	..	..
St.	15/0	Anglo-American	69 —71	4 4 6	F,My,Ag,N	69⅛	69
St.	30/0	Do Preferred	113 —114	6 3 0	F,My,Ag,N	114⅛	113
St.	30/0	Do. Deferred	26⅛—26⅞	5 1 0	F,My,Ag,N	26⅛	26⅛
St.	4%	Commercial Cable 4 per Cent. Deb. Stk.	88 —90	4 9 0	Jn,Ap,Jy,O	87⅛	88⅛
10	6/0	Cuba Submarine Ord.	9⅞—10⅛	5 17 0	Feb, Aug	10	..
10	10/0	Do. Preference 10 per Cent.	17⅛—18⅛	5 13 0	Feb, Aug	..	..
5	2/0	Direct Spanish Ord.	3⅛—4	5 0 0	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	8⅛—8⅞	5 16 0	April, Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	101 —103	4 8 3	Jan, July	..	..
10	2/0	Direct United States Cable	7⅛—8	6 9 0	Ja,Ap,Jy,O	7⅞	7½
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100 —102	4 9 0	June, Dec	..	..
St.	65/0	Eastern Ordinary xd and bonus	137 —140	5 1 0	Ja,My,Jy,O	139	137
St.	17/6	†Do. 3½ per Cent. Pref. Stock	84 —86	4 2 0	Ja,My,Jy,O	85⅜	84½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (red.)	101 —103	3 18 3	May, Nov	..	..
St.	6/6	Eastern Extension xd and bonus	13⅛—14	5 2 0	Ja, Ap, Jy, O	13⅜	13⅜
10	4%	Do. 4 per Cent. Deb. Stock	101 —103	3 18 3	Feb, Aug	102½	..
25	4%	Eastern and S.Af., 4% Mauritius Sub. Debs	99½—101½	3 19 0	May, Nov	..	..
10	26/0	G.N (of Copenhagen), with Coupon 82	31⅛—32⅛	5 8 0	Jan, July	..	..
10	52/6	Indo-European xd and bonus	56⅛—58⅛	5 6 6	May, Nov	..	..
100	5%	Mackay Companies Common	93 —96	5 4 0	Ja,Ap,Jy,O	..	..
100	4%	Do. Preference	78 —80	5 0 0	Ja,Ap,Jy,O	..	..
1	..	Marconi's Wireless Teleg. Co.	1⅛—2⅛	..	April	2⅜	1⅛
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (red.)	100 —102	3 18 3	June, Dec	..	..
2½	1/3	†West Coast of America	1⅛—1⅜	5 0 0	May	1⅛	..
100	4%	Do. 4 per Cent. Debs.	99⅛—101½	3 18 9	Jan, July	..	..
10	1/6	†West India & Panama	2⅜—2⅝	5 0 0	May, Nov	2⅛	2⅛
10	6/0	†Do. 6 per Cent. 1st Pref.	10⅛—10⅝	5 16 0	May, Nov	10⅛	10⅛
10	6/0	†Do. 6% 2nd Pref.	9⅛—9⅞	6 5 0	May, Nov	..	..
100	5%	Do. 5 per Cent. Debs.	102 —104	4 16 0	Jan, July	..	..
10	3/0	Western Telegraph	13⅜—14⅛	5 3 0	Mr,Jn,O,D	13⅞	..
St	4%	Do. 4 per Cent. Deb. Stock (red.)	101 —103	3 17 6	June, Dec	..	..
..	4%	Western Union Telegraph, $1,000 4% Bds	105 —108	3 14 0	..	..	..
—	4½%	Do. $1,000 4½% Fdg. & Rl. Est. Gd. Bnds	99½—102½	4 9 3	..	..	..

Shre	Last Dividend	Name.	Price Wed., June 14.	*Rate per cent. Yielded.	Dividend Due.	Business Week June Highest.	Lowest.
		Telephones.		£ s. d.			
100	2$	Amer. Telephn. & Telegh. Cap. St.	156 —158	5 2 0	..	..	..
St.	4%	Do. Coll. Trust $1,000 4 per Cent. Bds.	96 —98	4 2 6	Jan, July	..	..
St.	4%	Do. 4% Cons. Bonds 1936	115½—116½	3 9 0	..	..	..
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101 —103	4 17 0	Mar, Sept	..	..
5	3/0	Chili Telephone	7 1/16—7 1/16	5 11 6	August ..	..	..
1	0/7½	Monte Video Telephone Ord.	1/32—1	6 0 0	Nov	..	..
1	0/6	Do. 5 per Cent. Pref.	1/32—1/32	5 11 0	May, Nov	..	..
St.	6%	National Co. Pref. Stock	104½—105½	5 15 0	Feb, Aug	..	..
St.	6%	Do. Def. Stock	127 —129	4 13 9	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	10 —10⅜	5 11 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10 —10⅜	5 11 6	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.	5⅛—5⅜	4 9 0	Feb, Aug	..	..
St.	3½%	Do. Deb. Stock 3½ per Cent. (red.)	99 —101	3 9 3	June, Dec	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	99 —101	3 19 3	Jan, July	..	..
5	3/0	New York Telephone Co. 30 yr. Bnds.	100 —101	4 9 6	..	..	..
1	0/7½	Oriental	1 1/16—1 1/16	4 18 0	April, Oct	..	..
1	1/0	Do 6 per Cent. Cum. Pref.	1⅛—1⅛	4 16 0	April, Oct	..	..
St.	4½%	Do 4 per Cent. Red. Deb. Stock	87⅛—89½	4 9 6	Jan, July	..	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. (red.)	100 —102	4 9 0	Jan, July	..	..
5	3/0	United River Plate Ord. (1—150,000)	7 1/16—7 1/16	5 3 0	July	..	..
5	4½%	Do. (150,001—190,000)	7 1/16—7 1/16	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅛—5⅜	4 9 0	June, Dec	..	..
St.	4½%	Do. 4½ Deb. St. Red.	103 —105	4 5 9	Jan, July	..	..
		Financial, Investment, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4½—4⅝	6 17 0	Jan, July	..	..
10	2/0	Globe Telegraph & Trust	11¼—11⅜	5 2 6	Sp,DcMr,Ju	11⅜	..
10	3/0	Do. 6 per Cent. Pref.	13⅛—13⅜	4 10 0	Sp,DcMr,Ju	..	..
10	6%	Submarine Cables Trust (Cert.)	131 —134	4 9 6	April, Oct	132	..
		Colonial and Foreign Electric Railways, Tramways, &c.					
5	2/6	Anglo-Argentine 5% Cum. 1st Pref.	5⅛—5⅝	4 15 0	April, Oct	..	..
5	2/6	Do. 5% Cum. 2nd Pref.	5 —5⅛	4 17 6	Jan, July	..	..
St.	4%	Do. 4% Deb. Stock	96 —98	4 2 6	June, Dec	..	..
St.	4½%	Do. 4½% Deb. Stock	101 —103	4 8 3	..	..	..
St.	4½%	†Do. 5% Deb. Stock	100½—102½	4 18 6	..	..	..
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)	104½—106½	4 14 6	Jan, July	..	..
62	5%	Brisbane Electric Trams. Invest. Ord	6⅛—6⅞	6 3 0	May	..	..
5	4/0	Do. 5 per Cent. Cum. Pref.	5 —5⅜	4 17 6	May, Nov	..	..
5	2/6	Do. 4½ per Cent. Db. Prov. Certs.	102 —105	4 6 0	Jan, July	..	..
St.	4½%	British Columbia El. Rly. Df. Ord.	145 —149	5 8 0	Mar, Sept	..	..
St.	8%	Do. Pref. Ord. Stock	127 —130	4 13 3	May, Nov	..	..
St.	6%	Do. 5% Cum. Perp. Pref. Stock	110 —112	4 10 0	Jan, July	..	..
St.	5%	Do. 4½ per Cent. 1st Mort. Debs.	100 —103	4 7 6	April, Oct	..	..
40	4½%	Do. Vancouver Power Debs.	102 —105	4 5 9	Jan, July	..	..
100	4½%	Do. 4½% Perp. Con. Deb. St.	101½—103½	4 2 6	..	..	..
St.	4½%	Buenos Ayres Lacroze Trams 1st Mt. Db.	99½—101½	4 19 6	Mar, Sept	..	..
St.	6%	Buenos Ayres Port & City Tram, 1st Mt. Deb. Stock	93 —98	6 2 6	Feb, Aug	..	..
..	..	Calcutta Tramways (1 to 137,610)	5⅛—6	5 0 0	Mar, Sept	..	..
..	..	Do. 5 per Cent. Cum. Pref.	5⅛—5⅜	4 13 0	Jan, July	..	..
..	..	Do 4½% 1st Deb. Stock (red)	102 —105	4 7 0	Jan, July	..	..
5	5%	Cape Electric Tram Shares	⅛—⅜	..	..	..	..
St.	6%	City of Buenos Ayres Trams Co. (1904) Sh.	5⅛—5⅜	4 5 0	F,My,A,N	..	..
..	..	Do 4 per Cent. Deb. Stock	96 —99	4 0 9	June, Dec	..	..
..	..	Colombo Tr. & Ltg. 5% 1st Mt. Db.	95 —98	5 2 0	May, Nov	..	..
..	..	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	100½—102½	4 18 6	Feb, Aug	..	..
100	5%	†Hong Kong Tramways Co. 5 per Cent. 1st Mort. Debs.	75⅛—79⅛	6 9 0	June, Dec	..	..
1	..	Kalgoorlie Elec. Trams Sh.	1/32—3/32	..	Jan, July	..	..
100	5%	Do. 5 per Cent. "A" Deb. Stock	94 —97	5 3 0	Jan, July	..	..
100	5%	Do. 6 per Cent. "B" Ditto	66 —70	4 5 9	Jan, July	..	..
5	6%	†Lisbon Elec. Trams. Ord.	1 —1⅛	4 16 0	July	..	..
5	0/6	Do. 6 per Cent. Cum. Pref.	1 —1⅛	4 16 0	Jan, July	..	..
100	0/7½	Do. 5 per Cent. Reg. Mort. Debs.	99 —103	4 19 0	Jan, July	..	..
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	97 —99	5 1 6	..	..	..
100	5%	Manaos Trams and Lt. Co. 5% Debs	94 —97	5 4 6	..	..	..
100	$1½	Manila Elec. Ry. $1,000 Gold Bonds	100 —102	4 18 0	Feb, Aug	..	..
100	5%	Mexico Trams Co. Com. St.	124 —126	5 12 0	..	..	..
100	$1½	Do. Gen. Con. 1st Mort. 5% Gold Bds.	94½—96½	5 4 6	..	..	..
100	5%	Do. 6% 50 yr. Mort. Bds.	100 —102	5 19 0	..	..	..
St.	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922) (Nos. 601 to 2,000)	101 —103	4 7 6	Feb, Aug	..	..
100	4%	Do. do. (Nos. 1 to 4,600)	102 —104	4 7 6	..	..	..
1	0/6	Perth Elec. Trams Ord.	1/16—1/16	2 13 6	May	..	..
St.	5%	Do 1st Mt. Db. Stock	104 —106	4 14 3	Jan, July	..	..
5	3/0	Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	5⅛—5⅜	5 4 6	..	..	..
100	4½%	Do. 4½% 1st Mort. Deb. Stk.	99 —102	4 8 0	..	..	..
100	$1½	Rio Janeiro Tram, Lt. & P. Co.	116 —117	4 6 0	..	..	..
100	5%	Do. 30 yr. Gold Bnds.	103 —104	4 16 6	..	..	..
100	5%	Do. 50 yr. Mt. Bnds	95½—96½	5 4 0	..	..	..
5	3/0	Sao Paulo Tramway, Light & Power Co. $100 Stock	185 —188	5 7 0	..	..	..
10	5/0	Do. 5 per Cent. 1st Mt. $500 Db.	102 —104	4 17 0	June, Dec	..	..
100	4½%	Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	95 —100	4 10 0	Feb, Aug	..	..
		Colonial and Foreign Electricity Supply, &c.					
10	5/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	5⅛—5⅜	5 8 0	Mar, Sept	..	..
10	5/0	Bombay E.S. & T. 6% Cm. Pf.	10⅛—11⅛	5 5 6	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stk. (red)	98 —100	5 8 0	Jan, July	..	..
5	5/0	Do. 5 per Cent. 2nd Mort. Deb. Stock	98 —100	5 1 0	..	..	..
5	5/0	†Calcutta Elec. Supply Ord.	6⅞—7⅛	5 19 6	April, Oct	..	..
5	5/0	Do. 5% Cum. Pref	4⅛—5⅜	4 13 0	..	..	..
100	7/2½	Calgary Power Co. 5% 1st Mort. Bnds.	96 —98	5 2 0	..	..	..
100	$3½	Canadian Gen. Elec. Co. Com. St.	108 —111	6 8 0	..	..	..
100	5%	Do. 7% Cm. Pf. Stock	121 —124	5 5 0	..	..	..
100	$1½	Castner Electrolytic Alkali Co. (of U.S.A.) 1st Mort. Stl. Debs.	97 —102	4 18 0	Jan, July	..	..
500	5%	Elect. Development Co. of Ontario	83 —85	5 19 0	..	..	..
St.	5%	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	87 —90	5 11 0	Jan, July	..	..
5	..	Indian Elec. Sup. & Trac. Co.	1 —1⅛	..	..	..	..
10s	..	Kalgoorlie Elec. Power & Ltg. Ord.	1/32—1/32	..	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	8 6 6	..	..	..	..
100	5%	Kaministiquia Power Co. 5% Gold Bnds.	103⅛—105½	4 15 6	..	..	..
5	..	Madras E. S. Corp. Ord.	3 —3½	..	..	..	..
13⅜	..	Melbourne E. S. Co. Cons. Ord. St.	23 —33	..	..	..	..
102½	5%	Do. 5% 1st Mortg Deb. Stock	94 —96	5 4 0	..	..	..
500	5%	Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	89 —90	5 12 0	..	..	..
St.	$1	Mexican Lt. & Power Co. Com. St.	82½—84½	4 16 0	..	..	..
St.	$3½	Do. 7% Cum. Pref. St.	106 —108	6 10 6	..	..	..
500	5%	Do 5% 1st Mort. Gold Bnds.	94 —95	5 6 0	..	..	..
St	5%	Monterey Rly. L. & P. Co. 1st Mort. Db. Sk.	87½—91½	5 10 6	F,My,A,N	..	..
100	8/2½	Montreal Lt. Ht. & Power Co. Cap. St.	163 —166	4 16 6	..	..	..
100	5%	Northern Lt. Power & Coal 5% Gd. Bds.	63 —65	7 16 0	April	..	..
St.	£10	River Plate Electricity Co. Ord. Stk.	218 —228	4 7 9	May	..	..
St.	6%	Do. 6 per Cent. non-Cum. Pref. Stk.	107 —114	5 5 0	Jan, July	..	..
100	$1½	Do. 5 per Cent. Deb. Stock	104 —106	4 14 3	..	..	..
100	5%	Shawinigan Water & Power Co. Ca.	115 —118	4 6 0	Jan, July	..	..
100	5%	Do. 5 per Cent. Bds.	109 —111	4 11 0	..	..	..
St.	4½%	Do. 4½ Per Con. Mt. Db. St.	102 —104	4 6 6	..	..	..
100	5%	Toronto Power Co. 4½% Db. St.	101 —103	4 7 6	Jan, July	..	..
St	14½%	Victoria Falls Power Co. Pref. (1 to 805,000)	1/32—1/32	..	..	..	..
—	6d.	Do. (803,081 to 1,700,000)	1/32—1	..	..	..	..

* No allowance has been made for accrued interest or redemption. †† Ex Dividend. ‡‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

Imperial Inter-Communication.

From the official report of the proceedings before the Imperial Conference on Thursday last week, it would appear that an interesting discussion arose on the allied subjects of telegraph cable rates, cable facilities, and wireless telegraphic communication. On the first point Sir Joseph Ward (representing New Zealand) introduced a motion asking for increased facilities for inter-communication between Great Britain and her Dependencies by means of reduced cable rates throughout the Empire, agreeing that much had been already accomplished in this direction, but arguing that more remained to be done. The Postmaster-General (the Right Hon. H. L. Samuel), in expressing the British Government's sympathy with this proposal, pointed out that the result of representations to the cable companies had been the important reduction of 50 per cent. in plain-letter messages, and it was probable that there would shortly be announced a further reduction in the charge per word for Press messages. He further indicated that an attempt would be made to effect some Governmental control over cable rates, the companies receiving due security against any abuse of such powers by an appeal to the Railway and Canal Commission. Sir Wilfrid Laurier and the Hon. A. Fisher both agreed that these were solid concessions, but the Hon. G. F. Pearce objected that, while the various Colonial Governments were prepared to bring about reductions forcibly, even if a loss resulted, the Railway and Canal Commission would view the matter from the point of view of the operating companies earning a profit on their work. While admitting that this might be an improvement, it was not the full result desired by the Governments concerned.

To the man in the street this will appear a carping criticism, and it certainly seems to require some further explanation from Mr. Pearce as to what basis in particular he would suggest on which the vast businesses of the cable companies with their Governmental ramifications should be conducted. The feature of many of these discussions is the airing of vague proposals and suggestions without any indication of how the cost is to be met, or what is to be done to ensure that no injustice shall be meted out to those who have placed their money in submarine telegraph cable enterprise. Non-practical views, expressed before Chambers of Commerce and other aggregations of traders, ever on the alert for their own advantage without regard to the justice of the case, are all very well, but when subjects involving millions of the British public's money are discussed before the Imperial Conference, something more tangible, some facts and figures bearing upon the questions, would be more to the point; and we venture to say that any really practicable proposal emanating from the Imperial Conference would receive the fullest consideration from those responsible for the conduct of telegraph cable enterprise. We think it will be agreed that a really practical proposal has yet to be submitted.

The Hon. G. F. Pearce was responsible, at the same meeting of the Conference, for a resolution recommending the "Nationalisation of the Atlantic Cable." Mr. Pearce did not support this resolution by any really practical suggestions, and no information was vouchsafed as to what would happen if the Atlantic cables were "nationalised." What is the present nationality of the Atlantic cables? And what is the attitude of the owners of the Atlantic cables in regard to the question? The laying of an additional Atlantic cable for some of the purposes set out by Mr.

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PEARCE is, of course, a proposal whose financial results can be fairly estimated. So far as the proposal resolves itself into a question of expenditure of public money it is a simple one, but with the experience already gained with the Pacific cable the venture is one that is not to be lightly undertaken, at any rate so far as the Mother Country is concerned. We take it there is nothing to prevent the Australian Commonwealth, assisted by New Zealand and Canada, laying such a cable, but why the United Kingdom should be called upon to find a large sum of money for such an enterprise it is difficult to understand. The POST-MASTER-GENERAL had an easy task in shelving the question by means of a resolution given on another page of our present issue, where also a report of the "wireless" proposals of the Government is set out.

British Electric Traction.

APART from the interest which always appertains to the annual reports of large industrial undertakings, there is a special interest in the fifteenth annual statement of the directors of the British Electric Traction Co., in that the report seems to indicate a somewhat improved position in electric traction matters. Passing over the intimation that Sir CHARLES RIVERS WILSON, who has presided over the directorate of the Company from its inception in October, 1896, is about to retire from the chairmanship and is to be succeeded by Mr. E. GARCKE, whose strenuous work for the Company all associated with electrical matters fully realise, the views that Sir CHARLES presented to the meeting of shareholders last week contain many instructive details which, although not altogether new to our readers, very well bear repetition. The difficulties which the Company has either overcome or is suffering from are certainly numerous, and they cannot be re-stated too emphatically. They relate particularly to the trouble which must accompany competition with rate-aided rivals. We know from the reports that reach us from some of the great municipal electric tramway undertakings that the extremely low fares which predominate in many districts, the preference given to the often well-to-do and always much-considered "working man," have lowered the remunerative operation of tramway enterprise to its limit, in some cases resulting in loss. This result has come about in spite of the specially favourable terms upon which money can be borrowed on the security of the rates, of the advantages that municipal enterprises enjoy of being their own masters, in being the road authority, and in having a regular demand from local investors for their stock as investments, in having the call of the labour market in great measure, and otherwise. All this goes to show how necessary it is that sound business principles should actuate all classes of commercial enterprise. We do not think Sir CHARLES failed in his effort to show that the B.E.T. had not always been generously treated in the course of the negotiations in which, from the nature of its business, the Company has had to engage. Perhaps, however, special interest will be taken by electrical men in the chairman's very definite statement that the directors have decided to spend no more money in the extension of their enterprise unless and until they can secure better treatment. We can but hope that the clouds which hover over the Company's extensive and important undertaking will speedily pass away, and that the B.E.T. will once again become a profitable investment.

Edinburgh Theatre Fire.

THE public enquiry into the fire at the Empire Theatre, Edinburgh, which occurred on May 9th, has now been concluded; and the jury have returned their verdict (an abstract of which is given on another page of this issue). The evidence brings out two points very clearly; one, that the permanent electrical installation at the theatre was in no wise at fault, and the other, that the faulty construction of Lafayette's properties was at the bottom of the whole unfortunate business. The jury's verdict, therefore, seems rather beside the point. They simply recommend that theatres should be safely constructed and that more frequent examinations should be made of electric lights and water hydrants. This is, of course, all very well as far as it goes, but more important still is the examination of the artistes' own properties. In Lafayette's case these were extensive and included a complete electrical installation. Now it seems certain that it was among these properties that the fire originated. Assuming, as was stated in the evidence, that some of the joints were faulty, the advantage of inspecting merely the theatre installation is not very evident. Therefore, we think that more attention might be paid to the way in which the artistes' own installations are carried out, and that severe restrictions should be laid on the use of inflammable material for such purposes. Marking scenery as fireproof does not necessarily make it so, and this is a point that might be looked to. Further, though performances such as Lafayette gave may be very fine, is not the danger inseparable from carrying them out sufficient to render them illegal?

The I.M.E.A. at Brighton.

THE annual Convention of the I.M.E.A. which opens at Brighton on Tuesday next will be the first ever held wholly at the seaside. This, coupled with the fact that Mr. CHRISTIE is a popular President, should ensure a record attendance of members, even in spite of the distance from the North and the Midlands. The programme of meetings has already been published, but we reproduce it again in this issue for the convenience of our readers. The papers down for reading should promote a healthy and interesting discussion, particularly those on the internal combustion engine. Following the excellent precedent established last year at Glasgow, Thursday morning will be given over entirely to discussions. The subjects chosen, "The Purchase of Fuel" and "Street and Shop Front Lighting," embrace matters of considerable importance to station engineers, and we look for some interesting figures in the discussion on the latter. We are pleased to see in this year's programme a minimum of "official" functions. The municipalities in which the Convention is held always like to do honour to the members attending, but a plethora of public luncheons, &c., occupies too much of the time which engineers prefer to have at their own disposal. By confining its hospitality to a single conversazione Brighton has established a useful precedent, and one which we hope

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will be followed by other towns in future. In another part of this issue we publish two articles on the Southwick power house of the Brighton Corporation and details of some of the large consumers who are connected to the supply mains. We shall give a full report of the proceedings up to Thursday night in next week's number, which will be available on Friday to members at the Convention.

Electrification of the Boston Railways.—According to "Engineering News," one of the schemes for electrifying all railways entering Boston, a subject which has been much discussed recently, is likely to be favoured by the Massachusetts Legislature. The Committee on Railroads and Metropolitan Affairs on May 25th voted for a measure which provides that all the standard-gauge railways within the metropolitan district shall be electrified in such a manner and in such order as the Board of Railroad Commissioners may determine. The railways are to file plans and specifications for electrification with the Railroad Commission before September 1, 1912. The Commission will determine the extent to which public necessity demands electrification, and will also fix a date for beginning the work.

"The Production of Characteristic Röntgen Radiations." In a Paper on this subject, read before the Royal Society, Mr. R. Whiddington stated that a characteristic radiation could usually be excited only when the velocity of the cathode rays using the X-ray tube supplying the primary rays exceeded a certain value depending on the radiator. The value of this critical speed v_c had been accurately determined for the radiators Cr, Fe, Ni, Cu, Zn, Se; that for Al had been given in a previous Paper. It appeared that for the radiators studied v_c was proportional to the atomic weight of the emitting element, being very nearly 10^8 times the atomic weight. The potentials corresponding to these velocities ranged between 1,320 volts and 15,400 volts. An interesting result obtained during the course of the investigation was that the energy emitted in the form of Röntgen radiation by a cathode particle when suddenly stopped was proportional to the fourth power of its velocity.

Inspection of High-Tension Oil Switches.—We take the following note on this subject from the "Electric Railway Journal." In the regular inspection of the transmission lines, which is the price of continuous service, it is important not to overlook the periodical examination of high-tension oil switches, particularly with regard to ascertaining the character of the oil and the condition of the contacts and terminals. The frequency of the inspection may properly depend on the use of the switches and the voltage, but, in any event, an annual overhauling, in which the contacts are tested and cleaned and, if necessary, the oil is renewed, is essential to the best results. Some companies may go so far as to keep monthly records of the number of times the switches are operated and establish a system of inspection on such a basis. In a representative case the practice is to test the oil weekly in all oil switches by taking out a sample and measuring its dielectric strength with a spark gap of from 0·15 in. to 0·30 in., and also to make this test on any switch immediately after it has been opened on short-circuit or through other trouble. A series of tests made on a sample taken from one switch which had opened a severe short-circuit showed very low resistance at first, but the resistance gradually increased for 48 hours, when it had come back practically to normal. The reduction in dielectric strength was doubtless due to the free carbon which was formed in the oil by the arc at the time of the rupture and which finally settled at the bottom. The importance of filtering the oil as soon as possible after a break of violent character was thus clearly indicated.

Cable Interruptions.

	Date of Interruption
Assab—Perim	July 8, 1909
Malta—Trinoli	April 20, 1910
Latakia—Palura	May 26, 1910

The Prevention of Earthing by Climatic Conditions.—According to the "Electrical World," the salt, wet air encountered at Galveston, Texas, so thoroughly permeates all buildings with conducting moisture that it is impossible to earth the secondaries of transformers on account of the painful shocks given from the brass socket shells or other metal parts which make contact with the unearthed side of the line. Buildings of wood, brick or concrete become so conducting after a brief exposure to the climate of this semi-tropical island that even when standing on carpeted floors on upper storeys one finds it impossible to touch any live conductor at ordinary lighting voltages. The capacity leakage effect, even from unearthed secondaries, in many cases proves unpleasant. Being an advocate of earthed secondaries elsewhere, when Mr. Fred M. Lege, Jr., the present manager of the Brush Electric Lighting & Power Co., first came to Galveston several years ago, he immediately took precautions to see that his own house service was properly earthed. Painful shocks at once became manifest from various sockets and switches, and members of the family and servants soon grew so fearful of all fittings that the earth had to be removed. The model lighting installation at Ft. Crockett, the Government post at Galveston, is equipped with earthed secondaries which have given rise to much lightning and fuse trouble, making it impossible also to replace fuses without making the lines dead. The climatic conditions at Galveston also make it necessary to use porcelain instead of wooden strain insulators, besides other modifications of standard construction practice.

Free Lamp Renewals in Chicago.—While discussing "Maintenance of Service" in a Paper read at a recent meeting of the Commonwealth Edison Branch of the National Electric Light Association, Mr. W. L. Abbott, chief operating engineer of the Commonwealth Edison Co., Chicago, gave some interesting information about the free lamp renewal service provided by his Company. The practice of exchanging good carbon filament incandescent lamps for burned-out or defective lamps was begun in 1895. At first customers had to call at the principal office to renew their lamps, but later, outlying depôts were established, and now the lamps are delivered at the customer's door on request. With the growth of the Company the cost of this free renewal service has assumed large proportions, and it now amounts to 32 per cent. of the total distributing cost, the free lamp renewals costing the Company about £100,000 a year. A bureau of the operating department is in charge of this work, and 12 telephone lines are needed to handle the incoming calls. Seven horse-drawn waggons and five electric waggons are used in delivering lamps to customers. Both classes of vehicles for this service present an attractive appearance. Tungsten lamps, which are not renewed free, are delivered by boys travelling on the tramcars, each boy carrying about 50 lamps. Carbon lamps are carried in trays, and both in the delivery waggons and in the stock room the position of the lamps in these trays indicates the character of the lamps. New lamps are placed in the trays with bases up, the old lamps being placed with tips up. By this simple method there is no trouble in distinguishing the good lamps from the bad ones. Lamps returned by customers are carefully tested. In the year 1910 it was found that about half the lamps returned were burned out. From 15 to 30 per cent. of the remainder were broken, and from 15 to 30 per cent. were found to be good after testing and were returned to service, many of them being used by the Company itself in sub-stations and elsewhere. It has been found that by handling the returned lamps carefully the percentage of serviceable lamps has been increased to a noticeable extent.

Coronation Honours.—The Coronation Honours list, which was published on Tuesday morning last, is freer from political bias than is usually the case. Nevertheless, we consider that engineering and physical science should receive greater recognition than it has on the last few occasions, for in cases where honours are given it is often too evidently for reasons quite apart from the scientific attainments of the recipients. It is perhaps not unworthy of note that no peerage has been con-

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ferred purely for scientific attainments since 1897, when Lord Lister was so honoured. Surely it would not be difficult to find some scientist worthy of this honour The following names which appear in the list will be familiar to our readers :—

BARONS: *The Rt. Hon. Sir Chas. Benjamin Bright M'Laren, Bart.*, is actively interested in steel, shipbuilding and colliery undertakings. He is chairman of the Metropolitan Railway Co., and a director of the Tredegar Iron & Coal Co. and of John Brown & Co.

Sir Wm. Thomas Lewis, Bart., K.C.V.O., is a large employer of labour in South Wales in connection with the mining industries. He is a vice-president of the Iron and Steel Institute, and a member of the Council of the Institution of Civil Engineers. He has served on many Royal Commissions dealing with mining, shipping and trade disputes. He is a director of the South Wales Power Distribution Co. and of the Treforest Electric Consumers' Co.

BARONETS: *Herbert Samuel Leon, Esq.*, is a director of several electrical companies, including the Anglo-American Telegraph Co., the Smithfield Markets Electric Supply Co. and the Yorkshire (West Riding) Electric Tramways, being chairman of the two last-named.

C. T. Mander, Esq., is chairman of the Rees Roturbo Mfg. Co. and is intimately connected with other engineering work in and about Wolverhampton.

Sir Boverton Redwood, D.Sc., is an engineer and chemist who is well known for his researches on petroleum and its products. He is adviser on this subject to many Government departments. He is a past-president of the Society of Chemical Industry and a vice-president of the Royal Society of Arts.

Col. Arthur Griffith-Boscawen, M.P., is chairman of the Manx Electric Railway Co.

A. W. W. Dale, Esq., is principal of the University of Liverpool, and was formerly chairman of the Northern Universities Joint Matriculation Board.

John Purser Griffith, Esq., is engineer of the Dublin Port and Docks Board, and has rendered valuable services to the Royal Commission on Canals.

G. Croydon Marks, Esq., M.P., is senior partner in the well-known firm of Marks & Clerk, consulting engineers and patent agents. He is a director of the Bude Electric Supply Co. He has published a number of books dealing both with engineering and patent work.

K.C.B. : *Sir Robert Hunter, C.B.*, is solicitor to the General Post Office.

Alex. F. King, Esq., C.B., is second secretary at the General Post Office. Mr. King has charge of much of the telegraph work at St. Martin's-le-Grand.

Hon. Chas. A. Parsons, C.B., F.R.S., is, of course, well known to all readers of THE ELECTRICIAN as the inventor of the turbine that bears his name. He is managing director of the Parsons Marine Steam Turbine Co. and director of the Cambridge and Scarborough Electricity Supply Co.s. and the Parsons Foreign Patents Co. He was elected a Fellow of the Royal Society in 1898 and an honorary member of the Institution of Electrical Engineers in 1909.

Benjamin Arthur Whitelegge, Esq., C.B., M.D., has been Chief Inspector of Factories since 1896, and in this position is well known to readers of THE ELECTRICIAN.

James Alfred Ewing, C.B., F.R.S., has been Director of Naval Education since 1903, and before that was for some years Professor of Mechanism and Applied Mechanics at Cambridge. Prior to this he held similar positions at University College, Dundee, and at the Imperial University, Tokio. He has published works on magnetism, including "Magnetic Induction in Iron and other Metals" in THE ELECTRICIAN Series, and on steam engines. He delivered the "James Forrest" lecture in 1899 on "Magnetism" and the Kelvin lecture in 1910 on "The Work of Lord Kelvin in Telegraphy and Navigation." He was elected a Fellow of the Royal Society in 1887 and was awarded a Royal Medal in 1895.

Hay Frederick Donaldson, Esq., C.B., has been chief superintendent of the Royal Ordnance Factories at Woolwich since 1903. He is a member of the Councils of the Institution of Civil Engineers, Mechanical Engineers and the Iron and Steel Institute. He is also on the Board of the National Physical Laboratory, and is intimately connected with the work of the Engineering Standards Committee.

C.B. : *H. S. Carey, Esq.*, is assistant secretary at the General Post Office.

Edw. Rigg, Esq., I.S.O., is superintendent of operatives, at the Royal Mint.

G. Waller Wilcocks, Esq., K.C.M.G., is chief engineering inspector to the Local Government Board.

Arthur William Reinhold, Esq., F.R.S., is late professor of physics at the Royal Naval College, Greenwich. He has published Papers in the "Philosophical Transactions" dealing with the properties of thin films.

Col. H. C. L. Holden, F.R.S., is superintendent of the Royal Gun and Carriage Factories, Woolwich Arsenal. After serving in the Royal Artillery for some years, Col. Holden has since been employed on technical work connected with electricity and gunnery. He is the inventor of many instruments and apparatus both in these fields and in connection with motor cars.

K.C.M.G. : *John Rose Bradford, Esq., F.R.S.*, is a secretary of the Royal Society, and has also been prominently connected with the work of the University of London.

Current Topics.

Subjects of current interest dealt with in this issue include the following :—

Mr. A. H. Seabrook contributes an article on "Encouraging the Use of Electricity for Domestic Purposes other than Lighting."

Mr. W. A. Vignoles contributes an article on "Cheapening Services for Electricity Supply, with special reference to Three-wire Continuous-current Work."

Mr. C. E. C. Shawfield contributes an article on "Notes on Fuel Economy."

Mr. Justus Eck contributes an article on "Light and Shade in Indirect Lighting."

We describe the recent extensions at the Southwick power station of the Brighton Corporation. Particulars are also given of the installations of some large consumers connected to the electric supply mains.

An abstract is given of the annual report of Mr. G. Scott Ram, H.M. Electrical Inspector of Factories. The subject of accidents is dealt with in our Leading Article.

Particulars will be found on another page of the illuminated devices that have been erected in London in connection with the Coronation festivities.

The evidence at the public inquiry in connection with the recent Empire Theatre fire in Edinburgh is abstracted.

The Manchester electricity department has paid £15,000 to the city rate account out of the total net profits of £27,573 on the past year's working.

Parliamentary.—A Select Committee of the House of Commons has found partially proved the preamble of the Greater London Railway Bill, and certain sections of the original scheme were cut out.

In the House of Commons on Monday the Postmaster-General (Mr. Herbert Samuel), in introducing the Telephone Transfer Bill made a lengthy statement as to the intentions of the Government in regard to the future of the telephones.

Legal.—On Saturday Mr. Justice Swinfen-Eady delivered judgment in the action brought by the British Westinghouse Co. against the Electrical Co. for an injunction and for relief in regard to an alleged infringement of the Bremer flame arc lamp patent. After reviewing the evidence, his Lordship gave judgment for plaintiffs.

The Court of Appeal has concluded the hearing of the cross-appeal in the case of the National Telephone Co. *v.* the Postmaster-General but has reserved its judgment.

Companies' Meetings and Reports.—The statement presented by Chas. Rivers Wilson at the general meeting of the British Electric Traction Co. was made additionally interesting by his observations on the historical side of electric traction. Sir Charles announced his resignation as chairman.

At the meeting of the Victoria Falls & Transvaal Power Co. the Marquis of Winchester gave particulars of the development of the Company's undertaking in connection with the supply of electrical energy for mining on the Rand.

The report of Marconi's Wireless Telegraph Co. of New York for the past year gives some particulars of the position of wireless telegraphy in the United States.

At the meeting of the Aron Electricity Meter (Ltd.) on Tuesday the chairman, Mr. Hugo Hirst, gave particulars of the progress of the Company during the past year.

APPOINTMENTS VACANT AND FILLED.

A lecturer on the applications of electricity adapted for architects, &c., is advertised for.

A first-class mechanical and electrical engineer is required. He must have thorough experience in modern manufacture of c.c. and a.c. machinery. See advertisement.

A fully qualified draughtsman well up in electrical work (including switchboards and instruments) is required by Marconi's Wireless Telegraph Co., Watergate House, York-buildings, Adelphi, London, W.C. See an advertisement.

A draughtsman, with experience in building work for engineering and electrical purposes, is required for a consulting engineer's office. See an advertisement.

There is a vacancy for an electrical tester, with mains experience, in the Devonport Dockyard. Wages 45s. per week. Applications to the Electrical Engineer, H.M. Dockyard, Devonport. See advertisement.

A demonstrator in electrotechnology (£100 a year) and a visiting teacher of telegraphy and telephony (one evening per week, 10s

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are required at L.C.C. Paddington Technical Institute. Application form (T. 17) can be obtained from the Education Officer, Victoria Embankment, W.C. Applications by 11 a.m. June 26.

Mr. Chas. S. Jeffrey, of Glasgow, has been appointed chief assistant electrical engineer to the Rangoon Electric Tramways & Supply Co.

Mr. J. Edwin Storr has been appointed to the vacancy on the staff of the Yorkshire Electric Power Co. occasioned by the resignation of Mr. H. M. Sillar.

Mr. H. J. Spencer (resident engineer to the Electric Supply Co. of Victoria at Ballarat) has been appointed resident engineer at the municipal electricity works, Redfern (N.S.W.).

INSTITUTIONS AND SOCIETIES.

Royal Society of Arts.—The Council of this Society, with the approval of the President, H.R.H. the Duke of Connaught, have awarded the Albert Medal of the Society for the current year to the Hon. Sir C. A. Parsons, K.C.B., F.R.S., for his experimental researches into the laws governing the efficient action of steam in engines of the turbine type, and for his invention of the re-action type of steam turbine and its practical applications to the generation of electricity, the ventilation of mines and other large spaces, blast-furnace work, ship propulsion and other important purposes. The beneficial results which have followed upon these inventions include a cheapening of the production of mechanical power, greater economy and speed for steamships, and the first successful solution of the problem of rotary engines which long had baffled many other inventors.

Tramway & Light Railways Association.—The "Journal" of this Association for June contains an illustrated report on the results of tram brake block tests undertaken by Mr. W. Thom, at the request of the Special Committee of the Association which is considering the question of "Brakes, &c.," a translation of one of the Papers read before the International Tramways Congress at Brussels by M. de Backer upon the results obtained in Belgium since the passing of the Light Railways Act in that country, and matters relating to the affairs of the Association generally. The "Journal" for July, which is to be published shortly, will be a special Congress number, containing the Papers which will be read at the Tramways Congress to be held at Edinburgh on July 13 and 14.

Faraday Society.—The following nominations for the Officers and Council (1911-1912), to be elected at the annual general meeting on June 11, have been made by the Council:—*President:* Dr. R. T. Glazebrook, C.B., F.R.S. *Vice-Presidents:* Messrs. G. T. Beilby, F.R.S., S. Z. de Ferranti, F. W. Harbord, Alex. Siemens, E. Solvay, Prof. J. Hopkinson, F.R.S., Prof. J. Walker, F.R.S. *Treasurer:* Mr. F. Mollwo Perkin. *Council:* Mr. E. J. Bevan, Dr. H. Borns, Mr. W. R. Bousfield, Mr. W. R. Cooper, Dr. J. A. Harker, F.R.S., Prof. A. K. Huntington, Dr. T. M. Lowry, Mr. R. L. Mond, Dr. G. Senter, and Mr. M. Solomon.

EDUCATIONAL NOTICE.

Heriot-Watt College, Edinburgh.—This college gives theoretical and practical training for mechanical, electrical and mining engineers, chemical chemists, &c. The training for engineers consists of three years in the college and three years apprenticeship, on the sandwich system, in a local engineering works. Further information may be obtained from the Principal of the College, Mr. A. P. Laurie, M.A., LL.D., or from the Heriot Trust Offices, 20, York-place, Edinburgh.

ARRANGEMENTS FOR THE WEEK.

TUESDAY, June 27th.

JUNIOR INSTITUTION OF ENGINEERS.

7 p.m. Special General Meeting of Contributors to the Benevolent Fund at 39, Victoria-street, S.W.

WEDNESDAY, June 28th.

INSTITUTION OF CIVIL ENGINEERS—CONFERENCE ON EDUCATION AND TRAINING OF ENGINEERS.

10 a.m. Meeting at Great George-street. Address by Mr. Alex. Siemens. Discussions on "The Extent to which Mathematical and Scientific Subjects should Share with Other Subjects of Literate Education the Attention of Schoolboys who intend to enter later the Engineering Profession," introduced by Dr. J. Gray and Prof. S. P. Thompson, F.R.S.; "The Question of specialised Entrance Examinations for University or College Courses of Study in Engineering Science with a View to the Curricula to be followed, and also of the Inclusion in the Latter of Courses in Modern Languages," introduced by Prof. A. K. Schwartz; "The Requirements of Practical Training and of Scientific Study and the Apportionment of Time to Them," introduced by Mr. A. F. Yarrow and members of his staff and Mr. W. H. Allen; and "Practical Training in Workshops or on Works of Construction, with Special Reference to Training in the Engineer's Office," by Mr. W. B. Worthington and Mr. H. F. Donaldson.

THURSDAY, June 29th.

INSTITUTION OF CIVIL ENGINEERS—CONFERENCE ON EDUCATION AND TRAINING OF ENGINEERS.

10 a.m. Meeting at Great George-street. Discussions on "The Value of a University Degree in Engineering Science in Relation to Professional Competence," introduced by Prof. S. M. Dixon and Prof. C. F. Jenkin; "The Position and Uses of Engineering Laboratories in Relation to Education at College," introduced by Prof. W. E. Dalby, Prof. John Goodman and Prof. B. Hopkinson, F.R.S.; "The Relation of Engineering Employers and Colleges from the Point of View of the Practical Training of College Students," introduced by Prof. J. E. Petavel, F.R.S., and Mr. J. W. Horne; "The Relation of Practical Training to College Study; Whether, or to What Extent, Before, Sandwiched, or after its Conclusion," introduced by Prof. A. Barr and Prof. H. Louis; "Workshop Training as a Preliminary to Practical Training in Other Branches of Engineering," introduced by Mr. J. A. Brodie, Mr. J. M. Moncrieff and Prof. J. J. Welch.

FRIDAY, June 30th.

PHYSICAL SOCIETY.

5 p.m. Meeting at the Imperial College of Science. *Agenda:* "On the Effect of a Narrow Sawcut in the Edge of a Conducting Strip on the Stream Lines in the Strip and on the Resistance of the Strip," by Prof. C. H. Lees, F.R.S.; "The Capacity Coefficients of Spherical Electrodes," by Dr. A. Russell; "Exhibition of the Benkö Primary Battery," by Mr. W. R. Cooper.

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

TUESDAY, June 27th.

10 a.m. Meeting at the Royal Pavilion, Brighton. Welcome by the Mayor of Brighton (Councillor Thomas-Stanford). Presidential Address by Mr. John Christie (engineer and manager, Brighton Electricity Department). Papers on "Electricity Supply viewed from the Municipal Committee's Standpoint," by Councillor H. Leese (Stoke-on-Trent), and on "Modern Wiring Practice," by Mr. J. W. Beauchamp (chief electrical engineer, Tunbridge Wells).

2:45 p.m. Visit to the Southwick power house of the Electricity Department and to the works of the Brighton and Hove General Gas Co.

8 p.m. Reception and Conversazione at the Royal Pavilion by the Mayor and Mayoress of Brighton.

WEDNESDAY, June 28th.

8:30 a.m. Special Train (Brighton Central Station) for Portsmouth.

10:15 a.m. Meeting in the Lecture Hall, Municipal College, Portsmouth. Welcome by the Mayor of Portsmouth (Ald. T. Scott Foster). Papers on "Internal Combustion Engines working on the Diesel Principle," by Mr. H. L. Howard (chief electrical engineer, Barking), and on "Internal Combustion Engines for Power Stations" by Mr. R. M. Carr (chief electrical engineer, Leek).

2 p.m. Visit to H.M. Dockyard and the Power Houses of the Corporation Lighting and Tramways Committees.

5:30 p.m. Cruise in the Solent.

8:45 p.m. Special Train leaves Portsmouth Harbour Station for Brighton.

THURSDAY, June 29th.

10 a.m. Meeting in the Banqueting Room, Royal Pavilion, Brighton. Discussions on "Purchase of Fuel," opened by Mr. C. E. C. Shawfield (chief electrical engineer, Wolverhampton), and on "Street and Shop Front Lighting," opened by Mr. A. H. Seabrook (chief electrical engineer, Marylebone).

2:45 p.m. Visit to the Church-street Sub-station and the Locomotive Works of the L.B. & S.C. Railway.

7 p.m. Annual Dinner at the Dome.

FRIDAY, June 30th.

10 a.m. Annual General Meeting at the Royal Pavilion.

2:30 p.m. Motor trip to Arundel.

THE LONDON ELECTRICAL ENGINEERS.

Officer Commanding, Col. H. M. Leaf.

The following orders have been issued for the current week:—

Monday, June 26th, "A" Company.—Technical Drill, 7 p.m. to 9 p.m.
Tuesday, June 27th, "B" Company.—Technical Drill, 7 p.m. to 9 p.m.
Wednesday, June 28th.—Gymnastic Classes, 7 to 10 p.m.
Thursday, June 29th, "C" Company.—Technical Drill, 7 to 10 p.m.
Friday, June 30th, "D" Company.—Technical Drill, 7 to 10 p.m.
Saturday, July 1st.—Felixstowe Detachment, parade at Headquarters at 1 p.m.:—Dress: Service dress, drill order. Arms will be drawn at Headquarters before the parade.

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ANNUAL REPORT OF THE ELECTRICAL INSPECTOR OF FACTORIES.

In our last issue we referred to the chief points of electrical interest in the Annual Report for 1910 of Dr. B. A. Whitelegge, C.B., H.M. Chief Inspector of Factories. Accompanying this Report are several sectional Reports, including that of Mr. G. Scott Ram, H.M. Electrical Inspector of Factories. As this Report is of considerable importance the following abstract will prove of interest :—

The Regulations which became operative as regards the use of electrical energy in factories and workshops on July 1, 1909, came fully into force in generating stations on January 1, 1910. The memorandum explaining the effect of the Regulations and the exemptions allowed in the several classes of works and installations to which they apply was issued in February, and has proved of very great service in replying to occupiers and others asking for information, and has fully justified the labour spent in its preparation. Some questions have arisen as to whether certain forms or conditions of the transformation or conversion of electrical energy constitute "electrical stations." Thus, electrical energy taken from public supply mains is passed through motor generators, converters or rectifiers for use in cinematograph lanterns, or for the charging of secondary batteries. So long as the use of the transformed or converted energy is solely for the purposes of throwing pictures on a screen or for charging batteries, the transformation does not fall within the definition. If, however, the transformer or converter is on premises already under the Acts the Regulations will apply.

With regard to the observance of the Regulations generally, while many occupiers have taken trouble to ascertain if their installations are in conformity with the requirements, and have taken steps to put them in order where necessary, a large number have done nothing pending instructions from the Inspectors. Although it is the duty of the occupier to provide compliance without waiting for instructions, there are several circumstances which operate to cause delay. First and foremost is the fact that a vast number of occupiers, although making use of electrical energy in their works, understand little or nothing about it, and are quite incapable of determining whether the Regulations are complied with or not. In large works where an electrical engineer is employed the occupier may take his advice and do what appears necessary, but more often he hesitates to do anything until an Inspector points out the necessity. Moreover, the requirements were purposely drawn so as to give the utmost latitude in the design of apparatus and methods of protection, so as not to check or retard progress, provided that the object—safety to the user and other persons employed—is attained. Untechnical occupiers are naturally unable to decide whether there is safety or not, and even amongst electrical engineers many points of danger are apt to escape their notice until pointed out. Reports from some of the Inspectors show, however, that a good deal of work has been done in getting some of the more obvious defects remedied, such as bare conductors, fuses, switches, &c., protected, defective switches, &c., repaired.

In general, whilst more accidents causing burns occur with direct-current apparatus, the fatal shock accidents are nearly all with alternating current.

Several inspectors point out that in many districts the Corporations supplying electrical energy have their own rules as regards the consumer's installation and which in some cases are more strict than the Regulations, and that consequently the latter are well carried out, also that in some cases the electrical supply authorities have altered their own previous regulations to coincide with those under the Factory Acts. It is certainly to the advantage of the occupier when the supply undertakers look carefully after his installation. This supervision is not, however, universal; there are others, some being local authorities, who do not trouble about their consumers' installations in any way beyond making an insulation test before starting to give a supply. Further than this, some even hand over to the occupier the care of their service fuses. In some instances of fuse boxes left unsealed, they were probably deliberately left so that the occupiers could renew the fuses themselves. A stoppage due to blown fuses may, of course, prove expensive in the case of a large factory. Ordinarily service fuses are sealed up by the supply authorities, and are exempt from the Regulations. If, however, the occupier has access thereto, necessitating the exposure of live metal, the exemption does not apply, and the Regulations must be complied with. As the responsibility in such cases for the provision of suitable fuse gear is necessarily placed by the Regulations upon the occupier, the Department cannot call upon the supply authority to make the necessary provisions, but they can bring pressure to bear by proceeding against the occupier for a breach of the Regulations, and if necessary could prevent the use of electrical supply until the matter had been put in order by the supply authority. It is important, therefore, that supply authorities should recognise that service fuses on factory premises, if unsealed, and accessible to the occupier are subject to the Regulations.

Non-compliance with the Regulations is not by any means limited to old installations. I have come across some important plants, put up since the Regulations came into force and by well-known firms of electrical contractors, where the Regulations have evidently not been taken into consideration. In one case where the space at the back of a switchboard was 18 in. instead of the required 3 ft. passage the work had been put in under the supervision of a consulting engineer. Unfortunately for the occupier in such cases, it is he who is responsible under the Factory Acts. Some contractors and even a representative of a firm of consulting engineers admit not having seen a copy of the Regulations. The record of accidents for the year shows on investigation that the conditions leading up to the accidents in the majority of cases were such as neither complied with the definite requirements of the Regulations nor suggested any alternative means of safety.

As pointed out in my last year's report, non-compliance in certain particulars is often brought about by the use of unsuitable and dangerous apparatus supplied by electrical manufacturing firms. There are still many faulty designs of switches, fuses, connectors, hand lamps, &c., which continue to be re-produced. Several firms are, however, taking up the manufacture of articles specially designed to meet the requirements as to safety. Considerable attention has been given by manufacturers to the production of safe fuse-holders. One of the requirements is that fuses, unless protected by a switch cutting off all pressure, must be designed so that they may be handled with safety for the purpose of renewing a fuse, and this is a point which has been overlooked in many of the patterns commonly met with. I have noticed in my visits a tendency to the use of fuses or switch-fuses for very large currents under conditions where circuit-breakers would undoubtedly be safer and more suitable. This is probably due to the latter being somewhat more expensive. A type of fuse which has recently come into considerable favour has a porcelain cartridge fitting into contacts enclosed in a porcelain base. It is arranged so that it can be handled for renewal without danger of touching live metal, but it is not intended for use as a switch-fuse. It has an indicator for showing when a fuse has blown. One of the chief features is that the proper size of fuse for the circuit having been determined upon, the base is set to take that size of cartridge and no other. It is impossible for an unauthorised person to over-fuse the circuit by inserting a fuse of larger capacity. The cartridges contain the smallest possible amount of metal in the fuse, with the result that they break circuit without report or explosion under very severe conditions.

Attention has also been given to the construction and protection of automatic circuit-breakers. Many types of direct-current circuit-breakers are dangerous, particularly when used in confined spaces such as the driving cabins of cranes, through exposed live metal and from the flash or scattering of hot particles of metal when they come into operation. Enclosed circuit-breakers designed to overcome these defects have now been produced. The design of oil switches and circuit-breakers has also received consideration from several makers, with a view to preventing the possibility of explosion.

Unsatisfactory and dangerous work is often due to the cutting of price and acceptance of the lowest tender.

With regard to public supply stations, in many cases the question o compliance with the Regulations has been carefully gone into, but i others a waiting policy has been adopted. In several instances new mai switchboards have been put in, and in others steps are being taken t that end. In these cases the discarded switchboards have been anythin but satisfactory to the station engineers, who have been very glad of th assistance afforded them by the Regulations in obtaining the necessar grants for carrying out the alterations. A good deal of work has bee necessary in some cases to provide compliance with the regulation whic requires protection of conductors in the passage-ways of high-pressu switchboards. Safe means for operating high-tension isolating switch is also a matter which has had to be dealt with in several instances.

One of the most important of the Regulations (No. 28) provides again the employment of (technically) ignorant persons where there is dange Arising out of fatal accidents, two prosecutions under sec. 136 we undertaken against electric power companies for breaches of this an other regulations. In one case the company pleaded guilty and was fine £20. In the other, which was defended, a fine of £10 was imposed. The have been many instances of accidents, fatal and otherwise, under su circumstances, and this regulation was specially devised in consequen As I have pointed out in former reports, an ignorant (electrical person, whether an unskilled labourer or a skilled artizan, such as bricklayer, plumber or carpenter, cannot realise the danger to which is exposed. As has been repeatedly proved, it is of no use to tell him to careful not to touch certain conductors or apparatus where he is worki These conductors appear to him to be no more dangerous than a gas p or a water tap. If it is necessary to employ such persons near l conductors, the live conductors must first be so screened off that ther no danger. If work has actually to be done under conditions wh there is danger, then it is only fair that a competent electrical engin or other person with adequate technical knowledge should undertake it

The increasing use of electrical energy for motive power in factorie again indicated by the figures taken from the annual returns of hor power of motors connected to the mains of electricity supply undertaki published by THE ELECTRICIAN. Although the figures are not compl a number of undertakings giving no return and the large power compa not being included, an addition of 70,000 H.P. during the year is accoun for, bringing the known total of motors connected to public supply m up to over 630,000. In spite of the low price at which electrical ene can be purchased in many districts, occupiers of large works continu put down new electrical generating plant of their own.

Table I. summarises the accidents at electrical generating stations sub-stations.

The mechanical accidents are somewhat fewer than in the prev year (319 and 38), the reduction being chiefly under the heading "falls." The electrical accidents are also fewer, the number of fatalit four, being however the same. The actual figure, 45, for the pu supply stations, is remarkably small, and compares with 58 and 76 in

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Table I.—*Accidents at Electrical Generating Stations and Sub-stations in* 1910.

The figures in brackets relate to fatal accidents, and are included in the principal figures.

Description.	Public supply stations and elec. railways and tramways.	Other stations.
Non-Electrical—		
At engines, pumps and generators	31 (1)	6
At boilers and steam plant	44 (2)	5
At coal-handling plant	16	1
Falls	68 (2)	10
Struck by falling bodies	19	3
Miscellaneous	104	10
Total	282 (5)	35
Electrical—		
At switchboards when engaged in ordinary routine work—mostly due to faulty design of apparatus or to mistakes on the part of the switchman...	15	2
Cleaning, repairing, &c., at "live" switchboards or other "live" conductors	16 (2)	7
Cleaning, repairing, or other handling of switchboards or apparatus supposed to have been made "dead"—		
Skilled persons	5 (1)	—
Unskilled persons	—	—
Adjusting brushes and cleaning commutators	2	1
Miscellaneous	7 (1)	3
Total	45 (4)	13

two previous years. When it is considered that the output of the electricity supply undertakings increases enormously every year, and that in the earlier tables returns from tramway undertakings (other than those having combined stations for general supply and traction) were not included, it is evident that the relative proportion of accidents to the total output of electrical energy from the stations has fallen greatly, indicating a higher standard of safety as regards the plant and apparatus, and greater care on the part of those responsible for its operation. The Regulations may be assumed to have had a beneficial influence upon the result.

The nature of the accidents is much the same as I have described in previous reports. Several accidents from short-circuit, resulting in severe burns, were obviously due to carelessness. Thus, there were again the cases of men taking measurements of switchboards with steel rules, whilst two men were injured through "levelling" a live switch with a metal spirit-level, and another through the use of a stick of solder. Two of the four fatal electrical cases were due to men without technical knowledge working near electrical apparatus; a third case occurred during the cleaning of an extra-high pressure board supposed to be "dead." Whilst under the miscellaneous accidents, the fatal case occurred to a cleaner at an extra-high tension switchboard in a sub-station, who for some unexplained reason, probably mere curiosity, obtained the key and opened the door of a live panel.

Table II.—*Electrical Accidents in Factories other than Electrical Stations in* 1910.

The figures in brackets relate to fatal accidents and are included in the principal figures.

Arcing of { switches	48
Arcing of { fuses	13
Shock or burns from fuses when replacing fuse-wires	28 (1)
Flexible apparatus, connectors and flexible wires	54 (1)
Unprotected conductors, switches, terminals, fuses, &c.	21 (1)
Working on or near live conductors { Skilled persons	34
Working on or near live conductors { Unskilled persons	17
Miscellaneous accidents in electrical manufacturing works—mostly in testing operations	30 (1)
Adjusting brushes and cleaning commutators	7
Miscellaneous	24 (1)
Total	276 (5)

The total number of the accidents recorded in Table II. is slightly greater than last year. The increase of 18 accidents, or 7 per cent., is however, much less than would be the case if, as might be expected, the rate of increase in accidents should coincide with the rate of increase in the use of electrical energy. The number of fatalities is five as against eight for last year.

The accidents from the arcing of switches, including motor-starting switches, are mostly due to defective design or to the switches not being maintained in good order. A number are due to motor-starting switches having a no-volt release not being maintained in proper order, and failing to return to the starting position. On the next occasion when the motor switch is put on there is consequently a flash, and the man gets his hand burned. The accidents from the arcing of fuses are in nearly all cases due to absence of protection of the fuses, and are consequently due to a breach of the Regulations. Similarly with automatic cut-outs, which are often placed at the height of a man's face and sometimes in a confined space.

The accidents in the use of portable apparatus are rather numerous. Twenty occurred in handling the flexible wires, some being due to wires, originally well insulated and protected, being kept in use after the covering had been damaged or worn out, but others to the use of a "drawing-room" class of flexible in place of a well-protected "workshop" quality.

Twenty-four accidents were due to the use of unsuitable plug connectors, fifteen of which were of the two-pin wall type and nine of the "adapter" type where the connection is made to a lamp-holder. Both last year and the year before I described how a connector plug should be made so as to obviate the dangers. Such plugs are now obtainable from several manufacturers. In the fatal case a hand lamp with flexible wires was being connected by means of an "adapter" to a lamp-holder. The lamp-holder, which was a fixture, was placed above a metal platform in a boiler-house, so that the man standing on the platform was in connection with earth. In holding the adapter to put it into the lamp socket, the flexible wires would pass through the man's hand. The insulation on the wires was damaged at this point, so that he touched the bare wire. No switch was provided for cutting off the pressure to the lamp socket, so that as soon as the adapter made contact the flexible wires became live, and the man received a shock to earth. The current was alternating, and as frequently happens in such cases, the man was unable to move or let go or even to make the simple movement necessary to take the adapter out of the lamp-holder. Although assistance was at hand in a very short time, he was killed. The pressure on the lamp circuit was 115 volts, but as the circuit was taken from an auto-transformer from a 230-volt circuit, the pressure of the shock was probably 230 volts.

Fifty accidents were due to persons working on live switchboards and other conductors. The skilled persons are described as "electricians" or "wiremen," and probably would be cognisant of the risks they were running. As I have frequently pointed out, there is seldom any real need for such work on factory premises, as the work can be done when the conductors are dead, even if it is necessary to wait until after factory hours. The unskilled persons, variously described as "labourer," "handy-man," "fitter," "engine driver," &c., should not have been allowed to undertake such work.

Testing operations in electrical manufacturing works are carried on very largely by pupils and apprentices, and it is chiefly amongst them that the accidents occur. The average age of 26 of the 30 persons meeting with accidents was only 22 years. Carelessness due to want of experience and insufficient supervision are no doubt contributory causes. On the other hand, the means provided for carrying on the tests are often faulty. Thus, old pieces of cable with the insulation worn out are used for making connections, and switches which are out of order are used for making and breaking circuit. The fatal accident, which happened to a competent man of long experience, occurred in connection with a pressure test, and appears to have been due to a mistake in signalling, the man touching the piece of apparatus under test thinking that the pressure had been cut off by the attendant at the switch some distance away.

In Table III. are set out the fatal cases mentioned above.

Table III.—*Electrical Fatalities reported under the Factory Acts in* 1910.

No.	Month.	District.	Voltage of System.	Probable voltage of shock.	System. A = Alternating, 1 = Single-phase 2 = Two-phase. 3 = Three-phase, D = Direct.
1	March	Glasgow	11,000	7,000	A 3.
2	April	Glasgow	400	230	A 3.
3	April	Newcastle	5,750	3,300	A 3.
4	May	Kent	440	250	A 3.
5	May	Leicester	2,000	2,000	A 1.
6	June	Leeds	280	200	A 2.
7	June	Oldham	220	220	D.
8	December	Manchester	6,500	3,750	A 3.
9	December	Huddersfield	10,000	5,750	A 3.

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from *The Electrician* office, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published under 2s., and 5 per cent. for books published nett. Add 10 per cent. for abroad or for foreign books.]

"The Propagation of Electric Currents in Telephone and Telegraph Conductors." By J. A. Fleming. (London, 1911: Constable & Co.) 8s. 6d. net.

"Directions for Magnetic Measurements." By D. L. Hazard. (Washington, 1911: Government Printing Office.)

"Science Abstracts." Vol. XIV. Part 5. No. 161. Section A. Physics. Section B. Electrical Engineering. (London, 1911: E. & F. N. Spon.)

"The Proceedings of the Royal Society," Series A, Vol. LXXXV., No. A 578. (London, 1911: Harrison & Sons.) 3s.

"Practical Dynamo and Motor Management." (London, 1911: S. Rentell & Co.) 6d. net.

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ENCOURAGING THE USE OF ELECTRICITY FOR DOMESTIC PURPOSES OTHER THAN LIGHTING.

BY A. HUGH SEABROOK.

Summary.—The author considers briefly the bearing of the following upon this problem: The tariff, the "business-getting" department, showrooms, hiring, accounts, hire purchase, cookers and the business instinct. Examples are given of the methods followed by the author in the St. Marylebone undertaking.

The two essentials to effect this result are :—

(*a*) A suitable tariff.

(*b*) An efficient business-getting staff.

Each is as important as the other, and the one will not effect any substantial result without the other.

The result of this combination in St. Marylebone has been that during the year ending March 31, 1911, we increased our connections for "other uses" by no less than 800 kw. (largely in residences), as compared with an increase of 285 kw. during the previous year.

Tariff.

The only tariff which will encourage "other uses" is a differential tariff in which the primary charge is *not* in the form of so many units at a high price per unit, but based on the connected lighting load (the most preferable basis), rateable value, number of rooms or area of rooms. Obviously, no differential system employing current limiters is suitable, because "other uses" apparatus in that case cannot be connected to the lighting mains, *and only a tariff which permits this apparatus to be connected to the lighting mains is effective in encouraging "other uses" of electricity.*

In these tariffs referred to the secondary rate is a low price per unit, generally 1d., and the tariffs are so framed that the standing charges of the domestic electric service are based on the lighting installation, and it is assumed that electric light is used throughout the house. All apparatus other than lighting can then be connected to the lighting system where the latter will carry it, the only charge made being the low secondary charge per unit; the primary charge is not increased on account of "other apparatus." I consider it to be perfectly justifiable to insist upon the complete installation of electric light in a house before a consumer can have current for "other uses" at the secondary charge only. I am convinced that the proper way to make reductions in price to consumers is to offer something in return for a *quid pro quo*. I do not believe in making concessions and getting nothing in return.

The method of application is as follows: Suppose a consumer wants to put in "other apparatus," and we find he only partially uses electric light, and uses (as is generally the case) gas in the long-hour part of his house—*i.e.*, the basement—we say our charge for "other uses" is 2d. and 1d. on the maximum demand system; but "if you will *wire your house throughout* and enter into a contract on our 'telephone' system, you can have all units at 1d."

Our before-mentioned increase of 800 kw. has been obtained in spite of this insistence upon a complete lighting installation, and some people may argue that that might be a serious difficulty in the way of encouraging "other uses." So it is, where there is not an *efficient business-getting department* in addition to the suitable tariff; in fact, I should imagine it is a well-nigh insuperable difficulty.

One point in connection with the suitable tariff before I leave it. There are many people who believe that a differential tariff, with its primary charge based on the connected lighting load, is a good one; but they say that it—

(*a*) Prevents the liberal installation of lamps—*i.e.*, lamps will only be put in where absolutely necessary; and

(*b*) They do not know what to assess the primary charge on.

Taking (*a*) first. It is usual in a tariff of this kind to insist upon the complete electric lighting of the house, but to count as connected lamps only those in general use. All lamps, such as those used in cupboards, cellars, lavatories, bathrooms, larders and also all purely decorative lamps, &c., which are only turned on for occasional use, are termed "convenience" or "inactive" lamps. It is well known, by all who have taken the trouble to ascertain, that the liberal installation of "occasional" lamps, by increasing the diversity factor of the residence, improves its load factor, so that any tariff which discourages these lamps should be avoided.

Then, as to (*b*). When "convenience" lamps are counted out, it is generally found that the average residence uses 70 per cent. of its watts installed for lighting at any one time. This may sound a high percentage for large houses compared with the percentage usually shown by them on the maximum demand system, but it must be borne in mind that the larger the house the larger is the number of convenience and decorative lamps in use, and it will be found that 70 per cent. is about right. I notice Mr. Ayton, of Ipswich, takes 60 per cent., and Mr. Cottam, of Hampstead, about the same figure.

The following is a letter sent to all consumers adopting the "telephone" system, pointing out how cheaply "other apparatus" can be used :—

BOROUGH OF ST. MARYLEBONE ELECTRIC SUPPLY.

Dear ————,

Re "Telephone" System of Charging.

The "telephone" system of charging having been well taken up by consumers, it may not be out of place for me to remind you that, having adopted the system, the following advantages are yours :—

1. The most lavish use of electric light only increases the number of *1d. units.*

2. Once the annual charge is paid, electric light only costs *1d. per unit.*

3. It is not extravagant to use electric light freely on dark and dull days and in dark places at *1d. per unit.*

4. Waste of light in any direction, for instance, basements and servants' quarters, is only a matter of *1d. per unit.*

5. Auxiliary uses of electricity—ironing, grilling, fans, &c.—can be effected by connecting the apparatus to any convenient lamp-holder or plug in any room at a charge of *1d. per unit*, resulting in a saving in special wiring and meter rents.

6. Cooking and heating only cost *1d. per unit*, at which price electricity is *as cheap as* gas for these purposes.

We have already received over £20,000 in annual payments, which illustrates the popularity of the scheme.

Yours faithfully,

General Manager.

Business-getting Department.

Whether it is called Sales, Publicity, Commercial, Consumers' or any other name, the important thing is for every electric supply undertaking to have one.

One of its most important functions is not only to *get* business, but to *keep* it. In fact, it is getting increasingly difficult to keep existing business, and in my opinion it is preferable to effect this by employing a competent staff to keep in touch with consumers than to make wholesale reductions in price in order to keep consumers. At any rate, it is much less expensive to the undertaking.

A business-getting and keeping staff is of the utmost importance in encouraging the "other uses" of electricity. As an example, a woman buys an electric iron or a kettle, and perhaps after a time the "flex" breaks down, or the kettle is allowed to boil dry. *If there is no staff keeping in touch with the consumer that kettle and iron get put on the shelf or the scrap heap, and the supply undertaking never knows that they are out of commission.*

When such a staff as I have mentioned is in existence consumers very soon begin to know about them, and ring up immediately the least little thing goes wrong; in fact, they are in hasty moments, considered rather a nuisance, but that is only the temptation of the "old Adam" of the old times, when a consumer who dared to complain was promptly consigned to perdition.

We send frequent reminders to consumers as to keeping their apparatus in proper working order, and the following is one of them :—

BOROUGH OF ST. MARYLEBONE ELECTRIC SUPPLY.

Consumers are earnestly requested to let us know if any of their electrical apparatus, such as fans, radiators, irons, ovens, kettles, &c., are not in working order.

Frequently the faults are such that we can put the apparatus in order free of charge, and where this is impossible we will quote a low price for the repair.

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We wish to know of *all trouble of every kind*, so that we may have, at least, an opportunity of putting it right.

All that is necessary is to send a postcard instructing our representative to call at a stated time, either day or evening.

We fully realise—as a public-service undertaking—our obligations to our consumers, and it is our constant care to fulfil these obligations.

Any consumer experiencing any such failure on our part to carry this out would confer a favour by reporting it in writing immediately to the general manager.

There is a further advantage in looking after consumers' apparatus, because during every call our representative mentions some of the new domestic electrical apparatus which is constantly being put on the market, and probably leaves an illustrated pamphlet. He confirms the call by letter when he returns to the office; thus the consumer has a permanent record of the call and the apparatus talked about. To show that consumers do take notice of such letters and calls, we frequently receive orders for the apparatus months after our man has called; but in any case we do not forget it, because all calls, matters discussed, apparatus sold, &c., are entered on the consumer's card in the office.

The staff of this business-getting department works in very close touch with the accounts and mains departments. A much larger percentage of our "other apparatus" sales results from account complaints than would be imagined. All account complaints are dealt with by the business-getting staff, and the consumer is called on immediately upon receipt of the complaint. In many cases, by adopting a different tariff or using metal lamps, the consumer is shown how he can cut down his electric-light cost, and when satisfied as regards his light and not before, he is prepared to listen to the "other uses" to which we can put his electric service.

Trial Offers.

An offer to loan apparatus for short periods is a most effective way of introducing domestic electrical apparatus, and the sales resulting therefrom are most gratifying.

Two examples follow of the circular sent, generally with the quarterly accounts.

BOROUGH OF ST. MARYLEBONE ELECTRIC SUPPLY.

ELECTRIC FANS.

We shall be glad to send a competent representative to call upon you and supply any information you may require as to Electric Fans, if you will kindly fill in, tear off and send us the lower part of this form.

.....

To the GENERAL MANAGER,
Borough of St. Marylebone Electric Supply.
Please send a representative on.....next to give full information as to Electric Fans.

Signed .....

Address .....

Date.....191 .

BOROUGH OF ST. MARYLEBONE ELECTRIC SUPPLY.

SPECIAL TRIAL OFFER OF ELECTRIC IRONS.

We are prepared to supply you with one electric iron for a trial period of one month. If you would care to avail yourself of this offer, please sign (at the perforation) and sign the attached note.

A man in uniform will deliver the iron, upon receipt of the trial order, and will ask for a receipt to the effect that the iron has been delivered. He will call again in one month's time, and either receive an order from you for the iron or take it away.

No liability attaches to you in respect of the iron in the event of its not being purchased, except as regards current consumption. The price, if purchased, is 12s. 6d., and *it only uses about one-fifth of a unit per hour.*

Please have nothing to do with any person in connection with this transaction who does not wear the official uniform and does not produce his card.

.....

To the GENERAL MANAGER,
Borough of St. Marylebone Electric Supply.
Please send me one electric iron to use during a trial period of one month.
I do not undertake to purchase it even if it acts satisfactorily.
I accept the iron on the understanding that no liability rests with me in connection with it during the trial, except as regards consumption of current.

Signed.....

Address .....

Date.....191 .

Showrooms.

The supply undertaking must have showrooms where consumers can see all kinds of apparatus working, and where they can call for particulars as to rates of charge, &c.

An ideal showroom, in my opinion, should be situated on a ground floor, and it should not look like a sale room, but it *must* look like a sale room if space is limited. Near the entrance should be a commissionaire to wait on callers in fine and wet weather, just as they would be waited on at a large store. Inside should be a waiting room or lounge, with comfortable chesterfields and armchairs, and a small table near with the department's literature on it. Leading from the lounge should be a wide passage, and standing on each side of it various appliances, such as vacuum cleaners, radiators, cookers and so on. At the end of the passage are the cashiers' desks. Leading off from the lounge and passage (there should be no permanent partitions on this floor at all, merely columns for supporting the floors above) are the model kitchen, bathroom, bedroom, nursery, dining room and so on. They can be quite tastefully arranged by avoiding permanent partitions, and in each room is placed and shown working the various electrical apparatus which is suitable to be used in it. To my mind this is much to be preferred to the present usual arrangement of odd kettles, irons, fans, radiators, &c., standing about promiscuously, and which, I am sorry to say, owing to lack of space, is the arrangement in our own showroom.

A consumer sees a kettle among a lot of other things, which latter distract his mind from the kettle; but if he sees that kettle doing its proper work in its proper room he will be much more impressed with it.

The showroom windows, on the same principle, should not look like shop windows, and all through the showrooms the idea should be to impress the consumer that a public service is being sold, and not apparatus, the selling of the apparatus being only incidental to the selling of the service.

This may strike the average supply manager as a somewhat elaborate arrangement; but let him look back five years and note the advance made in showrooms since that time, and let him bear in mind that in the future the business side of electric supply is going to take its proper place in relation to the general undertaking, as it does already in other branches of commerce.

Hire.

In order to do a considerable business in electric domestic appliances it is necessary to *offer* hire terms. I say "offer" because it does not necessarily mean actually hiring in all cases; in fact, it is surprising the small amount of apparatus that we hire out in St. Marylebone, though I am convinced the possibility of being able to hire is useful in introducing the apparatus to the consumer. If we approach him on the basis of a direct sale he will probably turn it down, but if he is approached on a hire basis he pays more attention to the proposition, and though he sometimes hires, he generally buys. I think the explanation is that, in common with the general public, he has no idea that electrical apparatus is so far advanced that anyone has the courage to offer it on hire terms.

Hire of apparatus is no good as a business deal unless a very high rental can be obtained. On small apparatus it should be 50 per cent. per annum on the capital value, decreasing with larger apparatus, such as vacuum cleaners, and lowest of all in the case of cookers, which is the class of domestic apparatus it is most desirable to introduce. The high hire charges on small apparatus keep it down to reasonable limits, and make it a profitable business. As I said before, the main idea is to be able to talk to the consumer in hire terms if necessary.

Adjoining is a sample of our hire-agreement form.

Representative..... District..... No.....

METROPOLITAN BOROUGH OF ST. MARYLEBONE
ELECTRICITY DEPARTMENT.

AGREEMENT FOR HIRE OF FITTINGS.

The Mayor, Aldermen and Councillors (hereinafter called "the Council") hereby agree to let, and.....
of.....("the hirer"), hereby agrees to take on hire, at a rent of.....per.....

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payable in advance.....
(hereinafter called " the fittings ") from the.....
day of.....191 , for a minimum period of.....
and thereafter until the determination of this agreement by either party giving to the other one week's notice in writing expiring at or after the expiration of the said minimum period, for use on the premises occupied by the hirer at the above address, upon the conditions printed on the back hereof.

And the hirer hereby agrees to pay regularly and punctually the said rent in advance on.....in each.....
and the Council and the hirer hereby agree to perform and observe the said conditions.

Dated this .....day of 191

Signed on behalf of the Council.....
Town Clerk or General Manager.

Signature of hirer .....

Witness .....

Quotation dated .....

Sixpenny Stamp.

CONDITIONS.

1. The Council will bear the expense of repairs and renewals to the fittings arising from defective material, workmanship or design and fair wear and tear therein subject to the conditions of article 2 hereof but except as provided by this article the Council will not be liable for any loss or damage whatsoever caused by or consequent upon any breakdown or failure of the fittings.
2. The hirer shall be responsible for and shall bear the cost of making good all loss injury or damage of or to the fittings, however caused, except to the extent provided for by article 1 hereof and shall from time to time keep the same in good condition and substantial repair (fair wear and tear only excepted), but all repairs of and other work executed in connection with the fittings for which the hirer shall be liable as hereinbefore provided, shall be effected at the hirer's expense by the Council's servants or (at the option of the Council) by a person approved by them. The hirer shall forthwith give notice to the Council of any breakdown, failure, loss, injury or damage of or to the fittings. The hirer shall, during the hiring, insure and keep insured for their full value, the fittings against loss or damage by fire and any sum received by the hirer under such insurance shall be a debt due from him and shall be paid by him to the Council, and the Council, on receipt thereof, shall repair or renew the fittings as they may think fit, and no rent shall be payable by the hirer in respect thereof during the time occupied by such repair or renewal.
3. The Council's servants shall be at liberty at all reasonable times to enter the said premises for the purpose of inspecting the fittings and or effecting any repairs or renewals.
4. The hirer shall not remove the fittings or any part thereof from the said premises or attempt to assign, let on hire, charge, or in anywise deal with the same without the consent in writing of the Council previously had and obtained.
5. The Council's name plate, mark or brand shall not on any account be removed from the fittings or in any way defaced or obliterated.
6. The hirer agrees to take from the Council during the continuance of this agreement the whole of the electrical energy required for the said fittings.
7. If any rent or other sum due under this agreement shall be unpaid for seven days after the same is due and whether the same has been demanded or not or if the hirer shall file a petition in bankruptcy or shall have a receiving order in bankruptcy made against him or shall make any composition or arrangement with his creditors or any of them, or commit any act of bankruptcy or shall resolve or be ordered to be wound up or if he shall not duly observe and perform the terms and conditions of this agreement or any of them, then and in such case and in addition to any other right or powers possessed by the Council, it shall be lawful for the Council or their agents and servants on their behalf, although the Council may not have taken advantage of some previous breach or default or event (of a like nature or not) forthwith to put an end to the hiring and to enter upon the said premises to take possession of and remove the fittings and forthwith to recover any sum then due, together with the reasonable expenses of such discontinuance and upon such discontinuance the hiring shall cease, but without prejudice to any right which shall have then accrued. In the event of such discontinuance the hirer shall also pay the Council a sum equal to the rent of the fittings until the expiration of the period at which this agreement could have been determined by the hirer giving notice in accordance with the provisions of the agreement.
8. Any notice or demand under this agreement shall be sufficiently served if sent to the hirer by prepaid registered post addressed to him at the said premises.
9. The several words and expressions to which meanings are assigned by the Electric Lighting Acts, 1882 and 1909, the St. Marylebone Electric Lighting Acts, 1901 to 1904, and the Board of Trade and the Home Office Regulations have the same respective meanings in this agreement.

Maintenance.

The maintaining of consumers' lighting installations is most desirable because it keeps our business-getting staff (who look after the maintenance) in the closest possible touch with consumers; thus we know, for instance, when a new baby arrives, and can put forward suitable electrical nursery apparatus in an inobtrusive way, and talk about the extreme safety and desirability of electric radiators, milk warmers, airing apparatus and so on.

All our maintenance men wear a distinctive uniform and put on over-shoes in consumers' houses; they are also trained business-keepers and getters.

The following is a sample of our maintenance agreement. The idea of keeping these agreements small is that our representatives can carry the books in their pockets, and get the form signed and the business closed on the spot.

Representative..... District..... No.....

METROPOLITAN BOROUGH OF ST. MARYLEBONE
ELECTRICITY DEPARTMENT.

Agreement for Maintenance.

The Mayor, Aldermen and Councillors (hereinafter called " the Council ") at the request of.....
(" the consumer ") hereby agree to maintain the electric lighting installation at the premises occupied by the consumer at.....
.....
from.....till.....in the manner and upon the conditions set forth on the back hereof, for the sum of £.....per annum.

And the consumer hereby agrees to observe and perform the said conditions and to pay the said yearly sum in four quarterly payments regularly and punctually.

Dated the.....day of.....191 .

Signed on behalf of the Council.....
Town Clerk or General Manager.

Signature of consumer.....

Witness .....

Quotation dated .....

Sixpenny Stamp.

CONDITIONS.

1. The Council are to maintain all lamps in an efficient lighting condition, replace lamps which fail, clean shades and globes, inspect and renew fuses, inspect the installation generally, and test the installation at least once a quarter; but material and labour for repairs, renewals or alterations to the installation other than as above stated, are not included.
2. If the tests and inspection show it to be necessary for repairs, renewals or alterations to be carried out, an estimate is to be given for the work required, except in cases of small matters dealt with by the maintenance attendant at the time of his visit, according to the consumer's instructions, for which a reasonable charge will be made.
3. The consumer is to notify the electricity department on the occasions of the premises being overhauled for decorating purposes, &c., so that steps may be taken to prevent damage to lamps, and the Council is to be entitled to charge for all lamps which fail through rough usage.
4. The Council may determine their obligation to maintain at any time by a calendar month's notice in writing, in which event the proportion of the yearly sum to date of determination shall be payable immediately.

Account Forms.

No opportunity is lost of saying something about "other uses." All account forms have the following note or something akin to it:—

> If you adopt the "Telephone" System for lighting you can have electricity for heating, cooking, &c., at 1d. per unit. Our representative will call on receipt of a postcard.

> ELECTRIC RADIATORS are unrivalled for HEALTHY AND CHEAP HEATING.

In addition, each envelope containing the first application, second application and receipt also contains a leaflet on some particular apparatus, or a slip as follows:

The celebrated international dinner of 14 courses, which everyone has been talking about, given recently at the House of the Institute of Hygiene, Devonshire-street, W., was cooked by electricity in an ordinary "Marylebone" electric cooker.

It was only to be expected that such an Institute would press into its service the most hygienic agent known to modern science—viz., electricity; but when it is remembered that electricity is not only hygienic but cheap as well, and that electrical cooking apparatus is so far advanced in manufacture and standardisation that it can be hired out to consumers, then it behoves all householders who have any regard for hygiene (and, fortunately, they are an ever-increasing number) to adopt electricity for cooking.

BOROUGH OF ST. MARYLEBONE ELECTRIC SUPPLY.
19 and 20, York-place, Baker-street.

I do not propose to touch any further on this matter of the value of advertising and publicity as a means of increasing the "other uses" of electricity, as managers of supply undertakings cannot do better than adopt the suggestions of the chairman of the Electric Supply Publicity Committee in his periodical circular, and then to supplement them by local advertising in their own areas.

Hire-Purchase.

Just a word as to hire-purchase of apparatus.

The best basis is to charge 25 per cent. of the total price of the work in advance and before the work is commenced, then the balance to be paid off in eight quarterly instalments.

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The following is a sample of our hire-purchase form :—

Representative.................... District.................... No............

METROPOLITAN BOROUGH OF ST. MARYLEBONE
ELECTRICITY DEPARTMENT.

AGREEMENT FOR HIRE-PURCHASE OF FITTINGS.

The Mayor, Aldermen and Councillors (hereinafter called "the Council") hereby agree to let an..........................of........................ .... ("the hirer") hereby agrees to take on hire with option of purchase, as mentioned below and in the conditions, at a rent of........................ per..................payable in advance.. (hereinafter called "the fittings") for the term of two years from the ....day of..........................191......for use on the premises occupied by the hirer at the above address upon the conditions printed on the back hereof, and the hirer hereby agrees to pay regularly and punctually the said rent in advance on....................in each.............. during the said term.

The hirer has paid, or will forthwith pay, to the Council £................. ("the deposit") for the option to purchase the fittings at the price of £..........and upon the terms set forth in the said conditions.

The Council and the hirer agree to perform and observe the said conditions.

Dated this...........day of.......................191.......

Signed on behalf of the Council ....
Town Clerk or General Manager.

Signature of hirer..

Witness..

Quotation dated....................

6d.
Stamp.

Consent to be signed by landlord where consumer is only occupier.

I...the landlord of the above-named consumer, and owner (or lessee for an enexpired term of........... years) of the said premises, consent to the installation of wires and fittings in the said premises, upon the terms and conditions of the above agreement to be entered into by the consumer.

Landlord's signature ....
Address..
Dated this.......................day of..........................191

CONDITIONS.

1. The consumer has the option, subject to condition 7, exercisable at any time during the [illegible] (unless this term of two years mentioned in the agreement shall have been [illegible] determined under condition 7), of purchasing the fittings at the price of £ (hereinafter called "the price") in which event credit shall be given to the consumer for the deposit and the amounts paid by way of rent. The deposit will belong to the Council if the option is not exercised or the agreement determined under condition 7.

2. The consumer may exercise the option by giving notice in writing to the Council, and paying to the Council such sum as together with the deposit and the amounts paid [illegible] will amount to the price.

3. [illegible] the consumer shall have exercised the option and paid the price, the fittings shall be and remain the absolute property of the Council.

4. The consumer shall, so long as the fittings remain the property of the Council, [illegible] and keep the same in good order and condition, and bear the cost of all necessary repairs and renewals, including damage by fire, unless otherwise agreed, but all [illegible] in connection with the fittings shall be effected at the consumer's [illegible] the Council's servants or (at the option of the Council) by a person approved by them. The consumer shall forthwith give notice to the Council of any breakdown, [illegible] or damage of or to the fittings. The consumer shall also, so long as the fittings remain the property of the Council, keep the same insured against loss or [illegible] fire, in the amount of the price, in the joint names of the consumer and the [illegible]

5. [illegible] as the fittings remain the property of the Council, the Council's servants [illegible] at all reasonable times, to enter the said premises for the purpose of [illegible] the fittings, and or effecting any repairs or renewals.

6. [illegible] as the fittings remain the property of the Council the consumer shall not [illegible] the same, or any part thereof, from the premises mentioned in the agreement, [illegible] let on hire, charge, or in anywise deal with the same, and the Council's [illegible] mark or brand shall not on any account be removed from the fittings, or [illegible] defaced or obliterated.

7. If the consumer shall at any time during the said term, or while the fittings remain the property of the Council:—

(a) Fail to observe and perform any term or condition of this agreement, or
(b) Fail to pay any instalment of rent for seven days after the same has become due, or
(c) Be adjudicated a bankrupt, or file a petition in bankruptcy against himself, or have a receiving order made against him, or make any composition or arrangement with his creditors, or any of them, or commit any act of bankruptcy, or [illegible] be ordered to be wound up, or
(d) Execute or create any mortgage, incumbrance, or charge of or upon the premises [illegible] upon which the fittings are placed, or grant any bill of sale upon his [illegible] and chattels upon the said premises, or
(e) Suffer any execution or distress to be levied on his premises, or
(f) Cease during the said term to take from the Council all electrical energy required for the fittings, or
(g) Fail to pay for the electrical energy consumed within 14 days after demand,

[illegible] be lawful for the Council, or their agents on their behalf, forthwith to determine [illegible] but without prejudice to any right of the Council which shall have [illegible] and the Council shall be entitled to enter upon the said premises, and take [illegible] and remove the fittings, and forthwith recover any sum then due, together with the reasonable expense of such removal.

8. An inspector of the Council shall supervise the erection and installation of the fittings, and test the fittings upon completion. A certificate by the inspector that the fittings have been tested by him, and have passed the necessary tests, shall be conclusive evidence, that the fittings have been properly erected and installed by the Council, and the Council shall not be liable for any loss or damage whatever, consequent upon any breakdown or failure of the fittings.

9. The consumer shall give to the general manager not less than one month's notice of his intention to remove from the said premises, and if such notice be duly given and the fittings be left in good order and repair, the benefit of this agreement and the deposit and all rental payments then made, may, with the consent of the Council, be transferred to the incoming tenant, on his undertaking the liabilities and obligations of the consumer hereunder.

10. Any notice or demand under this agreement shall be sufficiently served if sent to the consumer by prepaid registered letter addressed to him at the said premises.

Hire-purchase is a powerful argument when others fail, but the consumer has to be known; mortal offence may be given by broaching the subject to the wrong man or woman.

COOKERS.

I regard cookers and radiators as the future big business for domestic supply. Radiators are already in very wide use in London, due chiefly to the general reduction in the price of current. They are not of such value to a supply undertaking as cookers, because the latter are used all the year round, and mainly in summer, whereas radiators are not used at all in the height of summer, though the number of days of use per annum is much greater than is generally realised, as consumers find them exceedingly useful to put on in cold summer evenings and nights. Cookers will also be more generally used than radiators, because the cost is as low as gas at 1d. per unit, and the enormous hygienic advantages which electricity possesses over gas, in addition to the absence of poisonous fumes, heat and general nuisance, ensure that the future of electric cooking will be exceedingly great.

It is difficult to keep pace with the manufacturers, as most of our leading firms are now actively engaged in turning out complete cookers, and design after design is being placed on the market, and each is generally better than its predecessor.

There is no doubt in my mind that if the supply people wake up and institute suitable tariffs, remove irksome restrictions and organise business-getting departments, as there is certainly the tendency to do now, the makers of the apparatus will not be found behind at their end. But makers cannot turn out cookers while supply people put all the difficulties they can think of in the way, and do not exert themselves to educate their consumers into electric cooking.

The splendid propaganda work being done by Mr. Berry puts all supply men under a deep obligation to him.

As soon as the demand arises the prices will tumble down, and *are* tumbling down. For instance, the best complete cooker I have yet seen is listed at under £12. What is needed is for supply undertakings to hire out cookers at a reasonable rate, even if at first the rate is not profitable. No new thing can be introduced on a profit-making basis immediately, and supply authorities must be prepared to lose at first on the hire.

Needless to say, none but the wealthy will buy electric cookers outright, any more than people will buy gas cookers, and we have got to make up our minds to adopt the same tactics as our gas competitors; in fact, as we know their struggles and difficulties in introducing gas cooking some years ago, we can start out on a more favourable basis.

An electric cooker must do all that a gas cooker will and more quickly. The old failures of electric cookers were due to too few watts being put in, which from the current consumption point of view was a most serious mistake. This is now rectified in modern makes, and we have not got the element trouble now which we had a few years ago.

A few points on electric cookers might be useful, the necessity for which has been ascertained from conversations between our business-getting staff and cooks and chefs. The hot plates require two or three heats, and should attain a temperature of from 600°F. to 650°F. to enable quick work to be done. I may say there are several suitable ones now on the market. The oven should be loaded to 2 kw. or 3 kw., and be preferably of a type in which the elements can be increased or decreased, or replaced by the consumers themselves. One is already available. The cooker circuits should be split up and taken to a separate switchboard and separate fuses, so calibrated that

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one faulty circuit cannot possibly put the whole cooker out of commission, as this is fatal. Each circuit should have an illuminated sign showing up when it is turned on; this is a current saver.

Particular care must be given to the design of switches and fuses, and no switches should be fixed to the cooker itself; the connecting cables should be in metallic flexible tubing from the terminal box on the cooker to the switchboard, and all non-electrical metal effectively earthed. All parts of the cooker should be accessible for cleaning. The cooker should be so designed that it is never necessary to remove it for repairs. Replacements of elements or other parts where trouble can possibly arise should be easily renewable, if possible without the necessity for using tools, and from what I have seen of recent designs I do not regard this as altogether impossible; anyway, it is eminently desirable.

This may not appear to have much to do with the heading of the article, but we certainly cannot introduce cookers, which will be the most important of all domestic apparatus, unless they are satisfactory, and as we are paying a great deal of attention to electric cooking in St. Marylebone, our experience may be useful to some one.

The Business Instinct.

The best results in introducing domestic electrical appliances and increasing the output can only be obtained when, as I am happy to say is the case in St. Marylebone, the "business instinct" permeates the whole staff. Every section of the undertaking depends on the goodwill of the consumers, and present business can only be kept and new business obtained by recognising this fact.

Fortunately our accounts department is our own, and not in another (frequently quite unsympathetic) department, and it is audited quarterly by Messrs. Price, Waterhouse and annually by the L.G.B., which is about as complete a check as could be obtained, and from a new business point of view a self-contained department with its own accounts is an enormous advantage. It works closely with the mains and sales departments, and the business instinct goes all through each, resulting in courtesy and attention to consumers.

The following states our policy and our intentions, and that attitude is the only one which will result in a big extension of business with corresponding financial benefit to the undertaking as a whole. It is borrowed from a foreign electric supply undertaking.

COMPLAINTS.

It used to be good form in the public-supply business to ignore the word "complaint." The word had an unpleasant sound to managerial ears. "Information desk," "Adjustment bureau," or "Department of claims," were among the terms favoured, and every effort was made to minimise the fact that the department ever received such a thing as a protest from one of our 8,000 consumers.

Times change and so do customers. We do not like the word complaint any better than you do, but we are frank to admit that in a business as large as ours some mistakes will happen and some imperfections occur. We know that you realise this, and will consider the manner in which we rectify errors, rather than the error itself.

We guard against defects and strive to prevent them to the best of our ability. When things go wrong with the electric service, we prefer to have you tell us immediately and give us a chance to straighten them out, instead of cherishing a grudge against us and telling your neighbours about it.

An overcharge or a delayed connection may be due to no conscious fault of ours, but the spirit in which we correct the mistake is the criterion by which you should judge our professed determination to render good service.

Our employés are instructed to be as polite and willing to repair grievances as the management itself, and we believe, as a body, that they are. If, however, one makes a slip and temporarily forgets his duties to the public, you cannot possibly regret it any more than we do.

The uninitiated person will scoff at such a leaflet. Well, I am quite content to let him scoff in his ignorance. I know this, however, that such an attitude as indicated in the leaflet is a business-keeper and getter, and is a distinct financial asset to the undertaking.

THE SOUTHWICK POWER STATION OF THE BRIGHTON CORPORATION.

The system of electricity supply at Brighton was one of the earliest installed, and the progress of the undertaking from comparatively small proportions to its present position as one of the largest of the municipal stations in the kingdom testifies to the ability and resource displayed in its management. We have dealt with the growth of the system in our columns from time to time, so that our readers have been kept acquainted with the alterations and extensions made. The most important step taken in the history of the scheme was the erection of the turbo-electric plant at Southwick and the gradual substitution, by the supply from this plant, of that given by the Willans units initially installed at North road, which was the original electrical centre of the Brighton network. This last-named station still stands, but is used to house the plant which receives and converts the energy transmitted from the South-

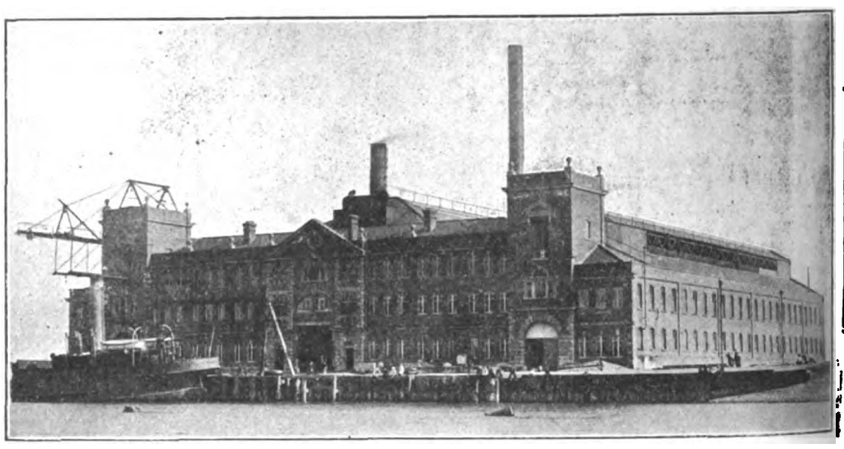

Fig. 1.—Exterior of Southwick Power House.

wick power house. An exterior view of this station is shown in Fig. 1. Since our description of the station (*see* The Electrician, Vol. LVII., p. 326) a large turbo-generator of 3,500-4,000 kw. capacity has been added. This plant is the combined product of Messrs. Richardsons, Westgarth and Siemens Bros. Dynamo Works, who supplied the turbine and generator respectively. This interesting unit may be seen in the background of the view of the station in Fig. 2, the last plant from the end. The turbine is of the two-cylinder Parsons type, and has been built to the designs of Messrs. Brown, Boveri & Co. It was selected because of its higher efficiency as compared with either the impulse or single cylinder reaction types. This type of turbine has been extensively adopted both in this country and on the Continent. There is a 6,250 kw. set of this pattern at the Dunston power station of the Newcastle-on-Tyne Electric Supply Co.

The two-cylinder turbine allows greater economy to be obtained by increasing the number of rows of blades without increasing the distance between bearings. In the single-cylinder type the larger pressure drop per row of blades necessitates a higher blade velocity and therefore a larger diameter of drum. This larger diameter reduces the blade height and increases the leakage loss by increasing the ratio of radial clearance to blade height. In the two-cylinder turbine, having a smaller pressure drop per row of blades, the velocity of the blades and therefore the diameter of drum may both be reduced. This admits of a greater blade height with a reduced clearance ratio, and results in a considerably improved steam consump-

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tion. The low-pressure portion of a Parsons turbine is generally admitted to be extremely economical, but it has always been stated that the high-pressure end has a much lower efficiency than the low-pressure end.

The high-pressure drum is of uniform diameter, and therefore is free from distortion troubles. The steam pressure at the inlet to the low-pressure cylinder does not exceed approximately 50 lb. per square inch, so that the low-pressure cylinder

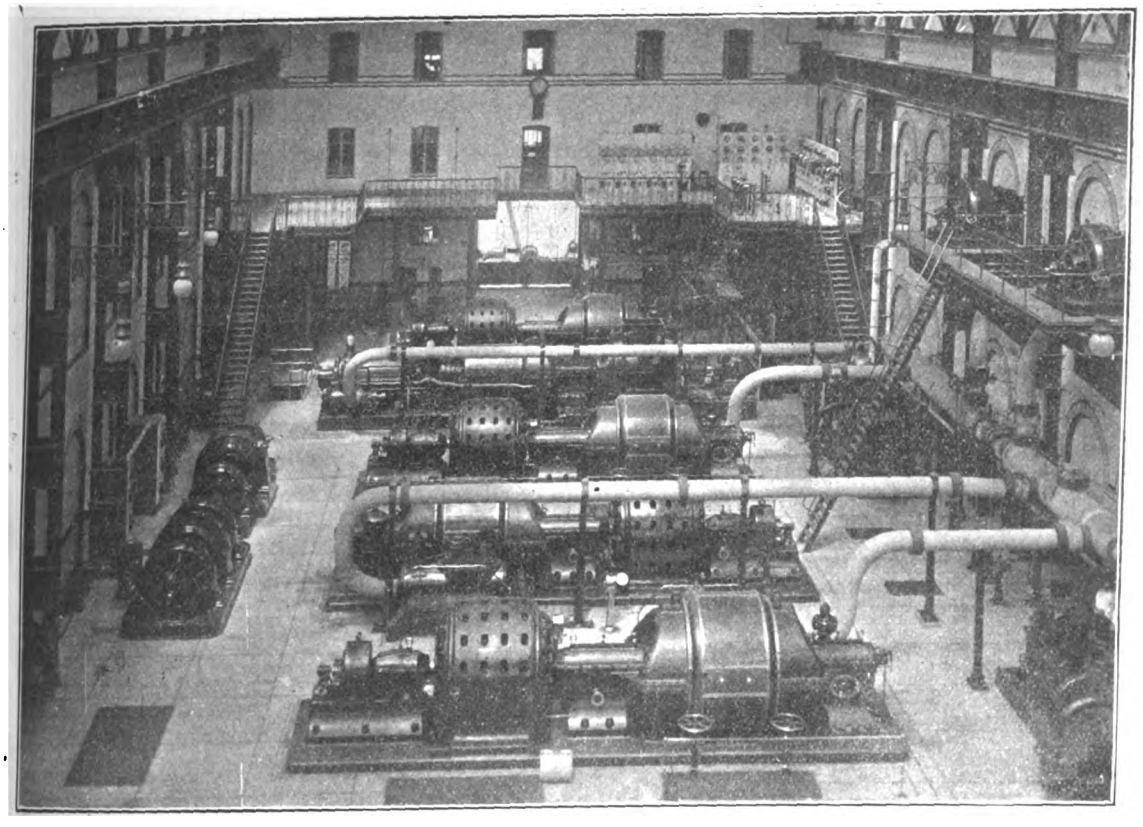

FIG. 2.—GENERAL VIEW OF ENGINE ROOM, SOUTHWICK.
The new 3,500 kw. set is the last but one from the far end.

is not subjected to any high temperatures. At the low-pressure end the rows of blades have been increased considerably as compared with the single-cylinder type and the efficiency of this portion is still further improved. Owing to the lower steam and blade velocities than in the impulse type, the

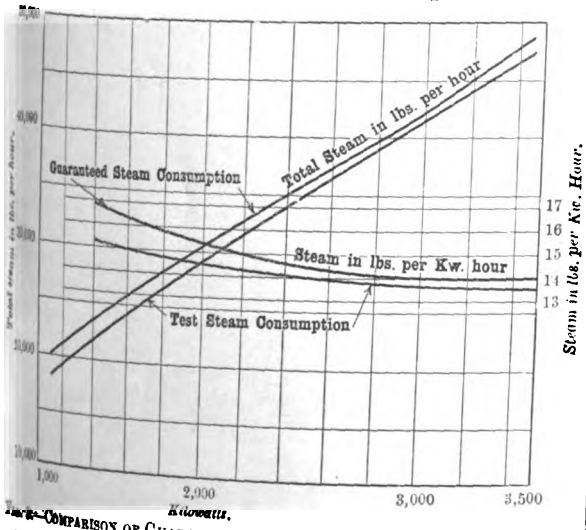

FIG. 3.—COMPARISON OF GUARANTEED AND ACTUAL STEAM CONSUMPTION.
3,500 kw. 1,500 R.P.M., steam pressure 180 lbs. sq. in. Temp. 530°F. Vacuum 28½ in. Barometer 30 in.

original efficiency of the turbo is maintained over a long period. Steam is admitted to the turbine through a double-beat valve controlled by the governor through an oil relay. The gear consists of a double-beat valve actuated by the spring-loaded piston, which is under control of the oil under pressure entering from the main lubricating system. The controlling pressure of the oil is determined by the vertical position of a sleeve and a spring-controlled governor. If the speed increases the governor lowers the position of the sleeve, thus increasing the outlet area of the oil pipe, which diminishes the pressure of the oil under the piston, resulting in a corresponding closing of the double-beat inlet valve. When the speed of the turbine decreases, the position of the sleeve is raised, whereby the exit area of the oil pipe is decreased with the opposite result. The oscillating movement of the valve, which practice has shown to be an advantage for close governing, in that all moving parts of the gear are kept in constant motion, is obtained by the very simple device of making the upper governing edge of the rotating sleeve at an angle with the axis. The exit area of the oil pipe is thus varied slightly once in a revolution of the shaft, with the result that a tremor is produced in the valve and its piston and rod, which is in synchronism with the revolutions of the shaft. Thus, the undesirable wavelike fluctuations in the steam pressure produced by the ordinary oscillating motion are avoided.

The guaranteed steam consumption of this set are given below, the conditions being 180 lb. steam pressure, superheat to 530°F., and a vacuum of 28·25 in.

3,750 kw.	14·2 lb. per kw.-hour.
3,500 kw.	14·0 ,, ,,
3,000 kw.	14·0 ,, ,,
2,250 kw.	14·9 ,, ,,
1,500 kw.	16·5 ,, ,,

Preliminary trials were taken recently, and the results reduced to guarantee conditions are shown by permission of Mr. Christie in Fig. 3, where the guarantees are also plotted. One test result was as follows:—

Load	3,550 kw.
Pressure	200 lb. per sq. inch.
Temperature	523°F.
Vacuum	28·46 in.
Consumption	13·0 lb. per kw.-hour.

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The condensing plant was made by the turbine builders, and is of their standard contraflo type, fitted with a vacuum augmentor and Edwards air pumps. The condenser has a cooling surface of 5,000 sq. ft., and is guaranteed to maintain a vacuum of 28·25 in. when dealing with 53,500 lb. of steam per hour and supplied with 6,000 gallons of water per minute at 70°F. During the turbine tests the water temperature was 63°F., and a vacuum of 28·25 in. was maintained without using the augmentor. A general view of the machine from the turbine end is given in Fig. 4.

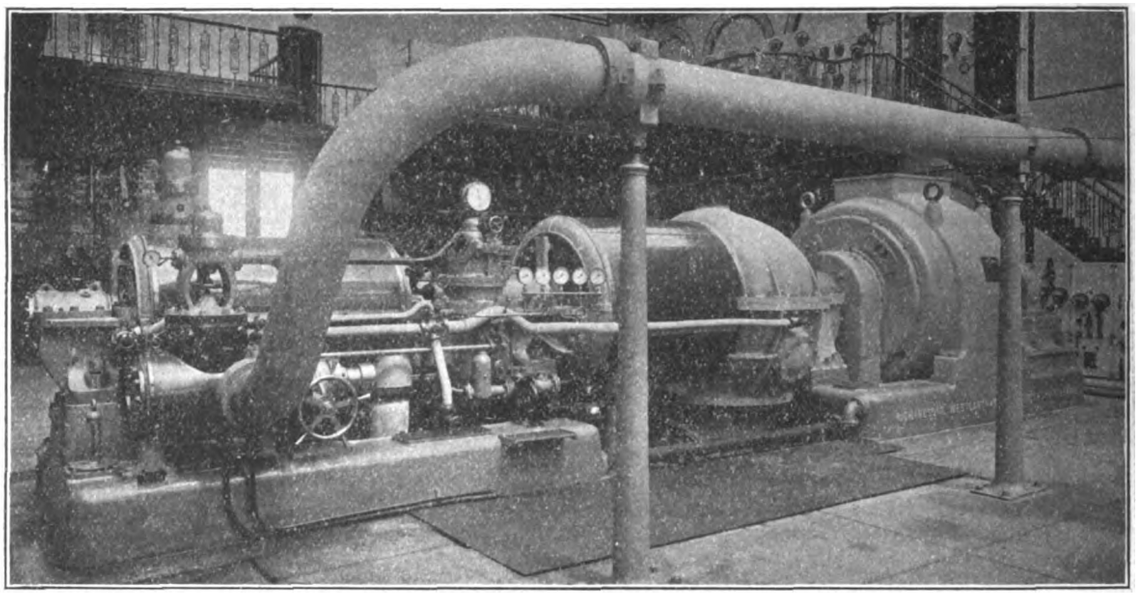

FIG. 4.—VIEW OF 3,500 KW. TURBO-GENERATOR FROM THE TURBINE END.

The generator of this large unit has a normal output of 3,000 kw. at 0·85 power factor. It delivers three-phase 50-cycle current at 8,000 volts when running at a speed of 1,500 revs. per min. The temperature rise after a continuous 3 hours' full load run, with the addition of 25 per cent. overload for 1 hour, was guaranteed not to exceed 75°F.; with the same period at full-load and the addition of 15 minutes at 50 per cent. overload the temperature rise was to be the same as the above.

The general construction of the machine follows the standard practice of the firm. Fan cooling has been adopted with a totally-enclosed stator frame. The cool air enters at the lower part of the machine, which is in the basement of the engine-room. This air is passed through a filter of the vertical screen type, made by the Buffalo Forge Co.; after passing through the windings of the machine under the action of the fan fixed at one end of the rotor heated air is discharged through an aperture at the top of the stator frame. Both stator and rotor are ventilated on Siemens' patent axial system, which provides for the passage of air through the active iron in a direct parallel to the machine shaft. The ends of the stator and rotor which are furthest removed from the air intake are naturally the hottest parts of the machine, and these are immediately accessible to a thermometer. A second fan is provided for drawing cool air through the rotor.

The stator slots are of the partially closed type, and the coils are pulled through, being subsequently supported on substantial end brackets. The rotor is provided with a distributed winding which is carried in equidistant open slots closed by metal wedges. The end connections are held down by four steel winding covers machined inside and out, and registered at either end on machined surfaces. The slip rings are of steel, and copper carbon brushes are used.

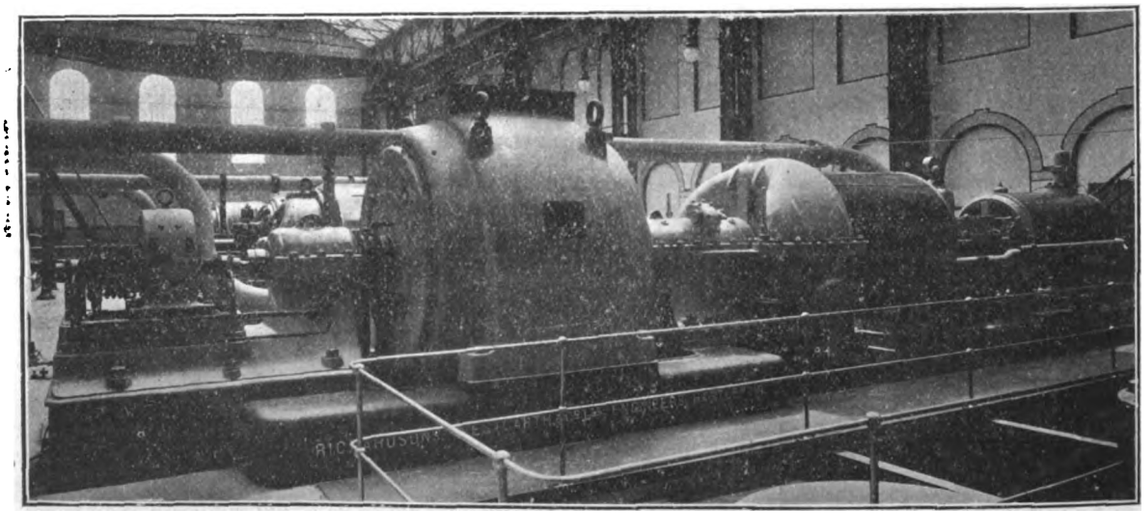

FIG. 5.—GENERAL VIEW OF 3,500 KW. TURBO GENERATOR.

The exciter is connected to the turbo-generator shaft through a flexible coupling, and it rests on its own bedplate, bearings being mounted on an extension of the turbine bed. Fig. 5 shows a view of this interesting set taken from the north end of the station.

The induced draught plant at the station consists of three large

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"Ulster" fans, made by Musgrave & Co., Belfast. Each fan is capable of effecting the combustion of about 20,000 lb. of coal per hour, and at the same time of maintaining a suction at the fan inlet up to 3 in. water pressure. The fans are driven by direct-coupled variable speed direct-current Westinghouse motors. The arrangement of the induced draught plant is exceptionally practical, the fans themselves being erected in the boiler house, and the shafts carried through the wall to the adjacent engine house. The motors driving the fans are

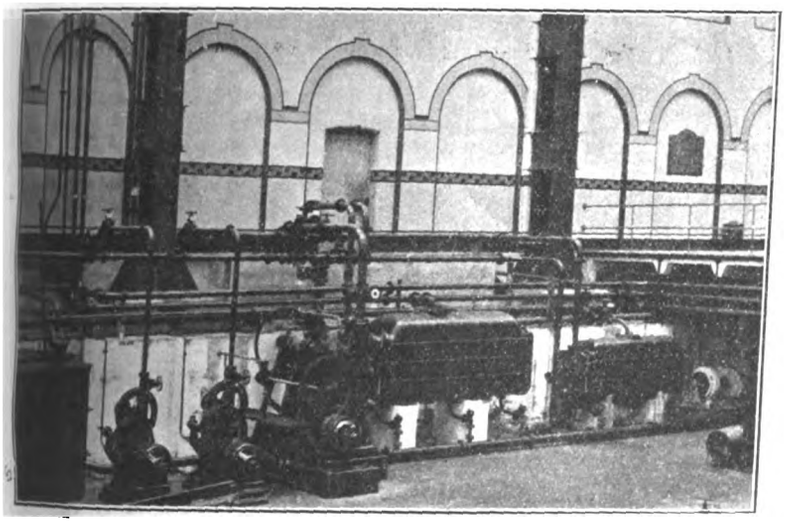

FIG. 6.—GENERAL VIEW OF OIL SYSTEM.
The oil coolers are on the right.

fixed on specially designed platforms in the engine house, having access by iron stairs from the floor.

The fans and all their fittings are of rigid construction, the cases being built of $\frac{5}{16}$ in. steel plate. Special attention was also paid to the bearings, which are of the ring lubrication self-aligning type. Unusually large connections are fitted to allow of a large volume of cooling water in the jackets in case of the gases being exceptionally high in temperature when the economisers are not in use. The gases are discharged directly from the fans into two steel chimneys.

One of the most interesting features of the plant at Southwick is the oil supply system for the bearings of the turbines and generators. In many turbine stations the oil is supplied to the bearings at a comparatively high temperature, and some difficulty is experienced in keeping the bearings cool. With a view to permanently obviating this, Mr. Christie has put into operation a system of oil supply in which a constant flow to the turbines is always assured and, what is equally important, the oil is filtered and cooled. By the two last-named processes it is possible to utilise the same oil again, and Mr. Christie has succeeded in maintaining a constant circulation of oil through a practically closed system. In this respect we believe the system at Southwick to be unique, and on that account it is worthy of detailed description.

In the whole system there are about 6,000 gallons of oil constantly circulating. Situated at a height of 40 ft. above the engine-room floor are two tanks which hold about 1,500 gallons of oil each. From these tanks the oil flows by gravity to the turbine bearings, whence it falls a further 10 ft. to the level of the filters in the basement. The oil flows over weirs in these filters after passing through a number of layers of filtering cloth. The filters are so constructed that sections can be shut off for the removal of the sediment, though this is only necessary at infrequent intervals. Arrived at its lowest level the oil is forced through cooling condensers into the roof tank by pumps. The coolers are two in number and were originally in use at the North-road station when the steam plant was running there. One cooler is of 3,000 to 4,000 sq. ft. surface, and the other 2,000 sq. ft. The cooling medium is sea water, which is circulated through the condensers by centrifugal pumps driven direct by 3 H.P. motors. The oil pumps are of the three-throw type, gear-driven by motors. There is one of 8,000 gallons per hour capacity driven by a 5 H.P. motor, and two of 4,000 gallons per hour capacity, each driven by a 3 H.P. motor. The large pump is run on the day load, and one of the small ones at night. A stand-by to these pumps is provided by two Worthington steam pumps each of 5,000 gallons per hour capacity. In the adjoining illustrations the general lay-out of this plant is clearly shown. A striking testimony to the efficiency of the system is afforded by the fact that Mr. Christie has been able to add quite new oil to the old with absolute impunity when making up the small loss in the system. The original oil has been in use over six years. The temperature at which the oil enters the works is during the summer about 85°F., and in the winter about 60°F. It will leave the works at 75°F. in the summer and proportionately lower in the winter. By this comparatively simple arrangement of plant the oil cost is kept at a low figure; but what is of prime importance, the bearings are maintained in good condition, and there is practically no danger of overheating. Mr. Christie is to be complimented on the installation and operation of such a unique system. Figs. 6 and 7 are a view of the complete oil system and a near view of the oil pumps respectively.

The latest pattern of Lea recorder is installed at the station, the notch tank being placed in the basement of the engine-room near the hot well. The recording instrument is mounted on a level with the engine-room floor, where it can be easily read. The arrangement of the air-pump discharge pipe is such that the water from any one turbine can be turned through the recorder, or the total of several machines running can be measured. The apparatus, which was installed by the Lea Recorder Co., Deansgate, Manchester, has a maximum capacity of 150,000 lb. of water per hour, through a half 90 deg. V-notch. The instrument has a stroke of 9 in., and is of the indicating, recording and counting type. We understand that the instrument is

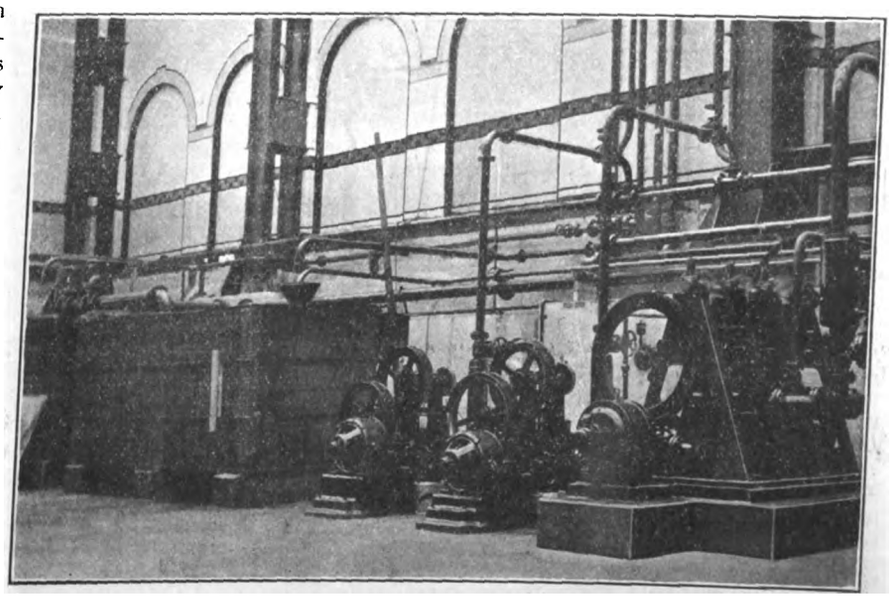

FIG. 7.—NEAR VIEW OF OIL PUMPS, WITH FILTER IN BACKGROUND.

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invaluable to the station staff in the preparation of the cost records of the running of the station.

Not the least interesting piece of work carried out in the station, and by Mr. Christie and his assistants, was the removal from the engine-room of the solenoid-operated 8,000-volt three-phase switches, which were originally installed under the operating gallery at the north end. This location was found to be unsuitable, and the whole of the machine and feeder switches have been transferred in two storeys into that portion of the building which was once a number of offices. This piece of engineering work, including as it did the rearrangement of the extra high-tension conductors and all the control leads, was carried through with complete success without a single interruption of the supply. Only those engineers who have undertaken a similar task will appreciate the difficulties encountered and the resourceful methods needed to overcome them. As at present arranged, on the cubicle system in a fireproof and damp-proof structure, the switchgear is regarded as a stable adjunct to the generating plant. The work referred to also involved the re-grouping of the control panels on the operating gallery, and the new scheme leaves the back of these panels clear of high-tension gear of any kind.

The plant at the North-road station, now used as a sub-station, comprises rotary converting plant aggregating 6,380 kw. capacity. An interior view of this station is shown

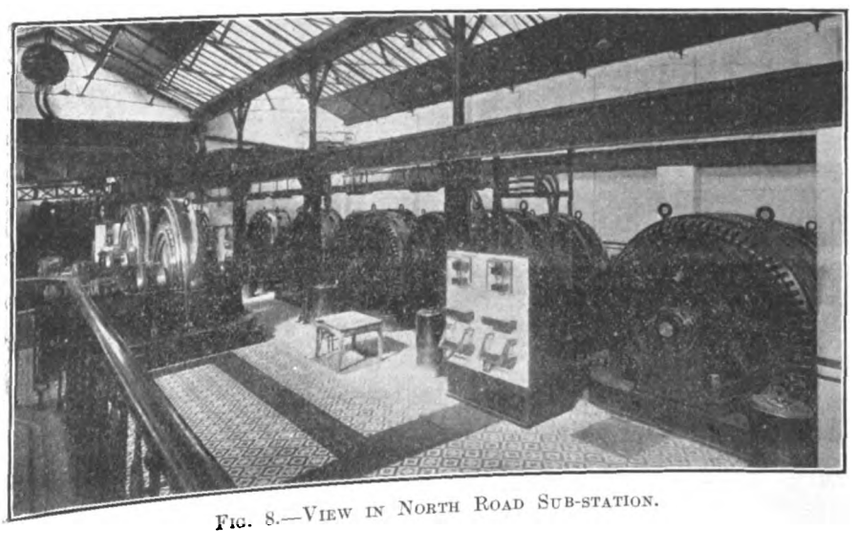

Fig. 8.—View in North Road Sub-station.

in Fig. 8. Two 1,500 kw. rotary converters are included in the plant, and the rest of the machines are induction motor-generators. The 500 kw. E.C.C. generators, which were originally driven by Willans engines, are being removed from their bed-plates in pairs and coupled to a 1,300 H.P. induction motor for use as motor-generators. Two pairs of these units have been converted in this manner.

SOME ELECTRICITY CONSUMERS OF THE BRIGHTON CORPORATION.

Although Brighton is not essentially a manufacturing centre, there are many industrial concerns in the town which require power for the operation of their machinery. The largest consumer on the network is at present the L.B. & S.C. Railway Co., who drive the whole of their railway workshops by electric power. This customer has come over gradually on to the supply by a process in which the steam engines formerly used have been superseded by electric motors. In these works the Company's locomotives are built and tested, and the machine-tool equipment is of an extensive character. A supply is given at 230 volts, the Corporation feeders being looped in and out to a large central switchboard. A considerable number of motors are installed, and these are all of the shunt-wound fixed-speed type. The majority were supplied by the General Electric Co. The driving is on both the individual and group systems. Four general sizes of motors are in use, these having an output of 5, 10, 15 and 30 H.P. The motors have been placed in the most convenient positions for belting or gearing up to the line shafting, and in the case of the latter they are bolted up to the columns supporting the roof, and the drive is by helical gear. The shops, in accordance with the practice of all railway engineering works, are fitted out with a fine equipment of electric travelling cranes. These are of the three-motor type, and in one or two cases are conversions from rope drive. The capacities range from 30 cwt. to 35 tons, and the longest span is 53 ft. 6 in. In the boiler shop there are four cranes of 40 ft. span, two of 20-ton capacity and two of 12-ton capacity. The 15-ton crane in the riveting shop runs at a height of 41 ft. from the ground, and is operated from the floor level by a tramway-type controller. In the frame shop there is a jigger crane to carry material from the well of the shop into the galleries on each side, or vice versa. In connection with this crane there is an automatic device for closing and opening the gates on the galleries to ensure that no one will walk through after the crane has passed. The cranes have been built by Messrs. Craven Bros. & Vaughan & Son, and the motors are respectively Lancashire Dynamo and Hall.

A most interesting crane is one in which a battery of accumulators is used for operating the motors. This is a 5-ton bascule crane by Craven Bros., and is illustrated in Fig. 1. The travelling motor is 8½ H.P., and is bevel-geared to the rail wheels. The hoist motor is 5¼ H.P. and the slewing motor 4 H.P. All these motors are Lancashire Dynamo, and are totally enclosed. The crane has a sweep of 17 ft. 6 in. and a lift of 14 ft. 6 in. at the long end. The battery is capable of operating the crane at full load for a period of 1 hour.

A number of large motors are in use in the works, the maximum horse-power being 70. Two Hall motors of this type are shown in Fig. 2 direct coupled to air compressors and running at 225 revs. per min. Another 70 H.P. motor drives a line shaft and another is in operation driving the deep well three-throw pumps which raise water for the works from the level of 160 ft. Another 70 H.P. motor drives a 40 in. Sirocco fan drawing off the smoke from the smiths' fires, which are of the down draught pattern. This type of fire was adopted in order to allow a clear overhead runway for the crane from the smiths' shop into the smiths' yard. A number of 30 H.P. motors are in use driving machine tools. One of these operates a 23 ft. planer, the drive being through Mitchell gear. A large set of vertical rolls in the boiler shop is driven by a motor of this size, and there are also two more of the same output operating the force pumps for the hydraulic accumulators and riveting plant. The main feeders into the works are of 1 sq. in. section, and the energy consumed for a year is in the neighbourhood of 1,500,000 units. The entire equipment is on modern lines, and engineers interested in machine-shop driving should take an opportunity of obtaining permission to view the works. We ourselves are indebted to the management for facilities to inspect the shops and take photographs, and particularly to Mr. Field for his courtesy in the supply of the foregoing particulars.

Another interesting plant is that installed in the Britannia Flour Mills, Southwick, where an old steam-drive was replaced by a number of electric motors. One machine has been erected so as to drive by ropes on to the pulley formerly driven by the steam engine. The supply is at 460 volts, and is given by the auxiliary rotary converting plant at Southwick station, which is just across the harbour. The same mains also supply the local district of Aldrington.

The Britannia Mill is the property of Messrs. C. R. Smith & Sons, and it is mainly through the foresight and enterprise of Mr. Richard Smith that the installation was carried out. The electric power plant includes two "Reform" motors, switch-

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board and control pillars. One motor with an output of 150 B.H.P. at a speed of 220 revs. per min. was required to drive the mill and wheat cleaning plants, and the other motors were installed to drive the machinery in the silo. The steam engine which ran at a speed of 64 revs. per min., was dismantled and the large motor erected in its place, the switchboard and starter being fixed alongside, thereby allowing convenient control. Fig. 3 shows this motor in position.

The water for washing the wheat is raised from a borehole below the engine-room by a three-throw ram pump driven direct from the motor shaft. To obviate extensive alterations and to bring the actual stoppage to as few days as possible, it was essential that the existing drives should be interfered with

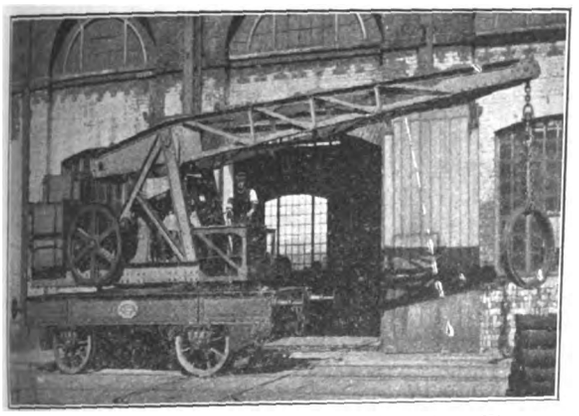

FIG. 1.—5-TON BASCULE CRANE IN L.B. & S.C. RLY. WORKS.

no more than was absolutely necessary. Thus, the large motor shaft was extended through the wall into the existing rope race of the mill where a rope pulley with third bearing was provided to receive the existing drives. The great advantage of having a separate motor for the silo is that the intake plant may be run independently of the mill.

The advantages which the use of electricity has brought about in this case are many. The storage capacity, which was previously insufficient, has now been increased by the use of the old boiler house. Considerable floor space has also been saved in the mill, as the motor requires but half of the space originally occupied by the engine alone. Speed troubles are

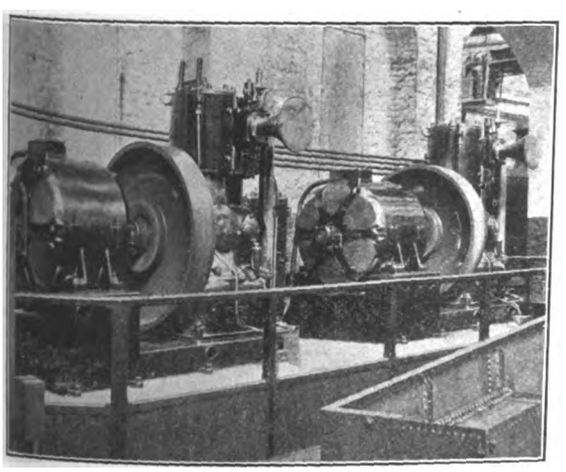

FIG. 2.—TWO 70 H.P. MOTORS DRIVING AIR COMPRESSORS, L.B. & S.C. RLY. WORKS.

a thing of the past, uniform turning motion is assured, noise is eliminated, easier starting could not be desired, and cleanliness reigns supreme. The air around the mill is no longer defiled by the smoke from the boilers, and inside the mill smut troubles have ceased. The whole of the work in connection with the installation was carried out by Henry Simon (Ltd.), Manchester, the well-known milling engineers, to whom we express our thanks for the above details.

The electricity department is always keen on opportunities for power supply. For instance, last winter the landing stage at the head of the West Pier was carried away during a gale, and the work of reconstruction is now in progress. A small machine shop has been fitted up, and the hack-saws, drills and grindstones are driven by a 10 H.P. motor. A number of portable electric drills for holes up to ⅞ in. are also used on the girders *in situ*. This equipment though small is invaluable to the engineers carrying out the work.

On the Palace Pier an important extension is in progress at the shore end. A large winter garden and pavilion is being erected, and when finished this will hold 2,000 people. The same general scheme of illuminations which are a permanent feature of the pier will be embodied in equipping this new piece of work.

The pile-driving for this extension is also being done by electric power. There is a 10 H.P. motor geared to a special winch, which is employed for the purpose of turning the head of the pile during the process of screwing it into the shingle and sand. The piles are of interest because they have enabled the extension work to be done expeditiously and with certainty, the type of pile having withstood the test of the severe gales which are experienced on the South coast.

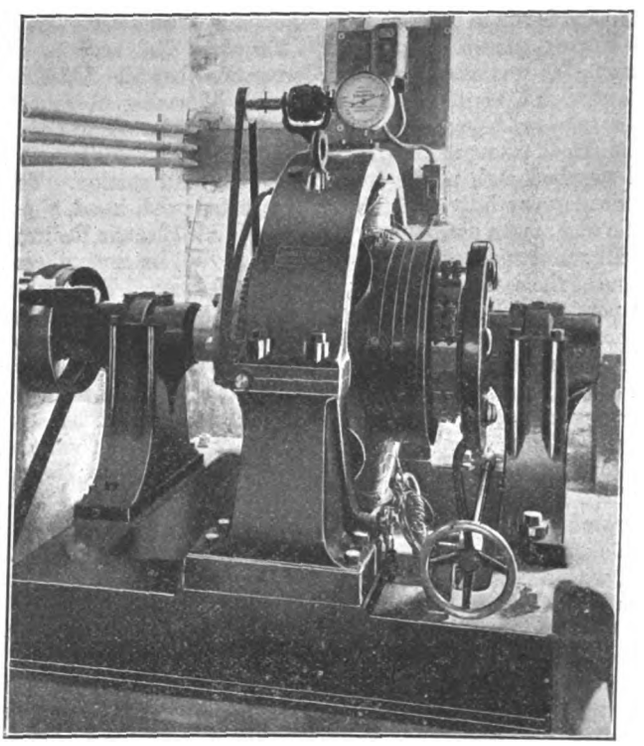

FIG. 3.—150 H.P. MOTOR DRIVING BRITANNIA FLOUR MILLS, SOUTHWICK.

At the sea end of the pier the Pavilion and Theatre have been practically remodelled. The management are most enterprising in bringing the pier well up-to-date, and have erected a spacious tea garden on the roof of the pavilion in addition to a large enclosed dining-room which overlooks the sea and is illuminated by Holophane bowls. The generally ornate design of the new building has been surmounted by minarets after the Moorish model. The entire structure is outlined by hundreds of electric lamps, and soft and pleasing effects have been produced. To encourage the use of the roof garden and add to the comfort of the public, two electric lifts have been installed on the east and west sides of the pavilion.

That the management are keenly alive to the value of electricity is shown not only by the foregoing, but more particularly by the fact that they have recently installed an electric oven and a number of large electrically-heated utensils. These are being used in the large kitchen which is needed for the extensive cuisine in connection with the dining saloon and tea garden. This apparatus is supplied from the ordinary network on the pier. It is of Prometheus manufacture, and is of the latest pattern.

For many years past the main and side streets in Brighton

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have been lighted by electric lamps. The three miles of sea front is brilliantly illuminated by as fine a row of open type arc lamps as can be seen in Europe. There are 372 arc lamps altogether, and in addition 178 public building lamps are supplied and maintained. The side street lamps are attached to the gas posts and are in lanterns of the same pattern. The original lighting was by carbon lamps, two in series on 240 volts. There are now in use 55-watt "Onewatt" lamps, burning singly at 240 volts, one in each lantern. Upwards of 2,000 posts have been fitted with these lamps. We understand that these lamps have an average efficiency of 1·25 watts per candle, and that they have proved eminently satisfactory on the score of life and ability to resist vibration. The filament of the lamp is of drawn tungsten.

Judging by the amount of illumination material which has been erected, Brighton is determined to keep up its reputation as "London-on-Sea." The Corporation have carried out an ambitious scheme in the lighting of the front, and have erected a continuous length of festoons between the arc lamp pillars. We understand that in the three miles of front some four miles of "strip" have been used. With the lamps at 1 ft. centres this means a total of 21,120 holders and lamps. Each lamp is of 5 c.p., and is run in parallel across the 230-volt network. There are feeding points about every 200 yds. The scheme of illumination was erected for the Coronation, but the I.M.E.A. delegates will be given an opportunity of seeing it, as the decorations are being left up for a month after the celebration.

The local tramways are, of course, run by the Corporation and supplied with power from the North-road station. The district is very hilly and the cars are fitted with hand, rheostatic and mechanical slipper brakes. Volk's Electric Railway is still running along the East front, and will be remembered as one of the earliest attempts at electric traction. The undersea portion at Rottingdean, over which a special elevated car ran for a time, has been disused since it was destroyed by a gale. The local motor-bus company has in service a fleet of electric omnibuses, and the battery charging plant is supplied from the ordinary network. An interesting arrangement of boosters is in use for the charging of each battery at its own voltage. Visitors will be given an opportunity of inspecting this plant.

The foregoing description gives an idea of the supply system operated by the Corporation, and will serve to show the extensive character of the electric service in Brighton. Needless to say, with a gas company supplying in the area the competition between the two systems is exceptionally keen. In fact, it accounts in no small measure for the progress which electricity has made.

In concluding this and the foregoing article we must express our thanks to Mr. Christie for the facilities which he has afforded us in collecting the information and for taking photographs at Southwick; to Mr. J. Cleary, the consumers' engineer, we are also much indebted for assistance.

LIGHT AND SHADE IN INDIRECT LIGHTING.

BY JUSTUS ECK, M.A.

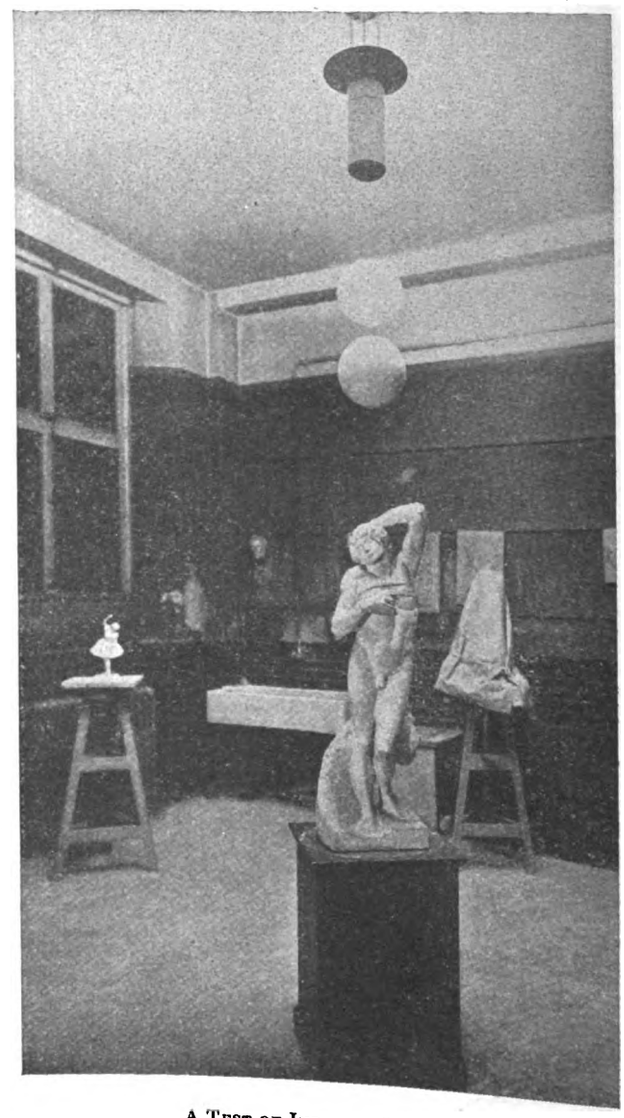
Summary.—The author controverts the view that indirect lighting gives an illumination that fails to give proper light and shade effects, and he supports his opinion by measurements taken in a room illuminated by an inverted arc lamp.

The question of the possibility or otherwise of securing correct light and shade effects in indirect lighting is at the moment receiving considerable attention from illuminating engineers.

Statements have recently been made at meetings of the Illuminating Engineering Society (London) and in the electrical press, as to the difficulty of obtaining by the use of such lighting those correct shadow values by which alone satisfactory relief can be secured, and upon the presence and correct values of which depends the ability of the eye to perceive and discriminate form, *i.e.*, to *see*.

Such statements are often dependent upon the assumption of conditions more or less impossible of attainment in practice; are rarely, if ever, accompanied by any data as to the dimensions of the rooms, the nature of the light sources, the size and type of reflector used, the colour values of the decorative scheme, or the character, colour and diffusion of the light itself, and whilst therefore very liable to prove misleading by reason of their incompleteness, are of little or no value in serious work.

In a recent article in THE ELECTRICIAN on the "Nomenclature of Primary and Secondary Sources of Light"* the author, a well-known electrical engineer, first pre-supposes abnormal conditions, thereafter proceeds to deduce results quite contrary to those usually obtained in practice, and finally, and as a result, condemns (by implication) indirect lighting as failing to give



A TEST OF INDIRECT LIGHTING.

sufficient relief and as unsuitable for the illumination of monochromatic objects, such as, for instance, statuary. The article in question possesses, however, one meritorious feature of considerable value, quite apart from its primary object, in that the author therein lays down certain definite conditions and suggests an experiment which has given rise to an investigation by the present writer which has led to results of peculiar interest to all illuminating engineers, and will doubtless stimulate research in others.

A room is assumed in which the walls, ceiling and floor all have a high-reflecting efficiency, and the statement is made that if, in the centre of that room is placed a single light source,

* THE ELECTRICIAN, May 26, 1911, p. 262.

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and below this, but protected from the direct rays, is suspended a small sphere, the latter will not to the human vision appear spherical however highly it is illuminated. It is not usually possible to place the light source in the centre of a room, *i.e.*, equi-distant between the floor and the ceiling, as well as equi-distant from the four walls; and, even were it possible, it would in practice be found exceedingly inconvenient in a room, for instance, 12 ft. high, to place the light source at a height of 6 ft. It is not usually possible to secure a sufficiently high and sufficiently even coefficient of reflection for ceiling, walls *and floor*, and it is difficult in practice to eliminate such items as pictures, doors, cupboards, &c.

Most rooms are provided with windows in one or more of the walls, which, unless provided with blinds tinted to exactly match the colouring of the walls and drawn whenever the artificial light is used, quite upset the balance of reflection, and even in those rooms in which windows are absent, and both ceiling and walls are white-washed, the reflecting value of the floor surface is usually sufficiently lower than that of the walls and ceiling to ensure the retention of the rotundity of the sphere.

Further, it will be found by anyone caring to repeat the experiment that even in a room minus windows, and in which the floor is tinted to correspond with the walls and ceiling, sufficient relief remains to render the sphere quite distinguishable visually, although under such circumstances a photographic representation cannot readily be secured; so that unless the sphere were so small as to be practically devoid of surface, or the room were itself spherical in form, it would apparently never present to the normal eye the appearance of a perfectly flat disc.

Turning now to the consideration of the question as it applies to actual installations used under normal conditions, the photograph reproduced shows the result of the suggested experiment performed in a room specially chosen because of its close approach to the assumed conditions by reason of the somewhat unusual character of its floor surface referred to later.

The room stands north-east-by-east, measures 22 ft. 9 in. by 20 ft. 2 in., and has a height of 13 ft. 8 in. from floor to ceiling. It is lighted during the day by two windows on the east side having an aggregate area of 51·6 sq. ft. and giving a ratio of window surface to floor surface of 0·112 to 1, from which it will be appreciated that the lighting is quite up to the average. The nature, colouring and surface brightness in foot-candles of the various surfaces, as measured by the Holophane Lumeter during clear bright weather at 3:30 p.m. on June 6, 1911, were as follows:—

Daylight Tests.

Position.	Nature of surface.	Surface brightness (foot-candles.)		
		Average.	Max.	Min.
Wall dado filling	A. Light brown glazed bricks	4·03	8·2	0·72
Wall above dado	B. Light greenish grey distempered plaster matt.....	4·2	5·6	2·6
Frieze and ceiling	C. White distempered plaster matt	6·2	7·8	3·6
Floor.....	D. Wood block impregnated with white pipe clay.....	5·2	4·6	4·6

The artificial lighting is carried out by means of a single inverted arc lamp, burning pure carbons and suspended in the centre of the room, the distance from the arc to the ceiling being 2 ft. 6 in. The lamp absorbs, including all circuit losses, 500 watts, and the current consumption is therefore equivalent to 1·49 watts per sq. ft. of floor area.

The surface brightness of the various surfaces measured under the artificial light at 9:30 p.m. on June 9, 1911, is given in the following table.

Below the lamp and on the same vertical centre was suspended a white cardboard disc, 9 in. in diameter, below this a white wooden sphere 9¾ in. in diameter, and finally, and still on the same vertical centre line, was placed the white plaster statue seen in the illustration. The distance from the floor to the centre of the sphere was 7 ft. 9 in., and to the centre of the disc, which was fixed at an angle to the wall containing the windows of about 73 deg., 8 ft. 8 in.

Inverted Arc Light Tests.

Position.	Nature of surface.	Surface brightness (foot-candles).		
		Average.	Max.	Min.
Wall dado filling	A. Light brown glazed bricks	4·6	5·2	3·5
Wall above dado	B. Light greenish-grey distempered plaster matt	0·87	1·4	0·63
Frieze.....	C. White distempered plaster, matt	4·4	5·2	3·8
Ceiling	C. White distempered plaster matt.....	42·0	54·0	30·0
Floor.....	Wood blocks impregnated with white pipe clay	2·4	2·6	2·2

The photograph was taken at 10:30 p.m. by the light from the arc lamp only. The difference between the disc and the sphere is most marked, and the photograph, which was exposed to show the gradation of light upon the sphere, disc and statue, and is, in consequence, under-exposed as regards the walls, which therefore appear darker than they really are, conclusively demonstrates the fallacy of supposing the light and shade effect to be lacking, or the objects illuminated to be devoid of relief.

A comparison of the surface brightness of the three objects by daylight, and the light of the arc lamp respectively is instructive as indicating the remarkably close approximation of the inverted lamp light to the daylight, as regards the creation of light and shade effects.

The readings obtained were:—

Object.	Daylight.		Inverted Arc light.	
	Highest light.	Deepest shadow.	Highest light.	Deepest shadow.
Disc	3·2	3·2	3·5	3·5
Sphere	22·0	2·3	7·6	0·78
Statue	8·32	0·72	2·1	0·22

Measurement in foot-candles.

It is interesting to note that at the particular height and angle at which the disc happened to be suspended, the surface brightness (day 3·2, night 3·5 foot-candles) is almost identical by either daylight or artificial light, and that as regards the sphere and statue, whilst the daylight illumination is greater in intensity, the ratio between the highest light and the darkest shadow remains almost constant, being for the sphere, by daylight 9·5, and by artificial light 9·7, and for the statue by daylight 11·5, and by artificial light 9·5, results which, having regard to the fact that the particular installation of which the room shown forms a part, was not designed with a view to the obtaining of any precise ratio of light and shade, but merely the provision of a satisfactory and restful artificial substitute for daylight, may be regarded as a striking testimony to the value of this system of illumination. Close inquiries among users of similar lighting for purposes in which the obtaining of correct relief and contrast is essential, and of such diverse natures as wood-carving, sculpture, clay-modelling, wood and metal engraving, drawing from casts and from life, and the designing of tiles and textile fabrics, elicit the fact that whatever may be the case with indirect illumination by other illuminants, there is with indirect lighting by inverted arc lamps no difficulty in obtaining a light which is not only sufficiently colour-true to permit of painting in oil and water-colours being carried on by night, but is also a closer approximation to daylight (as regards the light and shade ratios obtainable by its use) than anything either yet available or likely, as far as can be seen, to be forthcoming for some very considerable time.

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ELECTRICITY AND THE CORONATION.

There can be no doubt, in spite of the many grumblings to which it gives rise, that the Coronation is good for trade. This is directly due to a general desire on the part of people to see what there is to be seen, with the result that stands have to be erected for their accommodation and barriers for their protection. A feature, too, of all these celebrations is the illumination of the principal buildings and shops, a form of amusement which is directly advantageous to those engaged in electrical work.

It would be interesting to enquire when and for what reason what may be called building illumination was first started. Bonfires were, of course, used for signalling purposes, and it is not improbable that house illumination was undertaken on special occasions as an auxiliary to the rather meagre street lighting of the period. The flambeaux, which still exist at certain places, notably on the top of the Haymarket Theatre, and on several of the clubs, show what was done in the early days.

There is no doubt that the introduction of gas as an illuminant was a great incentive to the employment of decorative devices, such as crowns, stars, and mottoes, on occasions of national rejoicing, while with the more general use of electric light has come its employment for these purposes too, and the adaptation of the various devices to electrical working.

Compared with the Coronation of King Edward VII., electric lighting is being much more generally used; but apart from this there is very little novel to record. A number of places have contented themselves with erecting the Royal initials or monograms combined in some way with incandescent lamps, so that the device serves both as a day and night illumination. Others, more ambitious, are outlining the façade of their building with rows of lamps, sometimes of white alone and sometimes in red, white and blue, while in still other cases all the windows are outlined as well. In some very few cases, too, the illumination by means of incandescent lamps is combined with floral devices in such a way as to give a very pleasing effect at night. In fact, every effort has been made to make the decorations artistic, and the ease with which electric lighting may be combined with festoons, garlands, &c., has made the results in general quite successful.

Turning to particular cases, though it is perhaps rather invidious to distinguish where everything is so much the same, we may first mention the *Bank of England*. The scheme here is of interest, not only on account of its execution, but from the fact that this is the first time electricity has been used for the purpose. We understand that a sum of about £30 is being saved on the cost of lighting, extinguishing and re-lighting alone, and at the time of writing we have no doubt that the effect will be as splendid as it always has been, even though that flickering which is stated in some quarters to be so pleasing is absent. The main front of the Bank is lighted by three enormous monograms, and an equal-sized crown encircled by a wreath, these all being outlined by lamps. The façade of the building is picked out with rows of incandescent lamps, which run down the front of the columns and define the roof and sides, while on the front of the roof are a number of large glass pines supported on metal torch-shaped poles. Over 15,000 lamps are being used.

The *Royal Exchange*, where lamps are wound round the columns and lead across the portico, the *Mansion House* and the *Liverpool and Globe* office, as well as the adjacent buildings, are all artistically illuminated, and the open space in front of the Royal Exchange is sure to be the scene of a large crowd. Writing before the event we venture to say that it will form, in fact, one of the best illuminated areas.

Coming further west, one of the most novel devices is a large model of the "Olympic," which is fixed outside the office of the *White Star Line* in Cockspur-street. This model is lighted up from the inside, and shows every porthole aglow. Above it is an enormous white star, which is also electrically lighted.

The various clubs in *Pall Mall*, *St. James's-street* and *Piccadilly* have, as usual, taken this opportunity to go in for something extensive in the way of exterior illumination, though here again there is nothing very novel to be found. Initials and monograms are pretty general, and in many cases the buildings are outlined by rows of varied-coloured lights; in some cases the club's own monogram is also to be found. All the public buildings of the *London County Council* are decorated with cut-glass representations of the Royal crown and the City shield, and such symbols as "G. R.," while the Government offices content themselves with a cut crystal crown, which is placed over the main entrance, and serves both as a day and night decoration. Special mention may be made of the scheme adopted at the *Piccadilly Hotel*. The main pillars on the front of the building towards Piccadilly are coiled round with festoons of different coloured lights, while strings of lights hang between the pillars and a streamer of lights drops centrally from the festoon.

Attention may also be drawn to the scheme of lighting in *Piccadilly*. Festoons of imitation laurel are hung from the rows of Venetian masts on each side of the road, and these are combined with hanging incandescent lamps enclosed in globes of yellow uninflammable material. Every now and then these festoons are carried across the road in the same manner. These illuminations are fed from the mains of the Westminster Electricity Supply Corpn. through massive double-pole ironclad switches, which are fixed on the Venetian masts themselves, well out of the reach of the crowd. They are operated by a staff from the pavement, like the old-fashioned gas lamp.

Grosvenor Square-gardens are illuminated by incandescent lamps placed in Japanese lanterns. These are hung from the branches of the trees and are to be kept alight for 48 hours.

An unofficial scheme of illumination is to be found in *Cheapside* and *Cannon-street*, where the centrally hung flame arc lamps will, we fear, put many of the Coronation devices rather in the shade.

From the electrical engineering point of view it is gratifying to note that every possible precaution has been taken against fire risks. Permission to smoke will be very limited on the stands, and all care is to be taken to render both the electrical and gas lighted devices free from danger and tampering. Each circuit and sub-circuit in the case of electrical illuminations will be provided with double-pole fuses of suitable capacity, and the City Corporation recommend that the current in the sub-circuits should not exceed 10 amperes, while a similar restriction is imposed by the London County Council. Earthing of non-current carrying parts is recommended, while the temporary circuits should be connected direct to the main house switch to avoid overloading the house circuits.

A casual glance round the decorations at the time of writing shows that electricity is being much more used than on the previous occasion; and it will, therefore, be of interest to know how the increased demand is likely to affect the ordinary load on the stations. As regards the City, we understand that the only difference will be that the time of peak may be shifted on a little and lengthened out, but the winter demand is not likely to be greatly exceeded; for there will, of course, be no office or shop lighting, and thus a very considerable ordinary item will be removed.

In the West End matters are likely to be more serious, and every precaution is being taken to cope with a large demand. Unfortunately, some of the stations are pretty well loaded as it is, and benefits which would be conferred by linking up cannot be taken advantage of.

In conclusion, if a daylight view is anything to go by, the illuminations on the occasion of the Coronation of King George V. should be worth going a long way to see, and London for two nights, at any rate, should be turned into a "city of blazing light."

Accumulator Cars on Long Island Railway.—According to the "Electric Railway Journal," the Long Island Railroad has placed a single-truck storage-battery car in regular operation on its Bushwick branch to replace the steam trains. The car runs between Bushwick and Bushwick Junction, a distance of 3½ miles, and makes seven round trips.

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CHEAPENING SERVICES FOR ELECTRICITY SUPPLY, WITH SPECIAL REFERENCE TO THREE-WIRE CONTINUOUS CURRENT WORK.

BY W. A. VIGNOLES.

Summary.—The cost of the different items that are comprised in a "service" is discussed in detail. Particulars are given of mains boxes that have been found suitable, the question of using one service for several houses is considered, and the author finally gives detailed costs of services at Grimsby.

The Effect of the Metal Filament Lamp.—The question of the cost of services is one that has been brought very forcibly to the notice of central-station engineers by the introduction of the metal filament lamp, as the small current consumed results in a reduction in the revenue from a given number of lamps and consequently per service. The situation is still further aggravated by the large increase in the number of small consumers; electric light is now so cheap that the smaller consumer is coming on to the mains very rapidly, and it is no uncommon thing for the writer to receive applications from small shops requiring only three or four lights.

The question is, how to reduce the cost of services so that these very small consumers may be supplied at a profit. In this connection prepayment meters have to be considered, as in many of these small shops the tenants change very frequently, and there may be a large percentage of bad debts unless the accounts are looked after very closely.

The Ideal Service.—At first sight the problem of a cheap service seems to be very simple, and it is possible, on paper, to lay services at a cost of 30s. each; but this figure is difficult to realise unless the distributors are laid under the footpaths close to the buildings and the meters fixed in the buildings near the street.

In practice many difficulties arise which prevent this ideal being attained except in a small proportion of cases; houses may stand back from the road, while there is frequently no convenient place for the meter near the street, or the consumer has some objection to the only possible position.

Under the Electric Lighting Acts the consumer can be asked to pay for all service cable laid on private property, but in the face of strong gas opposition this can very rarely be enforced. On the other hand, it is impossible to fix the meter exactly where every consumer would like to have it, as the cost would be prohibitive. To meet the consumer as fairly as possible, it is the rule at Grimsby to supply 40 ft. of service cable, outside the building, free of charge, and to fix the meter in a reasonable position in the building as close to the outside wall as possible. If the house stands further back from the road than 40 ft., or the consumer wants the meter fixed in some special position, the extra length of service cable is charged at cost.

Distributors on Each side of the Road.—Laying distributor cables on each side of the road reduces the cost of services, but increases the cost of mains, as two cables cost more than one of twice the section, while the length of ground to be opened and reinstated is doubled. In streets where there are detached houses standing in their own grounds, and consequently comparatively few houses per mile of street, it is probably more economical in many cases to lay the distributor on one side of the road only, in spite of the extra cost of long services across the road to half the houses. This extra cost is considerable, owing to the great expense of taking up the macadam or other road surface. In most streets two distributors will be more economical in the long run, although expensive at first.

Size of Service Cable.—If a service is only required for supplying electricity for lighting, the determining factor in deciding upon the size of cable will for most small houses be the mechanical strength. Metal filament lamps take such a small current at 230 volts that a cable merely large enough to carry the current may be too small to handle and lay underground in a satisfactory manner.

The question of cooking and heating by electricity has during the last two years forced itself upon the writer's attention, and owing to the large number of applications received for heaters and cookers, it has been decided to lay every service with a cable large enough to deal with the probable requirements in this direction even if no demand for heating is made when the service is first put in.

Two-way double-pole fuse boxes (four fuses) are fixed in houses where lighting and heating are both in use, so that the two circuits can be kept quite distinct with their own meters and main fuses. During the last 12 months 30 single-way boxes had to be changed for the two-way, and now, whenever a service is put into a house of a certain size, a double-way fuse box is put in as a matter of course. It will be obvious that these features increase the cost of the services, but the writer is confident that the right course to adopt is to endeavour to persuade everyone to use electricity for heating and cooking; it is not policy to cut the cost of every service to the lowest possible limit by putting in only such material as is absolutely necessary to deal with the first requirements of the consumer.

While, therefore, a very cheap service is required for cases of small shop lighting, the usual problem is to provide a service of sufficient capacity to deal with both lighting and heating for houses standing back fr the road where the length of cable required is frequently 40 ft. or 50 ft.

Cost of Service.—The cost of the ordinary service is made up of the following items, including labour in each case:—

1. Mains box.
2. Service cable.
3. Fuse box in house.
4. Meter.

Mains Box.

The cost of the mains box depends very largely on the type of distributor and service cable used. It is probably most expensive when arranged for triple-concentric distributors and concentric services; this is due to the necessity of cutting the outer and middle conductors of the T.C.C. and then making them continuous again. The most satisfactory way of doing this is to use cone or other mechanical grip connectors on the four ends of these conductors, coupling them together by means of links. A box of this character runs into money, but the cost may be minimised by arranging the box to take two services. In a fair proportion of cases the second service is used, and the cost of this second connection to the main is then very trifling. A box of this type is used by the writer and is shown in Fig. 1; it costs just under £1 with all fittings for distributor and two service cables.

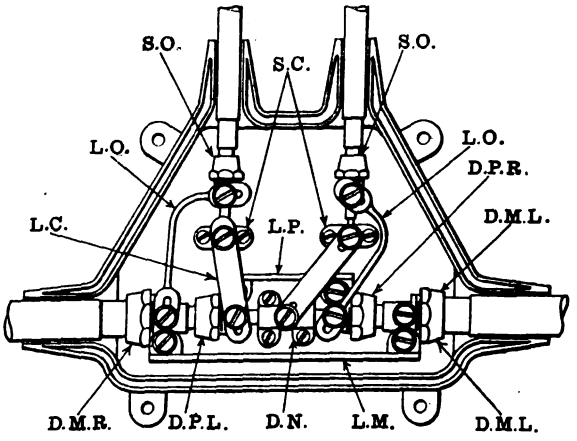

Fig. 1.—Double-Service Box for Triple-Concentric Cable.
Scale: 2 in. = 1 ft.

These boxes are made of cast iron, and were originally provided with screwed gun-metal glands on to which the lead of the cable was wiped; considerable trouble was experienced in keeping the glands watertight at the junction with the box, and after making careful experiments it was found to be quite possible to make a wiped joint between the lead of the cable and a boss or gland cast upon the *iron* box. This has been

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found to be a great improvement, and has done away with the breakdowns due to faulty glands besides reducing the cost of the box. This type of box has to be made with a removable lid, to allow the second service to be introduced when necessary. This is a disadvantage, as it is very difficult to make such a joint perfectly watertight.

Box for Street Lighting Service.—The writer has recently had to run a large number of services for public incandescent lamps, and owing to the small revenue from each lamp the cost of each service had to be cut down to a minimum. For the lamps connected to triple-concentric distributors, the box shown at Fig. 2 was designed; all the lamps on this class of

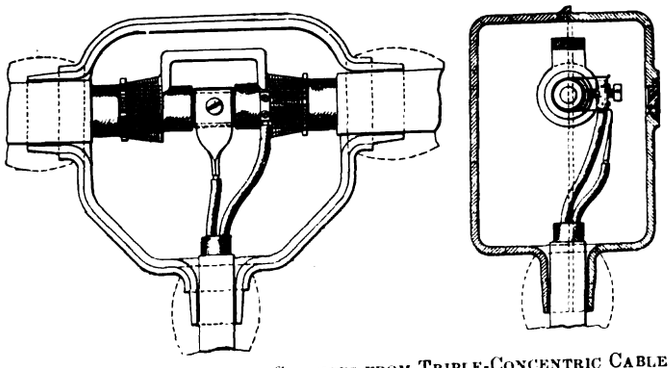

FIG. 2.—BOX FOR POSITIVE SERVICES FROM TRIPLE-CONCENTRIC CABLE

cable were connected to the positive side of the system (balance being obtained by connecting the lamps on three-core cable to the negative) so that it was necessary to cut the outer conductor only, the middle being simply bared to receive the connection; the inner conductor or core was, of course, not touched. The current required for each service is small, and sufficient contact is made by the copper strip nipped up on to the middle conductor with a Prescot fitting, without damaging the paper insulation underneath. The joints on to the outer fitting are made by binding the wires to the fitting and sweating; these joints have to carry the full current flowing along the main, so that they must be well made.

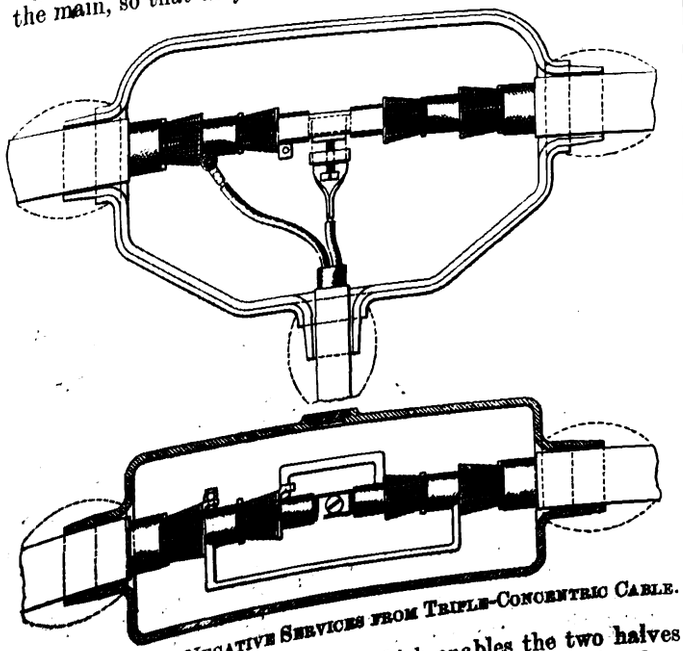

FIG. 3.—BOX FOR NEGATIVE SERVICES FROM TRIPLE-CONCENTRIC CABLE.

The box itself is of cast lead, which enables the two halves of the box to be sealed by soldering: this is much safer than any joint that can be made between the lid and the box where cast iron is used. Twin service cable is used connected direct to the fittings on the distributor, doing away with the fittings on the service cable. This box, with fittings, costs 5s. 6d.

It has been found by experiment that 30 to 50 amperes can be taken through this joint without heating, so that in future this box will be used for all services from the positive for not more than 20 or 30 amperes. (At Grimsby the core of the T.C.C. is negative and the outer is the middle wire.)

Lead Box for T.C.C. Work.—The box shown in Fig. 3 has been designed for negative services on triple concentric cable; the service cable would be twin and service connections would have to be capable of carrying 20 amperes at least. The cost of this box is about 6s. 6d.

Box for Three-Core Distributor.—With three-core distributors it is not necessary to cut any of the conductors; connections can be made by a Prescot form of fitting with a copper strip, as previously described. The box can therefore be considerably smaller than on triple-concentric cable, whilst the cost is also reduced by the reduction in the number of fittings. Fig. 4 shows the standard box of this type used with concentric service. The cost is 7s. 3d., while if the twin service is used, the cost is reduced to 5s. 6d. as no fittings are required for the ends of the service cable.

Twin Service Cable.—It is cheaper to use twin service cable in most cases, as, although it costs about 10 per cent. more than concentric, there is the saving in the mains box as mentioned above, and a further saving of about 9d. in the fittings in the fuse box, while labour in jointing is also less. The service would have to be a considerable length before the saving would be neutralised by the extra cost of cable, as this in the most usual cases would only be about 1d. per yard.

Fuse Boxes.—The writer is using a simple form of double-pole box for concentric services which can now be obtained at about 3s. 6d. The two-way double-pole box (four fuses) costs about twice the above. For twin cable the cost of the box is

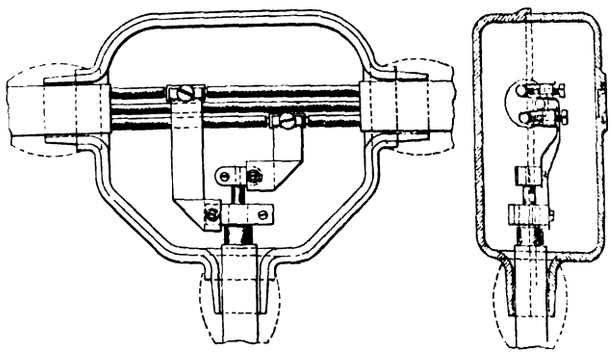

FIG. 4.—BOX FOR CONCENTRIC SERVICE FROM THREE-CORE.

reduced to 2s. 9d., as there are no fittings required. A smaller box suitable for 5 amperes and costing 2s. 6d. is used on the twin services for public lamps.

METERS.

For continuous current work the choice of a meter lies between:—

1. Electrolytic.
2. Commutator motor meter.
3. Mercury bath motor meter.

The electrolytic is the cheapest, but it suffers from the grave disadvantage that the reading is destroyed when the meter is re-set. Therefore, in case of a subsequent dispute, there is considerable difficulty in persuading the consumer that he has used the energy charged for.

The Reason Mfg. Co. have on the market a very neat combination of fuse box and electrolytic meter in one cast-iron case, which is very useful for small services, the meter reads to 100 units, and the whole arrangement is cheap and effective.

It is not necessary to discuss the merits and demerits of the various types of meter in a Paper on cheap services; each engineer must select the type he thinks most suited for his purpose, but the question of prepayment meters must be touched on, as this has to be considered when dealing with supply to small consumers.

Prepayment meters are useful in two ways, as a safeguard against bad debts and in simplifying the clerical work. The cost of a reliable prepayment meter is unfortunately somewhat

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high, while the cost of emptying meters may be quite appreciable when they are first adopted, as the distance between one meter and the next will be considerable; this latter feature will, however, be of less importance as the number of meters in use increases.

The writer understands that in most towns where prepayment meters are in use they are set at a higher rate per unit than the ordinary price in the town. This is what is done by gas companies, but in their case free fittings are usually included, and it is difficult to show logically why the consumer using a prepayment meter should pay more for electricity than the ordinary consumer unless he receives some such special advantages. If he gets nothing more than the ordinary consumer but pays cash in advance, he should, if anything, receive a discount.

In Grimsby the ordinary charge is 3¾d. per unit with 1s. per quarter meter rent, while prepayment meters are set at 3d. For every shilling taken from the prepayment meters 2d. is returned to the consumer provided he is not in arrears on any account, so that the net price is about 4d. per unit without meter rent.

The electricity prepayment meter is a vastly different problem from the gas prepayment meter, owing to the small amount of power that can be used for working the mechanism, and it has taken a good many years' work on the part of the makers to produce a reliable type. The writer is using two different makes both of which are satisfactory, while there are several other types on the market that seem very promising but which he has not yet tried.

Cost of Complete Service.

The following figures show the average cost for the 296 services for street lighting which the writer has run in the last nine months:—

	s.	d.	£	s.	d.
Double-pole fuse-box in post	2	6			
Main-boxes and fittings	5	4			
Cable roughing, &c., average length of cable, 11½ ft.	7	4			
Total for materials			0	15	2
All labour except labour in reinstatements and inserting jointing	11	0			
Labour and materials			1	6	2
Reinstatement of roads and pavements carried out by borough surveyor's department, including reinstatement of ground after gas lamp was removed	5	9			
Total cost per service			£1	11	11

Labour and reinstatement are heavier than if the same number of services had been run to private houses, as the whole of the service is laid in the public streets under the pavements or roadway, and the cost of reinstatement after the removal of the gas lamps is also included. On the other hand, owing to the large number that had to be dealt with, it was possible to proceed in a very systematic manner, and this will have tended to keep down the cost of labour.

The cost of ordinary services varies very considerably, and depends on the special conditions of each job, but the writer's experience is that under normal conditions, using a fuse-box costing 4s. 9d. (which is the price paid until recently) and concentric service cable to three core distributor, the cost works out at about £1. 18s.

By using the cheaper fuse-box and twin service cable, the cost of the service, including meter on three-core distributors, would be reduced to £1. 14s. 3d., and using the box shown in Fig. 3 the cost of a negative service on T.C.C. distributors would be about 1s. more. This figure will represent the minimum, and not the average, cost of a number; the latter will be determined by the proportion of long services and services with two-way fuse-boxes.

Several Houses on One Service.—Eighteen months ago the writer considered very carefully the running of one service for a row of houses, as it was felt that unless something drastic of this sort were done, the cost per service would never be reduced to the limits desired. The idea was carried out in one row of semi-detached cottages by running a service into one house and looping from the fuse-box in this to the fuse-boxes in the other cottages. The result was satisfactory and considerably cheaper than separate services, working out at 30s. per cottage, notwithstanding that these stood 42 ft. back from the road and a long length of cable was required for the loop (underground) between the detached pairs of cottages.

The same idea was considered for terraces, but there are difficulties in the way of carrying it out. In the first place it is a question how many houses should be connected to one service in view of the demand arising for heating and cooking, while there is great difficulty in finding a suitable position for the looping cable between the houses.

After carefully reviewing the whole position it was decided to abandon the idea of putting a whole row on to one service, but to arrange one service wherever possible to serve a pair of houses. The houses in the terraces in Grimsby are all right and left handed, so that a meter fixed, say, under the stairs on the party wall is only separated by a few inches of brickwork from a meter in the corresponding position in the house next door. The arrangement, therefore, is to run a service into one house, and loop from the fuse-box through the wall to the box in the next house by a foot or two of twin cable.

During the last 12 months out of 213 services 30 have been "looped" in this way, the average cost of the "looped" service (without the original) working out at £1. 6s. 10d., the individual costs of these varying from £1. 14s. to about 14s., depending on the special conditions to be dealt with. No particular difficulties have been experienced with this method; where new houses are erected and services are put in before the houses are taken, the work is done in this manner as a matter of course, but in nearly all cases permission to loop from an existing box has been readily given when asked for.

The advantages of this system are:—

1. Reduced cost.
2. No opening or reinstatement of street.
3. Less time required to connect up, and therefore main disconnected for a shorter period.
4. Less inconvenience to the consumer; the work can all be done in two or three hours.

The only disadvantage is that the principal service has sometimes to be a little longer in order to make it suitable for looping.

The general effect of the efforts at reducing the average cost of services is well shown by the figures tabulated below. From these it will be seen that in four years the cost per service has been reduced about 25 per cent., and it is hoped to reduce the cost still further by using a larger proportion of looped services, and the boxes shown in Figs. 2 and 3.

Grimsby Electricity Department.

Cost of Services.

Year.	Labour. £	s.	d.	Materials. £	s.	d.	Reinstatement. s.	d.	Total cost. £.	s.	d.
1906-7 ...	1	8	9	2	5	10	5	3	3	19	10
1907-8 ...	1	3	7	2	8	1	4	4½	3	16	0½
1908-9 ...	1	1	3	2	2	6	4	2½	3	7	11½
1909-10 ...	1	2	0	1	19	1	1	10½	3	2	11½
1910-11 ...	1	1	10	1	15	3	2	8½	2	19	9½

Mileage of Block Signals in the United States.—The Interstate Commerce Commission in the United States has issued a bulletin giving statistics of block signals in use on the steam and electric railways in the United States on January 1, 1911. Only those electric railways which are engaged in interstate commerce and are equipped with automatic absolute block signals are included in the tables. The total length of railways worked under the block system was 71,269 miles, an increase in one year of 5,511 miles. Of this amount 17,711 miles were equipped with automatic block signals. The increase in the mileage on which automatic block signals were used was 3,474 miles. Telephones were used for train dispatching on 41,717 miles of road, an increase of 17,373 miles during the year.

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With "THE ELECTRICIAN" for Sept. 14, 1906, was issued the first of a series of "Industrial Supplements," to be published from time to time with "THE ELECTRICIAN." The fifty-third issue of the Supplement published (Gratis) with the number of "THE ELECTRICIAN" for September 23, 1910, was the last of the monthly issues. "THE COMMERCIAL AND INDUSTRIAL SUPPLEMENT" to "THE ELECTRICIAN" is now issued weekly (Gratis). It will be found towards the end of the present issue.

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ACCIDENTS IN FACTORIES AND WORKSHOPS.

A certain loss of life and limb seems almost the inevitable penalty of industrial work in factories, and although employers may do everything in their power to protect their workmen, the number of accidents must still largely depend on the care exercised by employees and the extent to which certain rules are observed. This is particularly the case where electrical machinery and apparatus are concerned. The accident roll in this country is heavy, but it compares very favourably with that in other countries, due largely to the greater attention that is here paid to render apparatus used by both skilled and unskilled labour "fool-proof," that is to say, in protecting the workman as far as possible from the penalties of negligence or wilful disregard of regulations. The recently issued annual report of Dr. B. A. WHITELEGGE, H.M. Chief Inspector of Factories, shows that 129,550 accidents in factories and workshops were reported last year. When the accident roll in the mining industry is added to this, the total appears stupendous; but, fortunately, only a very small percentage of the accidents terminate fatally. The number of accidents in factories mentioned above includes only 1,080 in which fatal results followed, both figures showing an increase over those of the two previous years, largely, if not wholly, due to improved trade and more employment. It is satisfactory, moreover, to notice that whilst the total number of accidents in 1910 is 4 per cent. greater than in 1907, the number of fatalities is 9 per cent. less. In view of the present tendency to make more and more use of machinery, no striking reduction is to be looked for in the total number of accidents reported.

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any rate in the near future, but greater attention to fencing round machinery and to improvements in design of apparatus should reduce the proportion of accidents to the number of persons employed. On the other hand, the tendency of recent legislation to place greater responsibility on the employer may possibly have a counteracting effect.

If we turn our attention to electrical accidents, the record set out in the sectional report of Mr. G. Scott Ram, H.M. Electrical Inspector of Factories, is in one respect by no means unsatisfactory. In fact, in view of the enormous increase in the use of electrical apparatus during the last four years, the figures for 1910 compare, we think, very favourably with those for 1907. Thus, whilst last year 276 electrical accidents occurred in factories other than electrical stations, the number in 1907 was 258, whilst the number of fatal accidents has decreased from eight to five during the same period. A decrease has also taken place in the number of electrical accidents in generating stations and sub-stations. Improvements in the design of apparatus are undoubtedly largely responsible for the smaller percentage of accidents, although, of course, it is practically impossible to do more than estimate to what extent there is greater freedom from accidents, since the increasing use of electric motive power in factories can only be roughly ascertained. In this connection reference may well be made to our annual statistics giving the horse-power of motors connected to public supply mains. Much credit for the improved position must also be given to the efforts of the Home Office to ensure that electrical installations in factories shall attain at least to a certain standard of safety. The Regulations issued by the Home Office in 1909 and the subsequent Memorandum of Mr. Ram have done much to bring about an improved state of affairs; but in view of the fact that many owners of factories understand little or nothing about electrical apparatus, so that they are unable to say in what respect their plant fails to comply with the Regulations, progress must naturally be slow. In fact, a large proportion of the occupiers await instructions from the Inspector before taking any steps whatever to comply with the Regulations. Notwithstanding the delay thereby introduced, much good work has so far been done in removing obvious defects, such as bare conductors, unprotected fuses, &c. The difficulty involved, however, in bringing about the alterations desired is obvious from the fact that even electrical engineers themselves have not in many cases realised all that is implied in the Regulations, whilst some actually even admit not having seen them. Moreover, it is not only old installations that are involved, since some recent work does not comply with the requirements.

Although, as shown above, the record of electrical accidents is in one respect satisfactory, closer investigation shows that a large proportion of the accidents can be classed as preventable. Thus of 276 accidents in factories other than generating stations, 20 resulted from the use of flexible wires the covering of which was worn out or damaged, whilst 48 accidents occurred with switches—in nearly all cases due to bad design—and 24 with unsuitable plug connectors. Improvements in design take some time to bring about, but manufacturers are now paying much more attention to the various features to be guarded against, and in this connection Mr. Ram has rendered valuable assistance by the suggestions in this and previous reports, many of such suggestions having been acted upon. Moreover, the list of accidents might easily be reduced by nearly 20 per cent. if steps were taken to prevent unnecessary work being done on "live" switchboards, &c. Such work accounted for 51 accidents last year, skilled persons being concerned in two-thirds of the cases. As Mr. Ram points out, there is rarely any reason in the case of factories why any such work as may be necessary should not be carried out when the installation is "dead."

One of the most striking features of the fatal electrical accidents last year is that nearly half of them occurred on circuits at pressures which are usually considered not particularly dangerous. Thus of the nine fatalities, it is believed that the shock received in four cases was at from 200 to 250 volts. We think that particular attention should be called to this fact, since "low-pressure" circuits are not always treated with the respect that is their due under certain conditions. It is also interesting to notice that although most accidents, generally burns, occur with continuous current, alternating current is responsible for eight of the nine fatalities.

NOTES ON FUEL ECONOMY.

BY C. E. C. SHAWFIELD.

Summary.—The author emphasises the importance of calculating what the efficiency of any given station should be and then carrying out tests to ensure the efficiency approaching this figure. Notes are given on the working of engine-room plant, more particularly steam turbines, and the working of the boiler house. In conclusion, the author recommends a bonus scheme for the boiler-house staff, based on the evaporation of water per pound of fuel.

The power-house equipment of every central station may be divided broadly under two headings—viz., Engine Room and Boiler House. In the latter the object to be attained is the production of steam with the minimum expenditure of heat units, and in the former the production of electrical energy with the minimum weight of steam. Unfortunately, however, the path from the coal pile to the 'bus bars is of such a devious character and offers so many avenues of escape that comparatively few of the heat units contained in the fuel arrive at their destination in a saleable form. It must be admitted at the outset that the ideal efficiency of 100 per cent. is somewhat beyond the limits of practical endeavour; but, nevertheless, it is probable that there are but few power stations where the actual efficiency attained is within an appreciable percentage of the best result which is commercially possible.

It is rather instructive to determine by a few simple calculations what should be the best all-round efficiency of any central station as expressed in pounds of fuel consumed per unit generated, and it will frequently be found that the discrepancy between this calculated figure and the average daily working result is a good deal larger than it ought to be.

The following data are usually available in any central station, and are practically all that are required to form the basis for interesting and useful investigations:—

1. The test-bed efficiency of each generating set in the station at half, three-quarters and full load, expressed in pounds of steam per kilowatt-hour. This figure must include all steam used for auxiliaries.

2. The load curve of an average day at different seasons of the year.

3. The efficiency of each boiler, or class of boiler, installed in the boiler house, expressed in pounds of water evaporated from "feed" to steam per pound of fuel fired. These boiler

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efficiencies should represent the result obtained under the best conditions: that is, with the boiler clean and in good condition, all brickwork and settings sound and air tight, and assuming careful firing and steady load.

From these data there may be deduced certain standards of efficiency which represent the best results that it is possible to obtain from the plant installed in the engine room and boiler house respectively.

In the engine room the result should be expressed as pounds of steam consumed per kilowatt-hour generated, and in the case of the boiler house as pounds of water evaporated from feed to steam per pound of fuel consumed. These two results, of course, suggest a third—viz., the fuel consumption per unit generated. The figures obtained in this manner will, of course, vary very greatly in different stations under different conditions of generating plant, load factor and output; but, nevertheless, it will be found that practically every station has a certain "best possible performance" which may be determined from data readily obtainable, with a reasonable degree of accuracy, and these standards once determined are of considerable assistance in tracing and eliminating many sources of loss.

Let it be assumed that the calculations previously referred to have been made, and that certain values have been arrived at which may be, for a fairly average case, as follows:—

1. *Engine Room.*—A mean consumption of 24 lb. of steam per kilowatt-hour throughout the 24 hours under the average conditions of steam pressure, steam temperature, vacuum and load.

2. *Boiler House.*—A mean evaporation of 8 lb. of water from feed to steam per pound of fuel consumed.

3. *Deduced from* 1 *and* 2.—An average consumption of 3 lb. of coal per kilowatt-hour generated through the 24 hours.

In making the above calculations it will be assumed that the supplies of fuel are fairly uniform in their calorific value and in the percentage of moisture and ash contained.

It now becomes necessary to conduct a series of further investigations to ascertain to what extent the actual results obtained compare with the calculated standards, and it is here that the real difficulties are encountered. In the great majority of power stations the consumption of fuel is measured daily or weekly (usually the latter), and compared with the corresponding output of units at the 'bus bars, and a figure is thus obtained which gives the fuel consumption per kilowatt-hour generated. Unfortunately, however, there are but few cases in which it is known with any degree of accuracy what is the mean steam consumption per unit generated, or the average evaporation of water per pound of fuel burnt, and it is precisely these records which are the most valuable when the question of fuel economy is under consideration.

The Engine Room.

In the case of those stations which run under non-condensing conditions, or where the generating sets exhaust into condensers of the jet or ejector type, there are certain obvious difficulties in obtaining anything like a continuous record either of the steam consumption of individual sets or of the total steam consumption of the station. Nevertheless, there are two methods in which this may be done with a fair approximation to accuracy. One method is the insertion of steam meters of the disc type in the branch steam pipe to each generating set; the other is by passing the whole of the feed water to the boilers through some form of meter or recorder which gives a continuous diagram on a chart.

If the former method—that is the use of steam meters—is adopted, it is fairly easy to obtain a continuous record of the performances of the individual generating sets; but some time and trouble is necessary to combine the individual records in order to ascertain the performances of the engine-room plant as a whole, and the risk of error is considerably increased. Since, however, the mean performance of the engine-room plant as a whole is of more importance than the individual performance of any set, better results could probably be obtained from continuous measurements of feed water to the boilers. If this method be adopted it is necessary to see that a constant level is maintained in the suction tank or hot well which supplies the feed pumps, and also that the water in the boilers is maintained accurately at a constant level. If these precautions are adopted the feed input to the boilers will correspond within certain definite limits to the steam output to the engine stop valves, the inevitable discrepancy being accounted for by loss of water through the boiler blow-offs, through condensation in the steam range, and also by loss of steam through the boiler safety valves.

If, as is frequently the case, the whole of the generating sets exhaust into surface condensers, the obtaining of continuous records, either of individual sets or of the total consumption of the engine-room plant, becomes a very simple matter indeed, and the installation of recorders of the "V" or square notch type will prove to be a very sound investment.

If possible, arrangements should be made for separate measurements to be taken of the steam which has been usefully employed (that is, which has passed through the prime movers and returned through the condensers), and of the steam which is wasted by condensation in the steam range, separators, &c., and which is returned by the traps. The make-up water required by the boilers may also be included under this latter heading.

If it has been possible to obtain a continuous record in the form of a diagram of the steam consumption of the generating sets on any particular day, it is a simple matter to obtain by

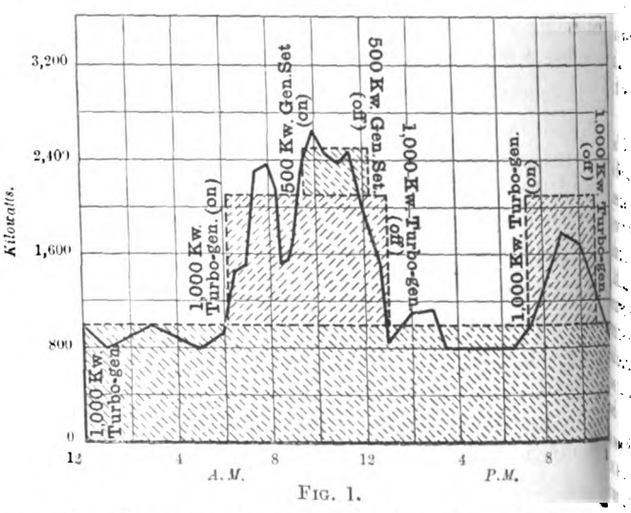

Fig. 1.

integration the average consumption throughout the 24 hours and also the actual consumption per hour at any period of the day. The average consumption throughout the 24 hours can be calculated and some of the causes of any excess consumption may be ascertained by a careful inspection of the diagram itself. For example, if at any particular hour of the day the actual recorded consumption of steam per kilowatt-hour generated is considerably in excess of the calculated standard it may be assumed that the set or sets in service at that time are consuming very much more steam than they should be at that particular load, or that the relation of generating sets to load—that is, plant load factor—is not the best that can be obtained. If the former supposition should prove to be correct then the obvious remedy is to overhaul the generating sets and their auxiliaries. If, however, the latter assumption is found to be true, then the overhaul is equally necessary in the case of the shift engineers and the running staff.

The plant load factor has an extremely important bearing upon the question of fuel economy, and a difference of from 5 to 10 per cent. in fuel consumption may readily be occasioned by good or bad arrangement of the apportionment of plant load. A useful method of checking the abilities of the running staff in this direction is to have plotted on the daily load curve a diagrammatic representation of the amount of engine-room plant in service each hour of the day. An example of such a combined load curve and diagram is shown in Fig. 1.

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In cases where any excessive steam consumption is traced to any particular generating set or sets, indicator diagrams should be taken at various loads and then compared with the original diagrams taken by the makers at the official test. An inspection of these will frequently indicate the cause of the trouble. In reciprocating engines of the high-speed vertical type, the excess steam consumption is often due to wear at the piston valves and rings, or to badly fitting or defective high-pressure piston rings. Inaccurate valve setting is sometimes another source of trouble, although the existence of defects of this description should be apparent on an inspection of the indicator diagram.

In the case of steam turbines the following principal causes of high steam consumption may be looked for :—

1. *Blade Stripping.*—Fortunately at the present day cases of blade stripping appear to be less frequent than they were a few years ago, due, no doubt, to the fact that the operation of turbines is somewhat better understood than was formerly the case, and to experience having shown what precautions are necessary to prevent this annoying class of breakdown. Nevertheless, it is quite possible at any time that a partial strip may occur at the high-pressure end of the turbine without giving any external evidence, and several cases have occurred where it was only when the turbine had been opened up that the discovery was made that a more or less complete strip had occurred on several rows of the high-pressure blading.

In the case of turbines of the reaction type, which are more subject to trouble of this description, it will usually be found that the stripping of two or three rows of the high-pressure blades results in a lower steam chest pressure throughout the whole range of load, and this is an indication which should be looked for should it be suspected that a partial strip has occurred.

2. *Excessive Radial Clearance owing to the wearing away of Blade Tips or Blade Shrouding.*—This is a defect which sometimes arises from unequal heating of the rotor when starting up, resulting in the rotor becoming temporarily distorted and bringing the blade shrouding or blade tips in contact with the shaft and casing. Although very little actual damage may be occasioned by an occurrence of this kind, yet sufficient metal may be removed from the shrouding or blade tips to increase appreciably the radial clearance, with the natural consequence that the steam losses through leakage past the blading are considerably increased.

3. *Steam Leakage round the Dummy Pistons.*—This is probably one of the most usual sources of loss in steam turbines after they have been running for a year or two, and the presence of this defect, as a rule, can only be clearly established by careful measurement of the actual clearances. Fortunately, it is usually easily remedied by readjustment.

4. *The Partial Choking up of Rows of Blades by the Deposition of Mud carried over by the Steam.*—This condition of things is apparently caused by the carrying over of mineral matter which is held in suspension by the steam, and is gradually deposited on the low-pressure blading. As a rule this deposition does not occur until after the steam has expanded down to atmospheric pressure or below, but once it has commenced the low-pressure blading of the rotor and the casing becomes covered with a fairly hard chocolate coloured mud, until sometimes entire sections of blading are almost completely choked up. The first symptoms of this species of defect are a falling off in the rated capacity of the turbine, together with an appreciable increase in the steam consumption, and the only remedy is a somewhat tedious process of cleaning each individual blade by means of scrapers and compressed air blast. As a means of preventing trouble of this description, care should be taken to see that the concentration of mineral matter in the water contents of the boilers is kept at a reasonably low figure.

It is not very often that excessive steam consumption is due to the auxiliary appliances in the case of reciprocating engines, this type of prime mover is much less affected by variations in vacuum than is the case with the steam turbine; and, indeed, it is very doubtful whether, in the interests of economy, it is advisable to attempt to obtain a higher vacuum than 24 in. to 25 in. in the case of reciprocating engines. Beyond this point very little decrease of steam consumption is effected, whilst any little saving there might be is more than counterbalanced by the lower temperature of the water of condensation, and by the additional power absorbed by the auxiliaries.

So far as steam turbines are concerned, the circumstances are entirely different; here the reduction in steam consumption as the vacuum is improved is very marked indeed, being approximately 5 per cent. for each inch of mercury above 26 in. The condensing plant of a turbo-generator is, therefore, a very important item, and not infrequently the increased steam consumption in the case of turbo-generators may be traced to a fall of vacuum in the condensers, which has not been revealed by the usual Bourdon gauge. The best form of vacuum gauge is undoubtedly the differential type, as illustrated in Fig. 2. These instruments are perfectly reliable, and have the advantage that they always record the true absolute pressure at the condenser, irrespective of barometric variations. Moreover, they are easily made and are not liable to derangement.

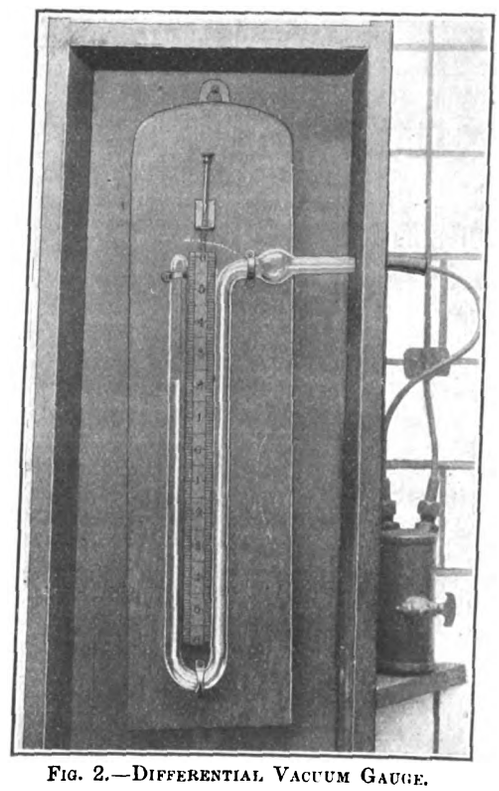

FIG. 2.—DIFFERENTIAL VACUUM GAUGE.

If the vacuum in any case is found to be considerably below standard, the causes may be looked for in the following directions, viz. :—

1. Air leakage.
2. Air-pump defects.
3. Insufficient supply or too high temperature of circulating water.
4. Choking of condenser tubes with scale or other foreign matter.

In the case of the first three causes the remedy is obvious.

In the fourth case—viz., the presence of scale—an effective method of dealing with it is to circulate dilute hydrochloric acid periodically through the water space of the condenser. When doing this it is necessary to see that both inlet and outlet branches are blanked off or otherwise closed, to prevent the acid reaching the circulating pump on the inlet side or escaping prematurely at the outlet. If the dilute acid is circulated through the tubes by means of a small pump for two or three hours it will be found that practically the whole of the scale is removed and the tubes are left clean and bright.

A careful investigation of the engine-room plant conducted generally on these lines will go a long way towards bringing the

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actual performance of the station, so far as the engine room is concerned, to a point within reasonable proximity to the standard which has been arrived at by calculation. It now remains to be seen what improvement can be effected on similar lines as regard the boiler-house equipment.

The Boiler House.

The first step to be taken is the measurement of the total weight of feed water delivered by the feed pumps, and if possible this measurement should be made in the form of a continuous record, so that it may be compared on a time basis with the corresponding record of steam used in the engine room. The difference between the total quantity of water put into the boilers and afterwards recovered from the condensers in any given period will form the basis for calculating the total number of heat units wasted in blowing down boilers, by condensation in the steam pipes, &c., and by the loss of steam through the boiler safety valves. Furthermore, if the measurements be in the form of a continuous record for any period, not only will the total amount of this loss be capable of calculation, but, what is of equal if not greater importance, the time of day at which the greatest amount of loss occurs will also be available.

Armed with this latter information, the task of reducing those losses is considerably simplified. It will sometimes be found that the losses through condensation in the steam pipes, &c., are greater at times of light load than full load, in spite of the fact that under light-load conditions the total weight of steam dealt with is very much less. This may be due to the fact that at light-load periods the rate of flow of steam through the pipes is greatly decreased and the degree of superheat is probably considerably lower.

As a method of reducing these condensation losses, careful attention must be paid to the condition of the lagging, and particularly to the covering of the steam pipe flanges and valve bodies. Moreover, the application of the bulb of a thermometer to the exterior surfaces of the lagging will in many cases reveal surprising differences of temperature, and will lead to the discovery of defects which might otherwise pass unnoticed.

The number of boilers in use at light load should be reduced to the minimum, the object being to carry the load on one or more boilers working at as nearly as possible their most efficient rate of evaporation, the remainder of the boilers being shut off the range and carefully banked.

The actual hourly evaporation of the boilers, as determined generally from the measurements of boiler feed and of engine-room steam consumption, should be plotted in the form of a curve on a scale diagram showing the number and capacity of the boilers actually under steam for each hour in the day. The capacity of each boiler is to be taken at that rate of evaporation at which it gives the highest efficiency. This curve will indicate the boiler load factor at any hour in the day, and it can readily be determined whether the boiler-house staff are working the plant under the most suitable conditions or whether fuel is being wasted through several boilers being operated at very inefficient rates for a number of hours in the day.

Unfortunately, it is very difficult to obtain anything like a continuous record of the total coal consumption over any given period, and in the great majority of cases the only method by which it can be arrived at is the somewhat expensive and laborious one of hand firing every boiler and measuring the total quantity of fuel fed thereto hourly. Nevertheless, even if this method be adopted, the results obtained will be found worth the trouble involved; and if plotted on a chart containing also the load and water consumption curves, the information which may be deduced therefrom will prove both interesting and valuable. In the majority of cases, however, the only coal measurements available will be the total quantity consumed daily or weekly, and this figure divided into the total water evaporated for the same period will give the mean evaporation from feed to steam per pound of fuel. It is to be feared that the figure thus obtained in everyday practice will be very much below the calculated standard, which, after all, represents a standard of boiler efficiency which is only likely to be obtained in a station possessing an abnormally high plant load factor.

Among the most potent sources of loss in the boiler house generally is the presence of scale or mud on the water surfaces of the boilers, and of soot or other incrustation upon the fire surfaces. In fact, it may be said that the highest possible degree of cleanliness of the inside and outside of the boiler is one of the primary requisites of efficiency.

It seems hardly necessary to refer to the wisdom of careful inspection of the brickwork of the boiler settings and of the flues to ensure that air leakage is reduced to a minimum, and that the thickness of the walls is sufficient to prevent undue loss by radiation. In this connection it should be noted that fireclay should not be used in boiler settings, or brickwork generally, unless the temperature is sufficiently high to flux it, otherwise in a short space of time it crumbles away, and loose, shaky brickwork, with all its attendant evils, is the result. Bricks if laid in cement, and if ample time is allowed for the latter to set naturally, will stand very much greater temperatures than is commonly supposed without the slightest deterioration.

If it be found that the boilers generally, the economisers and flues are in a good condition, it may be assumed that improved efficiency may be looked for in an alteration in the method of operation. In this direction improvement will usually be found obtainable only by constant experiments by a careful and frequent use of a CO_2 recorder of the Orsa type, and last, but by no means least, by giving the boiler house staff a practical interest in obtaining improved results.

If, for example, it has been determined that the best possible performance so far as the boiler house is concerned is the evaporation of 8 lb. of water from feed to steam per pound of fuel consumed, and that the average performance under normal working conditions is only 6½ lb., then a bonus scheme might be initiated somewhat on the following basis:—

The bonus to take the form of a percentage increase on wages according to the amount of steam generated per pound of fuel consumed above a certain minimum—that is, no bonus to be paid unless an evaporation exceeding, say, 6·6 lb. of water per pound of coal is obtained. For each one-tenth of a pound above this a bonus to be paid to the boiler-house staff as follows:—

Evaporation.	Bonus.
6·6 lb. of water per lb. of coal	Nil
6·7 lb. " "	2½%
6·8 lb. " "	5%
6·9 lb. " "	7½%
7·0 lb. " "	10%
7·1 lb. " "	12½%
7·2 lb. " "	15%
7·3 lb. " "	17½%
7·4 lb. " "	20%
7·5 lb. " "	22½%

These figures are, of course, only for the purpose of illustration, and the scale of bonus must necessarily depend upon purely local conditions, such as rate of wages, price of fuel, and also upon what is the maximum degree of improvement likely to be obtained.

The necessary calculations should be got out every week in a tabular form, and the result posted up in the boiler house, the actual bonus may be paid monthly or quarterly. In making these calculations allowance must be made for the water which is lost by periodical blowing down of the boilers, and it is advisable to arrange that each boiler is blown down at certain stated intervals and to a certain definite amount in the gauge glass, the operation being performed under the supervision of the boiler-house superintendent or the charge engineer. To illustrate this method of calculation, a typical weekly scheme of results is given in the following Table.

It may be, and has been, argued that a bonus scheme of this character is immoral, inasmuch as it attempts to secure by bribery that efficient service which should be freely rendered in return for the normal wages. This may or may not be true, but it is certain that, pending the arrival of the millennium, payment by results will always produce more efficient work than any other method of remuneration.

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In conclusion, the writer desires to emphasise the paramount importance of keeping continuous records of boiler-house and engine-room performances, as without such records it is very difficult, if not impossible, to discover and eliminate the many sources of loss, and to maintain a reasonably high standard of efficiency.

Weekly Evaporation Returns.

Day.	Fuel.	Water.			Evaporation per lb. of fuel (actual).	Bonus earned.
	Lbs. consumed.	Fed to boilers.	Lost through blowing down.	Evaporated.		
		Lbs.	Lbs.			
Thursday ...	...	964,500	...	964,500	...	...
*Friday	...	1,004,500	35,000	969,500	...	...
*Saturday ...	...	828,000	37,000	791,000	...	...
*Sunday.....	...	450,000	37,000	413,000	...	...
Monday	...	833,000	...	833,000	...	...
Tuesday.....	...	1,034,500	...	1,034,500	...	...
Wednesday ..	...	1,024,500	...	1,024,500	...	...
Total	896,000	6,139,000	109,100	6,030,000	6·74	2½%

* Boiler blown down and refilled.

CORRESPONDENCE.

THE TELEPHONE TRANSFER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The views of Mr. Hirst on this subject, so fully expounded at the meeting of a manufacturing company and so widely circulated in the Press, deserve some comment. It may be perhaps considered cynical to suggest that those views are somewhat coloured by a lively sense of orders to come; but I am impelled to that suggestion both because Mr. Hirst's published opinions are in direct opposition to those of almost every member of the electrical industry having knowledge of the subject, and of most of the technical, financial and lay Press, and because the Post Office looks like being the only future customer in this country for the Company for which Mr. Hirst was speaking.

As a business man, Mr. Hirst should find some difficulty in advocating so ardently the transfer of a business which under commercial management is operated at 58 per cent. of the gross receipts to a Department which operates the same business at over 74 per cent. of the gross receipts. The difference represents over 3 per cent. on the capital employed, which much more than offsets the lower rate of interest at which Government can raise capital as compared with a company or a Telephone Authority.

The telephone service is at present very little developed in this country, a state of affairs which *is*—Mr. Hirst to the contrary notwithstanding—very largely the fault of the Post Office, as the Post Office telephone policy has been obstructive from the very beginning.

To accelerate the development of the telephone, which has been artificially restricted for years past, requires large expenditure of capital. Mr. Faithful Begg, in a recent Paper before the London Chamber of Commerce, put the capital required for the next 10 years to develop the telephone adequately in the United Kingdom at £116,000,000. Is it likely that the Post Office, which earns a bare 3 per cent. on its telephone business, will be able to induce the Treasury or Parliament to invest any such sum in a Government telephone monopoly? It may be argued that when the National Company's business is taken over, the telephone profits of the Post Office will be greatly increased. So they will—for a year or two. But in time the same causes, relentless as the tides, which have turned the telegraphs into a losing business will wipe out the telephone profits: it is only a matter of time, if the telephone becomes a Government monopoly, when the Postmaster-General of the day will tell a thin and bored House that the telephones, like the telegraphs, are "past praying for."

As to pushing the telephone business, if that is not done by a trained business department much confusion would result. One powerful argument for a Telephone Authority is that under such management the very important question of business relations with the public would be adequately dealt with.—I am, &c.,

Westminster, June 17. HERBERT LAWS WEBB.

THE IMPERIAL CONFERENCE AND TELEGRAPHY.

Reduction of Cable Rates.

At the meeting of the Imperial Conference on Thursday last week Sir JOSEPH WARD presented a motion dealing with the subject of inter-commercial communication. He moved:—

> "That in view of the social and commercial advantages which would result from increased facilities for inter-communication between her Dependencies and Great Britain, it is desirable that all possible means be taken to secure a reduction in cable rates throughout the Empire."

Sir Joseph urged that the great question of cheapening cable rates between the Mother Country and her Dominions and dependencies had engaged attention for some years past and much had been actually accomplished, but the cheapening of rates had not gone nearly far enough. The cheapening of postal service had shown that not only was more use made of the reduced service, but the working was more profitable. The high cable rates were, he contended, injurious from the public point of view, and restricted their use, and he hoped action might be set on foot by the Conference to bring about an improvement.

The Postmaster-General (the Right. Hon. H. L. SAMUEL) said the Home Government sympathised with and supported this view, as, as Sir Joseph Ward had said, some progress had been made. Since the last Imperial Conference the Press rates to Australia had been reduced from 1s. to 9d. Steps were being taken by the United Kingdom to bring about the cheapening of rates in several directions. They had secured the consent of the principal cable companies to a reduction of 50 per cent. in the rates for cablegrams in plain language which might be deferred for a period not exceeding 24 hours, and they hoped that, with the approval of foreign administrations interested, the new rates might be shortly introduced. Secondly, negotiations were pending with a view to securing a further reduction of Press rates. Thirdly, the Government intended to adopt the policy that in all new landing licences there should be a clause giving effective Government control over rates, with due security to the companies against abuse of that power, in the form of an appeal to the Railway and Canal Commission. Fourthly, the development of the wireless telegraph system must have some effect on cable rates.

Sir WILFRID LAURIER pointed out the trouble was with the Atlantic cables. There was an impression in Canada, almost amounting to a conviction, that a combination existed in connection with the old cables, and the remedy suggested by the Postmaster-General was, he thought, a sound one for dealing with that combination, if it existed. In Canada they were acting on more or less the same lines.

The Hon. A. FISHER said Australia and New Zealand were dependent entirely on the cables for information as to public affairs, and he desired to know whether it would be feasible to grant a low rate, so far as the Pacific cable was concerned, for news cabled from Australia to Montreal, whence such news might be posted?

The Hon. G. F. PEARCE said the end they had in view was the development of the transmission of news between all parts of the Empire. Rates had been brought down, not by the voluntary action of the cable companies, but by the threat to lay the Pacific cable. The policy of the various Colonial Governments in bringing about reductions of rates had been to achieve that result, even at a loss. Such a policy could not be followed by the Railway and Canal Commission, as that body would decide the rates on such a basis as to leave a profit to the operating companies; therefore, the proposal would not secure the full result desired although it might be an improvement. Would the Postmaster-General give him some information regarding the refusal of the Treasury to sanction the construction of a new cable, which would mean an increased revenue to the Pacific Cable Board of £14,000 between New Zealand and Australia, the ground of refusal being that it would interfere with developments in connection with wireless telegraphy.

Sir DE V. GRAAFF said it would be a matter of great gratification to South Africa if the efforts outlined by Mr. Samuel were brought to a successful issue. A 50 per cent. reduction was a substantial concession, and the large number of people who did not use code would find their cabling facilitated and would benefit at once. He was glad to hear also that a reduction in the Press rates was contemplated. The Union of South Africa subsidised the Eastern & South African Telegraph Co., as in each year the company's revenue did not reach a certain sum the Government paid a certain amount, and had been doing so for some years past. The reduction outlined by the Postmaster-General would mean, of course, the continuation of that subsidy, but, in view of the advantages to be derived, the Union Government did not object. They were in favour of the reduction of cable rates throughout the world, and he supported the resolution.

Sir E. MORRIS also supported the motion.

Mr. SAMUEL said he would represent to the Chancellor of the Exchequer the strong desire felt by Australia and New Zealand that the Pacific Cable Board should be authorised, so far as the United Kingdom's consent was concerned, to proceed with the work to which Mr. Pearce had referred.

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Mr. ASQUITH promised further consideration of the matter, and the resolution was then agreed to.

Nationalisation of the Atlantic Cable.

The Hon. G. F. M. PEARCE then moved :—

"That this Conference strongly recommends the nationalisation of the Atlantic cable in order to cheapen and render more effective telegraphic communication between Great Britain, Canada, Australia and New Zealand, by thus acquiring complete control of all the telegraphic and cable lines along the 'All-Red Route.'"

Mr. Pearce said that in Australia they believed the only way any beneficial result could be secured was by nationalisation. Any proposal for an "All-Red" telegraph route involved laying a cable across the Atlantic and erecting a land line across Canada. The estimated cost of such a scheme would be £480,000 from Killala to Newfoundland with a connection to Nova Scotia and £120,000 for the land line across Canada. The estimated annual expense of working and maintaining the cable was £21,500 and of the land line £32,500, against which would be set certain existing expenses which would be incurred no longer (£22,000), leaving a net annual expenditure of £32,000. It was further estimated that a revenue of £36,000 would come in at once, in addition to new business which would probably accrue. He believed the scheme for an "All-Red" route was perfectly feasible, and was not likely to require special financial assistance from the Governments. Every attempt to obtain improvement in the existing service, either for business or Press purposes, was blocked by the Atlantic companies. The Pacific Cable Board carried Press messages over 10,000 miles of sea and land for 3d. per word, whilst the privately-owned cable companies charged 5d. for 3,000 miles.

Sir WILFRID LAURIER said in view of the statement made by Mr. Samuel on the previous resolution, he reserved his judgment on the present proposal.

Sir J. WARD had the following resolution on the paper :—

"That, in order to secure a measure of unity in the cable and telegraph services within the Empire, the scheme of telegraph cables be extended by the laying of a State-owned cable between England and Canada, and that the powers of the Pacific Cable Board be extended to enable the Board to lay and control such cable."

He said he held strongly that the nationalisation of the cables was the right course to follow. The proposals of Mr. Samuel were very important and constituted steps in the right direction, but the rates could be put on a satisfactory basis only by the Governments interested owning the cables. If they could arrive at an arrangement by which they took over the private companies on reasonable terms, it would be one of the finest things ever done for the Empire, and he belived it would be a good commercial transaction. If the Atlantic cables were British-owned, it ought to be possible to come to an understanding that if the companies were not willing to sell their cables at market value the Governments of the Empire would put down a cable or cables of their own. Even at a cost of £500,000 for the cable alone, he believed a substantial result would be obtained. The Government contributions, considered as a subsidy, would be a very small matter, but the resultant advantages would be immense. He thought the Conference ought to suggest the desirability of such a State-owned link being provided. With regard to the proposed second cable between Australia and New Zealand, its refusal by the British Treasury was regrettable. The reason given, the possible development of wireless telegraphy, was likely to result in no advance being made.

Dr. FINDLAY said the position in Australia and New Zealand was essentially different from the position on this side. They had to rely on the cable for all their outside news, and the question was, therefore, too large a one to be treated on a purely commercial basis.

Sir D. DE V. GRAAFF said the system of control foreshadowed by Mr. Samuel was a great step in the right direction. The nationalisation of cables might be desirable, but it was a question whether the present was the right time to undertake it. The first part of the resolution aimed at reduction of rates. A further point was the Government control of cables in time of war. The Union Government also issued landing licences to cable companies, and in that way obtained a measure of control. Mr. Samuel had told them that in 10 years' time existing licences would be falling in, and uniformity in this respect could then be brought about and the necessary control secured throughout the Empire. He thought the Conference would be wise to hesitate a little before passing this resolution, in order to see in what directions wireless telegraphy developed.

Sir E. MORRIS said the hopes held out by Mr. Samuel with regard to the control of rates promised largely to lessen the objections to the present privately owned cables, and also to remove some of the reasons in favour of nationalisation. The matter must not be regarded entirely from the commercial aspect.

The POSTMASTER-GENERAL said the proposal which had been put forward invited the various Governments, partners in the Pacific Cable Board, to incur the expenditure of about £500,000 for cable alone. In view of the deficiency between the amount of work which the Pacific cable could directly give to an Atlantic cable and the full capacity of the cable, the question was whether the deficiency could be made up by increased business. If the business were increased by a large reduction of rates, the load might be made up, but it would not increase the revenue. There would be little possibility of attracting business to the State-owned cable in the United States and Canada, because the land-lines in those countries were in the hands of private companies connected with the American cable companies. According to an estimate which had been made such a cable would involve a total annual expenditure of over £50,000, against receipts estimated at £25,000. An independent estimate by the British Post Office officials placed the probable expenditure somewhat higher. The Governments concerned would not be asked to undertake that additional loss on the ground of efficiency, because the present service was worked with speed and accuracy. If it were argued that it should be done in order to cheapen cable rates, the argument would be a stronger one if no steps were being taken at present in that direction. But, in view of the probability of a reduction in rates, he suggested that the Governments would not be justified in undertaking the large capital expenditure and the risk of loss that would be involved. He suggested the following as an alternative resolution :—

"That in the event of considerable reductions in trans-Atlantic cable rates not being effected in the near future, it is desirable that the laying of a State-owned cable between England and Canada be considered by a subsidiary Conference."

The original resolutions were then both withdrawn, and Mr. Samuel's resolution unanimously adopted.

Wireless Telegraphy.

Sir JOSEPH WARD afterwards moved :—

"That the great importance of wireless telegraphy for social, commercial and defensive purposes renders it desirable that a scheme of wireless telegraphy approved at the Conference held at Melbourne in Dec., 1909, be extended as far as practicable throughout the Empire, with the ultimate object of establishing a chain of British State-owned wireless stations which in emergency will enable the Empire to be to a great extent independent of submarine cables."

He said wireless telegraphy had advanced considerably, and offered a great inducement to have a world-wide Empire system established. In New Zealand they were having two high-power stations erected, which would guarantee to carry 1,250 miles during the day and much further at night. In addition they would have four low-power stations, and all the ships in New Zealand waters would be equipped with wireless apparatus. It would be grand to have a girdle of wireless stations round the Empire, particularly in time of war, when the existing cables might be cut. The system might also be of advantage from the commercial point of view.

The POSTMASTER-GENERAL said that the Home Government considered it very desirable that a chain of wireless stations should be established throughout the Empire, partly for strategic and partly for commercial purposes. Such a system should be State-owned, and should be established speedily. It was not thought advisable to establish the system in every direction simultaneously at the outset. The Government proposed to start with a chain of six stations in England, Cyprus, Aden, Bombay, the Straits Settlements and Western Australia, and from there to be linked on to New Zealand. Later on South Africa would be connected viâ either East or West Africa, or even by both routes. If favourable terms could be arranged it might be desirable, in the first instance, for one of the wireless companies to erect the stations; but failing that, the Admiralty might undertake the work. In any case, the working of the system would be by the Post Office and the local administrations in India and the various Dominions. It was suggested that the United Kingdom should bear the cost of the stations in England, Cyprus and Aden; that India should bear the cost of the station at Bombay; that New Zealand and Australia should bear the cost of the stations in their respective territories; and that the cost of the station at Singapore, that station being created almost exclusively as a link in the chain, should be equitably divided. With regard to the proposals of the Melbourne Conference, he was advised that the cost of crossing the Pacific by a chain of stations would be very heavy, while the strategic value would be small and the commercial value negligible. Such a system could, in fact, hardly be the beginning of an Imperial chain of wireless stations, and he suggested to omit any reference to the Melbourne Conference and pass a resolution in general terms in favour of a system of Imperial wireless telegraphy.

Sir JOSEPH WARD agreed to substitute the following :—

"That the great importance of wireless telegraphy for social, commercial and defensive purposes renders it desirable that a chain of British State-owned wireless stations should be established within the Empire."

The Hon. G. F. M. PEARCE supported the resolution, and hoped the Pacific would not be lost sight of. Other European countries possessed colonies in the Pacific, and it was possible they would not throw away their opportunities. Moreover, a Western Australian station was being established, and now was the time for the subject to be considered if there was any idea of adapting their system to any new scheme.

Mr. L. HARCOURT, M.P. (Colonial Secretary), said the question of the Pacific would not be lost sight of by the Colonial Office in the ultimate development of the scheme.

Sir D. DE V. GRAAFF supported the scheme on behalf of South Africa, and said he was glad to hear that a high-power station would be placed at Aden. As soon as that station had been erected, the Union Government would be prepared to consider the advisability of erecting another high-power station to form a link.

In regard to the financial side of the proposal, the POSTMASTER-GENERAL said the capital expenditure on establishing the stations would be borne in the manner and in the proportions he had described, but, as the stations would be links in a chain, the scheme must be viewed as a whole. He suggested that the working expenses and the receipts be pooled, and any profit or loss divided in an equitable manner to be arranged.

Sir JOSEPH WARD thought it would be more satisfactory if Australia and New Zealand themselves carried out what they required for their local purposes and agreed to share with the other portions of the Empire the costs of Singapore as a link between the various parts. He supported the proposal generally, it being understood that they were not committing

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themselves to the details, upon which they would later be consulted and upon which they would require their own experts to report.

The Hon. A. FISHER said Australia was in favour of a British linking-up by a wireless system. But the Commonwealth authorities had started their own scheme and intended to proceed with it. They must reserve to themselves the right to put up stations where and how they pleased. While supporting the proposed scheme for strategic, protective and commercial purposes, he wished to make it clear that they were not committing themselves upon the financial side.

The amended resolution was then approved.

EDINBURGH THEATRE FIRE.

The public inquiry into the recent fire at the Empire Theatre, Edinburgh, was held on Thursday last by Sheriff Maconochie and a jury.

Mr. G. M. Sinclair, stage manager of the theatre, gave a general description of the stage, means of exit, &c. The class of plant used by the deceased Lafayette (he said) was the same as that used generally by artists of the kind. It was customary for such artists to bring their own plant, and Lafayette brought a considerable quantity of scenery and electric fittings. He had a stage manager and an electrician of his own. The supply of electricity was given by the theatre company. In "The Lion's Bride" there was a curtain roof, so to speak, on the stage, and hanging below that canopy roof was a lantern. Holes had been bored in the lantern and covered with gelatine material, and inside there were seven coloured electric lamps. Electricity was supplied by means of a cable from the prompt side. There were a number of other electric light fittings on the stage. There were two sets of seven wax candles also. He was satisfied that the fire had nothing to do with any of the fittings on the stage. He had a little box of his own at the prompt side of the stage. On the night in question Lafayette had completed his act, and the tableau curtain had been lowered, when he heard shrieking. Lafayette's electrician ran out from the stage and let go the iron curtain. He (witness), seeing the danger of two perch-light men who would have been killed had the curtain struck them, arrested the descent of the curtain. The curtain would then be about 12 ft. down. The men escaped, and the curtain was then lowered further. The back doors on the stage must have been open, however, and the draught blew the tableau curtain underneath the fire-proof iron curtain, and stopped it about 2 ft. 6 in. from the floor. He could not see how the fire occurred. The lights on the stage went out very soon after the fire, but the lights in the auditorium did not go out for some time afterwards. All the hydrants and other appliances in the theatre were working satisfactorily. Lafayette's properties were marked "Fire-proof." Everything had been done in the way of fireproofing in the building that science could suggest. The men who were working the perch lights could not be situated anywhere else to be of use. The fire-proof curtain served its purpose. The theatre was not fitted with any special automatic arrangements in case of fire, except the fire alarms. Under Lafayette's arrangements everybody connected with the theatre had to leave the stage, and the stage left solely to his men, witness and the stage fire-men.

Mr. ADAM H. CAMPBELL, burgh engineer, said that on May 2 (a week before the fire) he made an inspection of the theatre for a report to the justices. He saw no reason for disagreeing with his predecessor in considering the arrangements satisfactory for licensing the theatre.

Mr. E. W. BUSSELL, who said he was in the habit of doing Lafayette's repair work and constructed the lantern which was used on the night in question, said the lantern was open at both ends and a good current of air could pass through it. It was covered with canvas, with holes made in it. The holes were covered with gelatine. Inside the lantern there were seven electric lamps. He was in the theatre at the prompt side in the dress at the time the fire broke out. He observed flame running along the communicating wire of the lantern. After giving the alarm, he came across the two midgets who were engaged in the performance, and he ran them off as quickly as possible. When he came back he saw that the flames were spreading rapidly among the scenery. So far as his work of supervision was concerned he found everything in order that evening. He did not think the fire had been caused by the lamps swinging against the gelatine cover.

SAMUEL LLOYD said he was in the theatre at the time of the outbreak. He first noticed an extraordinary light at the top of the lantern. He could not say what caused the light. It was customary to line lanterns with gelatine, and he thought the gelatine was the least likely to take fire.

EUGENE CAWOOD, electrician, said he supplied the cable for Mr. Lafayette's performance. From his experience of electricity the only thing he could think of as to how the fire originated, assuming that it occurred in connection with the lantern, was a faulty joint inside the lamp.

Mr. S. E. MERRICK, electrician to the Lafayette Co., said he had been using the lantern in question for some time previous to the night of the fire, and it worked quite satisfactorily. He considered the electric cable supplied was perfectly suitable.

Mr. FRANK A. NEWINGTON, electrical engineer to the city of Edinburgh, was asked to give his opinion as to what might have been the origin of the fire, and it might have been caused by the fusing of one or other of the wires in connection with the lantern.

Mr. C. B. FOUNTAINE, manager of the Empire Theatre, said when the outbreak occurred he ran round to the stage with the intention of having the iron curtain run down but on getting there he found that this had already been done. If the artistes had made immediately for the exits after the alarm was given there would have been no fatalities.

Other witnesses having been heard Sheriff MACONOCHIE summed up the evidence. He thought it right to raise the question as to whether there was celluloid used upon the lamp, but to his mind it was conclusively proved that there was not, and at all events they were bound to take it that there was not, because there was no evidence to the contrary. One gentleman who had experimented said gelatine did not flare up, but frizzled away. He thought the evidence distinctly came to this, that, for one reason or another, there was a fusing at the place where the flexible cord was attached to the lantern, or at some of the points inside the lantern, and that the india-rubber insulation caught fire, ran up the wire, and then dropped down on the inflammable material or touched the scene hung about it. Several experts had told them that the wire was sufficient to carry seven lamps of 8 c.p. They had also the testimony of fact, which was even better than the testimony of experts—the fact that the wire had borne the lantern for a number of times. The only suggestion was that if it was exposed to hard usage it was not a strong enough wire, but there was not a shred of evidence to entitle them to say that it was exposed to rough usage. If they took the view of the evidence, there was no doubt the verdict should be that the cable was sufficient, and that the precautions taken were proper. The only question was whether they were going to suggest any other precautions which the evidence might have suggested to them might be taken.

The jury, after consideration, returned a formal verdict, with the recommendation that in future the city authorities should exercise more care both in regard to the safe construction of theatres and more frequent examination of electric lights and water hydrants.

PARLIAMENTARY INTELLIGENCE.

TELEPHONE TRANSFER BILL.

On Monday, in the House of Commons, in Committee, on a resolution on which to found this Bill.

The Postmaster-General (Mr. H. L. SAMUEL) said the resolution and the Telephone Transfer Bill which would be founded on it would enable the accomplishment of the transfer to the State of the business of the National Telephone Co., a great corporation with £3,000,000 capital employing some 18,000 men and women and supplying for the use of the public about 500,000 telephones. That was the consummation of a policy which was decided upon in 1905 by the Government of that day. At that time the policy of transfer to the State of the whole telephone business of the country was sanctioned by Parliament. Mr. Samuel proceeded to make a brief statement of the events which led up to the present measure and of the development of the telephone in this country. In 1907, he said, the Post Office had agreed with the National Company that at the end of the company's licence (on Dec. 31, 1911) the Post Office would purchase the company's plant in London on certain terms. That agreement was discussed in the House of Commons and was approved. In 1901 an agreement was made on the same lines covering all the rest of the country, and it was that agreement which now came to be consummated. The substance of that agreement was that on Dec. 31 next, unless the Postmaster-General fixed a later date—and there was no intention of fixing a later date—when the business of the company came to an end, and when it legally could not carry on its business any longer, the Postmaster-General should purchase the plant, which included land and buildings, at its value *in situ*, no payment being made for goodwill, no payment being made for past or future profits, and no payment being made in respect of compulsory purchase. These were the provisions inserted, because the company's business existed solely by virtue of the licence held from the Postmaster-General, and if things were left to take their course the whole business would come to a sudden stop on Dec. 31, 1911. Therefore it was by no means inequitable that the plant should be purchased on what was generally known as "tramway terms." The Postmaster-General was, by the agreement, given the right to object to any portion of the plant on one of two grounds—either that it had not been provided according to agreed specification, or that it was unsuitable for the actual requirements of the Post Office system on Dec. 31 next. The precise interpretation of those words was now under consideration by the Court. Goodwill payments, however, under the agreement, had to be made in respect of private-wire service provided by the company, which was not provided by virtue of any licence of the Postmaster-General. Goodwill payment had to be made in respect of that equal to the profits of the last three years. Also there was the special case of Portsmouth and Brighton, where the company's licence under the Act of 1899 had to be extended till 1926; goodwill payments might be claimed in respect to that period. These extensions were because the municipalities of Brighton and Portsmouth had started systems of their own with licences terminable in 1926. The Act passed in 1899 provided that where municipal licences were extended, the licence of the company was also to be extended for an equal period, and that on the occasion of the purchase, goodwill payments would be required in respect of that period of extension. That applied only to these two cases. The value of the plant was to be ascertained by agreement, or, failing agreement, by the Railway and Canal Commission. That draft document was presented to the House by the then Postmaster-General, and was referred by the House to a Select Committee in 1905, who carefully investigated the whole question, heard evidence from the Post Office, the company and other parties, and ultimately presented to the House a report approving the agreement with some slight modifications, which were thereupon embodied in the agreement. The House acquiesced in the terms of the agreement. Recently preparations had been made between the com-

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pany and the Post Office for carrying the agreement into effect, according to the letter and the spirit of its provisions. A joint inventory was proceeding, but there was, he regretted to say, little or indeed no prospect of an agreement being arrived at between the two parties as to the value to be attached to the plant. The divergence of view between the company and the Post Office was so great that no negotiations were likely to bridge the gulf, and it was fully anticipated that the matter would have to be referred, as provided in the agreement, to the Railway and Canal Commission to determine the precise amount of money to be paid for the plant on tramway terms.

Clause 1 of the bill, which he should introduce would authorise, the Treasury to borrow to pay the sum awarded by the Railway and Canal Commission as the amount due to the National Telephone Co. in accordance with the agreement. There would also be a provision in the bill relating to a sum which amounts to about £1,600,000 which was in the hands of the National Company, and which represented subscriptions paid in advance by telephone subscribers. That sum had been gradually accumulating from year to year, and had been invested by the company in its own business, and of course it had paid for part of the plant. That sum of £1,600,000 must be handed over by the company in cash to the Post Office on the occasion of the transfer, and it was proposed that the Post Office should do as the company had done—use the money as part of the capital invested in the business. The agreement required that one-fourth of the purchase money should be paid in cash by the Postmaster-General to the company, and that sum of £1,600,000 would be used as a set-off against the sum payable in cash to the company. The Post Office had had considerable experience for some years past in the management of the telephone through the development of its own system. When the trunk wires were bought from the company in 1896 they were purchased for £450,000. The Post Office had invested in the development of trunk wires an additional sum of nearly £5,000,000 and, although he was far from claiming that the trunk-wire system was by any means perfect, and he looked to a very large development, extension and quickening of it, still he thought there would be a general consensus of opinion that in the last few years it had shown considerable improvement. In the United States, it must be admitted that between some of the large cities there was a rapidity of service which had not yet been attained in the United Kingdom, but it should be remembered that the charge made for the use of the trunk-wire service in the United States varies between 250 and 300 per cent. more than the charge in this country. Another £5,000,000 had been spent by the Post Office on the remainder of the Post Office telephone system in London and the provinces, and they had now over 100,000 connected with the Post Office system. The number of telephones belonging both to the Post Office and to the company 10 years ago was 200,000. There were now 600,000, but that number was quite inadequate to the population of the country. They were providing for a very large development subsequent to the transfer. The Treasury was already empowered under existing statutes to spend another £2,000,000—that was to say, there were £2,000,000 of unexhausted borrowing powers remaining. In the bill he proposed to ask for power being given to the Treasury to raise an additional £4,000,000, over and above what was required to purchase the National Company's plant for future developments of the trunk service and the local service where it might be found that profitable extensions could be made. They had been very closely watching the development of the telephone system in the United States, and for many years representatives of his department had been visiting that country to acquire information. The head of the telephone branch of the Post Office had been in the United States, and the chief engineer had also made an exhaustive study of the telephone system there. The telephone traffic manager had only just returned. They had established a system of travelling scholarships for Post Office engineers which would enable them to go over to the United States for considerable periods in order to make a minute study of the telephone in that country. Representatives of the Post Office had recently visited Sweden, and they were contemplating visits by other officers to that country, where telephony was so widespread and provided at remarkably cheap rates. They were also going to experiment with automatic and semi-automatic exchanges. They recognised that that was a highly specialised business which could not be conducted on routine methods, and they were very much on their guard against the possibility that the future progress of telephony in England might be hampered by what might be called the dead hand of the State. The responsible officers in the district would be given a large measure of local control, and they meant to use to the full the experience and capacity of the company's staff in connection with work upon which they were experts. The company's managers would be kept at telephone work, and they would be given a large measure of discretion in their own sphere. It had been argued that the telephones ought to be transferred to a telephone authority instead of the Post Office, as a telephone authority would be less amenable to Parliamentary pressure. The loss on the telegraphs was due to several causes. To the low Press rates, to the extension of the telegraph system in the rural districts, to the introduction of sixpenny telegrams and to the development of the telephone itself. The bulk of telegrams used to be telegrams despatched short distances, but now the bulk were becoming, more and more, messages sent over long stretches of the country, and which were not of a remunerative character at the 6d. rate. When the average cost of dealing with the telegram now as compared with 20 years ago was considered, one found that a telegram dealt with now was a different thing from what it was 20 years ago, owing largely to the advent of telephony. He was being pressed to promise immediate reductions in telephone rates, and those who complained that the Post Office was not to be trusted to manage the telephones in a businesslike way because it was too much open to pressure were often themselves the first to bring political and other pressure to bear in order to secure an immediate reduction of rates which might be unremunerative. There was an objection to the request that the question of rates should be referred, prior to the transfer, to a Select Committee of the House of Commons in order that the existing rates might be examined and a new scale devised. They did not know what the cost of the telephone company's plant would be. It had to be determined by arbitration, by the Railway and Canal Commissioners. The capital cost of the plant would, of course, be a predominant factor in fixing the rates to be charged. In connection with that exceedingly extensive system, the capital investment was a most important factor in the balance-sheet, and it would be perfectly impossible at present (when the value of the plant was undetermined) to fix what should be charged for the use of that plant. If a Select Committee were appointed this session there would be no data to place before it on which it could act, and the Committee would have no course open but to report to the House that it was unable to consider what were the proper rates to be charged for the telephone service when it had no estimate of the capital value of the telephone system or of what ought to be charged year by year for interest. He proposed to leave the matter over until after the award of the Railway and Canal Commission. Subsequently an alteration of the existing rates would be necessary for two reasons. First, there was an inequality in the rates at present. Some had their service on the "flat" and others on the measured rate system. There were many cases where subscribers were receiving their service below cost price, and the continuation of that system must be either a loss, to be made good by the State when the service was taken over, or the user must be subsidised by the small user at an unduly high rate for his smaller service. I hope, therefore, that if unremunerative agreements were terminated the present measured rates might be greatly reduced. When the revision came the rates should be fixed in accordance with fixed principles, first of efficiency, speed and accuracy, and it would be a false policy to put the rates so low that a highly efficient service would be impossible. The second principle was that it was to the interest of the State and of the community to encourage a very wide user of the telephone by great numbers of small users. In the third place, the telephone service should pay its own way. Telephone users should have the use of their own subscriptions. He proposed that when the valuation was completed a revision of rates should be undertaken on those lines by the Post Office. He proposed also that if that revision was not generally acceptable it should then be submitted to a Committee of Inquiry for examination, which should be either a Select Committee of the House or a Committee consisting of representatives of the chief commercial bodies of the country, and of others who had great interest in the efficient conduct of the telephone service.

One or two suggestions had been made as alternatives to the transfer of the telephone system to the State. When that subject was discussed by the House in 1905 municipal telephones were then being advocated by many persons. In 1899 there was a considerable movement in favour of municipal telephony. He favoured the policy of municipal trading and the ownership of the telephones by municipalities where it could be shown that they could be suitably managed by local bodies. But after a careful study of the subject he had come to the conclusion that the management of the telephones was not really a suitable enterprise for a local body to conduct. In the first place, local service was more and more being connected with the trunk service, and in years to come the custom of communication between town and town would rapidly increase. If, however, the trunk service was in the hands of the Post Office, and the local telephone exchanges were under the local bodies in the towns, friction and difficulty were sure to occur in arriving at speedy communication between the different towns. The municipal area was not the natural telephone area, which was rather that which had a town for its centre with outlying suburbs and districts. Those areas frequently were not all comprised within the municipal area, and difficulties would consequently arise—they did arise when the municipalities were in the business—owing to questions of finance, the rates charged and wages paid. Next there were all the economies to be gained by management on a large scale. A Government department which had perhaps 600,000, or perhaps 1,000,000, telephone subscribers, could place its contracts to much greater advantage than municipalities that had but 10,000 or 20,000 subscribers each. A Government department had at its command also highly skilled and highly paid expert advice always engaged in watching developments, always experimenting, always bringing up possible improvements in the service. Municipalities could not go to the expense of having experts of that calibre. Again, a Government department could easily obtain capital for its needs and the advanced requirements most necessary in developing the service, while municipalities were not as well situated in this respect. Experience showed that telephony was not a very profitable sphere for municipal enterprise. He had offered to purchase the Portsmouth system on similar terms to those paid by the National Company, or, alternatively, to sell them the National Telephone Co.'s plant at Portsmouth. Neither offer had been accepted by the Corporation, and therefore there would be a competing system. He was still in communication with Hull Corporation. There was no demand from any quarter for a municipal telephone service except from some individuals and associations in Glasgow, but there was no official request from Glasgow Corporation itself. It might be assumed, therefore, that municipalisation as an alternative policy was now generally abandoned.

More recently suggestions had been made, supported by the London Chamber of Commerce, that a Telephone Authority should be created on the lines of the Port of London Authority, which should, without control by the House of Commons or a Government department, conduct

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the whole telephone business. He was opposed to that suggestion on several grounds. One was that such an authority could not be fully representative without being too large to be workable. It would be necessary for the small users to be represented as well as the large, for the rural districts to be represented as well as the town districts; and he saw no prospect of any board being created that would represent all the various interests and districts entitled to representation. The House of Commons was the only sufficiently representative body to which to commit the ultimate control over so widespread and important a service as that of the national telephones. More important, perhaps, was the fact that the telephones were inextricably intertwined with the telegraphs, and it would be a most unbusinesslike and uneconomical proposition to endeavour to set up new lines of poles everywhere, to lay new underground cables, and to separate the buildings of the telephone system from the telegraph system. The alternative would be that the telephone authority should also be the telegraph authority. If that were so, it would mean taking over £1,000,000 a year loss on the telegraphs and the total break up of the whole organisation of the Post Office system. If the telephones were under one authority and the telegraphs under another it would result in so wasteful a system, a system giving rise to so much friction among the officials who had to deal with the two services, that it would become utterly impracticable in its working. Of all the various proposals made in regard to the telephone system this proposal of a separate telephone authority seemed to him to be by far the worst and most impracticable.

It was desirable and necessary that the company's employés should be taken over by the Post Office. Lord Stanley, in 1905, undertook that those employés of the company receiving less than £700 a year and having more than two years' service should be taken over, unless they had, unfortunately, an abnormal sick leave rate in any particular case. He proposed to redeem that promise and to extend it further, so as to take over the whole staff, no matter what their length of service might be. The pay they would receive would, in many cases, be greater than they were now receiving, and in no case would it be less, unless their rate of pay had been abnormally raised by the company in the last two years in view of or in connection with the transfer. The conditions in regard to leave and sick pay would also be considerably better than those provided by the company. The question of their seniority after they became members of the State system raised a good many difficulties which it would take some time to adjust, but in no case would their years of service with the company be left out of account in fixing the seniority of the transferred officers. The question of their classification in the various grades of Post Office employés was being investigated by a Departmental Committee. The pensionable servants in the company's employment would have two options: they might either take their share of the pension fund, put it in their pockets, and then come to the State and start afresh to qualify for pensions, the State adding two years' additional service in respect of their past service. Or, as probably they might regard as more advantageous, they might surrender to the Exchequer their share in the company's pension fund, and in exchange they would be given State pension rights attaching to the office to which they would be appointed as though the whole of their past service had been with the State and not with the company. Almost the whole of the pensionable staff of the company would be transferred to establishment posts in the Post Office, and therefore pensionable posts. They would receive a more liberal pension than was provided by the company. With regard to the other and larger class of servants of the company who were not subscribers to the pension fund, four times as many would be placed on the establishment as had hitherto been in the pensionable class in the company. These officers had desired that all their back pay service should count for pension service under the State. The cost of that had been calculated, and he found that it would involve what would be practically a bonus of £700,000 to those officers. There was only one case in which such a course had been taken, and that was when the original telegraph company was transferred to the State—a transaction which had since been recognised as having been carried out on most wasteful and extravagant lines, when vast sums of public money were given with both hands, and with the result that the telegraphs had been charged ever since with an excessive liability in respect of the transaction. There was no precedent for counting for pension purposes after transfer to the public authority service which was not regarded as pensionable by the previous employer. The matter was referred to the Select Committee which sat in 1905 to consider the purchase agreement, and after hearing evidence the Committee reported against that demand. However, they did not propose to stand upon the strict letter of justice. They proposed to give these officers not only better pay, better leave conditions, better conditions with regard to sick rates, and new pension rights, but, in addition, they proposed to add two years to their service with the State as a bonus to qualify for pension under the Civil Service. That was in accordance with the recommendations of the Select Committee. That bonus would be given not only to those who were pensionable under the company, but also to all those who were not pensionable under the company, and they were very much the larger number, including nearly the whole of the operating class, who would be pensionable when they were transferred to the State and came on the establishment as Civil servants.

Mr. AUSTEN CHAMBERLAIN said that if he had any complaint to make of the very business-like statement of the Postmaster-General it was that he did not tell the Committee a little more about his financial arrangements. He gathered from the resolution that, as regarded that portion of the purchase price of the company's plant which was not to be paid in cash, the bill would take power to raise the money by terminable annuities.

Mr. H. SAMUEL: Or Exchequer bonds.

Mr. AUSTEN CHAMBERLAIN said that he should have thought that, on the whole, terminable annuities were eminently the right financial weapon to deal with a transaction of that particular kind, for they would fix a date by which the capital liability would be extinguished. He was glad to learn from the speech of the Postmaster-General that some of the rather fierce controversies which raged round the two agreements were definitely closed, and that the Government which made those agreements had been justified alike by experience and by the verdict of their successors. He entirely agreed with what the right hon. gentleman had said about the municipalities and the telephone system. If the telephone system was to be worked by a public authority at all, and he agreed that it must be, it must be worked by a national authority. No other authority could deal with the whole country, reconcile all the interests that had to be reconciled, and make the system a thoroughly national system. He was not quite certain that, if they had a perfectly free hand to do as they pleased, it would not be wise for the House of Commons, even at that stage, to create a telephone authority national in character, acting under powers conferred by Parliament, but not subject to the same kind of perpetual pressure that every Postmaster-General was exposed to in that House. That, however, was not now a question of practical politics, and he desired to support the Postmaster-General in first creating an efficient public telephone service and then in maintaining it at the highest level of public utility. He differed from the right hon. gentleman when he said that the service was not to be worked for a profit. There were systems of public utility which must be worked even at a loss, but in his opinion the telephone service was not one of them. He did not want to dogmatise on the exact amount of profit, but thought that it might be taken at 5 per cent. on the capital outlay. Part should be devoted to the benefit of the taxpayer as a whole, at whose risk the work was being carried on. When the change came in the rates charged for the service, he hoped that he would bear in mind the case of the small user and would lower the minimum rather than the maximum charge. The only thing that he regretted in the absorption of the system by the State was the great addition it entailed in the number of State employés, which might prove a possible danger to public life. Whether they warded off that danger depended on the ability of the House to remember that it was the guardian of the interests of the nation, and that they must not be sacrificed to the interests of individuals, however well organised or clamorous they might be.

Mr. T. LOUGH, Mr. JOYNSON-HICKS, Mr. HELME, Mr. STUART-WORTLEY and Mr. PETO also took part in the discussion.

In reply, Mr. H. SAMUEL said the agreement between the Postmaster-General and the Telephone Company was that the payment of the purchase money should be made in the form of annuities. The company, however, had made representations since to the Treasury that those securities were not of a character readily marketable, and they would prefer to have the payment made in the form of Exchequer bonds. They were prepared to meet their views in that respect, the amount of money involved being very small, and accordingly powers were taken under the bill for the Treasury either to issue annuities or Exchequer bonds payable within a period of not more than 20 years. As regards the staff, he wished to make it clear that of course if a person had entered the service of the Telephone Company a week or a month before the transfer he would not be entitled to have the two years' service added. Many of the undertakings which had been given were of a character which it would be exceedingly difficult to put into the form of clauses, but, just as he was honouring the promises given by the present Lord Derby, and even going beyond them, he had no doubt that any successor of his would honour any undertaking he had given across the floor of the House. The officers of the company who were not placed on the establishment when they were transferred would receive a compensatory allowance. There would be no medical and no literary examination for the servants who were transferred. It was impossible to give any accurate forecast of how many years it would take before the full development of the system to which he looked forward could be secured. That must depend on the rates to be charged and the efficiency of the service, and the rates would depend on what they would have to pay the company. Therefore they had every reason to hope that the price would not be at all an excessive one, for the lower the price they had to pay to the company the more cheaply they would be able to supply a service to the subscribers, and the more rapid the telephone development would be.

The resolution was then agreed to.

GREATER LONDON RAILWAY BILL.

This Bill has been under consideration by a Select Committee of the House of Commons, and on Friday the Committee sanctioned the portion of the proposed line from Northolt to Victoria and Albert Docks, but disallowed other portions.

The CHAIRMAN (Sir J. Compton-Rickett) said the Committee were not satisfied with the promoters' case in regard to the cost of constructing the line, nor with regard to the anticipations of income. They could not believe the trade to and from the docks would continue to go down the Thames. They did not think it desirable that a large amount of trade should be carted through the congested streets of London to outside destinations, and considered that some such line should be constructed, because a large increase of trade immediately would tax the present means of communication to the point of congestion. The case of Tilbury did not appeal to the Committee so strongly as the case of the Victoria and Albert Docks. The Committee, therefore, disallowed the section of the line between Ilford and Tilbury. At the other end of the proposed line the Committee were not satisfied with the evidence as to north and south traffic or that the present means of communication were congested. They considered that Feltham was not a good place for a congeries of railways to the south, and that in the

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trade anticipated the promoters would be disappointed. They disallowed the portion of the line between Feltham and Northholt. The Committee hoped that the Great Western and Greater London Cos. would find it mutually desirable to arrange a passenger service from Paddington to the north and west of London, and they hoped that the junction with the Great Northern would affect passenger arrangements between King's Cross and the City. The Committee would leave to the Greater London Railway optional rights to make junctions on condition that all junctions affecting main running lines should be flying junctions. The line should be made within a reasonable time, and the Committee hoped no extension of time would be granted in the future. There should be a limitation for substantial construction to the satisfaction of the Board of Trade in three years, and two-thirds of the capital should be raised in two years. The portion of the line sanctioned would extend from Northolt to the Victoria and Albert Docks.

RAILWAY SIGNALLING AND ACCIDENTS.

In the House of Commons on Friday, Mr. Wardle raised a discussion on the administration by the Board of Trade in reference to the number of hours worked by railway men, urging that instead of a standard of 12 hours per day there should be one of 10 hours. He said that the question of accidents on railways was still a serious one for the men concerned. The Board of Trade did not seem to realise what their powers were, or they were slow in carrying them out. On the whole of the railways there were only 10 inspectors. There was great need of further inspection.

Mr. J. H. THOMAS said that since 1907 there had been three or four serious railway accidents, and the Government inspectors who inquired into these disasters attributed them to the failure of the men to observe rule 55. While strict observance of the rule might have prevented those accidents, it was impossible, under modern conditions of railway life, to give effect to it because it was not only dangerous and obsolete, but absolutely impracticable. The rule made it compulsory on the part of either fireman or guard of a train immediately the train reached a signal-box to proceed to the signal-box in order to remind the signalman that they were there, so that the signalman should not permit another train to run into them. The Board of Trade ought to abolish the rule, and compel railway companies to adopt some of the many mechanical appliances now available.

In reply, Mr. S. BUXTON said that, while not wishing to minimise the importance of the question of accidents, he would point out that, especially in the last 10 years, there had been a substantial reduction in the number of fatal accidents. As to non-fatal accidents, the increase was not so great as had been represented, because a large number of small accidents formerly not recorded, were now brought into the return. The Board of Trade had not found that the staff of inspectors and sub-inspectors was insufficient to cope with the work. He had been in communication with the railway companies in regard to the rule which required that, if a train was detained, the guard or fireman should walk to the signal box and speak to the signalman, so as to make sure that he was aware of the position of the train. Having regard to the improvements there had been in telephonic and electric communication, the Board thought that danger might be avoided by the use of appliances, and wrote to the companies pointing this out. Many of the companies had done a great deal in the way of fitting these mechanical appliances, but others had not done as much as lay in their power. The suggestion had been made that the Board of Trade should compel railway companies to fit these appliances; but the Board had no power to do so, and he hoped that it would not be necessary for them to seek such power.

Electric Traction on Standard Railways.—Last week Mr. CHIOZZA MONEY asked the Prime Minister whether his attention had been directed to the fact that German producers already possessed the advantage of cheaper railway rates than were available here, that Germany was now entering upon a vigorous policy of railway electrification, that electrification would give, in addition to still lower railway rates, cheap supplies of light, heat and power for industrial and social purposes; and if, in view of the increasing handicap which British producers and traders would soon suffer in these respects, he could say whether the question of railway nationalisation was engaging the attention of His Majesty's Government.

Mr. ASQUITH, in a printed reply, said he understood that railway rates were to some extent lower in Germany than in this country, but it was difficult to make an effective comparison. Steps were, he believed, being taken to equip portions of the German railways for electric traction; but a cheap supply of electric power for other industries did not necessarily depend on the electrical equipment of railways. He was unable to promise legislation with a view to railway nationalisation.

Telegraph (Construction) Bill.—This Bill was read a second time in the House of Commons on Monday. In moving the second reading, the Postmaster-General (Mr. Herbert Samuel) said it was a purely departmental measure of no general public interest. It dealt with telegraph lines and cables crossing railways and canals, and relieved the Post Office from payment for their maintenance in cases where those services were not rendered.

London Electric Railways.—On the 1st prox. the London Electric Railway Co. will introduce season tickets on the Baker-street and Waterloo, the Great Northern and Piccadilly and Hampstead lines.

Tickets will be sold to cover all journeys where the ordinary fare is 2d. or over, and will be sold at half rates to children under 15 years of age, to students, apprentices and junior clerks up to the age of 18 years.

LEGAL INTELLIGENCE.

British Westinghouse Electric & Mfg. Co. (Ltd.) v. Electrical Co. (Ltd.)

On Saturday Mr. Justice Swinfen Eady delivered his considered judgment in this action, relating to an alleged infringement of letters patent No. 18,786 of 1902, for "Improvement in electric arc lamps," granted to Hugo Bremer.

Defendants denied infringement and disputed the validity of the patent.

Mr. Justice SWINFEN EADY, in giving judgment, said the validity of the patent had come into question in a former action between plaintiffs and one George Braulik, when the patent was upheld by the Court of Appeal. But the evidence in the present case was different, and the alleged infringement was a different lamp. The patentee stated in the specification that his invention related to electric arc lamps of the kind in which the electrodes were inclined to each other, and both pointed in the downward direction, the arc being formed at their lower extremities, and he claimed as his invention an arc lamp having downwardly pointing electrodes and provided with both downward and horizontal feed mechanism, so arranged that a certain amount of operation of the horizontal feed mechanism takes place before the downward feed mechanism is permitted to operate, subject, however, to the disclaiming note, which was as follows: "The lamps to which this, my invention, applies are of the type in which the current is supplied to the electrodes through electrode holders in which the upper end of the electrodes are firmly clipped, and which are capable of being lowered simultaneously through the same distance, and about one of which the corresponding electrode can swing under the action of a device acting near its lower end, and I limit my claim to lamps of this description." It was determined in the former action that there was no substance in the objection as to insufficiency of specification, that the letterpress was clear and intelligible, and when taken in connection with the figures rendered it perfectly easy to understand the invention, notwithstanding certain trifling inaccuracies in the drawing which were not of a kind to cause difficulties to any electrician. The exact nature and extent of the invention, as described in the specification and shown in the drawings, was considered in that action, and reading the claim with the text of the specification it was determined that the claim was limited to the invention so described, and the exact limits of the claim were pointed out. He was bound by the construction put upon the specification by the Court of Appeal in the former action. It was urged, however, that the language of the plea of insufficiency was different in the present case from that in the former, and that if the patentee intended a floating feed the language of his specification was very inappropriate for that purpose. But that point was covered by the previous decision. The floating feed involved a lamp being so adjusted as to meet the variations of current arising from the irregularities and the resistance due to the irregularities of the carbons. The mechanism shown and claimed in the specification was capable of instantaneously adjusting the electrodes so as to compensate for the irregularities in them, and thus keep the light steady. The mechanism which struck the arc was capable of alternately shortening and lengthening the arc as the variations of the electrodes required, and it was that improved mechanism which rendered the lamp capable of instantaneous response to changes of resistance in the arc. It was said that there was no evidence of utility in the present case, but the sale of the "Excello" lamp was proved by Mr. Marshall. That lamp was made substantially in accordance with plaintiffs' specification, and was the pattern being sold commercially at present, and the manufacturers had already paid royalty on nearly 20,000 lamps to the owners of the patent in question. It was urged that some lamp manufactured and put on the market by plaintiffs themselves proved a failure, but he had no evidence of what that lamp was. It was then contended that plaintiffs' patent failed for want of novelty, that the invention had been anticipated, or at all events, having regard to common knowledge, there was no subject matter. With regard to Graham's lamp, he was satisfied that he did not contemplate or intend, or describe any arrangement intended to obtain a floating feed. The action of his mechanism was what had been referred to as "sudden death" action. There was no indication in the specification of floating or of any advantage or benefit being gained by any horizontal movement of the carbon beyond striking the arc. The essence of his invention was his device for regulating by an electromagnet the escapement, so as to provide for the knife edge being alternately engaged with and released from the series of pins, and thus regulating the feed of the carbons. The patentee's mode of regulating the length of the arc was by regulating the downward feed, and not by obtaining any horizontal floating action. Although a model of Graham could be made so that it would float, there was, in his opinion, no indication of obtaining a floating feed in Graham's specification from beginning to end. Crosby is much further off floating than Graham, and might be dismissed, for the reason and upon the grounds set forth in the judgments of Lords Justices Moulton and Buckley in the previous case. Wright's patent was for a magazine electric arc lamp, the object being to provide a lamp with a series of carbons arranged in magazines, and also having a central main for automatically feeding the carbons one after the other as they were consumed. It seemed quite a hopeless lamp. Prof. S. P. Thompson said that if you made the lamp with magazines it would be a very bad lamp indeed or badly balanced. With regard to floating, the extreme positions of the electromagnetic mechanism would vary in accordance with the number of carbons in the magazine, and the points of equilibrium would vary also. It was urged that defendants really admitted that

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Wright floated, but Mr. Swinburne's evidence amounted to this—that if the lamp did float the feed would become hopeless, because one carbon would go before the other, and that the only way to make the lamp work would be to arrange it so that there was no floating in the ordinary working, and that when it did feed it fed both carbons. Jamin was also referred to, but it seemed to have little if any bearing on the case, and the evidence about it was not elaborated. The carbons were not inclined but parallel while burning, and were only inclined to strike the arc.

The real contention of defendants was that the substance of plaintiffs patent was to be found in Graham, Crosby and Wright taken together and adding common knowledge. In his opinion that contention could not be supported. Plaintiffs' invention was for a lamp of a certain definite type, and was a distinct advance upon everything that had gone before; it had enabled flame arc lamps to come into general and commercial use; it had given to a definite type of lamp a floating horizontal feed in a definite manner and superior to anything which had gone before. The invention was new and useful, and subject matter for a valid patent. The infringement seemed clear. Defendants had in substance taken plaintiffs' lamp, although with variations; they pivoted the guides, with the result that there was a larger mass to be moved. But it could make no difference in principle whether one merely moved the electrode and its holder or whether one regarded the whole frame as being the electrode holder, pivot that, and then operate it as near the bottom as possible. Such a variation was covered by the doctrine of mechanical equivalents. The horizontal floating was obtained by a similar method in each case. The result was that plaintiffs succeeded, and were entitled to the relief claimed.

Mr. WALTER: I ask for an injunction, an enquiry as to damages and delivery up. I also ask for a certificate of the particulars of breaches, and also that the validity of the patent came into question.

His LORDSHIP granted the application and, by consent (if notice of appeal is set down within 14 days), the operation of the order, so far as the delivery up was concerned, was suspended until after the appeal has been disposed of, but no stay as to costs.

W. Canning & Co. v. Northern Flexible Metallic Tube Co.

On Monday and Tuesday Mr. Muir Mackenzie, official referee, heard this action to recover the balance of the price of an electric galvanising plant for galvanising iron strip. Defendants alleged that the plant was defective and counterclaimed for damages.

Mr. T. TERRELL, K.C., said the question to be decided was whether the plant supplied was efficient for its purpose. Plaintiffs contended that it was, and that if any defects did arise they were caused by want of skill on the part of defendants' employés. He explained that flexible tubing was produced by a process of coiling long iron strips or ribbons, a thin strip of rubber material fashioning the joints. It was necessary to protect the tubing, when made, from ravages of rust, and that was done by galvanising it or giving it a thin coating of zinc. In 1908 defendants were desirous of procuring a galvanising plant for galvanising their own strip, which hitherto they had not done. Plaintiffs agreed to supply the plant. Counsel explained the process of galvanising and said that the strips of steel wire passed through a tank containing a carefully prepared solution. An electric current passed from the anode in the tank through the solution to the steel strip which formed the cathode and deposited on the strip a coating of zinc. The electric energy was derived from a dynamo and the current used had to be carefully regulated. After plaintiffs had put down the plant in 1909 at a cost of £260, it was tested on Feb. 21 and described by defendants as "very satisfactory." In April they wrote still saying it was satisfactory but complaining that the zinc coating obtained was too dark, and asking plaintiffs' advice. Plaintiffs wrote asking for samples of the solution, &c., defendants were using but did not get them. Hearing no more, they rendered their final bill, but defendants refused to pay, contending that the plant was not satisfactory.

Mr. GEO. A. DARBY, electrician in plaintiffs' employ, gave evidence as to visiting Bradford to test the plant after it had been put down. Such plant needed careful watching to see that the electric current used was kept quite steady. He saw the plant while passing a quantity of steel strip through it. It did the work of galvanising very well, and defendant's representative expressed himself as quite satisfied with it. When he went down at a later stage, after the dispute had arisen over the settlement of the account, he found the plant in a very dirty and rusty condition. It was an eyesore compared with the condition the plant was in when plaintiffs handed it over. Changes had been made in the working of the plant which seemed to suggest that defendants had been trying to experiment with it. If the plant had been properly cleaned, put into working order and skilled men to attend to it, it would turn out perfectly galvanised steel strips.

Cross-examined by Mr. WAUGH, K.C., for the defendants, witness admitted that he had not worked similar plant to the one in question anywhere else. He was testing it for four and a-half days. It was necessary for the sawdust through which the steel strip passed for the purposes of drying, to be moved about to prevent that nearest the strip from becoming sodden. There was no mechanical device to do that on the plant in question. If there had been it would have been an improvement no doubt, but it would have put up the cost of the plant. The man attending the plant could have done that. If not properly dried by passing through the sawdust the strip would not be properly galvanised and rust would be produced. As to the suitability of the solution used in the electrolyte, he said the use of the hydrometer was not sufficient to test whether the solution had been made up properly.

Mr. H. RILEY, electrician in plaintiffs' employ, said that in testing the plant of this character it was necessary to find out the best current density required. He helped last witness to test the plant in question.

Mr. WM. S. RAWSON, consulting electrical engineer, said he had examined the plant and was of opinion that with proper supervision it ought to work satisfactorily. He did not think that the zincing would take on a dark colour in the electrolytic tank. He had seen the zincing come out porous when the current had been excessive. There was a switchboard and a resistance, and from the switchboard the operator would from time to time regulate the strength of current sent through the electrolyte.

Cross-examined, witness said, given reasonable supervision, a two hours' test was sufficient to see whether the electrical portion of the plant would work properly. He denied that the strip would show a black appearance in the electrolytic bath unless the current density was reduced to a very small minimum indeed. With the exception of rust on the original strip it would not become dark by reason of inefficient cleaning in the processes through which it passed. If the speed at which the steel tape was passed through the plant were increased it would be reasonable to increase the electric current density in order to maintain a uniform zinc coating on the strip. He agreed that the effect of hydrochloric acid on zinc would be to dissolve the zinc. It would not be a proper method to line boxes where hydrochloric acid was washed off the steel tape, with zinc. He should not have used zinc. If the current was maintained at a proper average he could not account for the strip coming out dark in places and subsequently rusting. Even if the swillers were not properly acting and the felt wipers did not take away all the caustic solution or acid, it was difficult to say whether they might not cause part of the strip to be darker in colour than others.

Mr. GEORGE ARTHUR POPE, works manager of plaintiffs, stated that he was associated with the design of the apparatus in question. The general principle of the design could not be followed in the case of defendants' plant because of want of space.

Mr. WM. E. HUGHES said plaintiffs gave him samples of steel strip galvanised and not galvanised for testing. Witness had been asked to find out what would be the quickest time and lowest current used in which to produce a deposit similar to that on the galvanised sample sent to him. With the aid of Sir Wm. Preece's process he had found that by using one-tenth of an ampere on a foot length of ¼ in. strip for a period of 10 or 15 minutes he obtained the deposit of zinc desired. He examined the plant in question on Feb. 8, 1911, at Bradford. It was in a filthy condition. He thought that if the plant had been properly worked under efficient supervision the results would have been satisfactory.

In cross-examination he said from what he saw the dynamo was quite sufficient for the purposes of supplying current, the electrolyte was satisfactory and the pickling tank and swills were suitable. Too much or too little electric current would make the zinc deposit on the steel tape darker, certainly too much time would.

Hearing adjourned till Monday.

National Telephone Co. (Ltd.) v. Postmaster-General.

The Court of Appeal (the Master of the Rolls and Lords Justices Farwell and Kennedy) continued the hearing of the cross appeals in this case.

Sir ALFRED CRIPPS, for the company, submitted that sub-clause *a* of clause 3 of the specification applied to both competitive and non-competitive areas. It was most important to bear in mind that as regards *a* the test was whether the plant was of the prescribed construction or specified in the list in the schedule to the agreement of Feb. 2, 1905. No objection could be taken to plant in the list, even if it was not constructed according to specification. Then by *b*, in competitive areas, what was taken out of *a* was plant, whether constructed according to specification or not, if it was not suitable to the Postmaster-General's system at a particular date. As for land and buildings, land was not to be bought and buildings were not to be constructed after 1905 without the consent of the Postmaster-General, but in competitive areas the assent did not protect the company if the buildings were not suitable. It could, of course, be contended that certain buildings were not suitable to the business that the Postmaster-General proposed to carry on. It was admitted that plant in the list could not be objected to under *a* All. that *b* provided was that construction according to the specification was no longer a protection to the company. That did not give the Postmaster-General the right to object to plant in the list as unsuitable to his requirements. The test of suitability was suitability to the system of the Post Office on a particular day. That excluded suitability to the Company's system. Suitability, therefore, had to be considered with reference to that limited test, and if in these circumstances it were construed as meaning necessity, the result would be absurd, because no portion of the company's plant could be said to be necessary to the Post Office. With regard to the notices, it must be remembered that the onus was on the company to obtain an award before a certain date that plant objected to was suitable. The notice, therefore, ought to be such that a reasonable business man on receiving it could decide whether it should be accepted or not having regard to his business interests. He contended that if a piece of plant was suitable for the requirements of the Post Office on Dec. 31, 1911, it did not become unsuitable merely on the ground of redundancy. If the test of the Post Office requirements was, what plant was required on that day, both services would be working on that day and it could not be said that plant which was actually in use was not required. With regard to notices, the Postmaster-General had obtained for himself the advantage that he could give notices of objection. That, however, did not entitle him to put on the company the burden, which might be extremely onerous, of finding out what was included in the

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notice. It was for the person who gave the notice to make plain what he was objecting to. It was no answer to say that the matters were so complicated that it would be impossible for the Postmaster-General to do that. The more complicated the matter, the more necessary was it that the notice should be such that a reasonable man of business could act on it. If it was impossible to give such a notice, then it was impossible to give a valid notice at all. There were a large number of matters in respect of which a valid notice could be given, but there was no reason for holding valid a notice on which no reasonable man of business could decide whether he should accept or contest the notice.

On Tuesday the Attorney-General having concluded his reply on behalf of the P.M.G., their lordships reserved judgment until June 28th.

Potts v. Metropolitan District Railway Co.

At Westminster (London) County Court on Friday, before Judge Woodfall and a jury, Wm. Potts sued defendant company for damages for personal injuries alleged to have been sustained through his having received an electric shock while standing on the platform at Putney Bridge station.

Mr. NIMMO (for plaintiff) said that on Dec. 8 last his client went to Putney Bridge station to catch a train to Southfields. There had been a heavy fall of rain shortly before, and on the platform there was a small puddle of water. Plaintiff walked to within 2½ ft. or 3 ft. of the edge of the platform, and was standing in the puddle when he suddenly received an electric shock of so severe a character that it precipitated him on to the permanent way. As a result he sustained serious injury. The explanation of plaintiff's unpleasant experience was that the heavy rainfall had caused the tape or covering of the electric cable to become so saturated that the current leaked from the "live" rail and passed through the girder and concrete, which formed the platform, to the water—a natural conductor—in which plaintiff was standing.

After hearing plaintiff's evidence,

Mr. A. E. COOPER, engineer to the defendant company, said he examined the cable after plaintiff had received the alleged shock, and found not the slightest trace of there having been a leakage. Had there been a leakage the current would have gone nowhere, except to earth, and the fact that plaintiff stood in water on the platform rendered him in no way liable to receive a shock. It was possible that if plaintiff from some unexplained cause fell off the platform on to the "live" rail he might have received a slight electric shock.

His HONOUR said the allegation that there must have been a leakage of electric current had not been satisfactorily proved, but even if there had been, the expert evidence was distinctly against the current having travelled to the station platform. Going further and presuming that plaintiff did receive an electric shock in the way he alleged, could it be said that the railway company had been guilty of negligence, seeing that the leakage was described as resulting from a sudden heavy downpour of rain?

The jury, after a few minutes' deliberation, found for plaintiff, awarding him £50 damages, and judgment was entered for that amount, with costs.

Belfast Corporation v. Cavehill & Whitewell Tramway Co.

A Divisional Court of the King's Bench Division, Dublin, delivered judgment last week in this application by the Corporation to set aside the award of Mr. Macassey, arbitrator appointed to settle the amount of the purchase money to be paid by plaintiffs for the company's undertaking.

The CHIEF BARON, in delivering judgment, said the question was, first, what was the basis upon which the award was made? And, secondly, was that the true basis? He had arrived at a clear conclusion that the basis upon which it was made appeared upon its face. He had come to the conclusion that the award was made upon a wrong basis, and consequently that there was jurisdiction in the Court to set it aside. The statement in the award was that the arbitrator had valued the undertaking as a going concern, ascertained as a revenue-producing undertaking, and that on such construction he was bound to assess the value on the basis of capitalising the revenue which the transferred undertaking was capable of producing. He considered he was precluded from having regard to any circumstances other than the circumstances of a maintainable revenue which the undertaking was capable of producing and the number of years' purchase to be taken for ascertaining the capitalised revenue. He declared that he had not adopted the construction contended for by counsel for the Corporation, and that in arriving at the value, which he fixed at £56,155, he had had regard not merely to the circumstances of the maintainable revenue which the transferred undertaking was capable of producing and the proper number of years' purchase, but to all the circumstances of the case to which he could properly have regard, assuming the construction contended for by the Corporation was not the true construction. Therefore if that was the true construction of the agreement he had acted on a wrong basis. The true mode of arriving at its value, in the opinion of the Court, was first by ascertaining what was its net annual value, what could be made out of the thing to be rented and then by capitalising the rental value of the undertaking. He was not to be taken as laying it down that it was the amount of rent that could be obtained if let, because the profit that could be made by a tenant would be part of the profits that would be made by the company or Corporation, and that element of profit was an element that would be taken into consideration. The arbitrator would be bound to take into consideration the reasonable probability, having regard to all the circumstances of the case, of the actual profit in previous years either being increased or diminished or continued, and in that way he might arrive at an average sum which would fairly represent what would be the average income for a number of years, and then capitalising and putting upon it such a number of years' purchase as he thought ought to be given in the circumstances. Accordingly the Court held that the award should be remitted back to the arbitrator, and they would extend the time for making tha award to Nov. 1 next. They would give no costs.

Arbitration as to Laying Power Mains.

At Batley last week Mr. W. H. Patchell sat as Board of Trade arbitrator to hear an appeal by the Yorkshire Electric Power Co. against the refusal of Batley Corporation to give consent to the laying of electric mains in Bradford-road in connection with the Company's scheme for the extension of their cables from Dewsbury to Gomersal.

Mr. W. B. WOODHOUSE, engineer and manager of the company, stated that the mains were intended, primarily, to serve one mill in Soothill, and he quoted from the company's Acts to show that they had power to supply energy and lay mains in Batley.

The Town Clerk (Mr. J. H. CRAIK) pointed out that it was specially provided that the company should not lay mains except with the consent in writing of the Corporation.

Mr. WOODHOUSE stated that in the Soothill Upper area the company had power to supply without consent, that power being preserved in the amalgamation order, so that both the company and the Corporation had power, in competition, to supply. The company had made an agreement with the owners of the Union Mills to supply energy, and he contended that the company's supply was more suitable than the Corporation's. He asserted that the Corporation's supply on the borders of Soothill was not satisfactory.

Mr. CRAIK contended that an alternative route for the company's main was practicable, and that Bradford-road was so full of tramways, gas and water mains, electric mains and sewers, that there was not room for any more.

Evidence was called on this point, and after Mr. Woodhouse had replied, asserting that the alternative route would be a mile longer than the one proposed, the inquiry closed.

Rail-less Trolley Traction.—The official opening of the Leeds and Bradford rail-less trolley routes took place on Tuesday, and subsequently those who took part in the proceedings lunched together at the Town Hall, Leeds.

There were about 200 guests at the luncheon: The Lord Mayor of Leeds (Mr. Wm. Middlebrook, M.P.) presided, and amongst others present were the Lord Mayor of Bradford (Mr. J. Moser), Sir Wm. Clegg (Sheffield), Mr. E. Priestley (chairman of Bradford Tramways Committee), Ald. C. F. Tetley (chairman of Leeds Tramways and Electricity Committee), Ald. Smithson, the Town Clerks of Leeds and Bradford (Mr. R. E. Fox and Mr. F. Stevens), Mr. J. B. Hamilton (Leeds city tramways manager) and Mr. C. J. Spencer (Bradford city tramways manager).

Sir WILLIAM CLEGG, chairman of the Sheffield Tramways Committee, proposed "Success to Rail-less Trolley Traction." He offered to Leeds and Bradford his hearty congratulations on being pioneers of this new system of traction. He believed that their venture would be most successful, but whether they would be as profitable as ordinary tramways he was a little doubtful. He was certain that the advantages of the rail-less system would outweigh any financial difficulties that might present themselves.

Ald. C. F. TETLEY responded to the toast. He regretted, however, that they had had to go to such distant countries to find the latest developments in traction, at a time when the enterprise in England was in some directions as great as ever, and when capital and mechanical skill were not less. Referring to the extraordinary development in electric traction during the past 20 years, he remarked that the first trolley system was started in America in 1888, and three years later the British Thomson-Houston Co. started a trial line from Sheepscar to Roundhay, in Leeds. From those small beginnings had grown the splendid success of municipal tramways, and he could not imagine that anyone who saw the traction of 1891 realised what the next 20 years would bring about. He hoped that complete success would attend the new system, and that its advantages would be fully appreciated. However, he was glad to think that they had joined with Bradford in being the pioneers of that great movement.

Mr. E. PRIESTLEY also responded. They were inaugurating what he believed would be a very successful means of traction. He believed that both Leeds and Bradford would go forward to success in the working of the system, which, as had been pointed out, had very material advantages for special routes. One advantage which had not been mentioned was that if the service on any particular route proved unprofitable the equipment could easily be moved to another. He believed that the example of Leeds and Bradford would be speedily followed by other towns.

The equipment of the route along Sticker-lane, Bradford, awaits the inspection of the Board of Trade, and a public service cannot be started until that inspection has been made. It is proposed as a start to run a half-hourly service with two cars, one of which has still to be completed. Later other cars may be added and the service reduced to 20 minutes, or even less. The cars are single deckers, constructed to hold 28 passengers, and they are driven by two motors, each of 20 H.P. They run smoothly on wheels with solid rubber tyres, and if necessary they can be steered to the extreme edge of the road. The fare of the single journey has been fixed at a penny.

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COMMERCIAL AND INDUSTRIAL SECTION.

MUNICIPAL, FOREIGN & GENERAL NOTES.

BRITISH NOTES.

Application for Extension of Patent.—The Automatic Telephone Co. are applying to the High Court for extension of the period of the patent No. 809/1898, for "Improvements in calling devices for telephone exchanges. Application will be made on or after July 29 to the Court for a time to be fixed for the hearing of the petition.

Bethnal Green (London).—The Council have decided to appoint a consulting engineer, at a fee of not more than 50 guineas, to report upon a municipal scheme for the distribution of electricity in the district, energy being taken in bulk from a neighbouring Council.

Birmingham.—The Tramways Committee are in negotiation with the City of Birmingham Tramways Co. for the acquisition of the company's undertaking in Aston, Yardley, King's Norton and other districts in the Greater Birmingham area.

Ewell.—Epsom Council have applied for an order to enable them to give a supply of electricity to certain premises in this district.

Glasgow.—At a special meeting of the Corporation last week the Tramways Committee recommended that the application of the motormen and conductors for a 48-hour week (instead of 54) and 14 days holiday with pay (instead of 5) be not entertained.

It was also recommended that the department continue to arrange the duties and reliefs of motormen and conductors so that the average time actually spent on the car would be as near as possible eight hours per day; that after the day's work of motormen and conductors be, as far as practicable, divided into two shifts, and that the number of long shifts be kept at a minimum. The committee further recommended that during the first, second, third and fourth six months the rates of pay remain as at present, these being respectively 4s., 4s. 2d., 4s. 4d. and 4s. 6d., but that in the third year they be increased in the fifth six months of service from 4s. 8d. to 4s. 10d., in the sixth six months from 4s. 10d. to 5s., in the fourth year from 5s. to 5s. 2d., in the fifth year from 5s. 2d. to 5s. 4d. and thereafter from 5s. 4d. to 5s. 6d.; conductors with over five years' service who have not qualified as motormen to be raised from 5s. to 5s. 2d. The extra cost to the department in wages would be about £5,500, and this sum, added to the recommendation for increases already adopted by the committee, would make the total net increase £9,000.

Hastings.—The Council have applied for sanction to a loan of £[illegible] for mains extensions.

Menai Bridge.—The Council have entered into an agreement with W. E. Berry for the erection of electricity works for public and private lighting.

Merthyr.—The Council have appointed a committee to consider the question of approaching the Merthyr Electric Traction & Lighting Co. with a view to ascertaining whether they were disposed to sell to the Corporation the whole of their undertaking within and adjacent to the borough. The committee is also to report upon the advisability of applying for powers to construct an electric tramway or other mode of conveyance along the main road between Merthyr and Treharris.

Nantwich.—The Rural Council have granted permission for the Council to lay mains in the district so as to supply current to the new County Training College and the new Postal Sorting Office.

Southampton.—The salary of the station engineer (Mr. J. B. B. Hewitt) has been increased to £215 per annum.

Stockton-on-Tees.—An unopposed inquiry was held here on Tuesday last into the application of the Council for sanction to borrow £6,750 for additional plant at the electricity works.

Theft of Electric Cable.—At Dublin City Commission last week two men named Meyne and Kavanagh were found guilty of stealing 11 yards of electric cable from the Technical Schools. The cable was being used in connection with the electric lighting installation for a new building. Each prisoner was sentenced to six months' imprisonment.

Weaverham.—The Rural Council have consented to overhead wires being used by a private company to supply current at Weaverham, Acton and Acton Bridge. The scheme will be carried out by Mr. A. J. Leigh, Northwich.

Wombwell.—The Council will apply for a provisional electric supply order, the area to include Darfield. An order is also being applied for by the Electrical Distribution of Yorkshire.

COLONIAL AND FOREIGN NOTES.

Australasia.—The Agent-General for New South Wales (123-5, Cannon-street, London, E.C.) will receive communications for a N.S.W. firm who wish to get into touch with a British maker of machinery for manufacturing ordinary and brazed mild steel unscrewed electric conduits.

Wanganui East (N.Z.) ratepayers have passed a resolution to raise a loan for tramway construction.

The Ruthning Electrical Co. propose to erect electricity works at Murwillumbah (N.S.W.), a town of 2,000 inhabitants, about 400 miles north of Sydney. The local Council have referred the matter to a sub-committee.

Mr. Woodford, civil engineer of the Public Works Department, has completed taking levels for a scheme for utilising the water power of the Shoalhaven river (N.S.W.) for the generation of electrical energy. The river, which comes within 20 miles of the city of Goulburn, rises 3,000 ft. above the sea level. It is proposed to conduct the water 24 miles in flumes and pipes from Devil's Bridge to a power house at Tanner's Gully.

Newcastle (N.S.W.) Council are strongly in favour of the electrification of the present steam tramways in the town. At a recent meeting they decided to ask the Minister for Works to construct another electric tramway. Mr. J. E. Donaghue has withdrawn his offer to act as consulting engineer to the Council's electricity department at 50 guineas per annum, as in view of the large amount of work involved his fee would be 100 guineas for the first and 50 guineas for subsequent years.

Mr. F. W. Clements calls attention to the fact that Adelaide Council have power under the Adelaide Electric Supply Co.'s Private Act to acquire the company's undertaking in 10 years, whereas the usual term in the other Australian States is 30 years, and in the case of English undertakings 42 years. He considers the Corporation are not justified in their threat to demand, through Parliamentary intervention, "more liberal terms" than they already have as to the acquisition of the company's undertaking.

The net profit on the Wellington (N.Z.) electric tramways last year was £6,225, and on the supply undertaking £4,346.

Austria-Hungary.—The Aussig Communal authorities will commence the construction of the Aussig-Pokau railway to Tellnitz station in the coming autumn. The expenditure will include about £14,500 for the construction of the line, £7,500 for a turbine and £5,800 for a storage battery.

The Zivnostenska Bank is interested in a project to erect iron-works (in which electrical energy generated by water power will be used) to work the rich iron deposits in Eisenstein (Bohmerwald).

Belgium.—An engineer at Brussels wishes to receive communications from British manufacturers desirous of supplying goods to the Belgian Government Departments, particularly for the telegraph and telephone services. Further particulars from Mr. T. E. Jeffes, British Vice-Consul, Brussels.

Canada.—The Imperial Trade Correspondent at Winnipeg (Mr. J. Appleton) says, in reference to the contract for the erection of a dam, power station, &c., at La Colle Falls, on the North Saskatchewan river, British firms could not tender, but there will be an opening for electrical machinery.

India.—"Indian Engineering" understands that consideration of the scheme for a system of electric lighting and electric fans for the general offices and press buildings of the Assam-Bengal Railway at Chittagong has been deferred because the initial cost is considered prohibitive.

"Indian Industries and Power" states that Marshall & Co. (Bombay) will illuminate the Bombay public buildings electrically on the occasion of the visit of the King and Queen in December next. The Bombay Electric Supply Corpn. will have available for this purpose and for private illuminations 2,200 kw. of plant. The devices on the public buildings will comprise about 200,000 5 c.p. carbon filament lamps.

Sweden.—The Bill dealing with the lease of State waterfalls to private persons has been passed, the maximum period for leases being 75 years instead of 95 as originally proposed. Leases may be cancelled by the Government if the holders use the water power for purposes other than those specified.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Colchester.—The income of the electricity supply department for the year ended March 31 was £16,248, against £15,146 in 1909-10.

Receipts from the sale of electricity to private consumers were £12,261 nett (952,153 units), against £10,990 (802,564 units); public

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lighting revenue was £968, against £959, and tramway revenue £2,699, against £2,948. Total costs were £8,949, against £8,410, and after paying interest (£2,351) and repayment of loans (£3,189), writing off £999 from prepayment installations and mechanical stokers account, and providing £385 for purchase of arc lamps for hire and £162 for purchase of meters, there was a net profit of £212, against £414. The capital expended is £36,430, an increase of £3,381. The maximum load was 1,050 kw., against 895 kw., and the load factor 16·11 per cent., against 17·5. The equivalent of 61,164 8 c.p. lamps is connected, against 56,191, and 1,483,458 units were sold, against 1,372,340. The works costs were 1·23d. (1·23d.) and the total costs 1·44d. (1·47d.) per unit.

Manchester.—The accounts of the electricity department were submitted to the Corporation last week.

The total capital expenditure was £2,733,207, an increase of £54,577 over 1909-10, but the net loan debt is £1,949,583. The revenue from the sale of current was £396,145 (including £118,223 from the tramways department, £870 from street lighting and £13,599 from private lighting, power and heating supplies to Corporation departments) and meter and motor rental, &c., brought the total revenue to £403,327. The total working expenses were £189,027, and included £108,349 cost of generation, £31,710 distribution, £34,947 rents, rates and taxes and £11,814 management expenses. The gross profit was £214,300, and after paying interest (£69,682), sinking fund (£89,543) and instalment of loan repaid to Public Works Loan Commissioners (£6,370), and placing £21,672 to renewals suspense account, there was a net profit of £27,573, out of which £15,000 was paid to rate account and the balance placed to special renewals account; 115,400,446 units were generated (against 95,542,254) and 83,308,848 were sold (against 42,886,223), including 54,718,320 to private consumers, 167,001 for public lamps and 28,423,527 to tramways department. The total maximum supply demanded was 28,240 kw. lighting and power and 9,310 kw. for traction. At the Dickinson-street and Bloom-street stations the first completed year of working with the large Tudor storage battery results in a very substantial reduction of the station costs.

South Shields.—The accounts of the electricity supply department at March 31 show capital expenditure £188,173.

The revenue from electricity supply was £26,307, an increase of £1,236; the working expenses were £13,185, a decrease of £245, and the gross profit was £13,122, an increase of £1,481. Interest and sinking fund came to £11,707, a decrease of £49, leaving a net profit of £1,415, making, with the profit on the quay of £19, a total surplus of £1,434, compared with a deficit of £209. £59,499 of the capital expended (over 31 per cent.) has been contributed by means of the sinking fund. The maximum load was 2,054 kw., against 1,760 kw., and the combined load factor was 19·32 per cent., against 20·53 per cent. The lamps and motors connected increased from the equivalent of 133,703 to 143,817 35-watt lamps, and the number of premises connected was 1,574, an increase of 100. 3,476,539 units were sold, an increase of 310,243. The lighting units increased by 1·5 and the power units by 7·4 per cent.; but there was a decrease of 14·4 per cent. in the traction units. The works costs were 0·57d., against 0·63d. per unit sold, and the total costs 1·66d., against 1·85d.

Sunderland.—The capital expended on the electricity supply undertaking at March 31 was £431,737, an increase of £7,281 over 1909-10.

Revenue from the sale of electricity was £53,568 (including £14,299 from the tramways and other Corporation departments and £2,566 from public lighting), and after adding meter rent (£671), public lamp maintenance (£988), &c., the total income was £55,485. The working expenses were £23,997, leaving a gross profit of £31,488. After taking into account the balance brought forward (£1,077) and paying interest (£12,403), sinking fund (£16,055) and £1,685 for condensing plant, pipework, switchgear, &c., there was a net balance of £112; 10,208,493 units were sold (6,850,966 for power and 1,206,431 for private lighting) 1,702,872 for traction and 448,224 for public lamps. The maximum supply demanded was 5,235 kw.

In his report, the borough electrical engineer (Mr. A. S. Blackman) states that the outstanding features of the year were the recovery in the shipbuilding and engineering trades from the great depression, the further reduction in generating costs (0·42d. to 0·37d. per unit) and the reduction in the average price from 1·5d. to 1·3d. per unit. The net profit of £1,189 on the year's working was made possible by the reduction in the coal consumption (from 4·35 lb. to 3·7 lb.). The power sales increased by 58·2 per cent. (from 3,961,302 units to 6,041,559) and the increase over the whole sales was 30 per cent. There are 1,256 consumers, an increase of 19; the equivalent of 94,377 32-watt lamps is connected for private lighting (an increase of 2,070) and 72,189 (3,097·8 H.P.) for power (an increase of 3,001 (123·6 H.P.). There are 215 arc and 355 incandescent lamps for street lighting, an increase of 263 incandescents.

West Bromwich.—The total revenue of the electricity supply department for the year ended March was £14,226, including £3,642 for private lighting, £8,547 net for power, £4,757 for traction and £380 for public lighting.

The total expenditure was £7,650, leaving a gross profit of £6,354 on the electricity supply and £222 on the hiring department. Interest and dividends on stock absorbed £1,734 and sinking fund £3,069, leaving a net profit of £1,782. 323,158 units were supplied for private lighting, 1,319,727 for power ,627,714 for traction and 100,974 units for public lighting.

TRADE NOTES AND NOTICES.

TENDERS INVITED

ALDERSHOT Urban District Council invite tenders for supply and erection at their electricity works of one 135 kw. Diesel direct-coupled set. Specifications and further particulars from the engineer, Mr. F. Garside, Electricity Works, Laburnum-road, Aldershot. Tenders to the Clerk to the Council, Mr. W. E. Foster, by noon July 4. See also an advertisement.

Tenders are invited for the supply of 150 miles insulated wire and 5 miles of telegraph cable to the Postmaster-General's Department in Victoria. Tender forms and specifications from the Commonwealth Office, 72, Victoria-street, London, S.W. See also an advertisement.

HAMMERSMITH (London) Borough Council invite tenders for supply of about 600 time switches suitable for controlling individual electric lamps for lighting side streets. The switches are required to deal with 1 ampere at a pressure of 120 volts single-phase a.c. 50 periods. Samples of switches tendered for should be addressed to the borough electrical engineer, Mr. G. G. Bell, 85, Fulham Palace-road, Hammersmith, W. Tenders to the town clerk, Mr. H. Thompson, by 4 p.m. Friday, June 30.

The Electricity Committee of HULL Corporation invite tenders for one year's supply of electric cables and for the supply of the two water-tube boilers required in connection with the extensions of plant at their Sculcoates-lane generating works. Tenders, addressed to the Chairman of the Electricity Committee, Town Hall, Hull, must be delivered by noon of Monday, June 26.

Tenders are invited for supply of lead-covered and vulcanised rubber-covered cable to the City of MELBOURNE. Specifications, &c., from the agents for the City Council, Messrs. McIlwraith, McEacharn & Co. Proprietory (Ltd.), Billiter-square-buildings, London, E.C., to whom tenders by noon Friday, July 7.

The Secretary of H.M. OFFICE OF WORKS invites tenders for providing and erecting at the South Kensington generating station complete surface-condensing plant, capable of dealing with 15,000 lb. of steam per hour, together with the necessary gantry and stanchions. Forms of tender and further information may be obtained at H.M. Office of Works, Engineering Division, 55, Whitehall, London, S.W., Tenders by 11 a.m., June 30, to Secretary, Storey's Gate, London, S.W.

GOVAN Corporation require tenders by June 27 for supply and erection of steam, exhaust and water piping, boiler, mechanical stoker, coal bunkers, and cooling tower and for extension of h.t. switchboard. Specifications, &c., from the Burgh Electrical Engineer.

BATTERSEA (London) Council require tenders by 4 p.m. June 30 for the supply of about 440 street lanterns for containing groups of metallic filament lamps. Specifications, &c., from the Borough Electrical Engineer.

The Great Southern & Western Railway Co., Kingsbridge Terminus, DUBLIN, require tenders by 10 a.m. July 5 for one year's supply of stores and materials, including electric light carbons, copper, iron, steel, oils, &c. Forms of tender from the Stores, Inchicore, Dublin.

SWINFORD (co. Mayo) Electric Lighting Committee invite tenders for the electric lighting of the town. Specifications from the Clerk to Swinford Rural Council, to whom tenders by 11 a.m. July 10 The requirements include suction gas plant, engines and dynamos storage battery switchboard, overhead lines and street lamps.

Mr. A. C. Freeman, 499, Sauchiehall-street, Glasgow, will receive tenders until 10:30 a.m. June 28 for carrying out an electric illumination and decorative lighting scheme for the Scottish Exhibition GLASGOW, 1911. Plans, &c., from the Chief Engineer's Department at the Exhibition.

MANCHESTER Electricity Committee invite tenders for supply and erection of two water-tube boilers, superheaters, coal chute ash conveyors and fuel economisers. Tenders to Chairman Committee, Town Hall, Manchester, by 27th inst.

IPSWICH Guardians require tenders by noon June 30 for alterations to switchboards and other electrical apparatus at the workhouse. Specifications, &c., from Mr. H. P. Girling, the Wharf Maldon, Essex.

CHARLEVILLE Electric Co. (Charleville, co. Cork) want tenders by noon June 30 for supply of suction gas plant, gas engine and electric generators, storage battery and accessories, switchgear, overhead lines and street lamp fittings. Plans, &c., from the Secretary.

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CARDIFF Corporation require tenders by 10 a.m. July 14 for the supply of economisers and induced draught installation and supply and laying of cables. Forms of tender from Mr. A. Ellis, The Hayes, Cardiff.

HESTON and ISLEWORTH Education Committee require tenders by 10 a.m. July 5 for electric lighting of schools in district. Specifications from Mr. C. E. Ryecroft, Electricity Works, Hounslow.

LONDONDERRY Corporation require tenders by mid-day July 7 for wiring, fittings, lamps, switchboards, connections, &c., for the electric lighting of the new Guildhall.

ROTHERHAM Corporation want tenders by July 8 for 12 months' supply of single vulcanised bitumen covered cable and electricity meters. Particulars from the Borough Electrical Engineer.

BIRMINGHAM Electric Supply Department require tenders by June 26 for 12 months' supply of electrical accessories, engineering and general stores, &c. Particulars from the City Electrical Engineer.

LONDON County Council require tenders by 11 a.m. July 4 for four electric traversers for car-sheds. Specification, &c., from the Clerk.

IPSWICH Guardians want tenders by noon June 30 for alterations of switchboard and other electrical plant at the workhouse.

The Metropolitan Water and Sewerage Board, Albert-street, BRISBANE, Queensland, want tenders by noon Jan. 30 next for supply and erection, of one, two or three complete units, each consisting of power generating plant and pump or pumps to lift not less than 6,000,000 gallons per day. Particulars from the Secretary.

Tenders are invited up to July 19 for the supply of insulators, telephones, copper and iron wire to the Postmaster-General's Department in QUEENSLAND, and up to July 25 for the supply of 12 sections of a branching multiple magneto lamp signalling switchboard, &c., or one automatic or semi-automatic switchboard, &c., to the Postmaster-General's Department, VICTORIA. Tender forms, &c., from 72, Victoria-street, London, S.W.

MORTLAKE (Victoria) Butter & Cheese Factory Co. require tenders by noon Aug. 14 for supply of dynamo and booster, storage batteries and accessories, switchboard, cables, &c. Specifications from Messrs. F. A. McCarty & Co., 31, Queen-street, Melbourne.

The Town Clerk, WANGANUI, N.Z., will receive tenders until July 12 for supply of generating plant, gas-producing plant and battery and booster for the Corporation tramways. Specification can be seen at 73, Basinghall-street, London, E.C. Local representation is necessary.

WELLINGTON (N.Z.) Corporation require tenders by 4 p.m. Aug. 24 for supply of a motor power waggon and accessories for the electric tramways department. Gonville and Castlecliff Tramway Board, Ridgway-street, WANGANUI (N.Z.) require tenders by 4 p.m. Aug. 14 for supply of overhead tramway material, feeders, &c. Conditions, &c., can be seen at 73, Basinghall-street, London, E.C. Representation in New Zealand is necessary.

NAPLES Municipal Authorities require tenders by July 9 for supply and installation of the following plant in connection with the supply of electric power to Naples from the river Volturno:

1. Tubing and accessories for harnessing the water at rate of 7,000 litres a second and for the fall of 190 meters; upset price 702,900 lire (£28,116.)
2. Machinery and apparatus for hydro-electric power station, transmission line (about 57 miles), and transforming station; upset price [illegible] lire (£30,000.)

Tenders to Presidente del Consiglio Generale dell' Ente Autonomo Volturno, Naples.

Manufacturers who are prepared to supply 600 km. (372 miles) copper wire 5 mm. dia. are invited to communicate with the Direzione dell' Ente Autonomo Volturno, Naples, who after two months from April 10 will send invitations to tender to firms whom they consider suitable.

Conditions of tender, &c. (in Italian) may be seen at 73, Basinghall-street, London, E.C.

Tenders will be received at the Royal Arsenals, SPEZIA and NAPLES until 11 a.m. July 11, for supply of incandescent electric lamps and brackets (total about £1,260). Conditions (in Italian) at 73, Basinghall-street, London, E.C. Local representation necessary.

The "Gaceta de Madrid" announces that tenders will be received up to noon July 4, at the Sección Colonial del Ministerio de Estado, Madrid, for the complete installation of a wireless telegraph station on the island of Fernando Po, for the purpose of carrying on telegraphic communications in the Gulf of Guinea. The cost is estimated at 92,150 pesetas (about £2,300) excluding excavation and foundation work. This call for tenders is reserved to Spanish firms, but should no award be made, a second adjudication will take place to which foreign firms will be admitted. In this latter event Spanish firms will be allowed a preferential margin not exceeding 10 per cent. over foreign estimates.

The Prussian State Railways Administration, HAMBURG, will receive tenders on July 4 for supply of two electric motors, four pumps, travelling crane, &c.

TENDERS RECEIVED AND ACCEPTED.

Orders have recently been placed by the Bengal Nagpur Railway Co. with the Edison & Swan United Electric Light Co. and Dorman & Smith for electric light fittings, the Brush Co. for a motor frame and switch pillar, the Lancashire Dynamo & Motor Co. for a motor frame and control gear, and Siemens Bros. Dynamo Works for electric wire.

The Hart Accumulator Co. have a large order for train lighting cells and acids for the East Indian Railway Co. to whom J. Stone & Co. are also supplying a complete train lighting equipment.

Carlisle Council have accepted the tender of the Premier Accumulator Co. for the supply of a new lighting battery, booster balancing set and switchgear at £1,755, and for the maintenance of the battery for 10 years at £77 per annum.

Nelson Council have accepted the tender of the Tudor Accumulator Co. for replating the storage battery, for its maintenance for 10 years, and also for the supply of a booster balancer and switchgear.

Ashton-under-Lyne Corporation have accepted the tender of the Bastian Meter Co. for supply of meters (10 ampere) for the ensuing year.

Hornsey Council have placed an order with Babcock & Wilcox for the supply of a water-tube boiler, automatic stoker, &c. Two other tenders were sent in.

Hornsey Council have also accepted the tender of the Beck Flame Lamp (Ltd.) for the supply and erection of flame arc lamps. Twelve firms submitted tenders.

Southampton Council have placed an order with Cole, Marchent & Morley for an air pump at £262.

Stoke-on-Trent Guardians have accepted the tender for the National Telephone Co. for a fire alarm system at £130.

Dunmow Guardians have accepted the tender of Mr. Archer for telephones at £14. 10s.

Commonwealth Contracts.—The Australian Postmaster-General's Department has accepted the following tenders —

Victoria.—Western Electric Co., 200 attendants' telephone sets (25s. each) and outside distributing wire; Noyes Bros., g.i. wire; International Electric Co., J. Bartram & Son and India Rubber, Gutta Percha & Telegraph Works Co., telegraph and telephone apparatus and material.

South Australia.—British Insulated & Helsby Cables, British General Electric Co., Siemens Bros. Dynamo Works, India Rubber, Gutta Percha & Telegraph Works Co., Western Electric Co., J. Bartram & Son, Lawrence & Hanson Electrical Co., T. Zwesker & Co., Geo. Wills & Co., Rabone, Feez & Co. and British & Foreign Indent Co., telegraph and telephone apparatus and material.

BUSINESS NOTICES.

In future the address of the National Electric Construction Co. (Ltd.) and its subsidiary companies will be 3, Laurence Pountney hill, Cannon-street, E.C. Telephone numbers are 5329 and 5330 Bank.

The partnership between S. A. Sillem, F. A. Donnison and Wm. Sillem (trading as the Phœnix Electric Co.), 17, Morwell-street, Tottenham Court-road, London, W., has been dissolved. Debts by Sidney D. Cox, who will carry on the business under the old style.

Patents Development.—The proprietor of patent No. 21,959/1908, relating to "Process and apparatus for producing oxides of nitrogen by means of a rotary flame," desires to enter into arrangements for exploiting same in this country. Applications to Messrs. Wheatley & Mackenzie, Chartered Patent Agents, 40, Chancery-lane, London, W.C.

The owner of patent No. 16,183/1908, for "Improvements in or relating to telephony and telegraphy," desires to negotiate for the granting of licences thereunder. Particulars from Messrs. Lloyd Wise & Co., chartered patent agents and consulting engineers, 46, Lincoln's Inn Fields, London, W.C.

"The Journal."—Part 207 of the "Journal" of the Institution of Electrical Engineers is now ready, price 5s. Particulars of the contents are given in an advertisement.

"Who's Who in Science."—Messrs. J. & A. Churchill announce that they have in preparation a new annual with this title, to be edited by Mr. H. H. Stephenson.

BANKRUPTCIES, LIQUIDATIONS, &c.

A receiving order has been made against Emanuel Ristori, civil engineer, 54, Parliament-street, London, S.W. First meeting of creditors June 30 at Bankruptcy-buildings, London, W.C. Public examination Aug. 15.

A receiving order has been made against Edwd. Jas. Crosier (trading as Crosier, Stephens & Co.), engineer, 2, Collingwood-street, Newcastle-on-Tyne.

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A receiving order has been made against Wm. Tulley (trading as Wm. Tully & Co.), mica merchant, 16, Water-lane, London, E.C. First meeting of creditors July 5 at Bankruptcy buildings, London, W.C. Public examination Aug. 15.

At the London Bankruptcy Court on Friday the public examination took place of Emil Laurence Oppermann, electrical engineer, &c., late of 74, Wool Exchange, E.C.

The liabilities were £2,425, assets £12. Debtor stated he was engaged abroad as an engineer prior to 1905. He then returned to England and became engaged in a syndicate in connection with a storage battery, which he sold in July, 1905, to the "X" Electric Accumulator Co. (Ltd.) for £3,158 in cash and £26,500 in shares, a large number of which were allotted to other persons. He acted as managing director of the company at £500 a year, until it failed in 1908. The "X" Synd. (Ltd.) was next formed to take over the business, and he acted as its managing director at the same salary until it went into compulsory liquidation in October, 1909. Since then he had been engaged in an unsuccessful attempt to promote a company to take over some rubber concessions in Sumatra. He had also lost money on other ventures.

On Friday Mr. Registrar Brougham suspended for three years the discharge of C. E. Marrian and H. E. Wells, merchants, 23, Ropemaker-street, London, E.C. (trading as Marrian, Wells & Co.).

It appeared that applicants closed their business in August, 1908, giving their creditors as security for their claims shares in the British Photo Lexigraph Co. (Ltd.), which they had formed for taking over an option to work an electrical advertising appliance. Owing to the refusal of London County Council to grant a licence to work the appliance in London, the company did not start business, and went into liquidation last February.

The trustee in the bankruptcy of Charlotte Rix (trading as Bridgwater & Wright), electrical engineer, 78, York-road, King's Cross, London, N., has been released.

A meeting to receive an account of the winding up of Neville Kaye & Co. (Ltd.) will be held on July 21 at the offices of Mr. J. H. Dixon, 11, Ironmonger-lane, London, E.C.

COMPANIES' MEETINGS AND REPORTS.

British Electric Traction Co. (Ltd.)

The fifteenth ordinary general meeting was held on Thursday last week, Sir CHARLES RIVERS WILSON, G.C.M.G., C.B., in the Chair.

The SECRETARY (Mr. Charles H. Dade, F.C.I.S.) read the notice convening the meeting and the report of the auditors.

The CHAIRMAN then said: I have presided at all the annual meetings of this Company, but this is the last occasion on which I shall do so as chairman of the company. It was 16 years ago that this company entered upon its career, with a view of affording a public service which at that time was little known in this country. Electric traction by the overhead system had been fully established in America for 10 years previously, and to a lesser extent on the Continent of Europe; but so little was known of the overhead system of electric tramways here that a good deal of the work of the company in the early years was devoted to removing the objections raised by local authorities and others to the adoption of the overhead system. To-day practically every tramway in this country is worked electrically, and, with the exception of London County Council tramways (which are mainly on the conduit system), and one or two undertakings in the provinces, all electrical tramways are worked on the overhead system. History shows that it is mainly the result of the work which this company did in educating public opinion that local authorities and others were able to adopt electrical tramways. During our existence I have been sometimes sanguine and sometimes depressed, but a gratifying feature of all our proceedings has been the constant sympathy which the shareholders have extended to the directors, and which has helped and encouraged us in the task of meeting and overcoming many difficulties. We found that at first we were able to make more or less satisfactory agreements with some local authorities, but it was not long before each local authority began to endeavour to get out of us a little more than the last one had got. The difficulties with the local authorities to which I have referred were of a varying character, and there were several exceptions. Middlesex County Council is one of the exceptions, and has demonstrated clearly the wisdom of making a statesmanlike and businesslike arrangement between the interests of the community and just treatment of a company, as compared with the folly of killing the goose that lays the golden eggs.

I have no desire to dwell unduly on the difficulties we have encountered, but in this the last statement I shall make to you as chairman of the company I wish clearly to emphasise the real cause of our troubles. I may appear to insist too much, as I have often before insisted, on the prejudice caused to our company by the action of local authorities. I have no wish to impute undue blame to those authorities, who have no doubt been actuated by a sincere desire to serve the interests of those whom they represent. If I am rightly informed, many of the smaller authorities are to-day experiencing the same troubles as ourselves from more or less the same causes. I wish to repeat what I said last year, that it is proved by the official returns of the Board of Trade that we are operating more economically and more profitably than other electrical enterprises in this country of the same class, and, I may add, at least as efficiently. The main reason why we are not now paying larger dividends is that the considerable investments which we have in the associated companies are not adequately remunerative. The average return on all our investments (over £5,000,000) is only 2·7 per cent., and as we are paying 5 per cent. on our first debentures and 4½ per cent. on the seconds, the balance is inadequate to meet the claims of the shareholders. I could offer you many reasons in explanation of this result.

Dealing with the report and accounts before you, we are able to point to an improvement in the position of the associated companies during the past year. The companies in which we are interested have earned something like £100,000 more than during the previous year, but they have become cautious in their adversity, and have put larger amounts to reserve, and only in a few instances have made small increases in the dividends. The conditions of trade appear to be better, and the weather conditions have so far also been favourable. It is reasonable to hope, therefore, that the result for the current year will be still further improved. We have effected a large reduction in sundry debtors and debit balances, from £447,947 to £247,997. We have taken debentures and shares in payment for the debts, each case being considered from a business point of view, and so the investments show an increased yield during the past year. Investments have increased from just under £5,000,000 to £5,240,000, and the average return on the larger volume of investment was greater than the average return on the smaller volume of investment in the preceding year. We have adopted the policy of realising our Consols. The average price in the books is £98. 3s. 8d. per cent., and the directors have definitely come to the conclusion that it is better to face the loss due to the realisation of these Consols and to invest the proceeds in other securities yielding a larger return. It is not easy to find in this country investments for capital to yield an industrial return, and we have great difficulty at the present time in profitably employing our surplus cash resources, because we are determined not to extend the business of electrical enterprise in this country unless and until we can secure better treatment and better prospects of making an industrial profit than is the case at present. There is, however, no difficulty in earning a little more than is obtainable from Consols. We have again purchased our second debenture stock to the extent of £36,134, and £6,408 of our first debenture stock, and have cancelled it. We were able to buy at prices much below their nominal value, and the difference, representing £12,393, has again been added to reserve. Our debenture stock has since gone up in price and the inducement to purchase is not now so great.

I have now to refer to the question of dealing with the arrears of dividend upon the preference shares, and to the reserve funds in relation to depreciation of assets. The last annual report stated that the directors proposed for the immediate future to deal with the depreciation as and when its amount is ascertained, and so long as such depreciation continues to transfer to reserve any profits or losses, other than accrued dividends or interest, made by the realisation of the then investments. With regard to arrears of preference dividend we have under consideration a scheme of re-adjustment of capital which we will submit at an early date. I may say at once that the directors do not think it is practicable or expedient, even if practicable, to propose any reduction of capital. What they will propose is a re-arrangement. Difficult as the problem is, the directors do not despair of being able to put before you an equitable scheme.

It is not without regret that I have made up my mind to retire from the position I have occupied for a good many years, and to resign that position into other and more vigorous hands. I assisted at the birth of this company, and I watched over the successes of its youth and the disappointments of a later period, but I believe now that the clouds are passing by, and that I may look forward with confidence to a successful future for the company under the able administration of Mr. Garcke. You know Mr. Garcke, and you know the work he has done for this company, but none who have not been behind the scenes can adequately understand what he has done; the labour, the industry, the enormous ability which he has brought to bear on the interests of the company. I wish to thank my colleagues on the board, Mr. Morse, our solicitor, Mr. Dade, our secretary, and Mr. Walmsley, our accountant, who form amongst them a staff second to none amongst industrial companies. I now move the adoption of the report and accounts, and the declaration of the dividends set out therein.

Mr. EMILE GARCKE, M.I.E.E., seconded, and expressed regret at Sir Charles Rivers Wilson's retirement. They were all very glad he had agreed to remain a member of the board.

Mr. SOAMES, after reviewing the company's position in regard to the item of loans, said: Sir Charles had touched on the policy of selling Consols and investing the money in other securities bearing a higher rate of interest. In view of the fact that they were paying 5 per cent. and 4 per cent. on their debentures, it would be better if they were to go on redeeming these debentures rather than investing in India 2½ per cent or Australia 3½ per cent.

A long discussion followed on several subjects relating to the account of the company; to the appointment of a shareholders' director, and committee of shareholders to confer with the directors; as to the adequacy of the reserves and the market value of the shares of which the reserve are composed; to the heavy task imposed upon Mr. Garcke on his taking the position of chairman as well as managing director of the company and other matters. After this discussion,

Mr. SOAMES moved:—"That a committee of shareholders be appointed by the present meeting to confer with the board as to the position of the company and on matters generally."

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The CHAIRMAN said: It is open to you to carry such a motion, but it will prove to us very embarrassing and very detrimental to the company. We propose at an early date to call you together again in special assembly to consider the scheme we shall have to lay before you, and then no doubt will be the moment for us to call you into council, either by way of a committee or otherwise, to thrash out the very important proposals which we shall lay before you—proposals which will have a great effect upon the future of the company. These are my reasons for deprecating the appointment of a committee.

Mr. GARCKE, after replying in some detail to the points raised in the discussion, said: I have consulted my colleagues, and they are perfectly ready to give the assurance that any future appointment of directors shall be subject to confirmation by the shareholders. With regard to the committee, I do not know whether it is for investigation or for conference, but what I say is, do not be carried away by eloquent speeches delivered on the spur of the moment without due consideration. Realise seriously the responsibility that you are incurring in disturbing the ordinary course of business. Either you have confidence in the board or you have not. If you have not confidence in us, then I do not want to be here; but if you have confidence in the board I appeal to you not to increase our difficulties and add to our embarrasments. I say that your proper course is to wait and see what the directors have to propose to you before you say, "Let us have a committee."

The CHAIRMAN: I will ask you first to pass the accounts.

The resolution approving the report and the declaration of the dividends was put and carried. On the motion for the re-election of the retiring directors, Mr. J. S. Raworth was re-elected, but Sir C. W. Fremantle was outvoted, and a poll was demanded by the chairman. After the re-appointment of the retiring auditors (Messrs. Deloitte, Pender, Griffiths & Co., and Messrs. F. W. Smith & Co.), Mr. Soames's resolution was put and carried. A poll was demanded, and the two polls were taken together, with the result following:—For the appointment of a committee, 2,982; against, 6,047. Majority against, 3,065. For the re-election of Sir Chas. Fremantle as a director, 6,047; against, 2,832. Majority for re-election, 3,215.

We are informed that these figures do not include the proxies given to the directors by shareholders who were not present at the meeting.

Aron Electricity Meter (Ltd.)

The fourteenth annual general meeting of this company was held on Tuesday, Mr. H. HIRST presiding.

The SECRETARY (Mr. M. Aron, F.C.I.S.) read the notice calling the meeting and the auditors' report.

The CHAIRMAN then said: The report and balance-sheet as presented to you show the healthy development and progress of our business. In comparing this year's report with last, I would refer, first, to the interesting item of gross profit on trading, £44,000. This is nearly £9,000 in advance of last year, and nearly every country has contributed to this result. The amount received from dividends on investments is reduced, as the expansion of our business drained our liquid reserves previous to our debenture issue. We had to realise these reserves during the year, I regret to say, at a loss, but no blame attaches to your directors for this. I refer to this not only on account of the items on the debit side of the account (£78. 6s. 5d. and £85), but more on account of the fact that we have had on a previous occasion to write trust securities down by between £700 and £800. Management charges are, of course, increased, but not in equal proportion to the increased business. On the credit side we have increased stock and outstanding accounts; but the increase is normal in proportion to the increase of business. The large amount of cash at our disposal is, of course, the residue of the recent debenture issue.

We are at last in a position to pay a dividend to the ordinary shareholders, and I personally thank them for the patience they have shown. I think the outlook is such that they may enjoy continued participation in our prosperity. I hope you approve of our recommendation to put £5000 to reserve and use £7,000 of this year's profits in writing off a portion of the costs of the debenture issue. As regards the business itself, the increased output, due to increased sales, has strengthened our power to compete in the world's markets; our organisation, thanks to the supervision and hard work of Prof. Aron, is being more and more perfected every year, and the loyalty and interest in the business of our staff is an asset of which we are proud. Concerning the taximeter business, we are pressed with the ever-increasing number of instruments placed on the streets. We have hitherto used the total revenue from this branch for the purpose of writing down the expenses and cost of the instruments which we have put out, and none of the revenue has so far been used in arriving at the figure which we record as our trading profit (cheers). By this conservative policy we hope to create a valuable annual contribution towards the dividends which we hope to pay. I now move the adoption of the report and accounts.

Sir JAMES PENDER, Bart., seconded the motion, and after a brief discussion the motion was unanimously agreed to.

A motion approving the declaration of dividend on the preference shares and of 6 per cent. on the ordinary shares for the period to March 31 last was carried.

The re-election of Col. R. E. Crompton and Mr. S. Barclay Heward as directors followed, and the auditors (Messrs. Price, Waterhouse & Co.) were re-appointed. A hearty vote of thanks to the Chairman and to Dr. Aron brought the proceedings to a close.

DIESEL ENGINE CO. (LTD.)—At the meeting on Friday the chairman (Mr. C. C. Ellis) said that there was an increase in expenses of about £1,000, almost entirely due to increase in staff to cope with new business. Owing to the number of contracts in hand at the end of the year they had carried forward £5,000 for completion of those, against £2,500 last year. The demand for their marine engines was likely to be large, as the possibility of superseding steam seemed greater almost every day. They were building an engine of 150 B.H.P. for a fishing vessel, and it should be ready in August. They hoped that it would be the forerunner of considerable business. Total orders carried forward from last year amount to about 7,200 B.H.P., or more than double that of the previous year. Trade seemed to be improving, and they were now getting as many orders as they could execute.

GLOBE TELEGRAPH & TRUST CO. (LTD.)—The report of the directors for the year to May 31 states that the net revenue for the year, after deduction of expenses, amounts to £211,858. 14s. 8d., and makes, with £27,681. 5s. forward, £239,539. 19s. 8d. From this has been distributed £131,085. 10s. 6d. in interim dividends, leaving an available balance of £108,454. 9s. 2d. The directors now recommend payment of the following final dividends: 3s. per share (less tax) on the preference shares (making 6 per cent., less tax, for the year) and 6s. per share net on the ordinary shares (making 6 per cent. net for the year). These dividends will absorb £79,922. 5s. 10d. and leave £28,532. 3s. 4d. to be carried forward.

MARCONI WIRELESS TELEGRAPH CO. OF NEW YORK.—The report for the year ended Jan. 31 states that, allowing for the usual depreciation (10 per cent.) on station and experimental work, the balance shows that the company is rather more than self-supporting, but fierce and undue competition have precluded it from obtaining as many orders as in the previous year. During the year the company sent and received 2,291 messages, containing 34,130 words more in 1910 than it did in 1909, and the money gain was about $4,000. Sale of apparatus did not show up as well, owing to competition and price-cutting, whereby a living profit was hardly left to contractors. Expenses of business remained generally about the same. Over $11,000 was written off as depreciation. The loss of $1,700 shown in general working was caused by the opening and running of stations on the east coast, south of New York, which stations will eventually be most useful and probably paying, in connection with coastwise boats that the company are gradually acquiring as part of the Marconi equipped fleet. The aim is to control the whole of this business in the same way that the system operates the trans-Atlantic liners. The outstanding capital stock has been reduced from $6,190,000 to $1,547,500 The number of commercial ship stations owned and controlled by the company and by the allied Marconi Companies is constantly increasing, and there are now 469 steamships trading to America and various ports of the world fitted with the Marconi system; nine pleasure yachts are also fitted and have working arrangements by which the shore stations communicate with, send and take messages to and from 68 commercial vessels fitted or operated by companies with which this company has commercial dealings. Since the last meeting four stations have been erected and equipped on the east coast of America south of New York: Cape May, N.J.; Virginia Beach, Va.; Fernandina and Palm Beach, Fla. (working arrangements are in existence whereby the company uses the Government station at Key West); and is about to put up a station intermediate and between Virginia Beach and Fernandina, so that with the established stations north of New York a vessel sailing from Maine to Florida can be in communication the whole time. The Wellman airship, which started from Atlantic City to cross the Atlantic, was fitted with Marconi apparatus. Successful work has also been done in connection with submarines.

Experiments recently conducted in England look to the acceleration of plant life by electrical treatment. It is stated that by such treatment small fruits can be brought to maturity weeks earlier, and the production of vegetables and large fruits can be much increased. If so, a new field opens for wireless.

While the s.s. "Prinzess Irene" was ashore a few weeks ago the operator thereon sent and received over 10,000 words. In May, 1910, the trans-Atlantic wireless circuit, Glace Bay, Nova Scotia, to Clifden, Ireland, was opened for the use of the Canadian public, and in August of the same year the use of trans-Atlantic wireless was also offered to the American public. The strength of the Marconi system has been greatly added to this year by a decisive judgment obtained in the High Court of England in the action brought by Marconi's Wireless Telegraph Co. against the British Radio-Telegraph and Telephone Co., wherein the judge held that defendant company had been infringing the Marconi patent. Defendant company did not appeal and undertook to dismantle its stations and cease infringing. In the United States the company holds a patent (granted in 1904) almost identical with the above as to specifications and claims, and steps are now being taken to prove and sustain the said patent by actions at law against manufacturers and users, and it is the intention of the company to carry such actions on to a final issue with the least possible delay.

VICTORIA FALLS & TRANSVAAL POWER CO. (LTD.)—At the meeting on Monday the Marquess of Winchester dealt with the financial position of the company. They had, he said, declared the preference dividend from Jan. 1, 1909, to Oct. 14, 1909, and a further amount at the rate of 1 per cent. per annum from Oct. 17 to Dec. 31, 1908 (5 per cent. had been already paid for that period in accordance with the British South Africa Company's undertaking). Their profits had been secured by the work of the Brakpan and Simmer Pan stations. Those were erected almost entirely out of the moneys provided by the early preference and debenture issue. Besides providing for depreciation during the year (£38,963) and £82,550 for interest and income-tax on debentures, they had earned an additional amount almost equal to the carry forward for the year, —their realised profit was £157,749—their total debenture interest would

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amount to £150,000. Thus the plant of the Brakpan and Simmer Pan stations, equivalent to about one-third of the larger output of the Rosherville and Vereeniging stations, were equal to meeting the interest demands of the whole debenture capital, leaving the profits on the shares and loan capital of the Rand Mines Power Supply Co. to provide for depreciation, amortisation and interest on share capital. The Power Undertakings Act, 1910, resulted in their having to exchange their concession for a definite license. This license would enable them to carry on their business under statutory powers for the full period of the concession. A further license had been acquired by the Rand Mines Power Supply Co. Active opertions were in progress at Vereeniging. That station would accommodate two sets each of 15,000 H.P. capacity. The foundations and water supplies were being so arranged that in the event of the engineers deciding that the increasing demands for power of the mining industry warrant the expenditure, additional sets could be expeditiously installed. Should the recommendations of their engineers necessitate any large increase, it would require that power be taken to increase the capital of the company. He did not, however, anticipate that it would be necessary; but the policy of the mining industry was in the direction of amalgamation, coupled with big electrical installations for reduction purposes, and it would not do to blind their eyes to the fact that, large as the business which they had secured was, there might in the future be considerable expansion. Undoubtedly savings in cost would follow the conversion of reduction plants to the electric drive; that would bring large quantities of ore hitherto considered unpayable within the limit of pay ore, and would thus increase in some instances the life of certain of the mines. Their asset in the Victoria Falls still remained in the background for future exploitation. They were not unmindful of its value, and the process for the treatment of the lead and zinc and copper ores of the north might yet provide them with a fertile source of profit.

The management in South Africa was still in the capable hands of Major the Hon. Walter Bagot, and he was ably assisted by Mr. W. E. Goldby as financial manager; and as chief engineer Mr. Bernard Price had amply fulfilled expectations. When they considered that their undertaking now consisted of four erected stations, one in course of erection, transmission lines extending for a distance equal to from London to Brighton, and that shortly, when the Vereeniging station was in operation it would mean an additional transmission system equal to the distance from London to Reading, together with a compressed air system equivalent to a pipe-line from London to Watford and back, that the total tons crushed on the Rand during 1910 were 21,500,000, and that their undertaking was responsible for providing nearly the whole of the power required for the reduction of 63 per cent. of that tonnage, they would appreciate the magnitude of the undertaking; and the responsibilities of their staff. He should not be doing his duty if he did not also mention the excellent work of their managing director (Mr. A. E. Hadley), who was absent in South Africa on their business when he last addressed them. Their contractors, in spite of a serious delay caused by the total loss of the steamship "Khedive" off East London, which had on board a large consignment of their machinery had maintained their delivery of plant, and the Rosherville station was now almost completed—not exactly on the date anticipated; but, taking into consideration that the action of the then Government of the Transvaal, through the introduction of the Power Bill, 1910, coupled with the shipwreck, caused delay beyond their control, he was satisfied that they had no reason to complain.

UNITED ELECTRIC TRAMWAYS OF MONTE VIDEO (LTD.)—Mr. G. A. Touche, M.P., stated at the meeting on Friday that the recent strike in Monte Video had affected all the tramways in the city, including their own. The directors made certain concessions and the conditions offered were accepted by the employés, who subsequently went on strike a second time, apparently with no justification. The strikers, being convinced of the firmness of the companies and wearying of the struggle, ultimately accepted this company's terms and resumed work. The strike had adversely affected the traffics while it had increased the permanent charges. The traffic receipts in sterling were £279,990, compared with £253,257, an increase of £26,733 (10½ per cent.); the total number of passengers carried was 32,474,355, against 29,293,804, an increase of 3,180,551 (over 10½ per cent.). Those results were obtained although 96,503 less car-miles were run compared with the previous year. The working expenses were 55·62 per cent., a decrease of 2·73 per cent., in spite of increased cost of maintenance and increased cost of coal. The net receipts amounted to £124,247, an increase of £18,775, or nearly 18 per cent. The first six months of the current year showed gross receipts £166,176, compared with £150,195, an increase of £15,981, or over 10½ per cent.; working expenses were 51·17 per cent., against 52·37 per cent., and the net receipts were £81,143, against £71,536, and deducting the decrease in May, owing to the strike (£3,170), the increase for the seven months was £6,437. For the past year the final dividend was 8 per cent. on the ordinary shares (making 7 per cent. for year), compared with 6 per cent. in 1910.

R. WAYGOOD & CO. (LTD.)—Mr. H. C. Walker referred, at the meeting on Friday last, to the past year's work of the company, which included a contract in connection with the new G.P.O. building in Newgate-street, London. In connection with the Festival of Empire at the Crystal Palace they had erected one of their electric passenger lifts from the terrace to the centre transept. Messrs. Harland & Wolff had entrusted them with the contract of fitting in the "Olympic" and "Titanic" eight electric passenger lifts and eight other electric lifts. As the result of fitting their lifts on the "George Washington," for the North German Lloyd, that company had placed an order for two passenger lifts for two of their largest ships. That was the first instance in which lifts had been fitted to ships already in service, necessitating special designing and arranging, and one of their engineers superintended the work of erection in Germany. A very large number of lifts for a wide range of users had been installed by the firm.

J. G. WHITE & CO. (LTD.)—The directors report for the year ended Feb. 28 states that the results of the business have continued to be satisfactory. The net profit on the year's trading is £91,466. The prospects for the future are looked upon by the directors as encouraging. The return of interest and dividends on investments during the year was equal to 8·2 per cent. on the amount of the valuation. The "Purchase of Business" account was written down last year out of profits from £47,975 to £15,000, and the directors recommend that the balance should be written off this year. A special dividend equalisation reserve is also established, and £15,000 out of the profits of the year are allocated to this account. The directors recommend an increase of the total dividend rate on both classes of shares to 12 per cent. per annum. This is the maximum dividend to which the preferred shares are entitled. In addition, an extra dividend of 10s. per share on the ordinary shares is recommended. After making these payments a balance of £19,813 will remain to be carried forward.

NEW COMPANIES, MORTGAGES AND CHARGES AND RECEIVERSHIPS.

NEW COMPANIES.

CANADIAN P. J. MITCHELL CO. (LTD.) (116,323.)—Reg. June 14, capital £21,000, to carry on the business of exporters and importers of and dealers in machinery, tools and plants, general, electrical and mechanical engineers, &c. First directors: Col. A. Durand, P. H. Brown and P. J. Mitchell. Reg. office: Caxton House, Westminster, S.W.

CAVENDISH ELECTRICAL CO. (LTD.) (116,324.)—Reg. June 13, capital £5,000 in £1 shares, to carry on the business of manufacturers of and dealers in scientific, medical and surgical apparatus, including X-ray, high-frequency, light and heat apparatus, Finsen lamps, vibrators, &c. Private company. First directors: W. E. S. Wissler, A. R. Winterson, E. H. Willis and J. Richert. Reg. office: 130, Great Portland-street, London, W.

MORTGAGES AND CHARGES.

REASON MFG. CO. (LTD.)—Memorandum of satisfaction to the extent of £250 on Aug. 14, 1909, of charge dated Jan. 15, 1900, securing £1,200, was filed on June 9.

SUFFOLK ELECTRICITY SUPPLY CO. (LTD.)—Issue, on May 16, of £325 debentures, part of a series of which particulars have already been filed.

RECEIVERSHIP.

LONDON ELECTRIC TREATMENT INSTITUTE (LTD.)—Notice of appointment of J. G. Elsworthy, 4, Bennett-street, London, S.W., as receiver and manager has been filed.

CITY NOTES.

MEMORANDA (June 21).—Bank rate 3 per cent. (March 9, 1911.) Price of silver, 24⅛d. per oz. Consols 79⅛—79⅜ for money and for account. Consols Pay Day, July 5; Stock and Shares Continuation Days, June 28 and July 12; Ticket Days, June 29 and July 13; Pay Days, June 30 and July 14; Mining Shares Carry Over Day, June 27.

PRICES OF METALS (London).—*Copper*, cash, 57¼; three months 57⅝. *Lead*, 13⅝ cash, 13⅝ three months. *Spelter*, 24½—24¾. *Tin*, 192 cash, 191¾ three months. *Iron*, Cleveland, cash, 46/4, three months 47/1.

BRITISH HOSIERY & ELECTROLYTIC BLEACHING CO. (LTD.)—petition to confirm a resolution reducing the capital of this compan from £60,000 to £24,525 will be heard in the High Court of Justic London, on July 7.

CONSOLIDATED GAS, ELECTRIC LIGHT & POWER CO. (OF BALT MORE.).—A dividend of 1¼ per cent. for the quarter ending June 30 h been declared.

HOBART ELECTRIC TRAMWAYS CO. (LTD.)—A dividend of 6 per cen tax free, has been declared, payable July 1.

KALGOORLIE ELECTRIC TRAMWAYS (LTD.)—This company's traff receipts for May were £3,529 and the total from Jan. 1 is £16,815.

MADRAS ELECTRIC TRAMWAYS 1904 (LTD.)—This company's traff receipts for the fortnight to June 16 were R20,371 (increase R1,57 Total from Jan. 1, R241,222 (increase R16,678).

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee ha appointed June 29 a special settling day in and granted a quotation t further issue of 11,850 £1 fully-paid ordinary shares of *Marconi's Wi less Telegraph Co. (Ltd.)*, and have appointed June 30 a special settli day in and granted a quotation to scrip, fully and partly (50 per cen paid, for £384,405 4½ per cent. preference stock of the *Central Lond Railway Co.* A quotation has also been granted to £350,000 5 per ce extension mortgage debentures of the *Buenos Ayres Lacroze Tramways* (

TROWBRIDGE ELECTRIC SUPPLY CO. (LTD.)—At the statute meeting last week, Mr. J. H. Blake said the company had made go progress and the supply of current from the Duke-street station w satisfactory.

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ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	June 14	1,458	− 6	2	3,283	+ 196
Airdrie	" 9	239	+ 12	23	4,931	− 15
Anglo-Argentine	" 17	48,004	+ 4,050	24	1,187,642	+ 127,219
Ashton-under-Lyne	..	..	..	..	..	..
Ayr Corporation	" 17	301	− 38	5	1,435	− 28
Barnsley	" 9	235	+ 66	23	4,118	+ 229
Barrow	" 9	406	+ 115	23	5,883	+ 364
Bath Electric Trams, Ltd.	" 14	878	+ 4	24	18,571	+ 472
Birmingham Corporation	" 10	8,136	+ 1,531	10	74,732	+ 5,417
Birmingham & Midland	" 9	1,260	+ 432	23	20,463	+ 1,615
Blackpool and Fleetwood	..	..	..	..	..	..
Blackburn Corporation	" 14	1,140	− 27	†12	14,085	+ 1,482
Bolton Corporation	..	..	..	..	..	..
Bombay	May 19	2,856	+ 204	20	57,458	+ 3,080
Bournemouth Corporation	June 14	1,729	+ 85	11	19,009	+ 1,178
Bradford Corporation	..	..	..	..	..	..
Brighton Corporation	" 18	956	− 56	¶11	11,400	+ 969
Bristol Trams & Carriage	" 16	6,493	+ 496	11	72,242	+ 7,637
Burnley Corporation	" 17	1,320	+ 72	11	15,155	+ 1,636
Burton Corporation	" 18	261	− 6	11	3,091	+ 114
Bury Corporation	" 18	1,228	− 34	¶11	14,694	+ 1,117
Calcutta Tramways Co.	" 17	R53,692	+ R1,492	24	R1,377,180	+ R47,180
Camborne-Redruth	" 17	136	+ 11	24	2,866	+ 3
Cardiff Corporation	" 10	3,323	+ 997	10	25,409	+ 2,788
Cavehill	..	..	..	..	..	..
Central London Railway	" 17	5,172	− 762	24	124,662	− 11,169
Chatham & Dist. Lt. Rys.	" 15	843	− 64	24	19,238	+ 27
City & South London Rly.	" 18	2,983	+ 27	24	79,966	+ 2,363
City of Birmingham	" 9	3,623	+ 804	23	66,999	+ 2,117
Cork Electric Trams Co.	" 15	570	+ 21	24	11,366	+ 192
Devonport & Dist. Trams	" 9	657	+ 215	23	10,427	+ 1,087
Dover Corporation	..	..	..	..	..	..
Dublin & Lucan Railway	..	..	..	..	..	..
Dublin United	" 16	5,946	− 155	24	130,106	+ 4,597
Dudley-Stourbridge	" 9	1,480	+ 743	23	18,457	+ 1,597
Dundee Corporation	" 14	1,163	− 83	¶4	5,209	− 46
East Ham Council	" 17	1,078	− 29	11	12,282	+ 761
Exeter Corporation	" 16	336	+ 8	11	3,762	+ 259
Gateshead & Dist. Trams	" 9	1,205	+ 230	23	23,157	+ 1,366
Glasgow Corporation	" 17	19,381	+ 338	§2	50,359	+ 4,815
Glossop Trams	" 17	136	+ 14	24	2,854	+ 162
Gloucester Corpn.	" 14	287	− 27	..	..	..
Gravesend-Northfleet	" 9	332	+ 116	23	4,500	+ 75
Great Northern & City Rly.	" 17	1,428	+ 75	24	36,809	+ 1,488
Greenock & Port Glasgow	" 9	863	+ 150	23	15,310	+ 2,116
Halifax Corporation	" 13	1,962	− 235	†11	21,637	− 2,432
Hartlepool Tramways	" 9	436	+ 186	23	5,431	+ 450
Hastings Elec. Trams Co.	" 15	980	+ 20	..	..	..
Hong Kong	" 17	$9,479	+ $748	24	$219,821	− $2,130
Huddersfield Corpn.	" 17	1,765	− 56	11	21,756	+ 2,490
Hull Corporation	" 17	2,742	+ 71	11	31,563	+ 1,181
Ilford District Council	" 17	522	− 26	12	6,361	+ 376
Ilkeston District Council	" 14	119	− 17	11	1,479	+ 100
Ipswich Corporation	..	..	..	..	..	..
Isle of Thanet Co.	" 17	720	− 16	37	13,931	+ 817
Jarrow	" 9	223	+ 97	23	2,902	+ 286
Keighley Corporation	" 15	171	− 16	11	2,139	+ 204
Kidderminster & District	" 9	289	+ 192	23	2,327	+ 175
Kilmarnock Corporation	" 17	156	+ 2	4	755	+ 16
Kirkcaldy Corporation	" 14	281	+ 26	11	3,198	+ 398
Lanarkshire Trams Co.	" 15	1,418	− 57	24	33,009	+ 350
Lancashire United	" 14	1,532	+ 132	24	31,143	+ 907
…ington	" 9	342	+ 155	23	3,434	− 6
…ds Corporation	" 17	7,037	− 331	11	84,949	+ 7,121
…ster Corporation	" 17	2,465	+ 22	11	28,500	+ 2,576
… Corporation	" 17	654	− 32	‡5	3,212	+ 176
…oln Corporation	" 17	116	− 1	11	1,183	+ 118
…pool Corporation	" 10	13,166	+ 1,710	23	258,134	+ 9,991
…pool Overhead Rly.	" 18	1,457	+ 45	24	34,306	+ 2,060
…udno&ColwynBayRy.	..	..	..	..	..	..
…don County Council	" 7	50,532	+ 7,432	‡10	435,271	+ 27,314
… Elec. Ry. Co.	" 17	14,175	+ 1,535	24	334,945	+ 16,805
… United	" 17	7,152	− 281	24	148,776	+ 3,265
…oft Corporation	" 17	179	+ 3	37	5,872	+ 288
…chester Corporation	" 17	15,703	− 447	12	183,387	+ 12,881
…ey Railway	" 17	2,052	+ 23	24	49,624	+ 1,087
…thyr	" 9	334	+ 127	23	4,602	+ 127
…opolitan Dist. Railway	" 17	12,182	+ 924	24	281,697	+ 18,464
…opolitan Elec. Trams	" 9	12,235	+ 4,417	23	191,604	+ 28,906
…eton	" 9	490	+ 149	23	7,279	+ 495
… Corporation	..	..	..	..	..	..
…castle-on-Tyne Corp.	" 17	4,037	+ 39	11	46,551	+ 3,458
…port (Mon.)	..	..	..	..	..	..
…ampton Corporation	" 16	515	+ 28	11	6,025	+ 623
…, Ashton & Hyde	" 9	704	+ 138	23	12,724	+ 437
…am Corporation	..	..	..	..	..	..
…(N.B.) Corporation	..	..	..	..	..	..
…(W.A.) Elec. Trams	" 16	1,508	+ 70	24	39,072	+ 1,949
…borough	" 9	198	+ 83	23	2,556	+ 170
…outh Corporation	..	..	..	..	..	..
…s	" 9	2,267	+ 578	23	43,938	+ 4,500
… Corporation	" 14	724	− 22	11	8,702	+ 732
…am Corporation	" 15	622	− 10	11	7,473	+ 778
…y	" 9	302	+ 48	23	2,215	− 9
… Corporation	..	..	..	..	..	..
…es	" 9	74	+ 22	23	1,044	+ 42
…eld Corporation	" 18	6,101	+ 71	12	78,188	+ 5,338
… Trams	" 17	$10,448	+ $420	24	$249,084	+ $12,424
… Metropolitan	" 9	1,385	+ 504	23	18,327	+ 501
… Staffs	" 9	1,250	+ 437	23	20,330	+ 1,691
…ton	" 14	1,256	+ 127	11	12,719	+ 1,109
…and Corporation	" 14	690	+ 75	11	6,649	+ 1,108
…port Tramways	" 9	571	+ 261	23	6,226	+ 165
…Hyde, &c., Jt.Bd.	" 10	1,088	+ 342	10	8,455	+ 1,185
…and Corporation	" 18	1,194	− 40	11	14,241	+ 1,430
…and District	" 14	423	− 10	33	14,836	+ 1,209
… Trams	" 9	1,622	+ 556	23	24,975	+ 1,754
… Corporation	" 14	150	+ 10	10	1,672	+ 185
…	" 9	57	+ 13	23	915	+ 1
…th and District	" 9	684	+ 414	23	4,480	+ 359
… Trams Co.	" 11	465	− 40	24	10,490	+ 930
… Corporation	..	..	..	..	..	..
… Corporation	" 17	502	− 13	24	13,243	+ 502
…on Corporation	..	..	..	..	..	..
… Corporation	..	..	..	..	..	..
…-super-Mare	" 9	521	+ 366	23	1,706	+ 120
…hampton Co.	" 9	757	+ 353	23	10,053	+ 662
…hampton Corpn.	" 14	909	+ 9	11	11,074	+ 1,219
…	" 9	507	+ 173	23	6,162	+ 261
…	" 9	146	+ 44	23	2,208	+ 51
… W.R. Trams	" 18	1,117	− 119	25	31,749	+ 1,057
… Woollen District	" 9	1,391	+ 369	23	23,563	+ 1,729

(a) The comparisons are with the corresponding period last year. * Partly electrical.
† Minus 3 days. ‡ Minus 2 days. § Plus 3 days. ¶ Plus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Shrs	Last Dividend	NAME.	Price Tues., June 20.	*Rate per cent. Yielded. £ s. d.	Dividend Due.	Business 6 Days to June 20. Highest.	Lowest.
		Electricity Supply.					
10	6/0	Bournemouth & Poole Elec. Sup. Ord.	8 —9	6 9 6	Mar, Sep	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref.	9 —10	4 14 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Second Pref.	10¼—10¾	5 6 0	Feb, Aug	10⅝	10 9/16
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	102 —104	4 6 6	Jan, July	103¼	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	7¾—8¼	6 1 6	March....	8¼	..
5	3/6	Do. 7 per Cent. Pref.	7½—8	4 1 3	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Deb. Stock	98 —101	4 0 6	June, Dec	..	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	3⅞—4⅛	5 2 6	Feb, Aug	4 3/16	..
5	2/3	Do. 4½ per Cent. Pref.	4⅝—4⅞	4 17 3	Feb., Aug	..	..
St.	4%	†Do. 4 per Cent. Deb. Stock (red.)	94 —96	4 4 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101½—103½	4 7 0	..	..	..
5	2/3	Do. City Undertaking 4½% Cum. Pref.	3⅞—4⅛	5 3 0	Jan, July	..	..
5	3/0	Chelsea Electric Supply Ord.	4 —4½	5 11 0	March ..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	100 —102	4 8 6	June, Dec	..	..
10	8/0	City of London Electric Lighting Ord.	11¾—12¼	4 15 0	Feb, Aug	12	11 15/16
10	6/0	Do. 6 per Cent. Cum. Pref.	12 —13	4 12 3	Jan, July	..	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	121 —125	4 1 0	June, Dec	..	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	101 —104	4 6 6	Jan, July	..	..
St.	5%	County of Durham Elec. P. D. 5% 1st Mort. Deb. Stk.	92 —94	5 5 3	Jan, July	..	..
10	6/0	County of London Elec. Supply Ord.	7⅝—8⅛	6 3 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11 —11½	5 5 0	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Deb Stock (red.)	109 —111	4 2 0	Jan, July	111	..
St.	4½%	Do. Second Deb. Stock	99 —102	4 8 0	May, Nov	..	..
5	4/0	Folkestone Electricity Supply Co. Ord.	4⅛—4⅝	5 19 0	April, Oct	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4¾—5¼	4 15 3	Mar, Sept	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red)	97 —100	4 10 0	Feb, Aug	..	..
5	5/0	Hove Electric Lighting Ord.	6¾—7¼	6 4 0	April, Oct	7¼	..
St.	4½%	Isle of Wight E. L. & P. Co. Deb. Stk.	83 —91	4 19 0	..	..	..
5	5/0	Kensington & Knightsbridge Ord	7 —7½	5 16 0	Feb, Aug	..	..
5	6%	Do. 6 per Cent. 1st Pref.	5¾—6	5 0 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	93 —95	4 4 0	..	..	..
St.	4%	Kensington & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	96 —99	4 1 0	April, Oct	..	..
St.	4½%	Kent Elec. Power Co. Irred Deb. Stk.	80 —84	5 7 0	Jan, July	..	..
3	1/2⅓	London Electric Supply Ord.	1¾—2¼	2 17 0	Mar, Sept	..	..
5	3/0	Do. 6 per Cent. Pref.	4¾—5¼	5 17 0	Mar, Sept	..	..
St.	4%	†Do. 4 per Cent. 1st Mort. Deb	89 —92	4 8 0	Jan, July	..	..
5	3/0	Metropolitan Electric Sup. Ord.	3⅝—4⅛	6 17 6	April, Oct	3⅞	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	4⅜—4⅞	4 14 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	102 —105	4 5 6	June, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	86 —89	3 18 6	Jan, July	..	..
..	4½%	Midland Elec. Corp. for Power Dist, 4½ 1st Mort. Debs.	93 —100	4 11 0	..	..	..
5	2/6	Newcastle Elec. Supply Ord.	3¾—4¼	4 14 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non Cum. Pref.	4 —4½	5 11 0	Feb, Aug	..	..
100	4½%	Do. 4½ per Cent. 1st Mort. Deb.	99 —101	4 10 0	Jan, July	..	..
100	5%	North Metro. Elec. Power Sup. 5 Morts.	99 —102	5 0 6	..	..	..
1	6%	Northampton Elec. Lt. & P. Ord.	1¼—1 5/16	4 11 6	Feb, Aug	..	..
1	5%	Do. 5% Pref.	1 3/32—1 5/32	4 6 0	Feb, Aug	..	..
St.	4%	Do. 4% Debs.	99 —101	3 19 0	June, Dec	..	..
10	10/0	Notting Hill Electric Ord.	12 —12½	5 17 6	March	..	..
5	4/3	Oxford Electric Ord.	6⅛—6⅝	5 13 9	March	..	..
St.	4%	Do. 4% Deb. Stk.	93 —95	..	..	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	8¾—9¼	5 8 0	Feb, Aug	9⅛	9 3/32
5	3/6	Do. 7 per Cent. Pref.	6¾—7¼	4 16 6	Feb, Aug	7⅛	7
St.	3½%	Do 3½ per Cent. Deb. Stock (red.)	85 —88	3 19 6	Jan, July	..	..
5	..	Smithfield Markets Electric Sup. Ord.	1⅛—1⅜	..	Feb.	..	..
5	4/0	South London Electric Supply Ord.	3 —3½	6 3 0	April	..	..
St.	5%	Do 5% 1st Mort. Stock (red.)	101 —104	4 16 0	..	..	..
1	0 8¾	South Metrop'n Elec. Lt & Power 7% 1st Pref	1⅛—1¼	5 18 0	Feb, Aug	..	..
1	0/7½	Do. 6 per Cent. 2nd Pref.	⅞—⅞	6 17 0	Feb, Aug	15/16	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	97 —100	4 11 6	April, Oct	..	..
5	1/3	Urban Electric Supply Ord.	½—1	..	April, Oct	½	..
5	1/3	Do. 5 per Cent. Cum. Pref.	2½—3	8 6 0	April, Oct	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	87 —89	5 2 3	April, Oct	88	87½
5	5/0	Westminster Elec. Sup. Ord.	7¾—8¼	6 5 0	Mar, Sept	8	7¾
5	2/3	Do. 4½ per Cent. Cum. Pref.	5 —5½	4 3 6	Jan, July	..	..
		Electric Railways and Tramways.					
1	..	Bath Elec. Trams Pref. Ord.	⅛—3/16	..	April	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	⅜—⅝	6 13 6	Jan, July	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	79 —83	5 8 6	April, Oct	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Deb. Stock.	90½—92½	4 17 3	Jan, July	..	..
10	4%	Bristol Tramways & Carriage Ord.	6½—7	5 10 9	Feb, Aug	..	..
10	4%	Do. Cum. Pref.	7¼—7¾	5 6 9	..	..	..
St.	4%	Do. 4 per Cent. Debs.	101 —102	3 18 3	Feb, Aug	..	..
10	..	British Electric Traction Ord.	1⅜—1⅝	..	June, Dec	1½	1 7/16
10	..	Do. 6 per Cent. Cum. Pref.	4 —4½	..	Feb, Aug	4	..
St.	5%	Do. 5 per Cent. Perpetual Debs.	95 —99	5 2 6	April, Oct	97¼	96¾
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	76 —81	5 14 6	May, Nov	..	..
St.	3%	Central London Ordinary Stock	71 —73	4 4 0	Feb, Aug	74¼	71
St.	4%	Do. 4 per Cent. Pref. Stock	87 —89	4 10 0	Feb, Aug	88½	..
St.	2%	Do. Deferred Stock	62 —64	3 3 6	Feb.	62	61¼
100	4%	Do. 4 per Cent. Debs.	104 —106	3 16 0	Jan, July	..	..
5	2/6	City of Birmingham Trams, 5% Cum. Pref.	4 13/16—5 1/16	4 19 6	April, Oct	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 18 9	April, Oct	..	..
St.	1¼%	City & South London Rly. Con. Ord.	31½—32½	4 11 0	Feb, Aug	32⅛	..
St.	5%	Do. 5 per cent. Perp. Pref. (1891)	109 —111	4 10 0	Feb, Aug	..	..
St.	5%	Do. (1896)	105 —108	4 13 0	Feb, Aug	..	..
St.	5%	Do. (1901)	104 —107	4 15 0	Feb, Aug	..	..
St.	5%	Do. (1903)	103 —106	4 15 6	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	102 —104	3 17 9	May, Nov	..	..
10	6/0	Dublin United Trams, 6 per Cent. Pref.	12½—13½	4 10 6	Feb, Aug	..	..
10	12/0	Gateshead and District Trams Ord.	8½—9½	6 19 6	..	..	..
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	⅞—1⅛	..	Feb, Aug	..	..
5	..	Hastings & District Elec. Trams, 6% C. P.	1½—2	..	Mar. Sept	..	..
St.	4½%	Do. 4½ Deb. Stock	75 —80	5 10 0	April, Oct	..	..
10	..	Imperial Tramways Ord.	3 —3½	..	Mar, Sept	..	..
10	..	‡Do. 6 per Cent. Pref.	4¼—4¾	..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Debs.	72 —74	6 3 6	Jan, July	..	..
..	2/0	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	2¼—2¾	5 10 0	Mar, Sept.	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	79 —84	4 15 0	Jan, July	..	..
10	6/0	Lanarkshire Tramways	10 —10½	5 12 3	Feb, Aug	..	..
St.	5%	Lancs Utd. Trams, 5% Prior Lien Deb. Stk.	82 —84	5 19 0	Jan. July	..	..
St.	4%	London Electric 4% Deb. St	98 —100	4 0 0	..	99⅝	99⅝
St.	4%	Do. 4% Pref.	85 —86	4 14 0	..	85¼	85
10	..	London United Trams, 5% Cum. Pref.	3⅞—4⅜	..	Jan, July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	77 —80	5 3 0	Jan, July	78	77
St.	..	Mersey Con. Ord. Stock	6 —8	..	Feb, Aug	..	..
1	1/1⅓	Metropolitan Elec. Tramways Ord.	¾—1 1/32	6 0 0	..	..	..
1	..	Do. Deferred	⅛—3/16	..	April	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	31/32—1 1/32	5 0 0	Feb, Aug	31/32	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	102½—104½	4 7 0	Jan, July	102½	..
St.	5%	Do. 5 per Cent. Db. Stk	102 —104	4 18 6	..	103	102½
St.	1½%	Metropolitan Railway Consolidated	48½—49	2 16 0	Feb, Aug	49½	47 15/16
St.	2¾%	Do. Surplus Lands Stocks	68 —70	3 19 6	Feb, Aug	69½	68¾
St.	3½%	Do. 3½ per Cent. Preference	90½—92	3 16 0	Feb, Aug	91¼	90¼
St.	3½%	Do. 3½ per Cent. "A" Preference	89 —91	3 17 0	Feb, Aug	89¼	89¼
St.	3½%	Do. 3½ per Cent. Convertible Pref.	89 —91	3 17 0	Feb, Aug	90	..
St.	3½%	Do. 3½ per Cent. Debenture Stock	93 —95	3 13 6	[illegible]	93½	..

* No allowance has been made for accrued interest or redemption.
† Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Share	Last Dividend	Name	Price Tues., June 20.	*Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business 6 Days to June 20. Highest	Lowest
		Electric Railways and Tramways—*Continued.*					
St.	3½%	Met. Rly. 3½ per Cent. "A" Deb. Stock	92 —94	3 14 6	Jan, July	..	..
St.	..	Metropolitan District Railway Ord.	29½—30	..	Feb. Aug	30½	29
St.	3½%	Do. 4½% First Pref.	88 —90	4 19 6	Feb, Aug	90½	88½
St.	3½%	Do. Assented Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	76 —78	4 10 0	Feb, Aug	77	76½
St.	3%	Do. 3 per Cent. Consoltd. Rent-charge	77 —79	3 16 0	Jan, July	—	..
St.	4%	Do. 4 per Cent. Midland Rent-charge	104 —106	3 16 0	Jan, July	..	—
St.	6%	Do. 6 per Cent. Perp. Deb. Stock	148 —150	4 0 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Ditto	98 —100	4 0 0	Jan, July	..	..
1	4½d.	Potteries Electric Traction Ord.	¼—⅜	5 6 9	April, Oct	9/32	..
1	0/6	Do. 5 per Cent. Cum. Pref.	[illegible]	7 5 0	Feb, Aug	..	—
St.	4½%	Do. 4½ per Cent, Deb. Stock	88 —91	5 0 0	May, Nov	..	..
1	1/2½	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	[illegible]	10 2 0	..	—	..
St.	4%	Do. 4 per Cent. Deb. Stock	75 —80	5 0 0	Jan, July	—	..
100	5%	Sunderland Dist. Elec. Trms. 5% 1stMtDb.	..	8 4 0	Jan, July	..	..
—	10/0	UndergdE.Rys.Lon.6% In. bds with coup 7	68 —70	1 12 6	June, Dec	69½	68½
—	5%	Do. 5% Prior Lien Bonds	100 —101	4 19 0	..	..	..
—	4½%	Do. 4½% Bonds with coup. 7	100 —102	4 9 0	..	101½	100½
	4%	Do. 4 per Cent. 1st Power Ho. Dbs.	100 —102	3 18 3	..	100⅛	..
	—	Yorkshire (W.R.) Elec. Trams. Ord.	¼—⅜	..	March ..	..	..
	..	Do. 6 per Cent. Cum. Pref.	2⅜—2⅞	..	..	..	..
St.	4½	Do. 4½ per Cent. 1st Debs.	84 —87	5 3 3	Jan, July	—	..
		Electric Manufacturing, &c.					
St.	4½%	Anchor Cable Co. 4½ % Deb. Stock	99 —101	4 9 0	—	..	..
1	..	Aron Electricity Meter Ord.	¾—⅞	..	..	¾	—
1	0/7½	Do. 6% Cum. Pf.	[illegible]	7 4 0	April, Oct	..	..
1	3/2½	Babcock & Wilcox Ord.	5⅛—5⅜	4 11 0	April, Oct	5⅛	—
1	0/7½	Do. Pref.	1⅛—1¼	4 0 0	..	..	..
5	6/0	British Insulated & Helsby Cables Ord.	6⅞—7⅜	6 15 6	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	6 —6½	4 12 3	Jan, July	..	—
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	102 —104	4 6 6	Jan, July	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt.Db.	96 —99	4 11 0	Mar, Sept	—	..
5	..	British Westinghouse 6 per Cent. Pref.	11/32—13/32	..	Feb, Aug	11/32	..
100	6%	Do. 6 per Cent. Prior Lien Dbs. (rd.)	101 —103	5 16 0	..	102⅞	—
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	61 —64	6 5 0	Jan, July	..	..
St.	4½%	BrushE.Eng. Co. 4½% Perp. 1st Deb.Stock	59 —64	7 0 6	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	41 —46	9 16 0	Jan, July	..	—
5	10/0	Callender's Cable Con. Ord. xd and bonus	8¾—9¼	7 11 6	Jan, July	8⅞	—
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅞—5⅛	4 17 6	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort Debs. (red.)	102 —104	4 6 6	Nov, May	..	..
1	1/6	Castner-Kellner Alkali Co.	3⅜—3½	5 1 0	May, Nov	3½	3⅜
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	104 —107	4 2 6	Feb. Aug	105½	104½
1	7½d.	Chadburn's (Ship) Telegraph Ord.	1 1/16—1 3/16	5 19 0	March ..	..	..
1	0/8¾	Consolidated Electrical Co.	⅛—¼	10 0 0	August ..	—	..
1	0/6	Consolidated Signal Co.	13/16—15/16	5 14 0	April, Oct	⅞	..
1	0/7½	Do. 6 per cent. Cum. Pref.	11/16—13/16	6 8 0	April, Oct	..	..
3	..	Crompton & Co (Nos. 1 to 85,000)	⅛—⅜	..	Jan, July	..	..
100	5%	Do. 5 per Cent. 1st Mort. Debs. (red.)	60 —70	7 14 0	Jan, July	..	..
5	1/0	Dick, Kerr & Co. Ord.	13/16—15/16	5 14 0	Sept.	⅞	..
5	0/7½	Do. 6 per Cent. Cum. Pref.	[illegible]—1 1/32	5 6 0	Sept	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	97 —100	4 10 0	Jan, July	..	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	11/16—13/16	..	Feb, Aug	¾	11/16
..	..	Do. (£5 paid)	1⅞—2⅛	9 3 0	Feb. Aug	2 1/16	2
St.	4%	Do 4 per Cent. Mort. Deb. Stock (red.)	69 —73	5 9 9	June, Dec	69	..
St.	5%	Do 5 per Cent. 2nd Deb. Stock	78 —81	6 3 6	Mar, Sept	..	..
..	..	Edmundson's Elec. Corp. Ord.	9/16—11/16	..	Jan, July	..	..
5	..	Do. 6 per Cent. Cum. Pref.	2½—3	..	May, Nov	2⅝	2 9/16
St.	4½%	Do 4½ per cent. 1st Mort. Deb. (red.)	86 —89	5 1 0	Jan, July	87⅛	..
2	..	Electric Construction Co.	13/16—1 1/16	..	Jan, July	⅞	..
2	2/9½	Do. 7 per Cent. Cum. Pref.	1¾—2	7 0 0	July	..	..
St.	4%	Do. 4 per Cent. Perp. 1st Mort. Debs.	71 —74	5 7 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	8¾—9¼	5 9 0	June, Dec	9 3/16	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs	88 —93	4 8 6	Mar, Sept	..	..
5	10/0	Henley's Telegraph Works Ord.	12⅛—12⅞	5 16 6	Feb, Aug	12¼	12 3/16
5	2/3	Do. 4½ per Cent. Pref.	4⅞—5⅛	4 10 0	Feb, Aug	[illegible]	4⅞
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	105 —108	4 4 6	Mar, Sept	..	..
10	15/0	India Rubber, Gut. Per., &c., Works	13 —15	5 19 6	Feb, Aug	15¾	13⅛
10	5/0	Do 5 per Cent. Cum. Pref.	10⅛—10⅞	4 14 0	..	..	..
100	4%	Do. 4 per Cent. Debs (red.)	96 —98	4 1 6	April, Oct	..	..
1	..	National Elec. Construction Co.	1/16—3/16	..	April	..	..
1	..	Richardsons, Westgarth & Co., Ltd. Ord.	9/32—11/32	..	Nov	..	..
1	..	Do. 6 per Cent. Cum. Pref.	19/32—21/32	..	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. Perp. Deb. Stock	78 —82	5 10 0	Jan, July	..	..
5	..	Simplex Conduits 6 per Cent. Cum. Pref.	4⅞—5	..	..	..	..
12	36/0	Telegraph Construction & Maintenance	35½—38½	5 16 3	Mar, July	37⅞	35⅞
100	4%	Do. 4 per Cent. Deb. Bonds (1909)	100 —102	3 18 6	Jan, July	..	..
1	1/0	Vickers, Sons & Maxim, Ltd., Ord	2 1/32—2 3/32	4 15 6	..	2 1/32	2 1/32
1	0/6	Do. 5 per Cent. non-Cum. Preference	1 1/16—1 3/16	4 3 0	..	1⅛	1 1/16
St.	5%	Do. 5 per Cent. non-Cum. Preferred	108 —112	4 11 0	..	108½	—
St.	4%	Do. 4 per Cent. 1st Mort Db. Sk. (red)	100 —102	4 0 0	June, Dec	100	..
100	4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.)	102 —104	4 7 6	June, Dec	..	—
100	5%	Do. 5 per Cent. 3rd Mort. Debs Scrip	103 —105	4 16 0	..	104	..
10	10%	J. G. White & Co. 6% Cum. Pref.	14½—15½	6 11 0	..	..	..
1	..	Willans & Robinson Ord.	⅛—⅜	..	Apr, Oct	..	..
5	..	Do. 6 per Cent. Cum. Pref.	⅛—1	..	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	55 —65	6 3 0	May, Nov	57	—
		Telegraphs.					
10	..	Amazon Telegraph	7¼—7¾	..	June, Dec	..	..
100	5%	Do. 5 per Cent. Debs. (red.)	100 —102	4 19 0	Jan, July	100½	..
St.	15/0	Anglo-American	69 —71	4 4 6	F,My,Ag,N	..	..
St.	30/0	Do Preferred	113 —114	6 3 0	F,My,Ag,N	113½	113¼
St.	30/0	Do. Deferred	26⅛—26⅞	5 1 0	F,My,Ag,N	26⅛	26 1/16
St.	4%	Commercial Cable 4 per Cent. Deb. Stk.	88½—90½	4 8 6	Jn,Ap,Jy,O	89½	88½
10	6/0	Cuba Submarine Ord.	10 —10½	4 17 6	Feb, Aug	10⅛	..
10	10/0	Do. Preference 10 per Cent.	17½—18½	5 13 0	Feb, Aug	—	..
5	2/0	Direct Spanish Ord.	3½—4	5 0 0	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	8⅛—8⅞	5 16 0	April, Oct	8½	..
50	4½%	Do. 4½ per Cent. Deb.	101 —103	4 8 3	Jan, July	..	..
10	2/0	Direct United States Cable	7¼—8	6 9 0	Ja,Ap,Jy,O	7¾	..
100	4½%	Direct West India Cable 4½%Rg.Db.(rd.)	100 —102	4 9 0	June, Dec	..	..
St.	65/0	Eastern Ordinary xd and bonus	135½—139½	5 1 6	Ja,My,Jy,O	139	137
St.	17/6	Do. 3½ per Cent. Pref. Stock	81 —85	4 2 0	Ja,My,Jy,O	84½	84½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (red.)	101 —103	3 18 3	May, Nov	102½	101½
St	6/6	Eastern Extension xd and bonus	13½—13¾	5 2 6	Ja, Ap,Jy,O	13⅜	13½
10	4%	Do. 4 per Cent. Deb. Stock	101 —103	3 18 3	Feb, Aug	101½	..
25	4%	Eastern and S.Af., 4% Mauritius Sub.Debs	99½—101½	3 19 0	May, Nov	..	..
10	26/0	G.N (of Copenhagen), with Coupon 82	31½—32½	5 8 0	Jan, July	..	..
25	52/6	Indo-European xd and bonus	53½—55½	5 6 6	May, Nov	..	..
100	5%	†Mackay Companies Common	92 —94	5 5 0	Ja,Ap,Jy,O	..	..
100	4%	†Do. Preference	75 —77	5 2 0	Ja,Ap,Jy,O	..	..
1	..	Marconi's Wireless Teleg. Co.	2 —2½	..	April	2¼	1⅞
100	4%	Pacific & Europe'n Tel.4%Guar.Dbs.(red.)	100½—102½	3 18 0	June, Dec	..	..
2½	1/3	West Coast of America					

Share	Last Dividend	Name	Price Tues., June 20.	*Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business 6 Days to June 2[0]
		Telephones.				
100	2$	Amer. Telephn. & Telegh. Cap. St.	155 —157	5 1 6	..	155½
..	4%	Do. Coll. Trust $1,000 4 per Cent. Bds.	96 —98	4 2 6	Jan, July	..
St.	4%	Do. 4% Cons. Bonds 1936	115 —117	3 8 6	..	..
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101 —103	4 17 0	Mar, Sept	..
5	3/0	Chili Telephone	7 1/16—7 5/16	5 11 6	August ..	7..
1	0/7⅕	Monte Video Telephone Ord.	⅞—1	6 0 0	Nov	..
1	0/6	Do. 5 per Cent. Pref.	⅝—⅞	5 11 0	May, Nov	..
St.	6%	National Co. Pref. Stock	104½—105½	5 15 0	Feb, Aug	104½
St.	6%	Do. Def. Stock	120 —123	4 17 0	Feb, Aug	127..
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	10 —10½	5 11 6	Feb, Aug	10..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10 —10½	5 11 6	Feb, Aug	..
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.	5 7/16—5 11/16	4 8 6	Feb, Aug	5½
St.	3½%	Do. Deb. Stock 3½ per Cent. (red.)	99½—101½	3 9 6	June, Dec	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	99½—101½	3 19 0	Jan, July	..
..	4½%	New York Telephone Co. 30 yr. Bnds.	100½—101½	4 9 6	..	101½
1	1/0	Oriental	1 1/16—1 3/16	4 18 0	April, Oct	..
1	0/7½	Do 6 per Cent. Cum. Pref.	1⅛—1¼	4 16 0	April, Oct	..
St.	4%	Do. 4 per Cent. Red. Deb. Stock	87½—89½	4 9 6	Jan, July	..
St.	4½%	Telephone Co. of Egypt 4½%Db.Stk.(red.)	100 —102	4 9 0	Jan, July	..
5	3/0	United River Plate Ord. (1—150,000)	7 1/16—7 11/16	5 3 0	July	..
3	4½%	Do. (150,001—190,000)	7 1/16—7 11/16	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅛—5⅝	4 9 0	June, Dec	..
St.	4½%	Do. 4½ Deb. St. Red.	103 —105	4 5 9	Jan, July	..
		Financial, Investment, &c.				
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4⅝—4⅞	6 17 0	Jan, July	11..
10	2/0	Globe Telegraph & Trust	11 —11½	5 2 3	Sp,DcMrJu	13
10	3/0	Do. 6 per Cent. Pref.	13½—13⅞	4 10 0	Sp,DcMrJu	
10	6%	Submarine Cables Trust (Cert.)	131 —134	4 9 6	April, Oct	..
		Colonial and Foreign Electric Railways, Tramways, &c.				
5	2/9	†Anglo-Argentine 5% Cum. 1st Pref.	5⅛—5⅜	4 15 0	April, Oct	
5	2/9	†Do. 5% Cum. 2nd Pref.	4⅞—5⅛	4 18 0	Jan, July	5
St.	4%	†Do. 4% Deb. Stock	94 —96	4 4 0	June, Dec	
St.	4½%	†Do. 4½% Deb. Stock	99½—101½	4 8 3	..	10..
St.	5%	Do. 5% Deb' Stock	100½—102½	4 13 6	..	10..
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)	104½—106½	4 14 6	Jan, July	10..
5	4/0	Brisbane Electric Trams. Invest. Ord	6⅛—6⅝	6 3 0	May	
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5⅛	4 17 6	May, Nov	
St.	4½%	Do. 4½ per Cent. Db. Prov. Certs.	101 —104	4 8 0	Jan, July	
St.	8%	British Columbia El..Rly. Df.Ord.	145 —149	5 8 0	Mar, Sept	
St.	6%	Do. Pref. Ord. Stock	128½—132½	4 12 0	May, Nov	
St.	5%	Do. 5% Cum. Perp. Pref. Stock	111 —113	4 9 0	Jan, July	
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	100 —103	4 7 6	April, Oct	
100	4½%	Do. Vancouver Power Debs.	102 —105	4 5 9	Jan, July	
St.	4½%	Do. 4½% Perp. Con. Deb. St.	101½—103½	4 2 6	..	
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	99½—101½	4 19 6	Mar, Sept	
St.	6%	Buenos Ayres Port & City Tram, 1st Mt. Deb. Stock	93 —98	6 2 6	Feb, Aug	
5	3/6	Calcutta Tramways (1 to 137,610)	5¾—6¼	4 19 6	Mar, Sept	
100	2/6	Do. 5 per Cent. Cum. Pref.	5⅛—5⅜	4 13 0	Jan, July	
1	4½%	Do. 4½% 1st Deb. Stock (red)	102 —105	4 7 0	Jan, July	
St.	..	Cape Electric Tram Shares	¼—⅜	..	..	
5	1/3	City of Buenos Ayres Trams Co. (1904) Sh.	5⅛—5⅝	4 5 0	F,My,A,N	
St.	4%	Do 4 per Cent. Deb. Stock	96 —99	4 0 9	June, Dec	
..	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.	95 —98	5 2 0	May, Nov	
1	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	100½—102½	4 18 6	Feb, Aug	
100	5%	Hong Kong Tramways Co. 5 per Cent. 1st Mort. Debs.	75½—79½	6 9 0	June, Dec	
1	..	Kalgoorlie Elec. Trams Sh.	[illegible]	..	..	
100	5%	†Do. 5 per Cent. "A" Deb. Stock	91½—94½	5 6 0	Jan, July	
5	6%	†Do. 6 per Cent. "B" Ditto	63 —67	8 15 0	Jan, July	
5	0/6	Lisbon Elec. Trams. Ord.	1 —1½	4 16 0	July	
100	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1½	4 16 0	Jan, July	
St.	5%	Do. 5 per Cent. Reg. Mort. Debs.	99 —103	4 19 0	Jan, July	
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	97 —99	5 1 6	Jan, July	
100	5%	Manaos Trams and Lt. Co. 5% Debs	94 —97	5 4 6	..	
..	5%	Manila Elec. Ry. $1,000 Gold Bonds	99½—101½	5 0 0	Feb, Aug	
100	$1½	Mexico Trams Co. Com. St.	123 —125	5 14 6	..	
..	5%	Do. Gen. Con. 1st Mort. 5% Gold Bds.	94 —96	5 4 0	..	
St.	6%	Do. 6% 50 yr. Mort. Bds	100 —102	5 19 0	—	
St.	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922) (Nos. 601 to 2,000)	101 —103	4 7 6	Feb, Aug	
St.	4½%	Do. do. (Nos. 1 to 4,600)	102 —104	4 7 6	..	
1	0/6	Perth Elec. Trams Ord.	11/16—13/16	2 13 6	May	
St.	5%	Do 1st Mt. Db. Stock	104 —106	4 14 3	Jan, July	
5	3/0	Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	5½—5⅞	5 4 6	—	
St.	4½%	Do. 4½% 1st Mort. Deb. Stk.	99 —102	4 8 0	—	
100	$1½	Rio Janeiro Tram, Lt. & P. Co.	114½—115½	4 10 0	—	
..	5%	Do. 30 yr. Gold Bnds.	103 —104	4 16 6	—	
100	5%	Do. 50 yr. Mt. Bnds	95½—96½	5 3 0	—	
..	$2½	†Sao Paulo Tramway, Light & Power Co. $100 Stock	184 —186	5 8 0	..	
..	5%	Do. 5 per Cent. 1st Mt. $500 Db.	102 —104	4 17 0	June, Dec	
100	4½%	Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	93 —100	4 10 0	Feb, Aug	
		Colonial and Foreign Electricity Supply, &c.				
5	3/0	Adelaide Elec S'ply Co. 6% Cu. Pr.	5½—5⅞	5 8 0	Mar, Sept	
10	6/0	Bombay E.S. & T. 6% Cm. Pf.	10¾—11⅛	5 6 6	..	
St.	4½%	Do. 4½ per Cent. Deb. Stk. (red)	99 —101	5 8 0	Jan, July	
..	5%	Do. 5 per Cent. 2nd Mort. Deb. Stock	98 —100	5 0 0	..	
5	5/0	Calcutta Elec. Supply Ord.	6⅞—7⅛	5 19 6	April, Oct	
5	2/6	Do. 5% Cum. Pref	4⅞—5⅛	4 13 0	..	
100	5%	Calgary Power Co. 5% 1st Mort. Bnds	96½—98½	5 1 6	—	
100	7/2½	†Canadian Gen. Elec. Co. Com. St.	108 —111	6 8 0	..	
100	$3½	Do. 7% Cm. Pf. Stock	121 —124	5 5 0	—	
100	5%	Castner Electrolytic Alkali Co. (of U.S.A.) 1st Mort. Stl. Debs.	97 —102	4 18 0	Jan, July	
500	5%	Elect Development Co. of Ontario	83 —85	5 19 0	..	
St.	5%	Elec. Supply Co. of Victoria 5 per Cent 1st Mort. Deb. St.	87 —90	5 11 0	Jan, July	
5	..	Indian Elec. Sup. & Trac. Co.	1 —1½	..	..	
10s	..	Kalgoorlie Elec. Power & Ltg. Ord.	1/16—3/16	..	..	
1	0/7⅕	Do. 6 per Cent. Cum. Pref.	[illegible]	8 6 6	April, Oct	
..	5%	Kaministiquia Power Co. 5% Gold Bnds.	103½—105½	4 15 0	..	
5	..	Madras E. S. Corp. Ord.	2¾—3⅛	..	..	
St.	..	Melbourne E. S. Co. Cons. Ord. St.	31 —36	..	..	
St.	5%	Do. 5% 1st Mortg Deb. Stock	92½—94½	5 5 6	..	
500	5%	Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	83 —90	5 12 6	..	
St.	$1	Mexican Lt. & Power Co. Com. St.	82½—84½	4 16 0	..	
St.	$3½	Do. 7% Cum. Pref. St.	106 —108	6 10 6	..	
500	5%	Do 5% 1st Mort. Gold Bnds.	94 —95	5 6 0	..	
St	5%	Monterey Rly. L. & P. Co. 1st Mort. Db. Sk.	89½—91½	5 10 6	F,My,A,N	
100	8/2½	Montreal Lt. Ht. & Power Co. Cap. St.	163 —165	4 16 6	..	

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NOTES.

The I.M.E.A. Meeting.

In accordance with our practice since the formation of this Association, we publish, in another part of this issue, a full report of the proceedings at this year's Convention at Brighton. The gathering has undoubtedly proved to be a record one, the numbers attending reaching the handsome total of nearly 500. Many of the members have travelled long distances, from Dundee, Glasgow, Edinburgh, Belfast, &c., to be present. The weather, though on the windy side, has fortunately been brilliantly fine. The arrangements this year have been on much the same lines as in previous years and no particular innovation has been made, except, perhaps, on the social side. The Papers read have been, possibly, below the average of past years. This would suggest that the Association finds it increasingly difficult to get engineers to prepare Papers. The remedy is comparatively simple. Greater opportunity for discussion should be given to the members. Rather than read Papers and work up the audience to the pitch of boredom thereby, the plan, adopted on the last day of the Convention, of holding an informal discussion on some suitable subject, should be extended to all the technical meetings of the Association. There is much good matter, which is now reserved for discussion in the smoke-rooms of the hotels, that could very well be deliberated upon in open conclave. The members of the Association, too, complain that the circulation of typed questions has become a nuisance and a hindrance. Why cannot some of the more important of these questions be dealt with in open discussion at the Convention? We hope that next year the Council will take a decided step in this direction; and we venture to prophesy an increased membership and wider sphere of utility for the Association as a result.

Wiring Regulations.

All engineers will sympathise with Mr. J. W. Beauchamp in his desire, as expressed in his Paper read before the Incorporated Municipal Electrical Association, that the number of wiring rules should be reduced to one set. It must be admitted, however, that things are moving in the right direction, for there are by no means so many sets of rules as there were a few years ago. Those issued by the Institution of Electrical Engineers have made steady progress and are now adopted by a large number of supply and insurance authorities. Nevertheless, the fact remains that the number of rules still in existence is larger than it should be, and the result is mainly to impede contractors in their work. The existence of only one set of rules would secure greater uniformity of work and would give the inferior class of contractor less excuse for his faults than he has at present. Unfortunately, it is one thing to make rules and quite another to enforce them, and in this respect electric wiring is at a disadvantage, because so much of it is necessarily concealed. Frequent inspection during the progress of the work is essential if there is to be any certainty that the quality is what it should be. Yet the supply authority generally carries out merely an insulation test, the result of which may depend more upon surface leakage than anything else. In fact, under certain conditions, this surface leakage may render it very difficult

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to obtain the specified result, and on that account alone it is desirable that wiring rules should be administered with some discretion.

ANOTHER point touched upon by Mr. BEAUCHAMP is the question of earth connections. It is no good earthing unless the earth connection is properly made. This is generally put out of sight and if found by a non-technical enquirer it probably appears to him to be a mistaken bit of work of an over-zealous contractor, which view is probably confirmed by the fact that if the connection is removed no harm seems to have been done. We notice that Mr. BEAUCHAMP suggests the use of a No. 18 wire as sufficient for earthing small installations. Electrically this may be the case, but for mechanical reasons we do not think so small a wire should be used. It generally costs very little more to put in a substantial connection, looking as if it really serves a purpose, and there is no reason why it should not be labelled as such to ensure proper respect.

The Electric Vehicle in Boston (U.S.A.).

THE slow development of electrically-driven vehicles in this country may be said to be due, in some measure at any rate, to the great improvements which have been made in the petrol engine. At one time much more progress was being made with the former type of equipment than is the case at present; electric broughams and landaulettes were being extensively used for town work and there was even in London a line of electrically operated omnibuses. The latter have entirely disappeared, and there seems some chance of the former meeting the same fate. It is of interest then to enquire why this unsatisfactory state of things should exist, seeing that in many ways the electric vehicle is possessed of advantages which are lacking in the petrol car.

FOR town work the two financial items that need be particularly considered are maintenance of the battery and the cost of charging. The limited radius of action is no disadvantage, because batteries of capacity sufficient for a day's work in town can easily be used. As regards the battery, present-day accumulators are quite capable of operating under traction conditions; and it therefore remains to be seen whether all is being done by the supply authorities in granting facilities for charging. This is important; for charging is an operation which occurs very often in the life of a battery and is particularly necessary to the electric vehicle. It is at this point we fear that we have failed in this country. Scarcely sufficient facilities have been given in the way of low rates for charging accumulators, and electrical engineers have not been sufficiently enterprising to use electric vehicles and so emphasise the advantages obtainable. This is unfortunate, for how much can be done is indicated by the results of a campaign recently undertaken in Boston by the Edison Electric Illuminating Co. This campaign was undertaken to create interest in the electrically propelled vehicle for pleasure and commercial uses, particularly the latter. To show its faith in its own prescription the Edison Co. changed all its vehicles to the electric drive and now, as the result of several months' working, it is able to announce that the economies effected will soon pay off the capital outlay. Further, an organisation known as the Electric Vehicle Club, whose membership consists of dealers in electric vehicles and accessories, has taken the matter up very strongly, and much editorial space is being given to the subject in the local newspapers. With these examples in front of them it is not to be wondered at that the inhabitants of Boston have gone in strongly for the electric vehicle. According to a local paper every dealer and agent in the city reports a large number of enquiries about electric cars; and the vehicles are, in fact, being sold faster than they can be delivered. Everyone speaks highly of their reliability, and their employment for emergency purposes, such as fire engines is becoming more and more extended. The results of the campaign are therefore highly satisfactory. Cannot our own supply authorities take the hint?

The London Electrical Engineers, Royal Engineers.—We take the following announcement from "The London Gazette" of Friday evening last:—Lieut.-Col. and Hon. Col. (Honorary Maj. in the Army) Rookes Evelyn Bell Crompton, Retired List (Territorial Force), is appointed to the Hon. Colonelcy of the unit. (June 24.)

Harmonic Analysis Diagrams.—*Erratum.*—We regret that in the footline to Fig. 4 of Dr. Beattie's article on the above subject, which appeared on p. 371 of our issue of June 16th, "fifth sine and fifth cosine terms" should read "second sine and second cosine terms."

Turin International Congress for the Applications of Electricity.—The following have been appointed as delegates to represent the Institution of Electrical Engineers at the Congress which is to be held in Turin in September, 1911:—Mr. S. Z. de Ferranti, Col. R. E. Crompton, C.B., Mr. W. Duddell, F.R.S., Dr. R. T. Glazebrook, C.B., F.R.S., Mr. R. Kaye Gray, Mr. R. Hammond, Major W. A. J. O'Meara C.M.G., Mr. A. Siemens and Dr. S. P. Thompson, F.R.S.

Telephony in San Francisco.—This subject was dealt with in a Paper read by Mr. S. G. McMeen before the Western Society of Engineers, and reported recently in the "Electrical Review and Western Electrician." The city of San Francisco has a population of about 465,000 and with the cities of Oakland and Berkeley, across the bay, the metropolitan area comprises a population of about 609,000. The three cities are equipped with an automatic telephone system divided into two main portions, that in San Francisco being equipped with the two wire system and that in the trans-bay cities being built on the three-wire system. The two groups are connected by a cable about 8½ miles long, of which 3½ miles are submarine. Each of the two main sections of the system has a main exchange and four branch offices, with a number of subsidiary offices containing only the subscribers' line switches. The climatic conditions of San Francisco are peculiar, and one of the most severe problems was to make the system moisture-proof. This was done by using underground lead-covered cable for all the main trunk and lateral lines, so that open overhead wire was used only for drop-wire purposes, and even these were insulated. The cables and conduit lines were laid out on the basis of estimated traffic conditions up to 1925. The effective calls are registered on meters, and a number of private branch exchanges, also worked on the automatic system, are in use.

Cable Interruptions.	Date of Interruption
Assab—Perim	July 8, 1909
Malta—Tripoli	April 20, 1910
Latakia—Palura	May 26, 1910

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Corona Losses on Transmission Lines.—The "Electrical World" states that experimental sections of high-tension transmission lines are being constructed at Purdue University, Lafayette, U.S.A., to study the corona losses occurring under conditions of high potential. A steel and a wooden pole line are being erected, the latter being equipped with movable insulator pins so that the distance between the wires may be varied. These transmission lines will be excited from the 300,000-volt transformer in the electrical engineering laboratory.

Electricity Supply on the Isthmus of Panama.—The "Electrical World" states that a new 500 kw. 2,200-volt three-phase turbo-generator is to be installed in the electric generating and air-compressor station near East Balboa on the Isthmus of Panama, replacing all the present electrical generating equipment at that point. Hitherto direct current has been used for the operation of the cranes on the Panama Railroad wharf and for the motors in the Pacific Division machine shop. These motors will now be superseded by alternating-current machines when the new generator, which is to be driven by the exhaust steam from the air compressors, is in operation. This will not only constitute a fuel economy, but obviate any necessity for additional boiler capacity. The Miraflores plant will supply the night load. In addition to the electricity required at Balboa during the day there is sufficient energy in the exhaust steam to enable the Balboa plant to transmit from 100 kw. to 200 kw. to the system now operated by the Miraflores plant.

Electricity and the Gala Performances.—Electricity has played an important part in the two gala performances given by H.M. the King in connection with the Coronation celebrations, the one at Covent Garden Theatre on Monday night and the other at His Majesty's Theatre on Tuesday. Besides being used for the stage and general lighting, electricity was in both cases combined with the decorations to give an exceedingly artistic effect. The house at Covent Garden was decorated throughout with roses, over 100,000, some real and some artificial, being used. From trellis work beneath the lowest tier of boxes the blooms rose circle above circle to the highest gallery, the intertwinings being lighted up with hidden lights. The King's box was decorated with a frieze of gold, white and mauve orchids, while in the box itself carnations were used, and here again electricity was used as a sub-decoration. The proscenium, too, was outlined with flowers and lamps. At His Majesty's a much simpler scheme was used. Round the boxes were festoons of poet's laurel, supporting clusters of golden fruit. The proscenium opening was decorated with crimson roses mingled with laurels. Here, again, electricity was used to bring out the beauties of the flowers, while special advantage was taken of it in decorating the fountains in the foyers. The extraordinary number of "star" actors and actresses taking part in the performance made some extra dressing room accommodation necessary. This was obtained by boarding up the ends of the arcade next the theatre and fitting the dressing tables which were placed in it by a temporary installation fed from the theatre mains.

International Electrotechnical Commission.—In conformity with the wishes of the Brussels Conference held in August, 1910, the delegates of the British, French and German Electrotechnical Committees met at Cologne in the middle of May last and accomplished very excellent work. Prof. Eric Gérard, having presided at the Brussels Conference, at which the subject of nomenclature had been much discussed, was specially invited to attend, so that not only was there a concurrence of ideas, but the delegates were entirely free to put forward their particular views. Those present were:—Prof. Eric Gerard (President of the Belgian Committee), M. E. Brylinski (Delegate of the French Committee), Dr. E. Budde (President of the German Committee), Dr. S. P. Thompson, F.R.S. (Delegate of the British Committee), and Mr. C. le Maistre, General Secretary of the Commission.

Before the actual work of the meeting was commenced, a most important suggestion was outlined by Dr. Budde dealing with the international unification of symbols. On behalf of the German-speaking nations, as represented by the Elektrotechnischer Verein of Berlin, Dr. Budde said that they would be prepared to abandon the use of "W" for resistance and adopt "R," if the English-speaking nations, on the other hand, would adopt "I" instead of "C" for current. Dr. Budde was quite ready to exclude "J" as synonym for "I," owing to the confusion which would arise due to the fact that "J" is already employed to represent other quantities. Dr. Thompson, on behalf of the British Committee, willingly concurred in this suggestion, and as the American Institute already employs "I" and, through the good offices of the American Electrotechnical Committee, the National Electric Light Association of America is being approached in the matter, there is every hope that at Turin the symbols "I," "E," "R" will be universally adopted. Such a decision, if ratified by the Commission, as no doubt it will be, will certainly be a most encouraging step in the right direction. The discussion of the work of the various Committees on the German list of terms put forward at Brussels was then entered upon, and a list of some 50 industrial terms and definitions was agreed to in French and English. The word "industrial" has been introduced so as to distinguish this work from that of the vocabularies in course of preparation by several of the Committees. The reason being that the vocabularies include definitions of a character more abstract and general and more rigidly scientific than is necessary in the case of industrial terms, which are more conventional and can therefore be defined in less academic language and yet prove of inestimable value to the industry by facilitating commercial transactions between buyer and seller. As the time at their disposal was so limited the delegates intend to meet again at Turin early in September so as to have an opportunity of revising their work prior to submitting it to the plenary meeting. In the meantime the work already carried out is being issued to the various Committees for their consideration. Special mention must be made of the work of the Danish Committee which was presented in such an admirable manner and has been of very considerable assistance to the Committees generally. The work of the Japanese, the Mexican and the Spanish Committees was also most complete. The small Committee has been so successful in its task that in all probability the appointment of other small international Committees, to study certain particular subjects in a preparatory manner, will be considered in the near future, and thus work will be going on continuously and more rapid progress thereby ensured.

Current Topics.

Subjects of current interest dealt with in this issue include the following:—

We give a complete account, up to last evening (Thursday), of the proceedings at the Convention of the Incorporated Municipal Electrical Association, held this week at Brighton. The presidential address was delivered by Mr. J. Christie, and the following Papers were read: "Electricity Supply from the Municipal Committee's Standpoint," by Councillor H. Leese; "Modern Wiring Practice," by Mr. J. W. Beauchamp; "Internal Combustion Engines Working on the Diesel Principle," by Mr. H. L. Howard; and "Internal Combustion Engines for Power Stations," by Mr. R. M. Carr. Abstracts of these Papers and of the discussions that took place are given in this issue, also of the two discussions that took place yesterday, viz., "Purchase of Fuel," opened by Mr. C. E. C. Shawfield, and "Street and Shop Front Lighting," opened by Mr. A. H. Seabrook.

We describe the Faraday House Testing Laboratories.

The public service of rail-less trolley vehicles was opened at Bradford on Saturday.

We give an account of part of the first day's proceedings at the Education Conference organised by the Institution of Civil Engineers, which was held this week on Wednesday and Thursday.

Municipal Loans.—An inquiry was held last week at Worcester into the Council's application for sanction to a loan of £3,375 for extensions of the electricity undertaking, on Wednesday at Aldershot an inquiry was held into an application for sanction to a loan of £2,500 for extensions of the electric supply department, and an inquiry has also been held at *Bispham* into the Council's electricity supply scheme involving an expenditure of £9,180. *Ealing* Corporation have been authorised to borrow £18,500 and *Walthamstow* Council £9,206 for extensions of their electricity undertakings.

Parliamentary.—The Telephone Transfer Bill was read a first time on Tuesday.

A Bill of 201 clauses has been introduced into the House of Lords to consolidate and amend the law relating to railway traffic.

A Bill to confirm the Pateley Bridge Electric Lighting Provisional Order has been passed by a Select Committee of the House of Lords.

Legal.—The Court of Appeal have allowed the appeal of the Postmaster-General from the decision of the Light Railway Commissioners as to the validity of the notices of objection to certain plant, &c., of the National Telephone Co., and the cross appeal of the Company was dismissed, with costs.

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Mr. Muir Mackenzie, Official Referee, has continued the hearing of the action brought by Messrs. W. Canning & Co. against the Northern Flexible Metallic Tube Co. for the recovery of the balance of the price of an electric galvanising plant.

Mr. Justice Bray has delivered an interesting judgment in the action Hartlepool Electric Tramways (Ltd.) *v.* Hartlepool Corporation.

A Divisional Court has dismissed the appeal of the Metropolitan Electric Tramways (Ltd.) as to the rating of the Company's lines in Tottenham.

Companies' Meetings and Reports.—Among the reports of meetings reported are those of the Indo-European Telegraph and the Globe Telegraph & Trust Companies; while reports of the Bombay Electric Supply & Tramways Co., the Chilian Electric Tramway & Light Co., Greenwood & Batley, and the Marconi International Marine Communication Co., &c., are also given.

OBITUARY.

Mr. P. S. Sheardown.—We regret to record the death of Mr. Percy Sewell Sheardown, electrical engineer of Dublin, which took place in London on 19th inst. Deceased, who was suffering from breakdown, due to overwork, came to London to see a specialist.

Mr. Sheardown received his technical education at the City and Guilds of London College, Finsbury, under Prof. S. P. Thompson and Prof. John Perry, during 1892-3-4, obtaining first place at the final examination in electrical engineering in 1894, and a medal and prize from the examining body. After a short service as assistant to the engineer at Bray electricity station, he joined the staff of the British Thomson-Houston Co., and worked in Dublin on the electrification of the Dublin to Dalkey tramway line. Later he joined the staff of the Dublin United Tramways Co. as assistant electrical engineer, was with the Company throughout their change-over to electric traction, and he held the appointment of chief electrical engineer to the Company at the time of his death. Mr. Sheardown took much interest in technical education questions, and was a lecturer on the engineering staff of Trinity College, Dublin University. He was vice-chairman of the Dublin local section of the Institution of Electrical Engineers in the session 1905-6.

G. Carels.—The death is announced of M. Gustave Carels, of Carels Frères, Ghent, manufacturers of turbines, steam engines, &c.

APPOINTMENTS VACANT AND FILLED.

Dundalk Urban District Council invite applications for the appointment of resident engineer for their electricity undertaking. The successful applicant will act as clerk of works, under the Council's consulting engineer, during the construction of the works. Salary £250 per annum. Applications to the town clerk (Mr. Mathew Comerford), Town Hall, Dundalk, by Monday, July 10. See also an advertisement.

A firm of incandescent electric lamp manufacturers require a qualified representative for the London district. See an advertisement.

A first class electrical engineer is required to take charge of instrument works. See advertisement.

A firm of electric incandescent carbon lamp makers require a skilled foreman for the stem, depositing and flashing departments. See advertisement.

A skilled assistant engineer is required for an incandescent electric lamp factory, with experience in the manufacture of carbon and metal lamps. See advertisement.

A meter tester and testing assistant is required for one of the electricity works of the County Borough of Stoke-on-Trent. Commencing salary 26s. per week. Forms of applications, &c., from the borough electrical engineer (Mr. C. H. Yeaman), Hanley electricity works, Stoke-on-Trent. See advertisement.

Owing to increased business, it has been necessary to reorganise the staff of the Clyde Valley Electrical Power Co., and the following changes and reappointments have taken place:—

Mr. D. A. Starr remains general manager and Mr. R. Robertson, who has held the post of secretary for several years, becomes commercial manager with charge of the selling and development department. Mr. H. E. Ferguson, who has held the position of chief accountant for several years, has been appointed secretary. Mr. D. MacFarlane MacLeod is resident engineer, and Mr. W. G. Crawford mains superintendent.

Mr. E. Taylor, fourth engineer in charge to Hammersmith (London) Council, has resigned to take up an appointment under the Board of Trade.

W. G. Hindley (Melbourne Corporation Electricity Department) has been appointed by Hampden (Victoria) Shire Council as chief engineer of the Camperdown and Terang electricity works.

Mr. G. D. Mathews, A.M.I.C.E., A.M.I.M.E., A.M.I.E.E., has left the Government service at the Royal Arsenal, Woolwich, and has joined the staff of the Tudor Accumulator Co., 119, Victoria-street, S.W.

INSTITUTIONS AND SOCIETIES.

Royal Society of Arts.—The annual report presented at the annual general meeting of the Society this week, mentions that the office of president has now been accepted by H.R.H. the Duke of Connaught. Up to the death of King Edward VII. it was occupied by H.R.H. the Prince of Wales (King George V.), and, on his accession to the throne, it was temporarily held by the Lord Chief Justice. There has been, as usual, an increase in the entries for the Society's examination, the total number of Papers worked this year being 24,360. Under the Fothergill Trust the Council has made the following awards for life-saving apparatus for use in mines and places where the air is noxious: gold medals to Mr. H. A. Fleuss and Mr. W. E. Garforth; and silver medals to Mr. R. Jacobson and the Mining Engineering Co. The Society's Albert Medal has been awarded to the Hon. Sir Charles A. Parsons, K.C.B., F.R.S. The Council, with a few alterations, was re-elected.

EDUCATIONAL NOTICES.

University of Sheffield.—The faculty of applied science comprises the departments of engineering, metallurgy, coal mining and architecture. The courses in engineering or in metallurgy extend over three years and prepare respectively for the degree of B.Eng. or B.Met. of the university. The lecture courses commence Oct. 4 and the technical laboratory courses on Sept. 18. Prospectuses and other particulars from the registrar, Mr. W. M. Gibbons.

City and Guilds Technical College.—This college provides a scientific training for students preparing to become electrical and mechanical engineers or chemists and for engineering pupils who desire to supplement their practical training by a two years' course of instruction in the principles of engineering science. The instruction is mainly given in the various laboratories, most of which have been recently re-equipped. The subjects of the entrance examination are mathematics and English, but the matriculation of any British University is accepted. The courses in electrical and mechanical engineering cover a period of two years and those in chemistry three years. There are also arrangements for three year courses in engineering. Particulars at the college, Leonard-street, City-road, London, E.C., or from the City and Guilds of London Institute, Gresham College, Basinghall-street, London, E.C.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, June 30th (to-day).

Incorporated Municipal Electrical Association.

10 a.m. Annual General Meeting at the Royal Pavilion, Brighton.
2:30 p.m. Motor trip to Arundel.

Physical Society.

5 p.m. Meeting at the Imperial College of Science. *Agenda:* "On the Effect of a Narrow Sawcut in the Edge of a Conducting Strip on the Stream Lines in the Strip and on the Resistance of the Strip," by Prof. C. H. Lees, F.R.S.; "The Capacity Coefficients of Spherical Electrodes," by Dr. A. Russell; "Exhibition of the Benkö Primary Battery," by Mr. W. R. Cooper.

NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION.

WEDNESDAY, July 5th.

12 noon. Council Meeting at the Institution of Electrical Engineers, Victoria Embankment.
3 p.m. Special General Meeting at the Institution of Electrical Engineers.

THURSDAY, July 6th.

2:30 p.m. Council Meeting at Balfour House, Finsbury-pavement E.C.

THE LONDON ELECTRICAL ENGINEERS.

Officer Commanding, Col. H. M. Leaf.

The following orders have been issued for the current week:—

Head Quarters will be closed for instruction during the week.

Saturday, July 8th.—The Plymouth Detachment will parade at Headquarters at 9:30 a.m. Dress: Service dress, drill order, with water-bottle and haversack. Arms will be drawn before this parade.

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SIXTEENTH ANNUAL CONVENTION OF THE INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

The I.M.E.A. is to be congratulated on its decision to migrate to the seaside for its annual meeting this year. The Conventions of the past few years have been confined to inland industrial centres, mainly because the Presidents of the Association were selected from towns in which large municipal stations were in operation. The seaboard towns, particularly those in the south, had been overlooked in choosing a *venue* for the annual Convention, and in Brighton not only has a good electrical centre been hit upon, but a seaside pleasure resort which it would be difficult to beat. Among the principal members attending the Convention we may mention Messrs. S. L. Pearce, G. Wilkinson, R. A. Chattock, J. E. Edgcome, W. W. Lackie, H. Faraday Proctor, C. E. C. Shawfield, S. J. Watson, A. C. Cramb, H. Richardson, A. H. Seabrook, C. H. Yeaman, F. M. Long, T. P. Wilmshurst, H. Collings Bishop, F. A. Newington, C. M. Shaw, A. A. Day, A. Clough, Aldermen G. Pearson, Sinclair, G. P. Smith, West, &c. A large number of visitors, among whom we noticed Mr. S. Z. de Ferranti (President Inst.E.E.) and a goodly sprinkling of ladies, were also present.

Brighton, Tuesday, June 27th.

The bulk of the members arrived in Brighton on Monday evening, and at the opening meeting on Tuesday morning the Mayor of Brighton extended a welcome to a "crowded house." In his opening remarks the Mayor established a precedent by omitting the well-worn phrase that electricity is "still in its infancy." He thought that the members would find much to interest them in the electrical undertaking at Brighton, especially as it was one of the oldest in the country, and had been in progressive hands from the start. He paid a high compliment to Mr. Christie, under whose guidance the scheme had been brought to its present state of efficiency.

After a vote of thanks to the Mayor for his presence in welcoming the Association, Mr. Christie read his Presidential Address.

PRESIDENTIAL ADDRESS.*

BY J. CHRISTIE.

When this Association met here, 15 years ago, in these same rooms, we were a comparatively small and unimportant gathering, numbering only 114 all told, made up of 38 municipal, 48 engineer and 26 associate members, and the total capital of the undertakings we were then responsible for did not much exceed £3,000,000. Our growth since then has been rapid, and to-day our roll of membership has increased to a total of 407, comprising four honorary, 168 municipal, 187 engineer and 48 associate members and associates; and as an Association we can justly claim to voice the opinions on matters electrical of practically the whole of the municipal undertakings throughout the Kingdom, whilst the capital invested in the machinery and plant directly under our control, and exclusive of tramway and company undertakings, has increased in these few years to upwards of £41,000,000.

Mr. Arthur Wright in the first presidential address most clearly enunciated the various questions of policy which should guide us in the administration of our responsible duties, and it is most gratifying, especially to those of us who have been members of the Association since its inception, to note how many of the intricate problems dealing with the commercial and technical sides of our business have been so satisfactorily solved, in many cases as the outcome of action taken by our Association.

Each year the task of finding a suitable text for the Presidential sermon becomes more difficult, and I must confess to having failed to hit on any new or original theme on which to address you.

The town of Brighton has always held a prominent place in the history of electric lighting and traction progress, and so far as I can ascertain she can claim to have been first in the field with regard to both these branches of our business. The first electric railway in this country was started here in August, 1883, through the enterprise of Mr. Magnus Volk. This line, running along the eastern sea front, is still in successful operation, and it is worthy of note that the dynamo now driving it has been in regular daily use for upwards of a quarter of a century. The only radical change effected, except with regard to modernising and improving the permanent way, rolling stock, &c., has been to replace the gas engine, which was the prime mover in those early days, with a 60 kw. motor and battery operated off the Corporation supply mains.

So far back as 1891 one of the earliest experiments in electric lighting in this country was carried out under the auspices of the Brighton Corporation. The installation consisted of six arcs, each lamp being run off its own separate machine. These for a time lighted a portion of the Madeira-road, and were then regarded as one of the wonders of the age. The following year Messrs. Hammond & Co. laid down a small plant which supplied a series of arc lamps installed in the business premises of several of our leading tradesmen, and this I believe was the first instance of a central station for the public supply of electricity being established in this country.

This pioneer lighting company kept pace with the times, the series arc, and, later, the ingenious multiple series incandescent lighting in turn gave place to the single-phase 2,000-volt alternating-current house-to-house transformer system.

In 1891 the Corporation obtained a Provisional Order, and shortly thereafter commenced a two-wire continuous-current supply with underground mains, competing for business with the company. In 1893 the goodwill of the company's business was purchased by the Corporation for the sum of £5,000, the old plant being finally shut down and sold a few months later. The supply business in the hands of the Corporation and under the management of your first president (Mr. Arthur Wright) continued to prosper; the two-wire system was changed over to a three-wire system, high-tension single-phase alternating current was again introduced to meet the demand in the outlying area at times of peak load, later the voltage of the supply in these districts was doubled, and the continuous current once more displaced the alternating.

In 1905 the North-road works as a steam generating station was superseded by the new three-phase turbine waterside station at Southwick, and the nuisance from a large works in the centre of the town was thus removed. The old works are now only used as a sub-station, probably one of the largest of its kind in the country at the present time, containing as it does upwards of 8,000 kw. of converting plant of various types.

To meet the continually increasing demands in the outskirts of the town, we will shortly have again to establish sub-stations, either equipped with three-phase alternating-current plant, or self-contained engine units of the internal combustion type. Thus history repeats itself.

Like all pioneers, our undertaking has had to pay the penalty of heavy capital outlay per kilowatt of useful capacity, although this is rapidly righting itself, due to many of the early loans becoming extinguished. As an offset against this, owing to the long use and acquaintance with the many advantages of electricity, we have established a goodwill which is now an asset of no mean value, as at the present time we have got 5,239 customers connected to our mains, and the consumption of electricity per head of population last year amounted to no less than 78 units, which still constitutes a record for a non-industrial town of 132,000 inhabitants.

Most undertakings by this time have successfully passed through that period of stress and reduction in lighting output consequent on the introduction of the metal filament lamp, and although we have all more or less experienced a temporary set-back and loss of revenue due to this cause, we can now only regard its advent as a blessing in disguise.

Brighton was the home of the maximum demand system of charging. We are generally agreed that this system is undoubtedly the most equitable from both the consumer's and supplier's point of view, and for fixing prices for large lighting and power contracts it must still always form the basis of our reckoning. There is, however, no denying the fact that even here, where it was first evolved, it became with certain classes—and they were in the majority—unpopular. So, in deference to the popular demand for an easily understood flat-rate, our Council some three years ago wisely granted the concession asked for. The maximum demand system for all new business was abolished; this rate to existing consumers who elected to retain it was at the same time raised from 7d. and 1d. to 6d. and 2d. per unit, the alternative offered being a flat rate of 4d. per unit for domestic and shop lighting, and 3d. per unit for hotels, licensed premises, churches, &c., with special rates to very large consumers of either class. This

* Abstract.

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somewhat drastic change of policy fortunately came into force just as the metal filament lamp came into general use, and to-day everyone is satisfied with the result.

How this tariff question will ultimately be solved it is impossible to say. In discussing the matter with Mr. Wright some months ago, he put forward as his belief that we might ultimately come to a fixed charge per square foot of floor area on the basis of a given number of watts per square foot, have no meters, and allow consumers to use the supply for any purpose without other restriction. On the grounds of simplicity this suggestion has much to commend it as compared with the "Telephone," "Norwich" and other systems we now hear so much about.

The development of a day load power supply on the restricted-hour basis is also another phase of our business which was first introduced in Brighton. This class of business comprises engineering shops, printing works, laundries, breweries, mineral-water factories, refrigerators, saw mills, ventilating and domestic machinery, and we have also obtained a lucrative business in charging the accumulators of electrobuses and other battery-driven vehicles. From these sources we have now worked up a day load of some 3,000 H.P. connected, consuming last year almost 3,000,000 units, and this has so improved our load factor that we have been able to effect most marked economies in our works costs. Practically all the small isolated steam plants in our area have now been displaced by electric motors, and the consequent diminution of the smoke nuisance resulting therefrom is a matter of no small importance in a health resort like Brighton.

There must be many cities and towns in the provinces more or less similarly situated which are also to a great extent immune from dense fogs where this system, with the restricted hours so modified to suit local conditions, could be adopted with advantage to both the consumer and the supply authority, and I can heartily commend it to my brother engineers for their careful consideration.

Now that electrically-operated bakers' ovens are a commercial success, this also opens up another class of business of somewhat similar character well worthy of investigation. These make demands, according to size, of from 25 kw. to 100 kw., and are usually only wanted between, say, 11 p.m. and 6 a.m., when our plant and mains are otherwise comparatively idle. The first cost and cost of maintenance are by no means prohibitive, and we could well afford to cut the price for this class of business to something like ½d. per unit, at which figure, I am informed, we can effectively compete with the existing methods of heating these appliances, whilst the advantages in the way of cleanliness and ease of regulation are all in favour of electricity.

In conjunction with the development of this power, heating and cooking business, it is most essential that the supply authority should also possess powers to sell and hire out motors and other suitable appliances. No hardship can be imposed on the local contractor by granting them, as in most provincial towns the average contractor is not in a position financially to establish a hiring system, and the prospective user for similar reasons is unable to purchase these accessories through the contractor.

We, in Brighton, have enjoyed these powers to sell and hire, but not to wire, since 1901. We never exercise them if there is any possibility of a consumer doing a deal through his contractor, and where we hire we have never experienced any insurmountable difficulty in arranging between the hirer and his contractor to carry out the necessary wiring. Invariably, however, we find that consumers who could afford to buy their motors outright prefer to continue to hire from us, and to have the assurance of knowing that all our stock of spares and the resources of our department are at their disposal in case of trouble. The rental we charge for motors is some 20 per cent. of prime cost, and for this we insure, clean, oil, adjust and regularly inspect each machine. This return with the service rendered just pays its way with a bare margin of profit, writing off the cost in ten years, but the department undoubtedly gains by the increased sale of energy and the satisfaction we are able to afford our consumers, and doubtless in turn this policy must be extended to the hiring of heating and cooking appliances which are daily coming into more general use.

As a matter of equity, these powers should be granted to all undertakers who seek them, and the fact that the money necessary to put them into force can only be raised after a Local Government Board inquiry has been held is, I think, sufficient guarantee that they will not be abused. No fewer than 28 undertakings, involving a capital outlay of upwards of £11,000,000 sterling, already possess them, and this is a very strong argument in favour of our legislation being revised so as to allow of all authorities being treated alike.

This brings me to the wider question of municipal trading—wiring, supplying and selling electric light fittings—and I must candidly confess that I am not in sympathy with municipal authorities carrying out this work themselves except under very exceptional circumstances. By friendly co-operation with the electrical contractors, much unnecessary expense in the way of elaborate show-rooms, canvassing and publicity organisation can often be saved without detriment to the undertaking in any way. I do not wish it to be thought that I depreciate these useful adjuncts to obtaining new customers, but I am convinced that in certain instances this so-called business-getting has been overdone. A suitable show-room to interest consumers and to demonstrate the use of the latest novelties in systems of lighting, power, heating and cooking apparatus, is most desirable, and if judiciously operated in conjunction with the collector's office, it forms one of the most valuable advertisements an undertaking can possess, but I do not consider that it is by any means always necessary actually to sell the goods to ensure success.

All undertakings where possible should have the collection of their accounts in their own hands, thus enabling the department to get into personal touch with the consumer, and to deal promptly first hand with any complaints that may arise. Some three years ago we took over the collection of our own accounts, and the results have been most satisfactory in every way, whilst bad debts have been reduced by no less than 60 per cent.

A capable engineer as publicity officer to assist and advise consumers free of cost as to the lay-out of their installations to the best advantage is also a necessity in all well-organised undertakings, and this is a branch of our business in which at the present time there is a dearth of suitable men. I would urge young engineers who possess the necessary personal qualifications to specialise in this department.

We are often alluded to as municipal traders, and in a sense this is true, but I consider it is wrong for us absolutely to compare ourselves with gas and electric supply companies. These concerns are in business primarily to obtain the biggest dividends they can possibly earn for their shareholders, irrespective of all other considerations, and their management have a more or less free hand to achieve this end. The concession to supply electricity (now so essential to the well-being of all communities) was granted to us in order that we might do the greatest good to the greatest number in our towns, by affording an efficient and reliable supply of electricity for lighting and power purposes at the very lowest possible cost, whilst paying our way.

If we embark in this retail trading, carrying out wiring installations, &c., to justify the existence of this new branch of our business, we must at times have to go into the highways and byways to obtain fresh consumers, and I fear that by so doing we will only boost up an artificial and temporary demand, necessitating the raising of additional capital to meet it, seldom finding that it will yield an adequate return on the outlay incurred, and in the end doing our undertakings no real lasting good.

By all means keep your wares well before the public eye; believe in them yourselves; do all you can to persuade others to believe in them; induce your committees to lay mains broadcast and of ample section wherever there is any reasonable prospect of business resulting; have a simple, easily understood tariff, as cheap as circumstances will permit; and lastly, if possible, keep friendly with and assist the local contractor and do not hamper him with harsh and unnecessary restrictions; then business of the right sort will, I am sure, come along almost automatically and just as fast as is good for your undertakings.

I would like to take this opportunity of referring to the work of the Electricity Supply Publicity Committee, and I cannot too strongly urge all municipal authorities to afford this committee every possible support and assistance in their power.

Alderman Pearson proposed and Mr. C. E. C. Shawfield seconded a vote of thanks to Mr. Christie for his address.

The President then called on Councillor Leese to read his Paper

ELECTRICITY SUPPLY VIEWED FROM THE MUNICIPAL COMMITTEE'S STANDPOINT.*

BY COUNCILLOR LEESE, J.P.

(Chairman of the Stoke-on-Trent Electricity Committee.)

Summary.—The author discusses a few of the subjects with which an electricity committee has to deal. Extensions, size of plant, profits, cost of supply, showrooms and tenders are all considered.

The Chairman of a Committee has to occupy a somewhat thankless position. He acts as the spokesman of his Committee to the Council and to the public, and often is called upon to be the interpreter of his engineer's reports and statements to the Committee; at the same time he is the buffer between the oft-conflicting forces of other municipal departments and his own; the recipient of all the grievances and complaints alike of workmen and of consumers. It seemed to the writer that some attention might usefully be directed to a few of these subjects.

* Abstract.

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In the first place, in connection with requests for information, it would avoid misconception if the term "units unaccounted for" was discontinued and something like "units utilised in distribution" inserted in its place. Also, why are engineers so fond of talking of the pounds of steam per kilowatt-hour? In this country, at least, it would surely be simpler and more direct to say "per Board of Trade unit."

It recently fell to the lot of the writer, as the chairman of the Electricity Committee of the district formed by the federation of the six Pottery towns, to have to consider what steps should be taken to deal with the immediate future needs of that moderately large area. Four of these towns owned electricity works, there being a difference in the pressure of supply between the three continuous-current systems, while the fourth was single-phase alternating.

After going into the question carefully it has been decided not to make additions to the small plant in the existing stations, but to build and equip a new power station, as nearly as possible in the centre of the area of supply. The scheme comprises a central power station (which will be connected with the four existing stations by trunk mains) containing two 1,500 kw. turbo alternators with the necessary equipment of boilers, switchboards, &c. The intention of the committee being to use the existing direct-current plant at Burslem and Stoke and the alternating-current single-phase at the Hanley works so long as it is economical to do so, and to supplement it with power in bulk from the central station. The four existing works will be equipped with rotary or motor convertors for the direct-current and motor generators for the alternating-current systems. Then, during heavy loads, the local steam plant will assist the new power house, and on light loads the supply can, if found desirable, be taken in bulk from the latter. The problem was complicated by two of the works having destructors combined with them and by the difficulty of coupling two alternating systems and still maintaining flexibility.

It appears from the records of what is taking place throughout the country that not one system but a combination of systems will soon be quite a common thing.

The size of plant for extensions is next discussed by the author, who considers that there is little advantage in going above 1,500 kw. sets for the majority of cases, especially as duplicate sets are usually considered necessary. Those committees who have put in single turbine sets trusting to their never going wrong seem to the author to have failed to recognise their responsibilities.

Some curves are also given to show the effect of not making extensions, it being found necessary to run a set of old make and small size during peak loads.

Profits.—Whether a profit from the electricity works should go towards a reduction of the rates is a very debatable point. The writer has always been of the opinion that in all industrial concerns owned and controlled by any Corporation a price should be fixed for the particular commodity they have for sale, such price to be sufficient to realise a sum which will provide all working expenses, interest on and repayment of capital, depreciation, and build up a reserve fund to meet unforeseen contingencies. If during any year's working a profit is made over and above what will provide for the above items, some arrangement should be made to give the consumer the benefit either by extra discount or other method to be decided by the committee. It has been argued that as the general rates are mortgaged for these industrial concerns, it is the whole of the ratepayers who should receive any benefit there is to be had. To show how unfairly this very often works out, take the writer's own district. A penny rate produces about £3,000, which means if the Electricity Committee decide to hand over £3,000 towards the rates, a fairly large number of consumers of electricity in this district, whose rateable value is about £9 or £10, would receive a reduction in their rates equal to 10d. per annum.

Again, a large manufacturer whose rateable value is £800 would receive a reduction equal to £3. 6s. 8d. on his rates and very often it will be found that the manufacturer has already been supplied with electricity for power purposes at the lowest charge it is possible to make with the object of increasing the day load at the works. Thus, the manufacturer has not only the benefit of cheap power but is also given an additional benefit in reduction of rates at the expense of the smaller consumer.

In the writer's opinion everything that can be done should be done to popularise the use of electricity in the houses of the poorer classes, and if a price must be charged in order to produce a profit for the reduction of rates then it will seriously handicap committees in the direction indicated.

When the six Potteries towns were federated, a clause was inserted in the Federation Act which compels the Gas and Electricity Committees in that area so to conduct the various works that no profit shall be made which can be handed over in reduction of rates. But in the event of a profit being made in any one year, then the price of electricity and gas shall be so adjusted as to absorb that profit.

This clause has given rise to a very peculiar situation, viz., during the discussions at the Council meetings one of the arguments used was that seeing no profit could be made for the reduction of rates, no extension should be made at the electricity works, no more customers should be taken on and the various works should remain as they were; the most ridiculous suggestion it was possible for a body of sensible men to take. Surely great benefits can be conferred upon the community in general in other ways besides reducing the rates. By-the-by, no one suggested that no more consumers should be taken by the Gas Department, who are under the same conditions as to profit-making.

In dealing with "cost price" it is difficult to convince a Council that the *average* price is not the cost price of electricity. Owing to this the non-manufacturer too often jumps to the conclusion that manufacturers are supplied below cost when the power rates are low, and low simply because the hours of use are long. It is unfortunate that none of the published tables give particulars showing the price for lighting and power separately. It is the absence of such information which renders it necessary at times to instruct one's engineer to send out a "catechism" to which sarcastic reference is occasionally made without much ground. It surely does not take long to give information, probably from memory, and the interchange of particulars of different works is especially valuable as a guide to members of committees who like to know what other municipalities are doing in such matters.

In portions of Stoke-on-Trent area, large power users get supply at ½d. per unit. This figure is sufficient to cover the cost of generation, but it does not allow for sinking fund and interest on mains. In the writer's opinion, the charge should be compounded of cost of generation added to the cost of distribution (which will vary according to the distance of the consumer from the works) just as a manufacturer quotes goods "F.O.R. his works" at one price and "delivered" at another and higher rate. Restricted hour supply for all purposes and at 1d. has been given in one of the writer's districts since March, 1906, and has met with encouraging success. Ordinary manufacturing works cannot cut off at 4 p.m. in winter, but there are sufficient users to justify the special rate, which is only given when a clock-controlled switch is provided by the consumer.

Showrooms.—The writer does not know what is the general experience of electricity committees as to the utility of showrooms, and he introduces this phase of the question with a view to eliciting opinions on the matter. His committee are, generally speaking, antagonistic to the use of showrooms. His own opinion is that, given a fairly large district to work in, a good showroom is a necessity to the success of the electricity undertaking, provided that it is kept up to date so far as general things are concerned, and also with all new novelties in electrical utensils. But, added to that, there should be in charge of the rooms an attendant fully conversant with all matters affecting supply, light, power, heating or cooking, and able to explain very fully the merits or demerits of any particular article or methods of using such article. Given all this, then, he feels confident that a showroom in a central position can be made a very useful adjunct to the electricity undertaking.

Taking smaller areas, the best method of getting consumers, and increasing the output at the works, is to employ a canvasser who can watch new property being built, wait upon the builder and explain the good qualities of electricity for lighting purposes in ordinary dwellings, and who should be thoroughly conversant with every phase of the question, and be able to put the case in such a way as must result in new customers. Personally, he would only employ for these positions the very best type of man it is possible to get, as everything in such cases depends on this.

A great deal can be done in the direction of canvassing by cordial co-operation between the local contractors and the Corporation. In Hanley some six years ago an attempt to work together was made which has succeeded beyond expectations. The contractors were given supply at 1d. per unit, all Corporation wiring is done by them, and they are lent any apparatus required for demonstration, while in special cases they are paid a commission. As a consequence, the electrical industry is in line and pulling together without friction and with advantage to the community.

Domestic Uses of Electricity.—Stoke-on-Trent has done a little in the direction of cooking appliances, and for some time has given this class of supply at 1d. per unit, but the trouble has been to obtain reliable and substantial stoves at a reasonable price. The £5 ovens are flimsy articles, while if £10 or more is paid the hiring rate is much in excess of a gas stove. The ordinary domestic user will not pay more than 2s. or 2s. 6d. per quarter. The cost of operation is low;

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in small houses, a Sunday's dinner for three or four persons can be cooked for 2d.

But there is one objection; in very few areas are the mains large enough to stand a row of houses taking on electrical ovens without trouble with the supply, and the additional mains necessary pile up the capital charges on the undertaking faster than the revenue from this class of business increases. In a district where the lighting supply was quite satisfactory, new houses were built and these were got for electric cooking, with the result that several hundreds of pounds had to be spent on mains to keep up the voltage.

Tenders.—One of the most puzzling things coming before an electrical committee is the question of tenders; and in a recent case of two turbo-generators one of the most peculiar things was that although the tender form gave all the conditions couched in the simplest language, and the contractor had sent in a price for the particular article, there is nearly always a covering letter to the tender, which, while accepting the conditions laid down in the tender form, suggests modification of this, that and the other, which, if agreed to, sometimes would almost alter the whole construction of the article in question.

DISCUSSION.

Councillor J. W. CROWTHER (Sheffield) did not agree with the policy of reducing the rates by means of the profits of the electricity undertaking. Adequate allowances needed to be made for sinking fund, interest on capital charges, &c. When engineers found money for the rates they were expected to do it regularly no matter what was the condition of the undertaking. Engineers should endeavour to get the maximum number of consumers at the minimum of cost. In Sheffield the power load had been increased, and the cost of production reduced from 4d. to 0·48d. per unit. He thought that in regard to the contractor they were a little too squeamish. He created much amusement by describing the average contractor as a draper who took to electricity as a side line. Showrooms he considered were usually on too modest a basis, and should always be in a main street. Some engineers hid the showroom "behind the power house." The small consumer should be encouraged, and it was better to get a man to put in a few lamps at first rather than more than he really wanted. Engineers needed to get in the £20 a year rental class of consumer, who usually paid. At present it was difficult to compete with gas on the score of fittings which were generally supplied free of cost, and only the labour of erection was charged. Electrical engineers were sorely in need of powers to put in stoves and ovens.

Mr. C. O. MILTON (Maidenhead) asked how the cooking load could be encouraged in very small towns where the mains were initially installed of small area, say 0·1 sq. in.

Mr. F. AYTON (Ipswich) took Councillor Leese severely to task in abrogating to himself, as he thought, the duties of chief engineer. Complaints should never be made to the Committee, but always to the engineer. If Committee men were addicted to asking a large number of questions he recommended that they be referred to the consulting engineers, who might be paid a reasonable fee for the advice given.

BAILLIE WILLOCK (Glasgow) in an amusing speech considered that the position of chairman of an Electricity Committee, far from being a thankless one, was a high honour—at any rate he felt it so. In Glasgow complaints seldom filtered through to the Committee. The men had a right of appeal to the Committee only after their complaints could not be settled by the engineer and his assistants. Much laughter followed the Baillie's remark that they had no consulting engineers in Glasgow. "We've had 'em and been without 'em, and know which is better." It was bad for consulting engineers "Glasgow way." The consumer had been encouraged in Glasgow of recent years, and since the Smoke Abatement Exhibition a flat rate of 1d. per unit had been in vogue for cooking and heating.

Mr. S. E. FEDDEN (Sheffield) endorsed the opinions expressed that the rates should not be subsidised from the profits of the undertaking. Nowadays the Local Government Board enforced such short periods for the repayment of loans that large profits could not be made. Taking his own undertaking, he had formulated a balance sheet to indicate the conditions under company working. It showed 5 per cent. on the preference shares, 4 per cent. on debenture, and 9·4 per cent. on ordinary shares, omitting sinking fund, interest, &c. He thought that Councillor Leese's undertaking with a load factor of 45 per cent. and ½d. a unit costs, should be able to allow for interest and sinking fund. Mr. Fedden was very emphatic on the matter of tenders. He strongly deprecated the practice of covering letters with tenders. The wording of many of these amounted almost to sharp practice, and he thought that contracting firms should send in "straight" tenders.

Alderman G. PEARSON (Bristol) thought that there was little chance with the Local Government Board short loans of an undertaking being mulcted on behalf of the rates, unless the price for energy was abnormally raised. A good reserve should be built up, and no profit shown, the surplus being used to reduce the price of energy to power users. In Bristol it was necessary to cut prices for power in order to compete with steam and gas. The undertaking ought to be at liberty to do what it liked with its profits, and not bound by Act of Parliament in the matter. As far as covering letters with tenders were concerned he thought the real difficulty was to get the contractor to complete the work to time. Covering letters could easily be ignored, but delivery was quite another matter. Complaints should always come to the engineer, and not to the Committee.

Councillor W. F. GOOD (Maidenhead) thought that the profits should be divided equally between (1) the reserve fund, (2) the reduction of charges to consumers, and (3) the reduction of charges for street lighting.

Baillie W. B. SMITH (Glasgow) spoke of the Smoke Abatement Exhibition and a subsequent commission at which Mr. John Burns was asked that the Government take steps to protect municipal undertakings which served a public purpose from the practice of taking their profits for the relief of the rates. Much harm was done by this practice in keeping up the price of public commodities like gas.

Mr. MILES WALKER (British Westinghouse Co.) thought that a misunderstanding was created by the remarks in which Mr. Leese was accused of assuming the duties of the chief engineer. These remarks reflected on Mr. C. H. Yeaman, and it was only right to say that there was no question about Mr. Yeaman having absolute authority, and that his relations with the committee were of the best.

Alderman F. W. SMITH (Liverpool) said that the ratepayers had a right to be considered in all municipal undertakings, and that when the rates could be relieved they should be. That was the practice in Liverpool. He disagreed with Mr. Good on the point of allocating part of the profits for street lighting. His remarks that the electricity department should not do the street lighting brought forth a chorus of groans.

Councillor LEESE, who reserved his reply for the proceedings, said that in blending the interests of six such districts as the Potteries towns there were naturally difficulties and acrimonious feelings to overcome. Answering a question as to the supply for cooking and heating with only one meter, the practice was to strike an average of the consumers' price paid over say two years, charge him this, and a 1d. per unit consumed.

After a hearty vote of thanks had been passed to Councillor Leese, Mr. Beauchamp read his Paper on

MODERN WIRING PRACTICE.*

BY J. W. BEAUCHAMP.

(Chief Electrical Engineer, Tunbridge Wells.)

Summary.—The author first discusses wiring regulations, and suggests that these should be as simple and light as possible, but that their enforcement should be more stringent. He proceeds to analyse the various existing regulations, pointing out the desirable features. Finally, cheaper wiring methods are discussed, the costs of various systems being tabulated.

During the development of the public supply of electricity, the attention of engineers has been exercised by a number of leading problems. First there was the design of plant and the economies of production. At a later period the question of tariffs attracted much attention, and continues to do so, although possibly its ultimate solution is now within sight. More recently, educative and publicity work has been the subject of study; but the growing experience of the public with regard to the cost and advantages of electricity supply is easing the work of the business-getting departments and bringing the supplier rapidly to the last barrier which must be overcome before the use of electricity can become general. That is the difficulty of introducing electricity into premises where, on account of cost, there is a disinclination to instal the necessary wiring and fittings, although the supply may be desired and its economy well understood.

Doubts have been expressed as to the probability of small consumers being remunerative; certainly such business is of a special character, but on account of its possible magnitude and the comparatively high load factor of lighting supply to private houses it deserves special treatment, more particularly as the growing demand for electric street lighting makes it necessary to lay cables in roads where only the smaller consumer can be obtained. The extent of this potential business is emphasised by returns which show that the proportion of premises taking electricity supply varies roughly from 5 to 25 per cent., according to the character of a community, age of the undertaking, competition, &c., whilst the percentage of houses rented at less than £30 per annum ranges from 40 to 70 per cent. of the total.

The great bulk of this lighting business can be obtained in time either by means of prepayment meters, contract rates, or the usual monthly accounts, according to the class of consumer; but the premises must be wired in exchange for a slightly increased supply rate, or on very simple and easy hiring terms. This is largely, but not wholly, a problem of policy and finance for the supplier; a suitably designed system of wiring would do much to assist in its realisation, and it is the object of the writer to draw attention to, and, if possible, to cause discussion of, the features of modern wiring practice and regulations insofar as they influence the cost of small installation work.

Wiring Regulations.—Although the I.E.E. Rules are adopted by most supply authorities there still remain so many exceptions and amendments that no real standard can be said to exist, and there is great lack of uniformity in the quality of electrical installation work

* Abstract.

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within any particular supply area, regulations being observed in the better class work and evaded or only complied with in a perfunctory manner where competition brings down the price of wiring. Against this tendency the supply authority can only struggle with difficulty as the general run of small house and shop wiring usually falls to the lowest tender, and in many cases there is not the most elementary form of specification to ensure that the several offers are based on the same requirements.

To enforce regulations in detail without obstructing work and progress is a comparatively expensive matter, requiring experienced and conscientious inspection and a decided sense of proportion on the part of the inspector. The proper course appears to lie in drafting simple and definite rules dealing with (1) safety of the consumer, (2) non-interference with the proper working of the supply to other consumers. The requirements of these regulations should be made as light as possible, but the enforcement of them should become more stringent.

A change in this direction should secure greater uniformity of work, tending to lower the cost of high-class wiring and force up the quality of the lower-class work.

Many of the existing rules are directed towards securing for the consumer a well-designed installation, with regard to capacity of conductors, sectionising, &c. As these cannot be enforced, and their value depends so much upon individual circumstances, they would be better eliminated from the category of "don'ts" and issued by the supply authority in the form of simple model specifications describing the requirements of good practice suitable for several different classes of wiring work. Such official specifications would in the writer's opinion do much to render practice and prices more uniform, and allow contractors to cultivate different classes of wiring work in accordance with their inclinations and capacity.

In any case, in view of the rapidity with which electrical practice changes and the fact that so much of our work is secured in competition with other systems of light and energy supply, it is undesirable that wiring regulations, however simple, should be administered in an inflexible manner, or pass under the control of any centralised body not directly interested in the commercial development of the supply undertakings involved.

The author gives a brief analysis of the regulations of a number of British and foreign authorities controlling or advising upon electrical work. This shows how great a divergence exists in their requirements, and suggests that, even after allowing for climatic differences and local conditions, the cost of wiring must be affected considerably by the varying limits imposed.

Insulation Resistance.—The usual insulation resistance test depends more upon the dryness of the building and the care used in connecting up fittings than upon the actual resistance of the dielectric, and a fair result may be obtained from wiring which has suffered considerably by careless workmanship and may be doomed to early failure. For these reasons a much lower insulation resistance than is usually called for would suffice, but should be supplemented by inspection of samples of hidden work in every case.

Limits of Capacity of Branch Lighting Circuits.—It would appear that the true limit lies in the ability to make proper current carrying connections in the various "loop-in" fittings used on branch lighting circuits; 10 amperes should be a workable maximum.

The limit of motor capacity which may be connected to one side of a three-wire system should depend upon the capacity of the system: in some cases most stringent regulations are issued by very large undertakings.

Motor Starting Currents (Maximum).—This regulation would be better stated in "limiting amperes" for any motor on a system or district according to capacity of cables or transformers—because having admitted, for example, a 10 H.P. motor at 1¼ times full-load current (say, 70 amperes), it is hardly reasonable to deny the users of smaller motors in the same district the privilege of taking the same value of starting current if by doing so they can be put to expense or their gearing simplified.

Limits of Pressure Drop at Full Load.—This provision is suitable for a specification to secure the use of cable of ample size, although where possible actual sizes to be used should be stated. Provided the wiring is not dangerously overloaded, the question of pressure drop concerns the consumer chiefly, and the increasing efficiency of lamps does not warrant the use of heavy wiring. The most striking difference between British and German wiring regulations lies in the permissible loading of cables.

Amongst several provisions which now seem curiously out of date are the following: Motors to be insulated; no installation to have more than two branch circuits; no copper fuses to be used; S.P. switches to be used on each main; meter shunt wire to be taken to lamp side of consumer's main switch; slip conduit prohibited; metal conduit to be avoided if possible.

A few, however, are conspicuously in advance of the period when they were written—for example: Bath-room lights to be out of reach of persons in water; tubes and frames to be continuous and well earthed to water pipes; no elbows to be used in conduit; no single wires to be used, and none less than 3·22's; the use of key socket holders to be restricted; internal lighting fittings to be insulated; meter main coil and all S.P. switches to be on live side of supply.

Several regulations in the more modern codes could be made general with advantage, *e.g.*: Electric irons to have some indicator showing when current is on. Capacity of cables for motors to be calculated on basis of short period overload ratings, and on basis of starting currents. Key socket holders in groups of not more than eight to be controlled by one separate switch. (One lamp of each group might have a plain holder when the burning of that lamp would indicate that the control switch was "on.")

In addition, a distinct definition of current carrying capacity for switches and fuse fittings is needed—most modern patterns fulfil every requirement with regard to breaking circuit, but are greatly overrated so far as concerns their power of carrying full load current continuously.

Earthing Regulations.—The rules mostly fail to define the essential requirements for security from risk of shock or fire, which are that every part of a metallic sheathing or conduit system containing conductors shall be permanently connected to earth by a conducting path of sufficiently low resistance to carry, without sparking or heating at any part of system, the maximum current which the main fuses of the installation will pass.

The earth wire, also, whilst requiring a definition of minimum size for reasons of mechanical strength, should have a stated size depending on the capacity of the installation; the minimum might be No. 18 S.W.G., No. 14 being unduly heavy and expensive for use on small installations; and, beyond this, the sizes used should bear a relation to the main fuses, or circuit breaker setting, of the system protected, being selected to carry the full current required to open the circuit without appreciable rise in temperature. Where local circumstances require the earthing wire to be of considerable length, its area should be proportionately increased:—

As an example of safe practice—

For all lengths up to 20 yds., and current up to 50 amperes, No. 18 S.W.G.

For all lengths up to 20 yds., and current up to 100 amperes, No. 14 S.W.G.

For all lengths up to 20 yds., and current up to 250 amperes, No. 12 S.W.G.

The connections between metal-work and tubing and the earth wire also need to be of low resistance and permanent character. Tests made with lamp or bell for the continuity of a tube system give little indication of the current-carrying capacity of the many joints and connections through which a fault current would have to be discharged, whilst the accidental earthing of the tube at one or more points, by contact with structural metal work or water pipes, may make such a test quite deceptive.

Earth connections should be made to the rising service pipes of town water systems, water meters being bonded across, or to metal plates buried in the earth in some position where natural dampness exists.

Where the system of wiring makes it impossible to render all metal-work of motors, lamps and other apparatus metallically continuous, it is advisable to run throughout the installation a substantial and visible earthing wire or tape, to which all apparatus can be connected, and to earth connect it at one point. This connection can be tested at intervals from different points of the installation by taking an ammeter reading between it and the live poles of the wiring through a small known resistance. The readings will show up any change in the state of the earth connection and prove its energy-discharging capacity in a way which tests with a bell or lamp do not do.

Where these methods of earthing are not possible it is necessary to resort to devices of the lightning arrester type, of which the Cardew & Partridge appliances are probably the most used—in these a small air gap is maintained between the outer, neutral or earthed pole of the system, and a connection which includes all tubing, frames and metal-work; in the event of the latter rising in potential beyond a certain limit the air gap is bridged by a spark or by electrostatic attraction of a light metal armature, and a short-circuit results, opening the fuses or circuit-breakers. The devices have the drawback that they will not operate with certainty excepting for pressure rises of considerable amount and so do not altogether avoid risk of shock; they are of more particular value on high-tension systems where good earth connection cannot be obtained.

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It is desirable to avoid connection :—

To girders and constructural ironwork, which is often insulated by concrete, and even if it appears to be well earthed, may be so through gas or other pipes making variable contact, and subject to removal.

To gas pipes of any kind.

To hot water and hydraulic supply pipes, as they are often jointed with imperfectly conducting material or are only connected to a water supply system through a tank and ball-cock.

To water pipes drawing supply from cisterns fed by ball-cocks, or from wells, as the connection may be broken by lowering of the water level below the delivery or suction pipes.

To other earth connections provided for telephones or bells, as these may increase in resistance or provide an alternative path through the instruments to other earths.

Earthing in positions which may receive sewage or corrosive waste liquids is not to be recommended, and drains and gulleys although full of water often afford a very indifferent connection to earth, owing to the insulating character of the concrete or earthenware of which they are built.

The increasing stringency of Home Office Regulations has led to the production of various fittings designed to fulfil them. These new designs appear to fall into two classes, one in which provision is made for earth connecting all metal-work, and the other in which insulating material shrouds all parts from which a shock might be obtained as a result of failure of internal insulation. When substantially made the latter class probably has the advantage—as its efficiency does not depend upon the condition of a more or less elaborate system of earthing wires, and damage to the insulating shields can be at once seen and remedied.

These precautionary measures are looked upon by many contractors as vexatious, the cost and trouble involved in meeting them is resented, and it becomes a matter of some difficulty to ascertain with certainty that a tube system, much of which is normally out of sight, has been made capable of safely clearing a fault which may arise in any part of it. In short, if the letter of the Regulations is observed, the cost of the cheaper classes of tube work is increased ; on the other hand, if, as is usual, installations are accepted for supply on the strength of a few visible connections between the tubing and a convenient water-pipe, the combined shock and fire risk, small as it obviously is, is distinctly greater than it would be if no earth connection were provided.

In an ordinary house wired with slip-joint tube, a leakage current occurring at any point at all remote from the service entry will probably have to run the gauntlet of sundry loose connections under floors and behind lath partitions on its way to earth. Undoubtedly these considerations present one of the gravest objections to the simpler systems of metallic conduit. Some device is needed to protect concealed wiring mechanically without involving the danger of spreading a leak, or the difficulty of furnishing a completely earthed sheath. Steel tube has much to recommend it on the score of protection for wires and low cost of erection, and has done much to encourage the wiring of small houses during construction for which purpose it is very suitable.

It would seem worth while to consider the extension of the principle of I.E.E. Rule 46 (1907 Ed.), earthing only portions of tube within usual reach in wet places, and keeping the remainder in isolated single lengths by the use of fittings and sockets which actually insulate instead of partially connecting as at present ; this could be effected by lined sockets or by serving the outside of the tube with compounded tape or braiding—a similar process is used for the protection of iron gas and water mains on the Continent, and would not increase the cost of the conduit appreciably, whilst protecting it from rust and destruction by ash concrete and plaster.

The principal weakness of the earthing precaution lies in the fact that it is not essential to the working of the installation, and the wires and joints upon which it depends may suffer damage without the fact being revealed until they fail to give the expected protection.

Conduit.—Condensation trouble is only serious where runs of conduit are subject to different temperatures, as in passing from living rooms to cellars and outdoor positions, and can, to a great extent, be prevented by providing drain holes at lowest points and by the use of inspection boxes well filled with slag wool or similar non-conducting substances at points between which considerable temperature difference may exist.

Corrosion in buried conduit is generally the result of condensation which, particularly with "close" joint tubes, permits surrounding plaster to become moist and chemically active ; this is very noticeable with plaster or concrete made from ashes. The use of "close" joint tube in any form of cement or plaster is undesirable, but difficult to prevent on jobs where brazed or seamless material is not insisted on throughout. There appears to be a useful field for a conduit lapped with coarse tape or jute and compounded outside for such positions.

The first test of a good class slip conduit lies in the inter-changeability of the tubes and fittings and the possibility of making firm metal to metal joints at all points after removing the enamel. One of the reasons for using inferior conduit on low-grade work lies in the fact that fittings are an easier fit and more rapid erection is secured at the expense, of course, of continuity. Various devices have been put upon the market to enable slip tubing to be made continuous without appreciable increase in cost. For the most part however, they introduce difficulties in use and are always apt to be omitted where tube is fitted in awkward positions, whilst their weakest feature is that they do not render it necessary to remove the enamel from the tube and sockets, and are, therefore, inferior to accurately made plain connections which cannot be socketed home until the metal is cleaned and some force employed—in some instances slip tubing has been put together with wet salammoniac in order to secure a rust joint, an injurious practice, owing to the corrosive and hygroscopic nature of the salt. There seems to be no reason, however, why a useful amalgam like jointing mixture should not be made, similar in composition to aluminium paint or the past solders.

Safety.—One of the greatest safeguards for the consumer lies in the use of correctly proportioned fuses, and, where possible, the cartridge form or the modern development of the old Edison screw plug fuse such as the "Zed" and "Dial" fuses, should be used, but the cheapness and convenience of the ordinary porcelain bridge fuse will prevent it from being easily superseded ; it is, therefore, desirable that consumers should be provided with simple information with regard to fusing.

The supply authority could well take this matter up by using printed cards to be fixed by the service cut-out and the distributing boards stating the usual fuse sizes rendered in terms of lamps and wire gauges.

Influence of Voltage Reducers on Installation Work.—The use of pressures has not apparently made much difference to wiring practice, nor has it become general to use material of lower insulation quality on new work where pressures of 50 to 100 volts are intended. If, however, the makers should produce a high-voltage lamp of small power and low price the transformers would presumably be abandoned in time, provided that the wiring were found suitable for the higher pressure, and here, in the writer's opinion, lies one of the advantages of the general use of pressure reducers on new work although the material may be of the usual H.V. quality the low working pressure tends to prevent faults, due to bad workmanship and careless handling of wire, from showing up as they would do on the usual supply pressures—a condition likely to lower the standard of installation work and give trouble in the future if reversion to higher pressure takes place.

In any case, where low insulation work or earthed concentric wiring is put in on the strength of the installation being separated from the supply network by static or rotary transformers, it should be made clear to the purchaser that he is possibly committed to the continual use of such transformers, or disappointment may arise in the future.

Small transformers are responsible for a considerable number of faults on consumers' premises, particularly where their cores or frames are connected to earth. It is somewhat unfortunate that suppliers have not endeavoured to keep control over house transformers by a rental system, which would have done much to keep up quality and avoid troubles which have arisen from improper selection of voltages, errors in connection, and waste through excessive magnetising consumption.

It is interesting to note how the general use of the house transformer affects pressure regulation, interposing, as it does, on alternating-current systems another link between the generator and the lamps which is susceptible to loading. The pressure regulation of small transformers varies from 2½ to 4 per cent., and as they are seldom fully loaded, excepting in works and business premises where some care has been exercised to suit the capacity of the transformer to the normal load, it follows that the average working pressure is raised somewhat at all times, particularly during off peak hours, and the cumulative effect of light load on cables, main and house transformers often results in such lamps as are in use being considerably overrun.

Lamp Holders.—The familiar bayonet pattern lampholder is contrasted with the foreign screw socket to the detriment of the former, chiefly on the score of poor conducting power and damage by overheating ; it is questionable, however, if it suffers from such faults to a degree which would warrant the expense and trouble attending from a general change on the part of makers of holders and lamps.

It is often contended that a screw socket may be used for flat-irons and other apparatus taking up to 10 amperes ; but the screw holder is not altogether ideal when used for any large apparatus on a fle

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cord, as the cord is twisted in screwing up, and heating apparatus of any size is almost always connected up with plug-sockets and will probably continue to be so. Yet another point in favour of the B.C. holder is that both poles are well enclosed and covered by the lamp; with the screw socket the lamp cap, which can often be touched, may be alive if care has not been taken to keep all the centre contacts on the switch or "live" wire.

Cheaper Wiring Methods.

Concentric Systems.—The most important recent development in wiring appears to be the re-introduction of the concentric principle in the form of the "Stannos" wiring system. Where it is possible to work on the surface of a building and use concentric conductors with the outer or return sheath earthed, a saving in cost of 10 to 15 per cent. over slip joint conduit wiring can be secured.

Its chief disadvantages appear to be: The multiplication of mechanical joints or points where loose connections may occur. The difficulty of securing to plaster and composition walls and ceilings. Comparatively feeble resistance to accidental damage. Risk of loss of continuity and consequent sparking or pressure rise on the outer conductor in the event of loose contacts or breakage of sheathing.

These difficulties are rather matters of detail and many of them can possibly be overcome. As the superior economy of this system over conduit is only apparent when the wire is used concentrically, it has so far been most successful on alternating supplies, where the use of a transformer affords a ready means of isolating the consumer's wiring from the supply network; as such transformers may also be used to reduce voltage, their cost is not altogether chargeable to the concentric wiring. Where, however, it is required to use double Stannos wiring, the outer sheaths acting merely as a mechanical protection, no trouble arises from inductive drop with ordinary sizes and currents. The great value of this material lies in the fact that faults quickly develop into short-circuits and put the bad section out of use, whilst repairs are easily carried out; in addition, all the simplicity and advantages of a single-pole system are secured.

Flexible wiring has been much discussed from time to time but no effort made to define its utility or to establish any regulations which might make it safe for certain classes of work without rendering it too expensive; in consequence a considerable amount of such wiring is actually in use in this country, the material being used in a most improper manner and only saved from failure by its high quality. Some attempts have been made to produce a strong and safe flexible wire, the result being usually rather clumsy and as costly as the cheaper forms of permanent wiring. There would appear, however, to be a field for such material in connection with heating circuits—a heavy armoured and fairly flexible cord to carry up to 10 amperes without overheating, and provided with good plug terminal fittings and fuses of the cartridge type, might reduce the first cost and consequent difficulty of inducing users of electric light to put in heating and cooking apparatus; such wiring could also be a tenant's fixture capable of removal to, and use in, other premises.

A disadvantage peculiar to all fixed surface wiring systems lies in the difficulty which is met with when re-decorating walls and ceilings, particularly when papering; this fault is sometimes lost sight of by those who advocate such systems on the grounds that existing decorations will not be injured.

Cost of Wiring Small Premises.—The influence of the system adopted upon cost is indicated by the following figures, which, although actually variable according to circumstances, are relatively representative of the principal methods available for wiring small houses. Examination of these figures also brings out the fact that on the cheaper systems labour costs become a much smaller proportion of the total, suggesting that it is only under some organised scheme of wiring houses in quantity, such as might be arranged by a supply authority, that the fullest economy of these methods can be realised.

This Paper was prepared before the publication of the 1911 edition of the I.E.E. Rules, but the writer was able by the courtesy of the Institution to inspect a copy. He finally draws attention to the principal changes in the Rules, in so far as they affect small installation work. The alterations of most interest are contained in the table of carrying capacity of cables. Although the new limits for $\frac{1}{18}$, $\frac{3}{22}$, $\frac{3}{20}$, and $\frac{3}{18}$ cable are only about 60 per cent. of the values allowed by the C.D.E., they represent a great practical advance, and should reduce wiring costs whilst allowing a good factor of safety against increase in loading which might take place after an installation has been put into service.

Relative cost per light of wiring in small private houses complete with metal lamps and simple pendants.

		£ s. d.	Per light. £ s. d.
Screwed seamless conduit (steel) and 600 meg. class non-association cable	Conduit...	0 5 9	
	Cable	0 5 9	
	Fittings	0 5 9	
	Labour...	0 5 3	
			1 2 6
Brazed slip conduit with clamp continuity fittings	Conduit	0 5 5	
	Cable	0 5 9	
	Fittings	0 5 9	
	Labour	0 4 3	
			1 1 3
Brazed slip conduit and 600 meg. class non-association cable	Conduit	0 4 0	
	Cable	0 5 9	
	Fittings	0 5 9	
	Labour...	0 4 0	
			0 19 6
Brass-cased paper tube	Tube	0 3 6	
	Cable	0 5 9	
	Fittings	0 5 9	
	Labour...	0 4 0	
			0 19 0
No. 1.—Close joint slip conduit (steel) and 600 meg. class non-association cable	Conduit	0 2 9	
	Cable	0 5 9	
	Fittings	0 5 9	
	Labour...	0 4 0	
			0 18 3
Wood casing and 600 meg. class non-association cable	Casing	0 1 3	
	Cable	0 5 9	
	Fittings	0 5 9	
	Labour	0 4 9	
			0 17 6
Stannos wiring (concentric)	Cable	0 6 3	
	Fittings	0 5 9	
	Labour	0 1 3	
			0 13 3
Twin rubber and lead-covered cable	Cable	0 6 3	
	Fittings	0 5 9	
	Labour	0 1 3	
			0 13 3
Rubber and cotton flexible and button insulators	Cable	0 5 9	
	Fittings	0 5 9	
	Labour...	0 1 3	
			0 12 9
600 meg. class non-association cable and cleat insulators	Cable and insulators ...	0 3 6	
	Fittings...	0 5 9	
	Labour	0 1 3	
			0 10 6

Discussion.

Mr. S. E. Fedden (Sheffield), in opening the discussion, said that in Sheffield gas was very cheap; nevertheless, the big houses could be got on the mains if not piped for gas and if the wiring could be done during the building of the house. He had hopes of getting the £20 a year houses if the builders could be got to notify the department of work being done. While he did not advocate jerry work he thought that the ideals of the wiring rules would have to be dropped in future. In small, dry houses the wires could be run through the joists without casing, and down the walls slip joint tubing was quite satisfactory. As to contractors, he felt that it was more and more necessary for the supply authority to deal with the consumer direct. The supply authority's interests and those of the consumer exactly coincided. The contractor, who was often a mushroom man, wanted to instal as many lamps as he could. His mistakes had to be remedied by the supply authority; in any case the electricity department was always there, and could be better looked up to for advice than a contractor who was here to-day and gone to-morrow. He thought that voltage reducers (auto-transformers) had had their day, and the future was with the 200-volt lamp. He knew of cases where the bills of consumers were heavier with than without voltage reducers, because of the magnetising losses. As to Stannos, his chief criticism was that it was too expensive. He thought that the makers could halve the price. In a certain case he found that wood casing with 600 megohm wires worked out at £35 and Stannos with double-wound transformer (one to one ratio) was £42. 10s., Simplex steel-armoured "flex" being £41. The labour was certainly reduced by 25 per cent., but the cost was 70 per cent. more for material. He still looked for a good substitute for slip or screwed conduit.

Mr. F. M. Long (Norwich) said that with 14 years' experience of free wiring they had been successful with wires run through the joists and in tubing on the face of the wall for the switch wires. He thought that most of the troubles were due to electrolysis caused by damp, and not by overloading of the wires. If proper care was taken in damp places to protect the system against the entrance of moisture then there should be no difficulty. As to flexibles, pure rubber was better than vulcanised, and though a little more expensive was better in the long run.

Mr. W. A. Vignoles (Grimsby) said that the author had not said enough about wiring on easy terms. He asked for further information. Money should be raised for free wiring, and he hoped that the Council of the Association would promote a Bill for that purpose. Speaking of slip-joint tubing he thought that it was not good because the clips were often left out at inconvenient places. In Grimsby, wiring through the joists was done, and single lead-covered wires used; down the walls these wires

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were drawn into tubes in plaster. He advocated a greater use of the auto-transformer on alternating-current systems, since the cost of the wiring could be reduced and it was safer to use a pressure of 25 volts in a house.

Mr. F. Ayton (Ipswich) considered that wood casing was still the best system if means were taken to keep out the damp by the use of water-proof paint. Flexibles were certainly a weak point, and money spent on them was well spent. He advised that steps be taken to rate switches on a voltage and not on an ampere basis. The holes in ceiling roses and switches needed to be standardised as to their position and centres in the base. When changes had to be made, the new fittings did not agree with the old ones. Both these matters he thought should be taken up by the Engineering Standards Committee through the agency of the Council of the Association. The same remarks applied to wall plugs.

Mr. Cridge (Electrical Co.) asked that engineers should maintain a high quality of insulation in all wiring work, and that when tests were made a qualified man should be sent and not a youngster with an exaggerated notion of his own importance.

Mr. A. E. Woodhouse (Woodhouse Steel Casing Co.) points out (in a written communication to us) that owing to the diverse opinions of engineers on wiring questions he had endeavoured to evolve a system embodying the good points of the various existing systems. He claimed that the Woodhouse steel casing had almost the flexibility of the cleat method, and after the installation was finished, the consultant could inspect everything, including the wires at any part. The conductors were simply installed as in wood casing, and when the covers were sprung on, they were protected throughout by steel as in tubing. Continuity was obtained by assembling the parts together without using special bonding pieces. Finally, the system was neater than others.

At the conclusion of the discussion on Mr. Beauchamp's Paper members adjourned for luncheon.

In the afternoon a large number of the members drove out to the Southwick power house of the Brighton Corporation. A description of the plant appeared in our last issue. Through the courtesy of Mr. Cash, the enterprising manager of the gas works of the Brighton & Hove Gas Company, a number of engineers took advantage of the invitation to see the works and were very interested in what they were shown. The invitation may be regarded as indicative of the friendly feeling existing between the two undertakings in the district. It is a spirit which is not always met with where the undertakings are respectively company and municipal owned.

The evening was spent in a most enjoyable manner at a conversazione given to the members by the Mayor of Brighton. An interesting precedent was established in the shape of a dance which was held after the reception. A most brilliant effect was produced in the elaborately decorated ball-room.

Portsmouth, Wednesday, June 28th.

Members had to be early astir this morning, a special train leaving for Portsmouth, where to-day's proceedings centred, at 8:30 a.m.

The party reached Portsmouth a little before 10 a.m., and at once proceeded to the Municipal College, where the Mayor of Portsmouth, Alderman T. Scott Foster, officially welcomed the Association.

The meeting took place in the Lecture Theatre, and the Papers under consideration were regarded as the most important at the present Convention.

The President first called upon Mr. H. L. Howard to read his Paper on

INTERNAL COMBUSTION ENGINES WORKING ON THE DIESEL PRINCIPLE.*

BY H. L. HOWARD.

(Chief Electrical Engineer, Barking.)

Summary.—After describing the features of Diesel engines, the author considers the question of oil supply. The cost of operation is next considered, the various items—fuel, labour, repairs and maintenance, &c.—being discussed separately. Taking the existing installation at Brighton as an example of a steam-driven station, the first cost of corresponding stations equipped with Diesel plant and gas plant are given. The Diesel installation shows to advantage in this case, as well as in a number of figures given for Continental installations. The use of Diesel engines in sub-stations is recommended, and the author expects striking developments in the next few years.

The internal combustion engine working on the Diesel principle, has, during the past few years, received considerable attention from engineers in charge of power stations, and although at the moment only sets of moderate size are at work or in course of construction (sets from 1,600 B.H.P. downwards), the great economy that has been obtained where they have been adopted has interested engineers connected with the larger undertakings to such a degree that within the next few years there will undoubtedly be some striking developments in the installation of high-power Diesel engines. Although very fine figures are being put forward for both steam and gas plants, yet in the author's opinion these can be greatly improved upon by the adoption of Diesel plant.

The standard Diesel engine of to-day is a single-acting four-cycle engine, and, unlike the gas engine, is not an *explosion* engine, for at every working stroke the fuel burns steadily as long as it is injected into the cylinder. No explosive mixture exists in the cylinder before the beginning of the working stroke, the compression in the cylinder being that of air alone. The volume of air drawn in is constant and is always sufficient to burn completely the maximum quantity of oil required at full load. The quantity of fuel injected varies with the load and is delicately regulated by the governor, there being no "hit and miss" method.

The compressed air used for the injection of the fuel oil is stored in a steel air bottle, at a pressure of about 800 lb. per square inch, which is kept automatically charged with air by means of a two or three-stage compressor, worked direct from the crank shaft. There are also two other air-bottles used for starting the engine.

A departure from the standard engine is that put upon the market by the Nederlandisch Fabrik of Amsterdam. This engine is fitted with a cross-head and guide, and has a comparatively short piston. It is also provided with a distance piece between the cylinder and

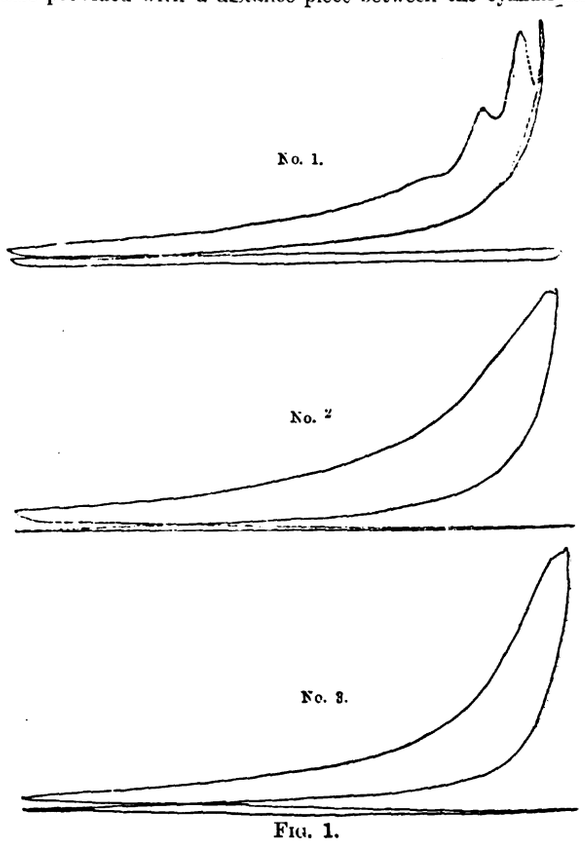

Fig. 1.

the crank chamber. The makers claim several points in its favour and, in the author's opinion, for high-power vertical engines it is the line that will eventually be followed.

One of the most interesting examples of high-power Diesel engine is the installation at Halle, where two 1,600 B.H.P. sets of the horizontal double-acting, four-stroke type, constructed upon the line of the Nuremberg gas engine, have recently been started up.

Fuel.—The answer to the usual questions as to the price of c fluctuating within wide limits and as to a reliable and continuou supply, is that, as petroleum is found in so many parts of the worl and as many new oil-fields are being opened up, it is obvious by th common law of supply and demand that the above factors cann vary over very wide limits, and any such variation should compa favourably with the variations in coal.

The oil fuel most generally used is the residue from crude petr leum, after the lighter spirits and oils have been distilled, and commonly known as "petroleum residue." This oil runs about 2 gallons to the ton, and is generally either Texas or Roumanian c As regards price, the author has recently fixed up a contract on beh of his Council, for a supply up to Jan. 1, 1913, at 37s. 6d. per t delivered into tanks at the Electricity Works, Barking.

* Abstract.

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Table II.

Name of Undertaking.	Capacity of Diesel plant Kw.	Max. load.	Load factor. per cent.	Average Cost of fuel per ton.	Lbs. of fuel per kw.-hr.	Units generated.	Works Cost in Pence per Unit.				
							Fuel.	Lubricating oil and stores.	Repairs and maintenance.	Wages.	Total.
Letchworth	135	90	27·2	43/6	0·655	95,169	0·153	0·042	...	0·160	0·355
Fareham	200	85	14·0	49/0	0·92	143,545	0·32	0·047	0·023	0·435	0·825
Daimler Motor Co.	436	495	46·0	53/4	0·624	1,887,200	0·178	0·033	0·023	0·064	0·299
Wakefield & District Lgt. Rlys.	400	350	30·66	57/6	0·76	743,658	0·160	0·015	0·057	0·162	0·394
Leatherhead	160	...	13·5	...	...	...	0·226	0·025	0·038	0·289	0·578

NOTE.—The period covered is in all cases 12 months, except Letchworth, for which it is five months.

Another factor is the possibility of using the by-products from gasworks, viz., gas-oil tar, and gas-tar oil. The former is the by-product from carburetted water gas plants, where gas oil is used to enrich the gas for illuminating purposes. It has a calorific value of about 16,500 B.Th. U. per lb., and is being extensively used on the Continent. The latter is the by-product from the distillation of gas tar. The author recently made a careful inspection of some plants using gas-oil tar, including a large double-acting tandem four-cycle engine, and a twin-cylinder horizontal two-cycle engine, the sets working with a 10 per cent. addition of crude petroleum—and was perfectly satisfied as to the practicability of using such fuel; so much so, that a 600 B.H.P. engine is now being built to his specification by the Diesel Engine Co., to run on either petroleum residue or gas-oil tar, and will be in commission this autumn.

Fig. 1 shows some diagrams taken from the same engine running on different kinds of fuel. It will be seen from No. 1 that the combustion is very late and is also attended by violent explosions. This diagram was taken when running entirely off creosote oil. No. 2 diagram gives the ordinary Diesel diagram, and is a clear illustration how good combustion and smooth running can be obtained by the special arrangements made for mixing 5 per cent. of crude oil residue with the creosote oil. No. 3 is the ordinary diagram when using crude oil residue.

Fuel Costs.—In dealing with this subject it will be well, perhaps, to take first the actual guaranteed consumption of the 600 B.H.P. engine mentioned above, using petroleum residue having a caloritic value of 18,500 B.Th.U., at 37s. 6d. per ton.

Table I.

Engine Load.	Fuel consumption in lb. per kw.-hour.	Fuel cost in pence per kw.-hour.
12½% over	0·58	0·112
1/1	0·58	0·112
3/4	0·61	0·122
1/2	0·69	0·132
1/4	1·01	0·202

Table II. gives some details of Diesel plants that have been in operation some years.

Referring to Table I., it will be seen that the engine maintains its high efficiency until well below half-load. An examination of the fuel consumption curves of other types of engine will at once show the marked advantage of the Diesel engine in this respect; and there are also no stand-by losses whatever. This factor will be seen upon reference to Fig. 2, which represents the results of 12 months' working of a plant having an output of less than a quarter of a million units, with an average load factor of 14·28 per cent. These results are particularly noteworthy, as they show what can be done in small towns and villages by way of solving the electricity supply problem in such places.

The engine can be started with absolute certainty in a simple manner by means of compressed air, without the least danger, at any time within a minute of entering the engine room, even after a lengthy period of rest. Again, the fuel costs are in no way dependent upon any other factor than that of the price of fuel, and the guaranteed consumption per kilowatt-hour; there being no question of the price to be obtained for by-products to be considered.

In determining costs with Mond gas plants, the state of the market for such by-products must be seriously considered, and when one is likely to have large quantities of sulphate of ammonia or other fertilisers to be disposed of, it is as well to bear in mind the rapid and extraordinary progress that is being made in Norway in this line, particularly with reference to the electrical fixation of nitrogen.

The amount of cooling water used is extremely small. It is circulated round the cylinders at the rate of about 4 gallons per brake-horse-power hour, the outlet temperature not exceeding 120°F. The make up water should in no case exceed 2½ per cent. This is a most important consideration to those engineers who, like the author, have to take town water from the main. Compare this item with steam plant, especially cooling water for the condensers of turbine plants, or with producer plant, for gas engines.

The Diesel engine is entirely automatic in its action, preparing its own fuel, stoking itself, and rejecting the waste gases. No highly skilled labour is required, the services of a machine-minder or engine-driver being sufficient. One man per shift (exclusive of switchboard labour) can easily do all that is necessary in a Diesel power station, up to 1,000 kw. capacity.

The expenditure under repairs and maintenance is found to be very small, although those interested in other types of engine often state that the reverse is the case. Taking an actual case of three-power stations, having installed 1,500 B.H.P., a sum of £177 was expended between them during the last completed year, some of these engines having run practically continuously. This sum corresponds to 1s. 6d. per brake-horse-power per annum, which the author considers a very liberal allowance indeed, and it is certainly much too high an average for large sets.

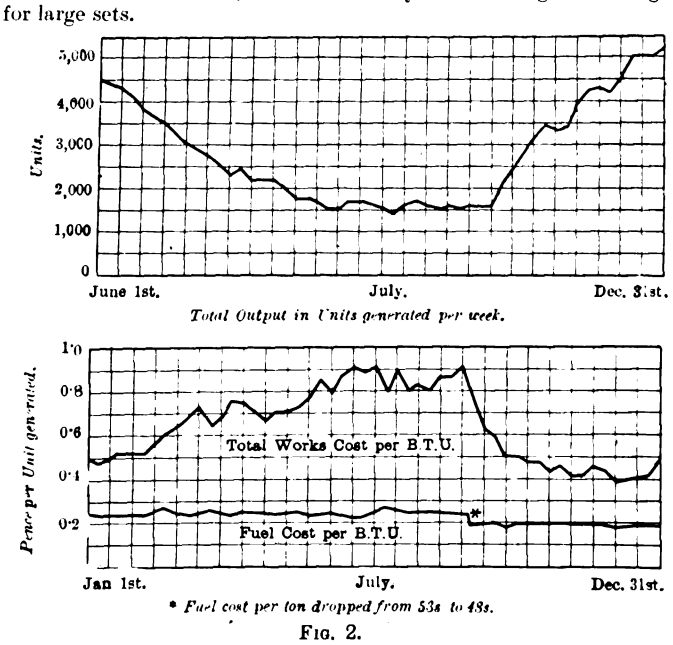

FIG. 2.

Records of several years' working of engines under various conditions show a consumption not exceeding 4 grammes of lubricating oil per Board of Trade unit generated, which at 1s. 8d. per gallon amounts to 0·019d. per unit. Also the cost of engine-room stores is reduced to a minimum, being considerably less than with either steam or gas plant.

High Power Diesel Stations.—There appears to be a feeling amongst engineers that, although the Diesel engine can compete with other forms of prime mover for small outputs, it is quite out of the question when large power stations are under consideration. That this is an entirely erroneous idea will be seen by the following comparison. The Brighton works is taken as an example of a large steam-driven station, and one of equal output for both Diesel and gas plant respectively is compared with it. The output in each case being 10,800,000 units generated, 9,000,000 units sold, with a load factor of 21·8 per cent. and a maximum load on generators of 5,900 kw.

The present capacity of the Brighton works is 10,200 kw., the approximate floor space per kilowatt installed 3·04 sq. ft., and the capital cost per kilowatt installed £19·52. The works cost per unit sold 0·70d., and per unit generated 0·583d., and total costs, including capital charges 1·124d. per unit sold, or 0·927d. per unit generated.

To obtain approximately the same capacity as the above, it would be necessary to instal seven Diesel sets, each of 1,450 kw. capacity, making a total of 10,150 kw. The total area occupied would be

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17,699 sq. ft. (engine room 15,177 sq. ft.) The capital cost would be as follows :—

7 sets	£98,000
7 intermediate tanks, each 1,000 galls.	200
2 fuel pumps	100
2 air compressors	1,000
7 circulating water pumps	700
Switchgear (7 gen. 6 feeders)	9,000
Piping	500
Main reservoir (250,000 galls.)	3,500
Buildings	30,000
Foundations	3,000
	£146,000
Cost per kilowatt installed	£14·38
Floor space per kilowatt installed	1·6 sq. ft.

Details of work costs :—

Fuel (37s. per ton) 10,800,000 units at 0·66 lb. per unit	£5,920
Lubricating oil (2 grms. per unit) at 1s. 8d. per gal.	440
Engine room stores	200
Repairs and maintenance, at 1s. 6d. per B.H.P.	1,090
Wages :—	
3 shift engineers at £3 ; 3 voltmeter boys at 25s. ; 6 drivers at 35s. ; 6 greaser cleaners at 27s. ; 2 fitters at £2 ; fitters' mates at 27s.,	£1,927
Station superintendent	250
Total	£9,827

	Per unit sold.		Per unit generated.
Fuel	0·158d.	...	0·132d.
Oil, waste, water, &c.	0·017d.	...	0·014d.
Repairs and maintenance	0·029d.	...	0·024d.
Wages	0·058d.	...	0·048d.
Total works cost	0·262d.	...	0·218d.
Capital charges—	0·311d.	...	0·259d.
Total costs on same basis as steam driven plant	0·573d.	...	0·477d.

Gas Plant.

The same number and size of sets have been taken for this plant as for the Diesel plant, and the particulars, costs and other details for gas plant, have been taken from the Paper of Messrs. Andrews and Porter, read before the Institution of Electrical Engineers in Nov., 1908. This gives capital cost per kilowatt installed £17·68, floor space per kilowatt installed 5·2 sq. ft.

A fuel consumption of 14,000 tons has been taken as an approximate consumption for the output.

14,000 tons of coal at 12s. per ton	£8,400
Lubricating oil 0·37 galls. per 1,000 H.P.-hours at 1s. 6d. per gallon	400
Oil for auxiliary plant	100
Engine room stores at 0·002d. per unit	90
Repairs and maintenance at 0·046d. per unit	2,070
Wages :—	
3 shift engineers at £3 ; 3 voltmeter boys at 25s. ; 6 drivers at 35s. ; 6 greaser cleaners at 27s. ; 3 producer hands at 35s. ; 6 producer hands at 27s. ; 7 ammonia recovery hands at 27s. ; 2 men unloading coal, &c., at 27s.	£2,779
Station superintendent	250
Total works cost	£14,089
Works cost per unit generated :—	
Fuel	0·186d.
Oil, waste, water, &c.	0·013d.
Repairs and maintenance	0·046d.
Wages	0·067d.
Total	0·312d.
Capital charges	0·292d.
Total costs on same basis as steam plant	0·604d. per unit generated.

Summary.

	Steam.	Gas.	Diesel.
Floor space per kilowatt	3·043 sq. ft.	5·2 sq. ft.	1·6 sq. ft.
Area occupied :—			
Capital cost	£199,162	£176,875	£146,090
Capital cost per kw. installed	£19·52	£17·68	£14·38
Works cost per unit generated	0·583d.	0·312d.	0·218d.
Total cost per unit	0·927d.	0·604d.	0·477d.

Sub-Stations.

When one carefully considers the capital sunk in huge generating stations, expensive E.H.T. distributing systems and large sub-stations, also the repairs, maintenance and labour attached to these adjuncts, it is a matter of some surprise that the Diesel sub-station has not been more extensively adopted.

It must always be remembered that a central station, with sub-stations is entirely dependent upon one main station for continuity of supply, and although every possible precaution may have been taken, yet some very small failure may result in a total or partial shut-down, the effect of which is disastrous in any town of importance. Again, what is the overall efficiency of some of your large works with sub-stations ? At Brighton, where there is one large sub-station, the maximum load on the turbines was 5,900 kw., the maximum load on the sub-station being 4,727 kw., or an efficiency of about 80 per cent., which figure, the author believes, is somewhat above the average.

Where central stations, with their sub-stations, have already been established and mains laid, there may not be very much to be said for the Diesel plant, excepting on the score of (*a*) continuity of supply; (*b*) peak load plant, thereby increasing the load factor on the main works, and (*c*) staving off large extensions in the main works, until such time as such extensions can be used at a most profitable period.

Where there are additional sub-stations to be put down and E.H.T. mains laid, there is undoubtedly an advantage with the Diesel sub-station. Therefore, in the author's opinion, it naturally follows that for any new scheme involving the supply of energy over a large area, by means of a central station and sub-stations, there is no question but that the Diesel sub-stations would be the correct scheme to adopt.

It cannot be seriously suggested that a Diesel sub-station is undesirable or impracticable in a large city. There is in London a 100 B.H.P. set in the basement of one of the largest drapery establishments in Oxford-street, also a 1,100 B.H.P. sub-station in the City at Cannon-street and a still larger one at Charing Cross. There is also another large one in course of erection at Lambeth.

It is difficult to make comparison between sub-stations on account of varying conditions, but in a large city with 1,000 kw. sub-stations, the capital cost of a complete sub-station would be about £20 per kilowatt installed, including buildings, &c.

So far, only large size units have been considered and those with moderate load factors. The author next gives some comparative results of the three systems on a 100 per cent. load factor, which is admittedly entirely in favour of steam and gas plants. These results were compiled by the Maschinenfabrik Augsburg-Nuernberg Co. upon the conditions appertaining to South Wales, and, the author claims, show that even under these favourable conditions both the steam and gas plants cannot compete with the Diesel sets.

The plant considered comprised two sets, one of 600 B.H.P. and the other of 150 B.H.P., and the figures may be summarised as follows :—

	Diesel.	Steam.	Gas.
First cost	£6,815	£6,650	£9,250
Cost per B.H.P.-hour including capital charges and depreciation)	0·164d.*	0·173d.†	0·178d.‡

All the above prices include packing, freight to c.i.f. Cardiff and services of skilled erectors. The plants are all three of equally good workmanship and reliability.

The general conditions assumed are as follows :—Combined ouptut of the two engines per annum : 4,554,000 B.H.P.-hours at a power-factor of 90 to 100 per cent. And the special conditions :—

Diesel Plant.—Price of liquid fuel, 40s. per ton. This is the present average price in this country. Anthracen oil or creosote oil which are distilates from coal tar, can also be used and could be got from the Bargoed coke oven plant. The commercial value of these oils is also about 40s. per ton.

Water required by using re-cooled water about 0·221 gallons per brake-horse-power-hour. Transport and storage of fuel easy and simple. No ashes, no banking losses. Starting up of engines possible within two or three minutes at any time.

Steam Plant.—Price of suitable coal 9s. per ton, evaporating 8 lb. of water per lb. Water required by using re-cooled water, about 1·7 gallons per brake-horse-power-hour.

Banking losses, ashes must be carried out, inspection of boilers necessary, starting up requires longer time.

Gas Plant.—Suitable fuel would be two-thirds coke breeze from Bargoed, mixed with one-third of coke, at a total price of 8s. per ton. The coke breeze must be non-coking, and contain not more than 25 per cent. ashes, not more than 25 per cent. particles smaller than 2 mm., not more than 25 per cent. smaller than 2·4 mm.

Water required by using re-cooled water about 1·2 gallons per brake-horse-power-hour.

Small banking losses, ashes must be carried away, smaller repairs of producers compared with boilers. Starting up in two to three minutes possible when producer in fire.

Some further Continental results on smaller Diesel sets with varying load factors given in the Paper show the average works costs (excluding capital charges) to be approximately 0·36d. per unit.

* Oil at 40s. per ton. † Coal at 9s. ‡ Coke at average of 8s.

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After Mr. R. M. Carr had read his Paper, of which an abstract is given on page 458, the following discussion took place on the two Papers :—

DISCUSSION.

Mr. CHAS. DAY (Mirrlees, Bickerton & Day) opened the discussion stating that he himself had had nine years' experience of Diesel engines, and that his firm had had 14 years' experience, one of their engines having been running at their works for that period. On the score of saving in fuel cost he said that engineers would be surprised at some of the figures available. Taking an average of a number of stations in which Diesel engines were used, the saving in fuel amounted to 40 per cent., the lowest in the list being 30 per cent. By comparison with gas engines the Diesel showed a saving of 60 per cent. These figures applied to fuel, but there was also an economy in wages, maintenance, upkeep, water, &c. In the early high-speed engines there was trouble with excessive consumption of lubricating oil, but these troubles had now been got over. He had found on test that the consumption of lubricating oil had dropped from 0·42 lb. per horse-power in the slow-speed type to 0·3 lb. per horse-power in the newer high-speed pattern. The difference was due to their having been using the lubricating oil in the cylinder of the engine. The oil used was about the same as that used in good steam plant. Although no guarantees were given with Diesel engines, they had been found by engineers installing them to be as satisfactory in operation as steam plants with which guarantees were regularly given. As far as the size of unit was concerned, with steam the larger the unit the better the economy, the lower the capital charges cost per kilowatt, and the lower the maintenance charges. With the internal combustion engine the position was reversed. The gross cost of working went up as the size increased. Above 150 H.P. per cylinder there were complications of higher temperatures, water-cooled pistons, &c. The size of unit with internal combustion engines had to be considered on a different basis from that of steam plant. The makers of Diesel engines were often accused of charging up unduly high prices and of obtaining large profits. His own firm, as their balance-sheet showed, paid no royalties and showed 2 per cent. profit. Regarding the vexed question of oil supply, Sir Marcus Samuel stated some time ago that the visible supply of oil was in excess of the visible demand. This statement had recently been repeated, and might be accepted. Well boring was being carried on extensively, and there was no likelihood of a scarcity for many years. Mr. Day concluded by endorsing Mr. Howard's statement that there would be startling developments with the Diesel engine in the next few years.

Mr. LEONARD ANDREWS (Key Engineering Co.) expressed surprise at Mr. Howard's figures, which showed that energy could be generated by Diesel plant at 30 per cent. less than with gas engines. The figures showing that cost of generating with steam plant was 50 per cent. greater than with gas would not be accepted by engineers as the best that could be done. Mr. Howard had based his gas-engine estimates on those of Porter and Andrews in their Institution Paper, and assumed an output of about half that given in that Paper—11 million units instead of 21 millions—from which he further assumed that the coal consumption decreased in the same proportion, allowing 14,000 tons of coal for this output. Any gas engine maker would, he felt sure, guarantee to generate the same output with 11,000 tons of coal. This would decrease Mr. Howard's estimate by 3,000 tons, or £1,800. Although Mr. Howard introduced the figures of ammonia recovery plant, given in the Paper mentioned, he omitted to credit the plant with the sale of the bye-products. At present prices that would mean £3,600 per annum. This meant in all about £5,400 was knocked off Mr. Howard's figures of £14,000, making £8,500 for the gas plant, and representing about £1,000 less than the Diesel cost, which he regarded as a very fair estimate. On the question of guaranteed consumption, Mr. Howard had pointed out that with the gas engine, from half load to 12½ per cent. overload, the fuel consumption curve was flat. He had plotted a curve of Mr. Howard's oil figures on the top of a gas engine makers' guarantee curve (oil at 40s. per ton and coal at 12s. per ton), and these curves coincided at half load. Above this the oil figures were 20 per cent. higher and at quarter load they were 10 per cent. lower than gas. This showed that above half load to full load the gas engine was better, and below half load the Diesel was to be preferred. He thought that the cost of oil would not follow the natural law of supply and demand. He had seen engineers in the colonies who were satisfied with the running of Diesel engines, but who complained of the uncertainty regarding the future price of oil, seeing that the rate was influenced by the manipulations of the oil trust. He referred to a 360 H.P. Diesel engine which he found running unattended in a cotton factory for at least a quarter of an hour. He thought there was a big future before the Diesel engine, which he did not look upon as a competitor of the gas engine. The installation of Diesels was an earnest of the future universal employment of internal combustion engines for electricity generation. Dealing with Mr. Carr's Paper and the rating of the engines, he thought that engineers should obtain definite information regarding the M.E.P. upon which the output was based. The rating of 70 lb. to 100 lb. per square inch was too high, as these pressures imposed great strains on the engine. Messrs. Galloways and Ehrhardt & Sehmer worked to a maximum of 70 lb., and the average working pressure was below this, so that there was a considerable overload capacity. He disagreed with Mr. Day that the cost of internal combustion engines increased with their size. The capital cost did not, and the efficiency increased, also the oil consumption was lowered, similarly with labour and repairs. Continental practice proved to the contrary in that where small engines of a few hundred horse-power were installed a few years ago the units now put down were of several thousand horse-power.

Mr. G. SEATON (Willans & Robinson) made an amusing speech, in which he recalled the early efforts of the gas engine makers with the small stations, and spoke of the manner in which they now fancied their chances for the larger stations in the big cities. Even Mr. Pearce had considered estimates for large gas engines. This he wished to describe in his own words as "holding out the carrot to the donkey." It was difficult to get figures as to working of gas engines until the beginning of this year, when a Paper by Mr. A. L. Chorlton (of Mather & Platt), before the Manchester Association of Engineers, provoked one of the finest discussions he had ever heard on the subject. He had asked Mr. Carr by telephone to attend the meeting, but was told that he was too busy, and he quite believed it. While he respected Mr. Andrews' opinion, he thought that a gas engine could be likened to a 6 ft. wife, it would keep a man at home. In the course of his 20 years' experience he felt that the bigger the gas engine the bigger the trouble.

Mr. H. Boot gave particulars of the Diesel plant which he had installed at Chichester some years ago, and in which he depended entirely on the plant without a battery. He thought that in a few years the Diesel engines which were now being installed in certain places would be found to be unsuitable. The makers were apt to give rather rosy figures which it was difficult to bear out in practice. He would like Mr. Howard to present the Association with the figures of two or three years' working, and he thought that the superiority of the Diesel over the steam engine would not be so apparent. Wages and skilled attendance were of importance, and, unless looked after, the plant after a few years might have to be scrapped. At Chichester he found that the fuel for the first year was 0·291d., wages 0·543d. and repairs 0·21d. per unit. Regarding oil supply there was a difficulty in transport and fewness of tank steamers, although the actual sources of oil would always exist. He instanced the use of oil fuel on Mexican locomotives, and in spite of the economy experienced, the fireboxes had to be changed back for coal, because of the difficulty in obtaining oil. He gave a number of maxims for those about to instal Diesel engines. The plant should be of moderate size, a price for spares should be obtained from the makers, also a 12 months' maintenance guarantee, the engine should be frequently indicated, there should be ample oil storage, and spare bottles for the compressed air, and lastly a tank for a reserve supply of cooling water.

Mr. G. WILKINSON (Harrogate) asked Mr. Carr for further particulars about the sale of by-products. Sulphate of ammonia would fetch £13 a ton, and as a rule there was a good yield from the sale of by-products. As to Diesel engines, he quoted a case of a 40 H.P. engine installed for sewage pumping in Harrogate which was running from 1902 1905. The cost of oil was £3. 10s. at the wharf, 10s. for carriage, and 7s. 6d. cartage, or £4. 7s. 6d. a ton at the works. The guarantee was 0·1d. per horse-power-hour, but it worked out at a round figure of £50, on the basis of seven days a week, 16 hours per day. This contrasted strongly with Mr. Howard's figure of 1s. 6d. per brake-horse-power, which would come out at £3 per annum. Although the engine was installed some nine years ago and the figures were accordingly exaggerated compared with present practice, they served to show that the guarantees of makers should not be considered too seriously. As to repairs, the engine in question had required one exhaust valve, 58 valve springs, 12 vulcabeston rings, one full cone, two pulverizers and nipples, six air pump rings, 30 air pump springs, and one cylinder liner. As to the future engine of the Diesel type, he thought that the single-acting pattern with cylinders back to back would come to stay. A 2,000 H.P. engine operating at 150 revs. per min. required a floor space of 887 sq. ft., with a double-acting engine, and 170 sq. ft. for a two-cycle engine.

Mr. MULHOLLAND (M.A.N. Co.) said the Diesel engine plant at the Halle Works included only one engine—built at the Augsburg works of the M.A.N., and only the foundations for two further engines had been built. At present the single-acting four-cycle engine was the standard engine, but in future, especially for engines of 1,000 B.H.P. and upwards (at least as far as firms experienced in building large internal combustion engines were concerned) this would not be the case, as otherwise the sad experience of the gas engine makers who tried to enlarge the small single-acting gas engines would be likely to be repeated. The double-acting four-cycle or the two-cycle engine would take its place. A single-acting two-cycle engine could be built safely and cheaply up to about 2,000 B.H.P., while a limit for single-acting four-cycle engine ought to be reached at 1,000 H.P. With regard to oil supply, in 1908 the world's production of crude oil was 38,000,000 tons; only one-500th of this was used in Diesel engines. Germany alone produced 300,000 tons of gas tar oil, which Mr. Howard said could also be used. He thought this proved that the artificial raising of the price of crude oil would be impossible. It had been his experience and that of the M.A.N., who built Diesel, steam, and gas engines and steam turbines, that the repairs of a substantially built Diesel engine were not larger than those of a first-class steam engine. He gave instances of M.A.N. Diesel engine installations in Germany of 2,760, 800, 1,250, 3,500, 1,700, 1,200 and 360 B.H.P.

Mr. KAULA (Willans & Robinson) said that his Company had a two-cycle 50 kw. Diesel engine in operation at the Royal Agricultural Show at Norwich, and though it was yet early to speak of the future of this engine in larger sizes, they were hopeful of developments. He reminded Mr. Andrews that the oil consumption of the Diesel engine was practically constant between half load, full load, and overload.

Mr. A. BLACKMAN (Sunderland) disagreed that the Diesel working pressures were low, in spite of the slow burning of the fuel. The substantial construction of the engines flatly contradicted this statement. There had been cases of the repeated breakage of crankshafts, which pointed to very heavy high stresses in the engine. He agreed with Mr. Day that the difficulties with the Diesel type engine increased with the size. He thought that Mr. Howard might have selected for comparison

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a station different from Brighton, where the coal costs were higher, due to freight charge charges. At Sunderland, instead of 0·583d. per unit generated, the works cost was 0·2104d., with turbine and reciprocators. These were actual, and not hypothetical figures. Modern steam plant could be installed at £12. 5s. per kilowatt, and, allowing 8 per cent. for capital charges, the costs incident to capital expenditure were 0·185d. per unit, which if added to works cost last year a total of 0·395d. was obtained, showing a saving of £2,600 over Mr. Howard's Diesel figures. The turbine in question required 17 lb. to 18½ lb. of steam per kilowatt, but with a modern turbine at least £2,000 could be knocked off the working expenses. If Mr. Andrews could beat Diesel figures by £1,000 a year with gas, a modern steam turbine plant would beat the Diesel figures by at least £4,600 a year. Diesels had a very small overload capacity compared with steam, which was another enormous advantage in favour of the latter.

Mr. H. L. Dixon (Leatherhead) gave some results with two 120 kw. units in his station. Repairs did not amount to more than £2 a year for the five years, and there was little prospect of immediate extensive repairs. A new cylinder liner would, he thought, be needed about once every seven years. For his small station the fuel cost was 0·22d., compared with the more usual 0·75d. or 1d., with inefficient steam plant. On the year's work the fuel consumption was 0·7 lb. per kilowatt-hour, as against the guaranteed figure of 0·64 lb. The load factor was 14 per cent. for the station. On the price of oil, he gave 77s. a ton five years ago, and now had a contract for four years at 48s. 6d. In his case the charges for transport were high as compared with those given by Mr. Howard.

Mr. W. G. Pickvance (Wrexham) said the Diesel oil engine having been dealt with so effectively, he proposed to offer some criticism of Mr. Carr's Paper. He did not appear to have considered the high-power horizontal engine, but to have confined himself to the vertical high-speed engine. If his engine had been low-speed horizontal his Paper would have been more exuberant in favour of the gas plant. Users of gas engines had told him (Mr. Pickvance) "Don't," and in almost every instance he found the type of engine was the old single-cylinder type. The horizontal high-speed gas engine was preferable to the oil engine. There were disadvantages in the latter, particularly the vertical high speed, the moving parts of which wore quickly.

Mr. S. E. Fedden (Sheffield) supported Mr. Blackman's defence of the steam turbine. He thought that coal costs for steam stations were falling, and in his own case he knew they would drop to 0·15d., and this was with mixed turbine and reciprocating plant. He deprecated the idea of the meeting countenancing the truth of the comparison given in the figures. He pointed to the need for under loading the internal combustion engine, or working it intermittently. A motor-car engine which would take a car anywhere up and down the country would be useless if placed in a motor boat. The marine motor had to be twice the size for a constant load such as was imposed on it by a motor boat.

Mr. L. V. Robinson (Richardsons, Westgarth) said that his Company were now building a marine type Diesel engine of 1,000 H.P. operating on the two-cycle principle. When the tests of this were completed they might turn their attention to a similar type for land use. He thought the Diesel engine most useful for sizes up to 500 kw. and 1,000 kw. Manufacturers were, however, prepared to go to sizes of 6,000 H.P. in four cylinders, each developing 1,500 H.P. As to repairs, he knew of a gas engine plant in the north of England of 550 H.P. which in three years had not cost more than £30 per annum. In the Far East his firm had a 4,000 H.P. gas plant in four units, running 2½ years, and on test this took 0·94 lb. of South China bituminous fuel per brake-horse-power-hour. The efficiency had been maintained and no trouble was experienced.

Mr. J. E. Edgcome (Kingston-on-Thames) asked Mr. Carr if, after what had been said, he would carry out his extensions in gas, Diesel or steam plant.

The authors reserved their reply for the Association "Proceedings," owing to lack of time.

The following is an abstract of Mr. Carr's Paper which was discussed conjointly with that of Mr. Howard.

INTERNAL COMBUSTION ENGINES FOR POWER STATIONS.—GAS ENGINES AND PRODUCER PLANTS.*

BY R. M. CARR.

(Chief Electrical Engineer, Leek.)

Summary.—The author gives a number of figures as to the first cost of steam-driven and gas-engine stations. These show that below 1,000 kw. the gas-engine station costs less than the steam plant. After giving particulars of the Leek electricity supply station the author next compares the works costs of gas and steam stations under 1,000 kw. capacity; and, in conclusion, he draws up a statement of the capital and running costs of a gas-driven station of 1,000 kw. capacity.

The author here proposes to confine himself entirely to gas engines and producer plants, and to deal more particularly with stations of comparatively small capacity. The ever-increasing demand for cheap units makes it absolutely necessary that some steps should be taken to reduce the works costs, and with a steam plant it is almost impossible for a small undertaking successfully to cater for a heating and power load. This is felt most keenly in small manufacturing towns; and in such cases a carefully designed scheme of internal combustion engines is generally advisable.

* Abstract.

In the first place, the thermal efficiency of a gas plant is admittedly much better than that of steam, but the advertised figures of some makers of gas engines are seldom, if ever, realised under ordinary working conditions, and it is impossible to get anything like such results with the fluctuating load of the average central station. On the other hand, electrical engineers are somewhat prejudiced against the gas engine, and are consequently inclined to magnify the troubles which exist.

Capital Charges.—The price of a gas-driven generator against a steam unit of the same capacity is undoubtedly higher, and when the size of the unit contemplated warrants the consideration of a steam turbine, the gas engine is a long way out of the running. If the whole installation, however, is considered, it is found that, below a certain capacity, the gas-driven station costs less than steam, while, as the capacity increases, the figures are reversed in favour of steam.

The following figures are the averages of the actual costs per kilowatt of a number of stations of both steam and gas:—

Stations under 500 kw. capacity.

Steam.		*Gas.*	
A.—Engines, dynamos, boilers, switchboard, accumulators, &c.	£36·0	A.—Engines, dynamos, producers, switchboard, accumulators, &c....	£28
B.—Land, buildings, &c....	19·1	B.—Land, buildings, &c. ...	12
Total per kilowatt	£55·1	Total per kilowatt	£40

Between 500 and 1,000 kw. capacity.

Steam.		*Gas.*	
A.—	£26·1	A.—	£24·4
B.—	11·8	B.—	9·0
Total per kilowatt	£37·9	Total per kilowatt	£33·4

Between 1,000 and 2,000 kw. capacity.

Steam.		*Gas.*	
A.—	£20·0	A.—	£22·0
B.—	9·5	B.—	8·5
Total per kilowatt	£29·5	Total per kilowatt	£30·5

The majority of steam stations under 500 kw. are run non-condensing. In the case of stations of between 500 and 1,000 kw. and between 1,000 and 2,000 kw. the figures given for the steam stations are the averages of the whole of the stations whose figures are published, but those of the gas stations are estimates, based chiefly upon manufacturers' quotations. In the case of steam the figures are probably higher than would be the case if a station of the capacity stated were designed at the present time. In preparing the estimates for the gas plant a similar allowance has been made. The three curves A. B. and C. (Fig. 1) illustrate the comparison between the capital expenditure for gas and for steam. These show that for very small stations gas costs much less than steam, but for anything above 1,000 kw. the equipment of a steam station costs slightly less than gas. If the curves were continued to, say, 8,000 or 10,000 kw., the difference becomes rather more marked in favour of steam.

The author also tabulates the cost of the plant and buildings at Leek, which station is entirely gas driven and is of 420 kw. capacity.

Engines and dynamos	£6,567
Producers, cooling plant, &c.	2,070
Switchboard and electrical auxiliaries	1,392
Accumulators.....	719
Travelling crane	189
Total	£10,937
Per kilowatt installed £26	
Land, buildings and foundations	£5,413
Per kilowatt installed £13	
TOTAL COST PER KW. INSTALLED, £39.	

The gas plant is of the "Wilson" pressure type manufactured by the Horsehay Co. (Ltd.), and consists of two producers, each nominally of 300 B.H.P. capacity, but which are capable of 25 per cent. overload without forcing to the point of inefficiency.

Water bottoms are provided for continuous running. The gas passes from the producers through an omnibus main into four dust catchers, which are merely cylindrical boxes, where the greater part of the dust is deposited. The cooling operation is carried out by means of a series of double tubes, fitted concentrically, the gas passing between the outer and inner tubes, a large cooling surface thus being obtained. The cooled gas is then washed, the tar which is extracted flowing into a tar separator, and the gas passes through sawdust purifiers, leaving the last of the tar in the process. The purifiers are connected in parallel in order that one may be cleaned without shutting down.

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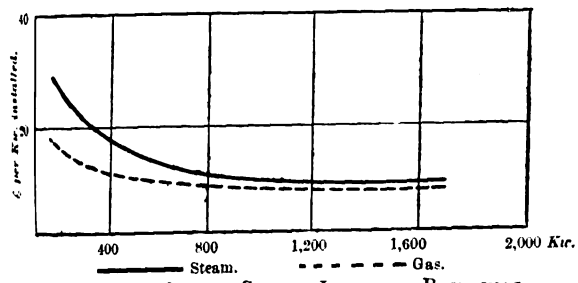
A small holder is provided, merely as a mixer and governor, but is not intended as a reservoir. From the holder an 18 in. main is provided and separate services connected to the various engines.

The generating plant consists of two horizontal Otto cycle, single-cylinder gas engines, each of 100 B.H.P., one four-cylinder vertical engine of 200 B.H.P. and one Korting two-cycle engine of 275 B.H.P. Each engine is coupled direct to a d.c. generator. The station is further equipped with a 400 ampere-hour battery and the usual balancer, boosters and other accessories.

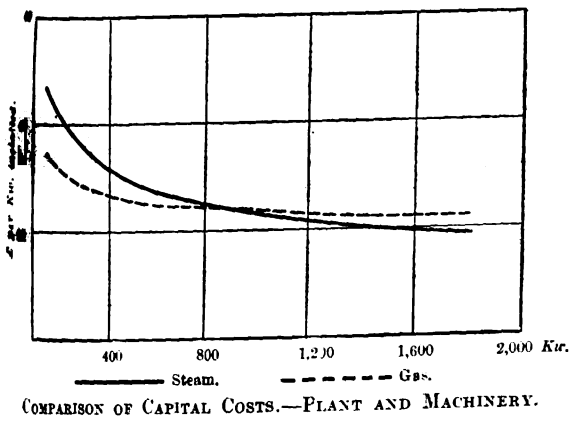
Running Costs.—It is usually acknowledged that the fuel costs of a gas-driven plant are considerably below those of a steam plant of similar capacity, but the other items, making up the total costs, have a considerable bearing upon the question when making the comparison. Particularly is this the case in repairs and maintenance of engines, which, in the author's opinion, will be somewhat greater after a few years of running for gas engines than for steam.

A



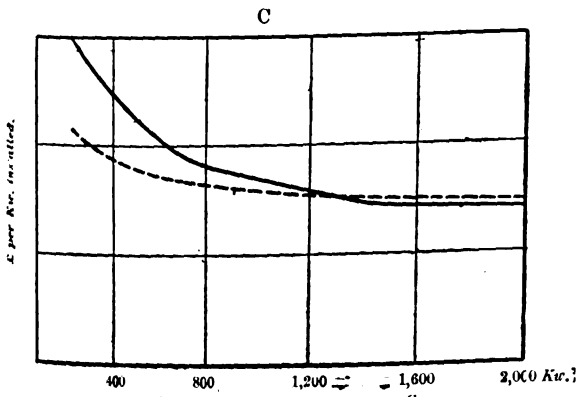
Comparison of Capital Costs.—Land and Buildings.

B



Comparison of Capital Costs.—Plant and Machinery.

C



Comparison of Capital Costs.—Total Capital Expenditure.

Fig. 1.

On the other hand, the repairs to a well-designed producer plant should not be anything like so great as those of boilers. The author met with difficulty in getting reliable figures. For purposes of comparison, however, he has taken the figures of three municipal undertakings, each entirely gas driven, also the averages of several other undertakings gas-driven (the names of which he is not at liberty to publish), and compared these with the average of all the municipal undertakings of a capacity of under 1,000 kw. Where the figures given were per unit generated, 20 per cent. has been deducted from the number of units in order to allow for losses, so that the figures shall fairly represent the costs per units sold.

—	Averages of Municipal gas undertakings.	Averages of other gas stations.	Averages of steam stations.
Capacity in kilowatts.....	314	632	600
Units sold per annum	299,210	874,720	502,980
Costs per Unit Sold.			
Fuel	0·28d.	0·26d.	0·53d.
Oil, waste, water and stores	0·06d.	0·04d.	0·06d.
Wages	0·26d.	0·16d.	0·30d.
Repairs and maintenance...	0·19d.	0·22d.	0·28d.
Total works costs ...	0·79d.	0·68d.	1·17d.
Rent, rates and taxes	0·10d.	not available	0·12d.
Management, &c...	0·41d.	not available	0·34d.
Total costs	1·30d.	...	1·63d.

Regarding the general running of producer plants, a great number of the failures one hears about are attributable to lack of knowledge and experience on the part of the attendants. For this manufacturers are somewhat to blame, as the rosy picture often presented of a suction plant which takes care of itself, requiring only a few buckets of coal per hour, is not often realised. The secret of success in producer gas plants is systematic cleaning, particularly in bituminous plants. Most of the stoppages are due to neglect of this important point.

Suction plants, burning anthracite and coke, up to, say, 200 or 300 H.P., are now an acknowledged success where ordinary care is taken, and some thousands of horse-power are in successful operation, but except in case of very small plants, they are not very desirable for central station work. One reason is that anthracite is expensive, except in districts in close proximity to the collieries where it is produced, and another reason is that a suction plant is not very suitable for the sudden variations in load often experienced in central station work. The author is of opinion that for a station of anything over 300 or 400 kw. capacity, a pressure plant with a small holder is preferable.

On a fully loaded suction plant 1 lb. of anthracite would be required per B.H.P.-hour, which at 30s. per ton would cost for, say, a 300 H.P. engine, 4s. per hour for fuel, while a pressure plant burning bituminous coal would require 1½ lb. per B.H.P.-hour, which at 10s. per ton for the same size of plant would work out at 2s. per hour. Another advantage which the pressure plant has over the suction type is that it is much more elastic in operation.

When installing suction producers a separate plant should be installed for each engine, but with a pressure plant the producers can be connected in parallel through an omnibus main in the same way that boilers and steam engines are connected, and the various engines can be started up or shut down as required without affecting the producer plant, and this is really the only way successfully to cope with the varying load of a central station. The holder ensures a comparatively even quality of gas, which is absolutely essential, as a varying quality means mis-firing, indifferent governing, and all the attendant evils at a time when steady running is most necessary.

The disposal of the effluent from the washer of a producer plant often presents a difficulty, especially in inland towns. When the water is turned into a sewer care should be taken that it is not hot. The author has recently met with opposition from the County Council to the effluent finding its way into a stream, but is getting over the difficulty by, instead of allowing the water to run away in a continuous stream, circulating it by means of a pump and tanks, and treating it with lime. This treatment has the effect of throwing down the sulphur compounds in the form of mud, and only a very small quantity of the treated liquor will be allowed to flow into the drain from time to time. This, it is expected, will quite get over the difficulty and also effect a saving in water.

In dealing with the tar the author has not met with much difficulty. The mixture of tar and water, after leaving the washer, passes into a separator, the heavy tar settling in the deep end of the tank, from which it is pumped from time to time and sold, and the water overflowing out at the end and circulated as before described. The tar is sold in barrels, the net price obtained being from 6s. to 11s. per ton, the price varying with the percentage of water found in the tar. The sawdust scrubbers are cleaned every week and the tarry sawdust, which usually extends to a depth of of 3 in. or 4 in., changed for clean. The tarry sawdust is burned under the vertical boiler, and with the addition of about 1 ton per week of coke breeze dust, is sufficient to raise all the steam required for the blower engine and the producers. The only trouble the author has experienced from tar in the engines was in one engine the design of which caused the

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gas to pass through the valves at a very high velocity; this velocity had the effect of dropping what tar remained in the gas, and after a few weeks these valves became clogged. This was got over by fixing a cast-iron box containing a series of grids of fine brass gauze near the gas inlet, and these grids are changed and cleaned every week. The engine is now entirely free from tar, and other engines are not in any way affected.

In choosing the site for a gas-driven station care should be taken to avoid a residential neighbourhood, as the noise from the exhaust and the occasional firing of a charge of gas in the exhaust pipe is very annoying. An excellent way of silencing the exhaust is by means of exhaust boilers, where the plant is large enough to warrant this. These boilers are not expensive, and besides acting as silencers, they are able to raise sufficient steam for all purposes required on the producer plant. The author deprecates the silencing of the exhaust by means of water in the exhaust pipes. The sulphuric acid formed by the mixing of the water with the sulphur in the gas causes rapid deterioration of the exhaust pipes, necessitating their complete renewal after a few years.

Where an exhaust boiler is not considered advisable, a very good method of silencing the exhaust is shown in the diagram (Fig. 2). This method was adopted at Leek with most satisfactory results. The exhaust enters the first pit direct from the engine, where it is allowed to expand and is broken up by means of a series of stoneware pipes set in concrete between the two pits, and passes from the second pit through two uptakes with practically no noise. With this method no back pressure is put upon the engine.

With most of the modern types of engine a sufficiently good cyclic regularity can be obtained either for direct current or alter-

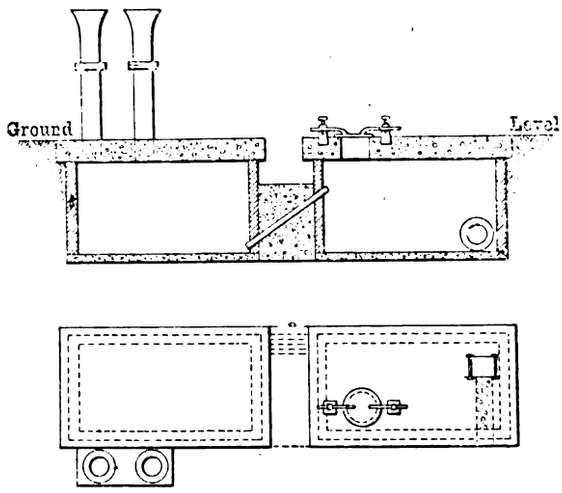

Fig. 2.—Gas Engine Exhaust Pits, Leek Electricity Works.

nating work, but for the latter close governing must be insisted upon. This is a point the importance of which has not yet been fully realised by some manufacturers. Another matter in which manufacturers are open to criticism is the rating of their engines, the temptation being slightly to overrate them. To engineers accustomed to the elasticity of steam engines regarding overload, this often leads to disappointment and dissatisfaction, especially after the engine has been running for some time, and, owing to wear, the compression has dropped slightly. A gas engine cannot be overloaded, and it is as well, when deciding the size of engine to put down, to specify a plant rather larger than what is really required.

To attempt to overload a gas engine causes overheating and pre-ignitions and the heavy strain put upon the engine in consequence causes rapid deterioration and costly repairs, to say nothing of the erratic running and consequential upsetting of the load while these pre-ignitions continue.

It must not be understood that the author is of opinion that gas engines as a whole are unsatisfactory for generating stations. There are engines which have been running for years, giving great satisfaction, and there is no reason why, with proper care and intelligent control on the part of those in charge, municipalities should not reap the benefit of the low running costs of a partially or totally gas-driven station.

In conclusion, the author draws up a statement of the capital and running costs of a gas-driven station of 1,000 kw. capacity. The proposed producer plant consists of three producers each of 500 B.H.P. capacity, and capable of 20 per cent. overload for two hours.

The producers are provided with a coal charging platform, which should be level with the railway siding. Connected from each producer is a complete cleaning and cooling plant consisting of dust-catchers, condensers, washers and purifiers, the latter coupled up in parallel for cleaning purposes. A gas holder 15 ft. diameter by 10 ft. deep is provided as a mixer and governor, and the whole plant arranged for continuous running.

The generating plant consists of three engines of 450 B.H.P. each and one of 150 B.H.P., coupled direct to three d.c. dynamos, each of 300 kw. capacity, and one of 100 kw. A boiler is provided in the exhaust of each engine, which will generate the steam required for the blower engine and for use in the producers, tar separating and other purposes. A cooling tower, for cooling the engine circulating water, and the necessary pumps are also provided. The station is further equipped with switchboard, 1,000 ampere-hour battery, boosters, balancers, and the usual offices, workshops, &c.

The complete cost of this plant, based upon manufacturers' quotations, comes to £21,120. or £21·1 per kilowatt; or, including £9,500 for land, buildings, &c., £30·6 per kilowatt.

Assuming a load factor of 20 per cent. and the annual sales to be 1,000,000 units, the maximum load would be 570 kw. This could easily be carried by the plant allowed for with sufficient spare plant held in reserve. Taking the fuel consumption at 2·25 lb. per unit generated, and adding 10 per cent. for stand-by losses, and assuming the station efficiency, *i.e.*, units sold to units generated, to be 80 per cent., then 1,326 tons of coal would be consumed per annum, which, at 11s. per ton, would cost £729.

The water required for the gas plant would be about 2,000 gallons per day, or 730,000 per annum. For engine cooling purposes 4 gallons per B.H.P.-hour is necessary, and allowing for an average running of two engines for 8 hours and one engine for 16 hours per day, 57,000 gallons per day would be circulated. 5 per cent. of this may be assumed to be evaporated or otherwise lost. This amounts to 1,051,000 gallons per annum, or 1,781,000 gallons altogether.

The cost of oil, waste and engine room stores should not exceed £200 per annum.

The wages item is based upon the following staff: three shift engineers, three drivers, three cleaners, one fitter, three producer attendants and two coal trimmers, and totals £22. 15s. weekly.

Breakdowns, however, could be covered by insurance; and for £120 per annum this risk could be met. In addition to this, £400 should be allowed for small renewals and ordinary wear and tear, which should be sufficient for all purposes, the repairs to a producer plant being very small indeed. The estimated works cost per unit sold is then as follows:—

Fuel	0·174d.
Water, Oil, waste and stores	0·058d.
Wages	0·283d.
Repairs and maintenance	0·124d.
	0·640d.

By the courtesy of the authorities the members were enabled to pay visits during the afternoon to H.M. Dockyard and the power houses of the Corporation's lighting and tramway departments, and subsequently a cruise on the Solent was taken in ideal weather.

Brighton, Thursday, June 29.

The meeting this morning took place in the Banqueting Room of the Royal Pavilion, Brighton. The programme comprised two discussions, viz.: "The Puuchase of Fuel," opened by Mr. C. E. C. Shawfield (Chief Electrical Engineer, Wolverhampton), and "Street and Shop Front Lighting," opened by Mr. A. H. Seabrook (St. Marylebone).

Purchase of Fuel.

Mr. C. E. C. Shawfield (Wolverhampton) in opening the discussion on "The Purchase of Fuel," said the importance of the matter to any electrical undertaking was one which hardly needed emphasis; particularly with the rapid rise in power loads of the last few years. In making a contract the position of the power station relative to the coal fields was one of the principal factors to be considered. The cost of carriage to Brighton was heavy and in the case of Birmingham it was comparatively small. The cost of carriage per heat unit was important. A cheap coal of 10,000 B.Th.U. calorific value might be best in some cases, whereas in the case of a station a long way from the coalfields it did not pay to buy coal with less than perhaps 13,500 to 14,000 B.Th.U. calorific value. Another important matter was the boiler house and the method of firing adopted. With hand firing the boiler doors were opened frequently for cleaning with an inferior class of fuel, and remained open so long that considerable strain was thrown upon the boiler. A good deal of heat was also brought out with the clinker, but with mechanically-fired boilers, which were to a large extent self-cleaning, a poorer class of fuel could be used and the heat units lost in cleaning were much less. The question of the percentage of incombustible contents had an important bearing

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on the commercial value of fuel. The incombustible contents included clinker, ash and moisture. The deleterious effect of the solid incombustible material seemed to be much greater than that of the moisture. The fireclay and shale had to be raised to the furnace temperature, and with internally-fired boilers it was removed at nearly furnace temperature, but although heat was expended in evaporating the moisture, the heat of the steam so produced largely passed back to the boiler, so that this heat was not entirely wasted. He had made experiments with fuel before and after washing. The fuel was fine, dirty, pit-bank sludge of a calorific value of 9,500 B.Th.U. per lb. of unwashed fuel, costing 4s. 5d. per ton delivered. The moisture contents were 5 per cent. and ash about 28 per cent. But that calorific value could not be taken as a true criterion of the commercial value as when tested by a calorimeter of the usual type. The ash contents were raised to the temperature of combustion and they subsequently gave up their heat to the water in the testing apparatus, but when it was burned in the boiler furnace practically the whole of the heat used to bring the ash and clinker to furnace temperature was lost because the ash and clinker was ejected in an incandescent condition. The calorimeter test gave 397,000 B.Th.U. per ld. Allowing for heat lost by rejection of ash and clinker this was brought down to a commercial value of about 290,000 B.Th.U. per ld. After washing, this coal gave an average of 11,700 B.Th.U. per lb., or an increase of 2,200 B.Th.U. This washed fuel cost 5s. 6d. per ton delivered. The moisture was 13 per cent. and the ash was reduced to about 11 per cent. That gave the same value per ld. as the unwashed fuel did by the calorimeter test (397,000 B.Th.U.). Deducting the heat used for raising the temperature of the uncombustible material this gave a net commercial value of 350,000 B.Th.U. per ld. So the effect of washing was to increase the calorific value from 290,000 to 350,000 B.Th.U. per ld. A colliery in South Staffordshire used a simple and effective washing apparatus consisting of a wooden trough about 12 in. wide and 12 in. deep and from 50 yds. to 100 yds. in length with a gradient of about 1 in 30. The unwashed fuel was fed in at the top with a stream of water. Shale and slate were deposited in the first 30 yds. of trough, and a comparatively clean fuel, improving in quality as the lower end was reached, was obtained. The fireclay remained suspended in the water and was carried away. This fuel frequently came to the works with 25 per cent. of moisture, but that could be removed by 24 to 48 hours storage in a perforated bunker.

Our report of the proceedings at Brighton yesterday (Thursday) is concluded on p. 472.

CONFERENCE ON EDUCATION AND TRAINING OF ENGINEERS, 1911.

This conference opened at the Institution of Civil Engineers on Wednesday last, a number of questions cognate to the wide subject of education being discussed.

Mr. ALEX. SIEMENS, president of the Institution of Civil Engineers, presided at the opening meeting and made the following prefatory remarks :—

It is my pleasant duty to welcome in the name of the Institution of Civil Engineers not only members of the Institution but also a number of distinguished visitors interested in the subject of the education and training of engineers, which is to be discussed at the meetings of this Conference. Thanks to the great Imperial gathering attracted to London by the Coronation, we are fortunate enough to see among us representatives from all parts of the Empire, who are familiar with the great variability of engineering problems under different conditions of climate and of development of the material resources of a country. Their experience will be of the greatest utility during our deliberations.

In calling this Conference together the Council have endeavoured to define the scope of discussion by declaring its object to be : "To consider the methods of preparation to be adopted by those who contemplate entering the engineering profession in compliance with conditions laid down by the by-laws for election into the Institution." The arrangement of our meetings is, therefore, based on the requirements of the by-laws, which demand that a candidate should possess : (1) A sound general education, developed upon lines suited to subsequent scientific study ; (2) a competent knowledge of those branches of science which form the basis of engineering ; (3) practical training under actual engineering conditions. In addition, there is the necessity, common to all professions, which Prof. Max Müller, in his first lecture on the Science of Language, defines as follows : ". . . no science and no art have long prospered and flourished among us, unless they were in some way subservient to the practical interests of Society . . . that interest depends on the practical advantages which Society at large derives from these scientific studies."

Applying this principle to the problem submitted to this Conference, it may be expressed by saying that a young engineer should be educated so as to become a dividend-earner for his employer, for this is the most reliable indication of his merit, and the corresponding reward will not be wanting. For the same reason he should possess some knowledge of business methods and of law, not with a view of becoming his own lawyer, but in order to be able to judge when legal advice is needed. Besides all these requirements he will find one or more modern languages very useful for obtaining remunerative employment, as the value of his services is thereby increased in the estimation of his employer.

The omission of the "business" aspect of education should not be taken as a sign of its unimportance, but owing to the very short time at our disposal the Council considered it desirable to indicate the lines to be followed by asking a number of prominent men to open the discussion on definite subjects in the three sections of the Conference, all of which have a direct bearing on the question of so instructing young men as to fit them to take part in the design as well as in the control and direction of engineering works.

It is hardly necessary for me to insist on the value of proper training for engineers after what I tried to demonstrate in my address last year, that modern civilisation owes its characteristic features to the success of the engineer in improving communications and in superseding manual labour by mechanical power. There is every indication that people more and more realise to what degree the conditions of living comfortably, according to modern ideas, depend upon the work of our profession, and the interest taken in this Conference is a sign of the serious view that is taken of the importance of its object. We may accept as a conclusive proof of this the fact that the Right Hon. Lord Pentland, Secretary for Scotland, and the Right Hon. Walter Runciman, M.P., President of the Board of Education, have kindly consented to act as Vice-Presidents of the Conference.

Whilst it is not proposed that definite resolutions should be arrived at by the Conference, but that it should be simply a means of forming and maturing the views of those interested in the subjects brought forward for discussion, the Council have felt that it would be desirable to give the widest and most immediate publicity to the proceedings of the meetings, and have accordingly invited the attendance of representatives of the Press to the gatherings. In this respect, the course taken differs from that adopted for the professional discussions of the Institution, which, of course, in their complete form, include criticism by correspondence on the part of members all over the world. These aim at securing a deliberately considered and permanently reliable statement of matters connected with engineering practice ; which, it is felt, can only be arrived at in a satisfactory manner by the procedure adopted for the Institution's own publications, of having all reports and criticisms fully revised by contributors before they are published. In the present case, however, the exchange of views which it is the purpose of the Conference to promote is not subject in any such [illegible] agree to the foregoing considerations, and as the object is rather to form opinion than to arrive at and to record definite conclusions, the Council are pleased to know that the Institution will be assisted and supported very materially in this Conference by the Press.

The President read a letter of apology from Prof. D. S. Capper, one of the honorary secretaries of the Conference, who was unable to be present owing to a recent accident.

Letters of apology were also read from Lord Pentland and Mr. Runciman, two of the vice-presidents, who were unable to be present owing to a Cabinet meeting.

Sir WM. WHITE thought this Conference might be considered as the third step which had been taken by the Institution in regard to the training of engineers. The first step, that of laying down an examination, had been followed by a tendency towards theory in training. That tendency was counteracted by a committee over which he had presided and which had laid down that the average student was the person to be considered. Geniuses would always find their proper level. He thought that the excessive devotion to the scientific side was a danger at the present time. This Conference would, however, endeavour to find the golden mean between too great theory and too great practice in the education of engineers. He thought the president and council in summoning this Conference had done well, not only in the interest of the Institution, but for the profession at large.

Sir JOHN WOLFE-BARRY said at the time examinations were established by the Institution scientific training was being neglected ; and that step had considerably raised the status of the engineer. He thought that the general education of an accomplished gentleman should not be lost sight of in the training of the engineer. A civil engineer ought to be a cultured gentleman with a theoretical and practical knowledge of his profession.

Mr. SIEMENS then declared the conference open.

Sections I. (General Education) and II. (Scientific Training) held a joint meeting in the library of the Institution, under the chairmanship of Mr. A. G. LYSTER. The first business was a short address by the chairman, of which we give an abstract below :—

Those who have at heart its best interests—and I am sure I can include amongst them all the members of this Institution—will agree that the general education of young men desiring to become

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engineers, with which subject Section I of the Conference deals, requires the closest attention of those who, on the one hand, realise what the necessities of the profession demand, and those on the other hand who control the selection and organisation of education; and so it seems very fitting that, in contradistinction to the too prevalent practice of "muddling through," the heads of our universities and public schools should meet the members of the profession and discuss with them the best preliminary training for those who are hereafter to uphold its traditions. The Institution itself has done much in recent years towards ensuring that all its members shall have a suitable intellectual equipment, which will not only qualify them for their membership here, but will be of advantage to them in the practice of their profession, and the by-laws of the Institution have been modified with the object of securing this end; but these efforts to obtain the best results require to be supplemented and supported by the action of university and school authorities.

It will probably always be a disputed question at what period specialisation shall be entered upon, and to what extent it shall be carried in the preliminary education of the would-be engineer; but I am sure we all agree that some specialisation is essential at some period or other, and that the young man who has made up his mind to enter the profession shall have his education sooner or later directed towards those special subjects which are likely to be of most use to him in his work. At the same time I feel certain that everybody will equally consider it a most undesirable thing that an engineer should be a mere one-sided creature, with no other intellectual equipment than a knowledge of the special subjects to which he would hereafter have to devote his attention, and that any system of education which produced such a result could not be satisfactory.

Education to be of real value should, I take it, not only furnish information and knowledge, but should also train and expand the intelligence and develop that type of character which fits a man to lead the best and most useful life, and all subjects and methods which can produce this result should be included in the curriculum of university and school life. It must be remembered, however, that a great many of these institutions were founded and organised in days when the conditions of life were very different from what they are to-day, and certainly much less strenuous, and when competition, both individual and international, was much less keen. The choice of professions, too, in those days, was much more limited, and so the curriculum established was one which lent itself much more to the development of scholarly culture than to the practical requirements of those who to-day have to fight the keen battle of life.

With an ever-increasing intensity of struggle, and with the developments of science ever enlarging its boundaries and multiplying its complexities, the demand for special training for the engineer becomes increasingly urgent, and unless he is to be debarred from our universities or public schools, it behoves the authorities to bring their educational standards into line with modern requirements.

As I have said before, we are very far from wanting the members of our profession to be engineers and nothing else; on the contrary, we want every opportunity given to the best type of man that the university and public school can produce to start with the best intellectual equipment as an engineer. Much has been done in the immediate past to bring this about, but there still appears to be much left to do, and this Conference has been inaugurated with the view of exchanging and focussing ideas on the subject between the authorities on either side.

A year or two ago I read a speech by the head master of one of our public schools, in which he was at pains to defend the restricted form of education in vogue at his school, and his defence might be summed up in this—that insamuch as there was no lack of applications for admission to the school, there could not be much wrong with the education given there. Well, gentlemen, if our Conference produced no other result than to condemn that spirit, we should at least not have met in vain. But we require, and I think not unreasonably, something more; we want, added to all the peculiar advantages that the university and public school can give, an education which more especially fits the young man for the career in life for which he is destined, and which, in the case of engineering, comprises a profession of rapidly increasing importance, and one more closely than ever before associated with our national progress and prosperity.

Dr. J. Gow then read a Paper, an abstract of which we give below:—

LITERARY EDUCATION AND ENGINEERING.

BY REV. JAMES GOW, LITT.D.
(Head Master of Westminster School.)

I propose to argue that a literary education, up to a certain point, which I will define, is of as much value to the engineer as to anybody else; and that, at least in the higher walks of his profession, he is likely to be injured by the want of it. I do not contend that literary studies are of any direct or immediate use to the engineer. His work must be largely deductive and mathematical, on which a literary education has no bearing. But presumably there are occasions when he is called upon to make use of chemistry or geology, or some other inductive science, and he is not properly equipped unless he has a fair knowledge of these sciences. Now it is notorious, at least to schoolmasters, that a boy who passes from the classical side to the modern side of a school has an immense advantage in inductive science over those who have been educated entirely on modern lines. Latin, as we teach it, with grammar and dictionary, is inductive science almost in the abstract.

Secondly, the engineer is doubtless often called upon to command a gang of foreign workers. The sooner and the better he learns their language the more easily he will control them and direct their labour. The language, of course, may be wholly alien to any that is spoken, or ever was spoken, in Europe; yet the necessary elements of language must always be the same. There are things to be named and relations between them to be indicated, and the man who, by training, is alive to this fact and on the watch for these elements, has a great advantage over another who learns at haphazard.

Thirdly, though it is perhaps not the business of the engineer to make contracts, it is undoubtedly his business to understand them and to give and receive orders accordingly. These transactions require a careful and exact appreciation of words by whomsoever used.

Hitherto, I have spoken only of linguistic education, but something also should be said of literary studies proper—the world of books, poetry, history, and the rest. The engineer, in Europe, and I suppose also in India, China and other countries which have an ancient civilisation, is frequently called upon to deal with places and things which have artistic merits or historical associations that endear them greatly to the general educated public. The French proverb which says, "Rien n'est sacré pour un sapeur," implies that, in France at any rate, the engineer has not always been tender to such sentiments, and even in England—perhaps even in London—there may be found monuments of engineering skill which many people would wish away. But of late years the general educated public has become much more numerous and more highly educated, and I suspect that a time is at hand when it will be advantageous to the engineer to mingle the *utile* with the *dulce*, to discern not only what is mathematically possible but also what is artistically impossible; not only what is cheap, but also what is nasty. For this purpose some general culture is necessary, some critical faculty, some pleasure in beauty, some habit of reading and delight in reading such as makes a man liberal in mind and sympathetic to the common run of his fellows.

And this same culture which keeps a man from being a prig may also serve to keep him from becoming a beast. I suppose that an engineer has as much pleasure as other folk, and it is just as important to him as to them what use he makes of his leisure. Most of the mischief that is done in life is done in leisure, and the rational employment of this time is the real object of general education. To be happy with a book, to know a good book from a bad one, to be able to read a first-rate book over and over again finding new pleasure in it every time—the man who can do this is master of himself and saved from a hundred base temptations. To these temptations, I imagine, the engineer is peculiarly liable, since he is so often lonely in a far country and a cruel climate. Many of you must know instances of young men who have gone to the bad in such conditions, and who might have been saved if they had had more resources in their minds and had known what to do with themselves when they were off duty.

But you may say to me that, even if I had proved my case, I have proved too much, and a man who is to have all the education that I want to give him will never have time to become an engineer at all. But, in reality, there is no fear that literary culture will absorb too much time. Against that danger there is a very efficient safeguard. The boy who is going to be a first-rate engineer will not take any more literary education after the age of 16 or thereabouts. Until that age clever boys are almost always equally clever at every subject, but at 16 their tastes begin to be pronounced and their minds cease to be receptive except in one particular direction. Parents are seldom awake to this fact. They see a clever little boy amusing himself with a toy engine, or making an aeroplane, or interested in motor cars, and they assume that his ultimate bent will lie that way, and trundle him off to the modern side or the engineering school. It is a mistake to be in such a hurry. The best plan, I am sure, is to give a boy a general education, mainly literary, up to 16, and at that point to watch him closely, and put him to what he wants to learn. If he is clever, he will be successful; if he is not clever, he will at least be happy and proud of his calling.

(To be continued.)

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EXPERIMENTS IN IMPACT EXCITATION.*

BY G. W. NASMYTH.

(*Concluded from page 376.*)

Summary.—In the concluding section of this article the author shows that minima in the Lepel oscillations occur at larger values of the direct current through the arc as the capacity in the shunt circuit is increased or the inductance diminished, and that the intensity of the oscillations increases. It is also shown that the frequency of the oscillations increases with the arc current and decreases with the arc length, and that the formula derived by the author for the frequency of the singing arc holds true also for the frequency of the oscillations produced by the new short arcs between metal electrodes.

The Intensity of the Lepel Arc Oscillations as a Function of the Arc Current, Capacity and Inductance.

It has just been shown that the Lepel generator resembles the arc more closely than the spark-gap, and has, in common with the Duddell and Poulsen arcs, a falling volt-ampere characteristic. Certain curious maxima in the direct-current voltage across the arc were observed as the arc length was varied at constant current, and the cause of these was finally traced to the influence of the capacity of the arc itself, these maxima in the voltage being accompanied by corresponding minima in the intensity of the oscillations.

Intensity of the Oscillations.—Two striking phenomena meet the observer. First, the alternating current, as measured by an unshunted hot-wire ammeter in the condenser circuit, is two or three times greater than the direct current measured by an ammeter in the main circuit. Second, if the direct current in the main circuit is varied, the intensity of the oscillations passes through a well-defined minimum. The value of the direct current at which this minimum in the oscillations occurs depends on the constants of the circuit, increasing when the capacity is increased and decreasing when the inductance is increased. The first characteristic indicates that these oscillations belong to the third class of "Wien" or "impact" oscillations; the second characteristic has interesting consequences in the theory of the relation of the intensity of the oscillations to the other factors of the circuit.

Inasmuch as the frequency of the oscillations varies with the current in the main circuit, the difficulties of calibration at varying frequencies made it impossible to use any kind of an ammeter with a shunt. Accordingly a special ammeter was constructed without the use of iron, in which the entire current passed through a small copper wire, 0·22 mm. in diameter and about 9·5 cm. long. This ammeter was connected in the oscillation circuit, as shown by the dotted lines in Fig. 1, and calibrated before and after each set of observations by comparison with the direct-current ammeter in the main circuit.

The results of the experiments on the variation in the intensity of the oscillations with the arc current are given in Fig. 7. Each curve corresponds to a definite capacity in the oscillation circuit, one Leyden jar representing a capacity of 0·00188 mfd. The same inductance, 14,400 cm., was used for the nine curves, so that the frequency range was from 324,000 with nine jars capacity to nearly a million with one jar. In each of the curves the oscillations pass through a minimum, well-defined in the curves for the larger capacities, less so at small capacities. These minima move over into the region of larger arc currents as the capacity is increased, following apparently a straight line law. This furnishes additional evidence that the capacity of the arc itself must be considered as connected in parallel with the capacity of the condenser circuit as far as the effect upon the intensity of the oscillations is concerned.

In the Paper the arc currents at which the minima in the oscillations occur are also plotted as ordinates with the corresponding capacities as abscissæ. The resulting curves are seen to be straight lines. As the inductance in the oscillation circuit is increased the slope of these lines is seen to decrease, at first rapidly, then more slowly. The arc current for minimum oscillations is apparently some inverse function of the inductance, and directly proportional to the capacity. At small inductances traces of a second minimum were observed at smaller currents, and at large inductances these secondary minima became more prominent than the others. These secondary minima follow the same straight-line law as the primary minima.

The straight lines of this figure all give an x intercept corresponding to the capacity of the arc itself, considered as a condenser. The mean value of the intercepts was found to be 0·54 Leyden jar, equivalent to 0·01 mfd.

The capacity of the arc is added to the capacity of the condenser circuit as far as the intensity of the oscillations is concerned. But for the frequency of the oscillations the author's experiments (described later) show that the arc acts merely as a resistance, and that its capacity effect does not enter directly. An important corollary of these two observations is that the Lepel arc may be available as a source of very high frequency oscillations whose intensity shall not be too greatly decreased. In other words, with an arc whose capacity is large, it may be possible to produce electric waves shorter than 1 metre, having a mean intensity much greater than that of the short waves produced by a Hertz oscillator.

Theoretical Considerations.—We can obtain some insight into the reason for the minima observed in the intensity of the oscillations, and shown in Fig. 7, with the aid of a formula first derived by M. La Rosa* for the maximum value of the oscillatory current. If we write down the energy relations for the condenser circuit for the instant of sparking and for the instant when the condenser current is a maximum, we have

$$\frac{Li^2_{max}}{2} = \frac{LI^2}{2} + \frac{Ce^2}{2},$$

where i is the condenser and I the generator current and e the sparking potential of the gap. Solved for the maximum condenser current, the equation becomes

$$i_{max.} = \sqrt{(I^2 + Ce^2/L)}.$$

The four assumptions under which the formula holds have been summarised by Vollmer as follows: (1) At the instant of sparking the condenser current $i = I$, the generator current. (2) The damping

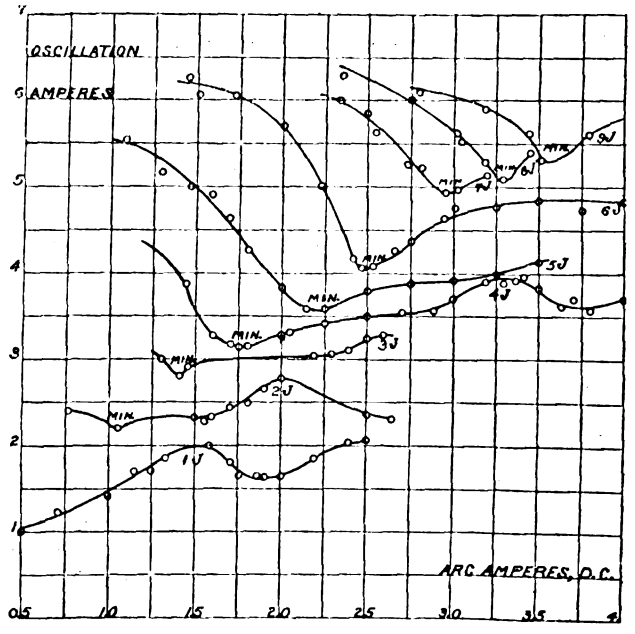

Fig. 7.—Variation in Intensity of Oscillations with Arc Current at Constant Capacities.

loss due to the resistance of the condenser circuit is negligible. (3) The energy produced in the condenser circuit on account of the falling characteristic of the arc during the discharge time T_2 is negligible. (In the Duddell oscillations this is the main source of energy.) (4) The energy $Ce_b^2/2$, stored in the condenser at the instant that the condenser current is a maximum is negligible. (e_b is the P.D. across the arc during the maximum discharge.)

In order that the formula shall hold for the short spark generators it is necessary to assume also: (5) The energy stored in the capacity of the spark-gap itself is negligible.

Theory shows that the assumption (1) is permissible, since for a sufficiently large choke coil in the main circuit the changes in the generator current are very small. The errors introduced by assumptions (2) and (3) tend to neutralise each other. Assumption (4) is unnecessary, as Vollmer has shown, if we use, instead of e^2, the difference of the squares of the sparking potential e and the P.D. across the arc during discharge, e_b. The author's experiments have shown that the capacity of the arc cannot be neglected in the short spark generators, but as a first approximation we may treat the equation as it stands.

If we assume the simplest relation, that the sparking potential is inversely proportional to the generator current, we have $e^2 = k/I^2$, the proportionality factor k being a function of the arc length. For small variations in the arc length it is probable that k may be con-

* Abstract of three articles in the "Physical Review."

* La Rosa, "Nuovo Cimento," Vol. VII., 5, 1904.

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sidered a constant. Using this value of e, the approximate formula becomes

$$i_{max.} = \sqrt{(I^2 + Ck/LI^2)}.$$

At large values of the generator current I the first term under the radical will be of importance and the second term small. For small values of the generator current the second term will be important and the first term small. Under the limiting conditions of very large or very small currents I, therefore, the condenser current maximum $i_{max.}$ will be large, but at intermediate values the condenser current will have a minimum in its initial maximum value and in its corresponding effective value. This is in agreement with the experiments of the author.

We can find the value of the current for which the oscillations will be a minimum by equating the differential $di_{max.}/dI$ to zero. The condition for a minimum is $I^4 = kC/L$, so that the critical current for minimum oscillations should be a function of the capacity and inductance at constant arc length. This also is in agreement so far with the author's experimental results. The experiments show, however, that the critical current is directly proportional to C instead of to the fourth root. The difference may be due in part to the influence of capacity on the relations of the maximum and effective values of the condenser current, and in part to the influence of the frequency, which is a function of the capacity on the sparking potential. The indirect effect of an increase in the capacity in lowering the sparking potential (through the influence of the duration and intensity of the oscillatory current) would also modify the relation between the capacity and arc current for minimum oscillations.

The capacity of the arc is in parallel with the capacity of the condensers and the divided circuit may give rise to the two minima, observed in the oscillations. The effective capacity of the condenser branch of the divided circuit is reduced by the inductance in series, however, and with a large inductance in the condenser circuit the capacity of the arc becomes more important. This is probably the reason why the second minima become more important than the first at the large inductance of 327,500 cm.

Impact Excitation.—The bearing of the minima in the value of the effective and initial maximum condenser current upon the problem of impact excitation is apparent. It is evident that the oscillations will be most quickly damped out when their initial value is least. The average intensity of the oscillations will be least also in this case. To secure the most favourable conditions for impact excitation, therefore, the arc current or arc length should be adjusted to give a minimum in the intensity of the oscillations. If the arc current is varied by means of a rheostat in the main circuit at constant arc length, capacity and inductance, the desired minimum can easily be found with the aid of a hot-wire ammeter.

The Frequency of the Lepel Oscillations.

Duddell and Poulsen Oscillations.—From theoretical considerations the author has derived* a formula for the frequency of the singing arc agreeing closely with all the experimental data which have been published on the Duddell and Poulsen arcs. In its general form this formula is

$$n = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{(R + dV/dA)^2}{4L^2}},$$

where n is the frequency, L is the inductance, C the capacity and R the resistance of the oscillatory circuit, and dV/dA is the slope of the volts-amperes characteristic curve. If we take the value for the slope as given by the author's experiments at high frequencies, viz., $-(c + ld)/A$, where l is the arc length, A the arc current and c and d are constants depending upon the electrodes and the atmosphere in which the arc is formed; and if, further, we neglect c and R, which are usually small in comparison with the term ld, we get the approximate formula

$$n = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{l^2d^2}{4L^2A^2}}.$$

The law of the variation of the frequency of the singing arc is fairly well known, and may serve as a guide in the investigation of the frequency of the short-arc metal-electrode generators.

Lepel Oscillations.—A loosely coupled secondary with variable air condensers and a hot-wire ammeter was used to determine the frequency, the connections being the same as in Fig. 1. It was soon found that the frequencies at which resonance could be obtained varied with the arc current. As some of the resonance frequencies were close together, considerable difficulty was experienced in trying to follow the variations of a single one as the current was changed, and it was finally decided to make a complete exploration of the field.

* Nasmyth, "The Frequency of the Singing Arc," "Phys. Rev.," 27, No. 2, p. 117, August, 1908.

The results of the more exhaustive experiments are given in Fig. 8, and show that the frequency of the oscillations produced by the Lepel arc increases with the arc current, as in the singing arc. The curves seem to occur in groups of three, and the middle curves in each group, marked respectively 1, 2 and 3, represent the largest amounts of energy for a given current, the companion curves above and below representing comparatively weak oscillations. Curve 1 is apparently the fundamental, and at large currents of 3 amperes or more this is the only resonance frequency that appears. It approaches asymptotically the frequency given by the Thomson formula $n = 1/2\pi\sqrt{L_1C_1}$ as the arc current is increased. The curve 2 is evidently the first harmonic; at 2 amperes, for example, when curve 1 indicates a frequency of 300,000 for the fundamental, the frequency for curve 2 is very closely twice as great, 600,000. The range is not quite large enough to make sure that curve 3 is the next harmonic, but this is probably the case.

The reason for the flatness of the curve 2*a* at 0·15 mm. in the region from about 1·5 to 2·5 amperes is clear from Fig. 5. This showed that the region of maximum voltage at 0·15 mm. is between 1·5 and 2·5 amperes, and Fig. 6 shows that the region of minimum oscillations corresponds with the region of maximum voltage. The currents plotted in Fig. 8 were measured by a direct-current ammeter in the main circuit, whereas the actual current which determines the resistance and characteristics of the arc includes not only this current, but the oscillatory current as well. The effective current

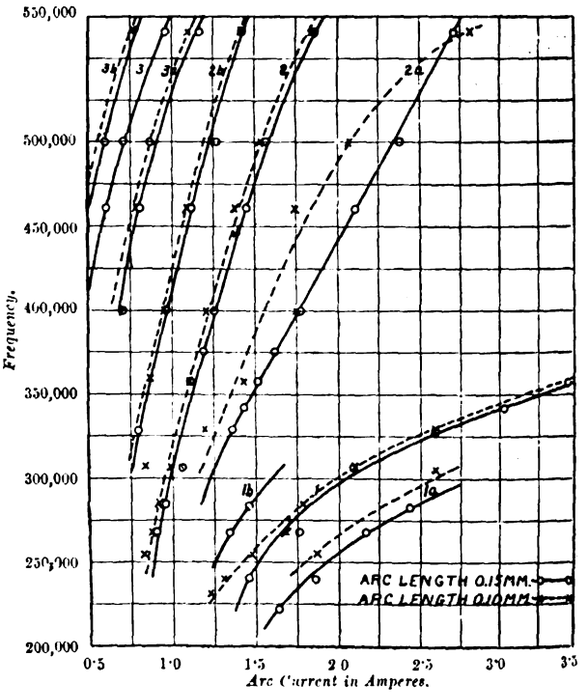

Fig. 8.—Change of Frequency with Arc Current.

traversing the arc is accordingly less relatively in the region where the full line curve 2*a* is flat, and if total currents through the arc were plotted instead of the direct current the flat part of the curve would bend over into its proper place in the region of smaller currents. The apparent shift of the curve 1*a*, and of most of the points in curve 1, in the same region, is explained in the same way.

Variation with Arc Length.—The full line and dotted line curves for arc lengths of 0·15 mm. and 0·10 mm., given in Fig. 8, show that the frequency decreases with increasing arc length, as in the case of the singing arc and in agreement with the formula above. On attempting to follow the changes in the curve I as the arc length was increased apparent inconsistencies were again met with, and the attempt to trace the course of the whole curve 1 was finally abandoned. The variation of the frequency of the fundamental with arc length at a constant current of 2 amperes was investigated. The results are given in Fig. 9. In both the curves of Fig. 9 the frequency decreases with increasing arc length except for regions of strongly marked minima in each case. On referring to Fig. 5 again it is found that these minima correspond to regions of voltage maxima and oscillatory current minima, so that the reason for the apparent discrepancies is traced as before to a decrease in the effective current through the arc. Thus, the minima in the oscillations and in the frequency for the 2 amperes direct-current curve both come at 0·15 mm. For the harmonic a smaller capacity and a smaller current were used than for the curves in Fig. 5, an

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the minimum should be shifted into the region of longer arc lengths or smaller capacities, as it is. If this allowance is made, we may say that the minima in the oscillations and the frequency both come at about 0·3 mm. A second minimum, less pronounced, seems to be indicated at about 0·6 mm. in the curve for the frequency, and it is possible that the corresponding voltage maximum lies just outside the range of Fig. 5.

Proof of the Formula.—It is apparent from the above curves that the frequency of the Lepel arc agrees qualitatively with the formula which has been found to hold true for the singing arc. With the exception of the irregularities due to the oscillation minima the curves are of the same form as the corresponding singing arc curves. A more rigorous test of the formula is obtained by plotting the square of the frequency against the square of the arc length. Both these curves prove to be straight lines outside the regions of the above-mentioned irregularities due to a decrease in the intensity of the oscillatory current through the arc. If the effective current through the arc had been maintained constant instead of the direct current, the agreement of the curves with the straight line requirement of the formula would have been as satisfactory as in the case of the Poulsen arc.

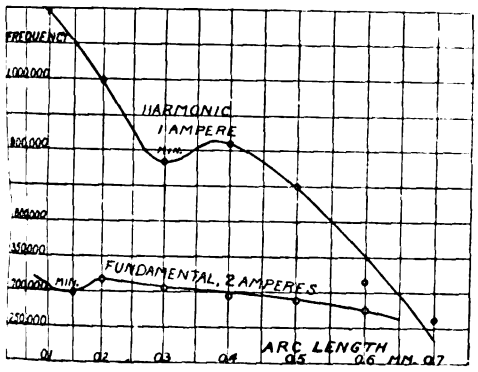

FIG. 9.—VARIATION OF FREQUENCY WITH ARC LENGTH.

Recent extensive experiments on the Poulsen arc* have shown that if the value of $d=k/\sqrt{C}$, where d is the arc constant and C the primary capacity, k has the same value for a given arc for all the values of inductance, capacity and Thomson frequencies used in practice. In its more general form the formula given above then becomes

$$n=\frac{1}{2\pi}\sqrt{\frac{1}{LC}-\frac{l^2k^2}{4L^2A^2C}}$$

The effect of capacity on the oscillation intensity and the form of the voltage current characteristics makes it very probable that the more generalised formula holds for the Lepel arc also, but sufficient data for a rigorous test are not yet available.

With a closely coupled secondary circuit and the arc current arranged to give minimum oscillations, a very sharp resonance curve with only a single wave is obtained by means of a loosely coupled primary circuit, as required by the theory of impact excitation. The maximum shifts with change of arc current, however, leading to the conclusion that the sharp resonance curve of the Lepel arc is due, not to free oscillations, but to *forced undamped* oscillations.

PHYSICAL SOCIETY.

At the meeting held on June 9, at the Imperial College of Science, Prof. H. L. CALLENDAR, F.R.S., in the chair,

A Paper on

"The Lüders' Lines on Mild Steel"

was read by Mr. W. MASON.

The conclusion is drawn that the Lüders' surfaces have the same or approximately the same inclination to an axis of simple pull or simple push. With stresses of opposite sign at right angles to each other the lines and surfaces are more inclined to the stress of greater intensity, and with equal intensities the surfaces are at about 45 deg. The author suggests that if a shear stress of given intensity be the only condition for that spreading of plastic strain which commences at the yield point, then there is no reason why there should be any variation in the angle of the Lüders' lines and surfaces. The variation suggests that not only the maximum shear stress—*i.e.*, the half difference of the greatest and least principal stresses—but also the magnitudes of the principal stresses are factors in producing the yielding condition in mild steel.

A Paper on

"A New Method of Harmonic Analysis by Averaging Selected Ordinates,"

was read by Prof. S. P. THOMPSON.

Assume with Fourier that the curve representing any periodic single-valued function of x may be expressed by the harmonic series:

$$y=A_1\sin x+A_2\sin 2x+A_3\sin 3x+\ldots.$$
$$+B_1\cos x+B_2\cos 2x+B_3\cos 3x.$$

Then to find the coefficient of any term, A_n or B_n, it suffices—subject to a limitation stated below—to measure off on the curve $2n$ equidistant ordinates over one period, that is spaced at successive intervals apart of π/n. Then, having reversed the sign of every alternate ordinate, the simple algebraic mean of them gives the coefficient sought. For cosine-coefficients the first ordinate must be taken at the origin; while for sine-coefficients the first ordinate must be taken at a point $\frac{1}{2}\pi/n$ from the origin. In symbols this is:—

$$A_n=\frac{1}{2n}\left\{y_{\frac{1}{2}\pi/n}-y_{\frac{3}{2}\pi/n}+y_{\frac{5}{2}\pi/n}-y_{\frac{7}{2}\pi/n}+\ldots.-y_{\frac{4n-1}{2}\pi/n}\right\};$$

$$B_n=\frac{1}{2n}\left\{y_0-y_{\pi/n}+y_{2\pi/n}-y_{3\pi/n}+\ldots.-y_{(2n-1)\pi/n}\right\}.$$

The limitation is that if in finding the nth harmonic, there be present also the $3n$th, or the $5n$th, or the $7n$th, &c., these will be included in the average found by the process, and must, if present, be separately determined and eliminated.

The process is much facilitated by the use of templates of transparent celluloid having equispaced vertical lines engraved upon them. They are laid down on the curve, and the values of the selected ordinates are thus readily measured off. For analysis of valve-motions, of alternating-current curves, of tidal observations, and diurnal magnetic variations, the method presents certain advantages, as it requires no multiplication of ordinates by sines or cosines.

The PRESIDENT commented upon the extreme ease with which the method adapted itself to the analysis of experimental curves.

Dr. RUSSELL remarked that the method could be usefully employed in interpolation as well as in harmonic analysis. In this connection he gave a brief *résumé* of Gauss's extension of Lagrange's interpolation formula. He also pointed out certain cases in which Fourier's analysis failed to be of practical use.

A demonstration of

"The Subjective Nature of the Difference Tone."

was given by Prof. S. P. THOMPSON.

Two tuning forks of frequencies 3.328 and 3.584 were sounded loudly. On striking the second the difference tone was heard, but while the notes from the two forks seemed to come in a definite direction from an external source the difference tone seemed to be located in the ear itself.

A demonstration of

"Spinning Tops and Gyroscopic Apparatus."

was given by Sir GEORGE GREENHILL.

A 52 in. Otto bicycle wheel was shown mounted on an axle with ball bearings, and spun by hand with the point in a small cup, to serve as a spinning top visible to a large audience.

The gyroscopic apparatus was made of an ordinary 28 in. bicycle wheel, the axle screwed into a stalk of a short length of rifle barrel, suspended from a lag on a bicycle hub; the hub is fastened to an iron bracket, which is bolted to the under side of a beam or sleeper, large enough to absorb vibration, and resting on two step ladders.

The wheel is spun by hand, and the axle is projected to obtain any desired gyroscopic motion, undulating, looped or with cusps.

The wheel can be detached by unscrewing the pin through the lug, and can then be used like the large wheel as a spinning top, or as the "Top on the top of a Top" described in Maxwell's "Life."

Put the wheel out of balance by a bar through the spoke and hold the axle, and it will serve as a pendulum, making oscillations however large, or complete revolutions; and the effect may be investigated of varying the angle of the axle with the vertical.

"A MODEL ILLUSTRATING THE PASSAGE OF A LIGHT WAVE THROUGH QUARTZ," constructed by Prof. H. N. ALLEN, of Poona, was described by Dr. H. S. ALLEN; and a Paper on "THE MEASUREMENT OF CONTACT DIFFERENCES OF POTENTIAL," by Prof. A. ANDERSON and Mr. J. E. BOWEN, and one entitled "A SHORT TABLE OF CIRCULAR AND HYPERBOLIC FUNCTIONS FOR COMPLEX VALUES OF THE ARGUMENT," by Mr. A. JOHNSTONE, were taken as read.

* Vollmer, "Jahrbuch der Drahtlosen Telegraphie und Telegraphonie," 3, pp. 117-173.

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"THE ELECTRICIAN" INDUSTRIAL SUPPLEMENT.

With "THE ELECTRICIAN" for Sept. 14, 1906, was issued the first of a series of "Industrial Supplements," to be published from time to time with "THE ELECTRICIAN." The fifty-third issue of the Supplement published (Gratis) with the number of "THE ELECTRICIAN" for September 23, 1910, was the last of the monthly issues. "THE COMMERCIAL AND INDUSTRIAL SUPPLEMENT" to "THE ELECTRICIAN" is now issued weekly (Gratis). It will be found towards the end of the present issue.

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INTERNAL COMBUSTION ENGINES.

There is a persistent feeling among engineers that the internal combustion engine, owing to its high efficiency as compared with the steam engine, must eventually take a more recognised position in power stations than it does at present. It is not surprising, therefore, that two Papers on this subject should be included in this year's programme of the Incorporated Municipal Electrical Association at Brighton. The Paper by Mr. R. M. CARR deals generally with the use of gas engines and producer plant. At the outset the author admits that the excellent results advertised by some makers of gas engines are seldom realised with the fluctuating loads found in electricity supply. Nevertheless there are certain distinct advantages in favour of gas plant more particularly in small stations. For example, there is the question of capital cost. In this Paper curves are given showing that for very small stations the first cost of gas plant is much less than that of steam, but when the capacity is above 1,000 kw. steam plant begins to be the cheaper of the two. On the other hand, repairs and maintenance are somewhat heavy, though possibly not so heavy as for steam engines and boilers combined. One of the weakest points in comparisons, as usually made, is no doubt the rating of gas engines. The natural tendency, due to competition, is to rate them too high. The gas engine is necessarily at a disadvantage when handling overloads as compared with the steam engine, and more particularly the steam turbine. Yet, taking all things into consideration, and notwithstanding early failures, it will be generally admitted that the small station offers a distinct field for the internal combustion

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engine. By "small station" we mean such a one as is likely to remain small for many years to come, and in country districts such cases are numerous.

The Paper by Mr. H. L. HOWARD is rather more restricted in its view, and deals purely with the Diesel engine. There is no doubt that a strong case can be made out for this ingenious engine in many ways. It possesses, of course, all the advantages of being self-contained, as does every oil engine, and thus it compares favourably not only with steam plant, but also with the gas engine, more particularly when this is supplied with pressure gas from gas producers. Moreover, it has the added advantage of having no ignition apparatus. Stand-by losses are nil, and therefore if the load is maintained above the half load of the engine, where the efficiency is good, the fuel cost throughout the year per unit generated is practically constant. Again, the labour required for running is a minimum, and it is stated that one man per shift, exclusive of switchboard attendance, is sufficient to run a Diesel station up to 1,000 kw. capacity. With regard to repairs, the position is not quite so evident, but results, as far as they go, tend to show that the repair bill is not heavy. Mr. HOWARD mentions a sum of 1s. 6d. per brake-horse-power-year as being a liberal allowance, and published figures seem to support this view. It is, however, necessary to bear in mind that the figures obtainable are for stations which have been in operation for a comparatively few years. As plant becomes older, the cost of repairs inevitably rises.

Mr. HOWARD takes the view that Diesel engines might well be used for large stations, and as an illustration he gives an estimate of the first cost and running cost of the Brighton station of 10,000 kw. capacity as it would be if equipped with Diesel engines. The first cost is shown to be lower and the running cost is much reduced by this substitution. Although we do not deny possibilities in this direction we doubt if very much faith can be put in estimates. Even the performances of stations which appear to be working under similar conditions vary considerably in the various items comprised in "works costs," and therefore such estimates are generally only rough guides. There is also a difficulty in comparing a station on new lines with an existing station. Every existing station supplying electric light and power has been equipped by degrees as the load developed. Consequently, a station like that at Brighton is not laid down initially for 10,000 kw. The plant installed originally, as regards size of units, was more suitable at that date than now, and doubtless the present plant will be still less suitable ten years hence. Thus a fair comparison cannot be drawn by taking the existing station, though it may be said that had the station been started with Diesel engines, assuming the estimates to be correct, it would now be showing considerably lower costs.

Mr. HOWARD also supports the use of Diesel engines for sub-stations, and we gather that he is in favour of eliminating the usual converter plant. In that case we do not quite see the point of the name "sub-station," for we then have a number of small stations running in parallel with the main station. We dealt with this question quite recently when referring to the employment of Diesel engines in the sub-stations of the Charing Cross Company, and we have not anything to add on the present occasion. This question must resolve itself eventually into the high efficiency of the large station plus transmission and conversion losses as compared with the lower efficiency of the small station with no transmission and conversion losses; and it appears to us that the large station must eventually win the day against a number of small stations below a certain size.

REVIEWS.

(Copies of the undermentioned works can be had from THE ELECTRICIAN Office, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.)

Les Enroulements Industriels des Machines à Courant Continu et à Courants Alternative. By EUGENE MARIC. (Paris: Gauthier Villars.) Pp. ix. + 240. 9fr.

The book before us is addressed to those engineers and students who wish to understand thoroughly the constitution of modern armature windings. It is not a treatise dealing with the subject of armature windings in all its generality, but limits itself to the consideration of windings in actual everyday use. The book then is intended rather as a help to the student than as a book of reference for the specialist on the subject.

The treatment throughout is simple and clear, and is, as far as is possible, non-mathematical. The subject is one which can best be made clear by introducing a large number of illustrations. The author has well realised this with the result that the illustrations are quite a prominent feature of the book. In all, there are over 200 figures. Of these, the majority are line diagrams, the remainder being photographic illustrations of actual windings and winding formers. The line diagrams are in every way excellent, those of polyphase windings being printed in three colours. The photographic illustrations are all well chosen, and have reproduced fairly clearly.

The book is divided into two main parts—continuous and alternating currents. Each of these parts is subdivided into the theoretical study and the practical realisation of the windings.

Dealing first with the continuous current portion, we note with pleasure that ring windings are only dealt with in so far as the study of such windings will enable the student to understand more easily the drum windings of the present day. The general theory and formulæ for lap and wave windings are stated clearly; we think, however, that more stress should have been laid on the fact that only certain combinations of slots and conductors can be used for wave windings without dead coils. Series-parallel wave windings are discussed at some length, and in an able manner. The method, due to Arnold, of representing these windings by an equivalent ring winding is the one employed. The need for equipotential connections and calculations connected therewith are both given. A useful little section on the choice of a winding and some examples of windings complete the theoretical study of this part of the subject.

The section dealing with the practical realisation of continuous-current windings contains much useful information. Quite a large chapter is devoted to the actual formation of the coils, many useful illustrations and diagrams of formers being given. There are also chapters dealing with the various shapes of slots and conductors in present use, plans and developments of the actual coils, and the testing of the individual coils and the finished windings. Altogether this section should give the student a very good knowledge of modern construction and methods.

In the alternating current section the first chapter deals, in a general way, with the production of alternating current. The second chapter is most valuable, and gives winding schemes for single and polyphase stators and rotors. The method adopted is to give one scheme per page, the chief

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features of each arrangement being clearly set forth beneath the winding diagram itself. Wave windings, for both stator and rotor, are given, and also a few special stator windings such as are used occasionally. The manner in which this chapter is arranged is such as to make the whole subject as clear and as simple as is possible.

The chapters devoted to the practical realisation of alternating-current windings follow much the same lines as those dealing with continuous-current windings. There are many carefully chosen photographic illustrations which should be of very great help to the student. We think it would have been well to have included a short section on the methods of supporting the end connections of stator windings, as this matter is of vital importance with high-speed alternators.

However, enough has been said to show that this book is a valuable addition to the literature already published on armature windings. It should be of great service to the student of the subject. A. E. C.

RAIL-LESS TRACTION AT BRADFORD.

On Saturday last, June 24, a public service of rail-less trolley vehicles was commenced at Bradford, which city shares with Leeds the distinction of being the pioneers of rail-less electric traction for public service in this country. In spite of the weather conditions on Saturday last being most unfavourable, heavy rain falling throughout the day, the service was run most successfully, no hitch whatever arising. A joint formal opening of both the Bradford and Leeds rail-less systems had taken place on the previous Tuesday (see our last issue, p. 434), but the public service could not then commence owing to the sanction of the Board of Trade not having been received.

It will be remembered that before embarking on a rail less trolley system the Bradford Corporation sent a deputation to the Continent to investigate the operation of the systems there installed. In view of the favourable report of this deputation, powers to equip several routes were sought in the 1910 session of Parliament; and when these were obtained the work was rapidly pushed forward with the result that the first route has now been successfully opened. This route should provide the Tramways Committee with useful experience as to the capabilities of rail-less traction under the conditions prevailing in this country.

The vehicles at Bradford, of which illustrations are given in Figs. 1 and 2 herewith, have been supplied by the Rail-less Electric Traction Co., of London, to the joint specification of Mr. C. J. Spencer, general manager of the Bradford Corporation Tramways, and Mr. J. B. Hamilton, general manager of the Leeds Corporation Tramways. Seating

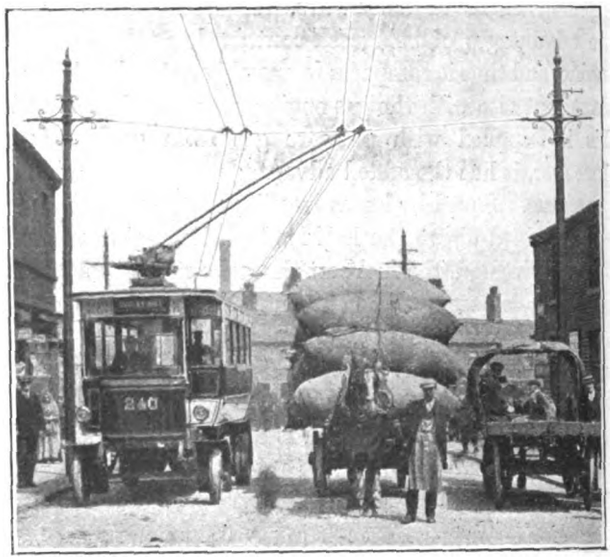

Fig. 2.—Rail-less Trolley Vehicle passing two Lorries.

accommodation is provided in each vehicle for 28 passengers, the ratan spring seats being arranged transversely. The wheel base of the car is 13 ft., and the overall width 7 ft., the distance between the centres of the rear wheel track being 6 ft. 3 in. The steering is arranged so that the vehicle will turn round in a radius of 12 ft. measured on the inner rear wheel. Two sets of brakes, operated by a foot pedal and side lever, are provided, one set acting directly upon the rear wheels and the other on a drum on the countershaft. This countershaft is driven through worm gearing by the motors, and drives the rear wheels by means of sprocket wheel and chain.

Each vehicle is fitted with two 20 H.P. motors of the Siemens interpole traction type with shunted fields, and runs on rubber-tyred wheels.

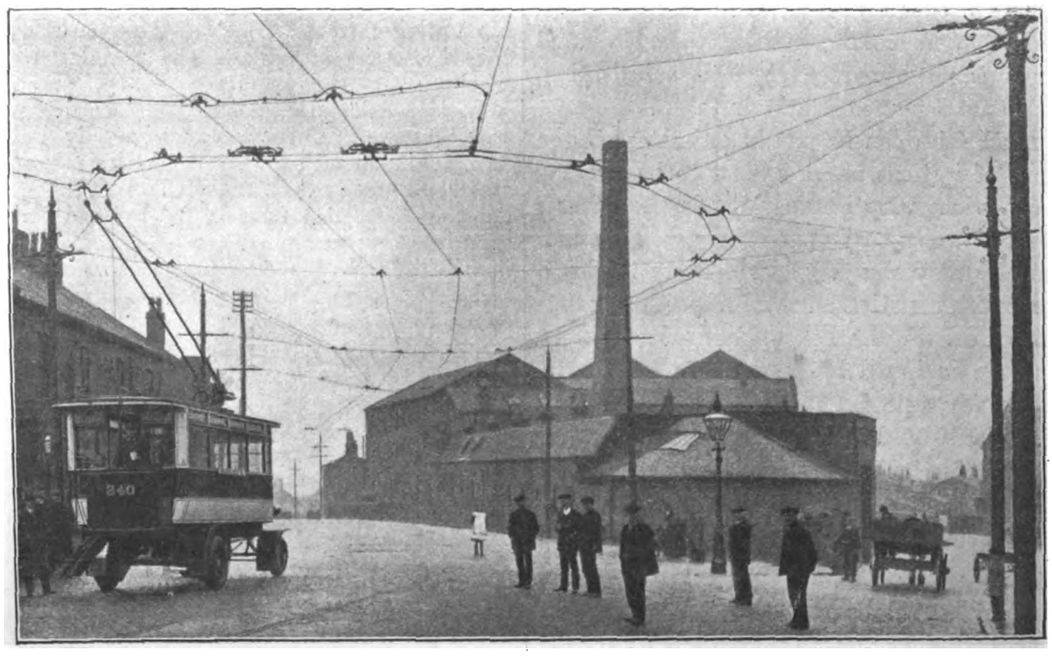

Fig. 1.—Rail-less Vehicle at Laisterdyke Terminus.

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The route on which the rail-less system has been installed is about 1¼ miles long and extends from Laisterdyke, on the Thornbury section of the tramways, to Dudley Hill on the Wakefield-road section. Side poles and span wires have been adopted, and as will be noticed from the illustrations herewith, the poles are of simple design, no ornamental bases being used. The feature of the system, of course, is the use of two overhead wires, the second being necessary owing to the absence of the rail return in the case of an electric tramway. An important advantage, however, is that the equipment can be easily removed to other routes in the event of the service proving unprofitable, or of an electric tramway being installed.

The route differs from those to which rail-less vehicles are usually particularly adapted, in that it lies in a densely populated district. It serves, however, to link up two important tramway routes, and if successful the system is likely to receive further applications where cheap construction is desired.

The illustrations indicate the great advantages of the rail-less system in regard to passing obstructions such as slow moving vehicles, which are apt to cause serious delays in the case of a tramway. Fig. 1 shows a view of the curve at the Dudley Hill terminus, which allows the vehicle to be easily reversed; whilst Fig. 2 illustrates the vehicle passing two laden lorries, the three vehicles occupying the whole width of road. This indicates the extreme flexibility of the system.

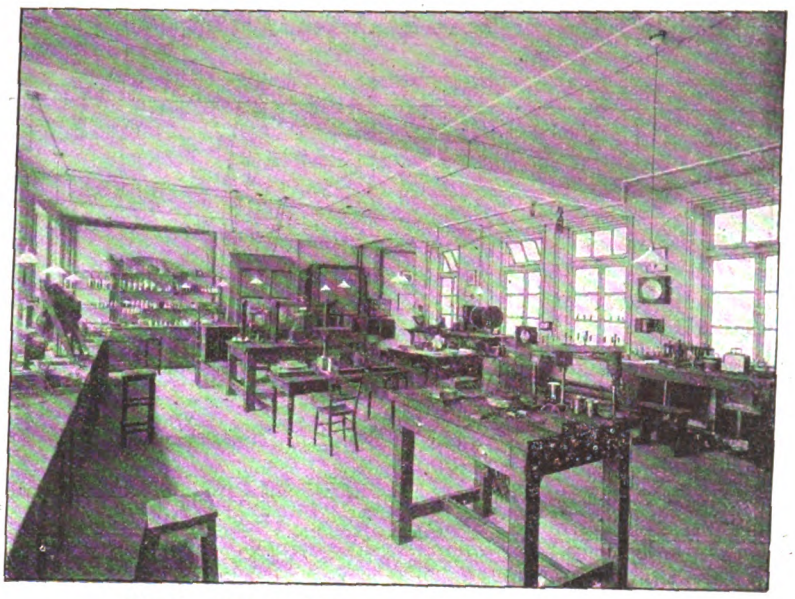

Fig. 2.—Another View of the Standardising Room.

THE FARADAY HOUSE TESTING LABORATORIES.

When Faraday House was founded by the Earl of Crawford, Mr. Robert Hammond and Mr. Francis Ince, rather over 20 years ago, its operations fell naturally into two classes, one of which had for its object the education of the young engineer and the other the provision of an independent testing authority.

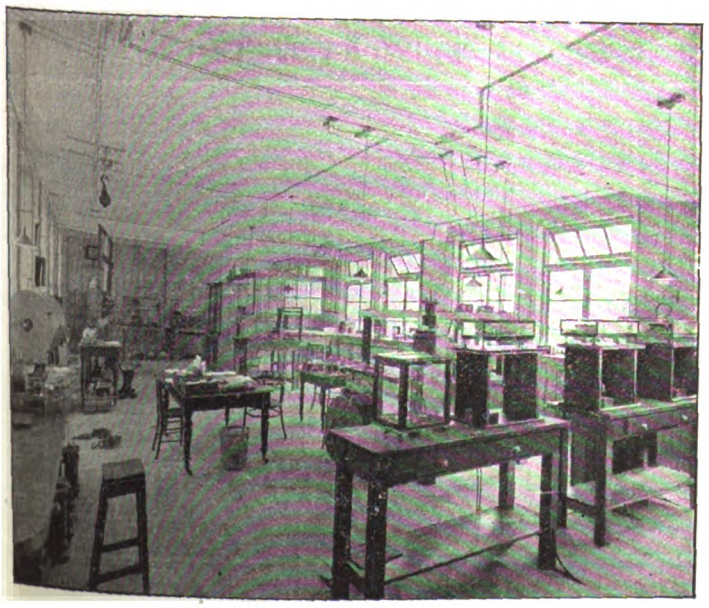

Fig. 1.—The Standardising Room.

Both these branches are still in full swing, and the original distinction between the two is still maintained. In reality, the only inter-connection that exists between the training college and the testing laboratories is that they are under the same roof, and that the staff of the former act in a consultative capacity to the latter. We propose in this article to give some account of the testing laboratories at Faraday House, and to devote a later article to the consideration of what the other part of the institution does towards training electrical engineers.

The importance of some such testing institution as Faraday House to the electrical profession and industry cannot be overrated. It is very often useful for an engineer to be able to obtain reliable and independent information concerning the merits of similar instruments and which one is best suited to his particular requirements. They may all be excellent in their various ways; and their various makers will doubtless emphasise this excellence in their catalogues. But by sending them to Faraday House, the engineer will not only be able to ascertain their respective merits, but will discover which is the best suited for the work he wants it to do.

The accompanying illustrations (Figs. 1 and 2) show two views of the main standardising room, which is situated on the first floor at Faraday House, in Southampton-row, W.C. The total area is 1,500 sq. ft., while an annexe, 34 ft. long and extending the whole width of the floor, is provided for photometrical work. The department is supplied with the necessary electrical energy from the institution's own generating plant and batteries, both direct and alternating current being available. The services are brought directly into the test room and consist of three-wire direct and alternating-current mains, as well as a two-wire direct-current supply. The battery room is on the second floor and the generating plant in the basement. In addition three separate services from the neighbouring electricity supply companies are available. The institution's own plant provides direct-current and also single, two and three-phase current at any frequency between 25 and 100. Three-wire services of both direct and alternating-current are brought into the laboratory from the supply companies, as well as a two-wire 500-volt circuit.

The wiring in the standardising room consists essentially of three pairs of mains running round the room, these mains being connected at intervals to terminal boards on the various benches. One wire of each main is looped into a small plug board to which all the Kelvin balances are permanently connected. By this means the current in any main can be connected to any ampere balance or standard resistance without breaking the circuit. In addition there are several other circuits running from the main switchboard for use in various parts of the laboratory. Every testing circuit can be connected

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to any source of supply by means of lugs at the switchboard. For distributing small currents a system of ordinary wall plugs has been devised and has been found most useful as regards its general adaptability to all classes of work. For large currents a battery of four accumulators is used, whose ultimate capacity is 2,000 amperes over short periods. For similar alternating-current work there is a transformer from which 1,000 amperes at 5 volts can be obtained.

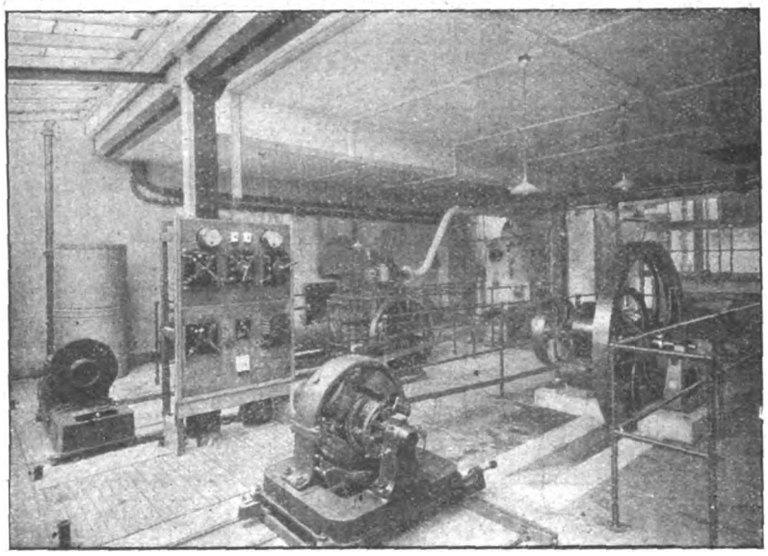

FIG. 3.—THE DYNAMO ROOM.

The photometer room is equipped for testing arc lamps and glow lamps as well as gas and oil burners. Life tests are taken at four pressures between 18 and 100 volts, and at three pressures between 100 and 200 volts. For cable work a Kelvin galvanometer is used, the table carrying the scale being fitted with a tank. One bench is equipped solely for iron and steel testing, while another is employed for extra high-tension work. In designing this plant the aim throughout has been to have all the apparatus for standard tests permanently connected up, and thus to avoid delay inevitable if any other arrangement is used.

Turning to the actual tests undertaken at the laboratory we may consider first the electrical section. Under this heading ammeters and voltmeters for commercial use are tested for accuracy within 1 per cent. of their maximum scale reading at a very low fee, while ammeters, voltmeters and wattmeters are calibrated for use as sub-standards, five points on the scale being given.

At the present time much interest is being taken in the problem of illumination, and it is, therefore, satisfactory to find that adequate photometric appliances are available at Faraday House. As mentioned above, a special standardising room is set apart for this work, where the usual apparatus in the way of photometers, measuring instruments and standard lamps are provided. If a lamp is required for use as a secondary standard, it is first "aged" and afterwards tested for candle-power. It is then run on the circuit for a few hours and again tested. Tests are made on arc lamps especially with regard to the candle-power and consumption of the carbons.

Both from the supply authority's and customer's point of view the accuracy of integrating meters is of importance. Special arrangements are therefore made at Faraday House for testing these. When it is realised that for over 20 years Faraday House has been appealed to in numberless cases where the accuracy of a meter has been questioned, it will be readily conceded that their experience is second to none in this class of work. It is gratifying to learn that the Board of Trade has appreciated the unique position occupied by Faraday House in this direction, and has appointed the Principal, Dr. Alex. Russell, electric inspector for no less than eight districts.

In connection with recent developments in the use of high electric pressures, both direct and alternating, special plant has been installed for measuring the electric strengths of insulating materials, and the information obtained from these tests is of great value to engineers. An entirely new method of measuring high voltages is being perfected. A unique feature of the work undertaken by this institution is the carrying out of mathematical calculations and investigations which during past years have resulted in improvements and economies in engineering work.

Samples of steel or iron for dynamos, transformers, instruments, &c., are tested for hysteresis loss and permeability, while wire and cables are also submitted to the usual tests for conductivity, insulation and capacity. Similar tests, which are sufficient to discover the suitability of the apparatus for the work it has to do, are made on lighting accessories, primary batteries, accumulators, tramway accessories and lightning conductors, while the staff also undertake the inspection of installations of electrical plant and machinery. Tests are also made on dynamos, motors and internal combustion engines, while investigations on the wide range of materials commonly in use for electrical purposes are also carried out.

Another branch of the institution's work is that dealing with the chemical analysis of dielectrics used by cable manufacturers. In addition to the testing work carried out, the institution provides on hire a complete set of instruments suitable for a wide range of purposes, so that engineers can make the measurements they require without being put to the great expense of purchasing new instruments. A further useful feature is that private workshops are provided on the premises at Faraday House, where inventors can carry out their investigations, having at the same time well-fitted carpenter's and engineer's shops at their disposal.

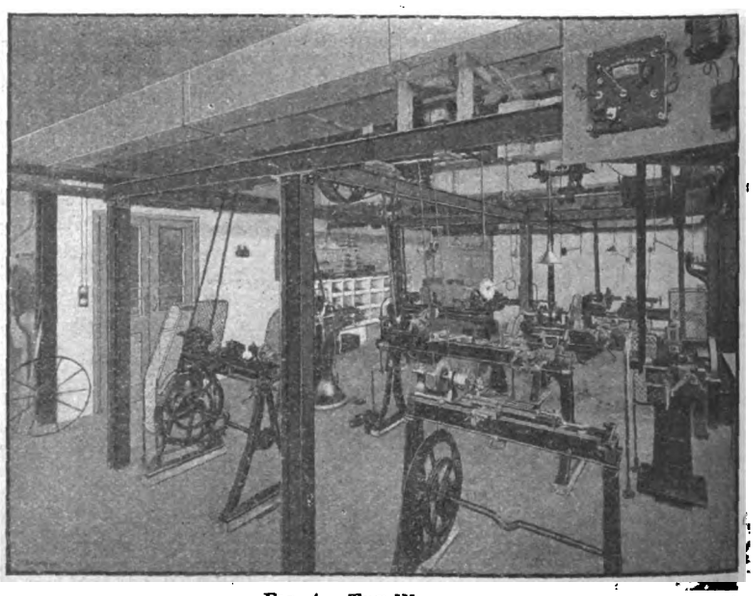

FIG. 4.—THE WORKSHOP.

It will be seen that the Faraday House laboratories fulfil a most useful function in the electrical engineering industry, and, at the same time, the institution has the advantage of occupying an entirely independent position, which is, of course, essential in carrying out work of this kind.

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CORRESPONDENCE.

LIGHT AND SHADE IN INDIRECT LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Justus Eck, in his valuable contribution to your issue of the 23rd inst., suggests that the objection I put forward to indirect lighting, viz., lack of contrast, does not exist, and proceeds to give as proof of his remarks the figures and photographic reproduction of a case of inverted arc lighting. Might I be allowed to suggest that this is again a confusion of terms. Inverted arc lighting can hardly be described as indirect lighting in the sense that I used that term, as the only thing in common is the fact that the actual arc is invisible. By indirect lighting I meant illumination derived from all directions. This is not the case in the room described by Mr. Eck; the illumination of the ceiling and the light derived therefrom was nearly 20 times that from the floor—hence a shadow factor of 97, which, as he correctly remarks, is an excellent result.

If Mr. Eck had replaced the inverted arc lamp by a light source giving equal candle-power in all directions and only shaded from the sphere by a small horizontal disc, the sphere would have had the same appearance as the vertical disc and the shadow factor would have been very near unity, which, of course, is the result one wishes to avoid.

This fault not only applies to indirect lighting, but also to shaded artificial illumination where lamps are placed indiscriminately in all directions; but it is one which never applies to inverted arc lighting, this being as a rule most successful when illuminating vertical objects.

The example of illumination given by Mr. Eck is an extremely good one, and there is only one small detail I should be tempted to alter, viz., to place the inverted arc near the window, which, if white blinds were used, would result in the windows at night by artificial light being in practically the same position as in the daytime, and not vertically below the objects in the centre of the room, thus producing a somewhat curious effect very rarely found in Nature.

I trust that this explanation will result in Mr. Eck exonerating me from any condemnation (by implication or otherwise) of inverted arc lighting, which is a system of illumination I strongly advocate when circumstances permit.—I am, &c.,

Westminster, June 26. HAYDN HARRISON.

"A NEW METHOD OF HARMONIC ANALYSIS."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I notice in current issues of the technical Press short abstracts of a Paper read by Prof. Silvanus P. Thompson at the meeting of the Physical Society on June 9. The Paper in question is entitled "A New Method of Harmonic Analysis by Averaging Selected Ordinates." As far as I can judge from a brief abstract, the method is, however, by no means new. It is, in fact, none other than the method published by Fischer-Hinnen in 1901 ("E. T. Z." XXII., p. 396; "Ecl. Elec." XXVIII., p. 422), and worked out in greater detail and with many illustrative examples in a later Paper ("Electrotechnik u. Maschinenbau," XXVII., p. 335, 1909; "Lum. Elect," VI., p. 177, 1909). In my laboratory instruction sheets I have for many years past described Fischer-Hinnen's method in the precise form given by Prof. Thompson. Indeed the method has so long figured in several well-known text-books, and has so often been discussed in periodical literature (*see*, for instance, P. M. Lincoln, "The Electric Journal," July, 1908) that to most persons interested in such matters it must be quite one of the most familiar of the many graphical processes of harmonic analysis.

But perhaps Prof. Thompson bases his claim to novelty upon the use of templates. The use of templates in various forms as aids to harmonic analysis is, however, a matter of ancient history, and, so far as Fischer-Hinnen's method is concerned, I had such templates as Prof. Thompson describes made, and used them for class demonstration purposes, shortly after the method was first published.

As is well known, the chief objection to Fischer-Hinnen's method is that it does not directly give the lower harmonics—particularly the fundamental. The reciprocal-sine diagrams recently described by me in THE ELECTRICIAN possess, on the other hand, the valuable property of giving any harmonic directly by simple addition. They can therefore be used even by the mathematically unskilled, and any intelligent typist, provided with a typewriter having an adding attachment, can, with their aid, be instructed to perform satisfactorily the duties of a "harmonic analyst."

There is, it has always seemed to me, another objection to the method as described by Fischer-Hinnen, and in practice I prefer to carry it out in a slightly modified form; but this I shall not discuss at the moment.

It is, of course, most useful to have an account of Fischer-Hinnen's method in Prof. Thompson's characteristically clear style, but it cannot be described as novel.—I am, &c.,

The University, Manchester, June 24. R. BEATTIE.

We have submitted Dr. Beattie's letter to Prof. Silvanus Thompson, from whom we have received the following reply:

TO THE EDITOR OF THE ELECTRICIAN.

SIR: By your courtesy which permits me to see Dr. Beattie's letter, I am able to reassure your readers. While admiring the hardihood of Dr. Beattie in condemning my Paper on "Harmonic Analysis"—which he has not seen—on the strength of the brief abstract report of it which has appeared in the Press, I may be permitted to traverse his hasty conclusions. The article of Mr. Fischer-Hinnen of 1909, to which he alludes, is quite well known to me—in fact, Mr. Fischer-Hinnen himself sent me a copy when it was published. It certainly uses selected ordinates; but so do the anterior methods of Strachey and of Baird. To admit this does not exclude the admission that there is novelty in the development due to Fischer-Hinnen, nor bar the possibility of the further development which there is in my yet unpublished Paper. The simple fact is that all these various methods are evolved from the fundamental integrals given 80 years ago by Fourier. Why should I deny the indisputable proposition that there is nothing new under the sun?—I am, &c.,

SILVANUS P. THOMPSON.

Technical College, Finsbury, E.C.
June 28.

THE TELEPHONE POSITION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The instant and earnest attention of telephone subscribers throughout the Kingdom is imperatively necessary if their interests are not to be utterly and irretrievably ruined.

The statements made by the Postmaster-General to a House, described by one authority as "thin" and by another as "attenuated," on the eve of a national event so absorbing as to prevent any attempt at serious debate, call for the closest examination and criticism.

The Postmaster-General said that there was no demand for Municipal control of telephones except from Glasgow. But it was only at the end of last February that a deputation representing some 300 responsible Councils and Chambers of Commerce pressed this very matter earnestly on his attention!

Mr. Samuel asserted that only six Municipalities established telephone systems, and of these only two survive. Candour—I am not charging Mr. Samuel personally with the lack of it—might have added a great deal to that bald statement. Municipalities are properly deliberate in entering new fields of enterprise, and in the case of the telephone this natural hesitation was increased by the extraordinary steps which were taken to intimidate them from moving, by exaggerating difficulties, detracting their advisers and prophesying disaster. This was done by never-ceasing articles and correspondence, mostly anonymous, in the Press, by circulars, by pamphlets, by books (two were actually published and circulated gratis), and by destructive evidence given at Local Government Board Inquiries. Those Local Authorities which did go in may there-

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fore justly be complimented on their courage. But by 1905 sufficient experience had been accumulated to show the falsity of the croakings, and that a cheap and efficient telephone service could be provided for something like half the customary rates. Wide spread interest was aroused by the published balance-sheets of the municipal undertakings, and it was evident that locally-owned telephones were on the eve of considerable extension, when the Post Office took steps to purchase the National Telephone Company's system, several years before any such movement was necessary seeing that the Company's licence had still six years to run. Having done this they refused to grant any more municipal licences, and several pending applications necessarily fell to the ground. It is interesting to note that the Select Committee on the purchase question went minutely into the merits and results of the municipal systems and embodied a recommendation that they should be continued in their Report. Succinctly, the Post Office did everything possible to impede municipal telephones, and when that policy was on the eve of failure through the success of the existing systems stopped further development by purchasing the National Telephone Company and refusing licences.

Mr. Samuel likewise told the House that of the six—he should have said seven—exchanges inaugurated by Local Authorities only two survive. Three is the proper number, however—Hull, Portsmouth and Guernsey. Of the other four, three—Brighton, Glasgow and Swansea—were killed by the set of circumstances created around them by the Post Office, circumstances which rendered it impossible for Brighton to continue the business, and which threatened the others with such a strong probability that they would be faced with heavy loss of capital on the expiry of their licences that prudence called a halt and forced a sale.

The Corporation of Brighton, which had established an efficient Exchange at less than half the rates previously in force in the town, were refused permission to expend any portion of their telephone loans in the adjoining borough of Hove, which for telephone purposes is quite inseparable from Brighton, although under both the Act of 1899 and their licence they were fully entitled to telephone Hove and had the consent of that Borough to do so. Competition with the Telephone Company was rendered impossible by this decision and the exchange had to be sold.

The Corporation of Glasgow, which, with the view of strengthening the Post Office in its deal with the National Telephone Company and for no other reason, had elected to take a licence for 13 years only, naturally assuming that it would be extended to the usual term, was refused a prolongation beyond 1913, not in so many words, it is true, but still to all intents and purposes refused. The consequence of this breach of faith and of certain advantages given by the Post Office to the Company in the Purchase Agreement, against which all the Corporations had vainly protested before the Agreement was signed, was that the Corporation was intimidated and, wrongly, I have always thought, parted with its undertaking. It was certainly impossible to repay its capital by 1913, the date to which its licence extended, and at the same time maintain the cheap rates for which it had been established, and the timid ones had their way.

Enquiries at Swansea would elicit the information that they were also forced out of the business by the Government. The Corporation there had established an efficient exchange which was paying its way on very low rates, but decided that it could not contend against the hostility shown it by the Government.

Three independent systems remain. Of these Guernsey has done so well under local control that it possesses the largest exchange in the Kingdom in proportion to population, London, Glasgow, Liverpool and the other great commercial centres not excepted. It gives an exclusive line to each subscriber, and makes the enterprise pay splendidly on an average receipt of £3. 6s. per telephone, out of which 10 per cent. is paid to the Post Office in name of royalty. For £5 the subscriber can call as often as he likes. The exchange is open day and night, while the Post Office telegraphs are hermetically sealed at 9 p.m. On the occasion of the death of his late Majesty the news reached the Island by military wireless, and was disseminated by the telephone exchange many hours before the Post Office opened the following morning.

The Corporation of Hull has successfully defied all efforts—and they have been many—to stop its telephonic enterprise, which continues to extend in spite of opposition, telephones in competition with it being supplied at 25s. per annum under Post Office permission. The municipal service, which has earned a world-wide reputation for efficiency, costs only £4 per annum on the average; £6. 6s. per annum for a business, and £5 for a private house, enables a subscriber to call as often as he likes. The exchanges are open day and night, and there is no charge for the junction wires to neighbouring towns.

The Corporation of Portsmouth is the third. It has also had to fight 25s. telephones, but has come through the ordeal well. It possesses an efficient system covering all the adjacent towns and villages, the use of the junction wires to which are included in the local subscription of £5. 17s. 6d. per annum which covers an unlimited number of calls. The smaller subscribers, like those at Guernsey and Hull, have the choice of several cheaper rates, and the system pays on an average revenue of £4 per annum. Like all the municipal exchanges the service is continuous day and night.

These three Local Authorities have not fainted by the way. They have performed a very great national service, although Parliament and the public are pleased to ignore the fact, in demonstrating that the proper capital cost of an efficient telephone system is £20 per telephone, and that an average receipt per telephone of £4 per annum is all that is required to make it pay.

Is it fair or in the public interest that they should be devoured and their efforts treated as of no account? Are their cheap rates to be discontinued? There is very great danger of it, for to the Post Office cheap telephones are anathema, and it is the Local Authorities which have proved that they are practicable.

There are no applications for new municipal licences simply because the Post Office have definitely announced that none will be granted. Who could doubt that after what has been effected the renewal of licences would be welcomed by the Local Authorities and largely taken advantage of?—I am, &c.,

Westminster, June 28. A. R. BENNETT.

[We regret that owing to pressure on our space it has been necessary to hold over some correspondence.—ED. *E.*]

SIXTEENTH ANNUAL CONVENTION OF THE INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

(*Concluded from page 461.*)

Brighton, Thursday, June 29th.

DISCUSSION ON PURCHASE OF FUEL—*Continued.*

Mr. SHAWFIELD, continuing, said: In the Midlands he fou it better to contract directly with a colliery, but in the No of England it was the practice to contract with agents. In deali with agents one had, perhaps, a larger range of collieries, and dealing with a colliery one was perhaps confined to one class of fuel, l in the latter case some control could be exercised over the quality. own Corporation made contracts annually, but for the last five or years they had purchased a definite quantity, 20 to 50 thousand tc according to the state of the market and the requirements of the stati When power contracts had to be considered that method was prefera Purchase on the basis of calorific value was an ideal method of p chasing, but in dealing with agents there might be insuperable d culties, although it was perhaps feasible when dealing with one or m collieries directly. It was, however, necessary to educate the colli owners up to this. He believed that Mr. Rider entered into a contr somewhat on that basis with satisfactory results, but in that case believed the contract was for the coal as delivered at Greenwich and as it left the colliery, which should be the basis for the coal ow Every central station should have a coal testing department, tests should also be made under the boilers. At Wolverhamp they had had such testing apparatus in use eight or nine years. The cost was about £10 or £12, and the annual expenditure in time

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material for taking daily tests was about £20 to £25. The result of installing the apparatus was an annual saving in fuel cost in the first two years of about £500 a year, simply owing to the improvement of the quality of the fuel. Testing laboratories might be established, and jointly controlled by the purchaser and the consumer. The payment for fuel should be based on its calorific value. He hoped to have that system in operation in the course of a few months. Another factor affecting the price of coal was wages. He had found it necessary to have a wages clause as follows :—

> The prices quoted in this contract are to be based on the present standard rate of wages as agreed upon between the colliery owners and the Miners' Federation in the federated area in England. This standard is hereby declared to be 50 per cent. above minimum. For every 2½ per cent. on the minimum variation from the present standard it is agreed that there shall be a corresponding increase or decrease upon the contract prices of the fuel. Such variation to be calculated as 2d. per ton for each 2½ per cent. variation in the rate of wages.

Colliery owners were thus protected against loss by increased wages. Legislation also had a considerable effect on price and quality of fuel. Immediately after the Eight Hours Act was passed about two years ago he noticed that in the South Staffordshire district there was an increase of 5 and 7 per cent. in the amount of incombustible contents in all fuel delivered, and he had serious trouble to get it rectified. The state of trade was impossible to foresee, but it was probable that would tend to increase the price of fuel during the next year or two. The price of low quality slack appeared to rise and fall in cycles of about four years, and he was led by his observation of this matter to think there might be a slight increase for the next three or four years.

Mr. F. Newington (Edinburgh) said that when he tested his fuel for moisture some two years ago the opposition of the merchants was very strong; they charged more for the drier fuel, and he did not think it was worth doing. Buying on a calorific basis would tend to increase the price of fuel artificially, and would, he thought, never come to pass. Coal would always fetch what it was worth. In Scotland they never dealt with collieries, but only through agents, who acted as a safeguard against strikes. No matter what result was obtained from calorimeters, the test of fuel under boilers was, after all, the real test. It might even be better to arrange a special boiler under which the tests could be regularly made.

Baillie Willock (Glasgow) said that the local conditions absolutely governed the question of coal supply and the choice of a suitable fuel. In Scotland they always sorted coal by machinery, and the class of fuel supply to electricity works was known locally as "pearls." Glasgow Corporation had adopted this class of fuel in 30,000 ton lots at 11d. per ton less than the single nuts which they had formerly used. It was better to deal with agents, because a coal-master always shut down his colliery in case of strike.

Mr. Ayton (Ipswich) said that the ideal method of purchasing fuel was on the heat units basis, but merchants would have to be educated up to it. He had made inquiries at the London Coal Exchange as to the opinion of masters and agents respectively of this method. The former were comparatively indifferent, while the latter who purchased at fixed prices would have to take all the risk of rejection, and covered themselves with increased prices. He hoped none the less that the large undertakings would continue the policy of educating coal suppliers in this direction. He instanced the L.C.C. Greenwich power station and that of the Underground Railways of London at Lot's-road, who both purchased fuel (about 150,000 tons a year) on a calorific basis. The specification of the L.C.C. occupied 11 printed pages, and that of the Underground Railways a half sheet of foolscap of 159 words. He thought that the Company's engineer was probably purchasing on a better basis with his extremely simple specification. As to the calorimeter tests which the L.C.C. chemist carried out, it seemed to him that the coal was half burned before the tests were completed. At the Underground Railway's station the engineers simply checked the coal for size and dust. Mr. Towle, resident engineer, Lot's-road, used the Berthier test, which took 20 minutes and cost 1½d. The test was as follows :—

> "Weigh out 1 gramme of finely powdered dry coal, mix with about 60 grammes of lead oxide (litharge free from silver), also mix, say, 15 to 20 grammes of glass powder (coarse). Put this in a Battersea clay crucible and cover with a layer (tablespoonful) of common salt, and heat in a forge fire or otherwise for about 20 minutes at a bright red. When cold, break crucible and extract the lead button from the bottom, clean off slag, then weigh and multiply its weight in grammes by 483. This will give the calorific value of the coal in B.Th.U. per pound. The constant 483 is worked out from the atomic weights and calorific values of the various constituents of the coal."

In the purchase of his fuel he dealt with agents, and obtained contracts for 12 months. He thought that the real test for fuel was after all that under the boiler, and the tests should not occupy a few hours, but should extend over several weeks.

Mr. Faraday Proctor (Bristol) pointed out that the scale of payment varying with the rate of wages (as specified by Mr. Shawfield) did not give the same variation for the coal owner as for Mr. Shawfield. The latter benefited more if wages went up, and the reverse if wages fell, and this might tend to a variation of wages. With regard to buying on a calorific basis, he found that Welsh coal owners would not quote in that way.

Mr. E. E. Hoadley (Maidstone) had tested numerous barges of coal by sending carefully taken samples to three testing laboratories. The results from these laboratories differed so much among themselves as to be worthless. In addition he made 24-hour tests under boilers, and found that coals having same calorific values within 1 or 2 per cent. gave very different results under the boiler. He now relied upon boiler tests, and bought on his general experience so obtained.

Mr. Christie said that at Brighton they used Scotch washed singles, which came in 700-ton barges, and was weighed and checked at the wharf. Calorific tests were also made, but they chiefly relied on the actual quantities burned under the boilers each day per unit generated. He recommended reinforced concrete bunkers, because they were free from rust and fire risk.

Mr. R. A. Chattock (Birmingham) was of the opinion that more heat was returned to the boiler from the clinker than was suggested by Mr. Shawfield. Personally, he preferred unwashed to washed coal, owing to the difficulty of drying the latter. He was also of opinion that it was better to deal with agents than with coal owners in getting coal for large towns. Indeed, he generally found that he was able to get no better prices from collieries direct, and as there were numerous agents competition was not lacking. With agents there was the advantage that one obtained a large range of collieries with which to deal. Coals of the same calorific value varied considerably from one another when tested under boilers. It was desirable to run tests continuously, both laboratory tests and boiler tests. At Birmingham they tested many varieties of coal besides the particular quality in use. In fact, one boat-load of new coal was tested every week and two boat-loads of the contract coal. They had a very complete testing department, and by this means they had reduced the average cost of coal from 8s. to 6s. 10d. per ton; the amount of ash had fallen from 21 to 14 per cent. and the cost of fuel per unit generated from 0·18d. to 0·14d., a decrease of 22 per cent. during a period of about three years. They now had very complete information about 130 different classes of coal in their neighbourhood, and therefore they knew pretty well what they were buying. By means of constant boiler trials they were now able to maintain an average thermal efficiency of 65 per cent. in the boiler house, including all losses, as compared with 80 per cent. obtainable on a full-load boiler test. The testing department cost about £400 per annum, including the salaries of the chemist and assistants, but the total cost of the coal burnt last year was £23,500, so that the cost of the testing department was only 1·7 per cent. of this sum. Their plan was fully justified by the saving effected. He did not think a testing laboratory could be jointly run by the colliery and consumer as it would lead to complications and would limit the market. In conclusion he, emphasised the extreme importance of testing both new coal and contract coal, but local conditions must always be taken into account.

Mr. H. H. Broughton, in a written communication, thought that the fact that electric supply undertakings could show a profit at all was highly creditable, when one remembered that of the total works costs the coal alone accounted for more than one-half, of which 90 per cent. was lost. The method used by the United States Geological Survey involved a determination of everything which affected heat value, and he advised engineers to refer to a Paper on "The Purchase of Coal under Specification," by Mr. J. E. Woodwell. Sampling by hand was unsatisfactory; for small coal it was better to use a sampling ram, and a 5 ft. length of 2½ in. steam tubing, with inwardly projecting studs at the lower end to retain the sample, answered the purpose very well. Large consumers would find it necessary to take into account not only heat value and percentage of ash, but also percentage of moisture, volatile matter and sulphur. Small consumers would be adequately protected by heat value and percentage of ash tests. He thought coal consumers would do well to secure the co-operation of a technical college provided with the necessary apparatus. Large consumers, however, would find it better to have their own laboratory. An alternative to laboratories at each supply station would be for several large stations to combine and equip laboratories at each of the large colliery centres.

Mr. Shawfield, in reply, was surprised that engineers were doubtful about methods of checking the quality of coal supplied to their stations, and wondered if they were as chary in checking the selection of turbo-machinery and plant. Baillie Willock was quite correct in stating that the matter was decided mostly by local conditions. Replying to Mr. Faraday Proctor re the wages clauses, he thought that the Coal Owners' Association, or whatever body fixed the rate of wages over the federated area, would hardly change the scale on his account. No one colliery owner could alter the wages on his own responsibility.

Discussion on Street and Shop Lighting.

Mr. A. Hugh Seabrook (St. Marylebone), in opening the discussion on "Street and Shop Front Lighting," said he proposed to leave the first part of the subject to Mr. Haydn Harrison. With regard to the competition of high-pressure gas in street lighting, in West Ham the Corporation had introduced an inclusive hiring scheme at £2. 1s. per quarter per lamp of 500 watts; the gas company had introduced a corresponding scheme which led to severe cutting of prices. The £2. 1s. was a remunerative price after the first two years when the cost of the lamps had been recouped. He recently went along the Barking-road, which took in the poorer districts of West and East Ham. East Ham also had an inclusive scheme, and their charges were less than those of West Ham. In the portion of Barking-road in West Ham not a single high-pressure gas lamp had been erected during the two years, since he left there, whereas he saw many in the East Ham portion. There was the same gas company in both districts, and he thought the reason West Ham kept its business, although their charge was higher than that of East Ham, was that it had an efficient business-getting department, and East Ham had not. Different districts, of course, had to fix their charges according to their conditions. In Marylebone they had to charge higher prices than in West Ham. With a 500-watt lamp at 3½d. per unit it was possible to supply a series

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of four arc lamps on the direct-current system, each of about 1,000 c.p., at a cost to the shopkeeper of 2d. per lamp per hour, or £30 for the four lamps per annum for 900 hours' burning. The gas people in London offered about 30s. a quarter for high-pressure gas, and sometimes as low as 25s. or 20s. for gas lamps of 1,000 c.p. The charge of 30s. is equivalent to £60 a year against £30 for arc lamps, excluding cost of wiring. Even after adding the cost of the wiring this still showed a slight advantage over the high-pressure gas. A useful lamp was a 4½-ampere flame lamp, which had just come out, and which enable them to cut their cost considerably because they could put in a flame arc lamp of greater candle-power than the gas lamp they had to compete with. This could be supplied at 1·35d. per hour, including current, trimming, supply of carbons and cleaning, or a total of £5 per lamp of 1,200 c.p. for 900 hours.

The detailed costs per lamp of the first mentioned were :—

	Per hour.
Maintenance and Current	1·4d.
Carbons, including wages, breakages, &c.	0·3d.
Trimming and cleaning	0·17d.
Establishment charges	0·13d.
Total	2·0d.

The detailed costs of the 4½-ampere arc lamp came out as follows :—

Maintenance and Current	0·79d.
Carbons	0·24d.
Trimming and cleaning	0·17d.
Establishment charges	0·15d.
Total	1·35d.

These figures made no allowance for current wasted in line resistances and this was not necessary with modern lamps. He believed Mr. Harrison had in his mind the joint arrangement between the gas company and the Metropolitan Electric Supply Co. for lighting Holborn, and that he intended to suggest that the electric light undertakers might keep up their shop and private lighting by some similar co-operation. He (Mr. Seabrook) was absolutely against anything of the sort. He preferred to keep his opponent where he could see him. The gas industry was better organised than the electric supply industry. From the commercial point of view, too, they were superior and the electrical industry was not in a position to play fast and loose and give them an inch in any way.

Mr. HAYDN T. HARRISON said the position of electric lighting in the street was becoming extremely interesting on the question of cost and it was getting even more interesting on the question of competition with gas. He had come to the conclusion that, provided the conditions were equal at the start, there was no doubt electric light in the streets would give equal light at a much lower cost than gas, but the conditions they had to face were different. In nearly every town in which an electrical undertaking had been started there was already a gas supply which had been carried out without any competition. They got their own prices for a large number of years and had paid off practically every penny of capital in connection with their street lighting. They had no interest and sinking fund to allot to any particular mains, or anything of that kind. The electric lighting undertakings had, in many cases, not been allowed to borrow money for street lighting or they had been allowed to borrow it at a high rate of interest on a very short period, and so they had been forced to borrow out of revenue. In a large number of towns where this had been done the cost of electric street fittings had been or was being repaid in a short period like five years, and yet the undertakings had been able to put in prices for equal lighting to compete with gas. At Marylebone, if the loans for street lighting had been borrowed under ordinary conditions, they would have been able to give 50 per cent. more illumination than they had given. Mr. Harrison then explained the circumstances of the substitution of gas for 70 arc lamps in Westminster, about which, he said, there had been some misapprehension. The 70 lamps formed only a small portion of the street lighting, and half the streets that had been lighted electrically were still so lighted. The gas company's price put in on that occasion was the lowest ever put in for public lighting in this country. The gas companies used this incident as an advertisement, and the electric lighting companies made up their minds not to allow this to occur again. In Holborn the gas company sent in a price; it was suggested that the electric lighting companies should be asked to tender, and they put in a price which was considerably below the gas company. Eventually the gas and electric companies were asked to tender again. The conditions were so onerous that the managers of the companies came together and decided that they would not accept them unless the Council paid 10 per cent. extra. The Council were now going to pay a sum which was remunerative to the electric lighting and gas companies, whereas in other districts, where competition had been allowed to get to a cut-throat condition, the gas and electric people had had to take on contracts in which a profit could not be made. Lighting was practically a monopoly. There need only to be two parties to it, but in a lot of places the competition was divided between six, seven or eight. He thought the gas and electric lighting companies ought to be able to make an arrangement to take on the work they were particularly suited for at prices which would be remunerative to the shareholders, or, in a municipal undertaking, to the ratepayers. He did not quite see why one should be so afraid of the gas managers. He thought a stand-off attitude was a sign of fear more than anything else. With regard to tungston lamps, the grouping of them was an important matter. The Institution of Electrical Engineers, the Surveyors' Institution, the Gas Association and the Illuminating Engineers had joined in a joint committee to formulate a standard specification for public lighting, and it would almost certainly be based on minimum illumination. If you had to provide a minimum illumination and were allowed to choose your own units you had to consider what units were most economical. Leaving out very large and important streets like certain streets in the City, where they had 0·8 candle-foot, he found that units between 100 and 500 c.p. were economical, both in capital expenditure and maintenance, and efficiency For the smallest streets where the minimum illumination was as low as 0·002 or 0·001, the tungsten lamp placed in about the same position as the existing lamp-posts gave the most economical result. The next unit above that would probably be between 200 and 300 c.p., and that you could obtain equally well by grouping the 100 watt lamps so as to get a high degree of reflection. These could go up to 600 or 700 c.p. With such groups they could obtain 1·5 c.p. per watt, which was an effective efficiency in the street. At the usual rates of 1½d. down to 1d. for public lighting, even with high-pressure gas, with all its incidental charges for mantles and maintenance, your prices would come out very nearly equal, excluding the question of capital charges.

Mr. S. J. WATSON (Bury) stated that he had experimented with groups of three metal filament lamps each of 300 c.p. and sometimes 200 c.p. He found that such groups of lamps placed 70 yds. apart gave an illumination equal to that of flame arc lamps. Metal lamps had, of course, many advantages, including absence of trimming, and his experience was that they did not suffer from vibration even when placed on tramway poles. He used a conical opal inverted shade and did not believe in enclosing the lamps more than necessary.

Mr. J. R. DICK remarked that street lighting by means of metal filament lamps was considerably hindered by the policy of the Local Government Board in not granting loans for street lighting fittings. In Brighton such fittings had been in use for 16 or 17 years and were still good for further work. It would be a great advantage if a time switch could be obtained for 20s. to 22s. There were many excellent time switches on the market, but they were too expensive. He also thought it was desirable to remember that although street fittings could be designed to give an exceedingly efficient distribution of light such fittings might be unsuitable if they offended the eye of the "man in the street."

Mr. A. C. CRAMB (Croydon) remarked that high-pressure gas was the most formidable rival for outside shop lighting. High-pressure mains were generally laid down the street, with branches carried up outside the shops, so that the whole thing was under the control of the gas company. In the case of a shopkeeper owning arc lamps, he had to maintain these, and found this troublesome, whereas by means of the terms given by the gas company the shopkeeper was relieved of any such trouble. If proper powers were obtained by which electricity supply authorities could take on the maintenance of lamps for outside shop lighting this would be retained, but not otherwise. Proper business organisation and hiring powers were all that were required. It would be possible, in fact, to get £1 for arc lamps above the price for gas with proper organisation. The gas companies merely desired to knock arc lamps out of this class of work, and therefore they did the business at rock-bottom prices.

Councillor CROWTHER (Sheffield) emphasised the importance of municipal authorities being able to undertake wiring work on equal terms with contractors.

Mr. A. J. CRIDGE (Electrical Co.) (communicated) noted that in Mr. Seabrook's opening remarks he had referred to the figure of 2d. per hour as a charge which could be made in respect of supply to arc lamps. He was not aware whether Mr. Seabrook charged by means of a time meter; if he did so, he would not have any trouble, but in Sheffield, where electricity for lighting was 4d. per unit, they had circulated a leaflet saying that the cost of running a flame arc would be 2d. per hour. They metered the energy used, and in the case under review there was an installation consisting of one arc lamp only. The consumer noted the hours of use, and refused to pay more than the equivalent of 2d. per hour for the supply. It was held by the Town Clerk that it was necessary to accept the sum offered, as the leaflet constituted a contract to which the Corporation was bound to adhere. Mr. Haydn Harrison had mentioned combination between the rival illuminating authorities, and Mr. Seabrook had shown them a glimpse of his inmost soul in opposing the suggestion. He (Mr. Cridge) thought they ought to take all straightforward methods of making money, and if reasonable combination was a means to this end, then let them reasonably combine. He wished to emphasise the usefulness of a business-getting department. The value of its missionary work was enormous. He had had charge of one which was evidently respected by Mr. Seabrook, since he had annexed several members of its staff. He would like to lay great stress on the necessity of taking publicity and business-getting seriously, and not playing at it. One frequently saw advertisements requiring men for a few months only—some spasmodic trial being in the air. How on earth could anybody expect to get hold of a good man unless they offered him continuity of employment as one of his prospects? In such circumstances undertakings would only secure a poor specimen, and in consequence would vote publicity no good. He had wondered, from reading the gas papers, whether there really was any distinct idea of business-getting in gas companies. The gas publicity committee was new, and he thought that if they had men in the gas industry who made the serious and well-sustained effort which some of the electric supply undertakings did, the gas people would go forward much more rapidly than they did. He advised electrical men to take in a gas paper and read it carefully week by week, as a means of bringing them to a wholesome state of humility.

Mr. SEABROOK replied very briefly to the discussion, and still maintained that an attitude of frank hostility to the gas competitors was best.

Several other communications were handed in, but we find it impossible to deal with these in the present issue.

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Members then adjourned for luncheon. Subsequently they inspected the plant at the Church-street sub-station of the Brighton Corporation Electricity Department and the locomotive shops of the L.B. & S.C. Railway, where an opportunity was afforded, by the courtesy of Mr. D. Earle Marsh, the locomotive superintendent, of inspecting the various shops of the Company, which are all electrically-driven by power supplied from the Corporation mains. A description of some of the interesting plant in these shops was given in our last issue.

The annual dinner was held at the Dome, and, owing to the large number of late applications, two rooms were necessary. Mr. John Christie, President, occupied the chair. This is the first occasion on which ladies have been present at this function, and the novelty had a satisfactory effect on the number attending. After the dinner an informal dance was held at the Grand Hotel, whose management was largely responsible for the success of this part of the programme.

"BEATARK" FITTINGS

The "Beatark" fitting, which we illustrate herewith, was originally designed to meet the wishes and with the assistance of Mr. S. Cameron Gibson for replacing the arc lamps at Nuneaton, and is essentially a fitting for meeting the present tendency of doing without a globe.

It consists primarily of a white enamelled metal reflector with a suitable metal cover. The reflector is designed to reflect the light over a wide area. Provision is made for the suspension of the lamp-holders above the reflector, either by springs or rigidly, so that only the lamp projects through the reflector in such a way that it is "locked" by the reflector, and glare is as far as possible prevented. The fitting is of such a shape that it can be easily adapted to fit on to existing arc lamp cases, where these are available, as was done at Bury. At Barrow it is suspended from the span wires over the roadway and a much more even distribution is thus obtained. A rubber sleeve is supplied to cover the joint between the lamp cap and holder, and in cases where corrosion is likely to take place the lamp caps may be painted or similarly protected and the lampholders copper plated.

GENERAL VIEW OF THE "BEATARK" FITTING.

Although this fitting was designed to eliminate the use of a globe, there are cases where this is considered necessary, and provision is now made for fitting one where desired.

The "Beatark" fitting is being used extensively, not only for street lighting, but for docks, yards, works, &c., both in this country and abroad, a large order having just been executed for India.

PARLIAMENTARY INTELLIGENCE.

PATELEY BRIDGE PROVISONAL ORDER.

On Tuesday a Select Committee of the House of Lords considered the Bill for the confirmation of the Pateley Bridge Provisional Electric Lighting Order. The West Riding of Yorkshire County Council opposed the order, which was granted to Messrs. Christy Bros. & Co., of Chelmsford, and empowered the promoters to lay down mains and works within a prescribed area. The County Council desired to put upon the company the obligation to take up, remove or alter their mains laid in the main roads of the County Council when any alteration, renovation or renewal in the road rendered that necessary.

Mr. VESEY KNOX (for the promoters) pointed out that those onerous obligations by local authorities had the effect of preventing the development in small areas of electrical enterprise, and precluded the people of those localities from having the advantage of electricity. There was no precedent for the insertion of the clause which the County Council desired to have inserted in the provisional order. The Council had ample protection under the general law.

Mr. J. D. FITZGERALD, K.C., for the County Council, said there were 30 cases in the West Riding where the power was granted in respect to gas and water companies, and there was no difference in principle in that case.

Mr. F. CHRISTY, managing director of Christy Bros. & Co., gave evidence, and stated that they hoped by the introduction of cheap electricity to supply power for use in the quarries of the district, and thus to help to revive that industry. If they had heavy additions to their expenses, such as the obligation which the County Council desired to impose, the thing would not be worth doing.

Other evidence was called, and the Committee decided that the Bill should proceed as it stood, and declined to make the amendments asked for by the Council.

TELEPHONE TRANSFER BILL.

In the House of Commons on Tuesday, on the report of the resolution relating to the transfer of the undertaking of the National Telephone Co.,

Mr. CLYNES expressed the hope that the telephone workers would be afforded the opportunity of approaching the authorities, should they so desire, on any important points in dispute between them.

Mr. GULLAND assured Mr. Clynes that the matter should be brought to the notice of the Postmaster-General.

The resolution was passed and the Bill was brought in and read the first time.

The text of the Telephone Transfer Bill was issued on Wednesday.

In a Memorandum accompanying the Bill it is stated that the provisions of the Bill are necessary in order to carry out agreements made with the National Telephone Co., and sanctioned by the House of Commons in 1905, for the transfer to the Post Office, on the close of the current year, of the company's telephone system, and also to provide money for the general extension of the telephone system. Part I. of the Bill provides for the mode in which the amount required for the purchase money payable on the transfer of the company's system, and for the general extension of the telephone system, is to be raised. A portion only of the purchase money is payable in cash, and the required amount of cash will be provided by the Treasury first, by applying for the purpose a sum amounting to about £1,600,000, which is payable to the Post Office by the company in respect of subscriptions received in advance by the company for telephone services; and as to the balance, by borrowing by means of terminable annuities, which must be repaid within 20 years at the latest. The amount of the purchase money which is not payable in cash is to be provided for by the Treasury by handing over securities to the company, the securities to be terminable annuities, calculated so as to repay the amount owing in 20 years at the latest, or, if the company agree, Exchequer bonds, which must be paid off within a similar period. Part II. of the Bill contains provisions as respects the pension rights, &c., of employés of the company who are taken into the service of the Crown. These provisions will be explained in a Parliamentary Paper which will be issued dealing generally with the position of these transferred employés.

RAILWAY LAW.

A useful Bill of 201 clauses, for the consolidation and amendment of the law relating to railway traffic has been introduced and read a first time in the House of Lords. Among the proposed amendments in the law is one to limit a railway company's liability for accidents to £2,500, £1,000 and £500 for a first, second and third class passenger respectively, half these sums being the limit in the case of persons carried at half fares, whilst £100 is to be the maximum for a child conveyed free. The Bill also provides that all by-laws, notices and conditions as to the acceptance and conveyance of traffic, &c., shall be legal and valid when sanctioned by the Board of Trade. The Board is also to be given an extension of its

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conciliatory powers, whilst the establishment by the railway companies of advisory committees to deal with local complaints is proposed. Maximum charges for passenger traffic are provided, and the existing law relating to "reasonable facilities," through rates, undue preference and rate increases is re-enacted and amended. In regard to arrangements for the working of traffic between two or more companies it is proposed to divide agreements into two classes, the sanction of the Board of Trade being sufficient in one class, whilst appeal to the Railway and Canal Commissioners or to Parliament is only to be necessary in cases of very great importance.

Greater London Railway Bill.—In the report of Sir J. Compton Rickett, Chairman of the Select Committee of the House of Commons which considered this Bill, it is pointed out that the length of the proposed railway is now reduced to 32½ miles. The Committee had gone through the Bill and had amended the title to a bill for incorporating the Greater London Railway Co. and to authorise them to make and maintain a railway from Northolt to the Victoria and Albert Docks and for other purposes.

LEGAL INTELLIGENCE.

National Telephone Co. v. Postmaster-General.

On Wednesday the Court of Appeal (the Master of the Rolls and Lords Justices Farwell and Kennedy) delivered their reserved judgment upon the cross appeals of the parties from the judgment of the Railway and Canal Commissioners in regard to the construction to be put upon certain clauses of the purchase agreement (under which the Postmaster-General takes over the company's system at Dec. 31 next) and as to the validity of notices to the company by the Postmaster-General that certain land, plant and buildings were unsuitable for the Post Office service. The company applied to the Commissioners for a declaration that the notices which referred to three exchanges in the Metropolitan area and 18 in other areas, were bad on the grounds of generality and vagueness. On behalf of the Postmaster-General it was contended that the phraseology of the agreement entitled him to reject land, plant and buildings and equipment as "unsuitable for the actual requirements of the telephonic service of the Post Office," in areas where already sufficient plant, &c. The Commissioners by a majority held that the notices in regard to the three exchanges in London were good, but the others were bad as being too vague.

The MASTER OF THE ROLLS in giving judgment said: This appeal depends upon the true construction of what is known as the purchase agreement of 1905. At the date of the agreement the Postmaster-General had granted licences to the National Telephone Co. which, or most of which, would expire at the end of 1911, and the company was carrying on a large and lucrative business. The Postmaster-General was also carrying on a large and increasing business of the same nature and in some places in direct competition with the company. They were rival exchanges. The policy of the Government was to get the whole telephone monopoly in the hands of the Post Office at the expiration of the licences and in the meantime to secure for the public certain advantages. Speaking in general terms, the effect of the agreement was that on, or as from, 31 Dec., 1911, the company was to cease to transact any telephonic business within the monopoly, and the P.M.-G. was to purchase, subject to certain exceptions, all the property of the company on or as at that same date. Now the Railway and Canal Commissioners were to settle any differences as to the exceptions and also the value as on Dec. 31, 1911, of everything purchased and not within the exceptions. The subject matter of the purchase is stated in clause 2. It comprised (1) all plant, land and buildings of the company brought into use with the sanction of the P.M.-G. and in use on Dec. 31, 1911, for the purposes of the licensed telephone business of the company; (2) any private wire business of the company with all plant, land and buildings in use by the company on Dec. 31, 1911, for the purposes of such business; (3) all stores and furniture in use on Dec. 31, 1911 and reasonably necessary for the purposes of the telephonic business of the company; and (4) spare plant reasonably necessary. Sub.-sec. 3 of clause 2 is important. "Plant, land and buildings shall be deemed to have been brought into use with the sanction of the P.M.-G., if such plant, land and buildings comply with one of the following conditions but not otherwise (that is to say): (*a*) if such plant, land or buildings are in use for the purposes of the company's business at the date hereof; or (*b*) in case of plant, if such plant is after the date of this agreement constructed by the company in accordance with the specification and rules set forth in the third schedule hereto; or (*c*) in the case of land and buildings, if such land and buildings are, after the date of this agreement, acquired or constructed with the consent in writing of the P.M.-G." Then there is a further provision which I need not *read* now. It will be observed that all plant, land and buildings in use at the date of the agreement of 1905 are to be purchased on Dec. 31, 1911. But plant subsequently acquired by the company is only to be purchased if it is constructed in accordance with a scheduled specification, and land and buildings subsequently acquired are only to be purchased if acquired or constructed with the consent in writing of the P.M.-G. Thus far there is no great difficulty, but it was part of the arrangements that the P.M.-G. should have the right to object to buy certain property which would otherwise fall within the terms of clause 2, provided he gave notice 12 months beforehand, and the Commissioners were six months beforehand to award where the objection were capable of being maintained. The Commissioners were also on or as on Dec. 31 to ascertain the value of the purchased property in case of difference. This part of the arrangement is found in a clause which it is necessary to read carefully. Clause 3, sub.-sec. 4, is as follows: "In the case of (*a*) plant not constructed in accordance with the specification and rules set forth in the third schedule and (*b*) plant of any kind, land and buildings, in use on Jan. 1, 1911, for the purposes of the company's licensed telephonic business in competitive areas." The P.M.-G. may, by notice in writing given to the company not later than Jan. 1, 1911, object to buy such plant, land or buildings as he considers will be unsuitable for the actual requirements of the telephonic service of the Post Office on Dec. 31, 1911. Now it will be observed that the right of objection to plant on the grounds of construction under (*a*) is without limit of locality, whereas the right to object to plant, land and buildings under (*b*) is limited to competitive exchange areas, a phrase defined in clause 1. I think it is plain that, although (*a*) is wide enough to include competitive as well as non-competitive areas, in practice it must be confined to non-competitive areas. It is also plain that the words "plant of any kind" in (*b*) comprises all plant mentioned in (*a*) including the scheduled list plant. The battle in this Court has raged around the word "unsuitable." I agree that the primary meaning of unsuitable apart from the context is unsuitable in nature or quality. But that word does not stand alone, nor is it, in my opinion, the most important word in the sentence. It is not the same thing as unsuitable for use in the telephonic service by reason of its character or nature. The word "actual" confines the gift of prophesy to what will happen on Dec. 31, 1911, and forbids speculation as to what may happen at a more remote date. In my opinion the meaning of the clause is reasonably clear. It deals with the case of a competitive exchange area where the Post Office has already or probably will have a service in full operation. If the Post Office has in that area adequate provision for the needs both of the company's subscribers in that area and of its own subscribers in that area the P.M.-G. is entitled to say 12 months beforehand "I shall not want this on Dec. 31; all the requirements of my service will be satisfied without this, it is not suitable for my requirements." The circumstance that (*b*) is not confined to plant but extends to land and buildings seems to me to strengthen the argument that the expression ought not to be narrowed so as to apply solely to nature or character. There are other indications in the agreement which confirm my view. I refer especially to sub-sec. (*b*) of clause 3. That sub-section deals with plant constructed during 1911 and with buildings constructed or acquired during 1911, and such plant must be in accordance with the specification or there would be no objection to purchase under sec. 2 and by it a right to object to three months after Dec. 31 is given. And the question for the Commissioners is to be "suitability of the plant for the actual requirements of the telephonic service of the Post Office on Dec. 31, 1911. It seems to me that these words cannot be limited to nature and character for, ex concessu, the plant is free from objection on that score. It is not easy to understand why (*b*) is limited to competitive exchange areas on any other view. In such cases there would obviously be a danger of duplication and superfluous plant and buildings—a danger which would not exist to the same extent in non-competitive exchange areas. I have not overlooked the fact that (*b*) does not apply to all places in which competition exists but is limited to 15 named competitive exchange areas. These were the most important areas and the parties were content to deal with them separately and apart from the rest of the country. With great respect to Mr. Justice A. T. Lawrence with whom Mr. Cathorne Hardy concurred I think he gave too narrow construction a to the words "unsuitable for the actual requirements of the telephonic service of the Post Office on Dec. 31, 1911." And I agree with the opinion of Sir Jas. Woodhouse on this point. The next question for our decision arises upon sub-sec. 2 of sec. 3. The scheme of the clause is that the P.M.-G. is to give notice in writing of his objection before 1911. If the notice is not acquiesced in by the company, the company must obtain an award from the Commissioners before June 30, 1911, that the property specified in the notice is suitable for the actual requirements of the telephonic service, otherwise the objection is to be deemed valid. Now as the notice of objection may be given in 1910, 13 months before the subject-matter of the purchase can be ascertained, it seems to me impossible to contend that the notice must specify every detail. It must be sufficient to indicate in general terms the nature of the property to which objection is taken. For example all plant falling under a particular description, attempting to give particulars of the place in which such plant will be found or the quantity of such plant, it will be for the company to apply to the Commissioners for an award that the objection is wholly bad or partially bad. Sir Algernon Cripps put forward as an example a cable containing several hundred wires some of which only are used for licensed telephonic business. The company may contend that such a cable is in use for the purposes of the private wire business and that the P.M.-G. is bound to purchase it because the wires cannot practically be severed. The Commissioners will decide one way or the other, for the cable will either be excluded from the purchase or not according to their decisions. Of course, I express no opinion on this point. The decision thus given will govern all similar cases. I think there will be no difficulty in applying the principle to the very numerous items in existence on Dec. 31, 1911. I feel no doubt that a general notice such as I have indicated is perfectly good. It is not made bad because it may include items which cannot be properly objected to. In my opinion all the notices are good in this sense, namely, that unless the company obtains an award in their favour, either wholly or in part, the property falling on Dec. 31, 1911, within the category objected to will be excluded from purchase. The opinion of the P.M.-G. expressed in the notice is prima facie decisive and the burden is thrown upon the company as challenging that opinion. It is obvious that questions of difficulty must arise. But I feel confident that the decision by the Commissioners

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of a comparatively small number of typical or test cases will dispose of these questions, and that, with few exceptions, the highly competent experts on both sides will agree details without appealing to the Commissioners in their character as valuers under clause 4 of the agreement after Dec. 31, 1911. With great respect to the learned Judge, I am unable to agree with his view as to the invalidity of the major part of the notices. His Lordship added that in his opinion the declaration contained in the order of May 29, 1911, should be discharged and the following order substituted: Declare that the words "unsuitable for the actual requirements of the telephonic service of the Post Office" in the purchase agreement do not relate solely to the nature or character of the plant, land or buildings. Declare that the fact that plant, land or buildings will not be actually required for the telephonic service of the Post Office on Dec. 31, 1911, owing to possession by the P.M.-G. on the said date of either plant or buildings adequate and suitable for the actual requirements of the telephonic service of the Post Office on that date is a valid ground for objection by the P.M.-G. within the meaning of the purchase agreement. Declare that the above declarations are applicable only to competitive exchange areas as defined in clause 1 of the purchase agreement. Declare that all the notices of objection given by the P.M.-G. were valid and sufficient.

The Lords Justices delivered judgments to the same effect and the appeal of the P.M.-G. was therefore allowed with costs and the cross-appeal of the company dismissed with costs.

W. Canning & Co. v. Northern Metallic Flexible Tube Co.

The hearing of this action was continued before the Official Referee (Mr. Muir Mackenzie) on Monday.

Mr. Geo. A. Darby, recalled, said there was a froth on the galvanising tank when he examined the plant at Bradford. Bubbles of gas were quite usual on the surface of an electrical apparatus of that kind. They were the result of the electrical action.

In cross-examination, Witness admitted that during the whole time the pickle vat was at work the iron bar in it and the bottom of the vat were being subjected to the action of the hydrochloric acid. With regard to the condition in which the steel tape left the swill boxes, he tested it by putting his fingers on the tape and then licking the former. Had there been any acid or alkali upon the tape he would certainly have tasted it.

Mr. Wm. E. Hughes was also recalled and gave further evidence in support of plaintiffs' case.

Mr. Waugh, K.C., opened the defence, and said that plaintiffs had not made a machine of that nature before but they had had every inducement to obtain the best results from the plant if it were capable of giving such results. Defendants agreed to purchase a plant which would do its work, and not an experimental machine. Plaintiffs' plant did not fulfil that expectation and he submitted that the evidence had already shown that the machine would not do its work efficiently. From the points of view of scientists and practical men the plant was an absolute failure.

Mr. Albert Crowther (trading under the name of defendant company) said that it was necessary to galvanise the steel strips used in that trade in order to prevent rust. He decided to do the galvanising on his own premises and approached plaintiffs with a view of having a galvanising plant installed. Plaintiffs inspected his premises and said that they could handle large enough, but they thought they might just fit the plant in. Certain alterations were made and plaintiffs expressed themselves satisfied with the size of the premises for the plant. A contract for £230 for a plant was submitted. The machinery was put down but he never succeeded in producing saleable strip from it. Plaintiffs tried to do so themselves but failed also and eventually took it away, after an arrangement that the dynamo installed should be retained but the rest of the plant removed. Plaintiffs asked £350 for the second plant, but defendant refused to pay that sum because he said the failure of the first plant had caused him considerable loss. Eventually, it was agreed that the price should be fixed at £260. After its erection the plant did not run properly and defendant suggested improvements. The strip from the pickling bath was too dark and it had other defects. Eventually, he wrote to plaintiffs stating that the plant would never be a success until the iron pickling vats were replaced by slate vats and other alterations made. Not obtaining satisfaction he refused to pay the balance of the contract price and the present action was commenced. During the four days Mr. Darby was testing the plant he produced about one reel of galvanised strip in short pieces. The full load of the plant was six reels and Mr. Darby started with this number, but they were constantly breaking owing to the bad running of the machine. Since he had had complaints about defective strip, owing to the inefficiency of the machine, he had lost orders, many of his customers having ceased to deal with him altogether.

In cross-examination, Witness admitted that he had only taken up the galvanising branch of his business during the last four years and did not profess to be thoroughly competent at it. He knew nothing about electric currents, &c., when the plant was installed. The machine was held out as being a very simple one to look after and one which anyone following the instructions given could have managed. He admitted that, although the passage of the strip through the hot sawdust bath failed to dry it as it should have done, he never complained to plaintiffs about it, nor did he complain that the gas burners under the sawdust bath were not efficient. He denied that he worked the machine with damp sawdust. The machine ran with a varying speed instead of an even drive with the result that at the time the strip passed through the sawdust so quickly that it was not properly dried. **The bad colour of the strip was not due to inefficient drying of the sawdust bath but to the fact that the sawdust was not properly cleansed from the strip. The swill boxes failed to act efficiently.**

Hartlepool Electric Tramways (Ltd.) v. Hartlepool Corporation.

On Wednesday last week Mr. Justice Bray delivered his reserved judgment in this case.

After reviewing the facts (which were given in The Electrician for June 16), his Lordship held that Messrs. Sellon and Ashby were the owners of the tramway undertaking and it was only they who could be required to sell to the Corporation. They had exercised the option of purchase although it was suggested that the Corporation were ignorant of the actual position. He was satisfied that they knew the position and that it was not until some time when they were before the Arbitrator that they raised the present contentions. In his Lordship's opinion the tramway material, plant, &c., belonged to the promoters (Messrs. Sellon and Ashby) and were being used by them for the purpose of the undertaking within the meaning of sec. 43 of their Act. The sale did not affect them because there was no approval by Board of Trade, and the undertaking remained in the promoters. The fact that the tramway was constructed by plaintiffs and not by the promoters did not affect the question, and the tramway never became the property of the Company. The latter might be under some obligation to transfer it to the Company but the Corporation would not be affected by that. He also thought that the tramway was being used by the promoters within the meaning of sec. 43 and that it was used by the Company as the servants or agents of the promoters. The real contention was that the Corporation were entitled to have the undertaking transferred to them, but they were to have all that for nothing. With that contention he could not agree. The Corporation were both entitled to purchase the undertaking on the terms mentioned in the agreed particulars of claim for £12,963. He gave plaintiffs leave to make any amendments which would entitle them to the relief he had mentioned. The order would be in the form of a declaration that the Corporation were entitled and bound to purchase the undertaking upon paying £12,963 to the promoters and that plaintiffs must undertake to execute any assignment or transfer, and that plaintiff Company should join in such transfer if required by the Corporation. Costs would follow the event.

Tube Railways and Land Tax.

On Monday the Court of Appeal (the Master of the Rolls and Lords Justices Farwell and Kennedy) commenced the hearing of the appeal in the case of the Central London Railway Co. v. Commissioners for Land Tax of the City of London from a decision of Mr. Justice Swinfen Eady, which raised the question as to plaintiffs' liability for land tax where the line lay under highways and the tax had been redeemed on lands abutting on those highways, and, further, where the line was under any land the surface of which had been exonerated from the tax by redemption.

In the Court below it was held that plaintiffs were not liable to pay land tax in respect of so much of the railway and works as was situated under any lands which had been exonerated from tax prior to the construction of the railway, but that they were liable to pay the tax in respect of so much of the railway and works as were situated under any lands not so exonerated, and that where the tax had been redeemed in respect of lands or houses abutting on the public street or highway the exoneration did not extend to the middle line of the street or highway.

At the conclusion of the arguments their Lordships reserved judgment

Tramway Rating.

Last week a Divisional Court (the Lord Chief Justice and Justices Darling and Bankes) heard an appeal of the Metropolitan Electric Tramways (Ltd.) as to the rating of their lines in Tottenham.

Mr. Danckwerts, K.C., appeared for the Company, and Mr. Ryde, K.C., for Tottenham Council.

Mr. Danckwerts said the question was whether or not a tramway was entitled to an exemption under sec. 211 of the Public Health Act, 1875, as being assessed at one-fourth only because it came within the definition of a railway. The magistrate before whom the question was raised, and who decided against the Company, held that he was bound by a decision of the High Court. The Court had also held that a tramway was entitled to that exemption, but as the later judgment had not over-ruled the decision on which the magistrate depended, a difficulty had arisen and there would be an appeal in any case, no matter what the decision of the Divisional Court was.

Mr. Ryde said that was true, and the Lord Chief Justice said that in those circumstances the Court would decide against Mr. Danckwerts, and dismissed the appeal.

STRIP LIGHTING AT HOVE.

In connection with the general scheme of illumination of the entire width of the Brighton & Hove front, we understand that the British Westinghouse Co. supplied the strip for the lighting of the Hove front to the Hove Corporation Electricity Department. This strip is of the company's standard manufacture, 7/22 twin cable insulated with pure and vulcanised india-rubber, taped and braided flat, and well compounded. B.C. holders with aluminium casings were employed, each holder being supplied with two small lugs for fixing purposes. This form of clip dispenses with the costly and cumbersome saddles frequently employed. The distance between the holders was 24 in., and Westinghouse carbon lamps were used in them. The whole of this material is of English manufacture throughout.

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COMMERCIAL AND INDUSTRIAL SECTION.

MUNICIPAL, FOREIGN & GENERAL NOTES.

BRITISH NOTES.

Aberdeen.—The proposed extension of the tramways to Footdee has been reported upon by the manager (Mr. R. S. Pilcher), but the Tramways Committee have postponed consideration of the matter until a report has been obtained on the rail-less trolley system at Leeds and Bradford.

The committee have decided to give free passes over the whole system to blind persons.

Aldershot.—An inquiry was held here on Wednesday by Mr. T. C. Ekin into the application of the Council for sanction to borrow £2,500 for additional plant, &c., for the electricity undertaking.

Bispham with Norbreck.—An inquiry was held last week into the Council's application for sanction to borrow £9,180 for electricity works.

Mr. R. H. S. Butterworth, who appeared for the Council, supplied the usual statistics of ratable value, &c.

The consulting engineer (Mr. J. W. Speight) supplied technical details of the scheme. In his opinion, the undertaking could be worked without becoming a charge on the rates, and its success was assured from the commencement.

Chester.—The borough electrical engineer (Mr. S. E. Britton) has prepared a scheme for utilising the water power of the Old Dee Mills in generating electrical energy.

The Lighting Committee recommended the Council to authorise them to engage an expert to report on the scheme, and in the event of such report being favourable to apply to the Local Government Board for sanction to borrow £5,000 towards the cost of executing the works, which it is proposed to meet as follows:—Appropriation from uninvested reserve fund, £5,000, loan £5,000, total £10,000.

The Improvement Committee were not, however, favourable to the scheme, but the Council passed the Lighting Committees's report on Wednesday with some slight amendment.

Coronation Telegrams.—847,000 additional words were telegraphed from London to the Provinces and foreign countries on Coronation Day, and 370,000 words on the following day, on the day of the Royal Progress. The average total for ordinary Thursdays and Fridays is 150,000 to 200,000. Between 50,000 and 60,000 words were despatched from Westminster Abbey by means of chutes and pneumatic tubes. This represents a much larger number of messages than has ever been handled before by the telegraph.

Coronation Traffic on Electric Railways.—The following numbers of passengers were carried on electric railways in London on June 22 and 23:—

Baker Street & Waterloo, 480,000; Charing Cross, Euston & Hampstead, 500,000; Gt. Northern, Piccadilly & Brompton, 520,000; Central London, 450,000; Metropolitan, 1,000,000; Metropolitan District, 1,400,000.

Dawlish.—The Dawlish Electric Light & Power Co. commenced the supply of electricity on the 20th inst. The plant includes a Crompton dynamo and Garrett steam engine and a storage battery. The contractors were Crompton & Co.

Ealing.—The L. G. Board have sanctioned loans of £7,000 for mains £6,000 for services, £5,000 for meters and £500 for transformers.

Electric Pumping of Sewage.—The L.G. Board have approved a scheme of main sewerage and sewage disposal for the parish of Owston and Skellow, in Doncaster rural district.

There are several miles of main sewers to be constructed with c.i. pipes, which will gravitate to an underground storage tank, from which the sewage will be electrically pumped to the disposal works, where it will be treated in open tanks, followed by filtration through percolating filters, before being discharged into the adjacent watercourse. The engineers for the work are Messrs. D. Balfour & Son, of London and Newcastle-on-Tyne.

Elland (Yorks.)—The Council offer to supply electricity in bulk to Greetland Council provided the latter agree to take a minimum quantity so as to cover interest and sinking fund on the capital expenditure involved.

Farnham.—The Public Works Committee have been authorised to obtain expert advice upon an offer of the Farnham Gas & Electricity Co. for the supply of electricity for pumping.

Fleetwood.—The Council have approved the following revised charges for electricity supply to private consumers:—

First 500 units 4½d. second 500 3½d. remainder 3d. per unit. For quarterly consumption above 2,000 units a flat rate of 3d. per unit; prepayment meters up to 5 amperes for lighting 5d. per unit, but no rental charged for meter; cinematograph machines 3½d. per unit if supplied off 200-volts circuit, but by motor generators off 400-volt circuit at power rate.

Hammersmith (London).—Mains are to be extended at a cost of £868 to supply current to Messrs. Clark's Lead Mills.

Herne Bay.—The Council have opened negotiations with the local gas Co. with a view to transferring their provisional electric lighting order to the company.

Industries in the Edinburgh District.—A public meeting was recently convened by the Lord Provost of Edinburgh, the Provost of Leith and the Convener of the County for the purpose of considering the steps to be taken to advance the interests of Edinburgh, Leith and Mid-Lothian as an industrial and commercial interest.

In the course of the discussion members emphasised the necessity for cheap land, cheap labour and cheap and good transit facilities in industrial development.

Ex-Bailie MACKENZIE (Edinburgh) said it seemed to him that the Corporation of Edinburgh should take the first step. They had a good deal of land in their hands for which they were getting little. If they offered cheap land with remission of taxation for a number of years, and offered cheap power, instead of taking from £40,000 to £50,000 of the surplus from the electric lighting undertaking and frittering it away in small reductions of a fraction of a penny on the rates, he thought they would achieve something. A charge of 1d. per unit was not cheap power. He would say that from March to October a cheap rate would be ½d. per unit. The Corporation had nearly £1,000,000 worth of plant standing there doing nothing, and it would be far better to encourage industries by offering electric power at ½d. per unit than by continuing the present rate (Applause).

Councillor CAMERON (Edinburgh) suggested that the city should endeavour to expand towards the sea. Granton was standing there a mud bank. There were Granton Docks—they could get them on a paying basis and develop the shipping west of the docks, and then they would have a commercial community again.

Ultimately it was remitted to Lord Provost Brown, to Provost Smith and to Col. Trotter to select a committee for inquiring into the question which had been raised, and to summon another general meeting.

Light Railway Orders.—During May 11 applications were lodged with the Light Railway Commissioners for light railway orders, but there were only three new schemes, the remainder being for extensions of time or amendment of powers. The new schemes were: Birmingham Corporation (Sharpe & Co., Agents); Great Northern Kirkstead and Little Steeping (G.N Rly. Co., R. Hill Dawe, Agent); Burry Port & Gwendreath Valley Railway (Seaton, Taylor & Co.)

Linlithgow.—The County Council have applied for sanction to a loan of £2,000 for additional generating plant to supply electricity in the Broxburn lighting district.

Llandudno.—The lighting of the promenade is to be improved by the erection of additional electric lamp columns—one between each of the present columns, each lantern to have four or five metallised filament lamps of 40 c.p. each.

L.C.C. Tramways.—The new electric tramway from Battersea Park-road, over Battersea Bridge to Beaufort-street, Chelsea, was opened for traffic on Coronation Day. The Council's cars now run over five of the Thames bridges.

National Electrical Manufacturers' Association.—The Council of this association have elected Mr. F. H. Nalder chairman in succession to Mr. H. W. Butler, who has for a time severed his connection with the electrical manufacturing industry.

A meeting of the Council will be held at the Institution of Electrical Engineers on July 5 at noon and a special general meeting on the same day at 3 p.m.

Olympia Electrical Exhibition.—Stepney (London) Electricity Committee report having considered a communication from the hon. sec. of the Associated Municipal and Electrical Engineers (Greater London) intimating that the Joint Publicity Committee have under consideration the question of providing an information bureau at the Olympia Electrical Exhibition, and that the London Electric Supply companies had made themselves responsible for a suitable stand, involving an expenditure of £1,000.

Of the cost of the exhibit the companies were contributing one-half, and it was considered that local authorities owning electricity undertakings should contribute the remaining £500, on the basis of the size of their undertakings by contributions varying from £10 to £30.

The Committee recommend the Council to contribute their share (£10) out of the funds of the electricity undertaking.

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Redditch.—Mr. W. A. Jackson of West Bromwich was recently called in to report upon the proposals of the resident engineer (Mr. W. J. Ferguson) to reorganise and extend the plant at the electricity works.

Mr. Jackson has now presented his report, which deals with the management of the present works as well as the proposed extension. Mr. Jackson considers the works are being managed in an efficient manner, and if allowance be made for the system adopted and the plant at the disposal of the engineer he considers the costs for the past year will withstand criticism. He could support with confidence the scheme of extensions submitted; it had been prepared in a sound, engineering manner, and he recommended its adoption by the Council. He considered that, with a complete year's working of the turbine plant and an increase in the power output at the average rate, the undertaking should become self-supporting.

School Lighting.—The Royal Victoria and Grosvenor Schools, Tunbridge Wells, are to be wired by the Council.

Shoreditch (London.)—On the recommendation of the Lighting Committee the Council have extended for two years from April 1, 1912, their agreement with the Great Northern & City Rly. Co. for the supply by the company to the Council of electricity in bulk, but the minimum payment in the second and third years is to be £600 and £800 respectively.

The Committee have received a report from the borough electrical engineer (Mr. C. Newton Russell) pointing out that the continued increase in the number of consumers necessitates a further supply of meters and indicators, and the necessary instruments are to be purchased at a cost of £260.

Walthamstow.—The L. G. Board have sanctioned a loan of £9,206 for additional electrical plant, and application is to be made for sanction to borrow £1,485 for a feeder cable.

West Ham.—Tenders are to be invited for water-tube boilers, coal-handling plant, turbo-alternator, river service pipework, &c., and also for buildings and converter for the Stratford sub-station.

With reference to the fixed price lighting scheme previously before the Electricity Committee, the electrical engineer (Mr. H. H. Couzens) has reported that the prospective customers were unable to further postpone the matter. While it would be desirable to keep the whole of the business in the hands of the Corporation, he did not anticipate that the Council could, at present at any rate, secure a loan from the L. G. Board on such terms as would enable them to put forward a scheme attractive to consumers and on sound business lines. The Committee decided not to entertain the idea of the supply of current through the intermediary company, but it should be referred to the Town Clerk and the electrical engineer to consider the desirability of including a clause in the next Bill to obtain powers.

Mr. Couzens has been authorised to negotiate for portion of a stand at the Olympia Electrical Exhibition at a cost not exceeding £30 and to purchase admission tickets up to an amount of £10 for distribution to existing and proposed customers.

Westminster.—The City Council have been taking energy from the Charing Cross, the St. James's and Pall Mall and the Metropolitan Cos. at 2¼d. per unit for light and 2d. for power, and as the Contracts Committee have been informed that the Council obtain energy for power from another company at 1d. per unit, inquiries were made of the three first-mentioned companies whether they would be prepared to make a reduction.

The Charing Cross and Metropolitan Cos. were unable to do so, but the St. James's Co. agreed to 1d. per unit for power, with a fixed charge of 7s. 6d. per rated horse-power per quarter. The contracts with two of the companies have been renewed for 12 months from June 24 on same terms as before, and with the St. James's Co. on the terms of the reduced charge.

Wood Green.—The electric light scheme prepared by Mr. G. W. Spencer Hawes and estimated to cost £21,000, has been again discussed by the Council.

The proposal was to obtain a bulk supply from the North Metropolitan Electrical Power Supply Co., the Council undertaking the distribution work. It was reported that circulars had been sent to occupiers of premises in streets in which it was proposed to lay distributing mains, but only 110 were in favour of taking current at present, in future 190; 88 doubtful, and against 337; 867 postcards were not returned. Ultimately, a resolution disapproving of the scheme was carried. It was stated that the Council had spent £1,200 in connection with electric lighting and that there ought to be some return. A suggestion was made that the Council should approach the Power Co. with the object of obtaining a quid pro quo, but nothing was done, as it was felt that it was a matter for the Committee.

Worcester.—An inquiry was held here last week into the Council's application for sanction to borrow £3,375 for the electricity undertaking.

The Chairman of the Electricity Committee (Councillor R. Clarke) said that at present the undertaking was working under a disadvantage, as they were supplying both alternating and continuous current. As a result of negotiations for a large amount of current for power, it was decided by the Committee to change over to the polyphase system. The cost of the necessary plant for supply of current and also the change over to the polyphase system would amount to £7,100, £3,375 of which they were asking for under a loan and the balance was to be raised by revenue, excepting the cost of the cable, which would be paid for out of the cable loan.

The city electrical engineer (Mr. C. M. Shaw) said the loan would enable the Council to supply power as well as light over the whole city. They could not supply power under the present alternating system because of the difficulty of starting the motors, and the very bad power factor which resulted from the single-phase system. During the past few years many applications had been received for power, but they had had to be refused owing to the fact that they could not extend the single phase for such a distance. Under the present system they could never expect to supply the outlying districts. From one firm alone they had an application for power to the extent of £700 per annum, but that, with innumerable smaller amounts, had to be refused, the total power refused during the past few years being over 400 H.P. At present both the alternating and continuous systems had to be run, and spare current had to be kept for each. By the polyphase system these would be combined, resulting in a net gain of 800 H.P.

There was an outstanding debt of £400 on some of the present machinery, and the inspector (Mr. T. C. Ekin) said that that would have to be deducted from any loan, and the Town Clerk, therefore, formally applied for an increase of £400 upon the loan.

In answer to the Inspector, Mr. Clarke said that the agreement with Messrs. Heenan & Froude had not yet been signed, but he hoped it would be during the next week.

Workhouse Lighting.—The Visiting Committee of Chester-le-Street Guardians have decided to obtain tenders (from local firms) for wiring the workhouse; electric current being supplied by the County of Durham Electrical Power Distribution Co.

Guildford Guardians have instructed Mr. Lankaster Burne to report upon the proposal to adopt electric lighting at the workhouse.

York.—The Tramways Committee recommend an extension of the tramways to South Bank at a cost of £17,000, and also to Heworth, a northern suburb, at a cost of £25,000 or £30,000.

Outing.—The Linolite Company's annual outing was held at Chertsey on Saturday. The party consisted of the works and office staffs. Mr. Ackermann (engineer and manager), Mr. R. L. Matthews (assistant manager), and Mrs. Ackermann were also present. Luncheon and tea were served at St. Anne's-hill by permission of Sir A. K. Rollit, and after tea the party drove back to London.

COLONIAL AND FOREIGN NOTES.

Argentina.—The first section of the electrified tramways of the Nacional Tramway Co., in La Plata, has been opened.

Sr. Jose Pedriali, manager of the Anglo-Argentine Tramways Co., states that the construction of the "tube" from Once to Plaza Mayo will be commenced on Sept. 15. The material has been ordered.

The Cia Alemana Transatlantica de Electricidad has acquired the electric cable undertaking of the Dolores Electric Light Co. for $340,000.

The first report of the Cia General de Electricidad de Cordoba (from March 9, 1909, to Dec. 31, 1910) states that the hydraulic power house of the Cia Argentina de Carburo de Calcio, including the dam of the Usina Molet, has been purchased for $600,000 (paper), half shares and half cash. This station has a capacity of 1,400 H.P., and with few modifications can be made to supply current to the city of Cordoba. Work has also been commenced on the equipment of a steam power house in Cordoba, the laying of mains, &c., and consumers are being connected. The capital is $1,500,000 (gold), of which $860,650 has been subscribed and $756,220 paid up, besides $270,000 7 per cent. bonds. The machinery was supplied by the Cia Industrial de Electricidad.

Australasia.—Eaglehawk (Victoria) Council have received tenders for the equipment of electricity works, and before deciding upon them councillors will visit Sunbury, Korumburra and Melbourne.

The Melbourne G.P.O. has been re-wired, and about 1,200 metal filament lamps have been installed in place of the arc lamps hitherto used in the mail room, under the superintendence of Mr. T. Hill, of the works branch of the Department of Home Affairs. The clock in the tower is now lighted by 112 16 c.p. metal filament lamps.

Tenterfield (N.S.W.) Council are about to appoint a Committee to consider the question of public lighting.

The Electric Energy Supply Co. (Brisbane) has applied for authority to supply electrical energy in Warwick (Queensland).

Cottesloe (W. Australia) Electric Lighting, Gas & Power Co. recently installed new plant at their power house, including a 150 H.P. Babcock & Wilcox boiler, a 120 H.P. steam engine and a 90 kw. dynamo giving current at 500 volts. The plant was installed by Messrs. Splatt, Wall & Co. (Perth).

Electric Railway across Pyrenees.—The new electric railway between Mont Louis (France) and Puigcerda (Spain), the highest point of which is 5,420 ft., was opened for traffic on Wednesday.

Exhibitions.—An international marine motor exhibition will be held at Copenhagen in July and August, 1912. The exhibits will include motor driven winches, &c. The Commissioner for Great Britain is Capt. A. Solling, 61, Heathland-road, Stoke Newington, London, N.

Applications for space at the international automobile exhibition

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to be held at Berlin from Oct. 12 to Oct. 22 next have to be sent to the Sekreträder Internationalen Automobil-Ausstellung, 16, Leipzigerplatz, Berlin, W.9, by to-day (June 30), but applications received later may be satisfied if space is available and possibly at an increased charge.

An International Municipal Congress and exhibition will be held at Chicago from Sept. 18 to 30 next. At the same time a Good Roads Congress will be held at Chicago.

The Government of Panama have voted £20,500 towards a fund for a universal exhibition at Panama to celebrate the opening of the Panama Canal.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Blackburn.—The accounts of the electricity department show capital expenditure of £279,484 on March 31, an increase of £5,090 during the past year.

The nett revenue from sale of current was £35,017, motor and lamp rental £1,607, and receipts from sale of lamps and fittings were £1,748, a total of £38,372, against £36,716. The total expenditure was £19,324, against £17,142, leaving a gross profit of £19,049, against £19,574. Interest required £6,765, income tax £403, instalments of loans and sinking fund £10,536, and depreciation £1,000, leaving £697 to be transferred to reserve, against £1,388. 4,836,276 units were generated, against 4,535,680, and 4,596,702 sold (2,367,281 to private consumers, 1,885,014 for traction and 344,407 for public lighting), against 4,308,005. There are 208 arc and 478 incandescent lamps for street lighting, against 209 arcs and 470 incandescents in 1910, and the maximum supply demanded was 3,200 kw., against 3,000 kw.

In the report of the borough electrical engineer (Mr. P. P. Wheelwright), it is stated that the results have been adversely affected by trade depression, and especially in the building trade, but the rate of connecting new consumers has been maintained. Although the number of units generated increased by over 100,000 the expenditure on fuel was nearly £100 less, but repairs and maintenance of plant and buildings showed an increase. The units sold for power showed an increase of nearly 34 per cent., and the effect of the metal filament lamp on the units sold for lighting had been exhausted. The motor hiring department increased the horse-power of motors connected by 120, bringing up the total brake-horse-power maintained by the department to 1,400, while the total brake-horse-power owned by consumers aggregate 1,600. The total connections for motors, heating and lighting are equivalent to 209,640 30-watt lamps, an increase of 7 per cent.

Bradford.—The accounts of the electricity supply department for the year ended March 31 last shows a net profit of £8,980, an increase of £1,580.

The income shows an increase of £4,117, of which £1,853 is for general supply, £858 for supply in bulk and £770 for tramway supply. The expenditure shows an increase of £2,537, of which £736 is for generation, £431 for distribution, £635 for rates and taxes and £401 for interest and sinking fund.

Colchester.—For the year ended March 31 the income of the tramways department was £10,269 (against £10,349), including £9,820 traffic revenue (against £9,873.)

The operating expenses were £8,046 (against £8,368), and the gross profit was £2,223 (against £1,980). Interest required £2,355 and repayment of loans £2,150, and after crediting amount from last year's account, the deficit was £2,170. The gross capital expenditure is £69,401. 1,738,172 passengers were carried and 431,789 car-miles run, against 1,725,948 passengers and 471,679 car-miles in 1909-10.

In a report by the general manager and engineer (Mr. R. C. Bullough) it is stated that the energy consumption per car-mile fell from 1·46 to 1·34 units, giving a saving of £250 in seven months.

Devonport.—The total revenue of the electricity department for the year ended March 31 was £18,035, including £16,418 from the sale of electricity for lighting, power and traction.

The expenses were £11,371, leaving a gross profit of £6,664 to meet dividends on and redemption of stock (£3,884) and interest and instalment of loans (£2,754), leaving a net profit of £26. The outstanding capital expenditure is £118,501. The total works costs were 1·344d. per unit sold (against 1·279d.), and the total costs (including capital charges) were 0·914d. (against 0·938d.). There are 531 consumers (439), and the equivalent of 41,610 (35,357) 8 c.p. lamps is connected. 2,222,470 units were generated; 530,214 units were sold for private and 36,512 for public lighting and 1,122,019 for traction, a total of 1,742,295 units sold against 1,651,614.

Dover.—The capital expended on the electricity undertaking at March 31 was £188,853, an increase of £1,659 over 1909–10.

The year's revenue was £22,574. Total expenditure was £9,131, leaving gross profit £13,443, to meet interest (£7,726) and sinking fund (£4,795) The net profit (£922) has been applied in reducing the outstanding deficit on net revenue account, which now stands at £4,624. Total works costs were 1·91d. per unit sold against 2·08d. 1,147,458 units were sold, including 596,992 to private consumers, 413,480 to the tramways department and 136,986 to the public lamps (65 arcs and 193 30-watt equivalent incandescent lamps). Total maximum supply demanded 416 kw. a.c. and 327 kw. d.c. Total connections equivalent to 54,826 30-watt lamps, an increase of 2,557 30-watt lamps.

Hull.—The City electrical engineer (Mr. H. Bell) has presented the seventeenth annual report of the electricity supply undertaking.

The gross revenue increased from £53,839 to £61,434. The working expenses were £28,687, leaving a gross profit of £32,746, an increase of £5,937. After capital charges, income tax, &c., had been met, the net balance carried to reserve was £8,223, bringing up the total unexpended balance in that fund to £10,838. The increased sales of current for lighting was approximately 6 per cent., and for power 27 per cent. The works costs were 0·69d. and the total working cost 0·88d. per unit sold. Very considerable extensions of plant and mains were about to be carried out, which, when the preliminary expenses in connection with the scheme had been met during the current year, Mr. Bell anticipates will produce more satisfactory results than have been obtained during the past year.

The City Accountant (Mr. W. H. Smith) has also presented the accounts of the undertaking, which showed that the income from sales of current amounted to £57,574, including lighting, £32,115. 16s. 9d.; power, £24,710. 5s.; and public lighting, £747. 15s. Sundry revenue brought the total to £61,434. 7s. 4d.

Lancaster.—The accounts of the electricity supply department for the year ended March last show capital expenditure £63,252 (no increase), of which £16,661 has been repaid or set aside for repayment.

Revenue was £9,133 and working and general expenses were £5,367, and, after providing £45 for allowances and bad debts, the gross profit was £3,721, to which has to be added bank interest £98. Capital charges were £3,331, and £400 has been placed to stock redemption fund (as a special contribution) and £88 to reserve. 774,530 units were sold (compared with 754,454 in previous year), revenue per unit was 2·62d.(2·79d.) and total cost 1·41d. (1·48d.) The total connections are 49,035 (equivalent) 8 c.p. lamps for lighting and 482 H.P. for power (exclusive of tramways).

The capital expenditure of the tramways department was £43,330 and £10,946 has been applied to reduction of debt, and £3,000 placed to reserve or renewals fund. Revenue was £5,445, working expenses were £5,376, interest required £1,337, and sinking fund £1,383, the year's deficit being £2,652 (against £2,897 in the previous year). 1,375,136 passengers were carried, 171,589 car-miles run and 248,611 units used. Total revenue per car-mile was 7·62d., working expenses were 5·06d. excluding, and 7·52d. including power.

Luton.—Capital expenditure of the electricity department for 1910–11 was £71,678, an increase of £5,389, over the preceding year.

Total revenue was £15,021. Working expenses were £6,942 and gross profit £8,079. Interest required £2,190, sinking fund, &c., £2,721, and after paying cost of new loans (£40) there was a net profit of £3,128. 2,782,631 units were generated (against 2,341,880) and 2,360,009 units sold (against 1,891,352) including 2,007,265 to private consumers (against 1,494,927). The equivalent of 38,709 8 c.p. lamps is connected (against 34,910), motors are equal to 2,338 H.P. (against 2,028 H.P.) and the heating connections are equal to 113 kw. (against nil). The total maximum supply demanded was 1,310 kw. (against 1,173 kw.)

Manchester.—The traffic revenue of the tramways department for the year ended March was £799,079 (against £777,219), other revenue amounted to £8,531 (£8,546) and the net revenue of the parcels department was £2,484 (£2,263), the total income being £810,094 (11,195d. per car-mile), against £788,029 (11,02d.).

The working expenses were £519,142 (against £511,070), the gross profit was £290,952 (£276,959), and after adding bank interest, &c. (£11,616 against £5,431) the available balance was £302,568 (against £282,390). After providing for interest (£55,227, against £53,500), rent of leased tramways (£24,597, against £25,753) and other charges, there was a net balance of £214,023, out of which £48,709 was contributed to sinking fund and loan instalments, £86,250 to reserve, renewals and depreciation fund, £4,064 to street improvement and £75,000 to relief of rates. The gross capital expended is £1,981,161 (against £1,957,594). The length of track operated at end of year was 182 miles 1,694 yds., an increase of nearly a mile; there were 600 cars, an increase of 18; the passengers carried were 165,800,077 (against 159,049,096), the car-mileage was 17,367,200 (against 17,161,774) and the number of units of energy used 29,063,006 (1·673 per car-mile) against 29,335,144 (1·709).

Stafford.—The income of the electricity department for the year ended March 31 was £4,920, including £4,596 from sale of current by meter and £180 from public lighting.

The expenses were £2,190, and after paying interest, sinking fund and income tax and providing £600 for depreciation there was a net profit of £152. The capital expended is £32,500. Of the 475,358 units sold, 8,225 were supplied to the public lamps, 152,818 were sold by contract and 314,315 supplied to private consumers. The total maximum supply demanded was 304 kw., and the equivalent of 26,904 8 c.p. lamps is connected.

Stalybridge, &c., Tramways and Electricity Board.—The accounts for the year ended March 31 show outstanding capital expenditure on the tramways of £237,582, and on the electricity dept of £209,978.

The revenue of the tramways was £36,785 (against £38,055), and the expenditure £27,229, (against £28,962), leaving a gross profit of £9,556, and after paying interest (£8,735) and providing for sinking fund (£6,759), there was a deficit of £5,938 (against £6,449). 9,718,195 passengers were carried (against 10,190,944) and 1,209,268 car-miles run (against 1,295,018)

The revenue of the electricity department was £32,067 (against £30,103), and the working expenses were £16,927 (against £16,757), leaving a gross profit of £15,140 (against £13,348). Interest required

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£8,510 (£7,867), and sinking fund £6,634 (£5,951), leaving a deficit of £5 (£469). 15,265,200 (13,959,778) units were generated; 11,388,087 (10,023,140) units were sold to private consumers, and 1,907,254 (2,055,012) supplied to the tramways department. The works costs were 0·243d. per unit sold (against 0·266d.), the total works costs were 0·306d. (against 0·333d.), and the total costs (including capital charges) were 0·579d. (against 0·607d.) The average revenue for the total supply was 0·576d. per unit (against 0·593d.), and for private supply 0·547d. (against 0·546d.)

Sunderland.—The annual report of the Tramways Department has been issued, and show total receipts for the year ended March 31, of £58,889. After paying expenses (including interest and sinking fund) there was a nett profit of £4,344, an increase of £756 over 1909-10. The passengers carried numbered 14,561,672.

Warrington.—The total income of the electricity supply department for the year ended March 31 was £19,386 (against £16,818), including £18,494 from sale of current (against £16,189).

The working expenses were £10,512, leaving a gross profit of £8,873, against £7,587. Interest came to £2,760 and sinking fund to £3,446, leaving a net profit of £2,668. The gross capital expended was £100,770, an increase of £2,500. The maximum load was 1,917 kw. (against 1,625 kw.) and the number (equivalent) of 8 c.p. lamps connected was 121,649 (against 106,143). 2,757,582 units were sold (excluding traction) against 2,243,822.

In the report of the borough electrical engineer and tramways manager (Mr. F. V. L. Mathias) it is stated that the undertaking continues to make good progress. The consumption of current increased by 18·53 per cent. There was an increase of 529,317 units in the power demand, but there was a drop of 15,557 units in the demand for lighting. The works costs were 0·481d. (against 0·489d.) and the total costs 0·656d. (against 0·644d.). 417 new consumers were connected to the mains during the year.

Wellington (N.Z.).—The revenue of the electric lighting department for the year to March last was £45,587 (increase £773). Working expenses show a net decrease £2,324, due to the economical working of the Parsons turbine. Capital charges were £17,632 (increase £979), and net profit, after provision for depreciation, was £4,346 (against £2,228).

Revenue from tramways and power supply was £142,788 (increase £3,327), and working expenses were £95,965 (increase £3,018). After meeting capital charges and placing £14,407 to depreciation, the net profit was £6,225 (against £6,123). Capital expenditure during the year was £7,791.

West Ham.—The total income of the tramways department for the year was £131,542, and the net profit £19,542, compared with £18,409 for 1910-11.

Zeehan (Tasmania).—The accounts of the municipal electricity undertaking for the year ended December, 1910, show revenue £3,808 (against £2,749 in 1909), expenditure £2,898 (£2,069). Interest at 4 per cent. and sinking fund at 1 per cent. absorbed £425 (£425), and net profit was £485 (£253). Average revenue per unit sold was 4·243d., and cost of generation 3·882d. The prices range from 9d. (maximum for lighting) to 2½d. (minimum for power).

TRADE NOTES AND NOTICES.

TENDERS INVITED

The Council of the Metropolitan Borough of POPLAR invite tenders for the supply, delivery and erection at their Glaucus-street electricity works of overhead coal bunker, coal conveyor and extension and modification to existing coal conveyor. Specification and form of tender from the borough electrical engineer (Mr. J. Horace Bowden). Tenders to the Town Clerk (Mr. Leonard Potts), Council Offices, High-street, Poplar, London, E., by 10 a.m., July 15. See also an advertisement.

STOKE NEWINGTON (London) Public Library's Committee invite tenders for the installation of wires and fittings for electric lighting and ventilating at the Public Library, Church-street, Stoke Newington. Copies of specification and forms of tender from the librarian and clerk (Mr. George Preece), Public Library, Stoke Newington, N., where tenders are to be delivered by July 10. See also an advertisement.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.) are prepared to receive tenders for the supply, delivery and erection at the site of their Cossipore station, Calcutta, of auxiliary plant, and pipework. Copies of specification, drawings, &c., from the Secretary of the company, Mr. Francis R. Reeves, Salisbury House, London Wall, London, E.C., to whom tenders by 10 a.m., July 24. Specification and drawings can be seen at, but not obtained from, the offices of Messrs. Kennedy & Jenkin, consulting engineers, 17, Victoria-street, London, S.W. See also an advertisement.

ALDERSHOT Urban District Council invite tenders for supply and erection at their electricity works of one 135 kw. Diesel direct-coupled set. Specifications and further particulars from the engineer, Mr. F. Garside, Electricity Works, Laburnum-road, Aldershot. Tenders to the Clerk to the Council, Mr. W. E. Foster, by noon July 4. See also an advertisement.

The Tramways and Electricity Committee of BELFAST Corporation invite tenders for the supply of a circulating water pump and a motor-driven air pump. Specifications and form of contract from the city electrical engineer, Mr. T. W. Bloxam. Tenders to the town clerk, Mr. R. Meyer, by 10 a.m. Monday, July 17. See also an advertisement.

Tenders are invited (up to Aug. 15) for the supply of (*a*) 80,000 insulators and (*b*) indiarubber covered wire to the Postmaster-General's Department in VICTORIA, and (up to Aug. 23) for the supply of letter box fronts to the Postmaster-General's Department in QUEENSLAND. Tender forms and specifications from the Commonwealth Office, 72, Victoria-street, London, S.W. See also advertisements.

Tenders are invited up to Aug. 9 for supply of four motor cars (petrol) complete and for the supply of letter box fronts to the Postmaster-General's Department in SOUTH AUSTRALIA. Tender forms and specifications from the Australian Commonwealth Offices, 72, Victoria-street, London, S.W. See an advertisement.

Tenders are invited (up to July 18) for the supply of 4 tons 6 cwt. bare hard-drawn copper cables, and (up to July 21) for the supply of 35,700 incandescent electric lamps to the City of MELBOURNE, Australia. Copies of specification, tender forms, &c., from the agents for the City Council (McIlwraith, McEacharn & Co. Ppty., Ltd.), Billiter-square-buildings, London, E.C. See also advertisements.

Tenders are also invited for supply of lead-covered and vulcanised rubber-covered cable to the City of MELBOURNE. Specifications, &c., from the agents for the City Council, Messrs. McIlwraith, McEacharn & Co. Proprietory (Ltd.), Billiter-square-buildings, London, E.C., to whom tenders by noon Friday, July 7.

ECCLES Corporation invite tenders for supply and erection of a high-efficiency type centrifugal pump, driven direct by s.ph. a.c. motor (approx. output 63,000 gallons per hour against 35 ft.). Tenders to Town Clerk by July 17.

Tenders are also invited for supply of 150 miles insulated wire and 5 miles of telegraph cable to the Postmaster-General's Department in Victoria. Tender forms and specifications from the Commonwealth Office, 72, Victoria-street, London, S.W.

The Great Southern & Western Railway Co., Kingsbridge Terminus, DUBLIN, require tenders by 10 a.m. July 5 for one year's supply of stores and materials, including electric light carbons, copper, iron, steel, oils, &c. Forms of tender from the Stores, Inchicore, Dublin.

SWINFORD (co. Mayo) Electric Lighting Committee invite tenders for the electric lighting of the town. Specifications from the Clerk to Swinford Rural Council, to whom tenders by 11 a.m. July 10. The requirements include suction gas plant, engines and dynamos, storage battery switchboard, overhead lines and street lamps.

CARDIFF Corporation require tenders by 10 a.m. July 14 for the supply of economisers and induced draught installation and supply and laying of cables. Forms of tender from Mr. A. Ellis, The Hayes, Cardiff.

The directors of the Great Southern & Western Rly. Co. (Kingsbridge, DUBLIN) require tenders for annual supply of stores, including arc lamp carbons, wire, tools, metals, &c. Tenders by 10 a.m. July 5.

HESTON and ISLEWORTH Education Committee require tenders by 10 a.m. July 5 for electric lighting of schools in district. Specifications from Mr. C. E. Ryecroft, Electricity Works, Hounslow.

LONDONDERRY Corporation require tenders by mid-day July 7 for wiring, fittings, lamps, switchboards, connections, &c., for the electric lighting of the new Guildhall.

ROTHERHAM Corporation want tenders by July 8 for 12 months' supply of single vulcanised bitumen covered cable and electricity meters. Particulars from the Borough Electrical Engineer.

GREENOCK Corporation want tenders by 10 a.m. June 30 for 12 months' supply of oil and engine room stores to the electricity department. Specifications from the Burgh Electrical Engineer.

REDDITCH Council invite tenders for supply of single-phase alternator direct coupled to Willans steam turbine, condensing plant and pipe work. Tenders to the Clerk by 5 p.m. July 10.

TUNBRIDGE WELLS Council invite tenders (until July 8) for year's supply h.t. and l.t. cables. Tenders to Town Clerk.

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LONDON County Council require tenders by 11 a.m. July 4 for four electric traversers for car-sheds. Specification, &c., from the Clerk.

The Deputy Postmaster-General, HOBART, will receive tenders until noon July 31 for supply of telegraph and telephone material. Specifications, &c., from 72, Victoria-street, London, S.W.

The Deputy Postmaster-General, BRISBANE, will receive tenders until noon Aug. 16 for supply of paper-insulated lead-covered cable, and silk and cotton insulated lead-covered telephone switchboard cable, covered wire, g.i. and steel standard wire, c.i. pipes, iron and steel poles, insulators and copper wire, and accessories. Specifications, &c., from 72, Victoria-street, London, S.W.

The time for the receipt of tenders by the Ministry of Public Works, Constantinople, for an electric power and tramway concession for JERUSALEM, is extended to Sept. 13. Specifications (in French) may be seen at 73, Basinghall-street, London, E.C.

The Metropolitan Water and Sewerage Board, Albert-street, BRISBANE, Queensland, want tenders by noon Jan. 30 next for supply and erection, of one, two or three complete units, each consisting of power generating plant and pump or pumps to lift not less than 6,000,000 gallons per day. Particulars from the Secretary.

Tenders are invited up to July 19 for the supply of insulators, telephones, copper and iron wire to the Postmaster-General's Department in QUEENSLAND, and up to July 25 for the supply of 12 sections of a branching multiple magneto lamp signalling switchboard, &c., or one automatic or semi-automatic switchboard, &c., to the Postmaster-General's Department, VICTORIA. **Tender forms, &c., from 72, Victoria-street, London, S.W.**

MORTLAKE (Victoria) Butter & Cheese Factory Co. require tenders by noon Aug. 14 for supply of dynamo and booster, storage batteries and accessories, switchboard, cables, &c. Specifications from Messrs. F. A. McCarty & Co., 31, Queen-street, Melbourne.

WELLINGTON (N.Z.) Corporation require tenders by 4 p.m. Aug. 24 for supply of a motor power waggon and accessories for the electric tramways department. Gonville and Castlecliff Tramway Board, Ridgway-street, WANGANUI (N.Z.) require tenders by 4 p.m. Aug. 14 for supply of overhead tramway material, feeders, &c. Conditions, &c., can be seen at 73, Basinghall-street, London, E.C. Representation in New Zealand is necessary.

Tenders will be received at the Royal Arsenals, SPEZIA and NAPLES until 11 a.m. July 11, for supply of incandescent electric lamps and brackets (total about £1,260). Conditions (in Italian) at 73, Basinghall-street, London, E.C. Local representation necessary.

The "Gaceta de Madrid" announces that tenders will be received up to noon July 4, at the Sección Colonial del Ministerio de Estado, MADRID, for the complete installation of a wireless telegraph station on the island of Fernando Po, for the purpose of carrying on telegraphic communications in the Gulf of Guinea. The cost is estimated at 62,150 pesetas (about £2,300) excluding excavation and foundation work. This call for tenders is reserved to Spanish firms, but should no award be made, a second adjudication will take place to which foreign firms will be admitted. In this latter event Spanish firms will be allowed a preferential margin not exceeding 10 per cent. over foreign estimates.

Tenders will be received at the Stadtbaudeputation Offices Breslau (Germany) on July 25 for supply of centrifugal pumps and electric motors.

TENDERS RECEIVED AND ACCEPTED.

Hammersmith (London) Electricity Committee have received the following tenders for supply and erection of high-pressure steam and feed-water pipes, exhaust steam feed-water heater and circulating pipes, steam valves and feed-water heaters :—

Aiton & Co. (*accepted*), £1,568; Edwin Danks & Co., £1,192; Foster Bros., £1,405; J. Spencer (Ltd.), £1,458; Babcock & Wilcox, £1,560; Stewarts & Lloyds, £1,625 and £1,685; E. Le Bas & Co., £1,635; J. Wilson & Co., £1,699. 10s.; Ashwell & Nesbit, £1,980; Wembley Heating Co., £2,160. Messrs. Aiton & Co. undertake delivery in eight weeks. The tender of the Alphonis Custodis Chimney Construction Co. (at £392. 15s.) for the erection of a chimney stack at the generating station extension has also been accepted. This stack is to be erected in lieu of a steel chimney included in the tender of the Sterling Boiler Co., accepted conditionally in January last.

Stepney (London) Council received the following tenders for the annual supply of carbons :—

W. Giepel & Co. ("Henrion" Carbons) (*accepted*) £810. 15s. 3d. and £720. 15s. 3d.; Electrocarbon (A. G.), £873. 3s. 6d.; C. W. Webster (Cia Fabrik de Carbones Electricos), £956. 7s.; Ship Carbons (Ltd.), £958. 18s. 7d.; Brush Co., £980. 5s. 11½d.; Electrical Co., £999. 12s. 3d.; Gilbert Arc Lamp Co., £1,030. 11s.2d.; Sloan Electrical Co., £1,066. 7s.2d.; General Electric Co., £1,110. 3s. 9d.; Globe Electric Co., £1,121. 4s.; Union Electric Co., £1,122. 17s. 3d.; Crompton & Co., £1,153. 6s. 9d.; Siemens Bros. Dynamo Works, £1,249. 15s.

Stepney (London) Council have accepted the following tenders for annual supplies :—

Reason Mfg. Co., meters (up to and including 10 amperes). £181. 5s.; demand indicators, £418. 5s.; time switches (up to and including 25 amperes), £275; British Thomson-Houston Co., meters above 10 amperes, £311. 11s.; Venner Time Switches (Ltd.), time switches above 25 amperes, £88; Kirk & Randall, erection of substation at Wapping, £4,435.

London County Council has accepted the tender of Dick, Kerr & Co. (at £2,093. 10s. 9d.) for the overhead electrical equipment of the Brixton-Herne Hill tramway, and the tender of H. L. Holloway (at £1,818) for the erection of workshops, store, &c., at Stockwell substation.

Cowans, Sheldon & Co. have received an order from the Imperial Japanese Navy for a 30-ton electric travelling crane for the Imperial Dockyard at Kure, Japan. The crane will deal with a load of 30 tons at a radius of 125 ft.

Southend Council have accepted the following tenders for meters :—Ferranti, Ltd., 3 amperes, £1. 16s. each; 5 amperes, £2; 10 amperes, £2. 5s.; Venner & Co., 100 5 ampere prepayment, £2. 5s. each.

Barking Electricity Committee have provisionally accepted the tender of A. E. Symes (at £2,497) for extensions to the electricit station buildings.

Worcester Council have accepted the tender of the Electric Construction Co. for a 200 kw. motor generator at £640, and that of the Phœnix Dynamo Co. for a 125 kw. alternator at £250.

Mansfield Council have placed an order with Bertram Thomas for switchgear at £116.

Fulham (London) Council have placed an order with A. Emanuel & Son for display fittings, radiators, &c., for the showrooms.

Mirfield Council have accepted the tender of Mather & Platt for electric pumping plant.

Radcliffe (Lancs.) Council have placed a contract with G. Longfield-Beasley for electric fire alarms at £410.

Southend Council have accepted the tender of How & Reed for wiring two ward blocks at the sanatorium at £45.

Government Contracts.—The following contracts were placed by British Government Departments during May :—

Admiralty.—Whipp & Bourne, circuit breakers, &c., Craigpark Elec. Cable Co., gutta percha; Edison & Swan Co., lampholders; D. Jaroslaw, mica; A. Graham & Co., navyphones.

War Office.—British Insulated and Helsby Cables, India Rubber Gutta Percha and Telegraph Works Co., Midland Electric Wire Co., Siemens Bros. & Co., Western Electric Co., Ward & Goldstone, and Hooper's Telegraph & India Rubber Works, electric cable; Crysdeo (Ltd.) and "Z" Electric Lamp Mfg. Co., incandescent electric lamps; Electric Construction Co., electric motors; J. Spencer, Ltd., telegraph poles.

India Office.—J. Stone & Co., dynamos.

Crown Agents for the Colonies.—Babcock & Wilcox, marine type boiler; Bullers Ltd., telegraph poles; Stewarts & Lloyds, boiler tubes; Shropshire Iron Co., copper wire.

Office of Works.—H. Hann, erection of new Wimbledon telephone exchange.

General Post Office.—British Insulated & Helsby Cables flexible cords, indicators, switchboards, p.c. cable, distribution cases and bronze wire; London Electric Wire Co., flexible cords, flameproof wire; British L. M. Ericsson Co., telephones, plugs; Western Electric Co., bell receivers, switchboards and apparatus for Mayfair exchange extension; Johnson & Phillips, p. c. cable; Siemens Bros. & Co., p.c. cable and submarine cables, distribution cases; Jones & Attwood, c.i. bends and couplings; Taylor, Tunnicliff & Co., insulators; Waterlow & Sons, Wheatstone paper; T. Bolton & Sons, and F. Smith & Co., bronze wire; J. C. Fuller & Son, flameproof wire; Rylands Bros., g.i. strand wire; Greig & Matthews and G. P. Trentham, laying pipes in Glasgow and Pontypridd, respectively; J. A. Ewart and W. H. Holman, laying pipes and earthenware ducts in South London and in Brighton, respectively; Peel-Conner Telephone Works, Local exchange equipment at Barry, Ilford, Nelson and Rotherham.

BUSINESS NOTICES.

Messrs. J. & H. Grevener notify that, owing to increase of business, they have decided to centralise their offices, works and warehouses at 40, Southwark-street, London, S.E., where all future communications should be addressed. The telegraphic address remains "Grevener London," telephone 7180 City (four lines).

The limited partnership between A. E. Woodhouse (Craven House, Kingsway, London, W.C.) and Edgar Jones (Mount Nessing, Albury, N.Z.), manufacturers and sellers of electrical appliances, trading as the Woodhouse Steel Casing Co., has been dissolved, and the business transferred to the Woodhouse Steel Casing Co. (Ltd.)

The partnership between C. A. Miller and L. Sandford-Thompson, electrical engineers, 54, Gordon-street, Glasgow, has been dissolved. Debts by Mr. Miller.

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Messrs. Marsh, Son & Co., have removed from 15, Gerrard-street, Soho, to 167 and 169, Wardour-street, Oxford-street, London, W.

Plant for Sale.—Mr. A. Underwood, 3, Queen-street, London, E.C., has for sale a 220 H.P. compound vertical Allen engine coupled to a 220-volt 750-ampere dynamo, a 58 H.P. motor-generator (440 volts to 110/125) and a switchboard.

Coronation Pressure at Siemens.—Messrs. Siemens Bros. Dynamo Works inform us that their move in keeping their supplies department at 39, Upper Thames-street, London, open all night on Wednesday last week was much appreciated by contractors, who kept the staff busy right through the small hours. It may be safely asserted that more than one of the large displays of illumination would have been incomplete if there had not been some electrical supply firm to turn to in the dead of night.

Handbook of Electrical Literature.—We have received from Schulze & Co. (Leipzig) their "Handbuch der Elektrotechnischen Literatur, 1900-1910," which contains classified lists of electrical works by Continental authors and a good selection of the principal translations from English books on electrotechnical subjects. The Handbook is published at 1s.

Patents Development.—The owner of patent No. 16,183/1908, for "Improvements in or relating to telephony and telegraphy," desires to negotiate for the granting of licences thereunder. Particulars from Messrs. Lloyd Wise & Co., chartered patent agents and consulting engineers, 46, Lincoln's Inn Fields, London, W.C.

The proprietors of patent No. 23,878 of 1900 for "Improvements in process of and mechanism for separation of conductors from non-conductors" desire to enter into arrangements for exploiting same in this country. Applications to Messrs. Haseltine, Lake & Co., patent agents and consulting engineers, 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

Herr Theodor Hummel, 61, Klingenthalstrasse, Basle, Switzerland, wishes to grant licences for a patent system for the control of lights on staircases of buildings, &c.

Electrical Fittings at the R. A. S. Show, Norwich.—Messrs. Siemens Bros. & Co. inform us that the stand at the Royal Agricultural Show now being held at Norwich of Messrs. Boulton & Paul, electrical contractors, Rose-lane Works, Norwich, has been wired with "Stannos" and is fitted throughout with Holophane reflectors and Tantalum lamps. The Norwich Show was visited on Wednesday by the King.

BANKRUPTCIES, LIQUIDATIONS, &c.

The estates of John Munro & Co., electrical engineers, &c., 45, Yorkplace, Edinburgh, and of the sole partner, John Munro, have been sequestrated. Meeting to elect trustee and commissioners on June 30 at 18, George-street, Edinburgh.

Wm. Hy. Steed, motor and electrical engineer, 40, Charter-road, and carrying on business at 13, Stamford-street, Kingsway, Altrincham, has obtained an absolute order of discharge.

A meeting will be held on July 26 at Messrs. Elles, Sclaman & Co., No. 2, Bucklersbury, London, E.C., to receive an account of the winding-up of the Electric Conversion Synd. (Ltd.)

Deed of Assignment.—A dividend is to be paid under a deed of assignment executed on March 11, 1901, by Bernard G. Jones (trading as Bernard G. Jones & Co.), electrical engineer, &c., Newport, Mon. Claims to Mr. John Tamplin, Westgate-chambers, Newport, Mon.

COMPANIES' MEETINGS AND REPORTS.

Indo-European Telegraph Co. (Ltd.)

An extraordinary general meeting was held on Wednesday, under the presidency of Mr. J. HERBERT TRITTON.

The SECRETARY (Mr. John I. Bethell) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, at the general meeting held on April 27 last the chairman of that meeting stated that the Articles of Association of the company, which were drawn up as far back as the year 1868, were no longer suitable to modern requirements, owing to the various alterations and additions to company law during the 40 years which have elapsed. He also informed you that the company's solicitors, who had often directed our attention to this matter, had recommended that the entire set of Articles should be re-drafted; that with this the directors had expressed their agreement, and that the work had been put in hand; also that the fresh Articles of Association would be presented to you for adoption at an extraordinary general meeting to be held at an early date. These fresh Articles are laid before you to-day for approval. They have been settled by an eminent counsel, and are approved by the board of directors. They have also been submitted to and approved by the Government directors of Germany and Russia. I will only add a few words to what was said on the last occasion as to the necessity for having new Articles, and our reasons for deciding that it is better not to attempt to revise the old ones. Provisions which were formerly inserted in Articles of Association, and which were then thought to be legal, are now, either by reason of alterations in the law or decisions of the Courts, ultra vires, and other provisions which were formerly inserted have been found to be superfluous. On the other hand, provisions which are found to be useful in the working of a company and are now usually inserted are not to be found in the old Articles. The old Articles are, in fact, now quite out of date. Taking all the above facts into consideration, the company's solicitors were of opinion, and counsel advised, that while the old Articles should undoubtedly be brought up to date, it was not practicable to alter them in a satisfactory manner, and that the proper way would be to prepare new Articles, embodying therein all that was not antiquated and useless in the old Articles, and inserting such new provisions as are now found to be generally useful.

The chairman proceeded to refer to the amendments and alterations which had been made in the Memorandum and Articles. This was followed by a resolution that the existing Articles should be cancelled and the new Articles as now submitted be approved.

The Right Hon. Sir FRANCIS MOWATT seconded the motion, which was carried unanimously without debate, and an intimation by the chairman that the confirmatory meeting is proposed to be held on July 17 terminated the proceedings.

Globe Telegraph & Trust Co. (Ltd.)

The 38th ordinary general meeting was held on Tuesday, under the presidency of the MARQUIS OF TWEEDDALE, K.T.

The SECRETARY (Mr. Sidney Collett) read the notice convening the meeting and the auditor's report.

The CHAIRMAN then said: The report we have to submit to you is the best we have ever presented to our shareholders during the 38 years of the Company's existence, and this follows last year's report which was an improvement on the one which preceded it. The dividends of the companies in which our investments are made are liable to fluctuations, and it is therefore impossible to foresee changes that may take place and which might affect the dividends we are enabled to distribute. The receipts for the 12 months to May 31 last, after deducting the usual working expenses, were £211,858, against £209,117 in the preceding year, an increase of £2,741. We have distributed three quarterly interim dividends of 2s. per share net to our shareholders and three interim dividends on the 6 per cent. preference shares, less tax. These distributions have absorbed £131,085 and the directors now recommend payment of a final dividend on the ordinary shares of 6s. per share net, making 6 per cent. net for the year against 5⅞ per cent. net last year. This, with the final 3s. on the preference shares, together absorbed £79,922, leaving £28,532 to be carried forward. This satisfactory result is largely due to the increased dividend we have received from the Telegraph Construction & Maintenance Co. During the year we have continued the policy of making a redistribution of some of the investments held by the Company, making the distribution of our capital more equal. In regard to the dividends we have received, that shown against the Mackay Companies common shares requires explanation. Some of the dividend relates to shares which have been sold so that although the return per cent. per annum is not quite so high as appears on the report, it is considerably better than in the preceding year, inasmuch as we have received this year a dividend of 5 per cent. against 4¼ per cent. Seven of the certificates held by this Company in the Submarine Cables Trust were drawn on May 4 at £120 per certificate. This drawing realised £840 and the money has also been invested in the common shares of the Mackay Company, while the coupons of reversion have been placed among the Company's securities and will some day be of considerable value. The valuation of our securities shows an increase over cost price of £494,130, or £124,000 better than this time last year. I now move the adoption of the report and accounts and the declaration of the dividend therein set out.

Sir JAMES PENDER, Bart., seconded the motion which, after a brief discussion, was carried unanimously.

The retiring director having been re-elected and the retiring auditors reappointed, a vote of thanks to the chairman and directors brought the proceedings to a close.

BOMBAY ELECTRIC SUPPLY & TRAMWAYS CO. (LTD.)—The report for 1910 states that the total revenue for the year (including sale of current to tramways) was £219,317, an increase of £21,489 (10·86 per cent.) over the previous year. Total expenditure was £122,139, increase £7,007 (6·09 per cent.). Net receipts (£97,177) show an increase of £14,482, or 17·5 per cent. Deducting £32,383 for debenture interest and other charges and adding amount brought forward (£4,567), the total available is £68,731. Preference dividend being paid, the balance was £32,748. The directors now recommend that £15,000 be placed to depreciation account and £6,000 to sinking fund for capital redemption, leaving £11,748 to be carried forward. Traffic receipts were £144,182, against £134,153. Working expenses in Bombay were £73,488, compared with £70,596. Balance of receipts over expenses was £73,222, compared with £65,918. Gross receipts for the year, including amount represented by sale of current to tramways, amounted to £66,921, compared with £57,552. Receipts exclusive of revenue represented by current supplied for tramways, were £37,043, against £31,493 for 1909. Working expenses were £43,897, against £40,934. The balance (£23,024) compares with a balance of £16,618 for 1909. The capital expenditure during the year, in connection with the construction of the new Kussara power station, on new mains

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and the development otherwise of the supply of electricity for lighting and power, and the further equipment and improvement of the tramways, amounted to £129,882.

CHADBURN'S (SHIP) TELEGRAPH CO. (LTD.)—For the year ended March 31 the profit was £18,843, and after deducting directors' fees, depreciation, &c. (£7,867) and adding balance from last year (£1,774.), the total was £12,750. The preference dividend and an interim dividend at the rate of 6 per cent. on the ordinary stock absorbed £5,400, leaving £7,349. 14s. 10d., out of which the directors propose to pay a dividend on the ordinary shares of 10 per cent. per annum (less tax) for the half-year ending March 31 (making 8 per cent. for the year) carrying forward £4,349. 14s. 10d.

At the meeting on Tuesday Mr. W. Chadburn said that they had had a satisfactory year and there was an increased profit compared with 1910. A good deal of the apparent increase, however, was simply due to the fact that they had invoiced more work than they had executed. The directors had decided to proceed with the proposed extensions, which should give a further capacity of 25 to 30 per cent.

CHILIAN ELECTRIC TRAMWAY & LIGHT CO. (LTD.)—The result of the past year's working, after deducting all charges, is a balance of £106,564. 6s. 1d., added to £8,988. 17s. 10d. brought forward, making £115,553. 3s. 11d. £60,000 has been placed to renewals reserve and £5,000 to insurance suspense account, leaving £50,553. 3s. 11d., preference dividend absorbs £39,000, leaving £11,553. 3s. 11d. to be carried forward. The tramways have carried 83,148,755 passengers, earning $7,308,957·95, against 75,670,443 passengers and $6,436,720·15 in 1909. Receipts for light and power during 1910 amounted to $4,070,272·84, and the total working expenditure was $2,438,005·53, leaving net profit $1,632,267·31, against $1,224,764·77. Additional rolling stock is on order. The demand for light and power by private consumers is steadily developing. A strike of the tramway staff in July, 1910, affected the traffic receipts, but an agreement was arrived at, and the full operating service was resumed. The workshops staff, however, continued their unreasonable demands, and it was found necessary to discharge the whole staff and engage new men.

GREENWOOD & BATLEY (LTD.)—The accounts for the year ended March 31 show, after providing for debenture interest, management expenses and doubtful debts, a profit of £20,197. 19s. 4d., added to £2,211. 12s. brought forward. The directors report that although some of the subsidiary and connected companies gave satisfactory results, they consider it advisable to depreciate and also to provide for a possible loss in connection with others, and they have, therefore, transferred £10,000 from reserve, together with £3,000 from the balance of £22,409. 11s. 4d., leaving £19,409. 11s. 4d. to credit of profit and loss, out of which the directors have written off £10,000 for depreciation, and they recommend that the 7 per cent. preference dividend be declared (£7,027. 17s. 3d.), leaving £2,381. 14s. 1d. to be carried forward.

MARCONI INTERNATIONAL MARINE COMMUNICATION CO. (LTD.)—The report for 1910 states that at the end of 1909 the company possessed and worked 143 telegraph stations on board ships on the high seas, and on Dec. 31., 1910, the number had increased to 250, and at the present date there are 303 such telegraph stations at work. The profit for the year, after allowing for debenture interest, was £10,765, leaving (with amount brought forward) £15,321. The directors recommend a dividend for the year at the rate of 5 per cent., absorbing £10,202, leaving £5,118 to be carried forward..

THAMES IRONWORKS, SHIPBUILDING & ENGINEERING CO. (LTD.)—The directors' report for 1910 states that the electrical department has been kept busy throughout the year in the manufacture of the "Thames" snap switch, which has been adopted by the Admiralty, and with other Admiralty orders for electrical fittings. An electrical installation for the Metropolitan Water Board at their Walton pumping station has also been completed. The work on the electrical installation of H.M.S. "Thunderer" has been much advanced.

J. G. WHITE & CO. (LTD.)—At the meeting yesterday (Thursday) the chairman (Mr. J. G. White) stated that the net profit for the year under review amounted to £91,466, against £64,801, and constituted not only by far the largest profit ever shown, but the greatest increase ever made over the preceding year. They considered the position of the business in hand as being quite satisfactory and the outlook as most encouraging. Mr. White proceeded to analyse the accounts. Their investments stood at £150,781, an increase of £28,000. The dividends on their securities, omitting one large item which could not be considered as a recurring amount, totalled £12,439, or more than sufficient to pay 6 per cent. on the company's entire preference and share capital. The company's financial department was becoming increasingly important, and it was likely to grow. Its growth had not interfered with the efficiency of the engineering and construction departments, which were better able than ever to undertake a wide range of engineering and construction work. Recent additions had been branches for designing and supervising hydro-electric and other water-power developments, water supply systems and sewage disposal plant. During the year the increased business in the operation of tramways and electric lighting had resulted in the formation of a separate department for the management of such concerns. The balance available for allocation amounted to £88,812, and in considering the distribution of that sum they had to bear in mind that the strong position of the company was due to a considerable extent to the building up of substantial reserves. During the 10½ years of the company's existence it would have paid in dividends £160,708, and had retained in the business £182,787, mainly contributed by the ordinary shareholders for the benefit of the company. The directors believed in continuing that policy of building up reserves, and, therefore, proposed that £15,000 should be allocated to writing off the balance of the purchase of business account, and that £15,000 should be placed to the credit of a new reserve for the equalisation of future dividends. They then felt justified in recommending a dividend of 7 per cent. for the half-year on both preferred and ordinary shares, making a total of 12 per cent. for the year, and that a further dividend of 10s. per share should be paid on the ordinary shares, leaving £19,812 to be carried forward.

NEW COMPANIES AND RECEIVERSHIPS.

NEW COMPANIES.

RECORD ELECTRICAL CO. (LTD.) (116,488.)—Reg. June 24, capital £20,000 in £1 shares (10,000 preference), to carry on the business of manufacturers of and dealers in electrical machinery and appliances, electric measuring instruments, meters, wires, cables, &c., and to adopt an agreement between C. W. Von Roemer, J. W. Record and T. J. Boorne. Private company. First directors are J. W. Record (man. dir.) and others to be appointed by the subscribers.

TITAN TRACKWORK CO. (LTD.) (116,457.)—Reg. June 20, capital £5,000 in £1 shares, to carry on the business of tramway and railway track manufacturers, layers and maintainers of permanent ways, points, crossings, switches and rails, &c. Private company. First directors: S. Osborn, J. P. and W. McKennel (appointed by Samuel Osborn & Co.), and E. Parry and L. W. Costa (appointed by Railway & General Engineering Co.).

RECEIVERSHIPS.

HILO MFG. CO. (LTD.)—Notice of appointment of H. Dobell, 3, Lombard-street, E.C., as receiver and manager, by order of Court dated June 13, 1911, has been filed.

CITY NOTES.

MEMORANDA (June 29).—**Bank rate 3 per cent.** (March 9, 1911.) **Price of silver, 24⅜d. per oz. Consols 79⅛—79⅜ for money and for account. Consols Pay Day, July 5; Stock and Shares Continuation Day, July 12; Ticket Day, July 13; Pay Days, June 30 and July 14; Mining Shares Carry Over Day, July 11.**

PRICES OF METALS (London).—*Copper*, **cash, 56⅞; three months 57½.** *Lead*, **13½ cash, 13⅝ three months.** *Spelter*, **24⅜—24¼.** *Tin*, **194¾ cash, 189½ three months.** *Iron*, **Cleveland, cash, 46/3, three months, 47.**

AMERICAN TELEPHONE & TELEGRAPH CO.—The directors of this company have authorised the issue of $50,000,000 of new stock for new construction work. A quarterly dividend of 2½ per cent. has been declared.

BAHIA TRAMWAYS, LIGHT & POWER CO.—The revenue for May was £13,333 (increase £2,625), and the aggregate from Jan. 1, £64,000 (increase £11,172).

COMPANIES STRUCK OFF THE REGISTER.—The following were struck off the Register of Joint Stock Companies on June 23:—

Eaton Telephone Disinfector Co., Electro-Brass Co., Garonne Valley Electric Supply Co.

EASTERN TELEGRAPH CO. (LTD.)—This company announce payment on July 15 next of dividend at the rate of 3½ per cent. per annum (less tax) on the preference stock for the quarter ending 30th inst., and a first quarterly interim dividend of 1¼ per cent. on the ordinary stock (tax free) in respect of profits for the year ending Dec. 31, 1911. The transfer books of the ordinary stock will be closed from July 7 to 14 inclusive.

EASTERN EXTENSION, AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.)—The directors have declared an interim dividend for the quarter ended March 31 of 2s. 6d. per share, tax free, payable 15th prox. The share register will be closed from July 7 to 14 inclusive.

NATIONAL ELECTRIC SUPPLY CO. (LTD.)—An interim dividend of 3s. per share (less tax) on the ordinary shares for the half-year to June 30 has been declared.

NATIONAL TELEPHONE CO., LTD.—Subject to final audit, the directors recommend the following dividends for the half-year to June 30:—At the rate of: 6 per cent. on both the preferred and deferred stocks, less tax, carrying £200,000 to reserve, and about £18,000 forward.

RIO DE JANEIRO TRAMWAYS, LIGHT & POWER CO.—A dividend of 1¼ per cent. is payable Aug. 1.

SHAWINIGAN WATER & POWER CO. (LTD.)—A dividend has been declared of 1½ per cent. on the common stock (equal 5 per cent. per annum) for the quarter ending 30th inst.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed July 5 a special settling-day in and granted a quotation to the provisional certificates for a further issue of 20,000 £10 shares, fully and partly (£4) paid, of the *City of Santos Improvements Co. (Ltd.)*, and £61,400 4½ per cent. debentures of £100 each of the *Christchurch Tramway Board*. The Committee have been asked to allow the further issue of £21,000 4½ per cent. first mortgage prior lien gold bonds of £100 each of the *Montreal Water & Power Co.*, and $500,000 additional common stock and $250,000 additional 5 per cent. consolidated first mortgage bonds for $1,000 each of the *Shawinigan Water & Power Co.* to be quoted.

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ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	June 21	1,513	+ 64	3	4,796	+ 260
Airdrie	„ 16	232	+ 7	24	5,163	− 7
Anglo-Argentine	„ 24	45,941	+ 2,591	25	1,233,593	+ 129,810
Ashton-under-Lyne	„ 24	391	− 10	13	5,481	+ 481
Ayr Corporation	„ 24	321	− 29	6	1,757	− 58
Barnsley	„ 16	166	− 7	24	4,285	+ 222
Barrow	„ 16	328	+ 25	24	6,211	+ 389
Bath Electric Trams, Ltd.	„ 21	826	− 89	25	19,397	+ 383
Birmingham Corporation	„ 17	6,865	+ 153	11	81,597	+ 5,569
Birmingham & Midland	„ 16	843	− 5	24	21,306	+ 1,610
Blackpool and Fleetwood	..	..	..	..	..	..
Blackburn Corporation	„ 22	1,056	− 114	†13	15,142	+ 1,360
Bolton Corporation	„ 25	2,790	+ 364	13	32,107	+ 2,685
Bombay	May 26	2,756	+ 212	21	60,214	+ 3,232
Bournemouth Corporation	June 21	1,594	− 106	12	20,604	+ 1,072
Bradford Corporation	„ 24	6,323	− 1,006	12	69,264	+ 6,300
Brighton Corporation	„ 25	1,156	+ 176	¶12	12,556	+ 1,145
Bristol Trams & Carriage	„ 23	6,940	+ 659	12	79,182	+ 8,296
Burnley Corporation	„ 24	1,414	+ 194	12	16,569	+ 1,730
Burton Corporation	„ 25	469	+ 202	12	3,561	+ 316
Bury Corporation	„ 25	1,266	+ 98	¶12	15,960	+ 1,215
Calcutta Tramways Co.	„ 24	R54,398	+ R2,976	25	R1,431,578	+ R50,156
Camborne-Redruth	„ 24	129	+ 10	25	2,995	+ 16
Cardiff Corporation	„ 17	2,427	+ 28	11	27,835	+ 2,817
Central London Railway	„ 24	7,995	+ 2,125	25	132,657	− 9,044
Chatham & Dist. Lt. Rys.	„ 22	951	− 2	25	20,190	+ 25
City & South London Rly.	„ 25	4,119	+ 1,041	25	84,085	+ 3,404
City of Birmingham	„ 16	2,958	+ 58	24	67,057	+ 2,175
Cork Electric Trams Co.	„ 22	502	− 28	25	11,868	+ 164
Devonport & Dist. Trams	„ 16	501	+ 69	24	10,928	+ 1,156
Dover Corporation	„ 17	234	+ 20	11	2,675	+ 411
Dublin & Lucan Railway	„ 23	169	+ 6	25	3,223	+ 12
Dublin United	„ 23	6,139	− 223	24	136,244	+ 4,371
Dudley-Stourbridge	„ 16	863	+ 84	24	19,320	+ 1,681
Dundee Corporation	„ 21	1,197	− 42	¶5	6,407	− 89
…t Ham Council	„ 24	1,211	+ 37	12	13,491	+ 853
…ter Corporation	„ 23	431	+ 88	12	4,194	+ 348
…head & Dist. Trams	„ 16	1,005	− 22	24	24,162	+ 1,344
…gow Corporation	„ 24	20,200	+ 1,351	§3	70,560	+ 5,871
…sop Trams	„ 24	151	+ 31	25	3,005	+ 193
…cester Corpn.	..	..	..	..	..	..
…vesend-Northfleet	„ 16	206	− 8	24	4,706	+ 67
…at Northern & City Rly.	„ 24	1,589	+ 241	25	38,398	+ 1,729
…nock & Port Glasgow	„ 16	815	+ 46	24	16,125	+ 2,162
…fax Corporation	„ 20	1,914	− 129	†12	23,552	+ 2,302
…tlepool Tramways	„ 16	274	− 5	24	5,705	+ 446
…tings Elec. Trams Co.	„ 22	1,058	− 27	..	..	..
…ng Kong	„ 24	$12,595	+ $1,599	25	$232,416	− $531
…dersfield Corpn.	„ 24	2,0[illegible]8	+ 227	12	23,765	+ 2,717
…ll Corporation	„ 24	3,454	+ 668	12	35,018	+ 2,149
…rd District Council	„ 24	645	+ 76	12	7,006	+ 452
…on District Council	..	..	..	..	..	..
…tch Corporation	„ 24	505	+ 51	12	5,400	+ 577
…of Thanet Co.	„ 24	1,049	+ 40	38	14,980	+ 857
…w	„ 16	128	− 6	24	3,031	+ 280
…ley Corporation	..	..	..	..	..	..
…minster & District	„ 16	112	− 12	24	2,439	+ 162
…ock Corporation	„ 24	173	+ 21	6	929	+ 37
…dy Corporation	..	..	..	..	..	..
…shire Trams Co.	„ 22	1,473	+ 2	25	34,482	+ 351
…shire United	„ 21	1,283	− 169	25	32,430	+ 736
…gton	„ 16	166	− 8	24	3,600	− 14
…Corporation	„ 24	7,834	+ 514	12	92,783	+ 7,480
…er Corporation	„ 24	3,251	+ 737	12	31,751	+ 3,313
…Corporation	„ 24	711	+ 66	‡6	3,923	+ 242
…Corporation	„ 24	173	+ 45	12	1,656	+ 163
…pool Corporation	„ 17	11,584	+ 101	24	269,618	+ 9,992
…pool Overhead Rly.	„ 25	1,385	− 136	25	35,691	+ 1,924
…&ColwynBayRy.	„ 23	231	+ 13	§29	5,465	+ 258
…County Council	„ 14	44,139	+ 850	†11	479,409	+ 28,162
…Elec. Ry. Co.	„ 24	22,450	+ 9,855	25	357,395	+ 26,660
…United	„ 24	8,786	+ 1,486	25	157,562	+ 4,750
…Corporation	„ 26	268	+ 74	38	6,141	+ 380
…e Corporation	..	..	..	..	..	..
…ter Corporation	„ 24	16,467	+ 330	13	199,854	+ 12,927
…Railway	„ 24	2,099	+ 33	25	51,723	+ 1,120
…r	„ 16	208	− 11	24	4,810	+ 116
…itan Dist. Railway	„ 24	17,834	+ 6,440	25	299,531	+ 24,904
…itan Elec. Trams	„ 16	8,930	+ 543	24	200,534	+ 29,449
…e	„ 16	497	− 116	24	7,776	+ 612
…Corporation	„ 24	187	+ 33	§12	2,264	+ 485
…-on-Tyne Corp.	„ 24	7,160	+ 455	12	53,712	+ 3,915
…t (Mon.)	„ 21	850	+ 157	12	9,063	+ 706
…ton Corporation	„ 23	747	+ 219	12	6,772	+ 793
…Ashton & Hyde	„ 16	637	+ 51	24	13,361	+ 488
…Corporation	„ 25	2,046	+ 223	13	26,302	+ 1,485
…(N.B.) Corporation	„ 21	182	+ 8	5	985	+ 64
…(W.A.) Elec. Trams	„ 23	1,635	+ 175	25	40,706	+ 2,127
…ge	„ 16	116	− 1	24	2,673	+ 169
…a Corporation	„ 24	3,502	+ 1,084	12	27,281	+ 2,798
…	„ 16	1,832	+ 95	24	45,771	+ 4,595
…Corporation	„ 21	763	+ 22	12	9,465	+ 754
…am Corporation	„ 22	687	+ 31	12	8,161	+ 809
…y	„ 16	297	− 61	24	2,512	− 70
…Corporation	„ 25	4,945	+ 207	§12	61,774	+ 3,725
…	„ 16	54	+ 2	24	1,099	+ 44
…d Corporation	„ 25	6,556	+ 526	13	84,745	+ 5,787
…re Trams	„ 24	$13,250	+ $3,768	25	$262,334	+ $16,192
…Metropolitan	„ 16	885	− 25	24	19,212	+ 475
…	„ 16	844	− 7	24	21,174	+ 1,683
…pton	„ 21	1,315	+ 167	12	14,034	+ 1,273
…nd Corporation	„ 21	664	− 3	12	7,314	+ 1,105
…rt Tramways	„ 16	373	+ 46	24	6,599	+ 212
…ge, Hyde &c., Jt. Bd.	„ 21	750	− 21	12	9,947	+ 1,123
…nd Corporation	„ 25	1,699	+ 449	12	15,940	+ 1,879
…nd District	„ 21	425	− 27	34	15,261	+ 1,182
…Trams	„ 16	1,100	+ 4	24	26,075	+ 1,758
…Corporation	„ 21	165	+ 10	12	1,837	+ 196
…	„ 16	41	+ 2	24	956	+ 4
…th and District	„ 16	268	− 75	24	4,749	+ 283
…e Trams Co.	„ 21	1,337	− 137	25	11,827	+ 793
…y Corporation	„ 24	1,230	+ 246	12	13,781	+ 2,520
…Corporation	„ 24	643	+ 122	25	13,837	+ 625
…ton Corporation	„ 22	463	+ 63	12	4,811	+ 275
…m Corporation	„ 15	2,660	+ 90	11	30,357	+ 3,430
…uper-Mare	„ 16	197	+ 16	24	1,904	+ 135
…mpton Co.	„ 16	399	− 24	24	10,453	+ 638
…mpton Corpn.	„ 21	959	+ 33	12	12,033	+ 1,252
…r	„ 16	300	+ 5	24	6,461	+ 266
…	„ 16	99	− 3	24	2,307	+ 47
…W.R. Trams	„ 25	1,314	+ 133	26	33,063	+ 1,190
…Woollen District	„ 16	974	− 43	24	24,537	+ 1,685

(a) The comparisons are with the corresponding period last year. * Partly electrical.
† Minus 1 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Shares	Last Dividend	NAME.	Price Tues., June 27.	*Rate per cent. Yielded. £ s. d.	Dividend Due.	Business Week to June 27. Highest.	Lowest.
		Electricity Supply.					
10	6/0	Bournemouth & Poole Elec. Sup. Ord.	8—9	6 9 6	Mar, Sep	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref.	9—10	4 14 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Second Pref.	10¼—10¾	5 6 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	102—104	4 6 6	Jan, July	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	8—8½	6 1 0	March....	..	..
5	3/6	Do. 7 per Cent. Pref.	7½—8	4 1 3	Mar, Sept	7½	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Deb. Stock	98—101	4 0 6	June, Dec	99½	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	3¾—4¼	5 2 6	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	4½—5	4 17 0	Feb., Aug	4½	4½
St.	4%	†Do. 4 per Cent. Deb. Stock (red.)	94—96	4 4 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101½—103½	4 7 0	..	..	..
5	2/3	Do. City Undertaking 4½% Cum. Pref.	3¾—4¼	5 3 0	Jan, July	..	..
5	3/0	Chelsea Electric Supply Ord.	4—4¼	5 11 0	March ..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	100—102	4 8 6	June, Dec	..	..
10	8/0	City of London Electric Lighting Ord.	11¾—12¼	4 15 0	Feb, Aug	11⅞	..
10	6/0	Do. 6 per Cent. Cum. Pref.	12—13	4 12 3	Jan, July	12⅛	12¼
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	121—125	4 1 0	June, Dec	..	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	101—104	4 6 6	Jan, July	..	..
St.	5%	County of Durham Elec. P. D. 5% 1st Mort. Deb. Stk.	92—94	5 5 3	Jan, July	..	..
10	6/0	County of London Elec. Supply Ord.	7¾—8¼	6 3 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11—11½	5 5 0	Mar, Sept	11⅛	..
St.	4½%	Do. 4½ per Cent. Deb Stock (red.)	109—111	4 2 0	Jan, July	111	110¼
St.	4½%	Do. Second Deb. Stock	99—102	4 8 0	May, Nov	..	..
5	4/0	Folkestone Electricity Supply Co. Ord.	4¼—4¾	5 19 0	April, Oct	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4½—5¼	4 15 3	Mar, Sept	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red)	97—100	4 10 0	Feb, Aug	..	..
5	5/0	Hove Electric Lighting Ord.	6¾—7¼	6 4 0	April, Oct	..	..
St.	4½%	Isle of Wight E. L. & P. Co. Deb. Stk.	88—91	4 19 0	..	..	..
5	5/0	Kensington & Knightsbridge Ord.	7—7½	5 16 0	Feb, Aug	..	..
5	6%	Do. 6 per Cent. 1st Pref.	5¼—6	5 0 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	93—95	4 4 0	..	..	..
St.	4%	Kensington & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	96—99	4 1 0	April, Oct	..	..
St.	4½%	Kent Elec. Power Co. Irred Deb. Stk.	80—84	5 7 0	Jan, July	..	..
3	1/2½	London Electric Supply Ord.	1¾—2¼	2 17 0	Mar, Sept	..	..
5	3/0	Do. 6 per Cent. Pref.	4¾—5¼	5 17 0	Mar, Sept	..	..
St.	4%	†Do. 4 per Cent. 1st Mort. Deb	89—92	4 8 0	Jan, July	..	..
5	3/0	Metropolitan Electric Sup. Ord.	3¾—4¼	6 17 6	April, Oct	..	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	4¾—4¾	4 14 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	102—105	4 5 6	June, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	86—89	3 18 6	Jan, July	..	..
..	4½%	Midland Elec. Corp. for Power Dist, 4½ 1st Mort. Debs.	98—100	4 11 0	..	..	..
5	2/6	Newcastle Elec. Supply Ord.	3½—4	4 14 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non Cum. Pref.	4—4½	5 11 0	Feb, Aug	..	..
100	4½%	Do. 4½ per Cent. 1st Mort. Deb.	99—101	4 10 0	Jan, July	..	..
100	5%	North Metro. Elec. Power Sup. 5 Morts.	99—102	5 0 6	..	..	..
1	6%	Northampton Elec. Lt. & P. Ord.	1¼—1 5/16	4 11 6	Feb, Aug	..	..
1	5%	Do. 5% Pref.	1 3/32—1 5/32	4 6 0	Feb, Aug	..	..
St.	4%	Do. 4% Debs.	99—101	3 19 0	June, Dec	..	..
10	10/0	Notting Hill Electric Ord.	12—12½	5 17 6	March	..	..
5	4/3	Oxford Electric Ord.	6¼—6¾	5 13 9	March	..	..
St.	4%	Do. 4% Deb. Stk.	93—96	..	..	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	8¾—9¼	5 8 0	Feb, Aug	..	..
5	3/6	Do. 7 per Cent. Pref.	6¾—7¼	4 16 6	Feb, Aug	..	..
St.	3½%	Do 3½ per Cent. Deb. Stock (red.)	86—88	3 19 6	Jan, July	..	..
5	..	Smithfield Markets Electric Sup. Ord.	1¼—1¾	..	Feb.	..	..
5	4/0	South London Electric Supply Ord.	2 13/16—3 1/16	6 3 0	April	..	..
St.	5%	Do. 5% 1st Mort. Stock (red.)	101—104	4 16 0	..	..	..
1	0/8	South Metrop'n Elec. Lt & Power 7% 1st Pref	1¼—1½	5 18 0	Feb, Aug	..	..
1	0/7	Do. 6 per Cent. 2nd Pref.	⅞—1	6 17 0	Feb, Aug	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	97—100	4 11 6	April, Oct	98	..
5	1/3	Urban Electric Supply Ord.	¾—1	..	April, Oct	⅞	..
5	1/3	Do. 5 per Cent. Cum. Pref.	2¾—3	8 16 0	April, Oct	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	87—89	5 2 3	April, Oct	83	..
5	5/0	Westminster Elec. Sup. Ord.	7¾—8¼	6 5 0	Mar, Sept	..	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	5—5¼	4 3 6	Jan, July	..	..
		Electric Railways and Tramways.					
1	..	Bath Elec. Trams Pref. Ord.	⅜—7/16	..	April	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	⅝—⅞	6 13 6	Jan, July	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	79—83	5 8 6	April, Oct	79	..
St.	4½%	B'ham & Midland Trams 4½ 1st Deb. Stock	91—93	4 17 0	Jan, July	92½	..
10	4%	Bristol Tramways & Carriage Ord.	6¼—7	5 10 9	Feb, Aug	..	..
10	4%	Do. Cum. Pref.	7¼—7¾	5 6 9	..	..	..
St.	4%	Do. 4 per Cent. Debs.	101—102	3 18 3	Feb, Aug	..	..
10	..	British Electric Traction Ord.	1⅛—1⅜	..	June, Dec	1⅛	..
10	..	Do. 6 per Cent. Cum. Pref.	4—4½	..	Feb, Aug	4 1/16	..
St.	5%	Do. 5 per Cent. Perpetual Debs.	96—99	5 2 6	April, Oct	97	96
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	77—81	5 14 0	May, Nov	77¼	..
St.	3%	Central London Ordinary Stock	71—73	4 4 0	Feb, Aug	72	71½
St.	4%	Do. 4 per Cent. Pref. Stock	87—89	4 10 0	Feb, Aug	87	..
St.	2%	Do. Deferred Stock	59—61	3 4 6	Feb.	60	58¼
100	4%	Do. 4 per Cent. Debs.	104—105	3 16 0	Jan, July	..	..
5	2/6	City of Birmingham Trams, 5% Cum. Pref.	4 13/16—5 1/16	4 19 6	April, Oct	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs	99—102	3 18 9	April, Oct	..	..
St.	1½%	City & South London Rly. Con. Ord.	31¼—32¼	4 11 0	Feb, Aug	32¼	31¼
St.	5%	Do. 5 per cent. Perp. Pref. (1891)	109—111	4 10 0	Feb, Aug	..	..
St.	5%	Do. (1896)	105—108	4 13 0	Feb, Aug	..	..
St.	5%	Do. (1901)	104—107	4 15 0	Feb, Aug	105¼	105¼
St.	5%	Do. (1903)	103—105	4 15 6	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	102—104	3 17 9	May, Nov	..	..
10	6/0	Dublin United Trams, 6 per Cent. Pref	12¼—13¼	4 10 6	Feb, Aug	..	..
10	12/0	Gateshead and District Trams Ord	8¼—8¾	6 19 6	..	..	..
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	¾—1¼	..	Feb, Aug	..	..
5	..	Hastings & District Elec. Trams, 6% C. P.	1½—2	..	Mar. Sept	..	..
St.	4½%	Do. 4½ Deb. Stock	75—80	5 10 0	April, Oct	..	..
10	..	Imperial Tramways Ord.	3—3½	..	Mar, Sept	..	..
10	..	‡Do. 6 per Cent. Pref.	4¼—4¾	..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Debs.	72—74	6 3 6	Jan, July	..	..
..	2/6	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	2¼—2¾	5 10 0	Mar, Sept.	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	79—84	4 15 0	Jan, July	..	..
10	6/0	Lanarkshire Tramways	10—10½	5 12 3	Feb, Aug	..	..
St.	5%	Lancs Utd. Trams, 5% Prior Lien Deb. Stk.	82—84	5 19 0	Jan, July	..	..
St.	4%	London Electric 4% Deb. St.	93—100	4 0 0	..	99¼	99¼
St.	4%	Do. 4% Pref.	85—86	4 14 0	..	85	..
10	..	London United Trams, 5% Cum. Pref.	3¾—4¼	..	Jan, July	4 1/16	4 1/32
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	77—80	5 3 0	Jan, July	80	77¼
St.	..	Mersey Con. Ord. Stock	6—8	..	Feb, Aug	..	..
1	1/1½	Metropolitan Elec. Tramways Ord.	31/32—1 1/32	6 0 0	..	..	..
1	..	Do. Deferred	⅛—3/16	..	April	5/32	..
1	0/6	Do. 5 per Cent. Cum. Pref.	31/32—1 1/32	5 0 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	102½—104½	4 7 0	Jan, July	103	..
St.	5%	Do. 5 per Cent. Do. Stk	102—104	4 18 6	..	104	..
St.	1½%	Metropolitan Railway Consolidated	46¼—47¼	2 17 6	Feb, Aug	48	47
St.	2½%	Do. Surplus Lands Stocks	68—70	3 19 6	Feb, Aug	69¼	69
St.	3½%	Do. 3½ per Cent. Preference	90—92	3 16 0	Feb, Aug	91¼	90
St.	3½%	Do. 3½ per Cent. "A" Preference	89—91	3 17 0	Feb, Aug	90¼	90
St.	3½%	Do. 3½ per Cent. Convertible Pref.	89—91	3 17 0	Feb, Aug	[illegible]	..
St.	3½%	Do. 3½ per Cent. Debenture Stock	93—95	3 13 6	Jan, July	[illegible]	93[illegible]

* No allowance has been made for accrued interest or redemption.
† Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Sect.	Last Dividend	Name.	Price Tues., June 27.	*Rate per cent. Yielded.	Dividend Due.	Business Week to June 27. Highest.	Lowest.
		Electric Railways and Tramways—*Continued.*		£ s. d.			
St.	3½%	Met. Rly. 3½ per Cent. "A" Deb. Stock..	92 —94	3 14 6	Jan, July	93	..
St.	..	Metropolitan District Railway Ord.....	28½—28¾	..	Feb, Aug	29⅛	28⅛
St.	3½%	Do. 4½% First Pref.	88 —90	4 19 6	Feb, Aug	..	..
St.	3½%	Do. Assented Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	76 —78	4 10 0	Feb, Aug	77	76⅛
St.	3%	Do. 3 per Cent. Consoltd. Rent-charge	77 —79	3 16 0	Jan, July	—	..
St.	4%	Do. 4 per Cent. Midland Rent-charge	104 —106	3 16 0	Jan, July	..	..
St.	6%	Do. 6 per Cent. Perp. Deb. Stock.....	148 —150	4 0 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Ditto.....	98 —100	4 0 0	Jan, July	..	..
1	4½d.	Potteries Electric Traction Ord.	⅛ —⅜	5 6 9	April, Oct	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.....	⅜—½	7 5 0	Feb, Aug	⅜	⅛
St.	4½%	Do. 4½ per Cent, Deb. Stock.....	88 —91	5 0 0	May, Nov	..	..
1	1/2½	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	⅛—⅜	10 2 0	..	—	..
St.	4%	Do. 4 per Cent. Deb. Stock.....	75 —80	5 0 0	Jan, July	..	..
100	5%	Sunderland Dist. Elec. Trms. 5% 1st Mt Db.	..	8 4 0	Jan, July	..	..
..	10/0	Undergd E. Rys. Lon. 6% In. bds with coup 7	67 —69	1 13 0	June, Dec	69⅛	68⅛
—	5%	Do. 5% Prior Lien Bonds.....	100 —101	4 19 0	..	..	..
—	4½%	Do. 4½% Bonds with coup. 7	100 —102	4 9 0	..	101⅛	..
—	4%	Do. 4 per Cent. 1st Power Ho. Dbs. ..	100 —102	3 18 3	..	..	..
5	..	Yorkshire (W.R.) Elec. Trams. Ord.....	⅛ ⅛	..	March ..	..	..
5	—	Do. 6 per Cent. Cum. Pref.....	2⅛—2⅜	..	..	..	..
St.	4⅛	Do. 4⅛ per Cent. 1st Debs.....	84 —87	5 3 3	Jan, July	—	..
		Electric Manufacturing, &c.					
St.	4½%	Anchor Cable Co. 4½ % Deb. Stock	99 —101	4 9 0	—	..	..
1	..	Aron Electricity Meter Ord.....	⅛—⅜	..	..	..	..
1	0/7½	Do. 6% Cum. Pf.	⅝—¾	7 4 0	April, Oct	⅝	..
1	3/2½	Babcock & Wilcox Ord.	5⅛—5⅜	4 11 0	April, Oct	5⅛	5⅛
1	0/7½	Do. Pref.....	1⅛—1⅜	4 0 0	..	..	..
5	6/0	British Insulated & Helsby Cables Ord...	6½—7⅛	6 15 6	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.....	6 —6½	4 12 3	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)..	102 —104	4 6 6	Jan, July	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	96 —99	4 11 0	Mar, Sept	—	..
5	..	British Westinghouse 6 per Cent. Pref....	⅛—⅜	..	Feb, Aug	102⅛	102⅛
100	6%	Do 6 per Cent. Prior Lien Dbs. (rd.)..	101 —103	5 16 0	..	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock.....	61 —64	6 5 0	Jan, July	61⅛	..
St.	4½%	Brush E. Eng. Co. 4½% Perp. 1st Deb. Stock	59 —64	7 0 6	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock.....	41 —46	9 16 0	Jan, July	..	..
5	10/0	Callender's Cable Con. Ord. xd and bonus	8¼—9⅛	7 11 6	Jan, July	5⅜	5⅛
5	2/6	Do. 5 per Cent. Cum. Pref.....	4¼—5⅛	4 17 6	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort Debs. (red.)..	102 —104	4 6 6	Nov, May	3⅜	3⅛
1	1/6	Castner-Kellner Alkali Co.....	3⅛—3½	5 1 0	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)..	104 —107	4 2 6	Feb, Aug	106⅛	..
1	7½d.	Chadburn's (Ship) Telegraph Ord.	1⅛—1⅜	5 19 0	March ..	..	..
1	0/8½	Consolidated Electrical Co.....	⅛—⅜	10 0 0	August ..	—	..
1	0/6	Consolidated Signal Co.....	⅛—⅜	5 14 0	April, Oct	⅛	..
1	0/7½	Do. 6 per cent. Cum. Pref.	⅛—⅜	6 8 0	April, Oct	..	..
3	..	Crompton & Co (Nos. 1 to 85,000)	⅛—¼	..	Jan, July	..	..
100	5%	Do. 5 per Cent. 1st Mort. Debs. (red.)..	60 —70	7 14 0	Jan, July	..	..
5	1/0	Dick, Kerr & Co. Ord.....	⅛—⅜	5 14 0	Sept.	..	..
5	0/7½	Do. 6 per Cent. Cum. Pref.....	⅜—½	5 6 0	Sept	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock.....	97 —100	4 10 0	Jan, July	..	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	⅛—⅜	..	Feb, Aug	⅛	..
..	..	Do. (£5 paid)	1⅛—2⅛	9 3 0	Feb. Aug	..	..
St.	4%	Do 4 per Cent. Mort. Deb. Stock (red.)	69 —73	5 9 9	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock.....	78 —81	6 3 6	Mar, Sept	..	..
..	..	Edmundson's Elec. Corp. Ord.....	⅜—⅝	..	Jan, July	⅜	..
5	..	Do. 6 per Cent. Cum. Pref.	2½—3	..	May, Nov	2⅞	2⅝
St.	4½%	Do 4½ per cent. 1st Mort. Deb. (red.)..	86 —89	5 1 0	Jan, July	..	..
2	..	Electric Construction Co.....	⅛—1⅛	..	Jan, July	..	..
2	2/9½	Do. 7 per Cent. Cum. Pref.....	1½—2	7 0 0	July	..	..
St.	4%	Do. 4 per Cent. Perp. 1st Mort. Debs...	71 —74	5 7 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref. ..	8¼ —9⅛	5 9 0	June, Dec	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.....	88 —93	4 8 6	Mar, Sept	..	..
5	10/0	Henley's Telegraph Works Ord.....	12¼—12⅝	5 16 6	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	4⅛—5⅛	4 10 0	Feb, Aug	4⅛	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	105 —108	4 4 6	Mar, Sept	..	..
10	15/0	India Rubber, Gut. Per., &c., Works....	11⅛—13⅛	6 0 0	Feb, Aug	12	11⅛
10	5/0	Do 5 per Cent. Cum. Pref.	10⅛—10⅞	4 14 0	..	..	..
100	4%	Do. 4 per Cent. Debs. (red.)	96 —98	4 1 6	April. Oct	..	..
1	..	National Elec. Construction Co.....	⅛—⅜	..	April	..	..
1	..	Richardsons, Westgarth & Co., Ltd. Ord.	⅜—½	..	Nov	..	..
1	..	Do. 6 per Cent. Cum. Pref.	⅜—½	..	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. Perp. Deb. Stock....	78 —82	5 10 0	Jan, July	..	..
5	..	Simplex Conduits 6 per Cent. Cum. Pref.	4⅞—5	..	..	..	..
12	36/0	Telegraph Construction & Maintenance..	36½—38½	5 16 3	Mar, July	..	..
100	4%	Do. 4 per Cent. Deb. Bonds (1909)	100 —102	3 18 6	Jan, July	..	..
1	1/0	Vickers, Sons & Maxim, Ltd., Ord.....	2⅛—2⅜	4 15 0	..	2⅛	2⅛
1	0/6	Do. 5 per Cent. non-Cum. Preference..	1⅞—1⅞	4 3 0	..	..	..
St.	5%	Do. 5 per Cent. non-Cum. Preferred ..	103 —112	4 11 0	..	—	..
St.	4%	Do. 4 per Cent. 1st Mort. Db. Sk. (red)	100 —102	4 0 0	June, Dec	100¼	..
100	4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.)	102 —104	4 7 6	June, Dec	..	..
100	5%	Do. 5 per Cent. 3rd Mort. Debs Scrip...	103 —105	4 16 0	..	..	..
10	10%	J. G. White & Co. 6% Cum. Pref.	15⅛—16⅛	6 10 0	..	16	15
1	..	Willans & Robinson Ord.....	⅛—⅜	..	Apr, Oct	..	..
5	..	Do. 6 per Cent. Cum. Pref.....	⅜—½	..	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.....	55 —65	6 3 0	May, Nov	..	..
		Telegraphs.					
10	..	Amazon Telegraph	7⅛—7⅜	..	June, Dec	..	..
100	5%	Do. 5 per Cent. Debs. (red.)	100 —102	4 19 0	Jan, July	..	..
St.	15/0	Anglo-American	69 —71	4 4 6	F,My,Ag,N	..	..
St.	30/0	Do Preferred	113½—114½	6 2 6	F,My,Ag,N	114	113
St.	30/0	Do. Deferred	26⅛—26⅝	5 1 0	F,My,Ag,N	26⅛	26⅛
St.	30/0	Commercial Cable 4 per Cent. Deb. Stk...	88½—90½	4 8 6	Jn.Ap,Jy,O	89½	..
St.	4%	Cuba Submarine Ord.....	10 —10¼	4 17 6	Feb, Aug	10⅛	..
10	6/0	Do. Preference 10 per Cent.	17½—18½	5 13 0	Feb, Aug	—	..
10	10/0	Direct Spanish Ord.....	3½—4	5 0 0	April, Oct	..	..
5	2/0	Do. 10 per Cent. Cum. Pref.....	8½—8¾	5 16 0	April, Oct	8⅝	..
5	5/0	Do. 4½ per Cent. Deb.	101 —103	4 8 3	Jan, July	..	..
50	4½%	Direct United States Cable.....	7⅛—8	6 9 0	Ja,Ap,Jy,O	..	..
10	2/0	Direct West India Cable 4½% Rg.Db.(rd.).	100 —102	4 9 0	June, Dec	..	..
100	4½%	Direct West India Cable 4½% Rg.Db.(rd.).	136½—139½	5 1 6	Ja,My,Jy,O	138	136½
St.	65/0	Eastern Ordinary xd and bonus	8½ —85	4 2 0	Ja.My,Jy,O	85½	84½
St.	12/6	Do. 3½ per Cent. Pref. Stock.....	101 —103	3 18 3	May, Nov	..	5
St	6/6	Do. 4 per Cent. Mort. Deb. Stk. (red.)..	101 —103	3 18 3	May, Nov	..	..
St	4%	Eastern Extension	13¼—13⅝	5 2 6	Ja, Ap, Jy, O	13⅜	13⅛
St	6/6	Do. 4 per Cent. Deb. Stock	101 —103	3 18 3	Feb, Aug	..	..
10	4%	Eastern and S.Af., 4% Mauritius Sub. Debs	99½—101½	3 19 0	May, Nov	99½	..
.5	4%	E.N (of Copenhagen), with Coupon 82 ..	31½—32½	5 8 0	Jan, July	33½	31½
10	26/0	Indo-European	56½—58½	5 6 6	May, Nov	..	..
25	52/5	†Mackay Companies Common	92 —94	5 5 0	Ja,Ap,Jy,O	..	..
100	5%	†Do. Preference	75 —77	5 2 0	Ja,Ap,Jy,O	..	..
100	4%	Marconi's Wireless Teleg. Co.	2½—2⅝	..	April	2⅛	2⅛
1	..	Pacific & Europe'n Tel. 4% Guar. Dbs. (red.)	100½—102½	3 13 0	June, Dec	..	..
100	4%	West Coast of America	1⅛—1⅜	5 0 0	May	..	..
2½	1/3	Do. 4 per Cent. Debs.	99½—101½	3 18 9	Jan, July	..	..
100	4%	West India & Panama	2½—2⅝	5 0 0	..	..	..
10	1/6						
10	6/0						

Sect.	Last Dividend	Name.	Price Tues., June 27.	*Rate per cent. Yielded.	Dividend Due.	Business Week June
		Telephones.		£ s. d.		Highest.
100	2$	Amer. Telephn. & Telegh. Cap. St.	153 —155	5 2 0	..	155⅛
..	4%	Do. Coll. Trust $1,000 4 per Cent. Bds.	96 —98	4 2 6	Jan, July	98
St.	4%	Do. 4% Cons. Bonds 1936	114 —116	3 9 0	..	..
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101 —103	4 17 0	Mar, Sept	..
5	3/0	Chili Telephone	7⅛—7⅜	5 11 6	August ..	..
1	0/7½	Monte Video Telephone Ord.....	⅛—1	6 0 0	Nov	..
1	0/6	Do. 5 per Cent. Pref.	⅛—½	5 11 0	May, Nov	..
St.	6%	National Co. Pref. Stock.....	104⅛—105⅛	5 15 0	Feb, Aug	104⅛
St.	6%	Do. Def. Stock	120⅛—123⅛	4 17 0	Feb, Aug	123
10	6/0	Do. 6 per Cent. Cum. 1st Pref.....	10 —10⅛	5 11 6	Feb, Aug	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.....	10 —10⅛	5 11 6	Feb, Aug	..
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref....	5⅛—5⅜	4 8 0	Feb, Aug	5⅛
St.	3½%	Do. Deb. Stock 3½ per Cent. (red.)....	99⅛—101⅛	3 9 6	June, Dec	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.).....	99⅛—101⅛	3 19 0	Jan, July	100⅛
..	4½%	New York Telephone Co. 30 yr. Bnds.....	100⅛—101⅛	4 9 6	..	101⅛
1	1/0	Oriental	1⅛—1⅜	4 18 0	April, Oct	..
..	0/7½	Do 6 per Cent. Cum. Pref.	1⅛—1⅜	4 16 0	April, Oct	..
St.	4%	Do. 4 per Cent. Red. Deb. Stock.....	87⅛—89⅛	4 9 6	Jan, July	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. (red.)	100 —102	4 9 0	Jan, July	..
5	3/0	United River Plate Ord. (1—150,000)	7⅛—7⅜	5 3 0	July	7⅛
5	4½%	Do. (150,001—190,000).....	7⅛—7⅜	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅛—5⅜	4 9 0	June, Dec	..
St.	4½%	Do. 4½ Deb. St. Red.....	103 —105	4 5 9	Jan, July	..
		Financial, Investment, &c.				
5	3/0	Elec. & Gen. Investment 6% Cum. Pref...	4⅛—4⅜	6 17 0	Jan, July	..
10	2/0	Globe Telegraph & Trust	11 —11⅛	5 2 3	Sp,DcMr Ju	11⅛
10	3/0	Do. 6 per Cent. Pref.	13⅛—13⅜	4 10 0	Sp,DcMr Ju	13⅛
10	6%	Submarine Cables Trust (Cart.)	131 —134	4 9 6	April, Oct	..
		Colonial and Foreign Electric Railways, Tramways, &c.				
5	2/9	†Anglo-Argentine 5% Cum. 1st Pref.	5⅛—5⅜	4 15 0	April, Oct	5
5	2/9	†Do. 5% Cum. 2nd Pref.....	4⅛—5⅛	4 18 0	Jan, July	..
St.	4%	†Do. 4% Deb. Stock	94 —96	4 4 0	June, Dec	95
St.	4½%	†Do. 4½% Deb. Stock	99⅛—101⅛	4 8 3	..	100
St.	5%	Do. 5% Deb. Stock	100⅛—102⅛	4 18 6	..	101
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)....	104⅛—106⅛	4 14 6	Jan, July	..
5	2/6	Brisbane Electric Trams. Invest. Ord	6⅛—6⅞	6 3 0	May	..
5	4/0	Do. 5 per Cent. Cum. Pref.	5 —5⅛	4 17 6	May, Nov	10
5	2/6	Do. 4½ per Cent. Db. Prov. Certs.....	101 —104	4 8 0	Jan, July	10
St.	4½%	British Columbia El. Rly. Df. Ord.	146 —150	5 7 6	Mar, Sept	14
St.	8%	Do. Pref. Ord. Stock	128⅛—132⅛	4 12 0	May, Nov	13
St.	6%	Do. 5% Cum. Perp. Pref. Stock.....	111 —113	4 9 0	Jan, July	..
St.	5%	Do. 4½ per Cent. 1st Mort. Debs.....	100 —103	4 7 6	April, Oct	11
40	4½%	Do. Vancouver Power Debs.	102 —105	4 5 9	Jan, July	..
100	4½%	Do. 4½% Perp. Con. Deb. St.	101⅛—103⅛	4 2 6	..	..
St.	4½%	Buenos Ayres Lacroze Trams 1st Mt. Db.	99⅛—101⅛	4 19 6	Mar, Sept	..
St.	5%	Buenos Ayres Port & City Tram, 1st Mt. Deb. Stock	93 —98	6 2 6	Feb, Aug	..
St.	6%	Calcutta Tramways (1 to 137,610).....	5⅞—6⅛	4 19 6	Mar, Sept	..
..	..	Do. 5 per Cent. Cum. Pref.	5⅛—5⅜	4 13 0	Jan, July	..
100	2/6	Do. 4½% 1st Deb. Stock (red).....	102 —105	4 7 0	Jan, July	..
1	4½%	Cape Electric Tram Shares	⅛—⅜	..	..	..
St.	..	City of Buenos Ayres Trams Co. (1904) Sh.	5⅛—5⅜	4 5 0	F,My,A,N	..
5	1/3	Do 4 per Cent. Deb. Stock.....	96 —97	4 0 9	June, Dec	..
St.	4%	Colombo Tr. & Ltg. 5% 1st Mt. Db.....	95 —98	5 2 0	May, Nov	..
..	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	100⅛—102⅛	4 18 6	Feb, Aug	..
1	5%	Hong Kong Tramways Co. 5 per Cent. 1st Mort. Debs.	75⅛—79⅛	6 9 0	June, Dec	..
100	5%	Kalgoorlie Elec. Trams Sh.	⅜—⅝	..	..	..
100	5%	†Do. 5 per Cent. "A" Deb. Stock.....	91⅛—94⅛	5 6 0	Jan, July	..
5	6%	†Do. 6 per Cent. "B" Ditto	63 —67	8 15 0	Jan, July	..
5	0/6	Lisbon Elec. Trams. Ord.	1 —1⅛	4 16 0	July	..
100	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1⅛	4 16 0	Jan, July	..
St.	5%	Do. 5 per Cent. Reg. Mort. Debs.	99 —103	4 19 0	Jan, July	..
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	97 —99	5 1 6	Jan, July	..
100	5%	Manaos Trams and Lt. Co. 5% Debs	93 —96	5 4 0	..	..
100	5%	Manila Elec. Ry. $1,000 Gold Bonds.....	99⅛—101⅛	5 0 0	Feb, Aug	..
100	$1⅛	Mexico Trams Co. Com. St.	124⅛—126⅛	5 14 0	..	..
..	5%	Do. Gen. Con. 1st Mort. 5% Gold Bds.	95 —96	5 4 0	..	..
St.	6%	Do. 6% 50 yr. Mort. Bds.	100⅛—102⅛	5 19 0	..	—
St.	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922) (Nos. 601 to 2,000)	101 —103	4 7 6	Feb, Aug	..
..	..	Do. do. (Nos. 1 to 4,600)	102 —104	4 7 6	..	..
1	0/6	Perth Elec. Trams Ord.	⅛—⅜	2 13 6	May	..
St.	5%	Do 1st Mt. Db. Stock	104 —106	4 14 3	Jan, July	..
5	3/0	Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	5⅛—5⅞	5 4 6	..	—
St.	4½%	Do. 4½% 1st Mort. Deb. Stk.	99 —102	4 8 0	..	..
100	$1⅛	Rio Janeiro Tram, Lt. & P. Co.....	115⅛—116⅛	4 7 0	..	..
..	5%	Do. 30 yr. Gold Bnds.	102⅛—103⅛	4 16 0	..	..
100	5%	Do. 50 yr. Mt. Bnds	95⅛—96⅛	5 3 0	..	—
100	$2⅛	†Sao Paulo Tramway, Light & Power Co. $100 Stock	184 —186	5 8 0	..	..
5	5%	Do. 5 per Cent. 1st Mt. $500 Db.	102 —104	4 17 0	June, Dec	..
100	4½%	Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	93 —100	4 10 0	Feb, Aug	..
		Colonial and Foreign Electricity Supply, &c.				
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.....	5⅛—5⅞	5 8 0	Mar, Sept	..
10	5/0	Bombay E.S. & T. 6% Cm. Pf.....	10⅛—11⅛	5 5 6	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stk. (red).....	98 —100	5 8 6	Jan, July	..
..	5%	Do. 5 per Cent. 2nd Mort. Deb. Stock..	99 —101	5 0 0	..	..
5	5/0	Calcutta Elec. Supply Ord.	6⅞—7⅛	5 19 6	April, Oct	..
5	2/6	Do. 5% Cum. Pref	4⅛—5⅛	4 13 0	..	..
100	7/2½	Calgary Power Co. 5% 1st Mort. Bnds....	96⅛—98⅛	5 1 6	..	—
100	$3⅛	†Canadian Gen. Elec. Co. Com. St.....	103 —111	6 8 0	..	..
100	5%	Do. 7% Cm. Pf. Stock	121 —124	5 5 0	..	..
100	5%	Castner Electrolytic Alkali Co. (of U.S.A.) 1st Mort. Stl. Debs.	97 —102	4 18 0	Jan, July	..
500	5%	Elect. Development Co. of Ontario.....	83 —85	5 19 0	..	..
St.	5%	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	87 —90	5 11 0	Jan, July	..
..	..	Indian Elec. Sup. & Trac. Co.	1 —1⅛	..	..	..
10s	..	Kalgoorlie Elec. Power & Ltg. Ord.	⅛—⅜	..	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	⅜—½	8 6 6	April, Oct	..
100	5%	Kaministiquia Power Co. 5% Gold Bnds...	103½—105½	4 15 0	..	..
5	..	Madras E. S. Corp. Ord.	2⅛—3⅛	..	..	..
St.	..	Melbourne E. S. Co. Cons. Ord. St.....	3⅛ —3⅝	..	..	..
St.	5%	†Do. 5% 1st Mortg Deb. Stock	94 —96	5 5 6	..	..
500	5%	Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	83⅛—85⅛	5 12 6	..	..
St.	$1	Mexican Lt. & Power Co. Com. St.	82⅛—84⅛	4 16 0	..	..
St.	$3⅛	Do. 7% Cum. Pref. St.	105 —108	6 10 6	..	..
500	5%	Do 5% 1st Mort. Gold Bnds	91⅛—95⅛	5 5 0	..	..
St	5%	Monterey Rly. L. & P. Co 1st Mort. Db. Sk.	89⅛—91⅛	5 10 6	F,My,A,N	..
100	8/2½	Montreal Lt. Ht. & Power Co. Cap. St.	175 —180	4 13 6	..	..
100	5%	Northern Lt. Power & Coal 5% Gd. Bds ..	63 —65	7 16 0	..	..
St.	£10	River Plate Electricity Co. Ord. Stk.	218 —220	..	..	..

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NOTES.

Car Meter Results.

THE annual report of Mr. T. B. GOODYER, manager of the Croydon Corporation Tramways, which was adopted at the meeting of the Council this week, furnishes convincing testimony of the advantages of meters for checking the energy consumed by tramcars. Mr. GOODYER has also prepared a valuable tabular summary, of which we have received a copy, of the information he has obtained from 88 municipal tramway undertakings with whom he has communicated. It appears that no less than 42 of these undertakings have fitted meters to *all* their cars, 17 have meters installed on *some* cars, whilst in 29 cases no use is made of meters. It is interesting to learn that ampere-hour meters are in use on 38 systems, watt-hour meters on 15 systems, and time meters in the remaining six instances. We also notice that more than three-quarters of those tramway managers who express an opinion of the value of meters in the detection of faulty cars reply in favour of using them.

As to the saving of electrical energy, the power consumption on the Croydon tramways during the 12 months ended March 31, 1910, averaged 1·281 units per car-mile, and for the year ended March 31st last 0·976 units per car-mile, meters having been fitted on all the cars (70) since April 22, 1910. It will be seen that the saving in energy resulting from the use of meters represents about 24 per cent., whilst the financial saving is equivalent to over £92 per car per annum. It would be interesting, we think, if information could also be obtained in such cases as to the effect on the maximum demand made by the tramways on the power station. If it were found that the maximum demand did not decrease in proportion to the smaller output the load factor would, of course, be worse, and in consequence the electricity supply department would be justified in demanding a higher price per unit, so reducing to some extent the financial saving which is claimed. On the other hand, it must be remembered that the economy brought about by car-meters is not confined to energy consumption, and at Croydon a saving of approximately 26 per cent. has resulted in respect of brake shoes, whilst other economies will doubtless also occur. The effect of the smaller energy consumption of the Croydon cars is shown in the records of the electricity supply department, the output for the past year being actually less than in the 12 months ended March 31, 1909, in spite of a satisfactory increase in revenue in the sales for power and heating and cooking.

AN inspection of the tabulated replies referred to above shows what a great difference there is in individual cases between the percentage reduction in the energy consumption per car-mile; this is doubtless partly accounted for by the amount of skill exercised by motormen in the different towns previous to the introduction of meters. Thus, in Accrington, Brighton, Burnley and Darwen the saving per annum did not exceed 5 per cent.; whilst at Bury it was about 22 per cent., at Gloucester 21 per cent., at Leith 23 per cent., at Wolverhampton 20 per cent., and, as mentioned above, 24 per cent. in the case of Croydon. A number of undertakings have not yet had the meters installed long enough to reply definitely in regard to the saving effected, but we think the above figures are sufficient to show that the question of installing meters should be seriously considered by all tramway undertakers. In this connection the London County Council, with about 1,600 cars, have just installed 40 ampere-hour meters as an experiment, motor

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watt-hour meters having been discarded from a number of cars as unsuitable for the conditions. It is interesting to notice that in the case of this undertaking special arrangements are necessary owing to the liability to reversal of polarity on the conduit routes; and the meters are arranged in pairs with ratchet and pawl mechanism.

Shop Front Lighting.

THERE is not much doubt that shop front lighting is quite an important advertisement of the particular illuminant used, provided, of course, that the effect produced is good. The gas companies appreciate this point of view, and on that account they are making a special effort to carry out as much shop front lighting as possible by means of high-pressure g To compete with this we have incandescent electric lighting and arc lighting; but, generally speaking, the question resolves itself into competition between what are sometimes called "gas arcs" and electric arcs. Mr. A. H. SEABROOK gave some interesting figures of the cost of such lighting with electric arc lamps at the meeting last week of the Incorporated Municipal Electrical Association at Brighton. The prospects of the small flame arc lamp, to which he then referred, seem particularly good for this class of work. There is, however, another aspect of the question to which too much attention cannot be drawn. Everyone desires, as far as possible, to be relieved of unnecessary trouble. Shopkeepers form no exception to this rule, and as they have their time fully occupied in earning their living, they naturally prefer to give their attention to subjects more particularly connected with their business than to the maintenance of their lamps.

GAS companies fully realise the importance of this aspect of the case. Consequently, they run high-pressure mains with branches on the exterior of business premises; and since they undertake the maintenance of the lamps the whole system is under their control, and the shopkeeper is entirely relieved from trouble and annoyance. In electric arc lighting this is often not the case. Electricity supply authorities have not the same powers as the gas companies. The shopkeeper, if he wishes to use electric light for the outside of his premises, probably has to buy his own arc lamps, and also to keep them in order. This may involve a certain amount of trouble to a non-technical man, and consequently when the gas company comes along with an offer to relieve him of all responsibility in the matter, the shopkeeper feels a strong inducement to accept the "gas arcs."

FROM the point of view of competition between gas and electricity there is no doubt that hiring powers are most important, and, further, that too much stress cannot be laid upon the necessity of a good business organisation. Competition there must always be, and the sooner that electricity undertakings are prepared to meet it the better. Mr. SEABROOK went so far as to say that he would rather not work in agreement with any gas undertaking; he preferred to keep his enemy at arm's length. We do not feel that we are prepared to go so far, for competition beyond a certain limit is undoubtedly undesirable, and may end in no one making any money. The aim of every business should be to make money on the most satisfactory basis, and if by having some working agreement with the gas companies, as the electricity companies have at present in the Holborn area, more profit can be made, it appears to us that this is the best thing.

The Attraction of Cheap Power Supply.

THE question—When is Electric Power Cheap?—was raised recently at a public meeting convened at Edinburgh for the purpose of considering what steps could be taken to advance the industrial and commercial interests of Edinburgh, Leith and Midlothian. The offer of cheap land, cheap labour and cheap power supply, and the provision of good transit facilities, were all suggested during the course of the discussion. That a cheap supply of electric power is by no means a negligible asset to a town is becoming more and more evident. Mr. A. H. SEABROOK was among the first to appreciate this fact, and during his sojourn at West Ham that borough experienced a considerable influx of manufacturing works, attracted by the low price at which electrical energy was obtainable. Other towns have since experienced the same effect. As to what constitutes cheap power, however, it is impossible to formulate any fixed definition, since it must naturally be determined by other factors, such as the cost of fuel in the district and the price of competing sources of power. Ex-Bailie MACKENZIE considered that 1d. per unit was by no means cheap power and suggested that ½d. per unit would be cheap from March to October. This, of course, raises the chief difficulty of the supply authority, that whilst the plant standing idle throughout the summer months could be employed profitably at such a rate, ½d. per unit would not usually be sufficient to provide for capital charges on the additional plant that would be necessary in the winter months. It is, therefore to the encouragement of a restricted hour demand that particular attention should be paid in such cases, and we think that more might be done by supply authorities as regards encouraging an electrochemical load which could be supplied continuously except for certain hours during the winter months.

Oil Fuel for Steam Boilers.—The Consolidated Gas, Electric Light & Power Co. (U.S.A.) are employing in their Westport station coal and oil simultaneously for fuel for their boilers. Each furnace is provided with four oil burners, the oil being delivered to the boilers at 20 lb. pressure per square in. and atomised by means of a steam jet. Under actual operating conditions the maximum boiler outputs obtained during seven-hour runs were as follows: With coal 1,188 H.P., with oil 702 H.P., with coal and oil together 1,445 H.P. It was found that a 2,000 kw. station load can be carried by each boiler when using coal and oil together with as much ease and certainty as 1,200kw. per boiler can be carried when coal is alone used. The results indicate a gain in output of 66⅔ per cent. by the use of the oil, or a saving of 40 per cent. in the cost of the boiler equipment for a given output. The cost of oil for producing a certain amount of steam is about 33 per cent. more than that of coal.

Cable Interruptions.	Date of Interruption
Assab—Perim	July 8, 1909
Malta—Tripoli	April 20, 1910
Latakia—Palura	May 26, 1910

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National Electric Light Association.—The attendance at the recent Annual Convention at New York of this Association reached 5,150, or almost double that of the St. Louis Convention last year when the attendance was a record one.

Wireless Telegraphy in Australia.—In reference to the advertisement which recently appeared in our columns inviting applications for the post of wireless telegraph expert in Australia, we are able to announce that Mr. J. G. Balsillie has been selected for the post and will shortly enter upon his duties.

Electricity in Textile Mills.—The Council of the Textile Institute, Manchester, has decided to co-operate with the Institution of Electrical Engineers in an investigation of the application of electricity to the textile industry. In the recent annual report of the Council of the Institution it was mentioned that the Special Committee had held several meetings.

Long-Distance Telephony.—The "Daily Chronicle" says that telephonic communication was successfully established between Paris and Aberdeen, a distance of about 1,000 miles, on Wednesday afternoon. Communication was made by way of London, Dover and Calais. It is stated that it was possible to hear quite distinctly and that there was no "buzzing."

International Congress of Applied Chemistry.—The eighth International Congress of Applied Chemistry is to be held at Washington and New York from September 4 to 13, 1912. Papers will be accepted for reading and discussion in the various sections, preference being given to those specially adapted for international discussion; and they must be sent in not later than July 1, 1912. Preliminary particulars may be obtained from the hon. secretary to the British Organising Committee, Mr. C. G. Cresswell, Society of Chemical Industry, Palace-chambers, Westminster, S.W.

Diversion of Niagara Water—The "Electrical World" mentions that an extension for two years (until June 29, 1913) of the present regulations under the Burton law governing the diversion of water from Niagara River for commercial power has been recommended by the United States Senate Committee on foreign relations. It was explained that the existing treaty with Canada, under which the diversion of water on both the United States and Canadian sides is limited, would expire in another 10 years, and it is proposed to continue the present *status quo* for that time.

Smithsonian Institution.—We have received a copy of the annual report of the Smithsonian Institution, Washington, U.S.A., for the year ended June 30th, 1909. As in previous years the greater part of the volume consists of an appendix containing a miscellaneous selection of Papers dealing with scientific investigations. Included among these are Prof. J. A. Fleming's Royal Institution lecture of June 4, 1909, on "Researches in Radiotelegraphy," and the 1909 presidential address of Sir J. J. Thomson to the British Association on "Recent Progress in Physics."

Accuracy of Meters.—An interesting report on this subject was presented by the Meter Committee at the recent meeting of the National Electric Light Association. A table is given showing the great improvement in accuracy between the years 1907 and 1910. During this period the light-load accuracy has increased from 84·4 per cent. to 95·9 per cent. and the heavy-load accuracy from 92 per cent. to 98·4 per cent.

The "Electrical World" states that of 7,558 tests of electric meters reported to the New York Public Service Commission, Second District, in April, 1911, 412, or 5·45 per cent., were fast; 6,046, or 79·99 per cent., were accurate, and 1,100, or 14·56 per cent., were slow.

New German Patent Law.—The Bill to amend the law on the working of patents in Germany has been passed in an amended form and came into force on July 1.

In place of Art. 11 of the Patent Law of April, 1891, the new law provides that "should a patentee refuse permission to an applicant for the use of the invention in return for reasonable compensation and guarantees, the right to use the invention may, if the grant of such permission is required in the public interest, be given to the applicant. The right may be given in a limited form and be made dependent upon conditions. The patent may be revoked (in the absence of international agreements to the contrary) if the invention be worked exclusively or mainly outside the German Empire or the protected territories. The attempt to transfer a patent to another does not avoid revocation. No decision shall be come to against a patentee under the new law until after three years from the notification of the grant of the patent.

National Physical Laboratory.—The National Experimental Tank, which we described in our issue of March 24th, p. 946, was formally opened on Wednesday afternoon by the Right Hon. Lord Rayleigh, O.M., F.R.S. Sir Archibald Geikie, K.C.B., chairman of the General Board of the Laboratory, presided at the ceremony. After Lord Rayleigh had delivered an address, Mr. A. F. Yarrow, who, it will be remembered, has given £20,000 towards the construction of the tank, emphasised the importance of British shipbuilders having such a tank in order that they might possess the same facilities for research as their foreign competitors. The carriage which tows the models along the tank was then started by the Marchioness of Bristol. After the ceremony the various departments of the Laboratory were open for inspection.

Electric Power Supply at Turin Exhibition.—"The Times Engineering Supplement" mentions that the electric light and power required for the Turin Exhibition is furnished by a number of firms by means of machines of different types. Water and fuel are provided by the authorities, who will also make some payment for the energy. Steam is generated by four sets of water-tube boilers, two being of the Tosi type and two by Babcock and Wilcox. The engines include a Tosi horizontal tandem of 600-800 H.P., a Tosi turbine with surface condenser, a vertical engine of 500 H.P. with Lentz valves, and a 1,200 H.P. turbine by Swiderski, of Leipzig. A two-cycle Diesel engine of 1,000 H.P. is supplied by Messrs. Tosi, one of 400 H.P. by the Société Italienne Langen et Wolf, and a third of 1,000 H.P. by Messrs. Sulzer, of Winterthur. The electrical machines come partly from the Tecnomasio Italiano Brown-Boveri and partly from the Savigliano factories.

Power Factors.—In a Paper presented by Mr. F. D. Newbury at the recent convention of the National Electric Light Association a table was given of the power factors of various kinds of central-station loads. Among those mentioned were the following:—Incandescent lighting with small reducing transformers, 90 to 95 per cent.; single-phase induction motor, squirrel-cage rotor, ½ H.P. to 1 H.P., 55 to 75 per cent., average 68 per cent. at rated load; ditto 1 H.P. to 10 H.P., 75 to 86 per cent., average 82 per cent. at rated load; polyphase induction motor, squirrel-cage rotor, 1 H.P. to 10 H.P., 75 to 91 per cent., average 85 per cent. at rated load; ditto, 10 H.P. to 50 H.P., 85 to 92 per cent., average 89 per cent. at rated load; polyphase induction motors, phase-wound rotors, 5 H.P. to 20 H.P., 80 to 89 per cent., average 86 per cent. at rated load; ditto, 20 H.P. to 100 H.P., 82 to 90 per cent., average 87 per cent. at rated load; arc furnaces, 80 to 90 per cent.; induction furnaces, 60 to 70 per cent.; electric-welding transformers, 50 to 70 per cent. In general, for the average central station load, consisting of lighting and motor service, a power factor of 80 per cent. may be assumed; and 70 per cent. for a plant having a large proportion of induction motors, arc lighting, electric furnaces or electric welding load.

Electrification of the Lapland Railway.—"Engineering" states that, in spite of an unusually severe winter, with a tremendous downfall of snow, the work on the Porjus Railway has been energetically proceeded with, and the work in connection with the hydro-electric station at Porjus has been commenced. The construction of the power line from Porjus will be taken in hand this month, and part of the line is expected to be finished before the end of the year. The directors of the two electric companies who have secured the contract for this important railway—Siemens-Schuckert Werke, Berlin, and the General Swedish Electric Co.—with other engineers, have just paid a visit to Lapland to inspect the localities and undertake some trial ore transports on the Kiruna–Riksgränsen section of the Lapland Railway—the portion which is to be electrified. The present large steam locomotives, of the so-called "R" type, haul, as a rule, 28 waggons, each with a load of 30 tons. The electric trains will comprise 40 waggons

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of the same size, propelled by two electric locomotives, one pulling and one pushing, with an aggregate capacity of some 2,000 H.P., and the average speed will be about twice that of the present trains. The increased speed will make it possible to despatch 12 trains in the day instead of the present nine trains, without increasing the number of passing places. The experimental trains had the weight of the future electric trains—that is, 40 waggons—but they were each hauled by two locomotives. Negotiations have also been entered into with the Norwegian railway authorities about a possible electrification of the Norwegian section of the line from Riksgränsen to Narvik.

An Electrical Winding Engine on the North-East Coast.—In a recent issue of "The Times Engineering Supplement" is given a description of an electric winding engine that has been installed at Esh Collieries, Waterhouses, co. Durham, by Messrs Pease & Partners. The depth of the shaft is 162 ft., the time of each wind 15 seconds, the average winding speed 648ft. per minute, and the time allowed for changing 10 seconds. The winding gear is fitted with a coned drum, varying from 5 ft. 6 in. to 7 ft. 6 in. in diameter. The 100 B.H.P. motor is of the three-phase type, and is supplied with current at 440 volts and a frequency of 40. The motor drives on to the drum shaft through a flexible coupling and a train of machine-cut helical gearing. The winder is fitted with automatic winding gear, which, in the event of an overwind, trips the main switch and cuts off the supply to the motor, and also operates the main post brakes. This gear also comes into operation in the event of a failure of the supply, and is further fitted with an emergency lever, by which it may be brought into operation by hand. The switch gear consists of an iron-clad column fitted with a three-pole oil switch with overload and no-voltage release; and an isolating switch is also provided. This latter is interlocked with the main switch and the various doors of the switch columns. The controller is of the rising liquid type, the control being carried out by means of one lever, which is "off" when in the central position. A small centrifugal pump and motor are provided on the controller. This set constantly delivers water from a storage tank contained in the controller bedplate to the tank containing the electrodes. The tank is fitted with a rising and falling shutter, which is operated from the control lever, and regulates the level of the liquid in the tank. The reversing switches are mounted upon the shaft that operates the controller, and one switch is provided for each running direction. The switches are worked by means of a link motion from the control lever.

Current Topics.

Subjects of current interest dealt with in this issue include the following:—

Mr. D. Owen contributes an article on "Brownian Movements."

We give a description of the Dunston power station of the Newcastle-upon-Tyne Electric Supply Co. This station was formally opened on Wednesday.

We continue our account of the Conference on Education and Training of Engineers organised by the Institution of Civil Engineers.

At the annual general meeting of the Incorporated Municipal Electrical Association at Brighton last Friday the annual report of the Council was presented, and the officers for the ensuing year were elected. The new president is Mr. G. Wilkinson of Harrogate, and next year's Convention is to be held in that town.

At a recent meeting of the Physical Society, Prof. Ernest Wilson read a Paper on "High-tension Electrostatic Wattmeters."

The introduction of electrically-operated stoking plant into gas works continues to have very satisfactory results, a large saving being effected. Perth Gas Committee recommend its adoption.

The text of the Memorandum issued by the Postmaster-General in connection with the Telephone Transfer Bill is issued, and is accompanied by the recital of the Memorandum as to the transfer of the Company's employés to the State, which was read in the House of Commons on August 9, 1905, during the debate on the agreement for the purchase of the Company's undertaking.

The Railway and Canal Commissioners have commenced the arbitration proceedings in regard to the purchase of the National Telephone Co.'s undertaking by the Postmaster-General.

Kingston-on-Thames Council are sending a deputation to Germany to inspect the works of the M.A.N. Company, in order to obtain information of the latest type of oil engine for their electricity works.

Municipal Loans.—*Dublin* Corporation have received sanction to a loan of £50,000 and *Eccles* a loan of £3,294 for additional generating plant, &c.—*Willesden* Council have also received sanction to a loan of £8,000 for mains and services.—Inquiries have been held at *Gloucester*, *Hornsey*, *Torquay* and *Aldershot* into applications for sanction to loans for extensions of the electricity undertakings.—*Salford* Corporation have applied for permission to borrow £3,000 for mains and services, and *Bath* Corporation have asked for sanction to a loan of £400.

Parliamentary.—A House of Lords Committee has approved the Central London Railway Bill.

The Metropolitan Railway and the Sidmouth Gas and Electricity Bills have also passed the committee stage.

The Macclesfield and District Rail-less Electric Traction Bill has been withdrawn.

Companies' Meetings and Reports.—Amongst the reports and meetings of companies are the directors' reports of the General Electric, Chili Telephone & Puebla Tramway, Light & Power Companies, the Madras Electric Supply Corpn. and Royce Limited, and the meetings of the India Rubber, Gutta Percha & Telegraph Works Co., the Marconi International Marine Communication Co., and the Metropolitan District Railway Co., &c.

OBITUARY.

Dr. G. J. STONEY.—We regret to record the death of Dr. Geo. J. Stoney, Sc.D., F.R.S., which took place in London on Wednesday.

Dr. Stoney was born in King's County, Ireland, in February, 1826. When he left Trinity College, Dublin, he became astronomical assistant at the Parsonstown Observatory and subsequently he competed for the Fellowship at Trinity, winning the second place and the Madden Prize. Later he was appointed professor of natural philosophy at Queen's College, Galway. After five years' work in Galway he returned to Dublin to become Secretary of the Queen's University, where he remained till the dissolution of the University in 1882. As Secretary of the University, Dr. Stoney wrote various reports and minutes on educational matters. In 1861 he was elected a Fellow of the Royal Society. His official duties curtailed his leisure for scientific research, but it may be mentioned that it was Dr. Stoney who first suggested the now familiar term "electron." He also made interesting investigations on helium, and he came to the conclusion that helium was constantly escaping from the earth. Apart from his University distinctions and University work he served constantly on the Council of the Royal Society. Lord Lister, when President, appointed him one of the vice-presidents. He was a Visitor of the Royal Observatory at Greenwich and of the Royal Institution in London. He was honorary secretary to the Royal Dublin Society for over 20 years, and at the Sheffield meeting of the British Association he was president of Section A. He was a foreign member of the Academy of Science at Washington and of the Philosophical Society of America. He served on the Committee of the British Association which decided on the "C.G.S." system of units, and on many other committees of the Association. Deceased leaves two sons and three daughters. His eldest son, Gerald, who has just been elected a Fellow of the Royal Society, is manager of the well-known turbine works of Messrs. C. A. Parsons & Co.

F. E. BAINES.—The death is also announced of Mr. F. E. Baines, a former assistant secretary at the General Post Office. Deceased, who had been Inspector-General of Mails, Surveyor-General of Telegraphs and Organiser of the Parcels Post, died at Hampstead (London) on Tuesday. He was the author of an interesting work (in two volumes) entitled "Forty Years at the Post Office."

JOHN GILLEY.—The death is announced of Mr. John Gilley, who has been with the Foster Engineering Co. from the commencement. Deceased, who was the Company's first outside representative, died on June 14 from consumption. Previous to his connection with the Foster Engineering Co., he was on the staff of the Jandus Arc Lamp and Electric Co. The many trade friends of Mr. Gilley will read this announcement with regret, as he was much esteemed by all with whom he came in contact.

APPOINTMENTS VACANT AND FILLED.

Dundalk Urban District Council invite applications for the appointment of resident engineer for their electricity undertaking. The successful applicant will act as clerk of works, under the Council's

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consulting engineer, during the construction of the works. Salary £250 per annum. Applications to the town clerk (Mr. Mathew Comerford), Town Hall, Dundalk, by Monday, July 10. See also an advertisement.

A meter tester and testing assistant is required for one of the electricity works of the County Borough of Stoke-on-Trent. Commencing salary 26s. per week. Forms of applications, &c., from the borough electrical engineer (Mr. C. H. Yeaman), Hanley electricity works, Stoke-on-Trent. See advertisement.

The Governors of Heriot-Watt College, Edinburgh, require an organiser of technical education. Salary £300 per annum. Applications to the Clerk, 20, York-place, Edinburgh, by July 24.

Lecturers in mechanical engineering (salary £100, rising to £170), and in chemistry and metallurgy (salary £200, rising to £250) are required at the Municipal Technical Schools, Wolverhampton. Applications by July 17 to the Secretary, Education Offices, Town Hall, Wolverhampton.

An assistant for engineering subjects including mathematics, and with some knowledge of chemistry and physics, is required for Gloucester Technical Schools. Salary £120 to £140. Applications to Mr. R. Leach, Technical Schools, Gloucester.

An assistant science master is required for Waterford Central Technical Institute. Salary £100, rising to £130. Particulars from the Principal. Applications by noon, July 29.

Mr. X. Mudd, late of Trinity College, Cambridge, has been appointed lecturer in applied mathematics at the Grey University College, Bloemfontein, S. Africa.

Mr. John W. Hogg, late of the Jandus Arc Lamp & Electric Co., has been appointed sales engineer of the electricity department of Sunderland Corporation.

Consequent upon the retirement of Mr. J. J. Steinitz the following staff changes are announced by the Brush Electrical Engineering Co.:—Mr. B. Broadhurst is to be general manager, headquarters at Loughborough; Mr. W. Johnstone becomes assistant manager, headquarters in London; and Mr. G. S. Wood (at present works manager at the Witton works of the General Electric Co.) has been appointed works manager at Loughborough.

Mr. G. Waring has been appointed shift engineer at Eccles electricity works.

INSTITUTIONS AND SOCIETIES.

Iron and Steel Institute.—A preliminary programme of the forthcoming annual meeting of the Iron and Steel Institute, which is to be held at Turin on October 2nd and 3rd, has been issued. Arrangements have been made for members resident in Great Britain to travel together. A special train leaves Holborn Viaduct Station at 9.30 a.m. on Friday, September 29th; Friday night will be spent in Paris and Saturday night at Aix-les-Bains. Turin will be reached in the evening of Sunday, October 1st. Among the Papers to be read are: "On the application of electrical energy to the manufacture of iron and steel in Italy," by Cav. Ing. Remo Catani; "On the autogenous welding of metals," by Dr. Francesco Carnevali; "On the physico-chemical properties of slags," by Prof. J. H. L. Vogt. From Wednesday, October 4th, to Monday, October 16th, a tour in Italy has been arranged, including Genoa, Rome, Naples, Florence and Milan. The party will leave Milan on Monday, October 16th, spend the night at Montreux, leaving the following evening by special train for Boulogne and London.

Institute of Metals.—The fifth volume of proceedings of this Institute has just been published. The major portion of the "Journal" consists of a series of Papers read at the annual general meeting of the Institute in January last. Among these Papers are: "A New Critical Point in Copper-Zinc Alloys; Its Interpretation and Influence on their Properties," by Prof. H. C. H. Carpenter and Mr. C. A. Edwards; "Some Practical Experience with the Corrosion of Metals," by Engineer Rear-Admiral J. T. Corner, C.B.; "Some Tests on White Anti-friction Bearing Metals," by Mr. H. J. Humphries and Prof. C. A. Smith; "The Adhesion of Electro-deposited Silver in Relation to the Nature of German Silver Basis Metal," by Prof. A. McWilliam and Mr. W. R. Barclay; and "The First Report to the Corrosion Committee," by Mr. G. D. Bengough. Particulars are also given of the newly-formed Birmingham branch of the Institute, whilst abstracts of Papers relating to the non-ferrous metals and the industries connected therewith are continued in the present volume. The Institute having recently become an incorporated institution, the concluding section of the "Journal" is devoted to the new memorandum and articles of association: there also appears a list of members of the Institute.

EDUCATIONAL NOTICES.

University of Sheffield.—The faculty of applied science comprises the departments of engineering, metallurgy, coal mining and architecture. The courses in engineering or in metallurgy extend over three years and prepare respectively for the degree of B.Eng. or B.Met. of the university. The lecture courses commence Oct. 4 and the technical laboratory courses on Sept. 18. Prospectuses and other particulars from the registrar, Mr. W. M. Gibbons.

City and Guilds Technical College.—This college provides a scientific training for students preparing to become electrical and mechanical engineers or chemists and for engineering pupils who desire to supplement their practical training by a two years' course of instruction in the principles of engineering science. The instruction is mainly given in the various laboratories, most of which have been recently re-equipped. The subjects of the entrance examination are mathematics and English, but the matriculation of any British University is accepted. The courses in electrical and mechanical engineering cover a period of two years and those in chemistry three years. There are also arrangements for three-year courses in engineering. Particulars at the college, Leonard-street, City-road, London, E.C., or from the City and Guilds of London Institute, Gresham College, Basinghall-street, London, E.C.

Heriot-Watt College, Edinburgh.—This college gives theoretical and practical training for mechanical, electrical and mining engineers, technical chemists, &c. The training for engineers consists of three years in the college and three years apprenticeship, on the sandwich system, in a local engineering works. Further information may be obtained from the Principal of the College, Mr. A. P. Laurie, M.A., D.Sc., or from the Heriot Trust Offices, 20, York-place, Edinburgh.

University College, Reading.—An endowment fund of £200,000 has been presented to this college so as to enable the Council within the next four years to apply for a charter of incorporation as an independent university. The donors are Lady Wantage, £50,000; Mr. G. W. Palmer and Mrs. Palmer, £100,000; and Mr. Alfred Palmer, £50,000. Mr. Alfred Palmer has also decided to present the college the freehold of 4 acres of land adjoining the main college site, and now used for horticultural purposes by the college under lease from him.

University College, University of London.—A gift of £30,000 towards the construction and equipment of the new chemical laboratories at University College has been made by Mr. Ralph C. Forster, who had previously given £4,500 to complete the purchase of the site.

Bootle Municipal Technical School.—The late Mr. Thos. Davies, of Bootle, has left £1,000 for a scholarship in applied electricity or engineering at the Liverpool University.

ARRANGEMENTS FOR THE WEEK.

THURSDAY, July 13th.

TRAMWAYS AND LIGHT RAILWAYS ASSOCIATION.

Annual Congress at Edinburgh. Papers on "Transfer Fares," by Mr. C. W. Shepherd, J.P. (General Manager, Edinburgh Corporation Tramways); and "A Few Reasons why Electric Traction in England remains Stationary," by Mr. G. H. J. Hooghwinkel.

FRIDAY, July 14th.

TRAMWAYS AND LIGHT RAILWAYS ASSOCIATION.

Congress at Edinburgh. Papers on "Notes on Tramway Problems," by Mr. C. W. Mallins (General Manager, Liverpool Corporation Tramways); and "Tramways and Light Railways Legislation of the Future," by Ald. W. Ivey (West Ham Tramways Committee).

THE LONDON ELECTRICAL ENGINEERS.

Officer Commanding, Col. H. M. Leaf.

The following orders have been issued for the current week:—

Monday, July 10th to July 14th.—Headquarters will be open from 10 a.m. to 4 p.m.

Saturday, July 15th.—Sheerness Detachment will parade at Headquarters at 3 p.m. Dress: Service dress, drill order, with water bottle and haversack. Arms will be issued before this parade.

Plymouth Detachment will parade as above at 9:30 a.m. Arms will be issued before the parade.

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BRIGHTON CORPORATION ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

The Brighton electric supply undertaking has been in operation for 19 years, and is noteworthy for the large output per head of population: and as Brighton is by no means an industrial town, many engineers may be surprised to learn that the output for power last year amounted to nearly 1½ million units, exclusive of over 2 million units supplied for electric traction. In his report upon the accounts Mr. J. Christie, engineer and manager of the undertaking, draws attention to the fact that the motor load must be approaching saturation point, but he is optimistic as to developments in electric heating and cooking, and anticipates that it will shortly be necessary for his Committee to consider what steps should be taken to meet the probable requirements of consumers in this direction.

In common with the majority of other engineers, Mr. Christie believes that the low-water mark in the progress of the electric supply undertakings brought about by the general use of metal filament lamps has been passed. In view of the fact that the output for private lighting last year at Brighton increased by 100,880 units, and now stands at 4,193,701 units, there are good grounds for this opinion. As regards the total output of 10,285,680 units, this shows an increase of 13¾ per cent. over last year's figures, the traction supply accounting for an increase of 84,804 units, whilst the special contract supply to the railway company and others has increased from 812,805 to 1,502,536 units. In connection with the supply to the tramways the price per unit has been reduced from 1·35d. to 1·2d.; and taking into consideration the conditions of the supply, Mr. Christie believes the tramway department now have the benefit of the cheapest supply of electrical energy in the country. Indeed, he does not consider it possible to make any further concessions until the costs of generation have been materially reduced.

During the past year 21 additional motors have been hired to consumers, bringing the total number of motors now on hire to 210, representing 1,041 H.P. The total number of consumers connected to the mains at March 31st last was 5,239, 219 new services having been laid during the year. This alone shows that the department is making good progress.

From the analysis of the accounts given below it will be seen that the total cost, excluding capital charges, has slightly increased, one or two of the items standing at a higher figure than a year ago. It should be noted that, on the average, 11d. per ton more has been paid for coal than was the case last year, which is equivalent to £1,108 on the quantity used. Due, however, to a better load factor and various economies in the operation of the plant, the weight of fuel consumed per unit sold has been substantially reduced—viz., from 5·95 lb. to 5·26 lb.—thus more than neutralising the increased price. The large increase in the cost of repairs and maintenance is due to alterations of the high-tension switchgear, oil cooling, hot well and circulating water pipe systems and repairs to sea defences. These items are, of course, exceptional, and will result in the plant being brought up to date, so that the benefit will be reaped in future years.

The maximum load on the feeders was 5,140 kw., the load factor being, therefore, 22·8 per cent., as against 21·8 per cent. last year and 20·1 per cent. in 1908-9. This steady increase in the load factor must be very gratifying to Mr. Christie.

As regards the prices obtained for energy, mention has already been made of the charge for energy supplied to the tramways. The lighting supply brought in an average revenue of 3·44d. per unit, the power supply 1·07d. per unit, public lighting 1·75d. per unit, bulk supply to Aldrington and Hove 1·83d. per unit and the contract supply 0·73d. per unit, the average for the whole output being 2·08d. per unit.

Turning now to the financial results, the total revenue from all sources was £98,821, an increase of £4,566 over that of the previous year. Working expenses absorbed 50 per cent., or £49,555 of this, and after providing for capital charges, &c., a net surplus of £4,751 is shown, as against £6,251 last year. Mr. Christie concludes his report by strongly recommending that this surplus be transferred to supplement the reserve fund, which at present stands at £12,993. He considers it is most essential that this fund should be conserved and brought up to the full statutory limit at the earliest possible date, as undoubtedly heavy calls will have to be made on it in the near future for the re-piling of the quay wall. Also, in view of the great strides being made in turbine design, if the undertaking is to be kept up to date he thinks it would be advisable, in the best interests of the department, to spend a portion of the reserve in reconstructing the old turbines in turn, as funds permit, in order to reduce their steam consumption.

We give below an analysis of the accounts for the year ended March 31, 1911, together with the cost per unit sold for each item, the latter figures for the previous year being also given:—

		Cost per unit sold. 1910-11.	1909-10.
Generating Costs.			
Fuel	£16,079	0·38d.	0·40d.
Oil, waste, stores, &c.	815	0·02d.	0·01d.
Wages at stations	5,666	0·13d.	0·15d.
Repairs and maintenance	6,123	0·14d.	0·08d.
Total Generating Costs	£28,683	0·67d.	0·64d.
Distribution Costs.			
Repairs of mains, meters, transformers, motors, &c.	£2,710	0·06d.	0·06d.
Total Distribution Costs	£2,710	0·06d.	0·06d.
Management Costs.			
Salaries, &c.	£5,124	0·12d.	0·13d.
Stationery and printing	195	—	—
Consulting engineer	1,000	0·03d.	—
Insurance	209	0·01d.	0·01d.
Law and compensation	16	—	—
General establishment and miscellaneous	1,287	0·03d.	0·02d
Total Management Costs	£7,831	0·18d.	0·16d.
Rents, rates and taxes	£4,087	0·10d.	0·11d.
TOTAL COSTS (*ex* capital charges and public lamps)	**£43,311**	**1·01d.**	**0·99d.**
Public lamps	£4,500	—	—
Work executed for consumers	£1,581	—	—
Capital Charges.			
Interest	£18,931	0·44d.	0·51d.
Sinking fund	£25,583	0·60d.	0·69d.
Total Capital Charges	£44,514	1·04d.	1·20d.
TOTAL COSTS (including capital charges and public lamps)	**£93,906**	**2·19d.**	**2·34d.**
Revenue.			
Private lighting	£60,188	—	—
Power	6,569	—	—
Special contracts and bulk	4,965	—	—
Traction	10,116	—	—
Public lamps	12,044	—	—
Meter and motor rents	3,017	—	—
Sundries (less bad debts)	1,758	—	—
TOTAL REVENUE (less bad debts)	**£98,657**	**2·31d.**	**2·51d.**
Balance	£4,751	0·12d.	0·17d.

The capital expenditure during the 12 months ended March 31st last was £23,433, making the total capital expenditure to that date £824,186. The various items included in this total are set out below, together with the cost per kilowatt of plant installed:—

	Total.	Per kw. installed.
Land	£17,946	£2·5
Buildings	149,889	20·7
Machinery	336,365	46·8
Mains	254,920	35·3
Meters, &c.	41,711	5·8
Motors for hire	8,031	1·2
Change of voltage	4,263	0·6
Purchase of patent rights	1,337	0·2
Engineer's commission	1,497	0·2
Office furniture	550	0·1
General expenses	1,127	0·1
Purchase of company's undertaking	5,000	0·7
Parliamentary expenses	1,550	0·2
	£824,186	£114·4

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Electric Tramway Undertaking.

Although this undertaking has been handicapped in several ways during the past year, it is yet able to show a profit of £137 on the year's working. In the first place, as Mr. W. Marsh, the engineer and manager, points out in his annual report, no Easter was included in the 12 months ended March 31st last, whilst the previous period of 12 months included two Easters. In view of the absence of the extra traffic which is always a feature of the Easter holidays, although the revenue for the year showed a decrease of £121 compared with the previous year's figure this result was not unsatisfactory. A number of passenger shelters have been erected in various parts of the town, and the whole cost has been charged against the year's revenue. The advertisements, however, bring in more than sufficient revenue to light and maintain the shelters.

Mr. Marsh mentions that the cost of repairs and renewals to the permanent way has been increasing somewhat rapidly of recent years, and the maximum has not been quite reached. The figure for 1910 was £5,554, and it is very satisfactory to notice that the whole of the renewals have been paid for out of the year's revenue, without any calls on the reserve fund. The undertaking has 17 acres of paving to maintain, and Mr. Marsh thinks few other tramway undertakings are so severely handicapped in having had the track paved with an inferior kind of wood. Granite paving is now being installed on several routes.

The number of car-miles run during the 12 months ended March 31st last was 1,126,676, 10,708,184 passengers being carried, and 2,023,109 units of electricity being used (*i.e.*, 1·79 per car-mile). The average traffic revenue per car-mile was 10·46d., and the working expenses 8·02d., or 74·23 per cent. of the receipts. We give below an analysis of the working expenses, together with the cost per car-mile of each item :—

		Per car-mile.
Traffic Expenses.		
Superintendence	£144	0·03d.
Wages of motormen and conductors	9,801	2·09d.
Wages of other traffic employés	541	0·11d.
Cleaning and oiling cars	862	0·18d.
Cleaning track	369	0·08d.
Fuel, light and water for depots	129	0·03d.
Ticket check	894	0·19d.
Uniforms	359	0·08d.
Miscellaneous	154	0·03d.
Total Traffic Expenses	£13,253	2·82d.
Repairs and Renewals		
Permanent way	£5,554	1·18d.
Electrical equipment of line	452	0·10d.
Buildings and fixtures	297	0·06d.
Machinery and plant	153	0·03d.
Cars	3,930	0·84d.
Total Repairs and Maintenance	£10,386	2·21d.
Management, &c.		
Salaries	£1,018	0·22d.
Store expenses	163	0·03d.
Printing and stationery	135	0·03d.
Fuel, light and water for offices	56	0·01d.
Law charges	7	0·09d.
Accident and fire insurance	753	0·16d.
Rents, rates	908	0·19d.
Miscellaneous	875	0·19d.
Total Management, &c.	£3,916	0·83d.
Power Expenses		
Current at 1·2d. per unit	£10,115	2·16d.
TOTAL WORKING EXPENSES (ex. capital charges)	**£37,670**	**8·02d.**
Capital Charges.		
Interest	£7,918	1·69d.
Sinking fund	5,022	1·07d.
Total Capital Charges	£12,940	2·76d.
TOTAL EXPENSES (inc. capital charges)	**£50,610**	**10·78d.**
Revenue		
Traffic receipts	£49,124	10·46d.
Advertisements, &c.	1,623	0·35d.
TOTAL REVENUE	£50,747	10·81d.
Balance	£137	0·03d.

HIGH-TENSION ELECTROSTATIC WATTMETERS.*

BY ERNEST WILSON.

It is well known that the quadrant electrometer can be used as a wattmeter on alternating-current circuits, and various methods have been devised for connecting it to the mains. The usual method is to impress upon the quadrants an E.M.F. proportional to the current in the main circuit, and to impress upon the needle either the voltage of the mains or a voltage proportional thereto. This is accomplished by passing the main current through a non-inductive shunt and connecting the quadrants thereto, and using a potential transformer when the voltage of supply has to be subdivided. The drawback to this method is that usually about 1 volt is required across the shunt, and when very large currents have to be dealt with the energy dissipated becomes large. As an alternative, "series" or "current" transformers can be employed, in which case the drop between the terminals of the primary coil can be very much reduced; but when considerable accuracy is required, especially on low power factors, this method is not reliable.

The use of a quadrature transformer whose primary winding is in the main circuit has been successfully developed by Dr. W. E. Sumpner in connection with iron-cored instruments.† It has also been developed in connection with electrostatic wattmeters,‡ and a diagram of one set of the connections is given in Fig. 1. In this diagram Q is the electrometer, whose moving system is connected to the ends of a non-inductive resistance, R, which is in series with

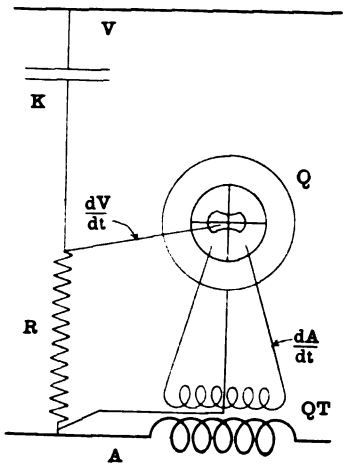

Fig. 1.

a condenser, K, across the supply mains. The quadrants of the electrometer are connected to the terminals of the secondary circuit of a quadrature transformer, QT.

The action of this instrument depends upon the equation

$$\frac{(2\pi f)^2}{T}\int_0^T VA\,dt = \frac{1}{T}\int_0^T \left(\frac{dV}{dt}\cdot\frac{dA}{dt}\right)dt,$$

in which V is the voltage of the supply mains, A the amperes in the work circuit, f the frequency of supply and T the periodic time.

The condenser can also be replaced by an inductive resistance. The arrangement shown in Fig. 1, however, has the advantage that the condenser K can be designed to withstand very high voltages, but it is only strictly accurate on sine curves. A number of experiments made with varying wave-forms showed that it is fairly reliable with approximately sine curves. The alternative arrangement has the disadvantage that it involves an inductive resistance capable of withstanding very high voltages, but it is independent of variation in wave-form. Each of these types is, of course, afflicted with the error arising from the proportion of the total voltage V to the voltage across the non-inductive resistance R, which on very high voltage systems becomes very small.

Fig. 2 shows in diagrammatic form a high-tension wattmeter whose moving system is directly connected to, and experiences the full voltage of, supply. The quadrants are connected to a small air-cored generator, G, which rotates in a magnetic field produced by and proportional to the current A in the work circuit. This generator is driven at known speed by a small motor, which can be either

* Abstract of a Paper read before the Physical Society. A brief account of the discussion that followed the reading of this Paper appeared in The Electrician for May 19, p. 212.

† "Journal" I.E.E., 1908, Vol. XLI., p. 227.

‡ British Patent Specifications 26,512, 1905, and 2,707, 1904.

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direct or alternating current. It was found that when the voltage V impressed upon the moving system is of the order 20,000 volts or more, the quadrants require a considerable voltage in order that accuracy and stability may be secured. In addition, the brushes of the generator have to be carefully adjusted so as to eliminate transformer action. The following are a few particulars of one form of generator which has yielded good results: The armature is of the two-pole type, and is wound with 100 sections, each having 50 turns and an area for magnetic flux of 130 square cms. The commutator has 100 parts. The field coil is built up of copper strip 2 in. deep by $\frac{1}{32}$ in. thick, and has four sections connected to blocks in such wise that they can be used in parallel or series or parallel-series groupings. The number of turns per section is 10. The speed of rotation is 3,600 revs. per min., and is registered by a Hartmann & Braun speed counter, capable of detecting a variation in speed of 0·3 per cent. The curve of voltage between the generator brushes was determined for various positions of a rotating contact-maker fixed to the shaft of the alternator and compared with the curve of current in the field coil. The agreement was as close as could be demonstrated by the method of test.

The electrometer in its first form resembled Lord Kelvin's quadrant electrometer. The suspension was made of phosphor-bronze strip, and the vanes, two in number, were each $10\frac{3}{4}$ in. long by about 4 in. broad at their widest part. In a later form of the instrument the quadrant pairs are the moving system, and are suspended by phosphor-bronze strip between two fixed sectors, which are heavily insulated and capable of withstanding several fold the normal voltage of the instrument. The suspended quadrants are $9\frac{1}{2}$ in. in diameter, and are $1\frac{3}{4}$ in. from the fixed sectors, the instrument being

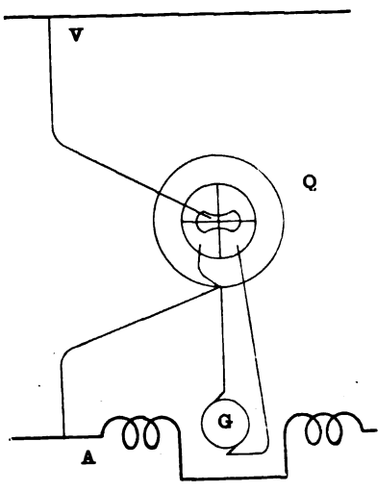


FIG. 2.

designed for 15,000 volts. The instrument obeys the straight line law, is accurate on low power factor and has a sensibility such that on a scale 50 in. distant from the mirror, the killowatts per millimetre deflection are 1·82 when the generator field coils are four in series.

A further piece of apparatus, depending upon the charging of condensers in parallel and the placing of them in series, has been used for multiplying a small voltage produced by the passage of the main's current through a low resistance shunt.

A NEW SECONDARY CELL.*

BY D. J. BLOCK.

It is a well-known fact that on electrolysing the halogen salts of zinc, cadmium, cobalt, nickel, iron, tin or copper, the metal is deposited at the cathode and the halogen at the anode, but no attempt appears ever to have been made to recombine these elements so as to recover, as kinetic energy, the potentiality degraded by their electrolytic dissociation. The cell herein described is designed to retain or store the halogen so eliminated within the body of the anode and to secure such an ionic emplacement as will, by recombination, return approximately all the energy used in effecting dissociation.

The cell (*see* diagram) consists essentially of a zinc containing jar "A," which serves as the cathode element; a paste, "B," of ground or granular carbon impregnated with an aqueous solution of ferric hydroxide, zinc bromide and zinc chloride; and an anode of porous carbon, "C," surrounded with cloth asbestos, the purpose being to form a carbonaceous wick to support the bromine against gravity, and to condense the chlorine. This is accomplished by using, in addition to the asbestos cloth, a specially prepared form of charcoal, which is able to retain within its pores about 200 times its volume (three-quarters of its weight) of chlorine gas and a larger quantity of liquid bromine. The mechanism of reaction is as follows:—

Anode.

$$15ZnCl_2 + 3ZnBr_2 + 18H_2O + 12Fe(OH)_3 =$$

On Charging

$$18Zn + 12Fe(OH)_3 + 30HCl + 6BrHO_3$$

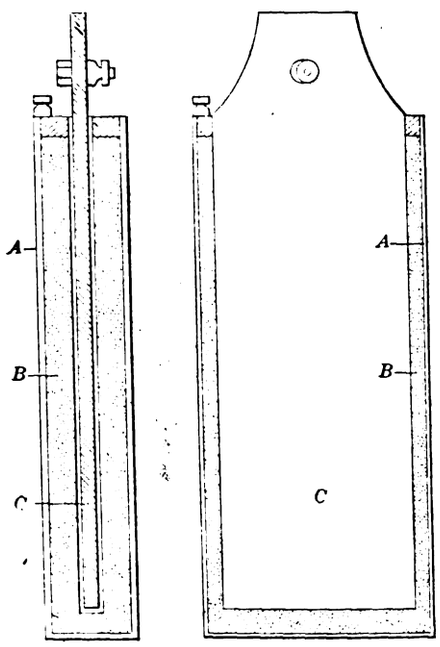
The ferric hydroxide then neutralises the bromic and hydrochloric acids, giving ferric bromate and ferric chloride, thus:

$$30HCl + 6BrHO_3 + 12Fe(OH)_3 =$$

On Discharging

$$10FeCl_3 + 2Fe(BrO_3)_3 + 36H_2O.$$

The ferric bromate and the ferric chloride are potentially equal to bromic and hydrochloric acids. The six molecules of bromic acid lose their 18 atoms of oxygen to the 18 atoms of zinc; the bromic acid becomes hydrobromic acid, and the zinc oxide so produced dissolves in the hydrobromic and hydrochloric acids hydrolysed from



SECTIONS OF CELL.

their ferric salts, giving back the original chloride and bromide of zinc, without the evolution of hydrogen and polarisation, thus:

$$18Zn + 10FeCl_3 + 2Fe(BrO_3)_3 + 36H_2O =$$
$$15ZnCl_2 + 3ZnBr_2 + 12Fe(OH)_3 + 18H_2O.$$

Some ferric chloride, not shown in the equation, is present to hold up the hydroxide and, in addition, a suitable substance is used to increase the conductivity of the electrolyte; neither of these interfere with the mechanism of electrolytic or chemical action, and consequently are omitted from the equation.

The first of these cells constructed had a cathode of iron and an anode of carbon surrounded with a paste of the haloid salts of iron. This developed surprising voltage irregularities, both on charging and discharging, due to the fact that the halogen salts of iron exist in two modifications. This is true also of tin and copper, so that in the selection of a cathode material for a second cell we were limited to lead, cobalt, nickel, cadmium or zinc. Of these, the latter was selected as best adapted to the purpose, although a cobalt cell is now under construction.

The zinc-carbon type of brom-chlorine accumulator cannot yet be considered a commercial success, the first of these cells having attained an electrical efficiency of but 28 per cent. This was largely due to high internal resistance, and has, in a measure, been overcome. One of the newer of these cells, now under test, shows an efficiency of nearly 52 per cent. However, this type of secondary cell has many desirable features, the chief of which, perhaps, is its light weight, the cell herein described developing one actual horse-power-hour per 15 lb. weight; the cost is low; no loss of energy due to hydrogen formation at the cathode can occur; and obviously, because of the neutral or weakly basic character of the electrolyte, the charged cell may be placed aside for long periods without loss of energy due to the corrosive action of the electrolyte.

* Abstract of a Paper read before the American Electrochemical Society.

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THE DUNSTON POWER STATION OF THE NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY CO.

Introduction.

In an article in THE ELECTRICIAN for January 13th, 1911, we described what the Newcastle Electric Supply Co. were doing as regards providing collieries on the North-east Coast with electrical energy. The activities of the Company are not, however, limited to collieries; in fact, they have upon their mains such varied consumers as shipyards, engineering and chemical works, as well as lighting, heating and cooking; the total connections, in fact, amount to some 150,000 H.P., a load which is spread over an area of 1,000 square miles, extending from Blyth in the north to Ginsboro' in the south, and westward from the coast to Consett and Bankfoot.

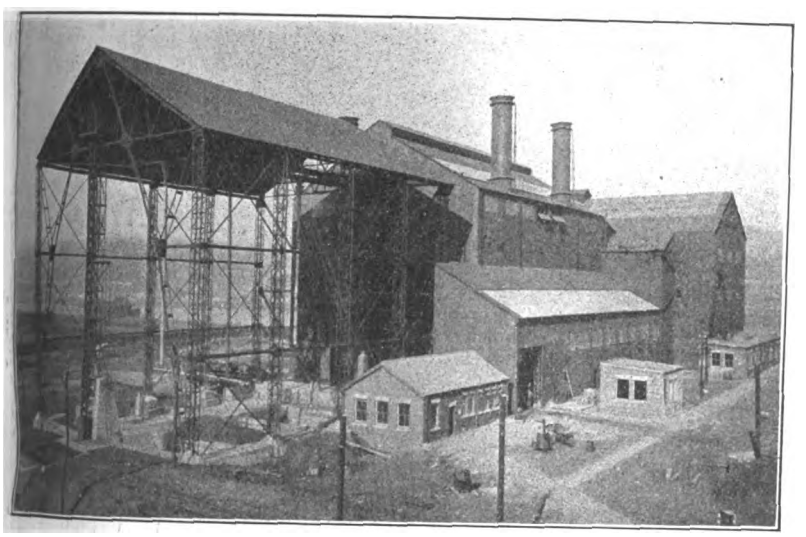

FIG. 1.—VIEW OF DUNSTON POWER STATION, WITH COAL STORE.

This enormous area is, of course, not supplied from one, but many stations, the principal of which is the well-known steam-driven plant at Carville-on-Tyne. Others, employing waste heat as a source of energy, are to be found at Blaydon, Newport, Weardale, Bankfoot and Bowden Close. It recently became necessary, however, to erect another steam-driven station, and a site at Dunston, on the south bank of the Tyne, was chosen. This site is about three miles from the high-level bridge at Newcastle and about eight from Carville. There is plenty of land at present available near by, and, as a result, works which are likely to require a supply of electric power are being attracted to the district. Dunston is also convenient geographically, being at the opposite end of the network from Carville. The Company's cables, which run down each side of the Tyne, are connected at Carville by a tunnel under the river and higher up the river at the High Level and King Edward Bridges. Further, the site is exactly opposite the Elswick works of Messrs. Armstrong, Whitworth & Co. Coal supplies, too, can be obtained with equal facilities from both the Northumbrian and Durham coalfields, and condensing water is plentifully present in the river.

General Arrangement.

The design of the station provides eventually, as will be seen from the diagrams herewith, for three boiler houses each with its own coal store, which will extend along the longer side of the engine room. The buildings are steel framed structures, and a minimum of brick-work has been used in their construction. All the main switchgear is placed in an entirely separate building some 150 yards away from the engine house. This arrangement, it is considered by the designers, has allowed not only a very light and convenient engine room to be erected, but what is more important, it has allowed the cables to be taken into and out of both sides of the switch house, thus facilitating the arrangements made for future extensions.

The "unit" system has been used throughout the Dunston station. That is, there is one coal store, one boiler house and one set of coal-handling plant for every eight boilers; and one boiler house containing eight boilers to every two turbo-alternator units. Further, there is one main steam pipe, one feed-water pipe, one hot-well feed pump, and one set of ash-conveying plant for each set of four boilers. There is one economiser and one coal shoot for every boiler; and each turbo-alternator has its own set of engine-room and boiler-house auxiliaries, the motors driving these auxiliaries being supplied with power from a separate transformer whose primary is fed from the particular unit concerned. It would appear that sub-

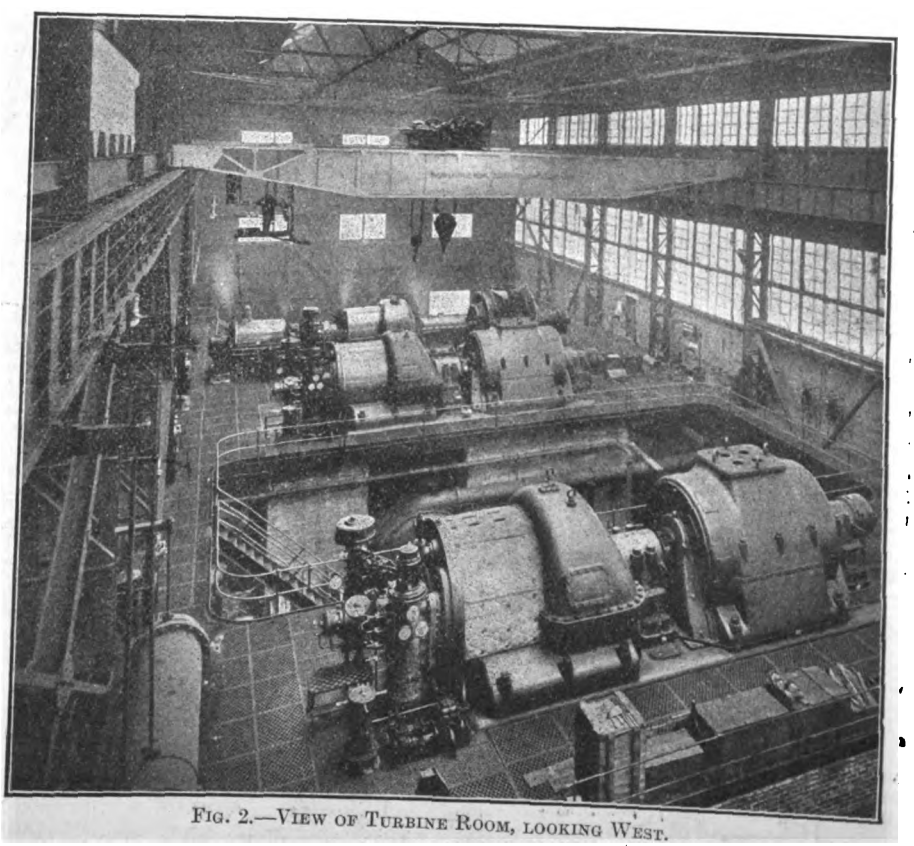

FIG. 2.—VIEW OF TURBINE ROOM, LOOKING WEST.

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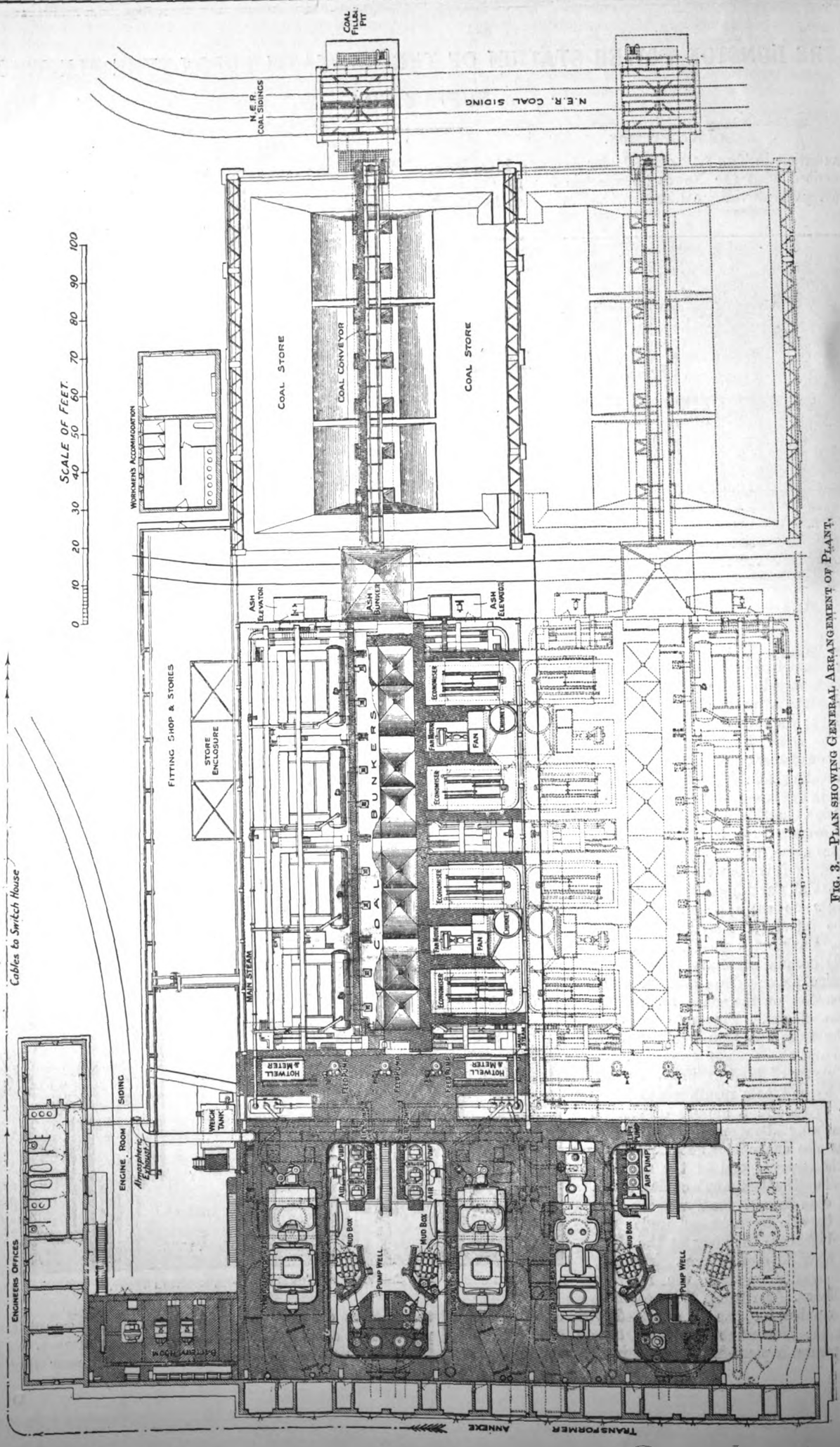

FIG. 3.—PLAN SHOWING GENERAL ARRANGEMENT OF PLANT.

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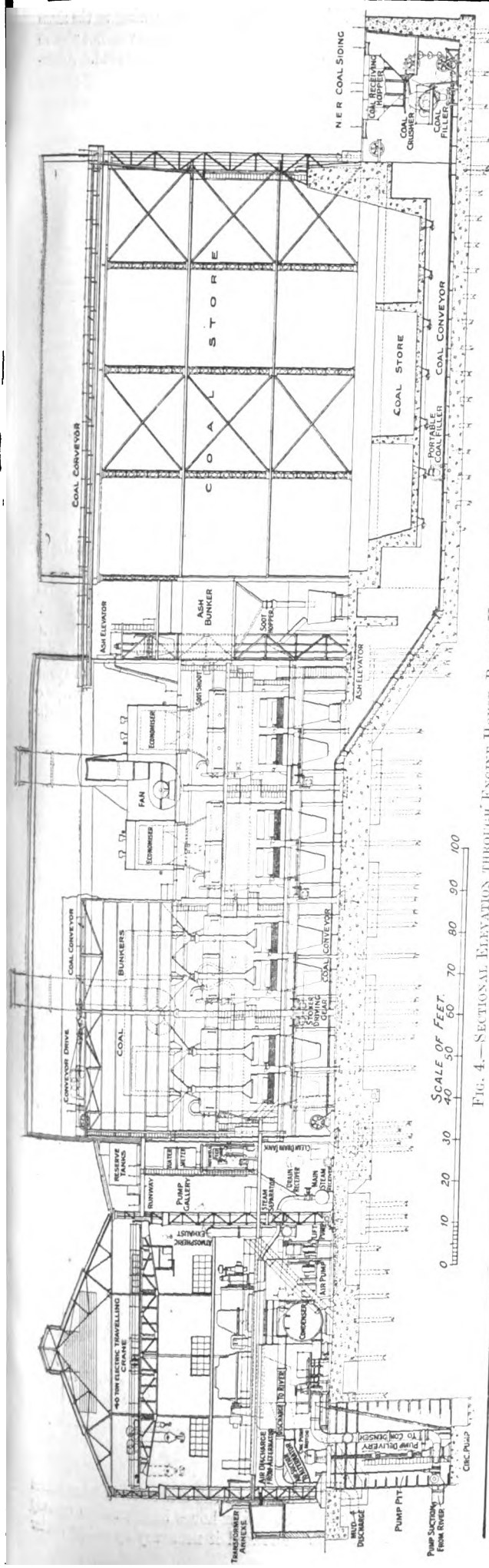

FIG. 4.—SECTIONAL ELEVATION THROUGH ENGINE HOUSE, BOILER HOUSE AND COAL STORE.

division could go no further. The design of the Dunston power station has, further, in general been carried out according to the ideas formulated by Messrs. C. H. Merz and W. McLellan, in their Paper on "Power Station Design," which was read before the Institution of Electrical Engineers in 1904 (*see* THE ELECTRICIAN, April 29th, 1904).

SYSTEM OF SUPPLY.

The station generates three-phase current at a pressure of 5,750 volts and a frequency of 50. It is a steam-driven station, the steam pressure used being 200 lb., whilst superheat is employed, so that the working temperature is practically 570°F. Dunston station has been designed on a 50,000 kw. basis, that is, six units with a nominal output of 8,000 kw. will eventually be installed, though their maximum capacity will be 10,000 kw. Four units have been provided for as a commencement, and three of these are already installed. If further extensions above 50,000 kw. are necessary a new station will have to be built, and adjacent land has been taken up for this purpose.

As mentioned above, the "unit" system has been followed throughout. There will be a separate boiler house for every two generating units, that is to say, there will be eventually three boiler houses, although only one of these has so far been completed. The boiler house taken as a unit will contain eight boilers, four on each side of the central gangway, but the design is such that three of these boilers will be capable of supplying sufficient steam for driving a generator unit at full load continuously.

BOILER HOUSE.

The boiler house is arranged with several floors, as will be noticed in Fig. 4. It includes first a very roomy basement, 18 ft. 6 in. high. Into this basement ashes are delivered from the boilers, and here, therefore, are placed ash bunkers, one for each boiler, and of capacity sufficient for storing the ashes obtained in 14 hours' working of the station at full load. This means that at ordinary loads ashes need only be cleared once in every 24 hours. In connection with this scheme, arrangements have been made so that the ashes need be handled as little as possible. They are removed in trucks from the ash-house bunkers. These trucks are then raised by electric lifts to the ground floor level. Next they are dumped into a large overhead bunker, which is used for ashes alone, and one of which is provided for each boiler house. This overhead bunker is of such capacity that 2 or 3 tons of ashes can be stored in it. A railway siding runs underneath it so that ashes may be taken away by rail or removed in trucks to the quayside and there dumped into barges. A view of the station with its coal store is given in Fig. 1.

Above the ash-house, on the next floor, are placed the boilers themselves, these being, as mentioned above, grouped in pairs. Each boiler, however, has its own superheater and economiser, though, as regards the fans and chimneys, the unit is again a pair of boilers. The fan and chimney for each double unit are placed directly over the corresponding boilers and the economisers are placed over the boilers in pairs.

Automatic operation is used for supplying the necessary coal to these boilers. Over the centre of each boiler house are arranged enormous coal bunkers which are capable of holding a week's supply of coal, assuming the whole station to be running at an average of half load during that period.

As regards the delivery of coal, it is first dumped into receiving hoppers by means of bottom dumping trucks. Next it is, if necessary, passed through a coal-breaker, and it is then lifted by means of a conveyor to the hoppers. This conveyor is capable of dealing with 40 tons of coal per hour and is electrically driven.

The boilers are fed by means of Babcock & Wilcox chain-grate stokers, the grate area per boiler being 168 sq. ft. The economisers are placed in a separate house above the boilers, where also are to be found the fans and fan motors.

The boiler house is equipped with a series of galleries at different heights and running the whole length of the house, so that the water level can be ascertained and other duties

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performed with ease, while access is obtained to the economisers and fan motors. Each mechanical stoker and each economiser scraper is driven by a separate enclosed electric motor. The whole boiler installation is designed so that when working at maximum economy the temperature of the chimney gases does not exceed 300°F.

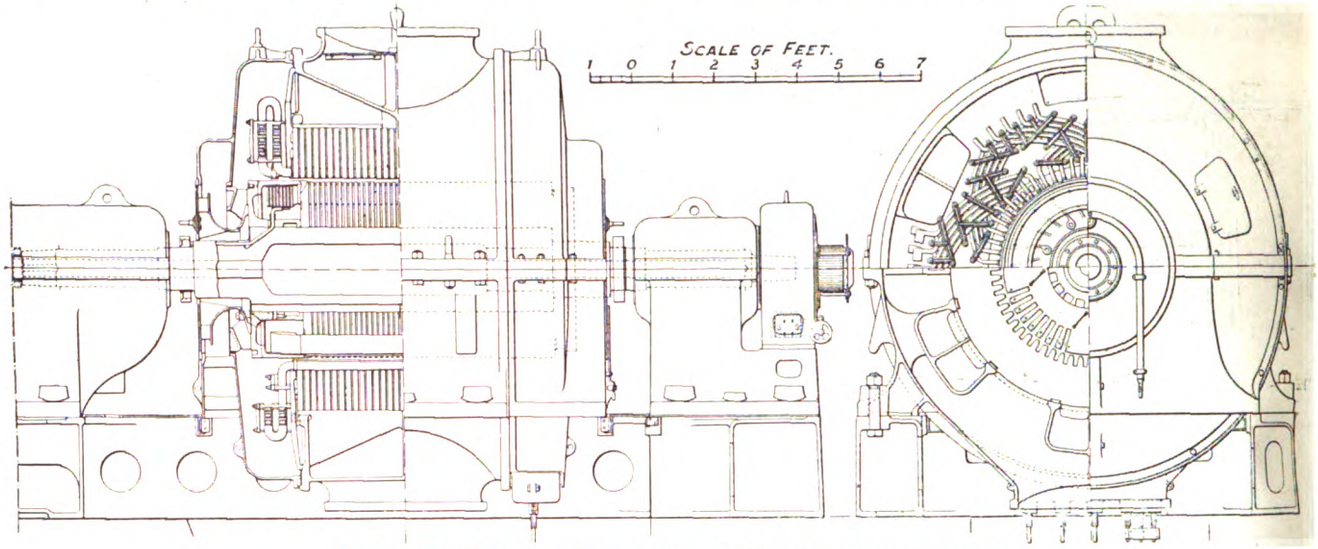

FIG. 5.—PART SECTIONAL ELEVATIONS OF 7,000 KW. TURBO-ALTERNATOR.

siding right through the boiler houses, but owing to the shape of the land on which the station was built this was not possible at Dunston, so that a conveyor had to be installed. Advantage has, however, been taken of this necessity to instal at the end of the boiler house a large store capable of accommodating sufficient coal to operate the station for three weeks. This store is additional to any coal there may be in the bunkers. When coal is delivered into this store it is supplied from the same conveyor which feeds the boiler house. This is effected as follows: Underneath the store is a tunnel; in this tunnel are placed filling hoppers which feed on to the conveyor so that the one conveyor either delivers coal direct to the boiler-

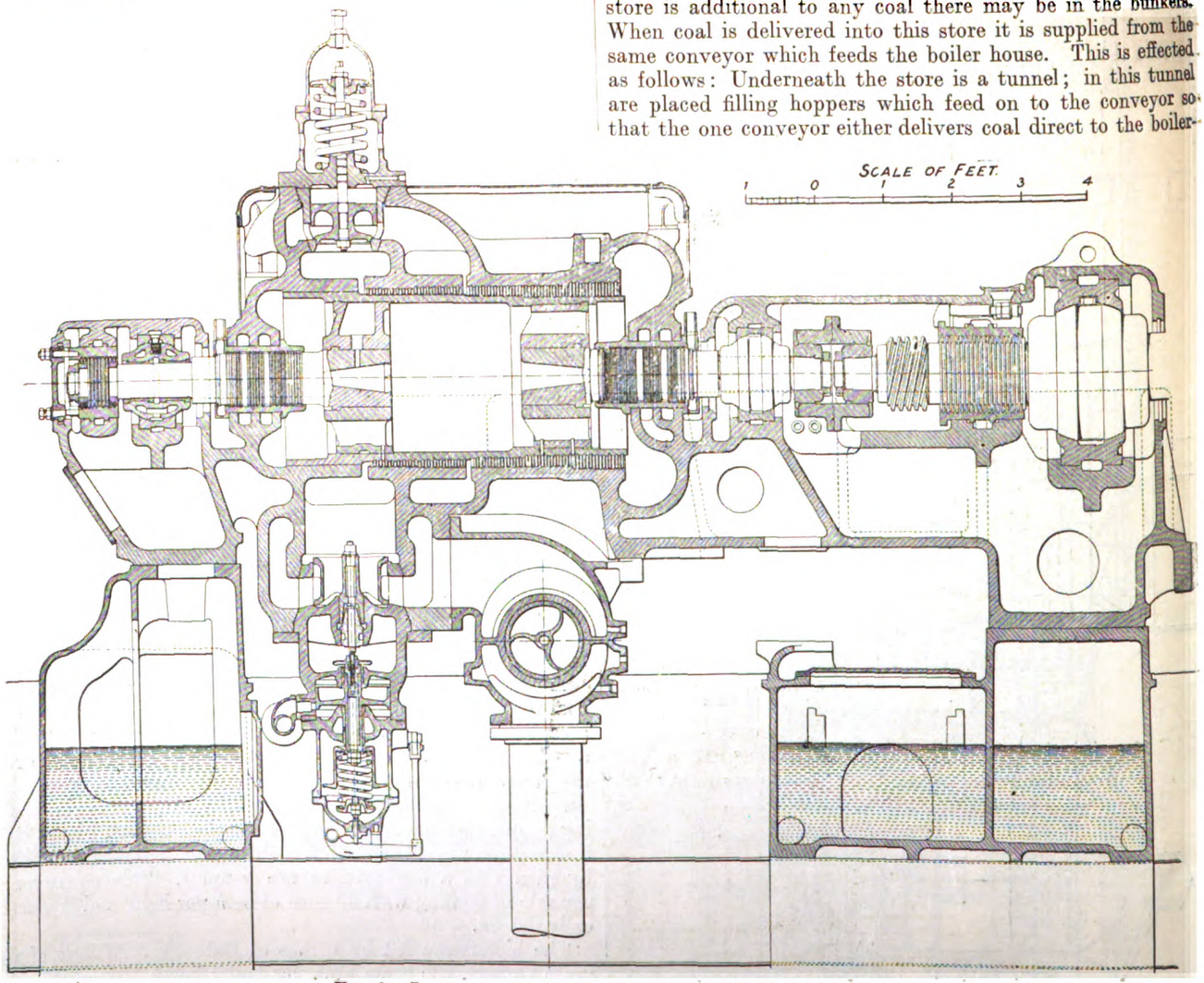

FIG. 6.—LONGITUDINAL SECTION THROUGH 7,000 KW. TURBINE.

As regards the design of the boiler house at Dunston, it may be interesting to point out the differences that exist between it and Carville. At Carville it was possible to run the railway house bunkers or delivers it to the coal store, or takes it from the coal store up to the boiler-house bunkers. The capacity of this store can be increased if necessary by adding further

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floors to the building. This will enable large quantities of coal to be kept in one building without any risk of spontaneous firing taking place owing to the fact that the store will ultimately be divided up by means of floors into layers not exceeding 12 ft. deep.

station is that adjacent to the siding is a large space on the ground floor level on to which the parts of any turbine alternator that has broken down can be dumped for repairs or overhauling. This space is traversed by a small overhead crane which also feeds the repair shop near by. This shop is in direct

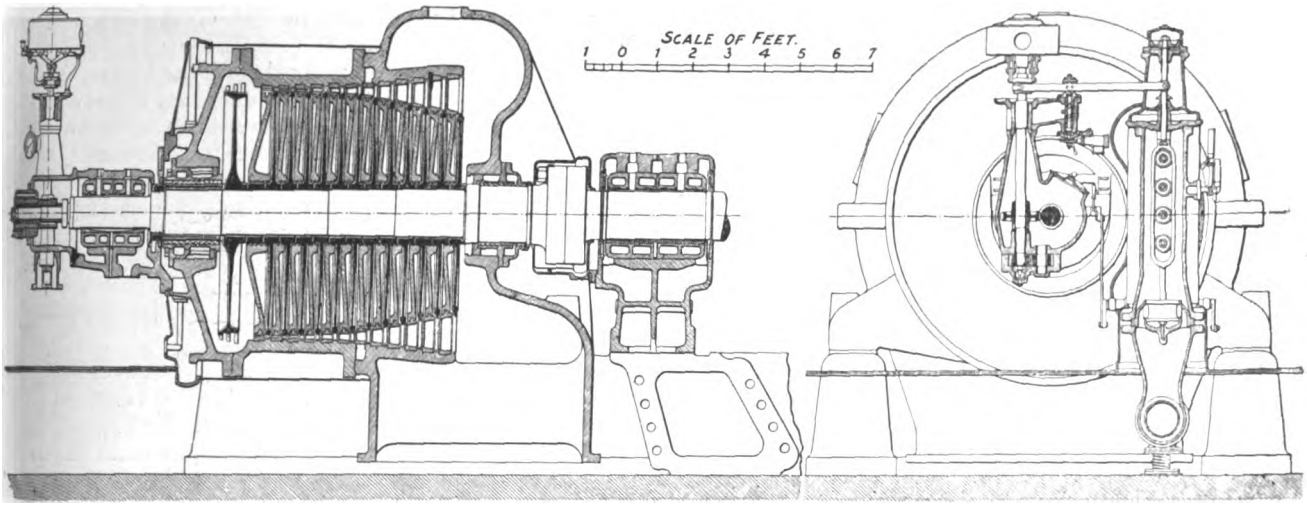

FIG. 7.—SECTIONAL ELEVATIONS OF 8,000 KW. TURBINE.

TURBINE ROOM.

The present turbine room, of which a view is given in Fig. 2, has been built to accommodate four turbines, each with a capacity of 8,000 kw. The railway siding runs right into the

communication with the offices, mess rooms, and lavatories for the engineers and staff at the station.

In designing the turbine room every effort has been made to obtain as compact an arrangement of the machines as possible.

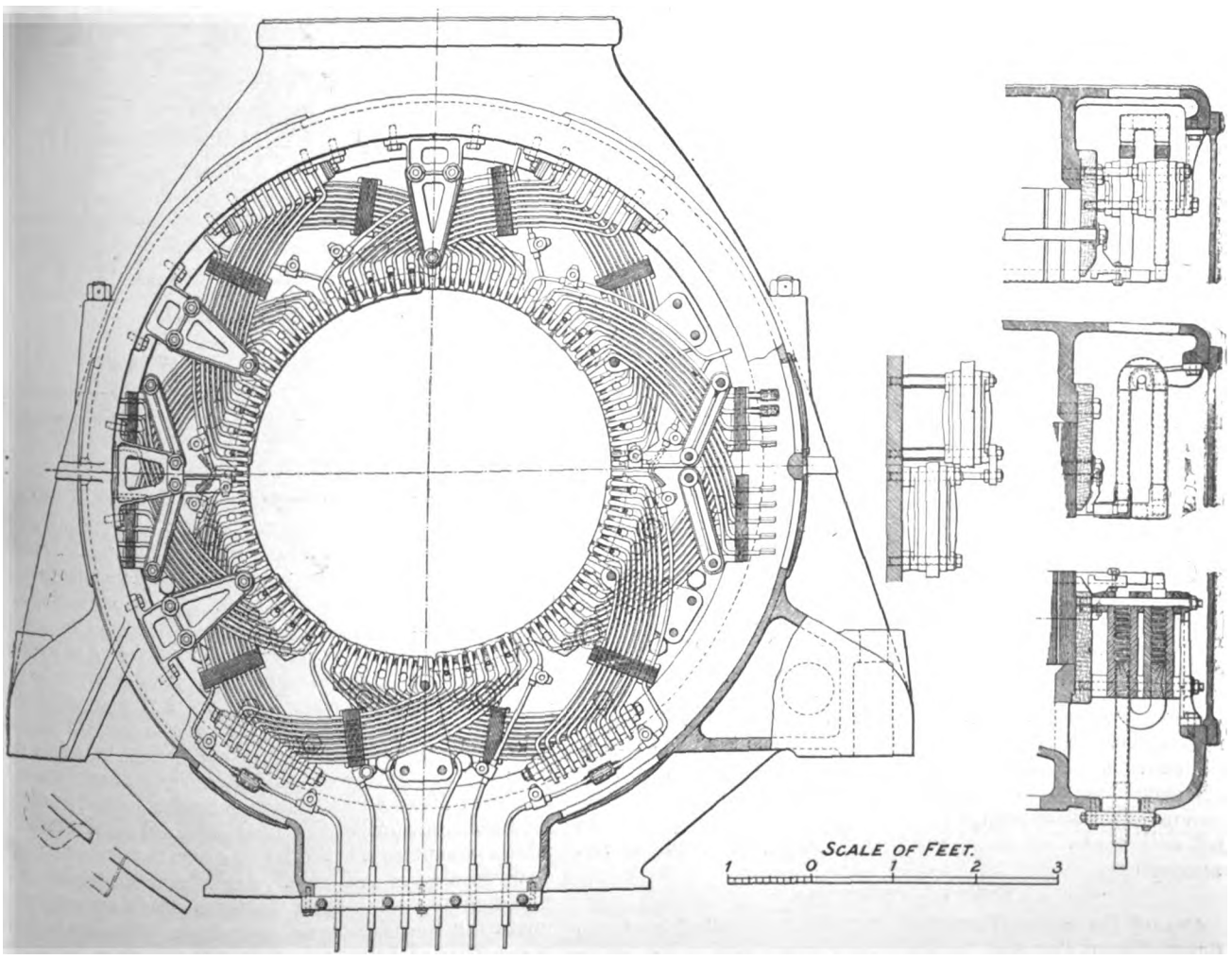

FIG. 8.—END ELEVATION AND DETAILS SHOWING END CONNECTIONS OF 8,000 KW. ALTERNATOR.

room and over it is placed an electrically-operated overhead travelling crane which can deal with loads not exceeding 40 tons. A point worth noticing in the design of this part of the

Such compactness not only facilitates the operation of the station, but also allows everything, including the auxiliary machinery, to be got at by the overhead crane. This accessibility

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of plant applies even to circulating water sumps, of which there will eventually be three, or one for every two units. These sumps are placed in the engine room, midway between each pair of turbines, and go down to a depth of some 70 ft. below the engine room level. In each sump are placed two electrically-driven centrifugal pumps, one for each generating unit, these pumps being so arranged that they are "drowned" at all states of the tide. The pump shafts are arranged vertically, and the motors driving them are placed on the engine-room floor level. The suction of each of these pumps is in direct communication with the intake sumps at the river by means of a 24 in. cast-iron pipe. The entrances to these sumps are provided with suitable gratings to prevent the introduction of foreign matter to the circulating system and in order to avoid blocking the condenser tubes. As a further precaution, self-cleaning screens are provided for each condenser. One salt-water pump is also installed in each sump for supplying water for general cleaning purposes.

A glance at the illustration showing the engine room will be sufficient to indicate that utility has throughout been the key-note of the design. Continental engineers usually erect a station with tile or brick floors all round the turbine. This is all very well, but it requires additional work to keep them clean, and, besides, renders the auxiliary units more or less

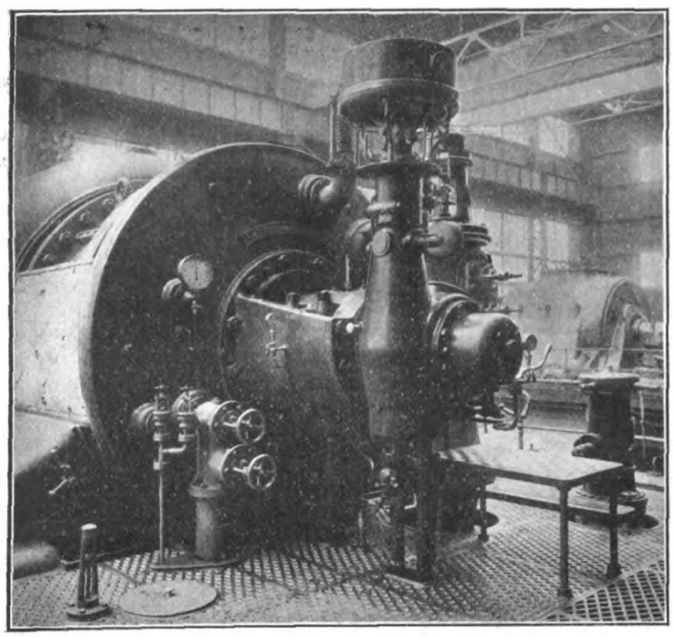

FIG. 9.—GOVERNOR GEAR OF 8,000 KW. TURBINE.

inaccessible. At Dunston, on the other hand, access to the turbine is secured by means of open cast-iron floor plates and galleries extending over the basement of the station at the turbine lever. Roof lights and large windows running the whole height of the engine room provide ample illumination round the main sets, while the basement is also in this way sufficiently illuminated.

On the same level as the turbines and between them and the boiler house are placed the feed pumps, the hot wells, the water meters, &c. These will all be operated by the turbine drivers. Beneath the pump gallery are various small pumps, and on the same level as the condensers are the electrically-driven air pumps. The feed pumps exhausts can either be taken to the hot-well tanks or to the water softener, or direct to the atmosphere.

TURBO-ALTERNATORS.

One of the turbo-alternators at present installed is of the Brown-Boveri-Parsons two-cylinder type, and the other two are of the A.E.G. impulse type. The alternators have been designed to stand the severest short circuits which are likely to come upon them in practice. Sections of the 7,000 kw. set are given in Figs. 5 and 6 herewith, and of the 8,000 kw. A.E.G. sets in Figs. 7 and 8, the governor gear of the latter sets being shown in Figs. 9 and 10.

The exciters for each alternator set are arranged on the ends of the alternator shaft. Special mention may be made of the ventilating arrangements which are so necessary for alternators running at a high speed. The arrangement adopted at Dunston has been to instal fans which draw air in from outside the building, a constant supply of cold air being thus obtained. At Dunston the fans are fixed to the alternators themselves, the air being drawn in through ducts and filtered on the way. The unit system has been used in this part of the plant too, there being a special duct and fan for each alternator. Further, the outlet air ducts are so arranged that the hot air can either be discharged direct to the outside of the building or into the engine room, so that the temperature of the latter can be controlled at will.

AUXILIARIES.

For driving the station auxiliaries three-phase current at a pressure of 440 volts and a frequency of 50 is used throughout. The auxiliaries belonging to each alternator are fed from a 500 kw. transformer which is installed in a fire-proof chamber opposite the alternator concerned. The primary of this transformer is directly connected through switches to the main

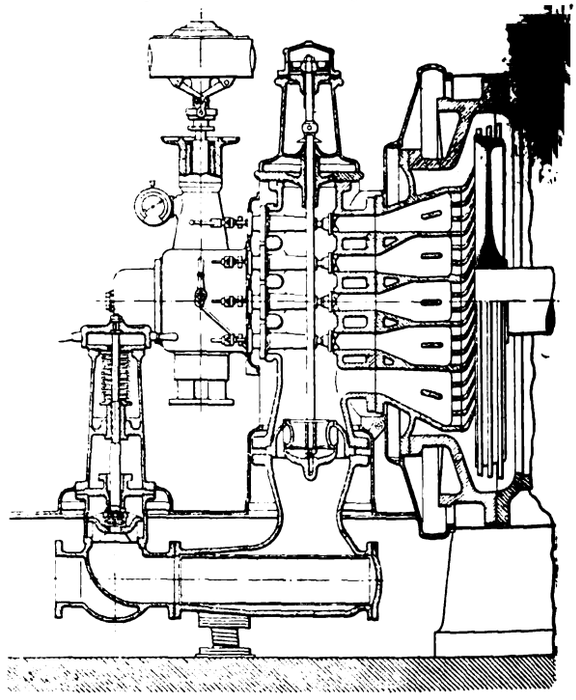

FIG. 10.—GOVERNOR GEAR OF 8,000 KW. TURBINE.

terminals of its own alternator, so that the auxiliaries are supplied even if the main alternator switch is open. In addition to these unit auxiliaries provision is made for the feeding of other motors in the station from a set of 'bus bars which are supplied from the main 'bus bars in the switch house through two 500 kw. transformers. These supply a set of low-tension 'bus bars which are placed on an enclosed gallery in the engine room. Although these 'bus bars are used in general for supplying the motor generators, the rotary converter and the isolated motors throughout the works, they can also be used for giving a supply at starting to the exciter circuit or auxiliaries of any one unit. Two 50 kw. motor generators are used for supplying direct current for lighting the station and charging the battery, which is kept as a stand-by to ensure that current for lighting shall be always available. A smaller motor generator is used for charging two other batteries which are employed for operating the high-tension switchgear. The large battery has a capacity of 1,000 amperes at the one-hour discharge rate and the two smaller batteries a capacity of 100 amperes at the same rate of discharge. The rotary converter is used for supplying power to the electric locomotives which work in the station yard.

(To be concluded.)

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SIEMENS MERCURY CONTACT TREADLE FOR RAILWAY SIGNALLING.

The recent railway disasters have drawn attention to the desirability of an extension of automatic signalling on railways, so that the following particulars of the most recent form of the mercury contact treadle of Messrs. Siemens Bros. & Co. should prove of interest. The object of this apparatus is automatically to close or open an electrical circuit by the passage of a train at a given point on a railway line. This circuit may be utilised for a variety of train signalling purposes.

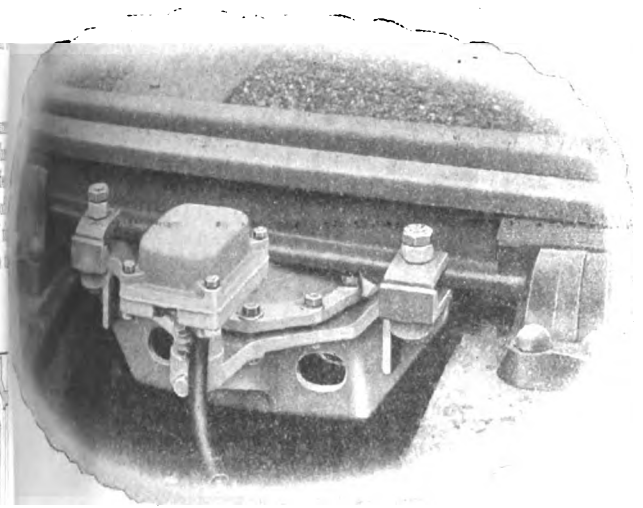

FIG. 1.—TREADLE ATTACHED TO RAIL.

The Siemens mercury contact treadle has already proved its practical value in a number of installations. The design of the apparatus obviates the many difficulties experienced with treadles in which a more or less complicated system of levers is used to magnify the deflection of the rail; and the apparatus also possesses the great advantage that, if proper care be taken when first erecting, it remains quite unaffected by changes of temperature. It is entirely self-contained and both dust and water tight.

Owing to the increasing use of electricity for power and traction purposes, it has been found desirable to make treadles in which the circuit, when open, shall be entirely free from earth. The Siemens types are now all fitted with two insulated contacts to meet this condition. The contacts are of several forms, all interchangeable, and are arranged to meet various conditions that may arise, viz., (1) To give one long contact during the passage of the whole of a train. (2) To give intermittent contacts during the passage of a train. (3) To maintain a normally closed circuit which is opened by a train.

The apparatus, which is illustrated in Fig. 1, is actuated by the deflection of the rail between two chairs due to a passing wheel, the slight movement obtained being transferred to the electrical contact in the manner described below. Fig. 3 is a cross section of the apparatus bolted to a rail. In this illustration the apparatus is shown fitted with the first-mentioned type of contact.

The treadle (Fig. 3) is in the form of a strong iron casting, A, which, by means of the clamps, B, B, is firmly bolted to the bottom flange of the rail. In the centre is a circular shallow recess, C. A thin steel diaphragm, D, is clamped between the rim of the recess and the cover, E, by the bolts. In the centre of the cover, E, are the steel plunger, F, and plate, G, resting on the diaphragm, D. An india-rubber ring, H, laid in a groove in the cover, E, surrounding the plunger, F, makes an elastic joint which is both water and dust proof between the treadle and under surface of rail. The passages, J and L, connect the recess, C, with the contact device inserted into the mercury chamber, K. The contact pins, N, are supported by, but insulated from, the cover, O, of the contact box.

The contact device consists of a cast-iron box having valves and passages, the action being similar to that of a pump. According to the type of contact given, mercury is either forced into or withdrawn from the contact box. It should be noted that the mercury is in such a state of circulation during the time that the diaphragm, D, is in movement that any scum that should happen to form on its surface will not detrimentally affect the contact, the latter being always made with perfectly clean mercury. The spaces in which the mercury is contained and operates are hermetically sealed, thereby preventing oxidation or accidental loss of the mercury.

In consequence of the different levels of the mercury in the space, K, and recess, C, the diaphragm, D, and with it the plunger, F, are always pressed firmly upwards against the foot of the rail with a pressure of about 150 lb. As soon as the rail experiences a slight deflection between the points of attachment of the treadle, due to the weight of a moving vehicle, the plunger, F, communicates the deflections, however slight, to the diaphragm, D, and thus displaces the

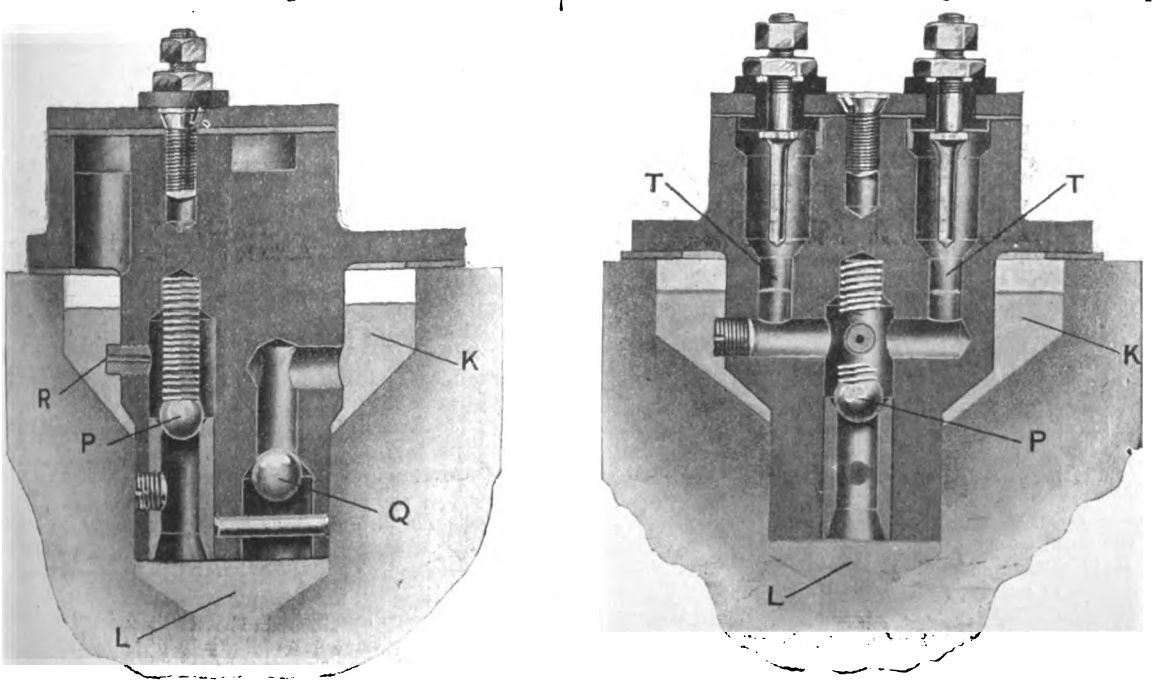

FIG. 2.—CROSS SECTIONS OF TYPE "D.P.C." CONTACT.

The treadle is supported solely from the rail between two contiguous sleepers, is quite independent of the ballast, and, being clamped to the bottom flange of the rail, no holes are required in the latter. Its range of sensitiveness is such that with the recent improvements it will work equally well on the lightest or the heaviest rails with any description of rolling stock travelling at slow or fast speeds.

mercury confined in the recess below. As the ratio between the area of the recess to that of the contact chambers is about 1,500 to 1, the amount of mercury displaced ensures good electrical contact being established.

The action of the first-mentioned type of contact, that for giving one long continuous contact during the passage of a train, is as follows (*see* Fig. 2):—The normal level of the mercury is about ¼ in. below

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the contact pins, but upon the deflection of the diaphragm, D, taking place, the mercury is displaced and rises via the delivery ball-valve, P, through the horizontal hole and thence into the contact chambers, T. In order to ensure that a continuous contact is established, another or suction ball-valve, Q, is provided, which, by reason of its tendency to float in the mercury, automatically seals itself on its face in an upward direction.

As soon as the reflex action of the diaphragm takes place, *i.e.*, as soon as a wheel has passed, the passage, L, is again filled with mercury by reason of the mercury passing the suction valve, Q, from the reservoir and replenishing quickly this part, to the extent of the amount of mercury passed through the delivery valve, P. Thus, whether the traffic consists of light or heavy stock, travelling either slowly or quickly, the treadle contact responds immediately and gives one prolonged contact.

Owing to the great displacement of the mercury, provision has to to be made for an overflow into the reservoir, K. This is arranged by making contact chambers at the top open into an annular channel, which is, in turn, connected by a hole leading into the reservoir, K. In actual practice it is found that with ordinary traffic this overflow always takes place, and, therefore, the contact pins are fully immersed

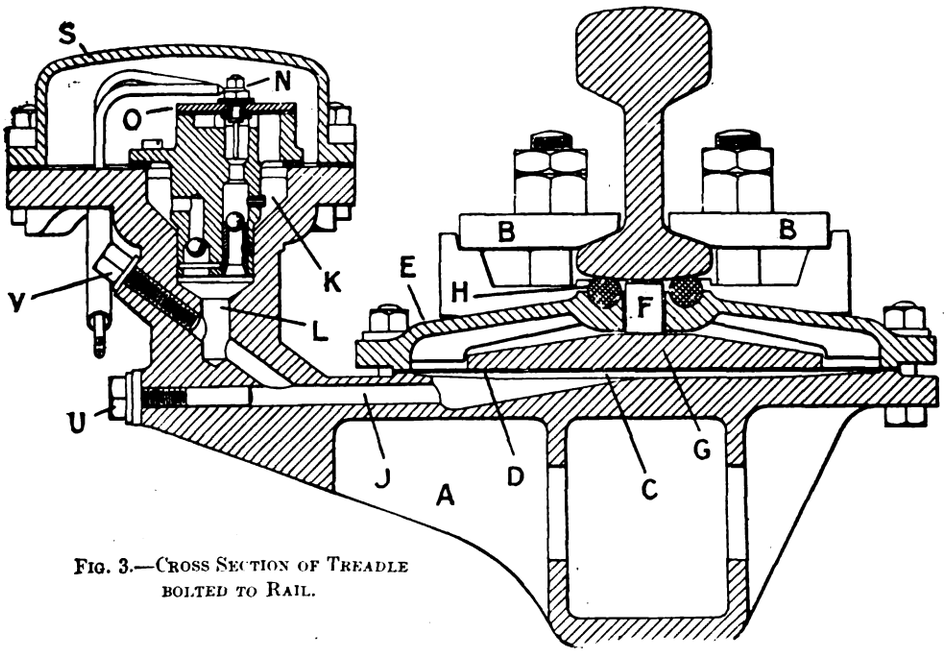

FIG. 3.—CROSS SECTION OF TREADLE BOLTED TO RAIL.

in the mercury. The mercury remaining in the contact chambers, T, maintains the circuit between the passage of the wheels, as it can only escape into the chamber, K, through the small hole in screw, R. The size of this hole can be varied so as to maintain a contact for 1 to 8 seconds after the last wheel has passed over the treadle.

Particulars of the operation of the other two forms of contact mentioned are contained in a pamphlet recently issued by Messrs. Siemens Bros. & Co.

CONFERENCE ON EDUCATION AND TRAINING OF ENGINEERS, 1911.

(*Continued from page 462.*)

Wednesday, June 28th (continued).

SECTIONS I (GENERAL EDUCATION) AND II (SCIENTIFIC TRAINING).

Prof. S. P. THOMPSON next read his Paper, an abstract of which we give below :—

ON THE EXTENT TO WHICH MATHEMATICAL AND SCIENTIFIC SUBJECTS SHOULD SHARE WITH OTHER SUBJECTS OF LITERATE EDUCATION THE ATTENTION OF SCHOOLBOYS WHO INTEND TO ENTER LATER THE ENGINEERING PROFESSION.

BY PROF. S. P. THOMPSON, D.SC., F.R.S.

Complaint must be made of the lack of definite aim in the teaching of secondary schools. A few boys are prepared for scholarships or for Sandhurst or Woolwich ; but is there in all England a single school which has a definite educational aim towards which it focusses the training for as many as 50 per cent. of its scholars ? In Germany matters are very different. There are two examinations which every boy in the secondary school must attempt, and the immense advantages of this reasoned organisation cannot be overstated. Again, there is only matriculation here ; each university wastes its energies over these examinations, and almost all the professional bodies have examinations of their own in addition.

With one of the recommendations made by the Institution of Civil Engineers' Committee, presided over by Sir Wm. White, viz., that a general knowledge of elementary physics and chemistry or natural philosophy is preferable to the pursuit in detail of some particular department in science, the writer finds himself in most hearty agreement. Many mistaken notions are abroad as to science-teaching in schools. Excellent as was the notion to give science a place in the school curriculum, the pressure put upon schoolmasters to introduce science subjects has had some strange results. The writer knows of one school where the "chemistry" taught twice a week consisted in making the boys "get up" a chapter from Roscoe's Elementary Lessons without their ever making, or even being shown, a simple chemical experiment. On the other hand, the heuristic method—a method used in due place by every good teacher since the days of Socrates—has been absurdly pressed, even to the detriment of progress. There can scarcely be anything more dreary than a forced heuristic lesson by a teacher who has neither inspiration nor sympathy. For at school the first object of science-teaching should be to evoke interest, not to impart the facts or data of science, still less systematise their re-discovery. All that has its place later. The fossilisation of science-teaching is indeed the thing now most to be feared. Not until a boy is 15 or 16, and is approaching the stage of matriculation, should science be allowed to degenerate into a grind. The stimulus of the approaching examination will carry him through the drudgery: and the amount of drudgery will be felt to be small because of the interest already acquired in the subject itself. It can hardly be too strongly urged that any specialisation in scientific subjects before that stage has been passed is essentially out of place and harmful.

Reverting to mathematics, it may be remarked that a great change has already come over mathematical teaching during the last ten years. This is partly due to the general discontent with the bad methods in vogue, partly to the strenuous crusade undertaken by Prof. Perry and other reformers. One difficulty which has been experienced by masters of progressive tendencies in the promotion of sensible reforms has been the stupidity of inspectors who have not yet grasped the importance of them. The benumbing influence of the older Cambridge traditions is also felt. Bad teaching is responsible more than anything else for distaste for mathematics. A really capable teacher will make his boys enthusiastic over matters that in the hands of others are deadly dull. A class can be made—the writer has seen it happen with students of 17 or 18—wildly excited over Bessel's functions : and a class of young boys has been known to sit up late in the pursuit of finding out all the prime numbers that occur between 1,000 and 2,000. If mathematical teaching is dull it is the fault of the teacher.

Of all the changes that have come over the teaching of mathematics, the greatest is the almost complete disappearance of Euclid. Theoretical geometry is now taught on other lines. But the writer is not sure whether the loss is not greater than the gain. Euclid in the hands of an uninspired teacher was probably the worst possible way of teaching geometry ; the worst, because it was too often attempted with boys who had not previously learned any geometrical drawing, and had, therefore, no conception as to what it was all about, and because the way in which the subject was treated was often merely to learn by rote something that neither the teacher nor the taught really understood or valued. But the teaching of Euclid was in one respect absolutely invaluable. If it is approached rightly after practice in geometrical drawing which familiarises the learner with the concrete facts, the study of Euclid constitutes an unrivalled training in methodical and cogent reasoning. The great charm and value of Euclid's presentation is the way in which one proposition hangs logically upon another. Sequence and sustained cogency of argument are the vital matters. The bad teacher ignored all this, requiring only verbal accuracy in memorising details, and brought disrepute on the finest mental discipline ever introduced into education. But Euclid is gone, and there has been nothing put in its place. It is the

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writer's deliberate opinion that boys nowadays are less capable of following a sustained train of thought than they used to be. The mental discipline of the chain of connected thought is strange to them. There may be other causes also; but this is assuredly a cause.

It may be that in the evolution of literate studies, particularly in the teaching of the analysis of sentences and in the logical composition of exercises, some equivalent discipline may be found. But it is doubtful whether in the study of English in the schools as much attention is given to analysis as was the case ten years ago. Every educator interested in maintaining a good balance in the subjects of preliminary education will surely agree that, while premature specialisation, whether in languages or in science, is to be deprecated, boys must be trained in thinking and in the expression of thought. In the conflict of subjects one is apt to lose sight of the fact that training in thinking and in the correct expression of thought is more essential than the study of any particular subject, whether Greek or geometry. It is, after all, not so important whether the hours per week given to science should be a few more or a few less, as that in all studies—science, mathematics, language or literature—there should be cultivated precision in the use of words, and cogency in modes of thought. These things are more important in the long run, and vastly more important in the ultimate making of a professional engineer, than the acquisition of a hoard of scientific facts. The secondary school must not degenerate into a house of cram.

Dr. Gow's* and Prof. Thompson's Papers were then jointly discussed.

DISCUSSION.

Sir JOHN WOLFE-BARRY, K.C.B., F.R.S. (London) said they would all be in accord with the last sentence of Prof. Thompson's Paper. In fact, the only point of issue between the two Papers seemed to be the amount of time that should be given to each subject. They would all be agreed that literature should be one of the subjects studied. It seemed that too much was attempted at secondary schools at the present time. Mind culture only should be undertaken up to the age of 16, and laboratories in such institutions, therefore, seemed unnecessary. Language and history were very important. He doubted, however, whether there was quite as much time as Prof. Thompson seemed to think for interesting lectures. What engineers wanted was more general culture than had been given by any system of engineering education so far laid down. When the time came for retirement, as he (Sir John) had now retired, the engineer would find how valuable was that broad outlook on politics and literature which only general culture could give. General culture was an absolute necessity for an engineer.

Mr. T. REUNERT (Johannesburg) pleaded that the Institution should lay down, as a result of this Conference, some definite syllabus for engineering education.

Dr. W. H. D. ROUSE (Cambridge) congratulated the Institution on paying so much attention to the subject of general education; but they might go further in bringing pressure to bear on the schools. The schoolmaster was at present exposed to the two forces of uninstructed public opinion and the examination evil. Prof. Thompson's remarks on the latter question were not half strong enough. Examiners paid attention to points that did not matter, and a well-educated boy who went in for certain local examinations had to be crammed to understand the questions proposed, though his general knowledge might be excellent. No intelligent plan of education was possible where local examinations had to be passed; and while State and teacher co-operated in Germany no such co-operation was present in this country. The fault of all this was really with the parents who took little notice of the effect of education upon their children's minds.

Mr. W. WHITAKER, F.R.S. (Croydon) disagreed with Sir John Wolfe-Barry that culture must be obtained early in life. Culture could be obtained all through life. More attention should be paid to the teaching of English, while mathematics was absolutely necessary for engineers.

Mr. R. MULLINEUX WALMSLEY (London) also called attention to the want of goal in British secondary education; but the ignorance of parents was to a large extent responsible for this. The London matriculation was bad, but all criticism of it had been destructive, and it could not be given up because of the funds it brought in. (Prof. Thompson: "That is scandalous.") Euclid had been deposed and nothing had been put in its place, so that there was a total absence of geometrical knowledge in pupils coming from secondary schools.

Mr. S. DE BRATH (East Grinstead) thought a syllabus of training would be a mistake. The present evil went further back than the secondary schools, that was, to the preparatory school. So bad, in fact, was preparatory education that Osborne had been founded by the Admiralty, and the War Office had under consideration the establishment of a similar institution for the training of prospective army officers. There was no need for a small boy to be worked hard, but his interest must be excited.

Prof. W. S. ABELL (Liverpool) thought the young engineer should be taught to think dynamically.

Col. J. E. CAPPER, R.E. (School of Military Engineering, Chatham), thought that secondary education should be so arranged that some grasp of economical questions was obtained. They found at Chatham the more diverse the subjects an officer was taught the better he seemed to get on. Further, he assimilated technical work better after a general education. The Institution could not be too careful in formulating any scheme of instruction for candidates, and the general standard of education should be made high.

Mr. T. H. BAILEY pointed out that the clever boy was not always the most successful, but he thought more might be done by putting clever boys in charge of six or seven duller boys for instructional purposes. This had been done in the Boy Scout movement with conspicuous success. It should not be the aim of the public schools to turn out professionally trained men, but it should be their aim to turn out gentlemen.

Dr. J. GOW (in reply) hoped the Institution would not start a new rigid examination. The schools were not responsible for the multitude of examinations, and if certain "equivalent" examinations were allowed it would be a great advantage to schoolmasters.

Prof. S. P. THOMPSON (in reply) said that the faults in present-day secondary education were not due to the schoolmasters. It was a scandal that any university should be dependent for its funds on matriculation fees. It was a great point that English should be properly taught. The Institution might well go further than they did at present and state expressly that they would accept without exception certain matriculation examinations in lieu of their own.

The following Paper by Prof. A. SCHWARTZ was next read:—

THE QUESTION OF SPECIALISED ENTRANCE EXAMINATIONS FOR UNIVERSITY OR COLLEGE COURSES OF STUDY IN ENGINEERING SCIENCE, WITH A VIEW TO THE CURRICULA TO BE FOLLOWED, AND ALSO OF THE INCLUSION IN THE LATTER OF COURSES IN MODERN LANGUAGES.*

BY PROF. A. SCHWARTZ, M.SC.

The functions of the secondary school and of the college course are as follows: (*a*) The function of the secondary school is to give a liberal general education—that is, to impart a limited amount of knowledge, in a range of subjects so selected and dealt with as to develop the mental faculties in a comprehensive manner. (*b*) The function of the college course is to impart a certain amount of knowledge of a specialised character, and to train and develop further the mental faculties along specific lines.

The function of the entrance examination for university or college courses in engineering science may be taken to be the determination of the fitness or otherwise of the candidates to pursue the contemplated course of specialised study. This question of fitness may be regarded from two standpoints as representing: (1) A satisfactory standard of general education. (2) In addition to a general education, a satisfactory standard of attainment of a specialised character in subjects germane to engineering science.

In the writer's opinion the matriculation examination of a university should follow the first of these alternatives, as it should be essentially a test of general education and should admit to all faculties. The governing bodies of the leading professional societies, however, have exhibited a growing tendency to call for some degree of specialisation in the matriculation examinations. Hence the special obligatory subjects, or higher papers frequently demanded (in addition to the ordinary subjects of the matriculation examination) to qualify for entry in the faculties of law, medicine or engineering. Similar conditions are frequently imposed in the entrance examinations to courses in engineering science in colleges which are not constituents of universities. These special demands have to be met by the secondary schools.

The average boy of 16 years of age who has had a liberal general education is not usually in a position to negotiate successfully these specialised entrance examinations; he, therefore, extends his school course, the final portion of which is, therefore, devoted to "preparing" him to meet the requirements of the examination market, or for the special requirements of his future career. The subjects which are in varying degree common to the college courses in engineering science and to the secondary schools are: Mathematics, mechanics, physics, chemistry, geometrical and freehand drawing, manual training and modern languages. In the matriculation examinations for the universities, and in the entrance examinations for engineering courses, these subjects are treated either as obligatory or optional subjects. Mathematics is invariably made obligatory, and the standard of the examination in this subject should, therefore, be such as may be compassed in the course of a liberal general education on either the classical or the modern side of a secondary school. The science subjects selected for tuition in the secondary schools vary in different schools, and this fact is recognised in the matriculation and entrance examinations by giving an option to the candidate in the selection of one or more of these subjects. The fact that these

* An abstract of Dr. Gow's Paper was given on p. 462 of our last issue.—ED. E.

* Abstract.

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options are widely exercised renders it impossible to commence the college courses in these subjects otherwise than *ab initio*. It is evident, therefore, that the treatment in the secondary schools of science subjects other than mathematics must be regarded as having an educative value rather than an instructional one. The object of teaching modern languages in the secondary schools at the present time is not so much the investigation of the logic of language, and the reflex action of its grammar on the structure of other languages—and particularly of our own—as to furnish the ability to think, and speak, and write in a foreign tongue. This teaching of modern languages may, therefore, be regarded as specialised instruction. Here again the average boy of 16 years of age falls short of the standard aimed at. For technical purposes a reading knowledge of the langauge is perhaps sufficient, but while the average boy, on leaving school, may be able to read a scientific French work with the aid of a dictionary, he is usually quite unable to deal fully successfully with a German work of a similar character. Instruction in German, therefore, frequently forms part of the courses in the engineering colleges, and, regarded as specialised instruction, it is not here out of place.

In conclusion, it appears to the writer to be particularly necessary, in the case of the engineer, that his secondary school training should be on as liberal lines as possible, since his subsequent training in the college, the workshop, and the office is largely materialistic. In this connection we shall do well to remember Tredgold's famous definition of a civil engineer as one who controls the forces of Nature for the use and convenience of man, and to note that this definition postulates not only a knowledge of natural philosophy, but a knowledge of the humanities also. What is wanted in the engineering courses is a supply of students with a wide mental outlook, whose faculties have been well trained and evenly developed, and any specialisation in the secondary school at the expense of this liberal training is to be deprecated. Let us bear in mind, with Emerson, that Nature is not fixed but fluid, and that spirit alters, moulds and makes it. The future of the whole human race is closely bound up with the work of the engineer; we should see to it, therefore, that his preliminary training shall be in no sense a narrow one.

DISCUSSION.

Mr. J. T. Jackson (Dublin) thought that an entrance examination should be designed with a view to discovering whether a student would take advantage, or not, of the course, and should further be designed to test the quality of the student's general education. Students should not be allowed to specialise before they were educated. In fact, their early training should not be too practical or their later training too scientific. There was very little connection between a student's success in the final examination and his success in after life, but there was a marked connection between age and success, for the younger the student started his work the better he seemed to succeed.

Mr. W. H. Patchell (London) said that the time available for the student to take a course was the crux of the question. More attention ought to be paid to modern languages, especially to Spanish and German, which were both of the highest importance to the engineer at the present time. He would like to enter a protest against trick examinations in which no honestly educated boy had a chance.

Dr. W. C. Unwin, F.R.S. (London), thought that non-specialisation in the early education of the engineer might be carried too far. A boy did not usually begin his engineering education proper until he was 18; that meant, under the Institution scheme, he earned no wages till he was 24. Was it then too much to ask that each student before entering college should have a good knowledge of elementary mathematics and of one branch of science? But there was considerable difficulty in complying even with these light conditions and the schools ought to have done better. His experience with regard to the after-career of students was not that of Mr. Jackson, but quite the reverse.

Mr. H. J. Spooner (London) found fault with the way mathematics was taught to engineering students. At the schools it was too theoretical, at the colleges it was practical, and the student had to unlearn much of what he had been taught; but to obtain a degree he had to turn to the theoretical side again, and therefore wasted time.

Mr. S. de Brath (East Grinstead) said the demands on the time of the student were so large that he should begin the study of modern languages early.

Prof. E. W. Marchant (Liverpool) drew attention to the absolute necessity of some specialisation from the first. All teaching must have some end in view. At present attempts were made to teach too many subjects, with the result that no real knowledge of any one subject was obtained. Science was just as good a basis of education as classics.

Prof. A. K. Schwartz (Liverpool), in reply, said that the Institution only asked for a moderate degree of specialisation in their examinations, but a matriculation had another object, that of ensuring the student had had a general education. All the faculties were demanding special matriculation examinations suitable to their particular needs, with the result that these examinations were not tests of general culture.

The Chairman (Mr. B. Hall Blyth) thought that such a conference as they had had that morning must lead to some good result. He would like to see Euclid re-introduced into the school curricula. He agreed that the present Institution examinations tended to encourage cramming, but they were trying to get over this difficulty.

SECTION III (Practical Training.)

Mr. R. Elliott-Cooper, vice-president of the Institution, who presided over the meeting of Section III., made the following opening remarks:—

The object of this Section is to discuss and endeavour to settle some of the difficult questions which present themselves to young men who seek to obtain such practical training as would fit them for the career of an engineer, apart from any particular branch of engineering, and also to enable them to obtain the recognition of the Institution of Civil Engineers, which is becoming more and more important. In discussing these questions, it is obviously most important that, if possible, all should be agreed as to what "practical training" really means. I am afraid, however, that the general opinion upon this point is by no means settled.

In the early days of engineering the practical training of a young engineer in the mechanical branch of his profession went very little beyond the performance of the work of a mechanic, under conditions that fell far short of what was necessary to train him so as to enable him to take a superior position in regard to the design or control and management of engineering works. A great advance was made when it was recognised that it was essential that young engineers should possess a sound general education and also some scientific knowledge bearing upon the theory and practice of their profession. Although such an education has generally shortened the period of practical training, it has by no means taken the place of such training, or rendered it less necessary to all who hope to succeed in their profession.

The first point which I should like to make clear is that real and useful practical training, whether in design, construction, or management of works, can only be obtained under the actual or commercial conditions which necessarily cannot be found in education establishments. There is an idea in the minds of a good many people that the old custom of pupilage had passed away. That, however, is very far from the case, and in my opinion, the routine (under proper supervision) of the drawing office and works, whether in the civil or mechanical branch, is just as important now as it was considered in former days, the only difference being that the young engineer of to-day is better equipped, by reason of the advance in scientific education, to take advantage of the practical training afforded him. Dealing for a moment with civil engineering (as distinct from mechanical engineering), it is obvious that any efficient training must embrace experience in various kinds of work, such as designing, drawing, specifying and estimating, all of which would be part of the ordinary routine of an engineer's office. He must also be trained in construction work, embracing setting-out, measuring-up, and general administration.

A great mistake which many young engineers make is in thinking that all that is necessary on completion of their college career to make them efficient assistant engineers, is either to go into a workshop and spend, say, two years, on the ordinary work of a mechanic, or (if civil engineering is to be his career) to go to a contractor upon some works of construction. The knowledge so gained is most useful, but without the office training, embracing the subjects, amongst others, which I have mentioned, he is only half equipped for the work of his profession.

There is doubtless a belief in some quarters that the system of training by definite apprenticeship and pupilage, which was certainly affected and modified some years ago by reason of the movement in favour of better scientific education, has fallen largely into disuse, and statements are sometimes made that it has been actually abandoned by the majority of engineers. Such an idea can only arise from an imperfect or very partial acquaintance with the engineering profession. It may be quite true that in a few branches of engineering, or pursuits cognate with engineering, pupilage, or its equivalent, does not occupy its former place, but taking the profession as a whole, that is not so.

In corroboration of this statement may be quoted the result of an inquiry made on behalf of the Council some months ago, which was directed to ascertain the position of pupilage, or other equivalent practical training, in manufacturing workshops and in the engineering departments of important railways, docks, and other large undertakings and authorities. The result of that inquiry was that in 75 per cent. of the cases considered there were regular arrangements for pupilage, and in only 25 per cent. was no provision made for such regular practical training. It may be observed that of the 25 per cent., more than half the cases occurred in the engineering departments of municipal authorities, which certainly might be expected to make better provision for the acquisition of practical training of a kind suited to prepare young men to become competent municipal engineers. The inquiry referred to was not addressed to engineers in private practice, but it is a matter of common knowledge that the system of pupilage remains extensively recognised amongst

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consulting engineers, although the requisite term of such training has been shortened in view of the better educational qualifications now generally possessed by young engineers.

The question of the conditions under which practical training can be, or should be, obtained, and of the means which might be taken to procure for intending young engineers, whether college-trained or not, fuller and better opportunities of acquiring that practical knowledge of engineering as actually performed which is essential to their becoming good assistants and, later on, efficient masters, is a matter for discussion and consideration by this section of the conference, from which it is trusted that good results and a better understanding may ensue.

This was followed by a Paper by Mr. A. F. YARROW, of which we give an abstract below :—

THE APPORTIONMENT OF TRAINING BETWEEN PRACTICAL WORK AND SCIENTIFIC STUDY, WITH SOME SUGGESTIONS APPLYING TO APPRENTICES IN OR ON WORKS FAR DISTANT FROM THEIR HOMES.

BY A. F. YARROW AND MEMBERS OF HIS STAFF.

The observations now submitted deal only with two points :—

First.—Although the advantages and disadvantages from a purely educational point of view of what is termed the "sandwich system" have been frequently dealt with, the social aspect of the question has perhaps been overlooked, and this is one point with which we propose to deal. In considering the question of engineering students, we have been frequently impressed by their need of being accommodated with courses of study which would enable them to get their practical training without the necessity of being banished from home influences for a continuous period of several years at a most critical time in their lives. It will be admitted, for instance, that London can no longer be looked upon as an engineering centre ; consequently, it is necessary for young men to obtain their practical training in the North, where engineering workshops exist.

This practical training, if continuous, would probably not be of less duration than three years, and these young men, who possibly have no friends or relations with whom they can live when serving their apprenticeship away from their family, must reside in lodgings under conditions of much discomfort, and if this condition should exist for lengthened periods during the student's youth, at an age when every young man is subject to a certain amount of temptation, experience has shown that the risk is considerable.

Now, if their practical and theoretical training can be so arranged that during the six summer months they work in the shops while living in lodgings, and during the six winter months they take up theoretical study in the colleges, living at home and subject to good influences and affectionate surroundings, this home influence is a source of great security, especially if the six months they work in the shops be during the summer, when their spare time can be spent in outdoor pursuits. Unless courses of study can be arranged to alternate with periods of practical work, so that the young man avoids being banished from his home, he will clearly be placed at a disadvantage compared with those young men whose homes are in the manufacturing districts, such as Glasgow, Newcastle or Birmingham. For these reasons we submit that the colleges, especially those in London, should endeavour to arrange their courses of study so as to conform to the social conditions indicated above as desirable, and that they should arrange their engineering courses of study during the winter months.

Second.—We would draw attention to the desirability that in works some member of the staff should be looked upon as an adviser to the apprentices, it being among his duties to get into personal touch with each young man. The young men should not be thrown into the shops without anyone to advise them in their studies or otherwise, or to whom they could turn in a difficulty. It is clearly undesirable for an apprentice to be simply under the eye of the foreman, who would probably not trouble himself about the interests of the lads themselves. Those who have worked in the shops will know that it is almost impossible for a young man to obtain an interview with the heads of the firm, even if he had the courage to do so ; he has to pass through the various offices, and will probably be stopped somewhere on his way, and even if he did get access to the heads, they would doubtless be engaged on important matters, and would have very scant time to devote to the lad. It would, therefore, be a very desirable thing if in works some gentlemen could make it part of his business, as it were, to befriend the apprentices. He should be accessible at all times, and should make a point of interviewing each lad at least once in three months, and ascertain if he could be of service to him. He should also from time to time ascertain what progress is being made by those lads who attend evening classes by periodical visits to the local technical schools. A record should be kept in a book for the purpose, so that the heads of the firm can see at a glance the opinion formed of the various apprentices.

This system would not only be a great advantage to the lads themselves, but would enable employers to recognise ability and industry, and select wisely those young men whose services they might desire to retain when their apprenticeship terminates, for it is a notorious fact that often employers have lost the services of many capable men through being ignorant of the talent that has passed through their works. Consequently, we submit that, taking a broad view of the two questions under consideration, employers would probably be gainers by facilitating what is herein indicated as desirable.

DISCUSSION.

Mr. F. E. ROBERTSON (Glasgow) said in regard to locomotive engineers it was surprising the number of candidates who came forward without any knowledge of elementary mechanics or metallurgy. The proportion of efficient candidates he estimated at not more than 5 per cent. Many candidates had no knowledge as to the differences in steel, nor of alloys of metal. The remedy he suggested was that men should not be recommended for positions in charge in the many departments of railway working unless the candidates had a practical knowledge of mechanical engineering.

Prof. J. O. ARNOLD (Sheffield) said he was surprised at Mr. Robertson's remarks. He was in close touch with the Midland Railway College and knew that in that establishment no such ludicrous conditions prevailed as were referred to by Mr. Robertson. The men were turned out absolutely efficient in all branches of railway work, and every possible step was taken to produce the kind of man Mr. Robertson asked for, the company requiring their apprentices to attend a metallurgical course in their fifth year.

Mr. E. R. DOLBY (London) said the trouble seemed to be that engineering as a profession was not more definitely sub-divided. In the building trade, four separate persons were responsible for the completion of the work, the architect, the quantity surveyor, the builder and the clerk of works. In turning out an engineer there was too much attempt to turn out men acquainted closely with a subject that should be divided into several sections.

Mr. C. O. BURGE (London) said no mention had been made of the preparation of a civil engineer for service abroad. Much of the great work in England had been already done and the civil engineer must in the future look to the Empire for scope for his abilities. It was necessary, therefore, that the training should comprise the conditions prevailing in the Colonies and abroad.

Mr. E. BENEDICT (London) said in regard to those remarks, in his early days he was advised to learn his profession in England and practice it abroad, and after a lengthy career he found that advice the best. The practice of the Midland Railway in regard to apprentices, he thought was a magnificent example of how it ought to be done. People or firms who accepted premiums should consider that they had a certain amount of responsibility. The educational material in the workshop should not be overlooked and the old steady hands should be selected to take charge of premium apprentices.

Mr. A. H. S. MCCALLUM (Chelmsford) said that the member of the staff selected to look after the apprentices would have to be very carefully chosen, as his work would be onerous, as apprentices in their own interests should not be allowed to follow their own ideas too closely. As to the college and works training, he thought strongly that it was a great disadvantage to keep the two distinct. The two should, as far as possible, be sandwiched together. The tendency was to mix the two classes of training more intimately. He divided engineers into two classes, the abnormal and the normal. The abnormally theoretical, the designer; and the normal, the practical man, the engineer in charge and the man who handled materials. The first mentioned was largely in the hands of the colleges, but for the practical engineer a combination of the theoretical and practical was necessary, which, however, entailed rather shorter hours at the works.

Mr. J. M. MONCRIEFF (Newcastle-on-Tyne) said he hoped there would be as few abnormal engineers as possible. As to the hours of working he considered it necessary that apprentices should start at 6 in the morning with the ordinary workmen.

Prof. E. G. COKER (London) said he agreed that there should be a closer connection between the workshop training and the college studies. He personally favoured the sandwich system because if the college course was gone through first the young man had only a vague idea of the importance of certain details in connection with practical engineering. Practical knowledge could not be obtained in a college or training school.

Mr. A. H. PREECE (London) said a practical training was essential for the engineer. The difficulty which cropped up was the receptive nature of the student. The whole future of an engineer depended largely upon his earliest training. The college course was important, but workshop experience was even more so, and it was a mistake for college people to advance the idea that the three-year course in works could be dispensed with.

Prof. W. E. DALBY (London) said the sandwich system as advanced by Mr. Yarrow carried with it so many advantages that it was almost superfluous to comment on it. The system should, however, be so arranged that there would be a certain amount of time available for research work. He agreed that the general average of candidates for railway engineering were deficient in the knowledge really necessary for their profession.

(To be continued.)

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"THE ELECTRICIAN" INDUSTRIAL SUPPLEMENT.

With "THE ELECTRICIAN" for Sept. 14, 1906, was issued the first of a series of "Industrial Supplements," to be published from time to time with "THE ELECTRICIAN." The fifty-third issue of the Supplement published (Gratis) with the number of "THE ELECTRICIAN" for September 23, 1910, was the last of the monthly issues. "THE COMMERCIAL AND INDUSTRIAL SUPPLEMENT" to "THE ELECTRICIAN" is now issued weekly (Gratis). It will be found towards the end of the present issue.

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THE PURCHASE OF FUEL.

The question whether fuel for electricity supply stations should be purchased on a heat basis gave rise to an interesting discussion last week at the meeting of the Incorporated Municipal Electrical Association at Brighton. Since the engineer desires as much heat as he can obtain for a given sum of money, it appears quite logical that the thermal value of the fuel should be taken as the basis of purchase and that British thermal units should be paid for rather than tons of coal. The cost of fuel is generally the largest item in works costs over which the engineer has control and therefore it is very important that this item should be brought down as low as possible. Thus it is not surprising that a number of station engineers have given careful attention to the subject. Among these may be mentioned Mr. C. E. C. SHAWFIELD, of Wolverhampton, who opened the discussion last week at Brighton, and Mr. A. P. CHATTOCK of Birmingham. By means of careful tests Mr. SHAWFIELD obtained an annual saving in the first two years after starting his testing department of £500 per annum. Similarly Mr. CHATTOCK obtained a reduction of 22 per cent. in his fuel cost per unit generated during a period of three years. Among the large undertakings which purchase fuel on a thermal basis may be mentioned the London County Council Tramways and the London Underground Railways each of which undertakings requires about 150,000 tons of coal per annum.

On the other hand, there are many engineers who are very opposed to taking the thermal value as a basis for purchase. They point out that coal agents object to such

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a basis, and the chance is that if the supplier of coal is made responsible for its thermal value he will, of necessity, put up his price in order to provide for the risk, so that in the end the purchaser will gain nothing. They also take the view that such tests are frequently very misleading.

With regard to the value of laboratory tests, it must be remembered that such tests are not by any means easy. If the very small quantity of coal used in tests is to be taken as a true sample of, say, a boat load of coal, then it is obvious that such sampling must be carried out with extreme care. The sample taken from the boat must be a true average sample of the boat load, and the small quantity of this taken for the test must again be a true sample of the larger quantity. Even if the sample has been properly taken, calorimetric testing requires a certain amount of skill.

Finally, there is the undoubted fact that the calorimeter takes account of all the heat, whereas the boiler rejects a certain amount, and only makes use of the remainder more or less efficiently. Moreover, the efficiency of the boiler depends not merely upon the boiler itself, but upon the stoking and the class of fuel, quite independently of its thermal value.

The question is complicated to a small extent by the fact that contracts may be made with either coal owners or coal agents. Generally speaking, it appears that coal agents are the more easily dealt with of the two. In some respects the coal owner is in a better position, because he knows what is coming out of his pit, and he ought, therefore, to be able to guarantee results more readily. On the other hand, he would feel more disposed to guarantee results at the pit than at some distant works. The coal agent, on the other hand, buys from a number of pits, and therefore the quality of his coal is likely to vary to a large extent. For that reason he is more likely than the coal owner to be opposed to the guaranteeing of thermal results, even though the treatment of the coal during transit is more in his hands. In any case, it is scarcely to be expected that the price of guaranteed coal would be so low as of coal that is not guaranteed.

As in most cases of this kind, the truth seems to lie between the extreme opinions expressed in this discussion. It appears to us that it is not essential for the moment that fuel should be purchased on a purely thermal basis, but it is extremely desirable that systematic tests should be made of all fuel that is used. The coal supplied would certainly be very much better if a continual watch were kept upon the ash, the moisture and the thermal units. Even laboratory tests, pure and simple, in this direction should be effective, but it seems to be almost equally important that frequent boiler tests should also be made. Pending the education of coal owners and coal agents towards the appreciation of these ideas, we hope that every station engineer will make himself familiar with systematic fuel tests; they afford a valuable check if nothing more, and we are sure the result will be satisfactory in the long run. There is really nothing to be gained by waiting. Suitable apparatus can be obtained without any great outlay; experience, however, is a matter of time, and cannot be acquired hurriedly.

RECENT PHYSICAL RESEARCH.

VIII.—BROWNIAN MOVEMENTS.

BY D. OWEN, B.A., B.SC.

§ 1. If a liquid containing very fine particles—for example, water to which a small proportion of milk is added, or a mixture of dilute sodium hyposulphite and dilute acid—is examined under the high powers of the microscope, the particles are seen to be in incessant to-and-fro motion. If lateral illumination is employed, particles far smaller than those detectable by ordinary illumination manifest themselves, standing out, by the light they scatter, against a dark background, just like stars in the night sky. The lively dance of bright spots, often in brilliant colours, when sunlight or the light of the arc is used, is a fascinating one to watch. In 1827 the English botanist Brown called attention to this phenomenon. For a long time no attention was paid to the subject, which was regarded by physicists as carrying no special significance. In 1888 Gouy published the results of experiments which clearly showed the character of these movements to be independent of external vibration, of convection currents arising from inequalities of temperature in the liquid, and of the intensity of illumination employed. The movement goes on always, to a less extent the more viscous the liquid. He therefore put forward the hypothesis that we have here an agitation of the same nature as that postulated in the kinetic theory of matter.

The kinetic theory begins with the atomic conception of matter, adding the hypothesis of the incessant movement of the constituent molecules of a body. In the case of gases the theory is capable of being mathematically followed out in many of its consequences, as has been done especially by Clausius and Maxwell. One fundamental theorem is that of the equi-partition of energy among the molecules of a gas, independently of the nature of the molecule. If m denotes the mass of any molecule, v its velocity, then $\frac{1}{2}mv^2$, or w, the mean kinetic energy of translation of the molecule at any particular temperature, is a universal constant. It follows that all gases contain the same number of molecules, n, per unit volume, at the same temperature and pressure; or, in other words, that the number N of molecules in the gram-molecule of any gas is the same. The number of molecules in 2 grams of hydrogen and in 36·5 grams of hydrochloric acid gas is the same, being of the order of, say, 60×10^{22}. The pressure exerted by a gas is the resultant effect of the molecular bombardment of any surface exposed to the gas. It is thence deducible that $pv = RT$, and that $w = \frac{3R}{2N} \cdot T = \alpha \cdot T$, R having a constant value, $83{\cdot}2 \times 10^6$, for the gram-molecule. Thus, if w (or α) is known, N is known, or vice versâ.

The electronic charge e is also connected with N, since Ne is the charge conveyed by 1 gram of hydrogen in the electrolysis of water—namely, 96,540 ampere-seconds or coulombs, or 29×10^{13} electrostatic units.

The kinetic theory connects such apparently diverse magnitudes in gases as the pressure, the coefficient of diffusion, the thermal conductivity, and the viscosity.

§ 2. When applied to liquids the kinetic theory, owing to the complexity introduced by inter-molecular actions, has not found accurate mathematical expression. Van't Hoff, noting that the values of osmotic pressure obtained by Pfeffer depended only on the number of molecules of dissolved salt per unit volume, and not on the nature of the salt, and that the pressure was the same as that produced by the same number of molecules in the gaseous condition, concluded that the mean kinetic energy of each one of the molecules concerned was equal to that of a gas molecule. Going a stage further, the conclusion seems inevitable that not merely a few distinguishable molecules, but that *all* the molecules of a liquid, solvent as well as solute, should be regarded as possessing this same quantity, w, of kinetic energy of translation. Where the

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liquid is electrically conducting, each ion is to be regarded as a molecule in the sense of possessing the same kinetic energy.

The kinetic theory has even been applied to the free electrons which are postulated as existing, like a very light gas, in the interstices of a metal. Supposing these electrons to possess the molecular kinetic energy w, dependent on the temperature of the metal, but independent of its chemical nature, the ratio of the electrical and thermal conductivities and the temperature variation of that ratio may be deduced. The calculated values show striking agreement with experiment. Lorentz, starting from this conception of free electrons, has deduced an expression for the heat radiation from a metal. Equating to the data of experiment, a value for w has been thence obtained agreeing very well with the value adopted for the ordinary gas molecule.

§ 3. The *Brownian movement*, as we have seen, raised the question as to whether the kinetic theory could be regarded as applying to particles consisting of assemblages of molecules so large as to be actually visible. Maxwell, writing on the kinetic theory, refers to the state of perfect repose which, even under the highest power of the microscope, appears to exist in a body. The Brownian movement forms an exception to this generality. Does it fall in the category of kinetic heat movement?

Since Gouy's arresting memoir of 1888 much has been done in the direction of an answer in the affirmative. In 1906 Einstein, and, independently, Smoluchowski, showed how to express the mean displacement of such a particle in terms of N. Einstein's formula is

$$\xi^2 = \tau \cdot \frac{RT}{N} \cdot \frac{1}{3\pi a \zeta},$$

where ξ represents the displacement in any given direction in a time τ, a denotes the radius of the particle assumed spherical, ζ the coefficient of viscosity of the surrounding medium. This equation contains the assumption that the particle possesses the mean kinetic energy of translation w, also that the frictional resistance to its movement through the medium is given by Stokes' celebrated formula, $F = 6\pi a \zeta v$, where v is the velocity of the particle with respect to the medium.

In 1908 and 1909 Jean Perrin made an extremely important series of experimental contributions to the subject. It is the main object of this article to outline the methods and the results of this remarkable research. His experiments fall in two classes. In the first place he conceived the idea of testing whether in a liquid medium in which are suspended granules of uniform size large enough to be visible, these particles follow the law of concentration that holds for a gas under the influence of gravity. In an enclosure at constant temperature the density of a gas is greatest at the bottom of the vessel, decreasing in geometrical progression as the height increases in arithmetical progression. The granules will follow this distribution if their mean energy of translation is constant. Denoting the value of this energy by W, the equation

$$\tfrac{3}{4} W \log \frac{m_0}{m} = \phi(\Delta - d) g h$$

holds; m_0 and m denoting the number of granules per cubic centimetre at two points between which the difference of level is h, ϕ the volume of each granule, Δ and d the density of the granular material and of the liquid respectively, g the acceleration due to gravity.

Microscope construction has now been brought to a high degree of perfection, and with the aid of lateral illumination particles of ultra microscopic magnitude can be rendered visible. Perrin realised the possibility thus presented of subjecting the above equation to the test of direct experiment. He prepared an emulsion containing granules of practically uniform size, and in showing that when allowed time—generally a few hours—to attain the steady state of distribution, the density of distribution of the granules decreases from the bottom of the vessel upwards, and this according to the exponential law. But whilst in the case of our atmosphere half density would be attained at a height of some 6 km., in the case of these emulsions the half concentration occurs with a rise of one-hundredth of a millimetre. The size of the granules and their density being also ascertained, a value of W was successfully arrived at. The crucial test is thus within reach of comparing this quantity with the constant w assigned by the kinetic theory to the gaseous molecular particle. It must be remembered that the latter quantity cannot be regarded as known with more than approximate exactness. The value of N may be taken as 60×10^{22}. The value of the corresponding number N′ obtained by Perrin for his granules was $70{\cdot}5 \times 10^{22}$.

Perrin's second series of experiments was in verification of Einstein's formula. The measurements required are of much difficulty. Armed, however, with a method of producing granules of uniform size, and with satisfactory means, discovered in the course of the preceding research, of measuring the size, he was able to establish the formula very satisfactorily over a large variation in size of granule, for granules of different material, and over a large range of variation of viscosity. The value $71{\cdot}5 \times 10^{22}$ so obtained for N′ shows practically perfect agreement with the value obtained by the first, radically different, method.

It appears, then, that Perrin's two lines of experiment lead to values for N (or for the mean kinetic energy of translation of the particle) which are of the same order as those assignable to a perfect gas. A more complete confirmation of the kinetic theory of the Brownian movement could hardly be looked for.

These experiments place the theorems of the kinetic theory on something like an experimental basis. Particularly of value are they in supporting the hypotheses of Van't Hoff and of Arrhenius in regard to solutions, when one remembers the strenuous opposition to their views that has proceeded from some chemists and physicists.

This work may well be regarded, as Perrin proposes, as giving a more accurate value of N than that deducible from gas data. Already physicists have come to regard the electrical method (depending, that is, on the determination of e) as more reliable than the older estimates. Possibly the accurate determination of e is of more interest even than that of N, and Perrin's number for the latter may be employed to furnish an independent value for the magnitude of the electronic charges. Taking, then, $N = 70{\cdot}5 \times 10^{22}$, we get the value $e = 4{\cdot}11 \times 10^{-10}$ E.S. units.

V. Henri has studied the Brownian movement cinematographically, taking photographs every twentieth of a second, with a period of exposure of one-three-hundred-and-twentieth part of a second. By the employment of solutions containing a sufficiently small number of particles per unit volume it is thus possible to obtain numerous points on the path of the same particle. The trajectory so derived is of the kind one imagines on the kinetic theory, though, of course, the straight elements joining two successive points do not represent the path between two collisions, but give merely the displacement of a particle after an immense number of collisions with molecules of the solvent.

Perrin has also studied the Brownian movement of *rotation*, for which Einstein had again found an expression, on the assumption that the kinetic energy of rotation is equal to that of translation. His measurements point to this equality, though probably the movements of rotation are not capable of sufficiently accurate measurement to justify the conclusion that absolute equality holds. This is of interest in connection with the theorem of the equi-partition of energy among the various degrees of freedom of a gas molecule, which has been advanced by Boltzmann, though not to the satisfaction of the majority of physicists.

§ 4. *Brownian Movement in Liquids.—Perrin's Work.*—The work of Perrin will now be considered in more detail. Let us consider first the different stages in the examination of the equation of distribution.

(*i.*) *Preparation of a Uniform Emulsion.*—After trial of several colloidal solutions, M. Perrin found a satisfactory material in *gamboge*, a substance well known as a water colour. One method of producing an emulsion is to treat the gamboge with methyl alcohol, which dissolves a considerable fraction. On

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adding to the clear solution a considerable quantity of water, a yellow opaque emulsion is produced which consists, as shown by examination under the microscope, of a swarm of yellow granules of various sizes, all perfectly spherical. These can be separated by centrifuging from the containing liquid, which can then be replaced by pure water. A systematic procedure is next adopted comparable to the fractionation of a liquid mixture by distillation, in order to produce an emulsion consisting of granules of any desired uniform diameter. The vessel of the centrifuge is filled to a definite height, say 10 cm., with the emulsion in water; the machine is turned at a definite speed, say 30 turns per second (corresponding to a centrifugal force 500 times greater than gravity). After a definite time (say 60 minutes), the motive power is cut off and the vessel allowed to slow down gradually. A jelly-like mass now occupies the bottom of the vessel, consisting of the aggregation of granules which have reached the bottom in the centrifuging process. Let a_1 denote the radius which a granule, initially at the surface, ought to have to reach the bottom at the moment centrifuging is stopped. All granules larger will, therefore, be found at the bottom of the vessel. But there will be present at the bottom some particles smaller than a_1, which, owing to their being originally present in the lower layers of the emulsion, have had time to reach the bottom. The supernatant liquid will consist of particles smaller than a_1. By means of a syphon these particles may be removed. The vessel is filled with distilled water to the original height, the sediment being well stirred to form once more a uniform emulsion. The centrifuging process is repeated in exactly the same way, and so on again and again, until finally the supernatant liquid is perfectly clear. All particles of radius less than a_1 have thus been removed. Now recommence operations on this sediment, but with a slightly shorter time of centrifuging. The supernatant liquid will then contain no particles of radius greater than a certain value a_2, whilst, clearly, none can be present of radius less than a_1. By choosing the interval of centrifuging so that a_1 is very nearly equal to a_2 a practically uniform emulsion is obtained.

(*ii.*) *Distribution of the Granules.*—Having secured a uniform emulsion, Perrin proceeded to examine the variation of concentration in successive horizontal layers when equilibrium had been attained. A shallow cylindrical vessel of height about one-tenth of a millimetre is taken (the cells made by Zeiss for enumeration of blood corpuscles were found quite convenient), and in it a drop of the emulsion is placed, the top being closed in by a cover glass, which is then varnished round the edges to prevent evaporation. The preparation, carefully levelled, is then examined under a vertical microscope of very high power, in which case the depth of focus is small. Only those granules can be seen clearly which are contained in a very thin horizontal layer of thickness about 1 μ ($\mu = \frac{1}{1000}$ mm.) To count the number of granules in any layer two methods have been employed. The first is by instantaneous photography; this is, however, only applicable when the granules are relatively large. The second method is to place in the focal plane of the eyepiece an opaque screen of foil, in which a small circular hole is pierced. The field of vision is thus restricted, and the eye is able to take in at a glance the number of granules present at a definite instant (a maximum of five or six is best). A very large number of observations is made at a given level at equi-distant intervals of time, and the mean of these is taken. The level is then altered by a known amount, and the counting process repeated. Some thousands of readings are requisite to secure a reasonably high degree of accuracy. The concentrations of the granules in five equi-distant planes 25μ apart were obtained, the first plane being 5μ above the bottom of the vessel (to eliminate the possible influence of the boundary). To take one example from Perrin's numbers: In the case of granules of radius 0·14μ, the numbers of granules found were in the proportion 100, 116, 146, 170, 200, whereas the numbers required for geometrical progression are 100, 119, 142, 169, 201. The exponential law was proved to hold for gamboge particles of radius 0·14μ and upwards, and also in the case of an emulsion of mastic of radius 0·52μ.

(*iii.*) *Size of Granules.*—At first the law of Stokes was invoked. The emulsion was placed in a capillary tube sealed at both ends and installed vertically in a thermostat. With a fine tube convection currents are avoided, and the granules fall steadily like a cloud, with a fairly sharp upper surface; their rate of fall being measured by a horizontal microscope. Equating Stokes' expression $6\pi\zeta av$ to the apparent weight of a granule, $\frac{4}{3}\pi a^3(\Delta - d)g$, a is determined.

A second method consisted in counting all the granules present in a small volume of the emulsion. If the total mass of the granules present is known, and the density of each granule, the volume, and thus the radius, of each granule may be calculated. The counting is done in the flat cell already described, the bottom of which is divided into squares of 50μ side. The method depends for success on an observation made by Perrin that in a feebly acid medium the granules collect on the walls of the glass bounding the preparation. As soon as a granule touches the wall it sticks there. After a few hours, therefore, all the granules will have left the preparation and be found fixed to the walls. A camera lucida is then fitted to the microscope, and a copy made on paper of the squares and contained granules, first on the ceiling, then on the floor of the cell; whence the number present is easily obtained. The determination of the density is referred to below.

The total mass of gamboge (or mastic) in a given volume of emulsion is easily determined by evaporation of a known volume to dryness a little above 100° C. A glass-like mass is left whose weight remains constant, not altering even when the temperature is raised to 130° C. or 140° C. The determination of this weight furnishes the required datum.

A third method depends on the fact that the granules under the influence of acid often arrange themselves in rods composed of several granules. The length of these rods being measurable, and the component granules distinguishable, and therefore capable of being counted, the diameter may be estimated.

The three methods give concordant results, providing incidentally a valuable confirmation of the applicability of the law of Stokes to such small granules. The most careful measurements were made on a gamboge emulsion. By the second method, in which some 11,000 granules were enumerated, the radius 0·212μ was obtained, whilst by Stokes' law the value 0·213μ resulted.

(*iv.*) *Density of the Granules.*—We have seen that the mass of resin in a given sample of emulsion may be readily determined by drying in the oven. The density of the residuum is accurately found, and taken to represent the density of the granules.

§ 5. The exponential distribution being thus established, and all the requisite data obtained, the equation of distribution allows of the determination of N, and that with a high degree of accuracy. Perrin's mean result, based on several series of experiments involving the measurement of some tens of thousands of granules is that Avogadro's constant $N = 70{\cdot}5 \times 10^{22}$.

§ 6. Perrin's next step was to seek for *experimental confirmation of Einstein's formula*, according to which the mean displacement of a particle is a given time depends only on the size of the particle, and not on its chemical nature. Tiny metal globules and air bubbles should show the same degree of agitation if their sizes agree. The formula assumes the applicability of Stokes' law. Treating this assumption as justified by the measurements already described, a verification of the formula must be regarded as a vindication of the second proposition contained in that equation—namely, that of the equi-partition of energy among the particles. Two quantities require to be measured: First the radius, and secondly the mean square of the displacement in any definite direction in a given time. The former was determined as in the preceding investigation. For the measurement of displacement, the direction chosen by Perrin was a horizontal one; steady movement under the influence of gravity was thereby eliminated. The position of a selected granule was dotted in the camera lucida, the microscope being set vertical, four readings

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being generally made on each granule at equi-distant intervals of half a minute. The square of any length being equal to the sum of the squares of the projections on any pair of rectangular axes in the same (horizontal) plane, the mean square of the displacement in any direction is found by halving the mean of the squares of the resultant displacement in the selected time.

The measurements, made under very different conditions, resulted in a satisfactory verification of the formula of Einstein. Thus, on increasing the viscosity of the suspending liquid to five times by the addition of sugar the displacement was reduced to the degree predicted. The law of variation with size was found to hold over a range of diameters from $0{\cdot}4\mu$ to 12μ. Taking the mean square obtained from over 3,000 displacements, the value $71{\cdot}5 \times 10^{22}$ was obtained for N.

§ 7. *Brownian Movements of Rotation.*—In the case of large spherical granules it is possible, owing to the presence of minute foreign inclusions, to observe persistent irregular movements of rotation, and even to measure their amount. Einstein has given a formula in this case, too, and Perrin's measurements go far to verifying the underlying assumption of the equality of the mean energies of rotation and of translation. Taking, for example, the case of spheres of mastic of diameter about 13μ in suspension in a solution of urea, the root-mean-square obtained from 200 angular measurements was 14·5 deg., whilst calculation predicts a rotation of 14 deg., in one minute.

§ 8. In conclusion, we have in the investigations on the Brownian movement a remarkable confirmation of a brilliant suggestion. Perrin's daring work can, indeed, be regarded as a triumph of experimental skill, and its outcome is an important contribution to our knowledge of some fundamental natural constants.

§ 9. *Other Related Work.*—Broglie and Ehrenhaft have made experiments on smoke particles electrically charged. Here, owing to the small viscosity of the surrounding air, the Brownian movements are considerably larger. In Broglie's work Einstein's formula was employed, and the value of N being assumed, the size of the particles was found. The photographic method was employed in the determination of the mean square of the particle displacement, which yielded for the value of $\frac{1}{\xi^2}$ in a time 3·5 seconds the number $0{\cdot}7 \times 10^{-5}$, leading to the value $a = 4{\cdot}9 \times 10^{-6}$ cm. Measurement of the steady speed of the particle in an electric field gave the value $v = 27{\cdot}5 \times 10^{-3}$ cm./sec. per unit field-strength. Applying Stokes' formula, we have for the charge on the particle $e = 6\pi a \zeta v$; whence the value $4{\cdot}5 \times 10^{-10}$ E.S. is obtained for e. Ehrenhaft, working with metallic particles, obtained the value $e = 4{\cdot}6 \times 10^{-10}$.

CORRESPONDENCE.

LIGHT AND SHADE IN INDIRECT LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Hadyn Harrison appears, from his letter in your issue of the 30th ult., to consider that my assumption that the expression "indirect lighting," used in his article in your issue of the 9th ult., related to indirect lighting by either incandescent or arc lamps, is attributable to a "confusion of terms."

There cannot, I take it, be any question but that the term "indirect lighting," as generally applied, has for many years been recognised, not only by illuminating engineers but also throughout the electrical trade as relating to one or other of the few systems of lighting in which the actual light sources are screened from the eye, and the illumination on the working plane is obtained by reflection, and I, therefore, venture to submit that the "confusion," if such exists, lies rather at his door than at mine.

Mr. Harrison has, moreover, of late been somewhat unsparing in his condemnation of "indirect lighting," which he has, for instance, quite recently characterised as "always depressing," * and objected to "on the score of the absence of shadows." †

Is it to be understood that in each of these instances, also, the method of lighting which he had at the time in mind was the purely imaginary and hypothetical system which he now describes? If so, his statement to this effect is surely somewhat belated, and ought, under such circumstances, in common fairness to those interested in the sale and installation of both incandescent and arc lamps, to have been made considerably earlier.

Such an instance constitutes still another example of the class of statement—misleading by reason of incompleteness—to which exception was taken in my article. Mr. Harrison's statement that inverted arc lighting can hardly be considered indirect lighting, is, to me, a most remarkable one, and his further explanation that by the use of this expression he meant "illumination derived from all directions," makes the confusion worse confused, as in the room described in my article the

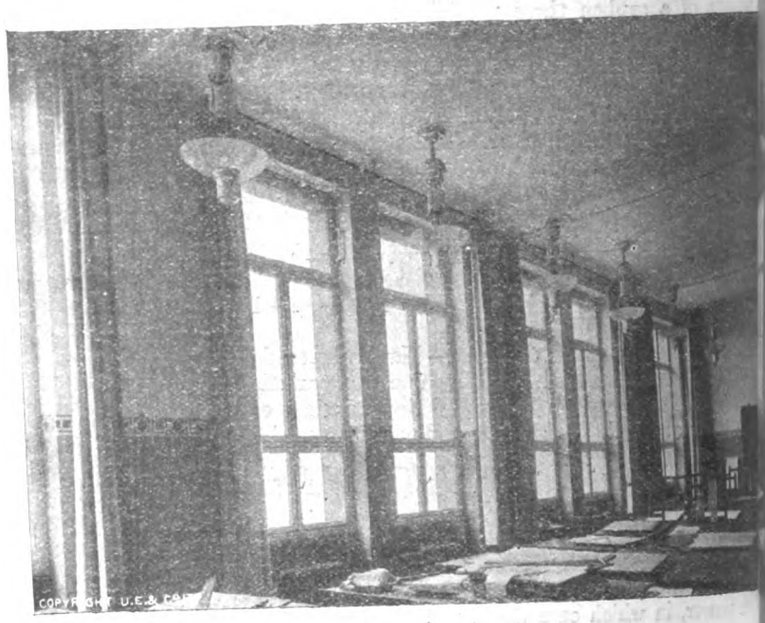

FIG. 1.—EXAMPLE OF INDIRECT LIGHTING IN AN OFFICE.

illumination *is* undoubtedly derived from all directions. If, however, what Mr. Harrison really means is illumination derived *equally from all directions*, which is quite another matter, then I unhesitatingly agree that this feature is neither possessed by this particular room nor by any other, with the possible exception of one constructed specially for the carrying out of photometrical measurements.

As regards the "light source giving equal candle-power in all directions," and the polar curve of which would in consequence be represented by a circle, if Mr. Harrison will be good enough to place such at my disposal I will arrange to have the experiments described in my article repeated in the manner he suggests; and by this means demonstrate to him that even with such a light source the light would not in practice be reflected equally by the ceiling, walls and floor, and the sphere would, in consequence, even under such circumstances, retain its appearance of rotundity.

Pending the advent of the light source in question, I can only state that using a single small incandescent lamp—selected as representing the nearest practical approach to Mr. Harrison's

* "Illuminating Engineer," May, 1911, p. 233.

† "Journal and Record" of Transactions of the Junior Institution of Engineers, June, 1911, p. 401.

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theoretical source—suspended in the centre of a rectangular chamber, closed in on all sides and specially constructed of material having a high co-efficient of reflection, to represent to scale the room in which the latter experiments were carried out, the miniature sphere used was, when viewed through a small inspection opening, quite distinguishable, visually, from the flat disc, although under such circumstances a photographic representation of it could not, as stated in my article, readily be secured.

As regards the position of the arc lamp in the room shown in my illustration, I quite agree with Mr. Harrison that a closer approximation to daylight lighting, as regards the nature and direction of the shadows cast, would have been secured by placing the lamp nearer the windows and providing the latter with white blinds. The room in question was, however, specially chosen for the purpose of demonstrating the excellence of the results obtainable by the use of inverted arc lamps in ordinary rooms—*i.e.*, under possibly unfavourable conditions—the disc, sphere and statue being placed on the vertical centre line of the lamp rather than elsewhere in the room for the same reason.

Fig. 2.—Example of Indirect Lighting in a Studio.

The suggested position for the lamp is in no wise new, as the company with which I am associated has, when consulted in respect of such matters—in which, I may perhaps be permitted to state, they claim to be specialists—been in the habit of placing the lamps in such positions as to ensure the artificial lighting corresponding as closely as is practicable with the natural lighting, as, for instance, in the case of the two installations shown by the enclosed illustrations, which, although taken before the epoch of artificial light photographs, serve to show clearly the positions of the lamps in relation to the windows, and also the reflecting curtains with which the latter are provided. In both these installations the character, direction and ratio of the shadows are almost identical both by day and by night. May I also point out to Mr. Harrison that so far from approximately vertical shadows constituting a "curious effect very rarely found in nature," such are, in point of fact, the only shadows obtainable over a considerable area of the earth's surface, and that at 3:30 p.m. yesterday the shadow cast by a circular office stool 16 in. in diameter by 22 in. high (standing out of doors in the centre of a large yard in bright diffused daylight) was, whilst clearly defined, out of centre only to the extent of 2⅜ in.

Finally, I would state that I accept with pleasure Mr. Harrison's disclaimer of any intention to disparage indirect lighting by inverted arc lamps, and am delighted to welcome him to the ever-increasing body of experts, who, having seen the error of their ways, are now, very rightly, as strongly in favour of this particular form of illumination as they were, in their unregenerate days, against it.—I am, &c.,

Union Electric Co. (Ltd.), London, July 4. Justus Eck.

THE NOMENCLATURE OF PRIMARY AND SECONDARY SOURCES OF LIGHT.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: While many scientific units are unsuitable for the measurement of engineering quantities, this hardly constitutes a reason for the choice of practical units which are unscientific. There is plenty of excuse for the pioneers of mechanical engineering for having bequeathed to us a heterogeneous jumble of units, many of which are unscientific and whose only claim to being "practical" is possibly the benefit which the engineer derives from the mental arithmetic involved. Such units, once established in practice, are extremely difficult to dislodge, and now that the subject of photometric units is open, it seems to me to be an excellent opportunity to put the whole matter on a footing which is both scientific and convenient.

Firstly, it is essential that the primary units of intensity and total light flux should be fixed, and that these should not be confused with each other. Owing no doubt to a slip, I notice that Mr. Trotter is actually made to state that "one candle-power is therefore the luminous flux per steradian," *i.e.*, intensity is flux! In common usage, however, the engineer absurdly specifies his lamps in watts per candle-power. Of course, we generally know that he means the mean horizontal intensity and leaves the rest of the polar distribution to chance. Hence we may actually have two lamps with exactly the same rating but giving quite different efficiencies when the total light flux emitted is compared with the power input. If the engineer is also a scientific man, he may have the temerity to ask for a figure comparing the total light flux, as measured by the mean spherical candle-power, with the watts taken, and, getting a true idea of the efficiency of the lamp, buy his lamp with the same scientific accuracy as he does his electrical energy. In other words, I object to candle-power or any other unit of intensity being used as a unit of light flux.

The unit of light flux at present most recognised is the lumen, which, I believe, Mr. Trotter intended to refer to as the light emitted by a source, having a uniform spherical intensity of one candle-power, in unit solid angle (or one steradian). To bring the purchase of light up to something like the same common-sense level as that which rules when dealing with other measurable commodities, we should rate our lamps in lumens per watt. From the definition above, it will readily be seen that the mean spherical candle-power is a direct measure of the light flux (lumens), but the term is confusing as it uses the term for intensity to express output.

Illumination, surface brightness and intrinsic brilliance are admittedly secondary quantities, but all of the same nature. Each may be defined in terms of the light flux emitted from a unit of surface, say, in lumens per square centimetre.

This method of definition is applicable whether the emitting surface be a white-washed ceiling or the filament of an incandescent lamp.

We may have a unit for these quantities and give it a name (say, for example, the lux*) which contains no reference to the method by which it is obtained. The engineer or architect knows that so many units of *illumination* are desirable for read-

* The lux is a unit fixed by the Geneva Congress, 1896; its magnitude is approximately $\frac{1}{12}$ foot-candle or 1/11,150 lumens per square centimetre.

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ing or writing surfaces, or that the production of a certain *surface brightness* is necessary, or again, a light source having an *intrinsic brilliance* exceeding a certain number of these units should not be directly exposed to vision, if glare is to be avoided. It would probably be necessary to get a range of values almost as great as that required for the comparison of resistances of conductors and insulators, but the quantities are still the same in kind and the method is quite practical.

On the other hand, the expression of intrinsic brilliance in terms of candle-power per unit area involves a mathematic anomaly and, as Mr. Trotter shows, a practical difficulty. It also gives the engineer no means of comparing the brightness of a light source with that of an illuminated surface.

Mentally, I think that most people will compare the brightness of different surfaces directly, *i.e.*, simply state that one is so many times brighter than another, and if this has to be reduced to figures, surely it is much easier to think of the light coming from a certain patch of surface A as being twice as much as that from a similar patch of surface B rather than think that the illumination on A is produced by a hypothetical candle held say d feet away as compared with the same candle held $\sqrt{2} \times d$ feet away from B.

It therefore appears to me that all the units required are :—

1. A unit of intensity.
2. A unit of total light flux.
3. A unit comparing the light flux with the area of the surface emitting it.—I am, &c.,

East London College, June 26. LEONARD MURPHY.

"INTERNAL COMBUSTION ENGINES WORKING ON THE DIESEL PRINCIPLE."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: On looking over your report of the discussion on Mr. Howard's Paper read at the recent Convention of the Municipal Electrical Association, I find that the report, either due to an error in reporting or the want of clearness on my part, does not, at one part, give correctly the views I at least intended to express.

Your report says: "Although no guarantees were given with Diesel engines, they had been found by engineers installing them to be as satisfactory in operation as steam plant, with which guarantees were regularly given." *Guarantees are regularly given by the makers of Diesel engines*, and the point I tried to bring out was that the guarantees given by Diesel engine makers very often appear to show results which are little or no better than the results to be obtained from gas or steam plant, judging from their makers' guarantees, but that, notwithstanding this, my experience had been that in every case there was a very substantial saving by the adoption of Diesel engines. I further explained that this was in no sense due to misrepresentation on the part of makers, but due to the fact that, whilst Diesel engines continue in daily practice to work up to the guarantee figures, this was almost impossible with other types of plant, and particularly with steam plant, as so much depends upon skilfulness of firing, and attendance, and on the condition in which furnaces, flues, and other parts are kept. A further reason which I mentioned was that the stand-by losses in small stations are relatively heavy, and with Diesel engines these losses practically disappear.—I am, &c.,

Stockport, July 3. CHAS. DAY.

SIXTEENTH ANNUAL CONVENTION OF THE INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

(*Concluded from p.* 475.)

On Friday morning members assembled in the Royal Pavilion, Brighton, for the annual general meeting of the Association, Mr. Christie presiding. The annual report of the Council was first read. The following is an abstract :—

ANNUAL REPORT OF THE COUNCIL.

The membership of the Association now stands at 407, made up as follows :—Committees (members), 168 ; chief electrical engineers (members), 187 ; honorary members, 4 ; chief assistants (associate members), 9 ; and assistants (associates), 39. There is a decrease of nine on last year's total.

The hon. treasurer's report shows that the nett result of the year's working is a surplus of £157 as against £93 last year, and a total surplus of assets over liabilities of £642. It must be borne in mind, however, that working expenses are very low, and that should it become necessary at any time to incur rent and other outgoings, the small margin at present in hand would soon be absorbed. This would also apply to any extraordinary expenditure which the Association might be called upon to incur in the way of Parliamentary work.

Two representatives of the Association, Messrs. Christie and Ayton, have been appointed as members of the Joint Publicity Committee, in addition to two members of the Council already members of such committee on a different representation, Messrs. Cramb and Seabrook. The committee have carried out a large business in poster and pamphlet work with good results, and the fact that a number of other municipal undertakings have recently joined testifies to the growing appreciation of the usefulness of the work carried on.

The Council have carefully considered and approved of the amended I.E.E. Wiring Rules, and consider it desirable that they should be adopted universally as a basis for standard practice.

This year two Papers were received from associates in competition for the travelling studentship. The Council has awarded the first place to the Paper on "The Motor Meter as Applied to the Measurement of Single-phase Alternating Current," the author of which is Mr. V. F. Bush, of Tunbridge Wells. The subject of the other Paper submitted was "Steam Power Generation : the Advantages of Mechanical Draft," the author of which is Mr. J. R. Campbell Murray, of Motherwell, to whom your Council has awarded a special premium of the value of two guineas. The Council consider both Papers to be meritorious, and they will be published in the "Proceedings" in due course.

As a result of a large number of meetings with representatives of the Municipal Tramways Association, a comprehensive and valuable report is now being dealt with by a committee, previous to its being considered by a joint committee of the two Associations.

During the year the Lamp Standard Sub-committee of the Engineering Standards Committee, upon which the Association are represented, has been engaged in the standardisation of bayonet socket lamp-holders and caps, and a standard specification has been issued. It is recognised that the ordinary standard bayonet socket lamp-holder is not well adapted for use with radiator lamps taking 250 watts at 100 volts, due to failure of the springs and contacts. The committee are therefore making further investigations in this direction. It is hoped that the result will be the production of a lamp-holder which can be used with uniform satisfaction with currents up to 2½ amperes.

In connection with the revision of the Institution of Electrical Engineers' form of model general conditions recommended for use in connection with contracts for plant, mains and apparatus for electricity works, particular attention has been drawn to a clause appointing the engineer (of the local authority) as sole arbitrator in cases of dispute. It is felt that this is a most unfair and improper clause, and your Council strongly urge the amendment of such clause in the preparation of all future contracts.

Finally, the membership shows a slight falling-off, due partly to the unusual number of engineers leaving municipal employ, but traceable also to the action of the Local Government Board in disallowing subscriptions paid to the Association by local authorities. This is a matter which the Council has under consideration. Other matters which are being dealt by the Council include the suggestion for the establishment of an information bureau and the desirability or otherwise of enlarging the Council with a view of securing wider representation of the smaller undertakings.

The election of officers for 1911-12 was next proceeded with. The following is a full list :—

President : G. Wilkinson (Harrogate).

Vice-Presidents : C. E. C. Shawfield (Wolverhampton) and R. A. Chattock (Birmingham).

Past Presidents : S. L. Pearce (Manchester), W. W. Lackie (Glasgow) and J. Christie (Brighton).

Council : W. Wyld (Birkenhead), A. C. Cramb (Croydon), F. Ayton (Ipswich), F. M. Long (Norwich), H. Richardson (Dundee), C. Furness (Blackpool), A. H. Seabrook (St. Marylebone) and S. J. Watson (Bury). Also, Councillor J. S. Rowntree (Harrogate), Bailie J. Willock (Glasgow), Councillor J. W. Crowther (Sheffield), Ald. W. Bruce (Sunderland), Councillor H. German (Brighton) and Ald. C. West (Coventry).

Hon. Solicitor : Ald. G. Pearson (Bristol).

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Hon. Treasurer: J. E. Edgcome (Kingston-on-Thames).
Hon. Secretary: H. Faraday Proctor (Bristol).

Harrogate was selected as the scene of next year's convention, provided the necessary arrangements can be made.

The Press were excluded from the subsequent discussion on the obtaining of municipal wiring powers.

ANNUAL DINNER OF THE ELECTRICAL CONTRACTORS' ASSOCIATION.

The annual dinner of the Electrical Contactors' Association was held at Frascati's Restaurant on Monday last, the chair being taken by Mr. G. Harland Bowden, President of the Association. Mr. Bowden had been re-elected to the position of president earlier in the day, this being the second year he will have taken office. The gathering was not as well attended as in previous years, the reason being that a number of the members were away on holiday, and many of the provincial contractors who had attended the annual meeting had been compelled to return home earlier in the day. We understand that practically all the London members were present, but even these did not make the dinner in any way representative of the Association. It seemed to us that there was not more than 15 to 20 per cent. of electrical contractors present.

The CHAIRMAN apologised for the absence of Mr. Terrell, K.C., M.P., who was down to reply to the toast of the Houses of Parliament. That gentleman was compelled to be present at the House at the debate on the Declaration of London.

Mr. R. TWEEDY SMITH, however, made a useful speech in proposing this particular toast, and dwelt upon the necessity for the Association doing its utmost to check the advance of municipal trading.

Mr. H. H. BERRY proposed the toast of the Contractors' Association, and referred in pleasing terms to the fighting fund which has been got together to protect the interests of the Association.

The PRESIDENT, in reply, remarked upon the growth of the Association, its 20 per cent. increase of members during the past year, and the contributions to the fighting fund which had resulted from his tour of the country. They now had a good sum at disposal, and much of this had come from a certain source which he understood might be looked to for further supplies when required. Most of Mr. Bowden's remarks were confined to the question of municipal electricity departments trading on the business of the legitimate contractor. He regretted that no working agreement had been come to as a result of the conference, and he felt that as far as contractors were concerned they had done their very utmost; in fact, they had gone the whole way to meet municipal engineers. While he did not give up hope of some arrangement being come to, he felt that it was necessary for contractors to protect their interests against the abrogation of their rights by the municipal electrical departments. He thought that the matter would have to be decided ultimately by the British public, who would settle whether it was right that municipal authorities should enter private premises and practically take the place of the legitimate contractor. The contractor was a ratepayer, and the competition of the local authority was grossly unfair to him, as such. He felt that the Association had no further concessions that they could make. He looked upon Mr. Christie's presidential address to the I.M.E.A. as a sympathetic utterance, and, as far as he knew, the Association was quite ready to try again to put matters upon a satisfactory basis. The Association would require steadfastness of purpose, and the members would need a good deal of self analysis so as to get rid of a certain lack of cohesion which was noticeable, and so that a united front might be presented for the purpose in view.

Mr. W. R. RAWLINGS proposed the Institution of Electrical Engineers and the N.E.M.A. and kindred associations (the Institution figured in the toast list as the Institute), and spoke of the gratitude which the Association felt to the Council for facilities to use the new building on the Embankment. As far as he was able to gather, the manufacturers were the only people in the industry who were making any money. One of the questions that he particularly wished to ask was, When does the manufacturer become a contractor? and jokingly answered—When he becomes a consulting engineer. He looked forward to the Electrical Exhibition, and anticipated an increased demand on the part of the public for electrical apparatus as a result of the show.

The reply to this toast was a double-barrelled one by Messrs. L. B. Atkinson and F. H. Nalder. Mr. ATKINSON referred to the useful work which had been done by the Cable Makers' Association in the standardisation of cables and in the raising of the quality to a point beyond which it was difficult to go. He thought that the contractor was between the upper millstone of the consumer and the lower millstone of the manufacturer.

The proceedings were livened by an excellent musical programme. Among the contractors present we may mention Mr. A. Rashleigh Phipps, Mr. G. Fox, Mr. G. W. Strode, Mr. W. A. Shaw, Mr. E. G. Wallis, Mr. W. R. Rawlings, Mr. H. Marryat and Mr. L. G. Tate, the hon. secretary of the Association.

TELEPHONE TRANSFER BILL.

In connection with Part II. of this Bill a Memorandum has been issued which states that the conditions of transfer were originally set out in the memorandum read by Lord Stanley in the House of Commons on Aug. 9, 1905. (This memorandum is now again issued, and is set out below.) The conditions set out in that memorandum have since been considerably modified in favour of the employés. The conditions in the main will be carried out as matters of administration. Statutory provisions are, however, required to modify in favour of the employés in certain cases some of the provisions of the Superannuation Acts. The whole of the staff of the National Telephone Co. with two years' service (with the exception of those in receipt of £700 a year or more) will be taken into the service of the Post Office, without the imposition of any educational or medical test. The staff of the company with less than two years' service will also be admitted to the Post Office under the same conditions, subject to a satisfactory certificate of conduct and efficiency being forthcoming. Those who have not served with the company for a time equal to the probationary period imposed upon new entrants to the Post Office service will be regarded as on probation for the balance of that period. The transferred officers will, as far as possible, be placed in the same classes as Post Office servants doing similar work; and they will enjoy the advantages and be subject to the conditions of the classes on which they are placed.

Except in the case of any persons whose salary may have been abnormally increased by the Company during the two years preceding the transfer, the initial rates of pay under the Post Office will not be less, and in many cases will be greater, than those paid by the company. Service with the company will be regarded as of the same value as service on corresponding duties in the Post Office for the purpose of seniority, annual leave and sick pay. The classification of the company's staff on transfer is not yet finally settled; but it may be stated that the great majority of the members of the company's pension fund will be placed upon pensionable classes in the Post Office; and that many thousands of persons who are not members of the pension fund will also be placed on pensionable classes, thus acquiring pension rights for the first time.

All officers of the company will be allowed to count the last two years of service with the company as service in the office to which they are transferred for the purposes of the application of the Superannuation Acts, and it is proposed so to amend the bill as to admit of any shorter period of service also being so counted. It will be open to members of the company's pension fund, as an alternative, to assign their share in the fund to the Postmaster-General, and to secure the privilege of counting for those purposes the whole of the period during which they have subscribed to the fund, or, in the case of original members of the fund, the whole of their duly authenticated continuous service with the company. In the case of original members of the fund who are placed upon pensionable classes, and who have assigned their shares of the fund to the Postmaster-General, the pension granted on retirement at the age of 65 (including annual value of the lump sum awarded) will not in any case be less than two-thirds of the salary which they were receiving on Jan. 1, 1896—the amount guaranteed by the company under the pension trust deed. Those members of the pension fund who are not placed upon a pensionable class will receive an addition to their salary of not less amount than the total annual contribution at the time of transfer paid by themselves and by the company into the pension fund, and in the event of their being given at any time a higher salary in the service of the Post Office they will receive an addition calculated on the same principle so long as they remain unpensionable. The qualifying period of 10 years prescribed by the Superannuation Act, 1859, for the acquirement of pensionable status, and the qualifying period of five years prescribed by the Superannuation Act, 1909, for the grant of a gratuity on death, will be waived in the case of persons who have been in the company's service continuously since Aug. 15, 1904. This concession, of course, only applies to persons who are on transfer or subsequently placed on pensionable classes. Service during the years 1910 and 1911 will be taken into account in the calculation of marriage gratuities, provided, in the case of telephone operators, that only so much of this period shall reckon as is subsequent to the completion of two years' full time service as operator. This is in accordance with the established practice in the Post Office.

TRANSFER OF NATIONAL TELEPHONE CO.'S SYSTEM TO THE STATE.

MEMORANDUM AS TO COMPANY'S EMPLOYÉS, read by the Postmaster-General in the House of Commons on Aug. 9, 1905, during the debate on the Agreement for the Purchase of the Company's Undertaking.

1. Subject to the other provisions of this memorandum, the Postmaster-General will take into the service of the Post Office the servants and officers of the company who have been not less than two years con-

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tinuously in the service of the company on Dec. 31, 1911, and such officers and servants shall enjoy the advantages and be subject to all the conditions of the rank or grade to which they are admitted in the same manner as other officers and servants of the Post Office in that rank or grade. This undertaking does not apply to the general manager or to officers of the company in receipt of £700 per annum or upwards.

2. The Postmaster-General has already by his agreement with the company conceded that officers or servants who have been continuously in the service of the company from Aug. 15, 1904, until Dec. 31, 1911, and who then become established servants of the Post Office entitled to pension, shall be so entitled, though they may retire before they have served 10 years under the Crown.

3. He is also willing, in the case of officers who do not participate in the pension scheme of the National Telephone Co., and who on the transfer of the company's business become established servants of the Post Office entitled to pension, to allow them to count for purposes of pension their continuous service with the company subsequent to Dec. 31, 1909, as service under the Crown.

4. As regards medical examination, the Postmaster-General cannot undertake to examine candidates for the Telephone Company's service, but he is willing to dispense in 1912 with the medical examination of any officer or servant if such officer or servant has been in the service of the company continuously for two years on Dec. 31, 1911, and has had no abnormal amount of sick leave during that time.

5. The pension fund of the company is in the hands of trustees, and its administration depends upon a private trust deed. The provisions of the deed are so different from the conditions of the Civil Service pension system that (apart from other difficulties) it would be impracticable for the Postmaster-General to administer the fund or to continue the same system for individuals. For instance, under the trust deed no pension can be granted to an officer who retires under the age of 65, whereas under the rules of the Civil Service an officer may be called upon to retire at 60, and if retiring at 60, either compulsorily or voluntarily, is entitled to a pension. The fund must, therefore, be closed, and officers and servants entering the Post Office must be subject to the Civil Service rules as to pensions (subject to the provisions of this memorandum). If, however, it be shown that by the closing of the company's pension fund and the substitution of the system of Civil Service superannuation the general body of the participants in the pension scheme of the company will be placed in a substantially less favourable position, the Postmaster-General will consider the expediency of adding a period (not exceeding in any case two years) to the service which under the rules of the Civil Service the officers affected are entitled to count for purposes of pension.

6. These arrangements cannot be fully carried out without the authority of an Act of Parliament, and this declaration is made subject to the passing of such an act. An act will be necessary to provide the money for the purchase from the company, and provisions on this subject will be included in that measure.

Mr. S. Roberts has given notice that he will move that the Bill be committed to a Select Committee of five members, three to be nominated by the House and two by the Committee of Selection.

PARLIAMENTARY INTELLIGENCE.

SIDMOUTH GAS AND ELECTRICITY BILL.

The Select Committee of the House of Commons on Unopposed Bills passed the preamble of this bill on Thursday last. The bill had already passed the House of Lords. The Urban District Council opposed in order to get a purchase clause inserted, but as a clause was agreed upon the opposition was withdrawn. The bill gave power to the company to, from time to time, raise additional capital not exceeding £15,000. The share capital is £30,000. The House of Lords Committee refused the Council a purchase clause, but gave them a suspensory clause. The Council were, however, not satisfied with that, but the promoters had now agreed to give them a purchase clause instead of the suspensory clause.

CENTRAL LONDON RAILWAY BILL.

This Bill, which authorises the Central London Railway Co. to construct a short double line, half a mile in length, from Wood-lane station, and to make a junction with the authorised line of the G.W. Rly. Co. at an estimated cost of £145,896, came before a Select Committee of the House of Lords on Tuesday. The Bill was opposed by the Metropolitan Railway Co., but the promoters contended that their proposal would not prejudice the Metropolitan Company, as their line and the Central London Railway were not in real competition until they reached the City. It was suggested that the Metropolitan line was so congested between Baker-street and Liverpool-street that the company had difficulty in providing for its traffic, and they had threatened to reduce the number of through trains which the Great Western Co. now run over their line.

Sir H. Oakley (late chairman of the Central London Railway), Sir James Inglis (general manager and consulting engineer to the G.W. Co.), and Mr. Basil Mott, C.E. (one of the engineers to the Central London Railway), gave evidence in support of the Bill.

On Wednesday the opposition was withdrawn and the Bill was allowed to proceed.

NEWCASTLE-ON-TYNE CORPORATION BILL.

This Bill was passed by a House of Commons Committee on Tuesday.

Mr. CRIPPS, for the Corporation, said the parties concerned had met and an arrangement had been come to that was satisfactory to all. He asked the Committee to agree to the insertion of an addition to Clause 128B, which would confirm an arrangement between the Corporation, the Newcastle-upon-Tyne Electric Supply and the Newcastle & District Electric Lighting Companies. The Newcastle & District Co. were satisfied with the amendment. They had an agreement with the Newcastle Electric Supply Co. which involved the Newcastle & District Co. taking some part of the supply under the heads of an agreement scheduled from the Electric Supply Co. The new clause was introduced and agreed to.

New Acts of Parliament.—On June 30 the Royal Assent to the Metropolitan Electric Supply Co. (Acton District) Act was read.

National Telephone Co.'s Staff.—In the House of Commons on Friday the Postmaster-General stated that when he said he would extend the promise which Lord Stanley read in the House of Commons on Aug. 9, 1905, by agreeing to take over members of the National Telephone Co.'s staff, even although they had had less than two years' service with the company, it was not his intention to extend it also by promising to take over officers in receipt of £700 per annum and upwards who were specifically excluded from Lord Stanley's undertaking. No doubt among those officers there would be some not near the age of retirement whose services would be of value to the Department, and he should carefully consider any proposals they might make to him to enter the Post Office at salaries bearing proper relations to those drawn by senior officers already serving in the Department.

Anglo-Norwegian Telegraph Service.—In the House of Commons on Wednesday the Postmaster-General stated, in reply to a question, that in regard to the working of the State cable between this country and Norway, the payment to the Great Northern Telegraph Co. for working the Anglo-Norwegian telegraph service was at the rate of 1¾ centimes a word for every word transmitted, together with 1½d. per telegram in the case of those telegrams which are collected and delivered by the company. The formal agreement on the subject, which would cover the general relations between the Post Office and the company, was still under consideration.

Metropolitan Railway Bill.—This Bill, which is proceeding as an unopposed measure, was ordered on Wednesday to be reported to the House of Lords for third reading. The proposals of the Bill include the widening of the railway, the construction of a station at Mount Pleasant, and the construction of subways for passengers at Marylebone.

Provisional Electric Lighting Orders.—The House of Lords Committee on Unopposed Bills on Tuesday passed Bills to confirm various Provisional Electric Lighting Orders, including the Portishead, Cirencester, Salisbury, Rhondda, and Chichester (Extension to Westhampnett and Westbourne) Orders.—The House of Commons Committee on Unopposed Bills has passed the Donaghadee Electric Lighting Order Confirmation Bill.

Macclesfield & District Railless Electric Traction Bill.—The promoters have withdrawn this bill.

LEGAL INTELLIGENCE.

National Telephone Co. v. Postmaster-General.

On Monday the Railway and Canal Commission sat as a court of arbitration in this case in order to decide matters of difference arising between the parties in respect of the "suitability" of certain plant, &c., to be transferred and the admissibility of these disputed items to the list of subjects for which compensation was to be paid by the Postmaster-General to the company.

Sir Alfred Cripps, K.C., M.P., Mr. Danckwerts, K.C., Mr. E. Mortin, K.C., Mr. Forbes Lankester, K.C., and Mr. H. H. Gaine appeared for the company; the Attorney-General, the Solicitor-General and Mr. G. R. Branson for the Postmaster-General.

By a deed of Feb. 2, 1905, it was agreed that the Postmaster-General should buy of the company on Dec. 31, 1911, (1) all plant, land and buildings of the company brought into use with the sanction of the Postmaster-General and in use by the company on Dec. 31, 1911, for the purposes of the licensed telephonic business of the company; any licensed telephonic business of the company which by virtue of the Telegraph Act, 1899, or of any of the agreements in writing between the Postmaster-General and the company particularly specified in the first schedule, or of any other agreement in writing between the Postmaster-General and the company (whether made before or after the date of the agreement), can be transacted for any period after Dec. 31; any private wire business of the company, together with all plant, land and buildings in use by the company on Dec. 31; all stores which on Dec. 31 are in the company's possession and which are suitable for use in accordance with the methods of work described in the specification and rules set forth in the third schedule, and all furniture in the company's possession at the same date, provided that they are reasonably necessary for the purposes of the telephonic business of the company according to the ordinary and businesslike way of carrying on such business. (2) Spare plant of every description in the company's possession on Dec. 31 (in-

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cluding works of all kinds in course of construction at that date shall be deemed to be plant in use by the company on Dec. 31 for the company's telephonic business. The above was subject to the provision that no exchange which had a capacity of more than 300 direct subscribers' lines, the construction of which was commenced after Aug. 15, 1904, should be deemed to have been brought into use with the sanction of the Postmaster-General unless its site and capacity should have been approved in writing by the Postmaster-General, or unless at the time when the question arose it should be determined by arbitration that such exchange would be suitable for the requirements of the telephonic service of the Post Office on Dec. 31, 1911. The Postmaster-General might, by notice in writing, given to the company not later than Jan. 1, 1911, object to buy such plant, &c., as he considered unsuitable for the actual requirements of the telephonic service of the Post Office. Save as otherwise expressly provided by the agreement, all questions and matters of difference under the agreement shall be referred to the Railway and Canal Commission.

Notices were given by the Postmaster-General rejecting certain plant, &c., and differences had arisen between the company and the Postmaster-General with reference to those notices; the company contended that the notices did not comply with the requirements of clause 3 of the deed, and also that the notices were in such a form as to include plant, &c., which would be in use by the company on Dec. 31, wholly or in part for the purposes of the private wire business of the company, and that under the agreement the Postmaster-General was bound to buy all plant, &c., in use for such business or which could not be separated from such plant, &c., without destroying or prejudicially affecting the same, and in that respect also the notices were void. The company asked the court to say that the notices of objection were void, and that all plant, &c., specified in the notices would be suitable for the telephonic service of the Post Office.

Sir ALFRED CRIPPS, in opening the case for applicants, said he wished to deal with the question on its merits, and he and his clients had very carefully considered how the case might be dealt with so as to bring the hearing within reasonable limits. He then read the judgments of the Court of Appeal upon the point of unsuitability, in the course of which the Master of the Rolls suggested that it might be possible for the parties to resolve the various plants and properties about which differences had arisen into categories, and so dispose of them en bloc. He (Sir Alfred) looked upon that view as optimistic. He pointed out that the judgment of the Court of Appeal, in dealing with the one point of "suitability," failed to take into account the case of a cable which could not be separated but which possessed a degree of suitability. Those cables could not be left out of account when the question of compensation came up for consideration before the court.

The ATTORNEY-GENERAL asked what he meant by some degree of suitability.

Sir ALFRED said it was a cable in which some of the wires were "suitable" for the purposes of the Postmaster-General and some unsuitable. He thought their lordships would come to the conclusion that that should be taken into consideration in estimating the compensation to be given to the company.

Mr. Justice A. T. LAWRENCE: Your argument is that in such a case as you give in illustration there must be a question of a quantum price, to be settled afterwards.

Sir ALFRED CRIPPS: Yes, my lord.

Sir JAMES WOODHOUSE inquired whether the case of private wires entered into Sir Alfred's illustration.

Sir ALFRED said he did not wish to exclude them from consideration, if the court came to the conclusion that a certain number of wires in a cable were suitable for and required for the service of the Postmaster-General.

Sir JAMES WOODHOUSE: Your opinion is that if some of the wires in a cable, according to the evidence to be given, turned out to be suitable and others unsuitable, the whole cable must not be refused on account of the unsuitable wires embraced in it?

Sir ALFRED CRIPPS agreed, but added that if it turned out in any case that the wires were easily separable that difficulty would not arise. It was where suitable and unsuitable wires were joined in one cable in an inseparable condition that he claimed the consideration of the Commission for the "suitable" wires as fit subject for compensation. The Government had given four typical cases to the company, which, if they were to embrace the whole of the Government's case, might shorten the proceedings considerably.

The ATTORNEY-GENERAL said these cases were typical of the Government case at large, but he could not be held to assenting to the proposition that there were no cases falling outside of them.

Mr. FRANK GILL, engineer-in-chief of the National Telephone Co., said that since he had been engineer-in-chief of the company he had added [illegible] stations to the system and 542 new exchanges. About 68 per cent. of the company's lines were now underground, and all of the work had been constructed in the most approved and modern style. The notices served by the Government upon the company were so wide that no two competent engineers could have agreed upon their meaning. There were in all 93 exchanges belonging to the Post Office and the telephone company in the London area, of which 61 belonged to the company. On Dec. 31, 1910, there were 118,596 exchange lines in that area altogether, of which 70,709, or nearly 60 per cent., belonged to the company. The total number of exchange stations was 194,003, of which 122,680 belonged to the company. In his opinion a considerable portion of the plant at the Avenue exchange ought to be maintained and utilised whatever the Postmaster-General's intentions might be. In the case of some of the notices it would be impossible to apply them for physical reasons, and in other cases they would amount to a ridiculous destruction of plant. In his opinion the company had in substance no superfluous plant. Cables used for connecting condemned exchanges could not be done away with without interfering with other lines of communication passing through and beyond the area of those exchanges. In many cases within the London area separation between condemned lines and useful lines would be impossible. Into the Gerrard exchange, to which, he understood, no objection had been taken, 33 cables entered, each carrying 600 pairs of wires, or an aggregate of 19,800 pairs. In 13 of those cables there were 496 lines connecting Gerrard with exchanges which had been objected to. Those cables, however, were not separable, because none of them contained only condemned wires. Most of the company's cables contained spare wires; those wires were not more than was necessary, and were not separable from the other wires in the cables.

On Tuesday Mr. GILL made a correction in his evidence. He stated that the number of exchanges in London operated by the Post Office was 33 (and not 31), and those operated by the company was 62. He had neglected to include the Treasury and the official switch as exchanges under the Post Office. There were 3,538 junction lines affected by the notices of rejection. These lines were about 17,000 miles in length, and on those there were about 2,747 calls per day. In his opinion the junction lines between the various exchanges were necessary for the public service. As to the necessity for those junction lines, witness gave as an instance the Croydon exchange, one of the 21 concerning which notices of rejection had been given. Between Croydon and exchanges not objected to there were 211 junction lines, and between Croydon and exchanges objected to there were 76. In addition, 35 junction lines passed through Croydon without using the Croydon switchboard. 211 of those lines were connected with exchanges not objected to, but because they originated with Croydon they would be objected to.

Mr. Justice LAWRENCE suggested that some method might be arrived at of avoiding the necessity for entering into so much detail. The Government thought they could not make their objections plainer in their notices, and, as things were, he did not see how the Court could get at the facts.

Sir JAS. WOODHOUSE said it appeared to him that what was really wanted was some scheme whereby the Post Office could show how the things they proposed to object to must come within the terms of the deed.

The SOLICITOR-GENERAL said he was anxious to save the time of the Commission, but the agreement was one under which they bought what they wanted, and they indicated what they wanted by the process of exclusion. It was not for them, but for the company to explain their position.

Sir ALFRED CRIPPS said his evidence was that not only on the question of "suitability," but on the question of "need" under clause 3, there was the question to be considered of an inseparable piece of plant. If the plant was suitable at all, in however small a degree, or if it were wanted at all, then, according to the view of the company, and, as he believed, of the Court of Appeal, if he appreciated its decision rightly, such plant could not be ruled out from the case under arbitration. By and bye, when they came to determine prices, the degree of suitability and the degree of need might be important matters to consider. But what he had shown was that all those lines had, of necessity, elements of suitability, and could not be ruled out at this stage.

Mr. GILL stated that the company had 880 instruments of the central battery type connected with the 21 London exchanges objected to by the Post Office. There were also 6,852 convertible instruments which, by quite a minor alteration, could be made practically central battery instruments. In addition, there were 13,266 instruments of the local battery type. All those could be made at a very small expenditure available for use on a central battery system. The local battery when used in connection with a central battery exchange would still receive its energy for speech from the battery in the subscriber's office, but the method of communication would be greatly simplified, so that the mere removal of the telephone from the hook would call the exchange, instead of having to ring. Witness gave the result of certain calculations made by him, which he said showed that the central battery system of the National Company was more economical than the magneto system. That central battery system was very suitable for the use of the Post Office, and he understood that the Post Office authorities intended to adopt the central battery system in some of its exchanges. Any attempt to replace the 21 London exchanges objected to by Dec. 31 would be likely to work an injury to the public service. Such a change could not be effected in a short time and ought not to be tried. In witness's view, substantially all the plant covered by part 1 of the notice was suitable for the working of the combined system. In the few instances where iron wires did exist they were suitable for the work. In one case, a very windy place, the ordinary copper wire was not stout enough, and, with the consent of the Post Office itself, the company put up an iron wire there, and it was doing its work well. In such a case as that he was prepared to argue that iron wire was suitable. There were only 86 miles of iron wire circuit belonging to the company, and of those 29 miles were especially arranged with the Post Office. He thought all the company's overhead wires would be suitable for the combined system. In only one case (at the Bank exchange) they had any difficulty with their telephone lines laid on or across or along a railway driven by electric power. All their cables laid in the proximity of electric railways were suitable for their work.

Cross-examined by Sir J. SIMON, witness said that in a place like London the central battery system was superior to the magneto system. If he were planning a new system he would have a central battery system. It was probable that had the company's business not been coming to an

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end shortly they would have gone much further in substituting the central battery system for the magneto system.

On Wednesday the Attorney-General said the parties were considering if some means could be devised for shortening the inquiry. He also suggested that in a matter of that great complexity counsel ought to have a spare day in order to examine the notes and submitted that taking that into consideration the court should not sit on Saturdays.

Mr. Justice LAWRENCE said he thought that it was reasonable to have a day. He ordered that there should be no sitting on Thursday this week, and that the court should not sit on Saturdays.

The SOLICITOR-GENERAL then resumed his cross-examination of Mr. GILL, who said there was more of the company's system in the City overhead than underground, and so far as it was an underground system in the City it was substantially because it used the underground system of the Post Office. Leaving out the underground system that they had hired or leased, the Post Office system was an underground and the company's an overhead system. He thought the Post Office had a very complete underground system. It would be necessary for the public service that the P.O., when it took over the business of the company, to lay down more underground wires in small lines in side streets, but the main arteries were fairly covered. He knew that the P.O. was now, and had been for some time, engaged in connecting the company's subscribers with its own main lines and installing its own instruments. Witness said that, as a matter of choice, he preferred an underground to an overhead system in the interests of economy. He mentioned certain underground cables laid by the company in Kensington.

The SOLICITOR-GENERAL said the P.M.G. was not only willing, but desirous of taking over that part of the company's property. He was authorised further to say that the P.O. made no objection to taking over any part of the company's underground system and plant laid in the public streets in London, but not those laid on private property. He desired especially to guard himself against being supposed by that to waive the objections of the P.O. to lines laid along the electric railways.

The SOLICITOR-GENERAL inquired what was the voltage of the current on an electric railway?—Witness said he believed, in the case of the District Railway, it was 500. An ordinary central battery worked at 24 and the ringing battery up to about 120 volts.

Counsel asked whether there would not be danger of shock to a subscriber if a voltage of 500 came along his telephone wire while he was using it, and witness said the probability was that it would burn the fuse wires.

With reference to the separability of wires in the cables, Sir John asked if it were witness's contention that the presence of a single pair of private wires in a cable threw upon the Post Office the obligation of buying the whole cable?—You are asking me a legal question which I cannot undertake to answer. All I say is you cannot separate the wires.

With regard to part 2 of the London agreement, witness said that, although the company had had certain non-metallic circuits, most of them were removed. He was, however, prepared to argue that those which were left were suitable for their purpose.

The SOLICITOR-GENERAL said that in cases where the company had copper-covered wires with an iron core the Post Office did not offer any objection to such wires on the ground that they were bi-metallic. Of course, they might have such wires overhead running from a condemned exchange, but that was another matter. With regard to want of audibility Sir John informed the court that the P.O. did not want to take advantage of any temporary want of audibility, but they desired to reject plant where the want of audibility was due to constructional difficulty.

On the question of the comparative efficiency and economy of the local battery and the central battery systems, witness agreed that the central battery system was generally more economical because fewer operators were required to attend to a given number of calls. That, however, was not always the case; for instance, he did not think the company could work the Avenue Exchange, London, any cheaper, and he was quite sure the P.O. could not.

The hearing was adjourned until to-day (Friday).

Workmen's Compensation.

At the County Court, Alfreton, last week, Judge Lindley sat as an arbitrator to determine an application by John Fearn for compensation in respect of injuries received at Wingfield Manor Colliery on Feb. 6. It appeared that Fearn worked an electrically-driven coal-cutter and during a mishap with the machine he was alleged to have received an electric shock, sustaining bad injuries, from which he now suffered. The accident was the subject of a police court prosecution at Alfreton, when Fearn was fined for working the machine with three wires in the fuse carrier. The magistrates held that he ought to have detected the presence of the wires by an examination, as required by the rules of the colliery. The man's wages were agreed upon at 38s. 11d. per week.

FEARN denied that he knew there were three wires in the fuse carrier when he was working the machine. He said he had remedied similar defects often.

SAMUEL JONES, of Wessington, formerly electrician at the colliery, said the accident was caused by a defect in the machine and not by reason of there being three wires in the carrier.

Respondent company's witnesses said that if there had been only one wire instead of three in the fuse carrier the accident could not have happened.

His Honour held that the accident occurred by reason of the fact that there were three wires in the carrier, and he was of the opinion that that amounted to serious misconduct on the part of Fearn. He therefore dismissed the application with costs.

W. Canning & Co. v. Northern Metallic Flexible Tube Co.

The hearing of this action was continued by the Official Referee (Mr. Muir Mackenzie) last week.

Mr. S. COWPER COLES gave evidence for the defence. He said he had examined the plant at Bradford. The dynamo was too small and the galvanising tank was wrong from the mechanical point of view. The wear and tear of the working parts was so excessive that it was impossible to keep the plant working continuously. The plant was also faulty from an electrical point of view.

In the course of the cross-examination of the witness, Mr. WAUGH, K.C. (for the defence) asked for an adjournment, to enable his clients to consider the position. On reassembling, it was announced that the parties had come to terms, which were not mentioned publicly, and Mr. Mackenzie made an order in accordance with these terms.

Tampering with Electric Apparatus.

At Barnsley Police Court last week John Tayler, a rope lad, was fined 10s. and costs for interfering with electrical apparatus at the Wharncliffe Silkstone Colliery. It was stated that defendant had left his ordinary work and interfered with the electrical apparatus to his own imminent danger.

W. Potts v. Metropolitan District Railway Co.

At the Westminster County Court on the 29th ult. Judge Woodfall granted a new trial in this case. As reported in THE ELECTRICIAN for June 23 (p. 434) a jury awarded plaintiff £50 damages for an "electric shock" alleged to have been received by him on the platform at Putney railway station.

Factory Prosecution.

At West Ham Police Court on Wednesday the Charing Cross, West End & City Electricity Supply Co. were summoned at the instance of Mr. W. Williams, Home Office factory inspector, on five informations for failing to comply with the regulations of the Factory and Workshop Act.

Mr. WILLIAMS said that the proceedings were under the electricity regulations of the Factory and Workshops Act, which came partly in force in 1909 and wholly in January, 1910. Those were the first proceedings under the Act. The facts were that on April 13 last there was a bad accident at the company's generating station. Geo. Charles Avent, a competent man, went behind the switchboard, and while there he received an electric shock, the voltage being 10,000. It was one of the few cases on record in which a man suffering from such a shock was alive to recount it, but he lost the use of his left arm, which was amputated.

The man gave evidence, and said that he had been employed at the company's station for 6½ years. On April 13 whilst cleaning the insulators at the back of an interlocking switch he got the shock and did not remember anything else.

Mr. LANE, for the defence, urged that Avent was acting contrary to the instructions of the company in entering the chamber. If he had asked, the current would have been cut off.

Mr. GILLESPIE said that from the man's own statement it appeared that he had no instructions to do that particular work.

Mr. WILLIAMS said that the object in bringing the case was that the regulations should be strictly observed, and with the consent of Mr. Gillespie he withdrew the summons.

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from *The Electrician* office, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published under 2s., and 5 per cent. for books published nett. Add 10 per cent. for abroad or for foreign books.]

"Hydro-Electric Practice." By H. A. E. C. Von Schon. 2nd edition. (Philadelphia and London, 1911: Lippincott Co.) 25s. net.

"The Journal of the Institute of Metals." Vol. V., No. 1. £1. 1s. nett.

"The Ventilation of Electrical Machinery." By W. H. F. Murdoch. (London, 1911: Whittaker & Co.) 3s. net.

"Electricity in Locomotion." By A. G. Whyte. (Cambridge, 1911: University Press.) 1s. net.

"Transactions of the South African Institute of Electrical Engineers." Vol. II. Part 3. April, 1911. 2s.

"How to Manage a Suction Gas Producer." By W. A. Tookey. (London, 1911: Percival Marshall & Co.) 1s. net.

"'Journal' of the Institution of Electrical Engineers." Vol. XLVI. No. 207, May, 1911. (London, 1911: E. & F. N. Spon.) 5s.

"Whittaker's Arithmetic of Electrical Engineering." 2nd edition. (London: Whittaker & Co.) 1s. net.

"Rubber." By P. Schidrowitz. (London: Methuen & Co.) 10s. 6d. net.

"Science Abstracts." Vol. XIV., Part 6, No. 162. Section A: Physics. Section B: Electrical Engineering. (London, 1911: E. & F. N. Spon.) 1s. 6d. each.

"Proceedings of the American Institute of Electrical Engineers." Vol. XXX., No. 6, June, 1911. $1.

"Annales des Travaux Publics de Belgique." 68th year, 20th series, Part XVI., June. (Brussels, 1911: Goemaere.) Fr.19.50.

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COMMERCIAL AND INDUSTRIAL SECTION.

MUNICIPAL, FOREIGN & GENERAL NOTES.

BRITISH NOTES.

Accrington.—The Electricity Committee have made an arrangement with Messrs. Howard & Bullough for supply of an additional 300 kw. for power. The agreement is for five years, and the firm undertake to pay for at least 500,000 units per annum.

The Board of Trade have sanctioned the laying of e.h.t. mains to the Rexenden boundary and also the supply of electricity in bulk to Haslingden Corporation.

Aldershot.—An inquiry was held last week into the Council's application for sanction to a loan of £2,500 for additional plant at the electricity works.

Evidence was given by the clerk to the Council (Mr. W. E. Foster), the chairman of the Lighting Committee (Mr. Calvert) and the electrical engineer (Mr. F. Gastide). Technical details were given by Mr. GARSIDE, who said that they anticipated by the installation of Diesel engines to be able to economise in their coal bill in the day time, and supply their large power consumers more cheaply. It was also necessary that they should increase their plant for the winter load. The department had in view a big contract to supply electricity, and it was quite possible they would get more, explained the engineer.

Applications for Restoration of Patents.—The Saltpetersäure Industrie Ges. (G.m.b.H.) have applied for the restoration of Patent No. 7,320/1907, for "Improvements in arc furnaces for the electrical treatment of gases," which expired on July 6, 1910, owing to non-payment of renewal fee.

Samuel Marsh Young has applied for the restoration of patent No. 13,746/1903, for "Improved method for operating signals on electric railways," which expired on June 19, 1908, owing to non-payment of renewal fee.

In both cases notices of objection (on Patent Form 16) must be sent by Aug. 28 to the Patent Office, 25, Southampton-buildings, London, W.C.

Asylum Lifts.—At the meeting of the Metropolitan Asylums Board on Saturday, the Asylums Committee recommended that in each of the two most recently-erected blocks for patients at Tooting Bec Asylum there be provided an electric lift capable of carrying 5 cwt., at an estimated cost of £210 per lift. It was stated that the hand lifts in the older blocks were so cumbersome that they were rarely worked unless absolutely necessary.—Agreed.

Barking.—The Council have deferred the consideration of the proposed extensions of the electricity generating plant and the L.G. Board have been asked to postpone their inquiry into the application.

Bath.—The Electric Lighting Committee recommend the Council to apply for sanction to a loan of £400 for a booster in connection with the supply of current to the Lower Bristol-road district.

Birmingham.—On Saturday the tramways running to Handsworth and along the Bristol-road to Selly Oak and King's Norton passed from the possession of the City of Birmingham Tramways Co. to that of the Corporation, and for the future they will be worked as part of the Corporation tramway undertaking.

In order to avoid delay the substitution of electric traction for the cable system has been effected in advance. The overhead work was completed and the track, which is to be used temporarily, has been bonded, and the cables supplying the electric energy have been laid by the Tramways Committee so far as the city portion of the line to Hockley Brook, and by the Handsworth Council on the remaining part. The route was officially inspected by Col. Yorke on Saturday.

Blackpool.—Application is to be made for leave to borrow £2,000 for four new tramcars of the toast rack pattern, two for this season and two for next year.

Brighton.—Rail-less Traction.—The Lighting Committee have increased the salary of the deputy manager of the electricity department (Mr. C. C. Fowler) from £350 to £375, with an increase to £400 at the end of 12 months. The salary of the chief clerk (Mr. G. T. Joyce) has been increased from £250 to £275, to be further increased to £300 in 12 months.

The Tramways Committee recommend that the members be authorised to visit Leeds to inspect the rail-less trolley system there and the question of applying for powers to establish a similar system in Brighton and along the Preston road to Patcham will be considered at the next meeting of the Committee

British Empire Trade Products.—A special supplement to the "Chamber of Commerce Journal" for July contains interesting information and statistics relating to the resources of the British Empire as a supplier of foodstuffs and also of raw materials for industrial purposes.

The statistics show the extent of the production in each colony and the condition of its development. Manufactured goods, other than food products, are not dealt with, and the figures relating to the imports to the United Kingdom are taken from the annual statement of the trade of the United Kingdom for 1910, and the statistics relating to trade and productions in British Possessions are mainly from official publications of the countries concerned. The products dealt with include rubber, gutta percha, gum arabic, lac, varnish, resins, &c., minerals and metals (including copper, nickel, tin, iron ore, manganese, zinc, asbestos, graphite, mica and asphalte), timber, fibres, &c. All who are interested in the development of trade within the Empire should procure a copy of this interesting supplement.

Croydon.—The Council have decided to re-open the Whiteboreroad tramway route.

The salary of the borough electrical engineer (Mr. A. C. Cramb) has been increased from £600 to £650, rising to £800 by three annual increments of £50. The salary of the Assistant Borough Electrical Engineer has been increased to £325, with a further increase of £25 in 12 months.

The charges for electric current are to be reduced as follows: For public lighting the price per lamp per annum for high candle-power lamps to be reduced £1 per lamp; for private lighting the flat rate of 4d. to be reduced to 3½d. per unit; heating and cooking from 1½d. to 1d. to consumers using electric light; traction from 1½d. to 1d. per unit for all current consumed in excess of 2,000,000. The charge for current for outside shop lighting has also been reduced, the total reductions representing a loss of £4,105 in revenue.

The accounts of the tramways department were approved on Monday.

Derby.—At the meeting of the Corporation on Wednesday the chairman of the Electric Lighting Committeee (Ald. Butterworth) announced that the profit on the electricity undertaking last year was £1,770, after paying all expenses, including interest, and paying nearly £12,000 to sinking fund account.

Dublin.—The L.G. Board have sanctioned a loan of £50,000 (out of the £128,129 recently applied for) for the electricity supply department. The question of granting power to borrow the remainder is under consideration.

Eccles.—Sanction has been received to a loan of £3,294 for a 500 k.v.a. steam alternator, &c., at the electricity works. The period of the loan is 18 years.

Edinburgh.—The Electric Lighting Committee recommend that current be supplied free of charge to the committee which is arranging the illuminations of the city during the Royal visit.

The committee also recommend a further reduction in the price of current to users of power. Previously the committee had recommended the reduction for private lighting from 2⅞d. to 2¾d. per unit. The applications for the use of electricity from May 16 to June 21 were equivalent to 11,512 8-c.p. lamps.

The Burgh engineer has been authorised to inspect and report upon the railless trolley systems recently inaugurated at Bradford and Leeds.

Electricity in Gas Works.—Perth Gas Committee recommend the Council to instal an electrically-operated stoking plant at a cost of £3,900.

The CONVENER (Coun. Clark) states that the claims which have been made for the new type of machine have been more than justified by the results obtained in other works. In Perth they were faced with the introduction of electric stoking machinery, or the alternative of an expenditure of £370 to £400 in repairs, a large proportion of which could be saved by the introduction of the new plant. No part of the existing plant would be sacrificed in the event of electric stokers being adopted. The economies to be effected by the introduction of new plant would result in a gross annual saving of fully £1,000.

Gloucester.—An inquiry was recently held into the application of the Council for sanction to borrow £13,500 for the electricity undertaking.

Of the loan £1,168 was for excess of expenditure, £5,604 plant extensions, £3,405 main extensions, £3,405 sundry distributory extensions, £1,200 for 250 services (at about £5), and £323 law costs.

The electrical engineer (Mr. F. H. Corson) gave technical particulars of the proposed extensions, to which there was no opposition.

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Heston and Isleworth.—Twickenham Electricity Supply Co. have arranged with the Council for a supply of current in the Whitton Park area.

Hornsey.—An inquiry was held last week into the Council's application for sanction to borrow £9,600 for extensions to the generating plant and mains.

The borough electrical engineer (Mr. N. Stainland) said that the demand for current was increasing at a satisfactory rate. The Borough Accountant said, in regard to the allocation of the profits, that it was desired to build up an adequate reserve and to reduce the price of current to consumers.

Kingston-on-Thames.—At the last meeting of the Council the Lighting Committee recommended that the chairman and vice-chairman, with the electrical engineer (Mr. J. E. Edgcome), should visit the Diesel oil engine works of the M.A.N. Co. at Augsburg and Nürnberg, and also, if possible, Munich, Dresden and Berlin.

Ald. MINNITT said they were shortly to have an electrical exhibition at Olympia, where they would be able to see types of every kind of engine, and he thought they should wait and see if they could get the information they wanted at Olympia.

Coun. SPRUNT said the Committee had now arrived at a point when the only question left to decide was whether they should adopt gas or oil engines. The expenditure they would have to incur shortly on the new engines would, probably, be £8,000 and it would be false economy for the sake of £40 or £50 not to get the best information concerning the engines first hand. The firm who made these engines employed 12,000 hands. They had made visits to various places, and they found that they could supply motive power which produced electricity much cheaper than their present plant.

Coun. LAMBOURN, replying on the discussion, said the committee suggested that Mr. Edgcome should go alone, and it was only on his strong representation that it was decided that two members should accompany him. They would certainly give a preference to English made goods if they were the best.

In response to requests from members, Mr. EDGCUMBE said the question of the engines was left an open one. The Committee had seen a number of gas and oil engines. There were two types of Diesel engines being made by four companies in this country, but the M.A.N. Co. turned out five times more than any other firm, and for engines of over 200 H.P. they adopted a type of which there were none at work in this country. Possibly, the double plant would involve an expenditure of from £8,000 to £10,000, and he thought it was only fair to himself that he should be supported by two members of the Committee.

The recommendation was carried.

Leeds.—On Wednesday a proposal of the Tramways Committee to purchase for £31,550 land for new tramway offices was referred back by the Council.

Leeds-Morley Tramway.—The new tramway between Leeds and Morley was formally opened for traffic on Wednesday.

Light Railways.—The Morley Corporation Light Railways Railways Order has been submitted to the Board of Trade for confirmation. This Order amends the Morley & District Light Railways Order, 1901. Objections must be lodged by July 28.

London County Council.—On Tuesday sanction was given to the borrowing of £11,236 by Shoreditch Council for electricity purposes. The report dealing with workmen's cars which was submitted at the last sitting was again adjourned.

L.C.C. Tramways.—Poplar Borough Council have been informed that the London County Council intend to proceed with the extension of the tramways in the East India Dock-road, from the existing terminus to the county boundary at Barking-road Bridge.

Maidstone.—Ten standards in Tonbridge-road are to be fitted with Osram lamps, thus effecting an annual saving of about £25 in the cost of lighting. The question of the cost of street lighting is to be considered at a joint meeting of the Electricity and Highways Committees.

Presentations.—Farnworth electricity works staff have presented a marble timepiece to Mr. A. J. Hutchinson, engineer and manager, on his marriage.

Last week the staff of Ealing electricity works presented a watch to Mr. Richard Golding, shift engineer, who is leaving to take up a position in Australia.

Provisional Order Revocation.—The Board of Trade have revoked the Higham Ferrers, Rusden and Wellingborough (Rural District) Electric Lighting Order, 1906, as from June 29.

St. Pancras (London).—The action against the National Telephone Co. to recover the cost (£180) of repairing the damage to the Council's mains, &c., in Upper Woburn-place by the company's workmen, has been settled, by the company paying the claim, each party bearing its own costs.

Salford.—Application is to be made to the L.G. Board for sanction to borrow £3,000 for mains and services in Prestwich.

In accordance with the recommendation of Sir Alex. Kennedy, alterations of the cut-offs of the generating engines at the electricity works are to be proceeded with at a cost of about £20 per engine. Tenders are to be invited for supply and fixing a new boiler.

Stoke-on-Trent.—At the last Council meeting a discussion arose in regard to a letter from the Potteries Electric Traction Co. inviting the Council to enter into negotiations for the purchase of their tramway power stations. The matter was referred to the General Purposes Committee.

Teignmouth.—Messrs. J. & W. Purves have notified the Council that they will apply for a provisional electric lighting order.

Torquay.—An inquiry was held on Tuesday into the Council's application for sanction to a loan of £5,000 for additional generating plant.

The town clerk (Mr. F. S. Hex) and the borough electrical engineer (Mr. C. W. Salt) gave evidence in support of the application. Mr. Salt supplied technical details of the plant in the generating station and of the proposed new plant. In the £5,000 asked for there was no sum for contingencies, and the inspector (Mr. H. R. Hooper) suggested that there should be a small sum allowed for that purpose, as it would be difficult to get the work done at the station for exactly the sum stated. Accordingly £250 was added for contingencies.

Willesden.—Sanction has been received to a loan of £5,000 for mains and £3,000 for services.

Worcester.—For outside shop lighting a special charge of 3d. per unit is to be made. The graduated fixed charge for heating and cooking has been abolished, leaving the 1d. per unit charge with a nominal charge of 1s. 3d. per quarter for the hire of the meter.

York.—Tenders are to be obtained for supplying and laying a cable to Messrs. Rowntree's works.

Batti-Wallahs Society.—Arrangements have been made for the members of this society to visit and inspect the R.M.S. "Olympic," at Southampton, on July 29. The party will be subsequently entertained to lunch by the president (Mr. W. Slade Oliver) on board the Royal Motor Club yacht "Enchantress," and will witness a regatta in the afternoon.

COLONIAL AND FOREIGN NOTES.

Australasia.—Thuringowa Shire Council recently decided to assent to the application of Mr. J. N. Perkes (on behalf of the proposed Townsville, Queensland, Electric Supply Co.) for authority to construct and work a tramway 2¼ miles in length. It is also proposed that the company supply energy for lighting in the district adjacent to the route.

The "Australian Mining Journal" says: Mudgee (N.S.W.) Council have accepted an offer by Mr. G. T. Edgar to supply electricity in the district for 15 years. The town has hitherto been lighted by gas.

Electricity has come largely into use in the Broken Hill mines with a material saving of costs in every instance. The latest addition to the power plants is that at the Junction North mine. The total cost of installation was £6,050, and it is effecting a saving at the rate of £7,500 a year. The plant includes a Belliss 350 B.H.P. engine and a General Electric (U.S.A.) 200 kw. generator, switchboard with Terrell regulator and 20 three-phase motors, varying from 2 to 35 H.P. The generator motors and switchboard were supplied by the Australian General Electric Co. The main cable in the main hoisting shaft is of the solid bitumen type and the cable to the mill is by W. T. Henley's Co.

Kurri Kurri (N.S.W.) Council have asked the East Greata Coal Mining Co. to supply electricity for street lighting, and supply will probably be given by overhead cables, permission for the erection of which Cessnock Council will grant under certain conditions.

Temora (N.S.W.) Municipal Council have engaged Mr. J. E. Donoghue, of the Electric Lighting Corpn. (Balmain), to prepare an estimate of the cost of establishing an electricity undertaking.

Messrs. Noyes Bros. have nearly completed the work of erecting and equipping electricity works for Moree (N.S.W.).

Newcastle (N.S.W.) Council recently adopted reports by a special commissioner and by Mr. J. E. Donoghue (of the Electric Light Corpn. Balmain) on the management of the Council's electricity undertaking and the late engineer (Mr. R. Brydon) has resigned in consequence. Mr. Donoghue considered that the engines were in fair condition, the site of the power house was bad, the pipework was in a very bad state of repair, the high-pressure cables were too close to buildings and the low-pressure mains for private supply were not designed to give a reasonably constant pressure at consumer's terminals. He suggested the expenditure of £1,400 for new low-pressure feeders and other alterations of mains and poles, £450 for sub-station equipment, £1,020 for street lamps, £220 for overhauling boilers, &c., £1,800 for condenser and cooling tower, £330 for water softener and water meter, £200 for changing single-phase motors and £259 for meters, &c. Mr. Bryden said £975 more was spent in public lamps in 1910 than in 1909, mainly on reconstruction, and £1,275 was debited against the year's revenue for accident compensation but the accident was not caused by any of the cables erected since he has been in charge of the undertaking. He had not been given credit for the improvements made or the largely increased output, which had more than doubled between March, 1909, and June, 1910, during which period generation costs had been reduced from 2·21d. to 1·20d. per unit. He was appointed when the cables, poles, &c., had reached the end of their useful life. The receipts for the year to December last were £8,206.10s.5d.

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and the working and general expenses (including £1,330. 5s. 1d. special charges) were £8,883. 4s. 1d., showing a loss of £676. 13s. 8d.

The Harden Gold Mining Co., Harden (N.S.W.) has ordered an electric pumping plant.

The Electric Lighting Corpn., Balmain (N.S.W.), recently decided to invite tenders for a 500 kw. mixed pressure turbine.

The Electrical Trades Union for N.S.W. have decided to ask the Arbitration Board to fix minimum daily wages of 9s. for arc lamp trimmers, 10s. for arc lamp trimmers doing patrol duty and maintenance work and 10s. 6d. for men in charge of small generating plants (under 5 kw.).

Devonport (Tasmania) ratepayers recently approved (by plebiscite) a proposal to borrow £3,200 for extension of the electric lighting system in East Devonport. A 540 ampere-hour battery and a new balancer and booster set are being installed by Messrs. Warburton, Franki & Co. at a cost of £1,200. A sub-aqueous cable will be laid in the river Mersey from Devonport to East Devonport, where the distribution will be by bare overhead conductors, erected by the Council's own employés.

With the reduced charge made by the Mount Lyell M. & R. Co. for the supply of current to Queenstown (Tasmania) municipality the local Council find that the undertaking pays its way, and it is announced that they will continue to supply carbon lamps free to their consumers.

The report of Mr. S. Irwin Crookes, who was commissioned by the public authorities of Whangarei county, North Auckland (N.Z.), to investigate the question of the utilisation of the Wairua Falls for the generation of electric power, states that the falls are 45 ft. in height, and at midsummer give a flow of 285 cubic ft. per second. The best position for a power station is 1½ miles from the falls, and there a fall of 132 ft. can be obtained, providing 3,300 H.P. minimum and 5,000 H.P. during nine months of the year. A few miles above the falls there is a natural layout for a reservoir, by which a continuous horse-power of 7,000 can be obtained. The falls are 18 miles from Whangarei town and also from Dargaville. A three-phase 20,000-volt transmission scheme is recommended, with turbines and generators of 1,500 H.P. to 1,700 H.P. at the outset. Totara poles would be particularly suitable for carrying the transmission line, and these poles, 35ft. in length, can be obtained in the district. The capital cost of the initial scheme would be: For power station £10,000, station equipment £6,000, deflector flume and penstocks £10,000, transmission lines and sub-station £28,400; total £54,400. Taking the cost as £60,000 (including contingencies), the interest at 5 per cent., and 5 per cent. depreciation, would come to £6,000 per annum, and working expenses would be more than covered by £3,000. Assuming that the proposed cement works, 4 miles from Whangarei, were established and took 700 H.P., the total revenue, with 600 H.P. supplied for other purposes, might be estimated at £11,700 (at £9 per horse-power) per annum, so that (says the report) a considerable profit would accrue.

The Public Works Committee for New South Wales recently heard evidence by Mr. Wm. Corin, electrical engineer of the department, on the Wagga and Tumberumba electric railway proposal. Mr. Corin said the construction of a light electric mountain railway was an up-to-date method of economically developing certain of the hitherto untouched resources of the State. He was of opinion that it would not be practicable with a standard gauge line to closely follow the coach road as Mr. A. J. Arnot had suggested on the route by way of Mount Horeh, but an intermediate course might be adopted with advantage. The cost of water-power works on Gilmore Creek would amount to £13,650, and the annual amount required for capital charges with 30 per cent. for repairs and renewals £1,842 for the generating station and (*ex*-traffic costs) £10,044 for the railway. At Buddong Falls greater power could be obtained, but as this was much further from the proposed line, the cost would be greater, and he had not made an estimate. The equipment of 50 miles of line would cost £150,000, if 20-ton locomotives and 45-lb. rails were used.

The telephone lines at Rockhampton (Queensland) are being placed underground, and a new exchange is to be equipped at the Telegraph Office. The cables will vary from 26 pairs to 208 pairs of wires.

In giving evidence before the Royal Commission on Suburban Traffic recently, Mr. Wm. Stone, electrical engineer, of the Victoria Railways Department, expressed the opinion that "from the technical standpoint electric traction in its present state of development is capable of fulfilling the most exacting requirements of passenger and goods traffic, either on suburban or main lines." He stated that, apart from interurban lines in the U.S.A., of which there are 7,783 miles, there are in 10 countries 1,495 miles of d.c. railways, 1,316 of single-phase and 161 of three-phase, a total of 2,882 miles. There are in England 195 miles d.c. and 19 miles single phase.

The Victorian Traffic Commission recently visited Adelaide (S. Australia) and took evidence. The acting mayor (Ald. Bontham) said there was no serious competition between the municipal tramways and the suburban railways. He would not favour State control over Adelaide tramways. The chairman of the Commission (Mr. Mackey) said the Adelaide cars had brightened up everything. The chairman of Walkerville Council and several members of the Municipal Tramways Trust also were opposed to State control.

A petition signed by 337 ratepayers and 85 tenants has been presented to Bundaberg (Queensland) Council asking them to consider the question of establishing electricity supply works.

Messrs. G. B. Lincolne & J. K. McDougall have been engaged as consulting engineers to prepare a report for Lilydale Shire Council on a scheme for electricity supply in Lilydale, Croydon, Ringwood and adjacent districts. It is probable that water power will be used.

A movement is on foot for the formation of a company to supply electricity in Bairnsdale (Victoria).

Townsville (Queensland) Council have decided to assent to the provision of electricity supply and electric tramways by the Townsville Electric Supply Co.

Shire Council have obtained an Order in Council authorising the installation of electric light and power plant for Euroa township.

Austria.—The Austro-Hungarian Government, which is considering the question of adopting electric traction on the State railways, have appointed two experts, one to visit England and the other the United States, in order to report on electric traction in those countries.

Brazil.—Consular reports state that the Government has given a contract to a Brazilian firm for electricity supply works and tramways in the city of Parahyba.

A report from Espirito Santo states that electric tramways are being substituted for the old mule drawn cars, but so far nothing has been done towards the contemplated electrification of the Diamantina Railway.

Canada.—A company is to be formed with a capital of $5,000,000 to erect hydro-electric works on the Khtada and Falls rivers, branches of the Skeena river. The company will also issue about £600,000 in 5 per cent. first mortgage bonds. It is intended to supply about 1,500 H.P. of electric energy from a provisional plant for the immediate demands of Prince Rupert, and to proceed to the construction of a permanent plant capable of supplying 15,000 H.P. on the completion of the Grand Trunk Pacific Railway.

The Imperial Trade Correspondent at Toronto reports that a company has recently been formed, with a capital of $1,000,000, to manufacture and deal in metals, carry on the business of mechanical and electrical engineers, etc., and construct and work gas and electric plants.

Cuba.—The Belgian Legation at Havana states that electric railways are to be built in the province of Santa Clara, and hydro-electric works will be established for supplying power.

The mountain torrents of Trinidad will be diverted into a reservoir having a capacity of 7,000,000,000 gallons. The Habanilla waterfalls, north of Cienfuegos, are to be harnessed to obtain the 30,000 H.P. estimated to be required to work the 300 miles of railway, for which a United States syndicate has secured a concession, between Cienfuegos, Cruces, Manicaragua, Santa Clara, Camiguani, Tunas, Fomenta, Sagua and Caibarien. The concessionaires also intend to supply electric energy to the towns through which the railway will pass, and to a number of sugar refineries.

Customs Duties.—Australian Customs decisions ordain that the following import duties are leviable:—

Electro-medical apparatus (for use with current from dynamos) for galvanisation, electrolysis and faradisation, and globe ear-phones, for use by deaf persons (as electrical appliances, &c.), 17½ per cent. ad val. (British goods 10 per cent.).

Italy.—Signor Jacques Sutter, engineer, has entered into a contract for the construction and working of an electric railway between Domodossola and the Swiss frontier, to connect the Simplon and St. Gothard lines.

Russia.—A consular report on the Moscow district states that during 1910 there was a considerable increase in the employment of electrical energy in Russia.

The Russian factories turned out as many Diesel engines in 1910 as in the whole of the preceding five years, and the output of cables and tramway and telegraph apparatus also increased. The provincial towns of Orel, Tamboff, Kaluga, Smolensk, Minsk, Tula and Moghileff have electricity supply; and other municipal works in progress or in contemplation.

It is stated (in a report from Krasnoyarsk) that in Eastern Siberia electrical goods find a good market.

A German contemporary states that F. A. Lipski and A. W. Below propose to form a company for the construction and working of an electric railway from Moscow to the Ssergievski Possad, with branch lines to the Northern Railway. The lines would be about 46 miles in length, and the cost of construction is estimated at 8,674,900 roubles (about £915,000). The project has been submitted to the Council of Ministers.

Spain.—The monopoly hitherto held by the Cia. Sevillana de Electricidad, a Spanish company with German capital, is likely to be invaded by competition.

The Soc. Catalana de Alumbrado por Gas, hitherto supplying gas only, have decided to also supply electricity. This company has a contract for lighting the town by gas, but by the desire of the Town Council this will be substituted by electricity. The necessary contract will be given to the company as soon as it is in a position to carry out the work. Mr. Bailey, an Englishman, is the local manager.

No progress has been made so far in the projected electric tramways in Cordoba city, though various schemes have been propounded, and the authorities are anxious to see them carried out, more especially a line to the southern slopes of the near Sierra.

Switzerland.—A concession has been granted for constructing an electric railway (partly rack and pinion system) from Meiringen to Engelberg, about 19 miles. The cost is estimated at £352,000.

Messrs. Buckler, Frei & Noef (Peterszell) have obtained a concession for constructing a narrow gauge electric railway from Waldstatt to Brunnadern, 12 miles in length, at a cost of £77,200.

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Wireless Telegraph Notes.—On July 1 the new law came into force which stipulates that any steamer carrying 50 or more passengers from any port in the United States to any place abroad distant 200 miles from the same port cannot be granted clearance unless provided with a wireless telegraph system in charge of a certificated operator. Penalty for non-compliance is £250.

It will be remembered that a similar ordinance came into effect in Italy on Jan. 1 last.

Uruguay.—A local engineering firm, representing a syndicate of French capitalists, is reported to have been authorised by the Ministry of Public Works to make surveys for an electric railway from Montevideo along the coast to Maldonado and Punta del Este, about 75 miles. Power is to be generated by low grade brown coal or peat obtained near Maldonado. The line is to be double and of gauge 1,676 metres (about 5,5 ft.). Power would be supplied on the overhead system.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Blackpool.—The total income of the electric supply department for the year ended March 31 was £33,972, including £17,760 from the sale of current for private lighting, £8,929 for current supplied to the Tramways Committee, £1,028 from the Blackpool, St. Anne's & Lytham Tramways Co., and £6,051 from public lighting, &c.

The working expenses were £15,978, leaving a gross profit of £17,994. Interest and sinking fund absorbed £12,724 and the net profit was £5,270 (against £6,266), of which £3,000 was devoted to relief of rates and £2,270 carried to reserve and renewal fund. 3,876,843 units were generated (against 3,884,151), 1,343,753 were sold by meter for private lighting and power, 279,872 for public lighting (270 arcs and 781 incandescent and Nernst lamps), 1,466,654 for traction, 54,000 for lighting Lytham-road South, and 438,051 were used on the works. There are 1,532 consumers, an increase of 102.

Glasgow.—The accounts of the tramways department were adopted by the Corporation on Monday.

The traffic revenue was £946,021, and rents, &c., brought the total income to £949,489, against £896,720. The working expenses (£533,179) included £270,792 for traffic expenses (against £265,395), £105,046 (£102,389) general expenses, £119,582 (£99,153) repairs and maintenance, and £37,759 (£35,974) for power, leaving £416,310 to meet rental of leased lines, &c. (£4,966), interest (£75,168), sinking fund (£89,794), income tax (£13,492), &c., and after appropriating £202,579 for depreciation and permanent way renewals fund the net balance (£68,678, against £53,028) was carried to the common good. The gross capital expenditure was £3,503,174, an increase of £78,446 over 1910, but the net expenditure is £1,800,259. There are 196¼ single miles of line open for traffic (against 190½); 237,967,307 passengers were carried (against 222,730,571), and 21,704,237 car-miles run (against 20,974,016). Total number of units used for traction and car lighting was 28,345,441 (26,860,126), or 1·31 per car-mile; traffic revenue per car-mile was 10·461d. (10·225d.), the average fare paid per passenger 0·954d. (0·963d.), and the precentage of expenses to total receipts 53·7 (53·82).

In moving the adoption of the accounts Bailie RUSSELL said that, favoured by good weather and somewhat improved trade during the past year, and with the exhibition in swing during the last month of the financial year, the result of their operations during the past 12 months exhibited a somewhat improved position. After giving an analysis of the accounts, he said that, as regarded the future, while they were making a good beginning, having £6,554 increase in one month, they had a considerable number of responsibilities facing them which should for a long time to come prevent any tampering with the financial position in the direction of reduced fares. They had a bridge at Dixon-street, a line of tramways up Portland-street, two bridges at Clydebank and several extensions that might require to be made in the course of the year. The cost of equipping the remaining cars with vestibules for the protection of motormen in inclement weather would cost £25,000, and they had still £8,000 or £9,000 to spend in equipping the remaining cars with top covers. The controllers were being brought up to date at a cost of a few thousand pounds. Brakes, now obsolete, were being replaced at an expenditure of about £25,000. The 100 old horse cars that they had still running would require to be discarded soon, and that meant in replacement an expenditure of something like £40,000. In addition, they had to face an extra expenditure this year, compared with last, of £9,000, representing the cost of the recent increase of wages, and on that point he was glad to say that the lowest paid able-bodied men in the employment (cleaners, sandmen and greasers) began with 23s. per week, advancing to 28s. per week in the course of three years. They might look for a further increase in the cost of the upkeep of the permanent way. All those things warranted them in maintaining a careful financial policy to enable them to go along on safe financial lines and be able to face anything unforeseen in the future. The thanks of the Corporation were due to the general manager and his entire staff for the continued ability displayed in the management of the department during the year.

Hornsey.—The accounts of the electricity department for the year ended March 31 show gross capital expenditure £154,344 (increase £3,869), of which £29,917 has been repaid.

Revenue was £19,752, working and general expenses were £7,636, and after providing £50 for bad debts and £674 for purchase of meters, £4,880 for instalment of loans and £4,691 for interest, there was a surplus of £3,103 to carry forward. Units generated were 1,657,846, supplied to public lamps 79,706, and to private consumers 1,044,774. The total maximum demand was 925 kw. There are 58 arc and 138 incandescent lamps for public lighting.

King's Lynn.—There was a net profit of £1,034 for the past year on the electricity undertaking against £838 in 1910.

The receipts from the sale of current were £6,312, against £6,177. In view of last year's profit a reduction of £223 was made in the charge for street lighting for the past year. The original capital was £50,766, and £20,495 has been repaid, leaving £30,271 outstanding. After the expenses for 1910-11 had been met the gross profit was £4,089, equal to 8 per cent. on the capital. After Oct. 1 next the price of current will be 4d. per unit. Out of this year's profit £280 of capital expended in excess of sanction has been met, and £300 handed over for relief of rates.

Sunderland.—The income of the tramways department for year ended March 31 was £59,071, including £58,889 traffic revenue.

The expenses were £37,189, leaving a gross profit of £21,882. Interest required £7,686 and income-tax £347, and after making provision for loan repayment (£10,355), placing £1,423 to reserve and renewals fund, and making sundry payments, the balance (£2,000) was carried to the borough fund. The gross capital expenditure is £393,546. 14,561,672 passengers were carried, and 1,451,905 car miles run; 1,702,872 units of energy were used (1·17 per car mile) and the average traffic revenue per car mile was 9·7d.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Tenders are invited for supplying plant and materials and the erection of electric supply station buildings for lighting the DUNDALK Urban District area, under its Electric Lighting Order, 1897. The plant includes generating station buildings, gas producing and generating plant, balancer and booster, switchboard, storage battery, mains (overhead and underground) electricity meters and travelling cranes. Copies of specifications, general conditions, &c., may be seen at the offices of the clerk, Mr. Mathew Comerford, Town Hall, Dundalk, or at the offices of the consulting engineers, Messrs. T. L. Miller, Wilson & Pegg, Donegall-square, Belfast, 709, Tower-buildings, Liverpool, or 19, Brazenose-street, Manchester. Tenders to the town clerk, Dundalk, by 10 a.m. of July 24. See also an advertisement.

The Urban District Council of ESHER and the DITTONS invite tenders for the installation of a system of wireless alarms in Thames Ditton and Long Ditton wards of the district. A plan of the district may be seen at the Surveyor's offices, where particulars may be obtained. Tenders to the clerk of the Council, Mr. E. A. Everett, Council Offices, Thames Ditton, by July 24. See advertisement.

ALDERSHOT Urban District Council invite tenders for supply and erection at their electricity works of one 135 kw. Diesel direct-coupled set. Specifications and further particulars from the engineer, Mr. F. Garside, Electricity Works, Laburnum-road, Aldershot. Tenders to the Clerk to the Council, Mr. W. E. Foster, by *noon* July 17. See also an advertisement.

Tenders are also invited up to Aug. 2 for the supply of telegraph and telephone material to the Postmaster-General's Department in WESTERN AUSTRALIA, and up to Aug. 23 for the supply of telegraph and telephone material to the Postmaster-General's Department in SOUTH AUSTRALIA. Specifications, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W. See also advertisements.

Tenders are invited up to July 31 for the supply of telegraph and telephone material to the Postmaster-General's Department in TASMANIA; up to Aug. 8 for the supply of measuring instruments, telephone instruments and parts, trembling bells and gong and 8 in. gong to the Postmaster-General's Department in VICTORIA; and up to Aug. 16 for cable, conduits, c.i. pipes, iron poles, insulators, wires, &c., for the Postmaster-General's Department in QUEENSLAND. Specifications from the Commonwealth Offices, 72, Victoria-street, London, S.W. See advertisements.

Tenders are invited (up to Aug. 15) for the supply of (*a*) 80,000 insulators and (*b*) indiarubber covered wire to the Postmaster-General's Department in VICTORIA, and (up to Aug. 23) for the supply of letter box fronts to the Postmaster-General's Department in QUEENSLAND. Tender forms and specifications from the Commonwealth Office, 72, Victoria-street, London, S.W. See also advertisements.

Tenders are invited up to Aug. 9 for the supply of letter-box fronts to the Postmaster-General's Department in NEW SOUTH WALES. Tender forms and specifications from the Commonwealth Offices, 72, Victoria-street, London, S.W. See advertisement.

Tenders are invited up to Aug. 9 for supply of four motor cars (petrol) complete and for the supply of letter box fronts to the

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Postmaster-General's Department in SOUTH AUSTRALIA. Tender forms and specifications from the Australian Commonwealth Offices, 72, Victoria-street, London, S.W. See an advertisement.

LONDON COUNTY COUNCIL require tenders by 11 a.m. for an electrical installation at Hamond-square elementary school, Hoxton. Specifications, &c., from the Chief Engineer, Spring-gardens, S.W.

The Council of the Metropolitan Borough of POPLAR invite tenders for the supply, delivery and erection at their Glaucus-street electricity works of overhead coal bunker, coal conveyor and extension and modification to existing coal conveyor. Specification and form of tender from the borough electrical engineer (Mr. J. Horace Bowden). Tenders to the Town Clerk (Mr. Leonard Potts), Council Offices, High-street, Poplar, London, E., by 10 a.m., July 15.

STOKE NEWINGTON (London) Public Library's Committee invite tenders for the installation of wires and fittings for electric lighting and ventilating at the Public Library, Church-street, Stoke Newington. Copies of specification and forms of tender from the librarian and clerk (Mr. George Preece), Public Library, Stoke Newington, N., where tenders are to be delivered by July 10.

WALTHAMSTOW Council require tenders by noon July 21 for feeder cables and stoneware conduits. Specifications, &c., from Mr. G. R. Spurr, Electricity works, Walthamstow.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.) are prepared to receive tenders for the supply, delivery and erection at the site of their Cossipore station, Calcutta, of auxiliary plant, and pipework. Copies of specification, drawings, &c., from the Secretary of the company, Mr. Francis R. Reeves, Salisbury House, London Wall, London, E.C., to whom tenders by 10 a.m., July 24.

The Tramways and Electricity Committee of BELFAST Corporation invite tenders for the supply of a circulating water pump and a motor-driven air pump. Specifications and form of contract from the city electrical engineer, Mr. T. W. Bloxam. Tenders to the town clerk, Mr. R. Meyer, by 10 a.m. Monday, July 17.

ECCLES Corporation invite tenders for supply and erection of a high-efficiency type centrifugal pump, driven direct by s.ph. a.c. motor (approx. output 63,000 gallons per hour against 35 ft.). Tenders to Town Clerk by July 17.

SWINFORD (co. Mayo) Electric Lighting Committee invite tenders for the electric lighting of the town. Specifications from the Clerk to Swinford Rural Council, to whom tenders by 11 a.m. July 10. The requirements include suction gas plant, engines and dynamos, storage battery, switchboard, overhead lines and street lamps.

CARDIFF Corporation require tenders by 10 a.m. July 14 for the supply of economisers and induced draught installation and supply and laying of cables. Forms of tender from Mr. A. Ellis, The Hayes, Cardiff.

REDDITCH Council invite tenders for supply of single-phase alternator direct coupled to Willans steam turbine, condensing plant and pipe work. Tenders to the Clerk by 5 p.m. July 10.

COWDENBEATH Council require tenders by noon, July 10, for the manufacture and erection of a Diesel oil engine and a c.c. generator. Specifications from the Burgh Surveyor.

SALFORD Corporation require tenders (by noon July 17) for supply of a water-tube boiler, with superheater. Particulars from Borough Electrical Engineer.

HAMMERSMITH (London) Council require tenders by 4 p.m. July 12 for the ensuing year's supply of Welsh steam coal for the electricity works.

Tenders are invited (up to July 18) for the supply of 4 tons 6 cwt. hire hard-drawn copper cables, and (up to July 2) for the supply of 35,700 incandescent electric lamps to the City of MELBOURNE, Australia. Copies of specification, tender forms, &c., from the agents for the City Council (McIlwraith, McEacharn & Co. Ppty., Ltd.), Billiter-square-buildings, London, E.C.

The Deputy Postmaster-General, HOBART, will receive tenders until noon July 31 for supply of telegraph and telephone material. Specifications, &c., from 72, Victoria-street, London, S.W.

The Deputy Postmaster-General, BRISBANE, will receive tenders until noon Aug. 16 for supply of paper-insulated lead-covered cable, and silk and cotton insulated lead-covered telephone switchboard cable, covered wire, g.i. and steel standard wire, c.i. pipes, iron and steel poles, insulators and copper wire, and accessories. Specifications, &c., from 72, Victoria-street, London, S.W.

Tenders are invited up to July 25 for the supply of 12 sections of a branching multiple magneto lamp signalling switchboard, &c., or one automatic or semi-automatic switchboard, &c., to the Postmaster-General's Department, VICTORIA. Tender forms, &c., from 72, Victoria-street, London, S.W.

The time for the receipt of tenders by the Ministry of Public Works, Constantinople, for an electric power and tramway concession for JERUSALEM, is extended to Sept. 13. Specifications (in French) may be seen at 73, Basinghall-street, London, E.C.

The Metropolitan Water and Sewerage Board, Albert-street, BRISBANE, Queensland, want tenders by noon Jan. 30 next for supply and erection, of one, two or three complete units, each consisting of power generating plant and pump or pumps to lift not less than 6,000,000 gallons per day. Particulars from the Secretary.

The Deputy Postmaster-General for NEW SOUTH WALES will receive tenders until 2:30 p.m., Aug. 23, for supply of telegraph, telephone and electric lighting material. Specification from the Commonwealth Offices, 72, Victoria-street, London, S.W.

MORTLAKE (Victoria) Butter & Cheese Factory Co. require tenders by noon Aug. 14 for supply of dynamo and booster, storage batteries and accessories, switchboard, cables, &c. Specifications from Messrs. F. A. McCarty & Co., 31, Queen-street, Melbourne.

WELLINGTON (N.Z.) Corporation require tenders by 4 p.m. Aug. 24 for supply of a motor power waggon and accessories for the electric tramways department. Gonville and Castlecliff Tramway Board, Ridgway-street, WANGANUI (N.Z.) require tenders by 4 p.m. Aug. 14 for supply of overhead tramway material, feeders, &c. Conditions, &c., can be seen at 73, Basinghall-street, London, E.C. Representation in New Zealand is necessary.

Tenders will be received at the Stadtbaudeputation Offices, Breslau (Germany), on July 25 for supply of centrifugal pumps and electric motors.

STAVROPAL (Caucasus) Municipal Council invite tenders until Aug. 14 (O.S. Aug. 1) for the construction and working of an electric tramway.

Tenders will be received until July 24 by the Civil Governor, Lerida (Spain) for the establishment and working of a telephone system in CERVERA.

Tenders will be received until July 26 by the Civil Governor, Santander, for the establishment and working of a telephone system in TORRELAVEGA (Spain).

Tenders will be received until July 21, for the supply of electrical energy for light and power to the Arms Factory, OVIEDO (Spain) for six years.

TENDERS RECEIVED AND ACCEPTED.

London County Council have received the following tenders for overhead equipment for the Brixton-Herne Hill tramway :—

Dick, Kerr & Co. (accepted)	£2,093 10 9
Clough, Smith & Co.	2,148 2 9
British Insulated & Helsby Cables	2,151 18 10
R. W. Blackwell & Co.	2,462 11 8

Chief officer's estimate £2,800. Permission has been given to sublet to Bradshaw & Sons, pole bases; British Mannesmann Tube Co., overhead poles; F. Smith & Co., trolley wire; Bartons, pole straps and scroll work; British Insulated & Helsby Cables, overhead fittings; and Leys Malleable Castings Co., span wire crosses.

London County Council received six tenders for compressed air cleaning apparatus for motors at car sheds, varying from £1,505 to £1,934, and three tenders, from £665 (incomplete tender) to £1,790. 9s. for lifting plant for unloading trucks, motors, &c., at car sheds.

Chief officer's estimate for both contracts £2,970. The Highways Committee recommend the acceptance of the tenders of the Globe Pneumatic Engineering Co. (£1,505) for the former and S. H. Heywood & Co. (£1,790. 9s.) for the latter contract, and that permission be given in the case of the cleaning apparatus contract to sublet the motors to Crompton & Co. and the compressors and receivers to F. W. Brackett & Co., and in the lifting plant contract to sublet to Dorman, Long & Co., D. Colville & Co., or Parkgate Iron & Steel Co., rolled steel sections; Parker Foundry Co., steel castings; H. Hollindrake & Son, iron castings; Abbott & Co., air receivers; Electric and Ordnance Accessories Co., motors and controllers; W. T. Glover & Co., cables; and Richd. Johnson & Nephew, overhead line work.

London County Council have also accepted the tenders of the British Westinghouse Electric & Mfg. Co. for checking meters at Greenwich generating station, £113. 7s., and the Electric Construction Co. for spare motor for coaling cranes at Greenwich generating station, £165.

Wigan Council have accepted the following tenders for annual stores for the electricity and tramways departments :—

General Electric Co., Eckstein, Heap & Co., Parmiter, Hope & Sugden, and British Thomson-Houston Co., electrical accessories; W. T. Henley's Telegraph Works Co., house service boxes; Morgan Crucible Co. and H. G. Meyer & Co., carbons; T. Tyldesley, gauge glasses; British Insulated & Helsby Cables and Watlington & Co., overhead material; Thos. Andrew & Co., iron; Wm. Parke & Co., steel; R. Bolton & Son, brass and metal castings; Douglas Forge Co., iron castings; Taylor & Jones, brake blocks; Fleming, Birkby & Goodall, tramcar accessories (steel spindles and graphite brushes); Percy Clark

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& Co., tyres; Wallwork & Co., tramcar resistances; Lion Spring Co., springs; P. R. Jackson & Co., British Westinghouse Co., and Dick, Kerr & Co., armature coils; British Thomson-Houston Co., gear cases; British Hele Shaw Clutch Co., gear wheels; L. Andrew & Co., sundries.

Worthing Council have accepted the tender of Mirrlees, Bickerton & Day for the supply and erection of oil-driven generating plant for the electricity works at £3,965. The electric generators are to be supplied by Bruce Peebles & Co., and the contract is subject to the sanction of the L.G. Board to a loan.

Nuneaton Council have accepted the tender of Galloways (Ltd.) for engine and pumps, at £1,723; that of Heenan & Froude for refuse destructor, at £775; and that of J. Thompson for Lancashire boiler, at £310.

The Midland Railway Carriage & Wagon Co. have accepted the tender of Belliss & Morcom for the equipment of the power station at their new works, Washwood Heath, Birmingham, to the specifications of Messrs. D. & A. Home-Morton, consulting engineers.

Gloucester Council have placed an order with Siemens Bros. & Co. for feeder and distributor cable at £1,211. 10s., and with the British Insulated & Helsby Cables for feeder and distributor cable, at £817, and for distribution pillars, at £200.

Norwich Corporation have placed orders with Venner & Co. for 334 time switches, making the number of time switches in use in that town considerably more than 400.

Margate Council have accepted the tender of Kingston & Co for wiring Cliftonville Pavilion, and that of Siemens Bros. Dynamo Works for lamp fittings, to replace arc lamps, at £6. 15s. each.

York Electricity Committee have accepted the tender of the Tudor Accumulator Co. for the maintenance of the storage battery at the electricity works, at £140 per annum.

The tender of Krupka & Jacoby has been accepted by Heston and Isleworth Council (at £80) for annual supply of metal filament lamps for street lighting.

Leyton Council have accepted the tender of the Union Cable Co. (at £164) for supply of turbo-generator connecting cables.

Dudley Council have placed an order with Bellis & Morcom for a high-speed steam engine at £675.

Haslingden Council have accepted the tender of Siemens Bros. & Co. for cables.

Eaglehawk (Victoria) Council have accepted the following tenders in connection with their electricity scheme:—

R. Hornsby & Son, suction gas engine, £1,118; Australian Metal Co., dynamo and booster, £260; Pfaff, Pinschof & Co., switchboard and apparatus, £128; Haes & Eggers, E.P.S. storage battery, £530. Consideration of the cable and wire tenders has been deferred.

The Governor-General of Victoria recently approved the purchase of 4,720 ft. c.i. piping from Stewarts & Lloyds, £293. 15s.

The Governor-General of Western Australia has approved the purchase of 1,000 four-way conduits (for the Postmaster-General's Department) from Mills & Co., £212. 10s.

The Bombay Electric Supply and Tramways Co. have placed an order with the Bastian Meter Co. for 300 three-ampere meters.

BUSINESS NOTICES.

The Electric & Ordnance Accessories Co. notify that in future they will be represented for their electric manufactures in and round Sheffield (for a radius of 10 miles) by Mr. H. E. Ridley, 104, Marlcliffe-road, Sheffield. The agency for "Vickers" centrifugal fans will remain, as before, in the hands of Mr. J. Crowford, 2, Exchange-street, Manchester.

Messrs. Gent & Co. have removed their London office to 25, Victoria-street, Westminster, S.W. Telegrams: Knifedge London; telephone: 548 Westminster.

Plant for Sale.—Mr. A. Underwood, 3, Queen-street, London, E.C., has for sale a 58 H.P. motor generator (440 volts to 110/125) and a switchboard.

Patents Development.—The owner of patent No. 16,183/1908, for "Improvements in or relating to telephony and telegraphy," desires to negotiate for the granting of licences thereunder. Particulars from Messrs. Lloyd Wise & Co., chartered patent agents and consulting engineers, 46, Lincoln's Inn Fields, London, W.C.

The proprietors of patent No. 23,878 of 1900 for "Improvements in process of and mechanism for separation of conductors from non-conductors" desire to enter into arrangements for exploiting same in this country. Applications to Messrs. Haseltine, Lake & Co., patent agents and consulting engineers, 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

The proprietor of patent No. 13,163/1905 for "Improvements in dynamo electric machines," desires to dispose of the patent rights or to negotiate for the granting of licences. Particulars from Messrs. G. F. Redfern & Co., patent agents, 15, South-street, Finsbury, London, E.C.

The proprietor of patent No. 27,552/1907, for "Improvements relating to means of transport by land, water or air, such as vehicles, ships or the like," desires to negotiate for exploiting same in the United Kingdom. Communications to Messrs. R. Bellield (Ltd.), consulting engineers, 3, London-wall-buildings, London, E.C.

I.R.G.P. Co.'s Exhibit at Glasgow.—We publish herewith a photograph of the exhibit of the India Rubber, Gutta Percha & Telegraph Works Co. at the Scottish Exhibition of National History, Art and Industry, now being held at Glasgow.

The goods exhibited include: An assortment of hose, packing, valves, washers, buffers, belting, carriage tyres, mats, cables, "Silvertown" fountain pens, heel pads and shoe soles, cells, ebonite goods of various kinds, testing and telegraph instruments, and gutta percha goods, repre-

senting a portion of the company's manufactures. It will be noticed that the company's golf ball, the "Silver King," won the amateur championship and the "Cruden Bay" professional tournament. Last week the open championship was won by Harry Vardon, playing with this excellent ball, and to this list of successes must be added the Scottish professional and Midland championships, and the Tooting Bec and Bramshot cups. The floor of the stand is covered with india rubber tiling, of which the compnay were the pioneers some 22 years ago. This material has been successfully laid on nearly 200 vessels and in over 60 banks, insurance offices and public buildings, and recently in Buckingham Palace and Marlborough House.

The Holiday Season.—All who have—or think they have—earned a holiday are turning their attention to the question of where to go, and how to get there. Most of the railway companies offer assistance in this respect and the Great Central Railway, whose service taps so many of the health, rest, pleasure and leisure resorts, have ready a programme of tourist and excursion facilities for week-ends and for longer periods which can be obtained from the chief station at Marylebone, the company's town office, and by post on request from the Publicity Department, 216, Marylebone-road, N.W. Many of the tours and holiday schemes include the health resorts on the North-Eastern Railway, and some of these are of special interest to those who may wish to include some of the more northern or north-eastern centres of health and recreation. Within the range of the G.C. Company's service is the beautiful Shakespeare country, the Chiltern Hills, and some charming country in the counties nearer London.

BANKRUPTCIES, LIQUIDATIONS, &c.

A receiving order has been made against Cuthbert Fenton Lindop electrician, lately trading at 62, Dale-street, Liverpool.

Thos. Chas. Francis, electrical engineer, 66, Liverpool-road, Stoke-on-Trent, has been adjudicated bankrupt. The first meeting of creditors will take place on July 12 at the O.R.'s, King-street, Newcastle, Staffs., and the public examination on July 18 at the Town Hall, Stoke-on-Trent.

A receiving order was recently made against the estate of the late E. Ristori, civil engineer, Parliament-street, S.W., and a meeting of creditors was held on Friday. It was reported that the liabilities would amount to about £100,000; assets were uncertain, consisting mainly of a claim against the Aluminium Corpn. (Ltd.)

A meeting to receive an account of the winding up of Mountain & Gibson (Ltd.) will be held on Aug. 1 at the offices of Thos. Bowden Son & Nephew, Parr's Bank-buildings, York-street, Manchester.

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PATENT RECORD.

APPLICATIONS FOR PATENTS.

*Note.—The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application, an asterisk is affixed.*

May 8, 1911.

11,245 Hirst & Brook. Electric motor controllers.
11,247 Yorke. Periodicity indicator and recorder.
11,09[illegible] Salom. Positive plates for storage batteries.
11,13[illegible] Lodge & Muirhead. Preventing interference in wireless telegraphy.
11,132 Crowe & British L. M. Ericsson Mfg. Co. Telephone transmitters, receivers or like devices.
11,140 B.T.-H. Co. (G.E. Co., U.S.) Vapour electric devices.

May 9, 1911.

11,162 Goldschmidt. Frequency transformer. (Convention date, 9/5/10, Germany.)*
11,19[illegible] Jones-Miller. Electrically indicating or recording the position, time and speed of trains on railways.
11,209 Isenthal. Method of and means for varying electrical capacity and/or induction.
11,234 Lake. (Bronislaw, Gwozdz, Germany.) Thermo-telephones.
11,237 Sterling Telephone & Electric Co. & Bell. Intercommunication telephone systems. (Addition to 1,631/10.)
11,238 Mehne. Electric time switches. (Addition to 14,052/09.)*
11,242 B.T.-H. Co. & Bingley. Electric heating devices.

May 10, 1911.

11,270 Williams & McCallum. Indicating earth leakage in electric circuits.
11,275 Perez. Arc lamps.*
11,310 British Electric Transformer Co. & McWilliam. Electromagnetically operated switch and like arrangements.
11,311 British Electric Transformer Co. & Berry. Distribution of alternating currents.
11,322 Casagrande. Device for reducing expenditure in electricity.*
11,326 Schniewindt. Electrical resistances. (Convention date, 18/5/10, Germany.)*
11,339 Bellini. Transmitters and receivers for wireless telegraphic and telephonic apparatus.*
11,349 B.T.-H. Co. (G.E. Co., U.S.) Electromagnetically-operated devices.
11,35[illegible] B.T.-H. Co. (G.E. Co., U.S.) Controlling means for electric circuits.
11,35[illegible] B.T.-H. Co. (G.E. Co., U.S.) Systems of electric motor control.

May 11, 1911.

11,407 Murray. Wireless telegraph transmitting stations.
11,4[illegible] Watkinson & Payne. Shade-holders for incandescent electric lights and the like.
11,43[illegible] James. (Ges. fur Verwertung technischer Patente m.b.H., Germany.) Combustion bridge for arc light electrodes.*
11,455 Aurilia, Attimo & Casoria. Automatic electromagnetic railway signalling devices.*

May 12, 1911.

11,497 Wolterbeck. Process of forming Planté plates.
11,543 Royston. (Electro-Chemical Rubber & Mfg. Co., U.S.) Method of attaching rubber to metals.*
11,5[illegible] Schneider. Electric heat regulator. (Convention date, 9/6/10, Germany.)*
11,5[illegible] Kirk. Insulating sockets.*

May 13, 1911.

11,58[illegible] Hailwood. Electric hand-lamps. (Addition to 436/11.)
11,[illegible] Hardon. Electric lighting for vehicles.
11,[illegible] Sanderson & Truman. Electromagnets.
11,[illegible] Slaughter. Electric welding.
11,[illegible] Nussbaum. Microphones.
11,[illegible] Schwerin. Treating finely sub-divided substances by electric osmose.*
11,[illegible] W. T. Henley's Telegraph Works Co. & Pfiffner. Sheathing for electrical conductors.

May 15, 1911.

11,673 Gisland. Electrical appliance for boiling water.
11,[illegible] Walton. Electrical switching apparatus.
11,[illegible] W. R. Sykes Interlocking Signal Co. & Sykes. Electrically-insulated fish-joints for railway rails.
11,735 Celst. Continuous-speed cones for dynamos with invariable speed of rotation. (Convention date, 14/5/10, Belgium.)*
11,7[illegible] Sheehy. Electromagnetic switch.*

May 16, 1911.

11,[illegible] Taylor. Changing the frequency of alternating currents.
11,[illegible] Ryan. Machine for making electrically welded chains, rings and the like.*
11,[illegible] Bingley. Electric heating apparatus.
11,[illegible] Harst. Spark plug.*

May 17, 1911.

11,[illegible] Boardman, Boardman & Boardman. Arc lamps of the open arc type.
11,[illegible] Brunella. Electrical connections.
11,[illegible] Brock. Processes and apparatus for magnetically separating materials. (Convention date, 17/5/10, Germany.)*
11,[illegible] Marconi's Wireless Telegraph Co. & Round. Variable inductances.
11,[illegible] Chemische Fabrik Griesheim Elektron. Depolarisers for galvanic cells or batteries. (Convention date, 10/10/10, Germany.)*
11,[illegible] Marks. (Gebrüder Siemens & Co., Germany.) Electric radiation furnaces.*
11,[illegible] Gebatz. Means applicable for use in locking electric incandescing lamps in their holders.

May 18, 1911.

11,[illegible] Barksdale. Shield or protector for telephone receivers.
11,[illegible] Gurney. Coal miner's electric safety lamp.
11,[illegible] Ghelke & Imperial Lamp Works (Brimsdown). Preparing tungsten and the like metal filaments.
11,[illegible] Girardeau. Mounting receiving and transmitting apparatus in radio-telegraphic stations. (Convention date, 28/5/10, France.)*
11,[illegible] Priestman & Lee. Electric incandescent lamps.
11,[illegible] Smith. Magneto-electric machine.*
11,[illegible] Page. Manufacture of electric accumulator electrodes and means for use therein.
11,[illegible] Bunnel. Manufacture of electrodes for electric arc lamps. (Addition to 6,960/02.)*
11,[illegible] Marks. (Siemens-Schuckertwerke G.m.b.H., Germany.) Measuring mechanical work output.*
11,[illegible] Seaman, Osborne, Cox, Gattie & New Transport Co. Means for distributing goods and the like.
11,[illegible] Chemische Fabrik Griesheim-Elektron. Regeneration of the hitherto waste products of galvanic cells or batteries. (Convention date, 3/6/10, Germany.)*

12,026 Adams Mfg. Co. (Cutler Hammer Mfg. Co.) Control of electric motors.
12,322 Newitt & Fletcher. Electrical heating appliances.
12,427 Berry. Switch apparatus suitable for use in electrical distribution systems.
12,521 Jones. Entrance devices for tramway vehicles and the like. (24/5/09, addition to 3,717/10.)
12,614 American Automatic Telephone Co. & Goodrum. Automatic telephone systems.
12,757 B.T.-H. Co. (G.E. Co., U.S.) Alloys useful as electric resistance conductors.
13,518 B.T.-H. Co. (G.E. Co., U.S.) Arc-light electrodes.
13,962 Electric Construction Co. & Pensabene. Controlling induction motors.
14,024 Allgemeine Elektricitats-Ges. Alternating-current dynamo-electric machines of commutator type. (19/6/09, patent of addition not granted.)
14,092 Siemens Bros. Dynamo Works. (Siemens Schuckertwerke Ges.) Electric condensers and the like.
14,505 Stewart & Westminster Tool & Electric Co. Electric drills.
15,792 Bowyer & Anchor Cable Co. Process for providing electric conductors with an identifying covering.
16,620 Clark. (Telelectric Co.) Electrically-operated playing apparatus for musical instruments and music sheets therefor.
17,312 Chadburn's (Ship) Telegraph Co. & Grant. Speed indicators.
17,819 Goldstone & Lightfoot. Electrical cord grips.
18,867 B.T.-H. Co. (A.E.G.) Devices for securing wires or conductors in place.
19,019 Leonard. Rheostats, electric heaters or like devices.
19,772 Ruthenburg. Electrolytic production of antimony.
19,804 Reid. Electric furnaces.
20,289 Byng & Archer. Electric heaters.
21,935 Bowyer & Anchor Cable Co. Apparatus for winding material in strips on a wire or the like.
22,103 Shipley. Appliances for fixing and removing electric incandescence lamps.
22,304 Darby. Electric lamp socket.
23,748 Baehr. Telephone receivers.
24,686 Bosch. Interrupter for ignition machines. (22/6/10.)
25,014 Beck. Telemeters.

SPECIFICATIONS PUBLISHED.

1910 Specifications.

[illegible] Phillips. Controlling of aerial vessels by wave-transmitted electricity.
[illegible] (International Telechronometer Co.) Telephone apparatus.
[illegible] Adams Mfg. Co. (Cutler Hammer Mfg. Co.) Starting devices for electric motors, particularly adapted for use with multiphase motors.
[illegible] Adams Mfg. Co. (Cutler Hammer Mfg. Co.) Electric motor plant having means for equalising the load on the source of electric energy.
[illegible] Safety device for locking incandescent electric lamps in their holders.
[illegible] Aiken. Controlling electric lights and apparatus therefor.
[illegible] Hebberd. Varying the voltage in alternating electric current circuits.

COMPANIES' MEETINGS AND REPORTS.

BULUWAYO WATER WORKS & ELECTRIC LIGHT CO. (LTD.)—The directors' annual report states that the proceeds of sales of water and electric light amounted to £16,861, compared with £18,432 in the previous year, the decrease being entirely due to the general use of metal filament lamps by private consumers, and their substitution for carbon lamps in the streets. Considerable economies in the management had been effected, and during the current year a marked increase in revenue was already shown.

CHILI TELEPHONE CO. (LTD.)—The report for the year ended March 31 states that the aggregate number of subscribers at all centres was 9,919, a gain of 1,101 for the year. The gross revenue in Chili from all sources was $2,041,198, against $1,851,689 in 1909-10, an increase of $189,509. The expenditure in Chili was $976,570, against $926,387, increase $50,183. The net income in Chili was $1,064,627, compared with $925,301, increase $139,326. Converted into sterling (at the average rate of exchange for the year) the figures were £48,357 for 1910-11, against £40,411, increase £7,946. The balance to credit revenue, including £2,987 from previous year, is £49,131, of which £22,805 has been carried to reserve. An interim dividend of 3s. per share (tax free) was paid on Jan. 15 last, and the directors now recommend a final dividend of 4s. per share (tax free), leaving £3,225 to be carried forward. The £110,000 new share capital, which was authorised at the extraordinary meeting in November, was duly issued, increasing the issued capital to £330,000.

EDMUNDSONS' ELECTRICITY CORPN. (LTD.)—For the year ended March 31 the net profit, after payment of interest, amounted to £16,138, compared with £10,768. 9s. 6d. last year. Adding £25,577. 17s. 5d. brought forward, there remains £41,715. 17s. 5d., which the directors recommend should be carried to reserve. The gross trading profit has increased by £2,335. 1s. 10d. The dividends and interest received have increased by £4,067. 16s. 2d., and the Urban Company's guarantee is less by £854. 2s. 10d., whilst the loss on working the local authorities' undertakings is increased by £1,871. 10s. 6d., the greater part of which is due to payments for interest and sinking fund on sums paid to the company in respect of work carried out during previous years. The total connections of the 21 subsidiary companies are equivalent to 1,441,883 33-watt lamps, against 1,334,584 33-watt lamps in 1910.

GENERAL ELECTRIC CO. (LTD.)—For the year ended March 31 the net trading profits and income from investments, &c., amount to £119,145. 19s. 2d., making, with £8,918. 15s. 4d. brought forward an available total of £128,064. 14s. 6d. After deducting debenture interest and depreciation (£32,330. 15s. 9d.), the balance was £95,733. 18s. 9d., out of which preference dividend has absorbed £12,500 and £43,615. 13s. 2d. has been transferred to reserve, leaving £39,618. 5s. 7d., which the directors recommend should be appropriated as follows:—Managing directors' and employees' bonus £7,431. 10s. 4d., 5 per cent. dividend on the ordinary shares £19,973, leaving to be carried forward £12,213. 15s. 3d. The total reserve account is now £202,103. 14s., and the directors have decided to apply towards writing down goodwill and patents £92,103. 14s., leaving the reserve at £110,000. The directors record with deep regret the death during the year of their late chairman and managing director, Mr. G. Byng. The result of the trading for the year has been satisfactory. The factories at Witton, Salford, Birmingham and London have been well employed during the year. The removal of all manufacturing departments other than telephone and telegraph apparatus from Salford to Witton has been completed, the central stores from Manchester have also been removed to Witton. The additional capital expenditure incurred during the year has been principally devoted to housing these departments. The investment account comprises mainly investments in undertakings owned or controlled by the company, and is developing to the satisfaction of the directors.

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INDIA RUBBER, GUTTA PERCHA & TELEGRAPH WORKS CO. (LTD.)—At the meeting last week Major L. Darwin stated that as it was the half-yearly meeting there were no accounts or report. He regretted that the directors, while declaring the full half-yearly dividend on the preference shares, were not also able to declare an interim dividend on the ordinary shares. The condition of the market for raw materials was abnormal during the first six months of the year and the board thought it wise to depart from their usual practice of declaring an interim dividend on the ordinary shares on this occasion. During October last the price of the highest grade Para rubber varied from 5s. 10d. to 7s. 1d. per lb.; at the end of December it was 5s. 6d. and in the early days of March it rose to 7s. 2d. They would, therefore, understand how difficult it was for the board, without a complete stocktaking, to decide whether or not there was a profit to divide on the past half-year's earnings. Quoting from an American journal on the position of rubber, Major Darwin said it was to be hoped that, in the interest of the manufacturer, the fall in prices might become less rapid, so that stocks might be realised at a profit. One, however, had always to face the possibility that even existing prices would not be maintained, because ordinary production and consumption did not justify them. The amount of business whih the company had done had been quite satisfactory, and the board thought their worst troubles were over; the principal anxiety that remained being the possibility of obtaining remunerative prices for the stock in hand, and in process of manufacture. However, special attention was being paid to that in the hope that the financial year as a whole would show the results which they all desired. Their sales of goods into the composition of which rubber did not enter, were quite normal, but appreciably better than was the case at the corresponding period last year.

A resolution, sanctioning the payment of an interim dividend of 5s. per share (less tax) on the preference shares was approved.

MARCONI INTERNATIONAL MARINE COMMUNICATION CO. (LTD.)—At the meeting last week Mr. G. C. Isaacs (who presided) stated that the company held an exclusive licence from Marconi's Wireless Telegraph Co. for the rights to instal and work their system of wireless telegraphy on board merchant and pleasure vessels of certain countries, including Great Britain. The number of telegraph stations installed under these rights had increased from 145 in the previous year to 250 at the date of the report, and had since further increased to 303. The directors expected that at the end of the current year the stations at work upon the high seas would be about 400. Many new coast stations had been, and were being, erected in all parts of the world, while a quite considerable revenue was derived from communications between ship and ship.

MADRAS ELECTRIC SUPPLY CORPN. (LTD.)—The directors' report for 1910 (the first complete year of working since the opening of the generating station) states that 1,882,787 units of electrical energy were sold, compared with 267,568 units in 1909. There are 719 consumers (against 355) and the equivalent connections in 8 c.p. lamps 75,329 (against 29,296). Gross revenue was £17,454 (against £5,057). During the year 2,611,061 units were generated and distributed at an average cost of 1·08d. per unit, and the board consider this satisfactory. Applications from new consumers for current for power and lighting continue to be received in satisfactory numbers. The board have appointed Messrs. Merz & McLellan as consulting engineers to the company.

METROPOLITAN DISTRICT RAILWAY CO.—At an extraordinary meeting on Monday the shareholders approved the agreement entered into by the company and the London Electric Railway Co. for acquiring the Lot's-road generating station of the Underground Electric Railway Co. The Bill authorising the transfer of the undertaking has already passed Parliament.

PUEBLA TRAMWAY, LIGHT & POWER CO.—The directors, in their siderable improvement in the results compared with previous years, the report for the year ended Dec. 31, 1910, state that there has been a connet profits in Mexico having been £61,677, against £48,677 for 1909, an increase of 26 per cent. After meeting expenses and interest, the balance profit for the year was £5,441. The gross and net receipts of the light and power department continue to show satisfactory increases. The tramway receipts show a decrease owing to abnormal trade conditions and to unusually heavy expenditure on maintenance. The growing demands of the City of Puebla, the absorption of the company's present available supply of power, and the necessity (under the company's concessions) of providing 16,500 H.P. within the city boundaries by 1913, have rendered it imperative for the directors to provide funds for the development of the Tuxpango Falls, and it is proposed to take power to create an issue of $3,000,000 5 per cent. prior lien bonds, with the right to increase to an amount not exceeding $6,000,000.

ROYCE (LTD.)—The directors' report states that, after providing for all trade expenses, depreciation, but before providing for debenture interest or crediting interest received from investments, the year's trading has resulted in a profit of £4,607. Interest on investments (£2,930) and profit on sale of an investment (£7,631) brings the total to £15,169. Deducting debenture interest (£650), the total profit was £14,519, which, with £766 brought forward, makes £15,285. £739 is transferred from reserve, and it is proposed to pay a 6 per cent. preference dividend for the year to March 31 less tax (£1,975) and arrears of dividend on preference shares (seven years), absorbing £13,824, carrying forward £224.

UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON (LTD.)—Sir E. Speyer presided at an extraordinary meeting on Monday when resolutions sanctioning the sale of the company's Lot's-road power station to a joint committee of the Metropolitan District and London Electric Railway Companies was approved.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

ANGLO-FOREIGN CONSTRUCTION SYND. (LTD.) (116,590.)—Reg. July 1, capital £3,000 in £1 shares to work and develop lands, railways, tramways, electric lighting systems, electric and other power installations and works, &c. Private company. Reg. office: 75 and 76, Lombard-street, London, E.C.

BRITISH ARC WELDING CO. (NORTH EAST COAST) (LTD. (116,553.)—Reg. June 30, capital £22,000 in £1 shares, to take over a process for electrical welding under a grant or licence given by the British Arc Welding Co. to R. F. Brigham and R. Cowan. Private company. First directors: R. F. Brigham and R. Cowan (managing directors for 10 years). British Arc Welding Co. have right to one nominee on board.

CORONA LAMP WORKS (LTD.) (116,527.)—Reg. June 23, capital £2,000 in £1 shares, to carry on the business of manufacturers of and dealers in electric lamps, fittings, bells, batteries, accumulators and electrical accessories, &c.; to acquire the business carried on as the Corona Lamp Works Co. and to adopt an agreement with G. N. Ogilvie. Private company. First directors: G. N. Ogilvie (chairman and managing director) and A. N. C. Mackley. Reg. office: 10, Ascham-street, Kentish Town, London, N.W.

DICKS (LTD.) (116,483.)—Reg. June 24, capital £5,000 in £1 shares, to take over the business of electrical, sanitary, motor and general engineers, ironmongers, &c., carried on by P. Dicks and J. Dicks at Winchester. First directors: P. Dicks (manager) and J. Dicks. Reg. office: 149, High-street, Winchester.

F. G. EDEY & CO. (LTD.) (116,551.)—Reg. June 29, capital £3,000 in £1 shares, to take over part of the assets of the business carried on by F. G. Edey & Co., and to carry on the business of electrical engineers and contractors, suppliers of electricity, &c. Private company. First directors: F. E. Edey and D. Edey. Reg. office: 25, Warwick-lane, London, E.C.

KIRKALDY & KEMP (LTD.) (116,577.)—Reg. June 30, capital £3,000 in £1 shares (1,000 6 per cent. cumulative preference), to take over the business of consulting engineers, motor garage proprietors, æronautical, electrical and general engineers, &c., carried on as Kirkaldy & Kemp. Private company. First directors: A. H. Kirkaldy, A. F. Kemp and A. Hehner.

SWITCH-ON-GAS LIGHTING SYND. (LTD.) (116,586.)—Reg. June 30, capital £1,100 in 1,000 ordinary shares of £1 each and 2,000 deferred shares of 1s. each, to take over from A. H. Nicholson, A. W. Brooking and C. Isaac the benefit of two inventions for improvements in electrically-operated valves, and to carry on the business indicated by the title. Private company. First directors: A. W. Brooking and C. Isaac.

W. C. TACKLEY & CO. (LTD.) (116,522.)—Reg. June 27, capital £500 in £1 shares, to carry on the business of electrical and mechanical engineers, electricians, manufacturers of and dealers in electrical equipment and machinery, &c. Private company.

MORTGAGES AND CHARGES.

ENGLISH ELECTRICAL CO. (LTD.)—Issue, on June 21, of £750 debentures, part of a series of which particulars have already been filed.

RECEIVERSHIP.

MAGNETO CO. (LTD.)—C. H. McPherson, 35, Newhall-street, Birmingham, ceased to act as receiver or manager on Dec. 31, 1910.

CITY NOTES.

MEMORANDA (July 6).—Bank rate 3 per cent. (March 9, 1911.) Price of silver, 24 7/16d. per oz. Consols 78⅛—78⅜ for money; 78⅛—78⅜ for account. Consols Pay Day, Aug. 2; Stock and Shares Continuation Days, July 12 and 26; Ticket Days, July 13 and 27; Pay Days, July 14 and 28; Mining Shares Carry Over Day, July 11.

PRICES OF METALS (London).—*Copper*, cash, 56⅛; three months 57. *Lead*, English, 13⅞—13⅝; Foreign, cash, 13⅛, two months, 13½. *Spelter*, 24⅜. *Tin*, English, 192½—195½; Foreign, cash, 195½; three months, 189. *Iron*, Cleveland, cash, 46/4, three months, 47/1.

BRITISH INSULATED & HELSBY CABLES (LTD.)—Warrants for interest on the 4½ per cent. first mortgage and 5 per cent. mortgage debenture stock have been posted.

DUBLIN UNITED TRAMWAYS CO. (LTD.)—The directors have declared a dividend for the half-year ended June 30 at the rate of 6 per cent. per annum (less tax) on both preference and ordinary shares, after setting aside £4,000 for renewal of cars and £2,000 accident insurance reserve, and carrying forward £9,564.

MADRAS ELECTRIC TRAMWAYS (1904) (LTD.)—The traffic receipts for the fortnight ended June 30 were R.20,069 (increase R.2,538). Aggregate from Jan. 1, R.261,291 (increase R.19,216).

MEXICAN LIGHT & POWER CO.—The directors have declared a quarterly dividend of 1 per cent.

R. WAYGOOD & CO. (LTD.)—The profit for the year ended March 31, including £2,665 brought forward was £23,395. A further sum of £1,000 is placed to reserve, and the directors recommend a final dividend of 7 per cent. per annum for the six months to March 31, making 6 per cent. for the year, leaving £3,395 to carry forward.

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ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	June 28	1,673	+ 303	4	6,469	+ 563
Airdrie	„ 23	241	+ 8	25	5,404	+ 1
Anglo-Argentine	July 1	47,224	+ 2,990	26	1,280,907	+ 132,800
Ashton-under-Lyne	„ 1	398	— 1	14	5,879	+ 479
Ayr Corporation	„ 1	275	— 57	7	2,032	— 115
Barnsley	June 23	221	+ 46	25	4,506	+ 268
Barrow	„ 23	386	+ 71	25	6,597	+ 461
Bath Electric Trams, Ltd.	„ 28	1,079	+ 213	26	20,476	+ 596
Birmingham Corporation	„ 24	7,716	+ 902	12	89,313	+ 6,471
Birmingham & Midland	„ 23	986	+ 117	25	22,292	+ 1,727
Blackpool and Fleetwood	July 1	753	— 376	..	..	..
Blackburn Corporation	June 28	1,174	+ 130	†14	16,316	+ 1,477
Bolton Corporation	July 2	2,601	+ 305	14	34,709	+ 2,990
Bombay	June 2	2,767	+ 97	22	62,981	+ 3,389
Bournemouth Corporation	„ 28	2,022	+ 363	13	22,626	+ 1,435
Bradford Corporation	July 1	5,653	+ 604	13	74,917	+ 6,904
Brighton Corporation	„ 2	1,020	+ 57	¶13	13,575	+ 1,201
Bristol Trams & Carriage	June 30	7,086	+ 959	13	96,268	+ 9,255
Burnley Corporation	July 1	1,292	+ 28	13	17,861	+ 1,758
Burton Corporation	„ 2	333	+ 64	13	3,894	+ 380
Bury Corporation	„ 2	1,213	+ 41	¶13	17,174	+ 1,256
Calcutta Tramways Co.	„ 1	R55,612	+ R5,022	26	R1,487,190	+ R55,178
Canborne-Redruth	„ 1	121	+ 2	26	3,115	+ 14
Cardiff Corporation	„ 1	2,368	+ 95	13	33,049	+ 3,378
Central London Railway	..	..	..	..	..	..
Chatham & Dist. Lt. Rys.	..	..	..	..	..	..
City & South London Rly.	„ 2	3,714	+ 457	26	87,799	+ 3,861
City of Birmingham	June 23	3,237	+ 247	25	70,294	+ 2,422
Cork Electric Trams Co.	„ 29	541	— 4	26	12,409	+ 160
Devonport & Dist. Trams	„ 23	525	+ 79	25	11,453	+ 1,235
Dover Corporation	..	..	..	..	..	..
Dublin & Lucan Railway	„ 30	147	— 13	26	3,370	— 1
Dublin United	„ 30	5,717	— 365	25	142,001	+ 4,043
Dudley-Stourbridge	„ 23	915	+ 98	25	20,235	+ 1,780
Dundee Corporation	„ 28	1,295	+ 68	¶6	7,702	— 21
East Ham Council	July 1	1,034	+ 2	13	14,526	+ 855
Exeter Corporation	June 30	324	— 1	13	4,518	+ 346
Gateshead & Dist. Trams	„ 23	1,339	+ 87	25	25,502	+ 1,432
Glasgow Corporation	July 1	19,199	+ 912	§4	89,759	+ 6,563
Glossop Trams	„ 1	121	+ 6	26	3,126	+ 199
Gloucester Corpn.	June 23	332	+ 37	..	..	..
Gravesend-Northfleet	„ 23	285	+ 48	25	4,991	+ 115
Great Northern & City Rly.	July 1	1,571	+ 148	26	39,969	+ 1,877
Greenock & Port Glasgow	June 23	899	+ 156	25	17,024	+ 2,318
Halifax Corporation	„ 27	2,915	+ 400	†13	25,747	+ 2,703
Hartlepool Tramways	„ 23	395	+ 72	25	6,100	+ 518
Hastings Elec. Trams Co.	„ 29	1,050	+ 73	..	..	..
Hong Kong	July 1	$10,007	+ $1,314	26	$242,423	+ $783
Huddersfield Corpn.	„ 1	1,826	+ 55	13	26,059	+ 2,913
Hull Corporation	„ 1	2,674	— 123	13	37,692	+ 2,025
Ilford District Council	„ 1	543	— 12	14	7,549	+ 440
Ilkeston District Council	June 28	157	+ 27	13	1,757	+ 107
Ipswich Corporation	July 1	431	+ 3	13	5,831	+ 584
Isle of Thanet Co.	„ 1	856	— 65	39	15,836	+ 792
Jarrow	June 23	155	— 47	25	3,186	+ 233
Keighley Corporation	„ 29	185	+ 6	13	2,577	+ 244
Kidderminster & District	„ 23	153	+ 24	25	2,592	+ 187
Kilmarnock Corporation	July 1	154	+ 3	7	1,082	+ 40
Kirkcaldy Corporation	..	..	..	..	..	..
Lancashire Trams Co.	June 30	1,520	— 31	26	36,002	+ 321
Lancashire United	„ 23	1,361	— 20	26	33,800	+ 721
Leamington	„ 23	237	+ 50	25	3,837	+ 35
Leeds Corporation	July 1	7,459	+ 302	13	100,242	+ 7,812
Leicester Corporation	„ 1	2,448	+ 68	13	34,199	+ 3,381
Lincoln Corporation	„ 1	621	— 15	‡7	4,513	+ 226
Liverpool Corporation	„ 1	124	+ 4	13	1,780	+ 167
Liverpool Overhead Rly.	June 24	14,133	+ 396	25	283,751	+ 10,388
Llandudno&ColwynBayRy.	July 2	1,483	+ 69	26	37,174	+ 1,993
London County Council	June 30	318	— 62	§30	5,783	+ 196
London Elec. Ry. Co.	„ 21	50,345	+ 6,226	‡12	529,754	+ 31,338
London United	July 1	15,025	+ 1,750	26	372,420	+ 23,410
Lowestoft Corporation	„ 1	6,799	+ 143	26	164,361	+ 4,893
Maidstone Corporation	..	..	..	..	..	..
Manchester Corporation	..	..	..	..	..	..
Mansfield Railway	„ 1	15,747	— 37	14	215,601	+ 13,913
Merthyr	„ 1	2,034	+ 28	26	53,757	+ 1,148
Metropolitan Dist. Railway	June 23	240	+ 6	25	5,050	+ 121
Metropolitan Elec. Trams	July 1	13,152	+ 1,217	26	312,683	+ 26,121
Middleton	June 23	10,715	+ 2,176	25	211,249	+ 31,625
Milan Corporation	„ 23	358	— 26	25	8,134	+ 585
Mumbles	..	..	..	..	..	..
Newcastle-on-Tyne Corp.	July 1	3,961	+ 221	13	57,673	+ 4,136
Newport (Mon.)	„ 1	701	+ 28	13	9,765	+ 735
Northampton Corporation	June 30	502	— 9	13	7,274	+ 784
Oldham, Ashton & Hyde	„ 23	582	— 41	25	13,943	+ 447
Oldham Corporation	July 2	1,871	+ 82	14	28,173	+ 1,568
Perth (N.B.) Corporation	June 28	216	+ 40	6	1,201	+ 105
Perth (W.A.) Elec. Trams	„ 30	1,531	+ 3	26	42,237	+ 2,147
Peterborough	„ 23	161	+ 31	25	2,834	+ 199
Plymouth Corporation	July 1	2,880	+ 734	13	30,163	+ 3,532
Pontypridd	June 23	2,024	+ 169	25	47,795	+ 4,764
Portsmouth Corporation	..	..	..	..	..	..
Potteries	„ 29	626	+ 36	13	8,787	+ 815
Rawtenstall Corporation	„ 23	322	— 19	25	2,834	— 89
Reading Corporation	July 3	4,863	+ 132	§13	66,633	+ 3,882
Rhondda Corporation	June 23	57	+ 1	25	1,156	+ 45
Rhyl Corporation	July 2	6,514	+ 537	14	91,239	+ 6,312
Rio de Janeiro Tramways	„ 1	$10,163	+ $718	26	$272,522	+ $16,910
Rotherham Corporation	June 23	1,082	+ 132	25	20,294	+ 607
Rotherham Corporation	„ 23	1,115	+ 260	25	22,239	+ 1,944
Rotherham Corporation	„ 23	1,586	+ 478	13	15,621	+ 1,755
Rotherham Corporation	„ 23	869	+ 212	13	8,183	+ 1,346
Rotherham Corporation	„ 23	384	+ 34	25	6,983	+ 246
Rotherham Corporation	July 1	703	— 6	13	10,619	+ 1,117
Rotherham Corporation	„ 2	1,292	+ 106	13	17,232	+ 1,985
Rotherham Corporation	June 28	431	— 5	35	15,693	+ 1,177
Rotherham Corporation	„ 23	1,350	+ 223	25	27,436	+ 1,982
Rotherham Corporation	„ 28	203	+ 65	13	2,045	+ 261
Rotherham Corporation	„ 23	53	+ 9	25	1,010	+ 13
Rotherham Corporation	„ 23	462	— 134	25	5,211	+ 149
Rotherham Corporation	„ 28	722	— 5	26	12,549	+ 738
Rotherham Corporation	July 1	1,087	+ 101	13	14,869	+ 2,621
Rotherham Corporation	„ 1	527	— 6	26	14,414	+ 619
Rotherham Corporation	..	..	..	..	..	..
Rotherham Corporation	June 22	3,073	+ 313	12	33,430	+ 3,744
Rotherham Corporation	„ 23	198	— 24	25	2,102	+ 111
Rotherham Corporation	„ 23	473	+ 42	25	10,926	+ 680
Rotherham Corporation	„ 28	1,158	+ 61	13	13,191	+ 1,313
Rotherham Corporation	„ 23	381	+ 63	25	6,842	+ 329
Rotherham Corporation	„ 23	111	+ 11	25	2,418	+ 58
Rotherham W.R. Trams	July 2	1,273	+ 169	27	34,336	+ 1,359
Rotherham Woollen District	June 23	1,231	+ 198	25	25,769	+ 1,883

Unless otherwise stated comparisons are with the corresponding period last year. * Partly electrical.
† Minus 3 days. ‡ Minus 2 days. § Plus 3 days. ¶ Plus 2 days. (a)

ELECTRICAL COMPANIES' SHARE LIST.

Shs	Last Dividend	Name.	Price Wed., July 4.	*Rate per cent. Yielded.	Dividend Due.	Business 8 Days to July 4. Highest.	Business 8 Days to July 4. Lowest.
		Electricity Supply.		£ s. d.			
10	6/0	Bournemouth & Poole Elec. Sup. Ord.	8 —9	6 9 6	Mar, Sep	8½	—
10	4/6	Do. 4½ per Cent. Cum. Pref.	9 —10	4 14 6	Feb, Aug	..	—
10	6/0	Do. 6 per Cent. Cum. Second Pref.	10½ —10¾	5 6 0	Feb, Aug	..	..
St.	4½%	†Do. 4½ per Cent. Deb. Stock (red.)	100 —102	4 9 0	Jan, July	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	8 —8½	6 1 0	March	..	..
5	3/6	Do. 7 per Cent. Pref.	7½—8	4 1 3	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Deb. Stock	98 —101	4 0 6	June, Dec	102	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	3¾—4¼	5 2 6	Feb, Aug	4¼	3¾
5	2/3	Do. 4½ per Cent. Pref.	4½—5½	5 2 6	Feb., Aug	4½	4½
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	94 —96	4 4 0	Jan, July	94½	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	102 —104	4 7 0	..	103½	102
5	2/3	†Do. City Undertaking 4½% Cum. Pref.	3¾—4¼	5 12 6	Jan, July	..	..
5	3/0	Chelsea Electric Supply Ord.	4 —4½	5 11 0	March	..	..
St.	4½%	†Do. 4½ per Cent. Deb. Stock (red.)	93 —100	4 11 0	June, Dec	..	..
10	8/0	City of London Electric Lighting Ord.	11¾—12¼	4 15 0	Feb, Aug	12¼	11¾
10	6/0	Do. 6 per Cent. Cum. Pref.	12 —13	4 12 3	Jan, July	12¾	..
St.	5%	†Do. 5 per Cent. Deb. Stock (red.)	119 —123	4 1 0	June, Dec	..	..
St.	4½%	†Do. 4½ per Cent. 2nd Deb. Stock (red.)	99 —102	4 9 6	Jan, July	..	..
St.	5%	†County of Durham Elec. P. D. 5% 1st Mort. Deb. Stk.	89½—91¼	5 10 6	Jan, July	..	..
10	6/0	County of London Elec. Supply Ord.	7¾—8¼	6 3 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11¼—11¾	5 6 0	Mar, Sept	11½	..
St.	4½%	†Do. 4½ per Cent. Deb Stock (red.)	110 —112	4 1 0	Jan, July	..	..
St.	4½%	Do. Second Deb. Stock	99 —102	4 8 0	May, Nov	101½	..
5	4/0	Folkestone Electricity Supply Co. Ord.	4½—4¾	5 19 0	April, Oct	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4¾—5¼	4 15 3	Mar, Sept	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red)	97 —100	4 10 0	Feb, Aug	..	..
5	5/0	Hove Electric Lighting Ord.	6¾—7¼	6 4 0	April, Oct	..	..
St.	4½%	Isle of Wight E. L. & P. Co. Deb. Stk.	88 —91	4 19 0	..	..	..
5	5/0	Kensington & Knightsbridge Ord.	7 —7½	5 16 0	Feb, Aug	..	..
5	6%	Do. 6 per Cent. 1st Pref.	5¼—6	5 0 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	93 —95	4 4 0	..	..	..
St.	4%	Kensington & Knghtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	96 —99	4 1 0	April, Oct	..	..
St.	4½%	Kent Elec. Power Co. Irred Deb. Stk.	80 —84	5 7 0	Jan, July	..	..
3	1/2½	London Electric Supply Ord.	1¾—2¼	2 17 0	Mar, Sept	..	..
5	3/0	Do. 6 per Cent. Pref.	4¼—5¼	5 17 0	Mar, Sept	4¾	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	89 —92	4 8 0	Jan, July	91¼	..
5	3/0	Metropolitan Electric Sup. Ord.	3¾—3¾	6 18 0	April, Oct	3¾	3¾
5	2/3	†Do 4½ per Cent. Cum. Pref.	4¼—4¾	4 17 0	Jan, July	4¼	..
St.	4½%	†Do. 4½ per Cent. Deb. Stock 1st Mort.	102 —105	4 5 6	June, Dec	..	..
St.	3½%	†Do. 3½ per Cent. Mort. Deb. Stock (red.)	84½—87½	4 1 6	Jan, July	86½	86
..	4½%	†Midland Elec. Corp. for Power Dist, 4½ 1st Mort. Debs.	96 —93	4 12 9	..	..	..
5	2/6	Newcastle Elec. Supply Ord.	3¼—4	4 14 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non Cum. Pref.	4 —4½	5 11 0	Feb, Aug	..	..
100	4½%	†Do. 4½ per Cent. 1st Mort. Deb.	97 —99	4 12 0	Jan, July	..	..
100	5%	North Metro. Elec. Power Sup. 5 Morts.	99 —102	5 0 6	..	..	..
1	6%	Northampton Elec. Lt. & P. Ord.	1¼—1⅝	4 11 6	Feb, Aug	..	..
1	5%	‡Do. 5% Pref.	1⅜—1⅝	4 6 0	Feb, Aug	..	..
St.	4%	Do. 4% Debs.	99 —101	3 19 0	June, Dec	..	..
10	6/0	†Notting Hill Electric Ord.	..	5 17 6	March	..	..
5	4/3	Oxford Electric Ord.	6¼—6⅝	5 13 9	March	..	..
St.	4%	Do. 4% Deb. Stk.	93 —95	..	..	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	9 —9½	5 8 0	Feb, Aug	9⅛	9⅛
5	3/6	Do. 7 per Cent. Pref.	6¼—7¼	4 16 6	Feb, Aug	..	..
St.	3½%	†Do. 3½ per Cent. Deb. Stock (red.)	84½—85½	4 2 0	Jan, July	..	..
5	..	Smithfield Markets Electric Sup. Ord.	1¼—1⅝	..	Feb.	..	..
5	4/0	South London Electric Supply Ord.	2⅛—3⅜	6 3 0	April	..	..
St.	5%	†Do. 5 % 1st Mort. Stock (red.)	98½—101½	5 0 6	..	..	..
1	0 8½	South Metrop'n Elec. Lt & Power 7% 1st Pref	1¼—1⅝	5 18 0	Feb, Aug	..	..
1	0/7½	Do. 6 per Cent. 2nd Pref.	⅞—1	6 17 0	Feb, Aug	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	97 —100	4 11 6	April, Oct	..	..
5	1/3	Urban Electric Supply Ord.	⅜—1	..	April, Oct	..	..
5	1/3	Do. 5 per Cent. Cum. Pref.	2½—3	..	April, Oct	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	87 —89	5 2 3	April, Oct	89⅛	..
5	5/0	Westminster Elec. Sup. Ord.	7⅜—8¼	6 3 6	Mar, Sept	8	8⅛
5	2/3	†Do. 4½ per Cent. Cum. Pref.	5 —5½	4 3 6	Jan, July	..	..
		Electric Railways and Tramways.					
1	..	Bath Elec. Trams Pref. Ord.	⅞—1	..	April	..	..
1	0/6	†Do. 5 per Cent. Cum. Pref.	⅞—1	..	..	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	79 —83	6 13 6	Jan, July	..	..
St.	4½%	†B'ham & Midland Trams 4½ 1st Deb. Stock.	87 —91	5 8 6	April, Oct	..	..
10	4%	Bristol Tramways & Carriage Ord.	6½—7	5 0 0	Jan, July	92	..
10	4%	†Do. Cum. Pref.	7 —7½	5 10 9	Feb, Aug	..	..
St.	4%	†Do. 4 per Cent. Debs.	100 —101	5 10 0	..	..	..
10	..	British Electric Traction Ord.	⅞—1⅛	3 19 6	Feb, Aug	..	..
10	..	Do. 6 per Cent. Cum. Pref.	3¼—4½	..	June, Dec	1⅜	⅞
St.	5%	Do. 5 per Cent. Perpetual Debs.	95 —99	..	Feb, Aug	4⅜	3¾
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock.	77 —81	5 2 6	April, Oct	98¼	96½
St.	3%	Central London Ordinary Stock	70 —72	5 14 0	May, Nov	..	..
St.	4%	Do. 4 per Cent. Pref. Stock	87 —89	4 3 0	Feb, Aug	71	70
St.	2%	Do. Deferred Stock	55 —57	4 10 0	Feb, Aug	88	..
100	4%	Do. 4 per Cent. Debs.	104 —105	3 11 6	Feb.	57	55
5	2/6	City of Birmingham Trams, 5 % Cum. Pref.	4⅛—5⅛	3 16 0	Jan, July	105½	105
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	4 19 6	April, Oct	..	..
St.	11%	City & South London Rly. Con. Ord.	31½—32½	3 18 9	April, Oct	..	..
St.	5%	Do. 5 per cent. Perp. Pref. (1891)	109 —111	4 11 0	Feb, Aug	32½	31¼
St.	5%	Do. (1896)	105 —108	4 10 0	Feb, Aug	..	..
St.	5%	Do. (1901)	104 —107	4 13 0	Feb, Aug	..	..
St.	5%	Do. (1903)	103 —105	4 15 6	Feb, Aug	105½	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	102 —104	3 17 9	May, Nov	..	..
10	6/0	Dublin United Trams, 6 per Cent. Pref.	12½—13½	4 10 6	Feb, Aug	..	..
10	12/0	Gateshead and District Trams Ord	8½—9¾	6 10 0	..	..	..
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	⅜—1	..	Feb, Aug	3½	..
5	..	Hastings & District Elec. Trams, 6% C. P.	1½—2	..	Mar, Sept	..	..
St.	4½%	Do. 4½ Deb. Stock	75 —80	5 10 0	April, Oct	..	..
10	..	Imperial Tramways Ord.	3 —3½	..	Mar, Sept	..	..
10	..	‡Do. 6 per Cent. Pref.	4½—4¾	..	Mar, Sept	..	..
St.	4½%	†Do. 4½ per Cent. Debs.	72 —74	6 3 6	Jan, July	..	..
..	2/0	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	2½—2¾	5 0 0	Mar, Sept.	..	..
St.	4%	†Do. 4 per Cent. Deb. Stock	77 —82	5 1 0	Jan, July	..	..
10	6/0	Lanarkshire Tramways	10 —10½	5 12 3	Feb, Aug	..	..
St.	5%	†Lancs Utd. Trams. 5% Prior Lien Deb. Stk.	79 —82	6 4 0	Jan, July	..	..
St.	4%	†London Electric 4% Deb. St.	95 —98	4 2 6	..	..	..
St.	4%	Do. 4% Pref.	85 —85	4 14 0	..	99½	97
10	..	London United Trams, 5% Cum. Pref.	3¾—4¼	..	..	85½	85½
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock.	74 —77	5 6 0	Jan, July	3⅜	..
St.	..	Mersey Con. Ord. Stock	6 —8	..	Jan, July	77	..
1	1/1⅛	Metropolitan Elec. Tramways Ord.	⅞—1⅛	6 0 0	Feb, Aug	..	..
1	..	Do. Deferred	⅝—⅞	..	..	..	..
1	0/o	Do. 5 per Cent. Cum. Pref.	⅞—1⅛	5 0 0	April	..	..
St.	4½%	†Do. 4½ per Cent. Deb. Stock.	103 —102	4 9 0	Feb, Aug	1	..
St.	5%	Do 5 per Cent Do. Stk	102½—101½	4 16 6	Jan, July	101	..
St.	1½%	Metropolitan Railway Consolidated	46½—47	2 18 6	..	104	..
St.	2½%	Do. Surplus Lands Stocks	68 —70	3 19 6	Feb, Aug	49	44½
St.	3½%	Do. 3½ per Cent. Preference	90 —92	3 16 0	Feb, Aug	69½	68
St.	3½%	Do. 3½ per Cent. "A" Preference	89 —91	3 17 0	Feb, Aug	92½	91½
St.	3½%	Do. 3½ per Cent. Convertible Pref.	89 —91	3 17 0	Feb, Aug	90	89½
St.	3½%	Do. 3½ per Cent. Debenture Stock	93 —95	3 13 6	..	94½	93½

* No allowance has been made for accrued interest or redemption.
† Ex Dividend ‡ The London Stock Exchange Committee have declined to quote these.

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ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Share	Last Dividend	Name.	Price Wed., July 4.	*Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business 8 Days to July 4. Highest.	Lowest.
		Electric Railways and Tramways—*Continued.*					
St	3½%	Met. Rly. 3½ per Cent. "A" Deb. Stock	92 —94	3 14 6	Jan, July	92½	..
St	..	Metropolitan District Railway Ord.	27½—28½	..	Feb, Aug	29½	28½
St	3½%	Do. 4½% First Pref.	88 —90	4 19 6	Feb, Aug	89½	89½
St	3½%	Do. Assented Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	76 —78	4 10 0	Feb, Aug	77½	—
St	3%	†Do. 3 per Cent. Consoltd. Rent-charge	76 —78	3 18 0	Jan, July	—	..
St	4%	†Do. 4 per Cent. Midland Rent-charge	102 —104	3 17 9	Jan, July	..	—
St	6%	†Do. 6 per Cent. Perp. Deb. Stock	145 —147	4 2 0	Jan, July	..	..
St	4%	†Do. 4 per Cent. Ditto	96 —98	4 2 6	Jan, July	..	..
1	4⅛d.	Potteries Electric Traction Ord.	¼—⅜	5 6 9	April, Oct	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	¾—⅞	8 6 8	Feb, Aug	..	..
St	4½%	Do. 4½ per Cent. Deb. Stock	88 —91	5 0 0	May, Nov	90½	89½
1	1/2⅓	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	⅞—⅞	10 2 0	..	..	..
St	4%	†Do. 4 per Cent. Deb. Stock	73 —78	5 6 0	Jan, July	76½	74½
100	5%	Sunderland Dist. Elec. Trms. 5% 1stMtDb.	..	8 4 0	Jan, July	..	..
—	10/0	UndergdE.Rys.Lon.6% In. bds with coup 7	65 —67	1 10 0	June, Dec	67	65½
—	5%	Do. 5% Prior Lien Bonds	100½—101½	4 19 0	..	100½	..
—	4½%	Do. 4½% Bonds Ex coup. 7	99 —101	4 10 0	..	101	99
—	4%	Do. 4 per Cent. 1st Power Ho. Dbs.	101 —103	3 18 3	..	..	..
5	—	Yorkshire (W.R.) Elec. Trams. Ord.	¼—⅜	..	March ..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	2½—2½	..	..	..	..
St	4½	†Do. 4½ per Cent. 1st Debs.	82 —85	5 8 0	Jan, July	—	..
		Electric Manufacturing, &c.					
St	4½%	†Anchor Cable Co. 4½ % Deb. Stock	98 —100	4 11 0	—	..	..
1	1/2⅓	Aron Electricity Meter Ord.	⅜—⅜	..	..	[illegible]	—
1	0/7⅕	†Do. 6% Cum. Pf.	⅞—⅞	7 10 0	April, Oct	..	..
1	3/2⅝	Babcock & Wilcox Ord.	5½—5⅝	4 11 0	April, Oct	5½	5½
1	0/7½	Do. Pref.	1⅛—1⅛	4 0 0	..	..	..
5	6/0	British Insulated & Helsby Cables Ord.	6⅝—7⅛	6 15 6	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	6 —6⅛	4 12 3	Jan, July	6⅛	—
St	4½%	†Do. 4½ per Cent. 1st Mort. Deb. (red.)	100 —102	4 9 0	Jan, July	..	..
St	4½%	British Thoms'n-Houst'n 4½% 1st Mt.Db.	96 —99	4 11 0	Mar, Sept	—	..
5	..	British Westinghouse 6 per Cent. Pref.	½—½	..	Feb, Aug	..	—
100	6%	Do. 6 per Cent. Prior Lien Dbs. (rd.)	102 —104	5 17 0	..	..	102½
St	4%	†Do. 4 per Cent. Mort. Deb. Stock	59 —62	6 6 6	Jan, July	..	—
St	4½%	BrushE.Eng. Co. 4½% Perp. 1st Deb.Stock	57 —64	7 0 6	Mar, Sept	..	..
St	4½%	†Do. Perpetual 2nd Deb. Stock	39 —44	10 10 0	Jan, July	..	..
5	10/0	Callender's Cable Con. Ord.	8½—9½	8 2 0	Jan, July	9⅛	8⅞
5	2/6	†Do. 5 per Cent. Cum. Pref.	4½—5½	4 17 6	Jan, July	..	..
St	4½%	†Do. 4½ per Cent. 1st Mort Debs. (red.)	101 —103	4 8 0	Nov, May	..	..
1	1/6	Castner-Kellner Alkali Co.	3½—3½	5 1 0	May, Nov	3½	3 7/16
St	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	104 —107	4 2 6	Feb. Aug	..	..
1	1/0	†Chadburn's (Ship) Telegraph Ord.	1 1/16—1 3/16	5 19 0	March ..	..	..
1	0/8⅔	Consolidated Electrical Co.	⅞—⅞	10 0 0	August ..	13/16	..
1	0/6	Consolidated Signal Co.	13/16—15/16	5 14 0	April, Oct	—	..
1	0/7½	Do. 6 per cent. Cum. Pref.	13/16—15/16	6 8 0	April, Oct	..	..
3	..	Crompton & Co (Nos. 1 to 85,000)	⅛—⅜	..	Jan, July	..	..
100	5%	†Do. 5 per Cent. 1st Mort. Debs. (red.)	57½—67½	8 0 0	Jan, July	..	..
5	1/0	Dick, Kerr & Co. Ord.	13/16—15/16	5 14 0	Sept	..	..
5	0/7½	Do. 6 per Cent. Cum. Pref.	[illegible]	5 6 0	Sept	..	..
St	4½%	†Do. 4½ per Cent. Deb. Stock	95 —98	4 13 3	Jan, July	..	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	3/16—11/16	..	Feb, Aug	3/16	..
..	..	Do. (£5 paid)	1⅞—2⅛	9 3 0	Feb. Aug	..	..
St	4%	†Do 4 per Cent. Mort. Deb. Stock (red.)	67 —71	5 16 0	June, Dec	..	..
St	5%	Do. 5 per Cent. 2nd Deb. Stock	78 —81	6 3 6	Mar, Sept	..	..
..	..	Edmundson's Elec. Corp. Ord.	5/16—11/16	..	Jan, July	..	..
5	..	Do. 6 per Cent. Cum. Pref.	2½—3	..	May, Nov	—	..
St	4½%	Do 4½ per cent. 1st Mort. Deb. (red.)	86 —89	5 1 0	Jan, July	..	..
2	..	Electric Construction Co.	13/16—15/16	..	Jan, July	..	..
2	2/9½	Do. 7 per Cent. Cum. Pref.	1⅞—2	7 0 0	July	1 13/16	..
St	4%	Do. 4 per Cent. Perp. 1st Mort. Debs.	71 —74	5 7 0	Jan, July	..	..
10	5/0	†General Electric (1900) 5% Cum. Pref.	8½—9	5 14 0	June, Dec	..	..
St	4%	Do. 4 per Cent. 1st Mort. Debs.	88 —93	4 8 6	Mar, Sept	..	..
5	10/0	Henley's Telegraph Works Ord.	12⅛—12⅞	5 16 6	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	4½—5½	4 10 0	Feb, Aug	5	..
St	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	105 —108	4 4 6	Mar, Sept	..	..
10	15/0	India Rubber, Gut. Per., &c., Works	11½—13½	6 0 0	Feb, Aug	12½	12
10	5/0	†Do 5 per Cent. Cum. Pref.	10½—10½	4 17 0	..	10½	..
100	4%	Do. 4 per Cent. Debs. (red.)	96 —98	4 1 6	April. Oct	..	..
1	..	National Elec. Construction Co.	1/16—1/16	..	April	..	..
1	..	Richardsons, Westgarth & Co., Ltd. Ord.	[illegible]	..	Nov	..	..
1	..	Do. 6 per Cent. Cum. Pref.	[illegible]	..	May, Nov	3/16	..
St	4½%	†Do. 4½ per Cent. Perp. Deb. Stock	77 —80	5 14 6	Jan, July	..	..
5	..	Simplex Conduits 6 per Cent. Cum. Pref.	4½—5	..	..	..	..
12	36/0	Telegraph Construction & Maintenance	36½—38½	5 16 3	Mar, July	36½	..
100	4%	†Do. 4 per Cent. Deb. Bonds (1909)	99 —101	4 0 0	Jan, July	..	..
1	1/0	Vickers, Sons & Maxim, Ltd., Ord.	2⅛—2 3/16	4 15 0	..	2 3/16	2⅛
1	0/6	Do. 5 per Cent. non-Cum. Preference	1 1/16—1 3/16	4 3 0	..	1	..
St	5%	Do. 5 per Cent. non-Cum. Preferred	108 —112	4 11 0	..	111	110½
St	4%	Do. 4 per Cent. 1st Mort. Db. Sk. (red)	99½—101½	3 19 9	June, Dec	100½	100
100	4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.)	102½—104½	4 7 0	June, Dec	103½	103
100	5%	‡Do. 5 per Cent. 3rd Mort. Debs Scrip	103 —105	4 16 0	..	104½	103½
10	12%	†J. G. White & Co. 6% Cum. Pref.	15 —16	6 15 0	..	..	..
1	..	Willans & Robinson Ord.	⅜—⅜	..	Apr, Oct	..	..
5	..	Do. 6 per Cent. Cum. Pref.	⅞—1	..	Apr, Oct	..	..
St	4%	Do. 4 per Cent. 1st Mort. Debs.	55 —65	6 3 0	May, Nov	..	—
		Telegraphs.					
10	..	Amazon Telegraph	7½—7½	..	June, Dec	..	..
100	5%	†Do. 5 per Cent. Debs. (red.)	98 —100	5 1 0	Jan, July	101½	93½
St	15/0	Anglo-American	69 —71	4 4 6	F,My,Ag,N	69½	..
St	30/0	Do. Preferred	113½—114½	5 5 0	F,My,Ag,N	114	113
St	30/0	Do. Deferred	26 —26½	5 1 0	F,My,Ag,N	26 13/16	26 13/16
St	4%	†Commercial Cable 4 per Cent. Deb. Stk.	87½—89½	4 10 6	Jn,Ap,Jy,O	88½	—
10	6/0	Cuba Submarine Ord.	10 —10½	4 17 6	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	17½—18½	5 13 0	Feb, Aug	17½	..
5	2/0	Direct Spanish Ord.	3¾—4	5 0 0	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	8½—8½	5 16 0	April, Oct	—	..
50	4½%	†Do. 4½ per Cent. Deb.	99 —101	4 10 0	Jan, July	..	..
10	2/0	Direct United States Cable	7½—7½	6 10 6	Ja,Ap,Jy,O	7½	7½
100	4½%	Direct West India Cable 4½%Rg.Db.(rd.)	98 —100	4 11 0	June, Dec	..	..
St	65/0	Eastern Ordinary xd and bonus	136½—139½	5 1 6	Ja,My,Jy,O	139	136½
St	17/6	Do. 3½ per Cent. Pref. Stock	81 —85	4 2 0	Ja,My,Jy,O	85½	84½
St	4%	Do. 4 per Cent. Mort. Deb. Stk. (red.)	101 —103	3 18 3	May, Nov	102½	101½
St	6/6	Eastern Extension	13½—13⅞	5 5 0	Ja, Ap,Jy,O	13½	13½
10	4%	Do. 4 per Cent. Deb. Stock	101 —103	3 18 3	Feb, Aug	102½	102
25	4%	Eastern and S.Af., 4% Mauritius Sub.Debs	99½—101½	3 19 0	May, Nov	..	..
10	5/0	G.N. (of Copenhagen), Ex Coupon 82	31½—32½	5 8 0	Jan, July	..	..
25	52/6	Indo-European	55½—58½	5 6 6	May, Nov	..	..
100	5%	Mackay Companies Common	92 —94	5 5 0	Ja,Ap,Jy,O	..	..
100	4%	Do. Preference	75 —77	5 2 0	Ja,Ap,Jy,O	..	..
1	..	Marconi's Wireless Teleg. Co.	2 5/16—2 7/16	..	April	2 1/16	2½
100	4%	†Pacific & Europe'n Tel.4%Guar.Dbs.(red.)	99½—101	4 0 0	June, Dec	..	..
2½	1/3	West Coast of America	1⅛—1⅛	5 0 0	May	..	..
100	4%	†Do. 4 per Cent. Debs.	97½—99½	4 1 6	Jan, July	..	..
10	1/6	West India & Panama	2⅛—2½	5 0 0	May, Nov	2⅛	2⅛
10	6/0	Do. 6 per Cent. 1st Pref.	10⅛—10⅝	5 16 6	May, Nov	10⅛	10½
10	6/0	Do. 6% 2nd Pref.	9½—10	6 4 6	May, Nov	..	..
100	5%	†Do. 5 per Cent. Debs.	101 —103	4 18 0	Jan, July	102	..
10	3/0	Western Telegraph	13½—13⅞	5 3 0	Mr,Jn,O,D	13½	13½
St	4%	†Do. 4 per Cent. Deb. Stock (red.)	99 —101	4 0 0	June, Dec	—	..
—	4%	Western Union Telegraph, $1,000 4% Bds	105 —108	3 14 0	—	..	—
—	4½%	Do. $1,000 4½% Fdg. & Rl. Est.Gd.Bnds	99½—102½	4 9 3	—	99½	—

Share	Last Dividend	Name.	Price Wed., July 4.	*Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business 8 Days to July 4. Highest.	Lowest.
		Telephones.					
100	2$	Amer. Telephn. & Telegh. Cap. St.	143 —145	5 11 0	..	153½	142½
..	4%	†Do. Coll. Trust $1,000 4 per Cent. Bds.	94 —96	4 4 0	Jan, July	96½	..
St	4%	Do. 4% Cons. Bonds 1936	114 —116	3 9 0	..	114½	114
St	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101 —103	4 17 0	Mar, Sept	102½	101
5	3/0	Chili Telephone	7 —7½	4 4 6	August ..	7 7/32	7⅛
1	0/7⅕	Monte Video Telephone Ord.	⅞—1	6 0 0	Nov	..	..
1	0/6	Do. 5 per Cent. Pref.	⅞—⅞	5 11 0	May, Nov	—	..
St	6%	National Co. Pref. Stock	104¾—105¾	5 15 0	Feb, Aug	105 1/16	104
St	6%	Do. Def. Stock	114 —118	5 3 0	Feb, Aug	123½	112
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	10 —10½	5 11 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10 —10½	5 11 6	Feb, Aug	—	..
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.	5½—5½	4 8 0	Feb, Aug	5½	..
St	3½%	†Do. Deb. Stock 3½ per Cent. (red.)	98 —100	4 1 0	June, Dec	..	..
St	4%	†Do. 4 per Cent. Deb. Stock (red.)	98 —100	4 1 0	Jan, July	98½	..
..	4½%	New York Telephone Co. 30 yr. Bnds.	101½—102½	4 8 6	..	101½	101
1	1/0	Oriental	1 11/16—1 13/16	4 18 0	April, Oct	..	..
1	0/7⅕	Do 6 per Cent. Cum. Pref.	1⅛—1¼	4 16 0	April, Oct	..	..
St	4%	†Do. 4 per Cent. Red. Deb. Stock	86 —88	4 11 0	Jan, July	87	8
St	4½%	†Telephone Co. of Egypt 4½%Db.Stk.(red.)	98 —100	4 11 0	Jan, July	98½	..
5	3/0	United River Plate Ord. (1—150,000)	7 7/16—7 11/16	5 3 0	July	7½	..
3	4½%	Do. (150,001—190,000)	7 7/16—7 11/16	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 1/16—5 3/16	4 12 0	June, Dec	..	..
St	4½%	Do. 4½ Deb. St. Red.	101 —103	4 8 0	Jan, July	101½	
		Financial, Investment, &c.					
5	3/0	†Elec. & Gen. Investment 6% Cum. Pref.	4 —4½	7 1 0	Jan, July	4½	
10	6/0	†Globe Telegraph & Trust	10⅞—11⅛	5 8 0	Sp,DcMrJu	11½	
10	3/0	†Do. 6 per Cent. Pref.	13 —13½	4 10 9	Sp,DcMrJu	13½	
10	6%	Submarine Cables Trust (Cert.)	131 —134	4 9 6	April, Oct	—	
		Colonial and Foreign Electric Railways, Tramways, &c.					
5	2/9	Anglo-Argentine 5% Cum. 1st Pref.	5 —5½	4 17 6	April, Oct	5 3/32	
5	2/9	Do. 5% Cum. 2nd Pref.	4 13/16—5 1/16	5 1 6	Jan, July	..	
St	4%	Do. 4% Deb. Stock	94 —96	4 4 0	June, Dec	95½	
St	4½%	Do. 4½% Deb. Stock	99 —101	4 10 0	..	100½	
St	5%	Do. 5% Deb' Stock	100 —102	4 19 0	..	101½	1
St	5%	†Auckland Elec. Trams. 5% Deb. (red.)	102 —104	4 17 6	Jan, July	..	
5	4/0	Brisbane Electric Trams. Invest. Ord	6½—6⅝	6 3 0	May	..	
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5⅜	4 17 6	May, Nov	5 1/16	
St	4½%	†Do. 4½ per Cent. Db. Prov. Certs.	100 —103	4 8 6	Jan, July	102	
St	8%	British Columbia El..Rly. Df.Ord.	146 —150	5 7 6	Mar, Sept	..	
St	6%	Do. Pref. Ord. Stock	128½—132½	4 12 0	May, Nov	131½	
St	5%	Do. 5% Cum. Perp. Pref. Stock	111 —113	4 9 0	Jan, July	113	
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	100 —103	4 7 6	April, Oct	—	
100	4½%	Do. Vancouver Power Debs.	102 —105	4 5 9	Jan, July	102½	
St	4½%	Do. 4½% Perp. Con. Deb. St.	101½—103½	4 2 6	..	101½	
St	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	99½—101½	4 19 6	Mar, Sept	..	
St	6%	Buenos Ayres Port & City Tram, 1st Mt. Deb. Stock	93 —98	6 2 6	Feb, Aug	..	
5	3/6	Calcutta Tramways (1 to 137,610)	5⅞—6½	4 19 6	Mar, Sept	6⅛	
100	2/6	†Do. 5 per Cent. Cum. Pref.	5 —5½	4 17 6	Jan, July	5½	
1	4½%	†Do. 4½% 1st Deb. Stock (red)	100 —103	4 8 6	Jan, July	..	
St	..	Cape Electric Tram Shares	⅞—1⅛	..	..	1⅛	
5	1/3	City of Buenos Ayres Trams Co. (1904) Sh.	5⅛—5⅝	4 5 0	F,My,A,N	5⅛	
St	4%	†Do. 4 per Cent. Deb. Stock	94 —97	4 4 0	June, Dec	—	
..	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.	95 —100	5 2 6	May, Nov	—	
1	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	101 —103	4 18 0	Feb, Aug	101½	
100	5%	Hong Kong Tramways Co. 5 per Cent. 1st Mort. Debs.	76 —80	6 8 0	June, Dec	79½	
1	..	Kalgoorlie Elec. Trams Sh.	[illegible]	..	..	..	
100	5%	‡Do. 5 per Cent. "A" Deb. Stock	91½—94½	5 6 0	Jan, July	..	
5	6%	Do. 6 per Cent. "B" Ditto	63 —67	8 15 0	Jan, July	..	
5	0/6	Lisbon Elec. Trams. Ord.	1 —1½	4 16 0	July	..	
100	0/7½	†Do. 6 per Cent. Cum. Pref.	1 —1½	4 16 0	Jan, July	..	
St	5%	†Do. 5 per Cent. Reg. Mort. Debs.	97 —101	5 1 0	Jan, July	..	
St	5%	Madras Elec. Trams. 5% Deb. Stk.	95 —98	5 3 6	Jan, July	..	
100	5%	†Manaos Trams and Lt. Co. 5% Debs	90½—93½	5 8 6	..	..	
..	5%	Manila Elec. Ry. $1,000 Gold Bonds	99½—101½	5 0 0	Feb, Aug	125	
100	$1½	Mexico Trams Co. Com. St.	120 —122	5 15 6	..	96½	
..	5%	Do. Gen. Con. 1st Mort. 5% Gold Bds.	95 —96	5 4 0	..	102½	
St	6%	†Do. 6% 50 yr. Mort. Bds	97½—99½	6 1 6	—	..	
St	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922) (Nos. 601 to 2,000)	101 —103	4 7 6	Feb, Aug	103½	
St	4½%	Do. do. (Nos. 1 to 4,600)	102 —104	4 7 6	..	..	
1	0/6	Perth Elec. Trams Ord.	13/16—15/16	2 13 6	May	..	
St	5%	†Do 1st Mt. Db. Stock	101½—103½	4 17 6	Jan, July	..	
5	3/0	†Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	5½—5¾	5 8 0	—	..	
St	4½%	†Do. 4½% 1st Mort. Deb. Stk.	97 —100	4 11 6	..	116	
100	$1½	Rio Janeiro Tram, Lt. & P. Co.	112¾—113¾	4 8 6	..	103½	
..	5%	Do. 30 yr. Gold Bnds.	100½—101½	4 19 0	..	96	
100	5%	Do. 50 yr. Mt. Bnds	95½—96½	5 3 0	—	..	
..	$2½	Sao Paulo Tramway, Light & Power Co. $100 Stock	180 —183	5 10 9	..	182	
..	5%	Do. 5 per Cent. 1st Mt. $500 Db.	102 —104	4 17 0	June, Dec	103	
100	4½%	Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	98 —100	4 10 0	Feb, Aug	..	
5		**Colonial and Foreign Electricity Supply, &c.**					
10	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	5½—5⅞	5 8 0	Mar, Sept	..	
St	5/0	Bombay E.S. & T. 6% Cm. Pf.	10⅝—11⅛	5 5 6	..	..	
..	4½%	†Do. 4½ per Cent. Deb. Stk. (red).	96 —98	4 12 9	Jan, July	..	
5	5%	†Do. 5 per Cent. 2nd Mort. Deb. Stock	96½—98½	5 2 6	..	..	
5	5/0	Calcutta Elec. Supply Ord.	6⅞—7⅛	5 19 6	April, Oct	1 5	
100	2/6	Do. 5% Cum. Pref	4⅞—5⅛	4 13 0	..	98	
100	5%	†Calgary Power Co. 5% 1st Mort. Bnds.	94½—96½	5 4 6	—	106	
100	7/2½	Canadian Gen. Elec. Co. Com. St.	108 —111	6 8 0	..	121	
100	$3½	Do. 7% Cm. Pf. Stock	121 —124	5 5 0	—	..	
500	5%	†Castner Electrolytic Alkali Co.(of U.S.A.) 1st Mort. Stl. Debs.	94 —99	5 3 6	Jan, July	84	
St	5%	Elect Development Co. of Ontario	83 —85	5 19 0	..	..	
5	5%	†Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	84½—87½	5 4 0	Jan, July	..	
10s	..	Indian Elec. Sup. & Trac. Co.	1 —1⅛	..	..	..	
1	..	Kalgoorlie Elec. Power & Ltg. Ord.	[illegible]	..	..	..	
..	0/7⅓	‡Do. 6 per Cent. Cum. Pref.	[illegible]	8 6 6	April, Oct	..	
5	5%	†Kaministiquia Power Co.5% Gold Bnds.	101 —103½	4 18 0	..	..	
St	..	†Madras E. S. Corp. Ord.	2⅞—3⅛	..	..	38	
St	..	Melbourne E. S. Co. Cons. Ord. St.	34 —39	..	..	96	
500	5%	Do. 5% 1st Mortg Deb. Stock	95 —97	5 4 0	—	..	
St	5%	†Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	85 —87	5 16 0	—	84	
St	$1	Mexican Lt. & Power Co. Com. St.	82 —84½	4 16 6	..	107	
500	$3½	Do. 7% Cum. Pref. St.	105½—107½	3 5 9	—	95	
St	5%	Do 5% 1st Mort. Gold Bnds.	94½—95½	5 5 0	..	91	
100	5%	Monterey Rly. L. & P. Co. 1st Mort.Db.Sk.	90 —92	5 10 0	..	178	
100	8/2½	Montreal Lt. Ht. & Power Co. Cap. St.	173 —177	5 14 0	F,My,A,N	..	
St	5%	Northern Lt. Power & Coal 5% Gd.Bds	51 —53	9 12 0	..	..	
St	£10	River Plate Electricity Co. Ord. Stk.	218 —228	4 7 9	April	..	
St	6%	Do. 6 per Cent. non-Cum. Pref. Stk.	107 —114	5 5 0	May	—	
100	5%	Do. 5 per Cent. Deb. Stock	101½—103½	4 17 6	Jan, July	123	
..	$1½	Shawinigan Water & Power Co.Ca	120 —123	4 2 3	—	109	
St	5%	†Do. 5 per Cent. Bds.	107 —109	4 12 6	Jan, July	..	
St	4½%	Do. 4½ Per Con. Mt. Db. St.	103 —105	4 6 0	—	..	
—	4½%	Toronto Power Co. 4½% Db. St.	99 —101	4 8 0	—	1	
1	1·85	†Victoria Falls Power Co. Pref.	15/16—1	—	Jan, July		

* No allowance has been made for accrued interest or redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

Patent Procedure.

It is seldom that a piece of modern legislation produces all the results which its framers desired, and sometimes it has an effect which is neither desired nor intended. A case in point is the Patents and Designs Act of 1907, one of the objects of which, according to the author of the measure, was "to benefit the poor working man inventor." It was proposed to effect this by making patent procedure cheaper, simpler and more expeditious. It is, however, doubtful whether the poor inventor has reaped any advantage from the Act; in one respect his position is certainly worse, for he has found that his patent is not so readily saleable as it was before the passing of the Act, and he is more dependent than ever upon the manufacturer and the capitalist for exploiting his invention. One of the reasons for this is the delay by the Law Officers of the Crown in hearing appeals from decisions of the Comptroller-General. The 1907 Act not only maintained the old procedure in this respect, but extended the right of appeal to the Law Officers. Owing to various causes, but principally to the increase of the public duties of the Attorney-General and the Solicitor-General, the work entailed by these appeals has fallen into arrear, and the average period which elapses between the date of the Comptroller-General's decision and the hearing of the appeal has more than trebled within the last few years.

This delay has become so serious that patentees, patent agents and manufacturers are complaining of it seriously. The Chambers of Commerce and other public bodies have also taken up the matter, and by way of a remedy an alteration of procedure is suggested, namely, the substitution of a judge of the High Court for the Law Officers of the Crown in all cases of appeal from decisions of the Comptroller-General. We think the proposal an excellent one, because, apart from the question of delay—which is, no doubt, serious enough in itself—it would result in more certainty and uniformity in patent procedure. The judge who usually tries actions for infringement of patents, &c., would be more expeditious in hearing these appeals, and his decisions would probably have greater authority. It is undoubtedly very desirable that some change should be made, for so long as there is any uncertainty about a patent it is unsaleable and manufacturers are not likely to entertain any proposal for developing it.

Electrical Accessories in America.

A feature of the Annual Convention of the National Electric Light Association of America is the presentation of a number of reports upon subjects of widespread interest. These reports are drawn up by committees of the Association and are based upon information collected during the past year. To give some idea of the completeness with which this work is carried out we may mention that the Committee reporting on electric heating, refrigeration, &c., found it necessary to appoint four sub-committees to deal with domestic and commercial heating appliances, cooking appliances, fancy lighting appliances, and domestic power appliances respectively. From the report we notice that of electric heating appliances the flat-iron is considered to be the greatest revenue-producer, averaging about 2s. 9d. per month. When it is realised that last year

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a quarter of a million flat-irons were sold in the United States and Canada, some idea can be gathered of the importance of this branch of the electric supply business. The difference between the results just mentioned and the poor achievements in this country can only be ascribed to the more extensive publicity campaign which has been a feature of the American electric supply business for several years. This view is strengthened by the fact that the electric heating pad is stated to be next in popularity to the flat-iron. Another direction in which evidently there is considerable scope for development is in the use of electrically heated tools, &c. The report mentions that some supply companies obtain a revenue of from £4,000 to £10,000 per annum from this source alone. Although electric cooking is not able to show results comparable with those mentioned above, the replies received by the Committee from the central stations showed that the prospects are encouraging.

The "G.B." System at Lincoln.

THE annual report of Mr. S. CLEGG, city electrical and tramway engineer, upon the working of the Lincoln Corporation tramways during the year ended March 31st last, will not prove very encouraging to other engineers desirous of adopting a surface contact system. A marked increase has taken place in recent years in the cost of maintaining the electrical equipment of the track, last year's figure of £141 having more than doubled on the present occasion. Of the total of £263 directly attributable to the "G.B." equipment, the renewal of stud heads accounts for £155. It should be noted, however, that this item was foreseen, the estimated life of the studs having been reached. The renewal of carbons also costs about £70. Mr. CLEGG anticipates that when the re-carboning has been completed during the present year, the cost of maintenance should fall to a much lower level; indeed, he looks forward to this item not averaging more than the estimated £90 over the period of 10 years covered by the "G.B." Co.'s guarantee. The initial years of an experimental equipment such as that at Lincoln inevitably bring to light unforeseen repairs and alterations; and this case serves to emphasise the futility of basing the cost of repairs of any undertaking on the first few years' working.

Electricity in Mines.—A circular, signed by Sir Henry Cunynghame, Permanent Assistant Under-Secretary, has been issued from the Home Office in the following terms :—

I am directed by the Secretary of State to say that he has received a number of objections from owners of mines under the Coal Mines Regulation Acts to the new special rules relating to the installation and use of electricity which have been proposed to them. It has consequently been necessary for the inspector of mines in charge of each district to appoint an arbitrator in the matter, in pursuance of the provisions of sec. 47 of the Coal Mines Regulation Act, 1887, and each of the inspectors has accordingly appointed Mr. James Swinburne, 82, Victoria-street, London, S.W., as arbitrator in the matter of objections to the rules received in respect of mines in his district. The Secretary of State trusts that it may be possible to settle the matter without arbitration, but as objection has been formally made to the rules, it is necessary, under the Act, that an arbitrator should be appointed.

Cable Interruptions.	Date of Interruption.
Assab—Perim	July 8, 1909
Malta—Tripoli	April 20, 1910
Latakia—Palura	May 26, 1910
Zanzibar—Mombasa	July 11, 1911
Bathurst–Bissao	July 11, 1911
Guam—Manila	July 12, 1911

1,500-Volt Railway Electrification.—The "Engineer" states that a contract has been placed for the electrification of two sections of road on the Piedmont Traction Co.'s system in North Carolina and South Carolina. This is the first railway in America to be equipped with apparatus for 1,500-volts current, although a number of lines are now operated at 1,200 volts. Power will be purchased from the Southern Power Co. and fed to the lines through motor generators in sub-stations.

Civil List Pensions.—A list of pensions granted during the year ended March 31, 1911, and payable under the provisions of Sec. 9 (1) of the Civil List Act, 1910, has been issued, and among the recipients is Mrs. Alice Augusta Gore-Fysh, who has been granted a pension of £50 "in consideration of the services to chemical and physical science of her father, the late Dr. George Gore, F.R.S., and of the circumstances in which she has been placed by his disposal of his fortune for the furtherance of science."

Safe Tramcar Step.—The "Electric Railway Journal" states that a device which prevents a car from being started when a passenger is mounting or dismounting is being tested on the lines of the Portland Railway, Light & Power Co. It consists of a hinged step which depresses about ½ in. when a weight of from 5 lb. to 10 lb. is placed upon it. This breaks an electric circuit connected with the contactor so that the latter fails to close. The device is arranged, however, so that the motorman is able to reverse his car regardless of the condition of the step.

Short-Circuit Currents.—In the report of the Committee on Electrical Apparatus to the National Electric Light Association at their recent Convention much attention is paid to the use of reactance coils to limit the current produced by generators on short-circuit. In the case of the 20,000 kw. units for the Commonwealth Edison Co. the series reactance limits the short-circuit current to from 12 to 15 times the normal full-load current. The reactance is formed largely by the auto-transformers used to increase the generator E.M.F. of 4,500 volts to the 'bus bar E.M.F. of 9,000 volts. The normal efficiency of the plant is not thereby lowered, while its performance under abnormal conditions is much improved. As a result of short-circuit tests made upon certain 12,000 kw. generators, the Committee recommend that the use of reactance to limit short-circuit currents be given most careful consideration. Reactance should be inserted in series with the armature of low-reactance turbo-generators, while all new equipment should be purchased with as high reactance as is compatible with good design.

Portugal.—The trade of Portugal for 1910 shows (says a Consular report) a yield of 1,200 tons of wolfram (tungsten) ore per annum, and makes the country the largest producer of this ore in Europe. Concessions for the working of the mines are mostly in French hands, but about half the total supply is obtained from surface finds by the country people. The ore contains about 65 per cent. tungstic acid.

Extensive finds of uranium ores, along with radio-active material, have been made, and it is claimed that the Portuguese ore is more suitable for the extraction of radium than any other known. The radio-active material is found in the gangues accompanying the uranium ores, which contain about 3 per cent. uranium oxide, and this by simple washing can be concentrated to about 20 per cent. As much as 0·05 per cent. radio-active material has been traced in the form of actinium, polonium and radium bromide salts.

Certain obstacles to the commercial development of Portugal may be removed (continues the report) and, if so, Mr. Gaisford (of the British Legation, Lisbon) suggests that British capital might find a profitable outlet in the equipment of works for the generation of electrical energy by water power, and the construction of electric tramways and railways.

New Inventions by Tesla.—At a recent meeting of the New York Section of the National Electric Light Association, Mr. Nikola Tesla outlined some startling developments as likely to result from his researches. From an account in the "Electrical Review and Western Electrician" it seems that his system for wireless transmission of energy comprises five distinct inventions, which he stated to be a transformer, a magnifying transmitter, the art of "individualisation," a receiver for condensing the energy, and stationary waves. The last mentioned he considered the most important. Continuing, Mr. Tesla

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said that the most marvellous discovery of his life was a means of projecting energy into space, absolutely without loss. In fact, a force impressed at one point could be made to increase with the distance. In the concluding portion of his address Mr. Tesla described a new form of steam turbine for converting thermal energy into mechanical energy, for which he claimed that the limiting efficiency was 99 per cent., as against 65 per cent. in present designs. He also stated that the new type would develop 10 H.P. per lb. weight. We trust that the report in our contemporary is correct.

A "New War Office Wireless System" is the subject of Journalistic enthusiasm as follows :—

Interesting experiments in wireless telegraphy are being carried out in the neighbourhood of Dorking by a party of Royal Engineers from Aldershot. Apparatus of a new type, known as "War Office Secret Patent No. 5," is being tried for the first time, and the results obtained so far have been highly satisfactory. All kinds of messages have been picked up, many of them in code. Greenwich time signals, it is curious to note, have been received from a German station.

This is vague to a degree. It is not so surprising as the daily papers seem to imagine that "all kinds of messages" are picked up "in code," and it is not really curious that "Greenwich time signals have been received from a German station." What a fascination these wireless developments continue to have for the average journalist !

Automatic Telephony.—We understand that a trial of automatic telephones is to be made at the Post Office Exchange at Epsom, Surrey, which is shortly to be changed over to automatic working. The order for the work has already been given and the automatic exchange will occupy a room below the present exchange. When the installation is complete all the present subscribers will be changed over to the automatic exchange in which provision will be made at first for about 500 lines. We understand that the full automatic service at Epsom will be in use about the end of the year, or early next year. On the success of this experiment and upon the results obtained at the automatic exchange which is to be installed in the General Post Office itself for the use of the staff, the future of the automatic system in this country will largely depend.

Recent Developments in Train Lighting.—In a Paper on this subject read before the Chicago section of the Illuminating Engineering Society Mr. C. R. Gilman, of the Chicago, Milwaukee & St. Paul Railway Co., said that the use of shades over bare lamps was the greatest recent general improvement in electric train lighting. Next to this in importance was the intelligent use of reflectors, this often involving a marked reduction in the number of lamps necessary to give a required illumination. In the "West" most railways used the head-end system of train lighting, installing a generating set in the baggage car next the engine and supplementing this source of energy by storage batteries. Tungsten lamps now played an important part in this lighting, a pressure of 64 volts being generally adopted. Mr. Gilman also mentioned that compressed gas was not being ousted by electric lighting, although the latter was preferred by the travelling public.

Furnace Economy.—The "Electrical World" draws attention to a bulletin issued by the United States Bureau of Mines in which the apparatus and methods in use by the Bureau for the sampling and analysis of furnace gases are described. The authors, Messrs. J. C. W. Frazer and E. J. Hoffman, say in their preface that the furnace conditions prevailing both in small plants and in large industrial establishments in America are frequently far from satisfactory. If such conditions are to be improved, they must be more thoroughly understood, and means must be found to ensure complete combustion of the fuel and yet to permit operation with such an excess of air as will result in the greatest efficiency. In this work the services of the chemist are indispensable. A very important problem is the determination of the small percentage of unburned combustible matter that escapes from the furnace in the flue gases. Under ordinary circumstances so little as 0·1 per cent. of unburned combustible matter in a furnace gas is equivalent to about 1 per cent. of the fuel used, and for the determination of such small percentages of gas more accurate and refined methods are required than have ordinarily been available hitherto.

"Lifting Magnets in Foundries."—In the course of a Paper read on this subject by Mr. H. F. Stratton, before the American Foundrymen's Association, and reported in "Metallurgical and Chemical Engineering," the author gave the following estimate of cost for a foundry melting 35 tons of metal daily, 300 days in the year. The cost of the magnet and crane installation, with a lifting capacity of 1,350 lb. of pig iron, is £800. A crane and a magnet of this size can handle 35 tons per hour at an operating cost (wages, fuel and oil) of 0·7d. per ton. The annual depreciation on the £800 equipment at 12 per cent. would be £96, and as 35 tons handled twice per day for 300 days represent 21,000 tons handled annually, the depreciation cost on this tonnage basis is 1·2d. per ton. This brings the total cost of handling, including wages, fuel, oil and depreciation up to 1·8d. per ton. It appears that 5d. per ton is a fair figure to assume for the cost of loading or unloading pig by hand, and on this basis the saving would be 33 per cent. on an investment of £800. To sum up, a foundry melting 35 tons of metal daily can instal both a crane and a magnet, and expect a return upon the investment, after allowing all charges, of more than 30 per cent. If it happens that a foundry is already equipped with either an electric or locomotive crane, a magnet can then be installed on a very profitable basis when the tonnage to be handled is considerably less. For instance, if an assumption be made that a foundry melts 20 tons daily, and that a magnet be installed on an existing crane, the cost of the magnet being about £180, then the cost of handling per ton, including wages, fuel, oil and depreciation on the magnet, is about 1·2d., which would represent a saving in this foundry of about £185 each year, or more than 100 per cent. on the investment. Handling scrap, in general, will be more expensive than handling pig iron, whether it be done by hand or by magnet, but the advantage in favour of the magnet is more marked in the case of scrap than in the case of pig.

Results of 1,200-volt Direct-current Operation.—In February, 1908, the Washington, Baltimore & Annapolis Electric Railway, comprising 96·33 miles of single track, was opened for combined single-phase and direct-current operation. It was soon found that the complicated equipment required to operate with both systems was not satisfactory for the development of a reliable and profitable service. It was therefore determined to replace the combination equipment by a 1,200-volt direct-current system. This change was completed in February, 1910. The "Electric Railway Journal" states that the installation of the direct-current equipment produced immediate economies in current consumption and greater reliability of service. Furthermore, successful operation for over a year has demonstrated that the maintenance of 1,200-volt direct-current equipment offers no greater difficulties than standard 600-volt apparatus. The records of the Company show that there has been a noteworthy decrease in those operating costs which are affected by the character of the equipment. Comparing the last six months of 1909 and 1910 respectively, it appears that whereas the maintenance of the alternating-current passenger cars cost 0·42d. per car-mile, with the direct-current passenger cars the same item amounted to only 0·09d. per car-mile ; whilst the maintenance of the electrical equipment of the cars was reduced from 0·18d. to 0·12d. per car-mile. The total operating expenses for the semi-annual periods named were reduced from 11·89d. per car-mile to 9·5d. per car-mile. Still better results are shown in the comparative statement for January, 1911, and January, 1910, which shows an increase of 17·37 per cent. in gross earnings, a decrease of 1·38 per cent. in operating expenses and an increase of 70·1 per cent. in net earnings. When single-phase rolling stock was in service electrical causes were responsible for 33·1 per cent. of the detentions, amounting to a delay of 1,186 minutes. Under the 1,200-volt system the same causes were responsible for 19·12 per cent. of the delays, but the total number of minutes' detention was reduced in much greater

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proportion, amounting to 215 minutes only. Another significant item is that of "power off." The delays from this cause were lowered from 586 minutes to 62 minutes. The total minutes detention from all causes was reduced from 3,579 to 1,124. A portion of these delays, however, is unavoidable, because the Company operate over foreign lines in Baltimore and Washington.

Central Stations and Contractors.—The encroachment of the supply authorities on the work of electric contractors is evidently not unknown outside this country, for in an address at the recent annual meeting of the Indiana Electric Contractors' Association, Mr. C. C. Perry, president of the Indianapolis Light & Heat Co., advised very strongly that lighting companies and electric contractors should keep within their own lines of business, while co-operating with each other for business success. He deplored the fact that there is a tendency on the part of lighting companies in some places to sell material and to do wiring. This should be stopped, he said, as it was the business of the electrical contractor to sell material and wire the buildings, and the lighting company should confine itself to making and selling electricity.

Electric Smelting at Trollhätten.—The British Minister at Stockholm has recently drawn attention to the report of the Swedish "Jernkontoret," or Iron and Steel Institute, for 1910. This contains some particulars of the results of the experiments made at Trollhätten in the smelting of iron ore by electricity provided at a cheap rate from the Government works. The plant cost £17,800 and smelting operations were commenced in November, 1910. According to the report, the results obtained show definitely that the question of smelting iron ore by electricity is solved even from the economical standpoint, if electricity is provided at low rates. Better results are to be expected if arrangements are made for a more effective circulation of gas, and it seems probable that this is feasible. So far, it appears that the experiment has paid expenses, and that in the present year better results are expected. After October, 1912, the Government intend to raise the charge for the supply of electricity. The Committee estimate that the smelting works cannot be a commercial success if the price exceeds the present rate of 40 kroner (£2. 4s. 5d.) per kilowatt per annum. The Government have offered to supply 6,000 electric horse-power for 10 years at 40 kroner per kilowatt, and for the following 10 years at 45 kroner. The question of continuing the experiment under these conditions is now awaiting the Society's decision. During the five months of operation 29 consignments of ore were used. The result of the operations was 413 kgs. of charcoal per ton of iron, and the consumption of electricity was ¼ kilowatt per year per ton. It was found on analysis that the electric product was practically free from remains of ores and cinders and oxidised iron taken up again by the furnace blasts. Silica-bearing electric iron is too slow for the Martin steel furnaces, as the want of oxygen makes itself felt. Foreign firms have reported that wire made from electric iron is fully as good as other qualities. Experiments have been made with satisfactory results at the works of Fagersta, Eskilstuna, Hagfors and Munkfors. The above statements have called forth a rejoinder in the Swedish Press to the effect that even if the gas is better regulated there will be no advantage over smelting with ordinary coal; that there is an immense and wasteful consumption of electric energy; and that the result is not more than 3 tons per horse-power-year. It is, of course, possible at Trollhätten, where electricity is provided cheaply, to smelt the iron without loss, but, says the writer in the Press, it is useless to talk of competing with coal smelted iron. The electric smelting cannot be made to pay where electric energy costs more than 36 kroner per horse-power-year. The only place where electric power could be supplied at so low a price is in the north, and there is a danger that the Grangesberg Company may smelt iron ore and export it to England; the freight to South Sweden would be prohibitive. The director of the works admits in reply that it would certainly not be possible, where there is a great demand for electricity for lighting, &c., to supply cheap electricity for smelting purposes, but in the north of Sweden where there is an immense reserve of water-power and great deposits of high-grade ore, the new process ought to be profitable.

Current Topics.

Subjects of current interest dealt with in this issue include the following:—

Messrs. J. W. E. Elliott and C. S. Parsons contribute an article on "Experiments on a Mercury Arc Converter."

We conclude our description of the Dunston power station of the Newcastle-on-Tyne Electric Supply Co.

We also continue our account of the Papers and Discussions at the Education Conference organised by the Institution of Civil Engineers.

An abstract is given of a Paper on "Some Recent Developments in Railway Telephony," read by Mr. G. Brown before the American Institute of Electrical Engineers.

An automatic telephone exchange is to be installed at Epsom.

Sheffield Council are recommended to authorise the expenditure of £61,000 on additions to generating plant, &c.

Interesting particulars of electrical progress in France are given in abstracts of Consular reports.

Municipal Loans.—An inquiry was held on Wednesday into the application of Doncaster Corporation for permission to borrow £12,0 for extensions of the electricity undertaking.—Sheffield Corporation are recommended to expend £61,000 on further extensions of plant.

Legal.—The Railway and Canal Commission continued this week the hearing of the case brought by the National Telephone C against the Postmaster-General in connection with the transfer the Company's undertaking to the Post Office. On Tuesday it was announced that the parties had made an arrangement as to the points in dispute.

The Court of Appeal on Tuesday dismissed the appeal of the London Electric Supply Corporation from the judgment of Mr. Justice Joyce in the action brought by the company against the Westminster Electric Supply Corporation as to the supply of electricity in portion of Westminster. Mr. Justice Joyce's judgment was reported in THE ELECTRICIAN of April 14 (page 30.)

It is announced that cross-actions have been lodged by the Marconi Companies against the Lodge-Muirhead Syndicate and by the Lodge-Muirhead Syndicate against the Marconi Companies for infringement of patents.

Companies' Reports.—An interesting report of the affairs of the Marconi Wireless Telegraph Co. is issued, showing a net profit according to the accounts, of £60,513. It is claimed that the successful working of the Company's trans-Atlantic service demonstrates its practical value. The report also mentions that a new and valuable invention, consisting of a duplex system adapted to wireless telegraphy, has been made by Mr. Marconi, who has applied for patents for his invention. It is announced that the Belgian Marconi Co. has declared a dividend of 10 per cent., the French Co. a dividend of 5 per cent., the Marconi International Marine Communication Co. (of which the parent company owns nearly the whole of the shares) a dividend of 5 per cent. The parent company declares the usual dividend on the cumulative 7 per cent. Preference shares, but this is subject to the approval of the general meeting about to be held. They also declare an interim Preference dividend up to June 30. A dividend on the Ordinary shares, it is stated, is also about to be declared.

The reports of the directors of the Electric Construction Co., and the Bombay Electric Supply and Tramways Co. are also abstracted.

OBITUARY.

J. E. NEALE.—The Indian Press recently reported that Mr. J. E. Neale, M.I.E.E., had died of empyema in the St. George's Hospital, Calcutta. Mr. Neale was telegraph superintendent of the Great Indian Peninsula Railway, and was the inventor of block signalling apparatus which was used not only on the Great Indian Peninsula Railway, but also on the Bengal-Nagpur, Eastern Bengal, Indian, Indian Midland and other lines.

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PERSONAL NOTE.

Mr. H. V. Browne.—The report of the Executive Committee of the British Chamber of Commerce for Spain brings us news of the departure from Barcelona of Mr. H. V. Browne, who has been for many years the representative in Barcelona of the Direct Spanish Telegraph Co., and who has been vice-president of the Chamber since its establishment. Mr. Browne is taking up his quarters in Marseilles, where he conducts the Direct Spanish Co.'s Marseilles branch as from July 1.

The President of the Chamber (Mr. G. R. Smither), at a recent meeting, expressed the great regret of the members at the loss sustained by the Chamber from the departure of Mr. Browne, whose many cheerfully rendered services had, he said, endeared Mr. Browne to them. A hearty vote of thanks was passed unanimously to the late vice-president of the Chamber for his good work and for his enthusiasm for the Chamber's welfare.

Mr. Browne, in expressing his gratitude for the kindness shown him, said he should always entertain feelings of high regard for the members of the British Chamber of Commerce for Spain, and should from Marseilles take an interest in its future success. A banquet took place subsequently at which H.B.M.'s Consul-General, Mr. J. F. Roberts, occupied the chair, and spoke feelingly of Mr. Browne's distinguished services to the British colony in Barcelona.

APPOINTMENTS VACANT AND FILLED.

A lecturer in electrical engineering is required at the East London College (University of London) for September next. Workshop experience essential. Commencing salary £160. Particulars from Prof. J. T. Morris. Applications to the Registrar of the College by Monday, July 31. See advertisement.

Test room assistants are required for testing and calculating a.c. and d.c. ammeters, voltmeters and wattmeters. See advertisement.

Several electrical fitters, experienced in fitting electrical installations in ships. Wages 36s. Applications to the Electrical Engineer, H.M. Dockyard, Devonport. There is also a vacancy for a supernumerary switchboard attendant at the Dockyard; wages 35s. per week. See advertisements.

The position of instructor in the electrical engineering laboratories of the City and Guilds of London Technical College, Finsbury, is vacant by the resignation of Mr. B. Betts. Salary £100 per annum. Particulars from the Principal. See advertisement.

Messrs. Dick, Kerr & Co., Abchurch-yard, London, E.C., require foremen for the glass blowing, exhausting and filament preparing departments of their lamp works. See advertisement.

A lecturer in physics and mathematics (£150, rising to £250 per annum) and a visiting teacher of mathematics (five evenings per week at 15s. per evening) are required for the L.C.C. Hackney Technical Institute. Applications (on Form T. 17) to the Education Offices, Victoria Embankment, W.C., by 11 a.m. July 21.

An assistant lecturer and demonstrator is required in the mathematics and mechanics department of Sunderland Technical College. Salary £150. Applications to Mr. Herbt. Reed, 15, John-street, Sunderland, by July 31.

A science master is required by Leicester County Council for the King Edward VII. Grammar School, Melton Mowbray. Commencing salary £140. Applications to Mr. R. Stuart Smith, Thornhill, Todmorden.

A demonstrator or assistant lecturer is required in the physics department of the University College of Wales, Aberystwyth. Salary £150. Applications to the Registrar by Aug. 24.

Battersea (London) Council require an additional commercial assistant for their electricity department. Salary £2 per week and commission. Applications by noon July 24.

The Governors of Heriot-Watt College, Edinburgh, require an organiser of technical education. Salary £300 per annum. Applications to the Clerk, 20, York-place, Edinburgh, by July 24.

An assistant science master is required for Waterford Central Technical Institute. Salary £100, rising to £130. Particulars from the Principal. Applications by noon, July 29.

Mr. L. Simons, B.Sc., has been appointed demonstrator in physics at Armstrong College.

INSTITUTIONS AND SOCIETIES.

Royal Society of Arts.—The Council on Monday elected Lord Sanderson, G.C.B., chairman for the year 1911-12. Lord Sanderson has been a member of the Society for over 30 years.

Institution of Electrical Engineers.—The annual conversazione was held last Thursday evening, July 6th, at the Natural History Museum, South Kensington. The guests, among whom were Lord Justice Buckley, Sir W. J. Howell, K.C.B., Sir S. Hutchinson, Rear-Admiral A. G. H. W. Moore, R.N., the Hon. Sir R. J. Parker, Sir W. Ramsay, K.C.B., F.R.S., and Sir W. Wilkins, K.C.M.G., were received by the President, Mr. S. Z. de Ferranti, and Mrs. Ferranti. We were surprised at the somewhat small attendance as compared with previous years, due probably to the hot weather. The usual programme of music was provided, viz., the string band of the Royal Engineers and the Alexandra Ladies' Quartette.

Tramways and Light Railways Association.—The "Journal" for July is a special "Congress" number, the four Papers which are being read yesterday and to-day at the Edinburgh Congress being given in full.

EDUCATIONAL NOTICES.

University of Sheffield.—The faculty of applied science comprises the departments of engineering, metallurgy, coal mining and architecture. The courses in engineering or in metallurgy extend over three years and prepare respectively for the degree of B.Eng. or B.Met. of the university. The lecture courses commence Oct. 4, and the technical laboratory courses on Sept. 18. Prospectuses and other particulars from the registrar, Mr. W. M. Gibbons.

University of Manchester.—A complete theoretical and practical training is given at this University to students preparing for the higher positions in the electrical engineering profession. The subject may be taken as part of the course preparing for the B.Sc. degree in both the Honours Schools of Engineering and of Physics, and a special course has also been arranged extending over three years, and preparing for the certificate in electrical engineering. The John Hopkinson laboratories (which are being extended) and dynamo house are fitted with modern electrical machinery, and good facilities are offered for educational and research work. The 1911-1912 session commences on Oct. 3. Prospectuses may be obtained from the Registrar.

City and Guilds Technical College.—This college provides a scientific training for students preparing to become electrical and mechanical engineers or chemists, and for engineering pupils who desire to supplement their practical training by a two years' course of instruction in the principles of engineering science. The instruction is mainly given in the various laboratories, most of which have been recently re-equipped. The subjects of the entrance examination are mathematics and English, but the matriculation of any British University is accepted. The courses in electrical and mechanical engineering cover a period of two years and those in chemistry three years. There are also arrangements for three-year courses in engineering. Particulars at the college, Leonard-street, City-road, London, E.C., or from the City and Guilds of London Institute, Gresham College, Basinghall-street, London, E.C.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, July 14th (To-day).

Tramways and Light Railways Association.

Congress at Edinburgh. Papers on "Notes on Tramway Problems," by Mr. C. W. Mallins (General manager, Liverpool Corporation Tramways); and "Tramways and Light Railways Legislation of the Future," by Ald. W. Ivey (West Ham Tramways Committee).

THE LONDON ELECTRICAL ENGINEERS.

Officer Commanding, Col. H. M. Leaf.

The following orders have been issued for the current week:—

Monday, July 17, to Friday, July 21, headquarters will be open from 10 a.m. to 4 p.m.

Saturday, July 22.—Sheerness Detachment will parade at Headquarters at 3 p.m. Dress: Service dress, drill order with water-bottles and haversacks. Arms will be issued before this parade.

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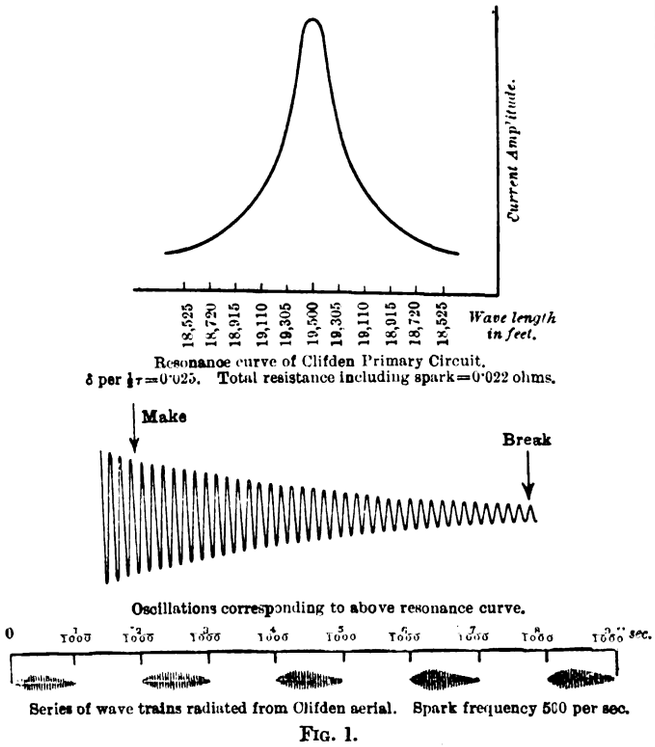
RADIO-TELEGRAPHY.*

BY G. MARCONI.

The practical application of electric waves to the purposes of wireless telegraph transmission over long distances has continued to extend to a remarkable degree during the last few years, and many of the difficulties which at the outset appeared almost insurmountable have been gradually overcome—chiefly through the improved knowledge which we have obtained in regard to the subject generally and to the principles involved. Although we have all the data necessary for the satisfactory production and reception of electric waves, we are yet far from possessing any very exact knowledge concerning the conditions governing the transmission of these waves through space—especially over long distances. Although it is now perfectly easy to design, construct and operate stations capable of satisfactory commercial working over distances up to 2,500 miles, no really clear explanation has yet been given of many absolutely authenticated facts concerning these waves. Why is it that when using short waves the distances covered at night are usually enormously greater than those traversed in the daytime, whilst when using much longer waves the range of transmission by day and night is about equal and sometimes even greater by day? What explanation has been given of the fact that the night distances obtainable in a north-southerly direction are so much greater than those which can be effected in an



Resonance curve of Clifden Primary Circuit.
δ per $\frac{1}{2}\tau$=0·025. Total resistance including spark=0·022 ohms.

Oscillations corresponding to above resonance curve.

Series of wave trains radiated from Clifden aerial. Spark frequency 500 per sec.

FIG. 1.

east-westerly one? Why is it that mountains and land generally should greatly obstruct the propagation of short waves when sunlight is present and not during the hours of darkness?

After referring to the general principles on which practical radiotelegraphy is based and the various systems which had been used by him to obtain wireless transmission, Mr. Marconi continued: At the long distance station situated at Clifden in Ireland, the arrangement which has given the best results is based substantially upon my syntonic system of 1900, to which have been added numerous improvements. An important innovation from a practical point of view was the adoption at Clifden and Glace Bay of air condensers composed of insulated metallic plates suspended in air at ordinary pressure. In this manner we greatly reduce the loss of energy which would take place in consequence of dielectric hysteresis were a glass or solid dielectric employed. A very considerable economy in working also results from the absence of dielectric breakages, for, should the potential be so raised as to produce even a discharge from plate to plate across the condenser, this does not permanently affect the value of the dielectric, as air is self-healing, and one of the few commodities which can be replaced at a minimum of cost.

Various arrangements have been tried and tested for obtaining continuous or very prolonged trains of waves, but it has been my experience that, when utilising the best receivers at present available, it is neither economical nor efficient to attempt to make the waves too continuous. Much better results are obtained when groups of waves (Fig. 1) are emitted at regular intervals in such manner that their cumulative effect produces a clear musical note in the receiver, which is tuned not only to the periodicity of the electric waves transmitted, but also to their group frequency. In this manner the receiver may be doubly tuned, with the result that a far greater selectivity can be obtained than by the employment of wave-tuning alone. In fact, it is quite easy to pick up simultaneously different messages transmitted on the same wave-length, but syntonised to different group frequencies. As far as wave-tuning goes, very good results—almost as good as are obtainable by means of continuous oscillations—can be achieved with groups of waves, the decrement of which is in each group 0·03 or 0·04, which means that about 30 or 40 useful oscillations are radiated before their amplitude has become too small perceptibly to affect the receiver. The condenser circuit at Clifden has a decrement of from 0·015 to 0·03 for fairly long waves.

The lecturer then gave a description of his well-known disc discharger, a patent for which was taken out in 1907. In this apparatus, with the frequency employed at Clifden, namely, 45,000, when a potential of 15,000 volts is used on the condenser, the spark-gap is practically closed during the time in which one complete oscillation only is taking place, when the peripherical speed of the disc is about 600 ft. a second. The result is that the primary circuit can continue oscillating without material loss by resistance in the spark-gap. Of course the number of oscillations which can take place is governed by the breadth or thickness of the side discs, the primary circuit being abruptly opened as soon as the studs attached to the middle disc leave the side discs.

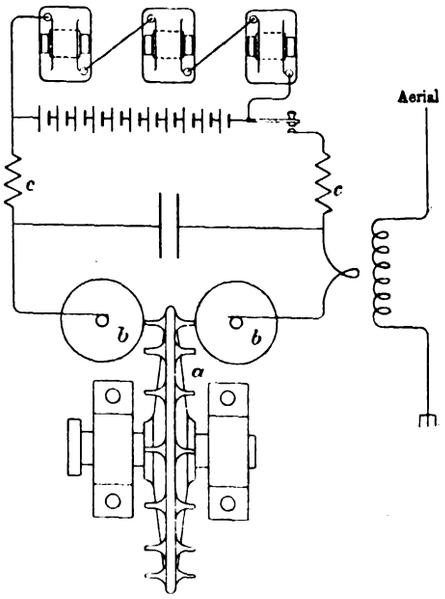


FIG. 2.—DISC DISCHARGER. (Continuous Current.)

This sudden opening of the primary circuit tends immediately to quench any oscillations which may still persist in the condenser circuit; and this fact carries with it a further and not inconsiderable advantage; for, if the coupling of the condenser circuit to the aerial is of a suitable value, the energy of the primary will have practically all passed to the aerial circuit during the period of time in which the primary condenser circuit is closed by the stud filling the gap between the side discs; but, after this, the opening of the gap at the disc prevents the energy returning to the condenser circuit from the aerial as would happen were the ordinary spark-gap employed. In this manner the usual re-action which would take place between the aerial and the condenser circuit can be obviated, with the result that with this type of discharger and with a suitable degree of coupling the energy is radiated from the aerial in the form of a pure wave, the loss from the spark-gap resistance being reduced to a minimum.

An interesting feature of the Clifden plant, especially from a practical and engineering point of view, is the regular employment of high-tension direct current for charging the condenser. Continuous current at a potential which is capable of being raised to 20,000 volts is obtained by means of special direct-current generators; these machines charge a storage battery consisting of 6,000 cells all connected in series, and it may be pointed out that this battery is the largest of its kind in existence. The capacity of each cell is 4 ampere-hours. When employing the cells alone the working voltage is from 11,000 to 12,000 volts, and when both the direct-current

* Abstract of a Discourse delivered at the Royal Institution on Friday, June 2nd.

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generators and the battery are used together the potential may be raised to 15,000 volts through utilising the gassing voltage of the storage cells. For a considerable portion of the day the storage battery alone is employed, with a result that for 16 hours out of the 24 no running machinery need be used for operating the station, with the single exception of the small motor revolving the disc. The potential to which the condenser is charged reaches 18,000 volts when that of the battery or generators is 12,000. This potential is obtained in consequence of the rise of potential at the condenser plates, brought about by the rush of current through the choking coils at each charge. These coils are placed between the battery or generator and the condenser *c*, Fig. 2. No practical difficulty has been encountered either at Clifden or Glace Bay in regard to the insulation and maintenance of these high-tension storage batteries. Satisfactory insulation has been obtained by dividing the battery into small sets of cells placed on separate stands. These stands are suspended on insulators attached to girders fixed in the ceiling of the battery room. A system of switches, which can all be operated electrically and simultaneously, divides the battery into sections, the potential of each section being low enough to enable the cells to be handled without inconvenience or risk.

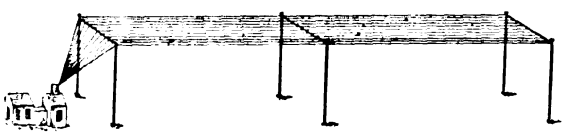

FIG. 3.

The arrangement of aerial adopted at Clifden and Glace Bay is shown in Fig. 3. This system, which is based on the result of tests that I first described before the Royal Society in June, 1906,* not only makes it possible efficiently to radiate and receive waves of any desired length but it also tends to confine the main portion of the radiation to any desired direction. The limitation of transmission to one direction is not very sharply defined, but nevertheless the results obtained are exceedingly useful for practical working. In a similar manner by means of these horizontal wires it is possible to define the bearing or direction of a sending station and also limit the receptivity of the receiver to waves arriving from a given direction.

Turning to the detrimental effect produced by daylight on the propagation of electric waves over great distances, the lecturer dealt with the generally accepted hypothesis of the cause of this, and stated that recent observations revealed the interesting fact that the effects varied greatly with the direction in which transmission was taking place; the results obtained when transmitting in a northerly and southerly direction being often altogether different from those observed in the easterly and westerly one. In regard to moderate power stations, such as are employed on ships and which in

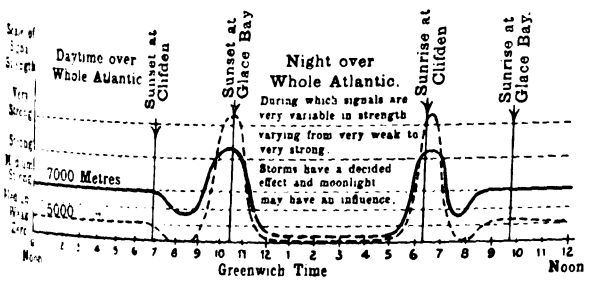

FIG. 4.

compliance with the International Convention use wave lengths of 300 and 600 metres, the distance over which communication can be effected during daytime is generally about the same whatever the bearing of the ships to each other or to the land stations, whilst at night interesting and apparently curious results are obtained. Ships, over 1,000 miles away, off the south of Spain or round the coast of Italy, can almost always communicate during the hours of darkness with the Post Office stations situated on the coasts of England and Ireland, whilst the same ships, when at a similar distance on the Atlantic to the westward of these islands and on the usual track between England and America, can hardly ever communicate with these shore stations unless by means of specially powerful instruments. It is also to be noticed that in order to reach ships in the Mediterranean the electric waves have to pass over a large portion of Europe and, in many cases, over the Alps. Such long stretches of land, especially when including very high mountains, constitute, as is well known, an insurmountable barrier to the propagation of short waves during daytime. Although no such obstacles lie between the English and Irish stations and ships in the North Atlantic en route for North America, a night transimssion of 1,000 miles is there of exceptionally rare occurrence. The same effects generally are noticeable when ships are communicating with stations situated on the Atlantic coast of America.

The diagrams Figs. 4 and 5 show the average daily variation of the signals received at Clifden from Glace Bay. The curves shown in Fig. 4 show the usual variation in the strength of these trans-Atlantic signals on two wave lengths—one of 7,000 metres and the other of 5,000 metres. The strength of the received waves remains as a rule steady during day time. Shortly after sunset at Clifden they become gradually weaker, and about two hours later they are at their weakest. They then begin to strengthen again and reach a very high maximum at about the time of sunset at Glace Bay. They then gradually return to about normal strength, but through the night they are very variable Shortly before sunrise at Clifden the signals commence to strengthen steadily and reach another high maximum shortly after sunrise at Clifden. The received energy then steadily decreases again until it reaches a very marked minimum a short time before sunrise at Glace Bay. After that the signals gradually come back to normal day strength. It can be noticed that, although the shorter wave gives on the average weaker signals, its maximum and minimum variations

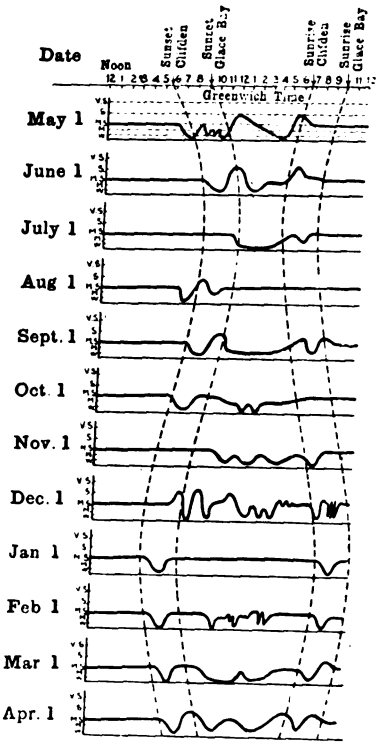

FIG. 5.—VARIATION OF SIGNALS AT CLIFDEN FROM MAY 1910 TO APRIL, 1911. Curve for the first day of each month being shown.

of strength very sensibly exceed that of the longer wave. Fig. 5 shows the curve for the first day of each month for one year from May, 1910, to April, 1911.

I carried out a series of tests over longer distances than had ever been previously attempted in September and October of last year between the stations at Clifden and Glace Bay, and a receiving station placed on the Italian s.s. "Principessa Mafalda," in the course of a voyage from Italy to the Argentine (Fig. 6). During these tests the receiving wire was supported by means of a kite, as was made in my early trans-Atlantic tests of 1901, the height of the kite varying from about 1,000 ft. to 3,000 ft. Signals and messages were obtained without difficulty by day as well as by night up to a distance of 4,000 statute miles from Clifden. Beyond that distance reception could only be carried out during night-time. At Buenos Ayres, over 6,000 miles from Clifden, the night signals from both Clifden and Glace Bay were generally good, but their strength suffered some variations. It is rather remarkable that the radiations from Clifden should have been detected at Buenos Ayres so clearly at night-time and not at all during the day, whilst in Canada the signals coming from Clifden (2,400 miles distant) are no stronger during the night than they are by day.

* "On Methods whereby the Radiation of Electric Waves may be Mainly Confined, &c.," "Proceedings" of the Royal Society, A., Vol. LXXVII., 1906.

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Further tests have been carried out recently for the Italian Government between a station situated at Massaua in East Africa and Coltano in Italy. Considerable interest attached to these experiments in view of the fact that the line connecting the two stations passes over exceedingly dry country and across vast stretches of desert, including parts of Abyssinia, the Soudan and the Libyan desert. The distance between the two stations is about 2,600 miles. The wave length of the sending station in Africa was too small to allow of transmission being effected during daytime, but the results obtained during the hours of darkness were exceedingly good, the received signals being quite steady and readable. The improvements introduced at Clifden and Glace Bay have had the result of greatly minimising the interference to which wireless transmission over long distances was particularly exposed in the early days. The signals arriving at Clifden from Canada are as a rule easily read through any ordinary electrical atmospheric disturbance. This strengthening of the received signals has, moreover, made possible the use of recording instruments which not only give a fixed record of the received messages, but are also capable of being operated at a much higher rate of speed than could ever be obtained by means of an operator reading by sound or sight. The record of the signals is obtained by means of photography in the following manner: A sensitive Einthoven string galvanometer is connected to the magnetic

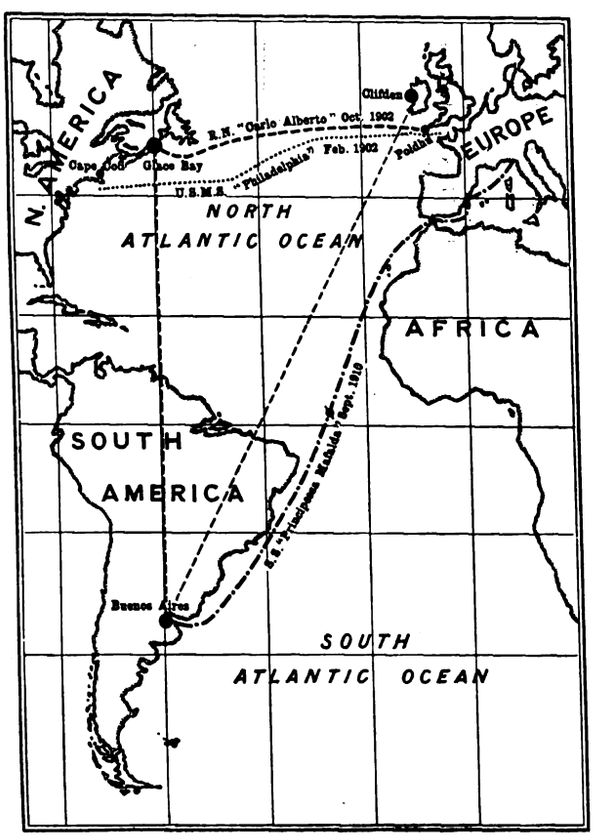

FIG. 6.—CHART OF NORTH AND SOUTH ATLANTIC.

detector or valve receiver, and the deflections of its filament caused by the incoming signals are projected and photographically fixed on a sensitive strip which is moved along at a suitable speed. On some of these records there are characteristic marks and signs produced amongst the signals by natural electric waves or other electrical disturbances of the atmosphere, which, on account of their doubtful origin, have been called "X's."

Although the mathematical theory of electric wave propagation through space was worked out by Clerk Maxwell more than 50 years ago, and notwithstanding all the experimental evidence obtained in laboratories concerning the nature of these waves, yet so far we understand but incompletely the true fundamental principles concerning the manner of propagation of the waves on which wireless telegraph transmission is based. For example, in the early days of wireless telegraphy it was generally believed that the curvature of the earth would constitute an insurmountable obstacle to the transmission of electric waves between widely separated points. For a considerable time not sufficient account was taken of the probable effect of the earth connection, especially in regard to the transmission of oscillations over long distances.

Physicists seemed to consider for a long time that wireless telegraphy was solely dependent on the effects of free Hertzian radiation through space, and it was years before the probable effect of the conductivity of the earth was considered and discussed. The importance or utility of the earth connection has been sometimes questioned, but in my opinion no practical system of wireless telegraphy exists where the instruments are not in some manner connected to earth. By connection to earth I do not necessarily mean an ordinary metallic connection as used for wire telegraphs. The earth wire may have a condenser in series with it, or it may be connected to what is really equivalent, a capacity area placed close to the surface of the ground. It is now perfectly well known that a condenser, if large enough, does not prevent the passage of high-frequency oscillations, and therefore in this case, when a so-called balancing capacity is used, the antenna is for all practical purposes connected to earth. I am also of opinion that there is absolutely no foundation in the statement which has recently been repeated to the effect that an earth connection is detrimental to good tuning, provided of course that the earth is good.

In conclusion, the lecturer remarked that wireless telegraphy was tending to revolutionise our means of communication from place to place on the earth's surface. For example, commercial messages containing a total of 812,200 words were sent and received between Clifden and Glace Bay from May 1, 1910, to the end of April, 1911. Wireless telegraphy has already furnished means of communication between ships and the shore where communication was before practically impossible. The fact that a system of Imperial Wireless Telegraphy is to be discussed by the Imperial Conference now holding its meetings in London shows the supremely important position which radio-telegraphy over long distances has assumed in the short space of one decade. Its importance from a commercial, naval and military point of view has increased very greatly during the last few years as a consequence of the innumerable stations which have been erected or are now in course of construction on various coasts, in inland regions and on board ships in all parts of the world. Notwithstanding this multiplicity of stations and their almost constant operation, mutual interference between properly equipped and efficiently tuned instruments has so far been almost entirely absent, and in regard to the high power trans-Atlantic stations the facility with which interference has been prevented has to some extent exceeded my expectations. The extended use of wireless telegraphy is principally dependent on the ease with which a number of stations can be efficiently worked in the vicinity of each other. Apart from long distance work, the practical value of wireless telegraphy perhaps may be divided into two parts: (1) when used for transmission over sea, (2) when used over land. Its chief benefit, however, lies in the facility which it affords to ships in distress of communicating their plight to neighbouring vessels or coast stations; that it is now considered indispensable for this reason is shown by the fact that several Governments have passed a law making a wireless telegraph installation a compulsory part of the equipment of all passenger boats entering their ports.

EXPERIMENTS ON A MERCURY ARC CONVERTER.

BY J. W. ELLIOTT AND C. S. PARSONS.

Summary.—Photographs are given, obtained stroboscopically, showing the changing over of the arc from one pole to the other in the mercury rectifier. Oscillograph records are also given, from which it is seen that a certain want of symmetry is present. The cause of this is briefly discussed.

The action of a mercury arc converter is based upon the following characteristic of the electric arc—namely, that it is a good conductor in one direction but a non-conductor in the opposite direction. Thus, when it is supplied with alternating pressure, it permits current to flow from the carbon anode to the mercury cathode, whilst entirely cutting off the half-wave which tends to pass in the opposite direction. In order to make both half-waves available for use as a direct current, two anodes are provided, the current entering alternately at each and leaving by the common cathode. For the converter to work continuously an arc must always be present at the cathode, and accordingly the currents in the two anode circuits are caused to overlap each other by means of inductances.

The following tests were recently carried out on a single-phase mercury arc converter manufactured by the Westinghouse Cooper Hewitt Co. (Ltd.). The converter is supplied with alternating current at 200 volts 50 ∽ per second. On the direct-current side the rated output is 4 to 10 amperes at 110 volts. The bulb containing the electrodes is suitably mounted

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behind a marble panel on the front of which are the terminals and fuses and the starting handle. The transformer and inductances are fixed to the base supporting the panel and the apparatus is enclosed in a sheet-iron casing provided with ventilating holes. The overall height is 22 in., the floor space required being 9 in. by 13 in. The leading dimensions of the glass bulb are: 12 in. overall height and 10½ in. across the horizontal arms, the diameter of the central spherical bulb being 3½ in. The alternating-current supply is connected to an

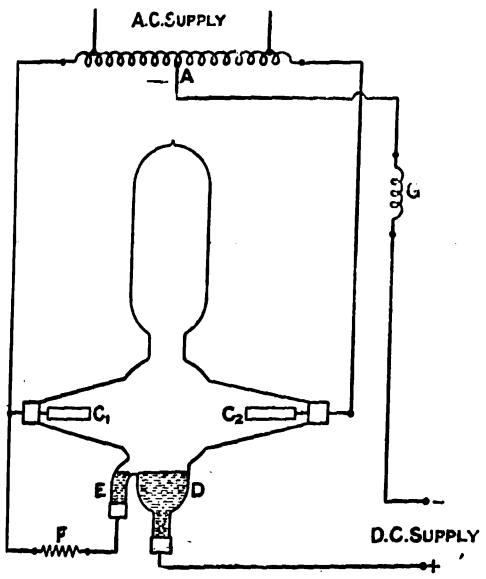

FIG. 1.

auto-transformer, the neutral point of which constitutes the negative terminal of the direct-current supply, as shown at A in Fig. 1.

The glass vessel B, which is exhausted to a high degree, contains the electrodes. The anodes C_1, C_2 are graphite tubes, the cathode consisting of a quantity of mercury contained in the lower part of bulb. The ends of the transformer winding are connected to C_1, C_2. On the production of mercury vapour in

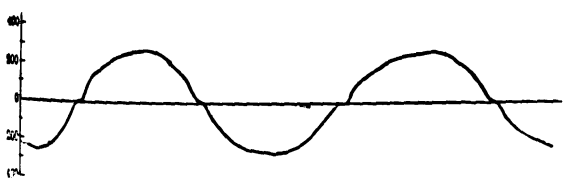

FIG. 2.—WAVE-FORM OF ALTERNATOR SUPPLY VOLTAGE.

the bulb, arcs play alternately from the anodes C_1, C_2 to the mercury pool D. In accordance with the principle stated above an unidirectional current flows from D, which constitutes the positive terminal of the direct-current supply. For the purpose of starting, a supplementary mercury pool E is provided, which is connected to one of the anodes through a resistance, F. The bulb is tilted slightly, thus causing contact to be made for an instant between the mercury in the two pools. An

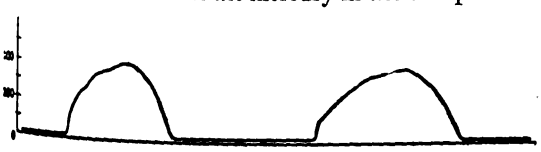

FIG. 3.—P.D. WAVE BETWEEN C_1 OR C_2 AND D.

arc is drawn out, which vaporises sufficient mercury to start the arcs between the main electrodes. The supplementary circuit is automatically cut out when the bulb returns to its normal vertical position. In order to start the converter, it is absolutely essential that the direct-current circuit should be closed. The upper part of the bulb serves to condense the mercury vapour. A choking coil, G, is placed in the direct-current circuit to smooth out the current wave.

The principal object of the tests was to investigate the changes taking place in the state of the arcs during their passage from the anode to the cathode. The interval during which an arc exists between C_1 or C_2 and D is $\frac{1}{100}$ of a second. It will be readily understood that it is impossible to perceive by direct vision any changes occurring in this short time, consequently a stroboscopic method of viewing the arcs during their various stages was adopted. A disc of stiff paper was mounted on the

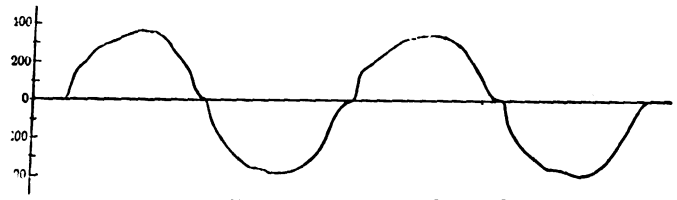

FIG. 4.—P.D. WAVE BETWEEN C_1 AND C_2.

shaft of the six-pole alternator supplying the converter. Three slits were cut in the disc near the edge at equal distances from the centre, and at angles of 120 deg. (*i.e.*, 360 electrical degrees) to one another. The disc was stiffened at its centre by thin metal discs, and screwed to a hub keyed to the alternator shaft. By means of the clamping screws the disc could be moved round with respect to the shaft, and screwed in the new position.

FIG. 5.—DIRECT-CURRENT VOLTAGE OBTAINED DIRECTLY FROM THE CONVERTER.

The angle through which it was moved was read off on a scale marked on the wooden hub. The speed at which the rim of the disc was travelling was 113 miles per hour. The converter was placed in front of the disc in line with the shaft, and viewed through the slits from the opposite side. As viewed through the slits the arcs will only be seen intermittently, the interval

FIG. 6.—WAVE-FORM OF DIRECT-CURRENT SUPPLY VOLTAGE TO EXTERNAL CIRCUIT.

between consecutive views being equal to the interval between successive arcs from the same anode. During the time which elapses between consecutive views, an arc from one anode has disappeared and another from the same anode taken its place. The arcs will, therefore, appear to be at rest, since successive images follow one another with such rapidity. With the eye

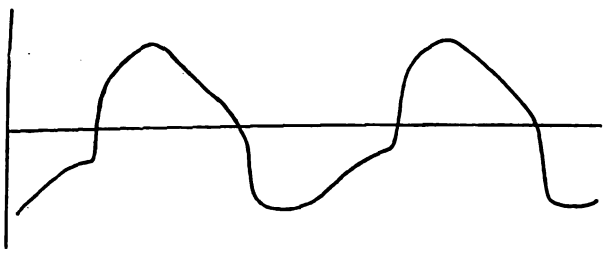

FIG. 7.—ALTERNATING-CURRENT WAVE-FORM SUPPLIED TO THE CONVERTER.

fixed in one position, the arcs as seen intermittently through the slits would appear to be in the same position. The time taken between two consecutive views corresponds to 360 deg. of phase displacement. Consequently as one moves the position of view round the disc—*i.e.*, with respect to the alternator—the state of the arcs at various parts of the cycle will be easily seen. In order to obtain a record of the state of the arcs at certain instants, photographs were taken. A camera was

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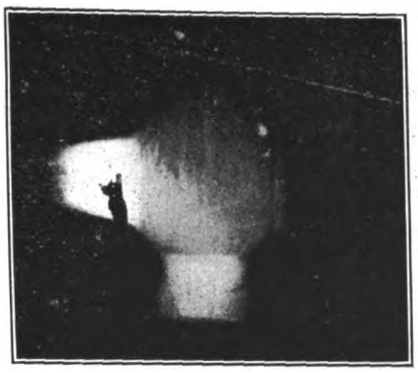
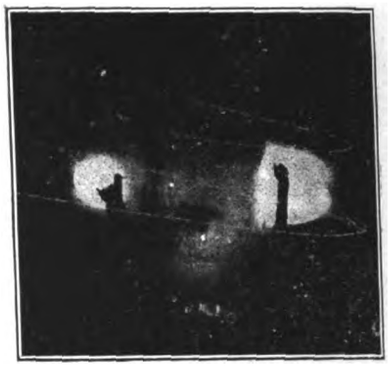
suitably arranged behind the disc with its lens in line with the slits, and was kept in a fixed position, the various views being obtained by adjusting the angular position of the disc with reference to the shaft. In this way a series of 20 photographs were taken, of which the series Nos. 1, 4, 5, 10, 11, 13, 17, 18, 19, 20 reproduced are at approximately equal intervals of time. The other series, 2, 3, 4, 5, 6, 7, show the changes taking place at one of the periods of overlap. The actual angle of displacement is indicated in electrical degrees. The constant load on the direct-current side consisted of a number of carbon filament lamps, the total current taken being 9·7 amperes, measured on a moving coil ammeter. Some extra photographs were also taken when the converter was working at half this load.

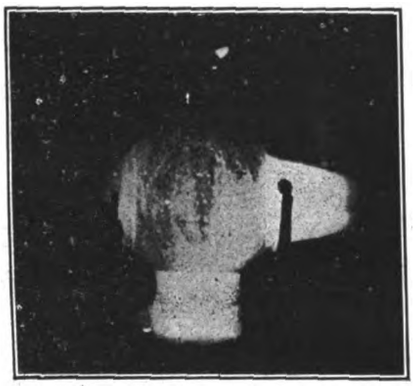


No. 1.—Phase Angle 0°.

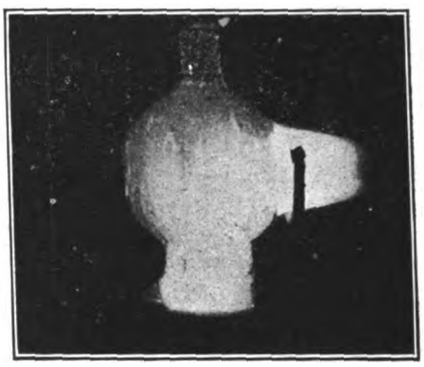
No. 4.—Phase Angle 37°·2.



No. 5.—Phase Angle 76°·2.

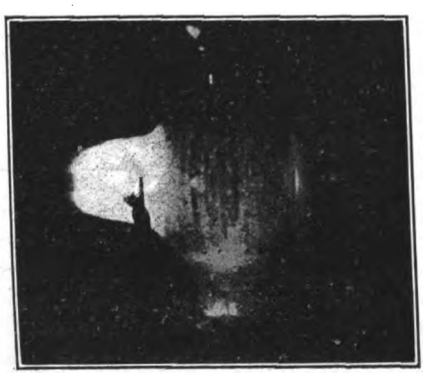


No. 10.—Phase Angle 114°.

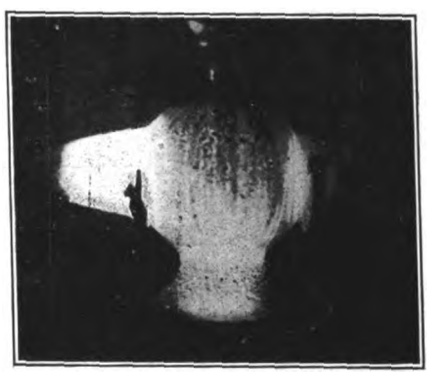


No. 11.—Phase Angle 153°·4.

No. 13.—Phase Angle about 192°·5.



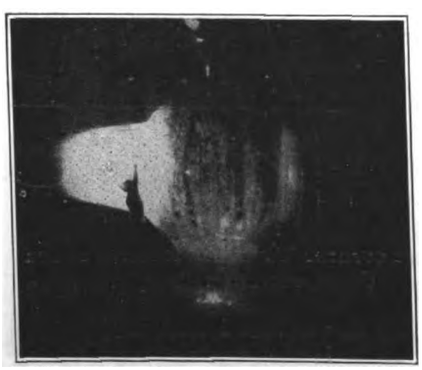
No. 17.—Phase Angle 232°.



No. 18.—Phase Angle 271°·5.

No. 19.—Phase Angle 312°.

First Series, showing Changes at approximately Equal Intervals of Time.



No. 20.—Phase Angle 351°.

No appreciable difference was noticed other than the reduction in the intensity of the light emitted. From the photographic records an examination of the light emitted at the anodes would suggest that the values of the angles of overlap are as follows:—

Overlap in Electrical Degrees.

Greater than 7·5 deg., less than 20 deg.	Probably 11½ deg.
Greater than 62 deg., less than 78 deg.....	Probably 70 deg.

It is thus evident that the two angles of overlap are widely different at the two points in each complete cycle at which the arcs change over. The probable explanation of this will be dealt with later.

Some oscillographs were also taken of the wave forms of current and voltage between certain points in the converter for the purpose of making its action clearer, and to see the degree of variation of the direct current and voltage obtained. The oscillograph used was a Duddell high-frequency type. Voltage waves were the most interesting, and some of these are repro-

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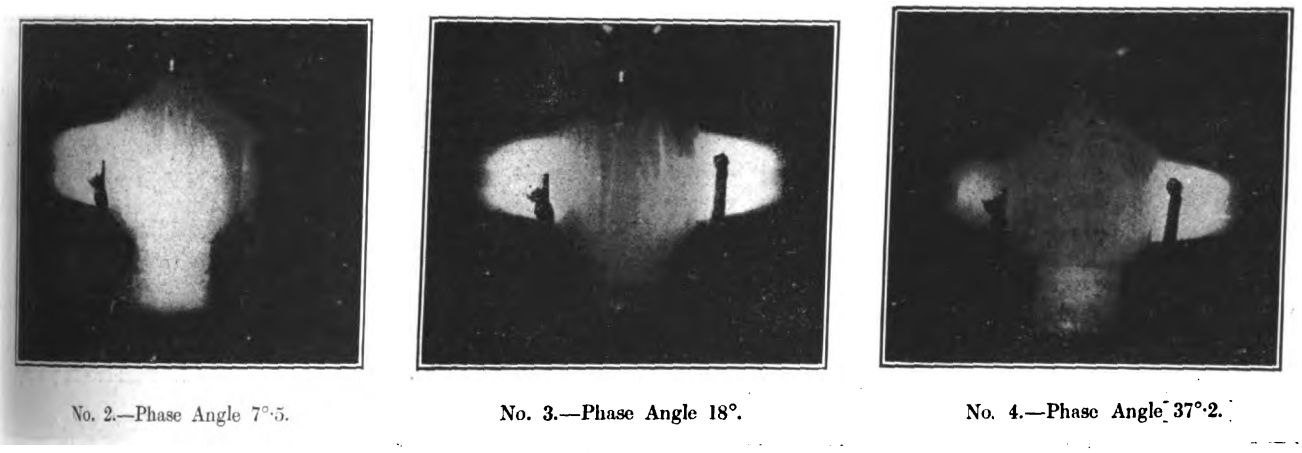
duced. Fig. 2 is the voltage wave of the alternator on this load, and was taken as a standard of reference for the other waves. Fig. 3 shows the form of the impressed voltage between C_1, C_2 and D, the waves obtained from both anodes being exactly similar. It will be noticed that there is a horizontal portion of the wave which indicates the period during which the arc is burning, and consequently there is only a P.D. of about 15 volts between the two points. When the arc is not burning the P.D. rises to the full value as indicated in the wave shown.

Fig. 4 shows the P.D. wave between C_1, C_2. The small horizontal portions here show the period during which the two arcs are burning simultaneously. In order to see the fluctuation in the direct-current voltage obtained directly from the converter, Fig. 5 was taken. This shows itself as merely the superposition of the waves between C_1 and D and between C_2 and D. The variation of the voltage is here very great, being from 15 to 200 volts, or about 92 per cent. of the maximum.

taken, and is shown in Fig. 7. This is particularly interesting on account of the fact that the wave is not symmetrical in the way in which alternating-current waves generally are. It possesses symmetry in that succeeding pulsations in either direction are similar, but the half periods represented below the line are dissimilar to those above. This suggests that the distortion is not equal in each of the anode circuits, and this difference is confirmed in the photographs by the different angles of overlap. The probable reason for this is that there is more inductance in one anode circuit than the other, the result being that the currents have relative positions as indicated diagrammatically in Fig. 8. An examination of the resultant current in the secondary portion of the transformer winding gives a wave-form as shown in Fig. 9. It is thus obvious that distortion similar to this would be produced in the supply current from the alternator. The difference in the inductances in the two anode circuits may be due to a difference in the windings, but is very



No. 2.—Phase Angle 7°·5. No. 3.—Phase Angle 18°. No. 4.—Phase Angle 37°·2.

No. 5.—Phase Angle 76°·2. No. 6.—Phase Angle, approx. 80°. No. 7.—Phase Angle 85°·5.

SECOND SERIES, SHOWING CHANGES DURING PERIOD OF OVERLAP.

Fig. 6 is the direct-current voltage wave as supplied to the external circuit—*i.e.*, after passing through the inductance coil G. The effect of this is very marked, the wave being smoothed out into a very regular form, the variation of voltage being reduced to 80 to 170, or only 53 per cent. of the maximum. This variation is not noticeable in glow lamps when working at

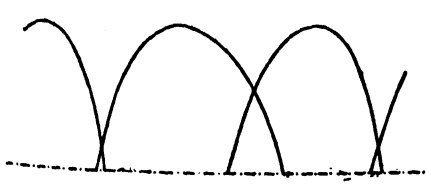


FIG. 8.

the normal frequency of 50 ∼. but if worked at a much lower frequency a very decided flicker is observed. Oscillographs of the current flowing to each anode were taken, and were exactly similar.

The direct-current wave is exactly similar to the voltage wave. The wave-form of the current from the alternator was likely due to the position of the shell-type inductance coil in the direct-current circuit, which is placed near one end of the auto-transformer, probably in close proximity to the inductance in one of the anode circuits which is wound on the end of the transformer coil. It was also noted that one of the arcs was

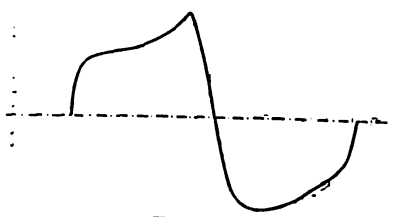


FIG. 9.

deflected from its central position to the back of the mercury pool, whereas the other arc played in the centre of the pool.

A comparison of the angles of overlap indicated by the voltage waves obtained by the oscillograph are not so widely different as those shown by the photographs. The only explanation which the authors can suggest is that the arc may

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continue to give out light after the current in it has completely disappeared.

Efficiency and regulation curves were also obtained and proved to be the same as specified by the makers. The method used for the test was the differential wattmeter method. The curves obtained are shown in Fig. 10. As will be seen, the efficiency is practically constant at all loads. The average efficiency in this case is about 84 per cent. It was impossible to find the form of efficiency curve at very low loads on account of the fact that the arcs will not burn when the load falls below about 3 amperes.

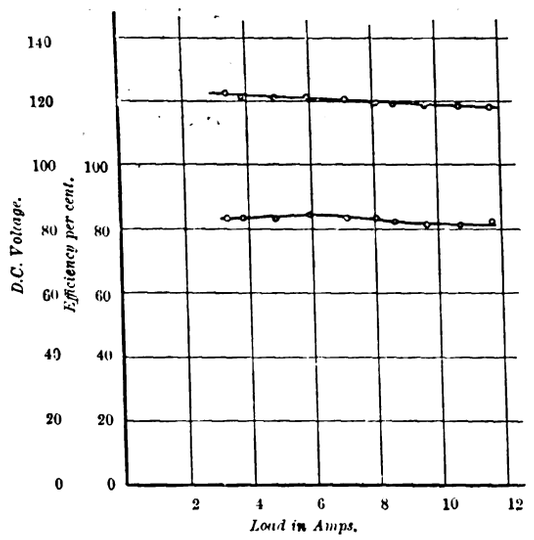

FIG. 10.—EFFICIENCY AND REGULATION CURVES.

It was, however, found that the converter would work on a lower load than it was possible to start with if the bulb was well warmed up and the load carefully reduced from the starting value.

In conclusion, our thanks are due to Prof. J. T. Morris for valuable assistance and suggestions, and to the staff of the Electrical Engineering Department of East London College, where the above work was carried out.

DEFINITIONS OF PHOTOMETRIC MAGNITUDES AND UNITS.

The following definitions were embodied in the 1910 report of a Sub-Committee on Photometric Units of the Committee on Nomenclature and Standards of the Illuminating Engineering Society of New York. This report was submitted at the Baltimore Convention, and is reproduced from the "Transactions" of the Society. The Sub-Committee consisted of Messrs. A. Blondel, A. E. Kennelly, E. L. Nichols, E. B. Rosa and C. H. Sharp.

Light (flux) is the stimulus produced by radiation which excites vision. It is proportional to the rate of flow of radiant energy and to a stimulus coefficient which depends chiefly on the spectral distribution of that energy.

The presence of a flux of light is recognised by the *illumination* which it produces. The illumination is proportional to the flux per unit area of the illuminated surface or to the flux density incident on that surface.

The *luminous intensity* of a point source of light is measured by the luminous flux per unit solid angle in the direction in which the intensity is taken. Two point sources of light are said to be equal in intensity when they produce equal illuminations at equal distances. Due to the fact that standardised point sources of light of unvarying intensity are obtainable, while it is not practicable to obtain a standardised luminous flux or a standardised illumination without a standardised source of light, the unit of luminous intensity has become the fundamental photometric unit from which the values of the unit of flux, of illumination, &c., are derived; that is, the unit of intensity is the fundamental photometric unit, although flux is the fundamental photometric magnitude.

The unit of luminous intensity is the *candle*. By candle is meant the common candle of Great Britain, France and America, for which the name "International Candle" has been proposed.

The term "candle-power" is used as the equivalent of the term "luminous intensity in candles."

The unit of luminous flux is the flux of light produced in a unit solid angle (one steradian) by a uniform source of one candle placed at the apex of the angle. This unit is called the *lumen*.

The unit of illumination is the illumination which is produced by a flux of one lumen falling on a unit plane area. This is equivalent to the illumination produced by a source of one candle at unit distance.

The unit of illumination in the c.g.s. system is the lumen per square centimetre. As a practical unit the milli-lumen per square centimetre is recommended.

In English-speaking countries the unit of illumination commonly employed is the "foot-candle" (lumen per square foot). This designation is preferable to "candle-foot." The corresponding metric unit "metre-candle" (lumen per square metre) is called the *lux* (plural lux). It is desirable that all values of illumination should be expressed in terms of lumens per unit area, the unit of area being chosen in accordance with the requirements of the situation.

By the *specific intensity* of a luminous surface or body is meant its apparent luminous intensity per unit area, expressed in candles per square centimetre of apparent area, or area projected on a plane perpendicular to the direction in which the measurement is made and including only a surface of small dimensions in comparison with the distance at which the measurement is made.

By the *specific radiation* of a luminous surface or body is meant its total luminous flux per unit area expressed in lumens per square centimetre or milli-lumens per square centimetre.

By *mean spherical intensity* of a source of light is meant the average value of its intensity as taken in all directions in space. It is equal to its total luminous flux in lumens divided by 4π.

By *spherical reduction factor* of a source of light is meant the ratio of its mean spherical intensity to its mean horizontal intensity.

The names of these units in the c.g.s. system and their mathematical relations to each other are shown in the accompanying table:

Photometric magnitudes.		Name of unit.	Equation of definition.
1. Intensity of light or strength of luminous source.		(International) candle	$I=\frac{dF}{d\omega}$; $I_s=fI$.
2. Luminous flux.		Lumen	$F=4\pi I_s$; $F=I\omega$.
3. Illumination	Specific flux or flux density.	Lumens/cm² or Millilumens/cm²	$E=\frac{F_i}{S}=\frac{I}{r^2}$
4. Specific radiation	Specific flux or flux density.	Lumens/cm²	$R=\frac{F_s}{S}=mE$
5. Specific intensity	Brightness.	Candles/cm²	$i=\frac{I}{S^*\cos e}$
6. ——		Lumen-hours or lumen-seconds	$Q=FT$

International candle abbreviated to C.
International lumen abbreviated to L.
Hefner unit abbreviated to HK, as now used in Germany.
f is the spherical reduction factor of a light source.
ω is a solid angle $=\frac{\text{area on a sphere subtending the angle.}}{\text{square of radius.}}$

r is distance from light source in centimetres.
m is coefficient of reflection or radiation ($1-m$ = absorption).
S is an area in square centimetres.
e is angle of emission.
i is an angle of incidence.

* S refers to surface seen from the point at which I is taken.

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THE DUNSTON POWER STATION OF THE NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY CO.

(*Concluded from page 500.*)

Switchgear.

The switchgear arrangements at Dunston are perhaps the most interesting part of the station, showing, as they do, a distinct advance upon previous practice. Instead of the usual elaborate switchboard which forms a striking feature of most power-house engine rooms, the Dunston engine room, as mentioned above, contains practically no high-tension switchgear or electrical instruments at all. With the exception of certain unobtrusive high-tension panels of the "iron-clad" type, which control the "unit" transformers that supply the auxiliaries belonging to each generating unit, and an indicating wall ammeter for each generator, the high-tension gear and instruments are installed in a separate switch-house 150 yds. away from the engine room, where are also placed both the main switches themselves and the operator and board operating them.

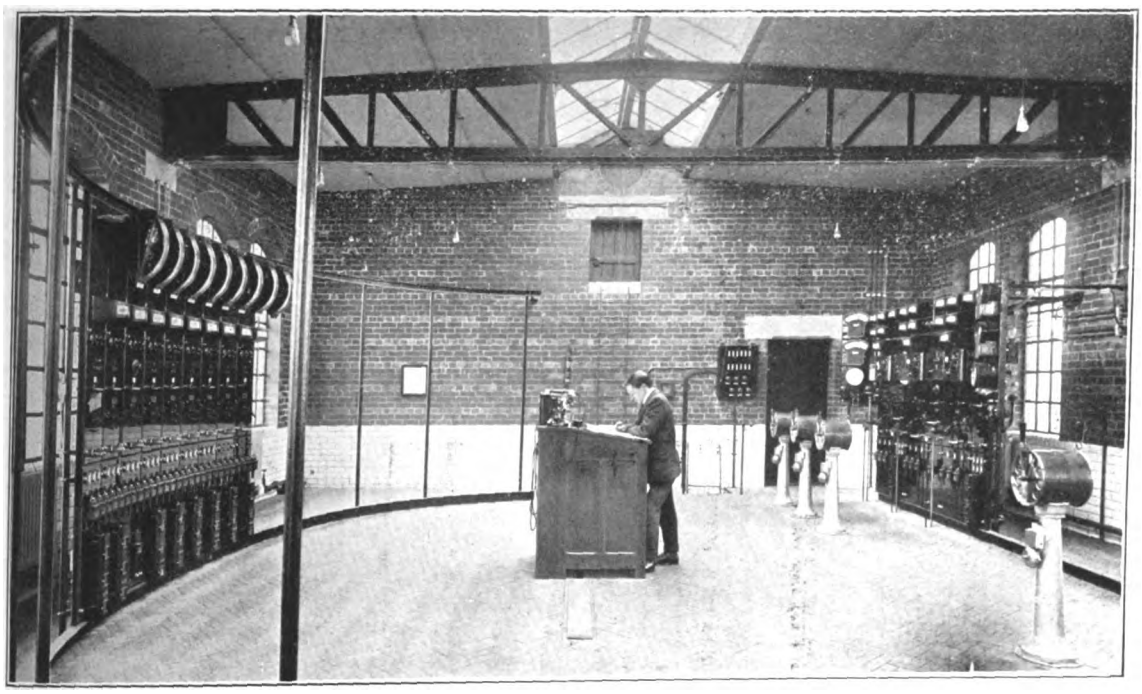

Fig. 11.—View of Switch Control Room.

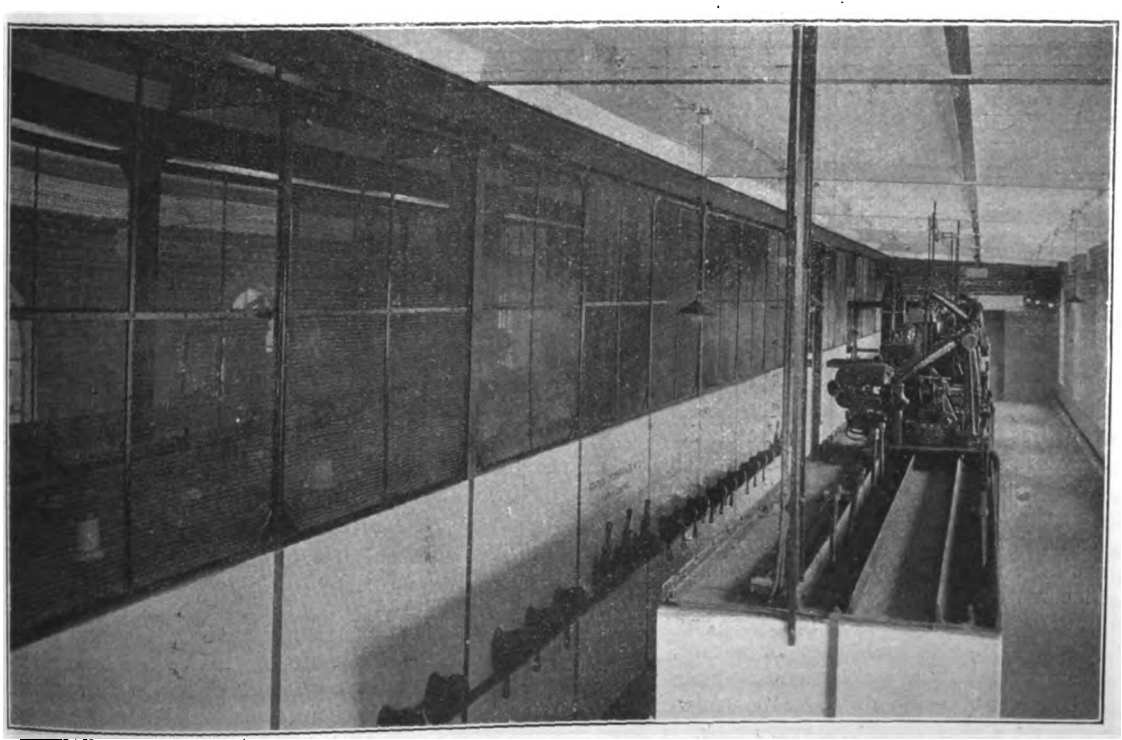

Fig. 12.—Switch-Room, showing 'Bus Bars and Operating Gear.

There is, however, in the engine room near each generator, a set of emergency gear for tripping the main high-tension generator switches in the switch-house, with which is inter-

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locked a field switch; there is also a large dial indicating ammeter to show the approximate load on each alternator. Apart from these and the direct-current gear for the motor generators, there are practically no electrical connections or cables visible at all the ducts, &c., for the whole of the wiring having been provided for in advance they are therefore properly hidden.

The general electrical conditions of the Newcastle-upon-Tyne Electric Supply Co.'s system are as follows:—Electrical energy is generated at 5,750 volts on the three-phase system and is fed into the network where it is transformed up to 11,500 or 20,000 volts, or down to 2,875, 600 or 440 volts; Dunston station has to run in parallel with various other stations.

The switchgear may be conveniently considered under the following heads:—The control board (Fig. 11) in the switch house for operating the high-tension switchgear in the switch house and the engine room; the main high-tension switchgear in the switch house which controls the generators, pole, oil break, neutral isolating switches and resistances, three sets of emergency tripping gear (breaking the exciter fields in the control room), three wall dial current indicators, while in the control room are the necessary boards and switches for operating all the high-tension gear.

The low-tension 440-volt three-phase gear consists of two transformer panels, two lighting motor generator panels, one traction rotary converter panel and three feeder panels for supplying three "unit" distribution boards.

The principal direct-current gear consists of one 500-volt traction board, one 100-volt power and lighting board, one main lighting distribution fuse-board, ten local distribution boards, one lighting battery panel (in the lighting battery room) and two control battery fuse panels (in the control battery room).

The switch house is a brick building with concrete roof, 89 ft. 3 in. long, 29 ft. 6 in. broad and 22 ft. 8 in. high. It has two floors and is divided into two divisions. The front of the building contains on the ground floor the offices, lavatories, &c., for the

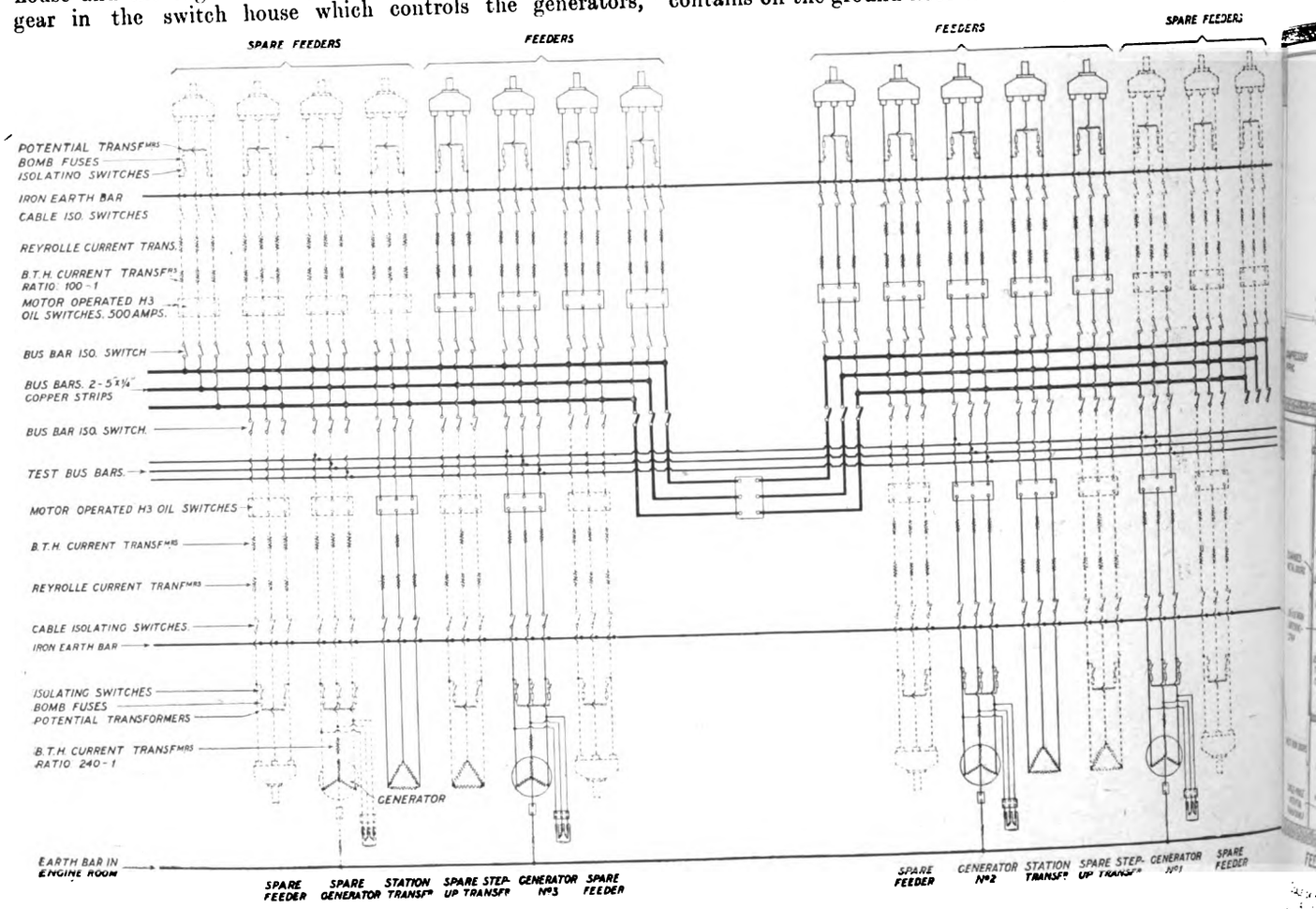

FIG. 13.—DIAGRAM OF E.H.T. MAIN CONNECTIONS.

feeders, main 'bus bars (Fig. 12), and the station power and lighting transformers; the high-tension switchgear in the engine room for controlling the "unit" transformers in the engine room, the low-tension three-phase gear in the engine room controlling the auxiliaries; the direct-current switchgear for exciting, the lighting and battery charging arrangement and locomotive driving.

The following is the principal high-tension (6,000 volts) gear at present installed:—In the switch house three complete 1,200-ampere generator panels and one skeleton panel, eight complete 6,000-volt 500-ampere feeder panels with protective gear, one feeder panel without protective gear, 11 500-ampere skeleton feeder equipments, two 1,200-ampere skeleton feeder equipments, two 500-ampere power and lighting transformer panels, one complete and one skeleton 2,000-ampere 'bus-bar section panel. In the engine room there are three 100-ampere ironclad panels for unit transformer, three 500-ampere single-

control room engineer. The control room itself contains the operating boards and is on the first floor. The back part of the building, which is shut off by iron doors from the remainder, is devoted to the switchgear itself, the main oil-break switches and 'bus bars being on the upper floor, the isolating switches, current and potential transformers, &c., being in brickwork cells on the lower floor. The bare connections between the switches and 'bus bars are on the underside of the roof of the lower room, but are in full view and accessible from the lower room by means of ladders. On the other hand, they are absolutely out of reach of accidental contact.

The control room (Fig. 11) is a well lighted apartment, 40 ft. by 29 ft. 6 in. with partial glass roof. It is mainly occupied by the semi-circular operating switchboards by which the feeders are controlled and by the smaller boards for generators. The operating board of black slate is divided into sections, the generator and transformer panels and 'bus-bar switches being

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placed separately from those controlling the feeders. With a view to simplicity and safety the connections to the various operating panels are arranged so that it will be possible at any time to change the position of any individual operating panel to any other position on the semi-circular range of the board. The control gear is operated by means of direct current at a pressure of 100 volts, which is from a small battery specially told off for the purpose. The general arrangement of the extra-high-tension connections is shown in Fig. 13.

There are three generator panels and one "skeleton" equipment. Each 6,000-volt generating panel on the control board contains the following instruments: One main ammeter and voltmeter, one power-factor indicator, one indicating wattmeter, one field ammeter, one integrating wattmeter for measuring on unbalanced loads. There are also one operating switch for the main oil-break switch, two pilot lamps for indicating the operation of this switch, as well as a synchronising and voltmeter plug, three-pole overload protective devices, chop-over type and is arranged to make or break the main oil-break switch immediately contact is made. Its position is indicated by the lighting of a red or blue lamp and when the circuit is broken the operation is automatically indicated by the position of a small coloured pin in the switch panel.

Switch Room.—As already mentioned, the switch room itself is a two-storey building. Access to the upper storey or switch gallery is obtained through an iron fireproof door leading from the control room; access to the lower storey is from the passage way under the control room. The 'bus bars and main oil break switches are in the switch gallery and the isolating switches, 'bus-bars connections, current and potential transformers, &c., on the lower storey, as will be noticed in Fig. 14.

The switch gallery is arranged as follows:—Three moulded stone tables run parallel to each other down the length of the gallery being continuous except for a space some 6 ft. or 7 ft. wide in the middle. The main 6,000-volt 'bus bars are placed on insulators on the central table which is 5 ft. 5 in. high and is

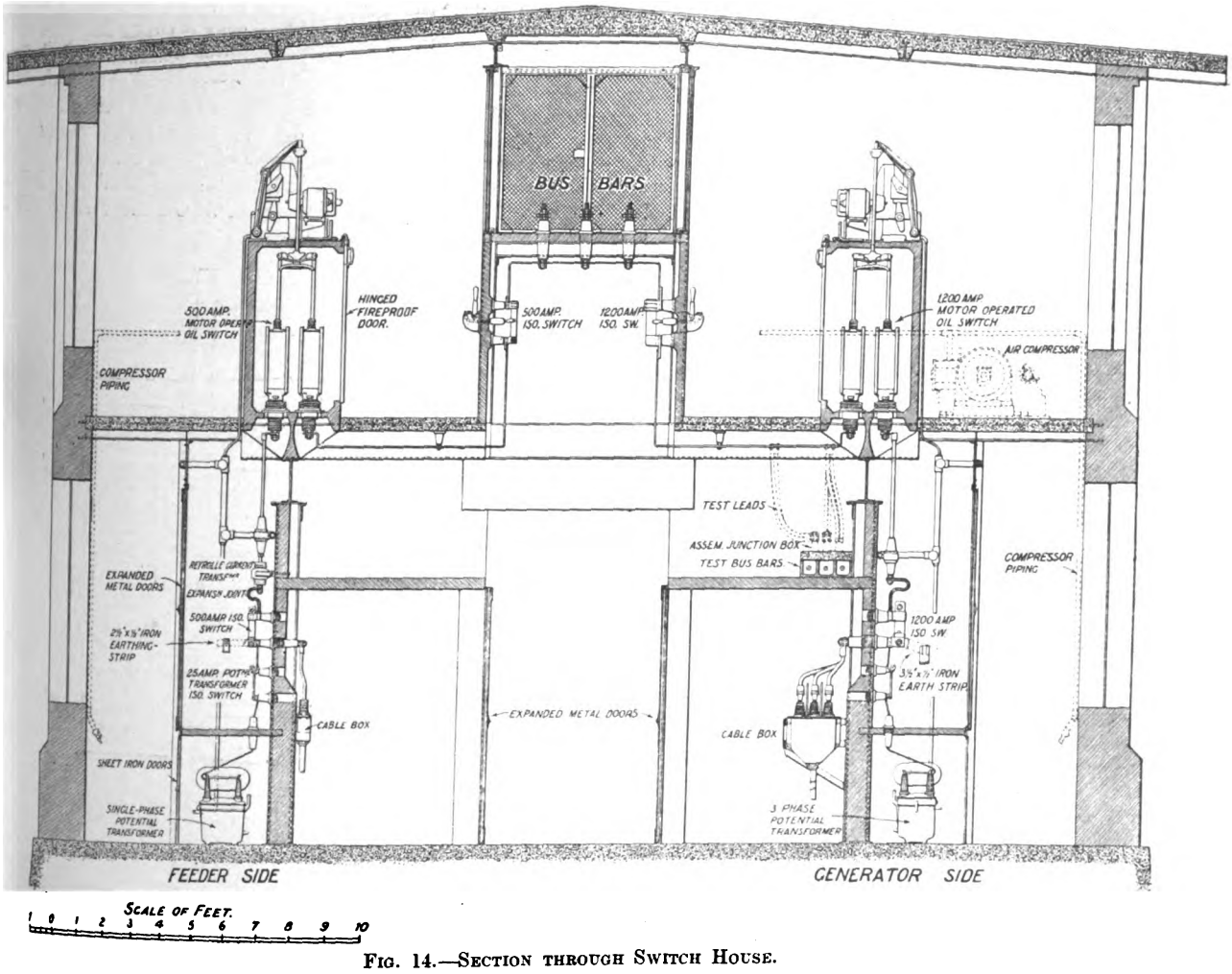

FIG. 14.—SECTION THROUGH SWITCH HOUSE.

three time limit fuses, one governor switch and one rheostat hand-wheel. In front of each generator panel stands a telegraph which communicates with a corresponding instrument in the engine room. At each end of the generator board is a synchronising panel with two voltmeters, two lamps and a rotary synchroscope.

In the same way, as described above for the generators, each feeder has an operating panel on the feeder control board. This panel contains an edgewise ammeter, a voltmeter, an operating switch for the main oil-break switch, two pilot lamps, red and blue, for indicating the position of the control switch, synchronising and voltmeter plugs, three time-limit fuses and three-pole Reyrolle protective relays.

Eight of the feeders are fitted with the Merz-Price balanced protective gear with time-limit relays, in parallel with the three fuses mentioned above. The control switch is of the protected by expanded metal screens throughout the whole of its length. They also run up to the ceiling, thus forming a cage in which the 'bus bars are visible for their whole length but are quite inaccessible unless the metal screens be removed. The bolts supporting the 'bus bars on the insulators also form the connections to the main switches. They pass through the top of the table which forms part of the ceiling of the chamber underneath. Along this ceiling are run the bare copper connections to the under sides of the switch tables. Along the sides of the central 'bus-bar tables are arranged the handles of the isolating switches, these, however, being only accessible from the chamber underneath. The 'bus bars, which consist of strips of copper 2½ sq. in. in section, and the tables and cage containing them are divided in the middle of the room by a main oil-break switch which is capable of opening on a load of 30,000 kw. This switch is illustrated in Figs. 15 and 17 here-

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with, and its operating gear in Fig. 16. The connections from the two sections of the 'bus bars to this switch are taken down through isolating switches under the floor along the ceiling of the chamber underneath and then up to the switch. The three isolating switches for each circuit are capable of being locked in the "off" position.

The other two tables also run the length of the room on each side of and parallel to the 'bus-bar table, and are also ivided in the middle, making, in fact, really four tables in all. Each of

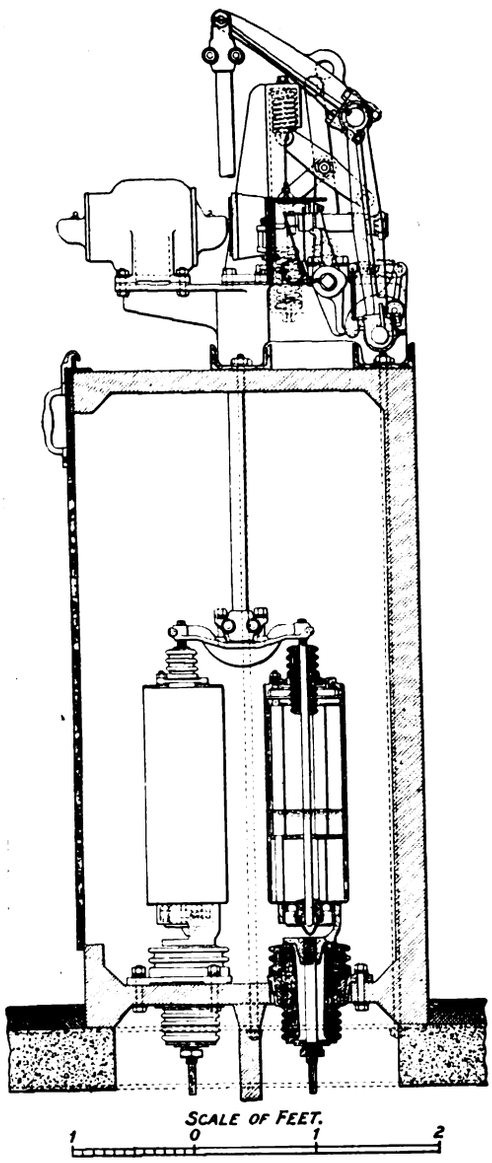

FIG. 15.—GENERAL ARRANGEMENT OF 30,000 KW. 6,000-VOLT 'BUS-BAR SECTIONISING SWITCH.

these tables is divided into eight cells, and each cell is divided into three compartments that contain the three portions of the oil-break switches. The motors and operating gear for each oil-break switch are placed on the top of the cell, and are left unprotected, since no part is alive. The fronts of the cells are protected by "uacolite" doors which are hinged so as to allow the escape of any hot air in case of explosion. From the lower part of each oil-break switch a connection passes through an insulator to the ceiling of the floor below, across which it is carried to the isolating switches and 'bus bars already described. The two tables on the left-hand side of the room are entirely devoted to feeders, while those on the right side of the room contain five skeleton feeder panels, one skeleton generator panel, three generator panels and two transformer panels, all of the same size. Each main high-tension switch panel is of the same size and is arranged so that it is exactly opposite its own portion of the 'bus-bar and its own 'bus-bar isolating switch, an arrangement which reduces the risk of a mistake to a minimum. For each generator, feeder and transformer there are three identical 'bus-bar isolating switches and a three-pole motor-operated main oil-break switch in the switch gallery. Nine complete feeder panels are already installed, and provision is made on the 'bus bars for 11 further feeders, each of 500-amperes capacity, and for two feeders each of 1,200-amperes capacity. The switches already installed with the exception of the 'bus-bar dividing switch, are identical in size and design. The whole of the chamber is painted white and is lighted by side windows, the roof being solid concrete. There is ample space to pass round all the switches, and the room is well illuminated. It is, moreover, perfectly safe from accidental contact with any current-carrying parts.

On the ground floor there are three passage ways corresponding to the three tables in the upper room. The central passage has on each side brick-work cells corresponding in number and position to the different high-tension switches exactly below which they are placed.

The various three-core feeder and generator cables enter from outside the switch house and are brought up through the floor of these cells to a three-way dividing box from which the three single cables are led to three separate terminals fixed on insulators on the vertical brick-work wall at the back of the cell. These terminals and insulators extend through this wall to the isolating switches on the other side. The two side galleries also contain a series of brick-work cells, the top portion of which is closed in by expanded metal doors and the lower portion by sheet-iron doors. On the vertical wall at

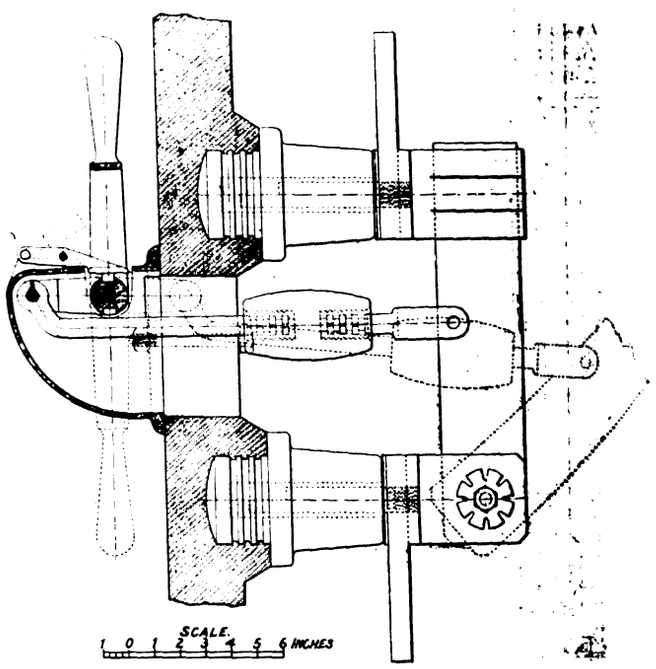

FIG. 16.—OPERATING GEAR OF ISOLATING SWITCH.

the back of these cells are fixed the three single-pole isolating switches already referred to, the lower terminals of which extend through the wall to the cables. The upper terminal is connected by an expansion joint to a vertical copper rod carried straight up to the lower terminal of the oil-break switch through a current transformer for operating the protective gear and another current transformer for the ammeters. From the lower side of the isolating switch connections is taken a smaller isolating switch to the potential transformer which itself is situated in the lower part of the cell under a brick-work cover but accessible from the front by the removal of the sheet iron door. The current, after passing through the outer terminal of the oil-break switch descends by the inner terminal through a moulded stone-work division between the two terminals and is carried by bare conductors across the roof to the central part of the chamber, where it is bent upwards and passed vertically through its own 'bus-bar isolating switch to the lower side of its own 'bus-bar terminal.

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These arrangements are specially interesting as representing the latest designs for the protection from breakdown of switchgear and high-tension circuits. Solid earthing connections are carried throughout the upper and lower chambers to the metal work and cases of all switches, transformers, &c. A set of special test 'bus bars, which are laid in solid, are run the whole length of the lower chamber and out to the test pond; and arrangements have been made for temporarily connecting these leads to the various generators. Broadly speaking, all the panels are of the same kind, the feeders, generators, power and lighting transformers all having their main oil-break switches and single-pole isolating switches between the 'bus bars, and between the cables and their corresponding panels on the control board in the control room. The isolating switches, it will be noted (*see* Fig. 16), are designed to ensure that they shall not be thrown out by the magnetic forces exerted by heavy currents. The 'bus-bar isolating switches are operated as already stated by fixed and link-work handles from the upper gallery, while the lower isolating switches can be operated when required by long wooden handles. The main oil-break switches have their main contacts outside the oil as well as a renewable breaking contact under the oil. They are arranged so that the motors wind up a spring for each make or break, and they are therefore tripped immediately the control circuit is made. The switch can be locked when open. The potential transformers on the generators are of the three-phase type, while those on the feeders are single-phase. All the high-tension panels with the exception of the transformer panels are provided with the Merz-Price system of balanced protective gear.

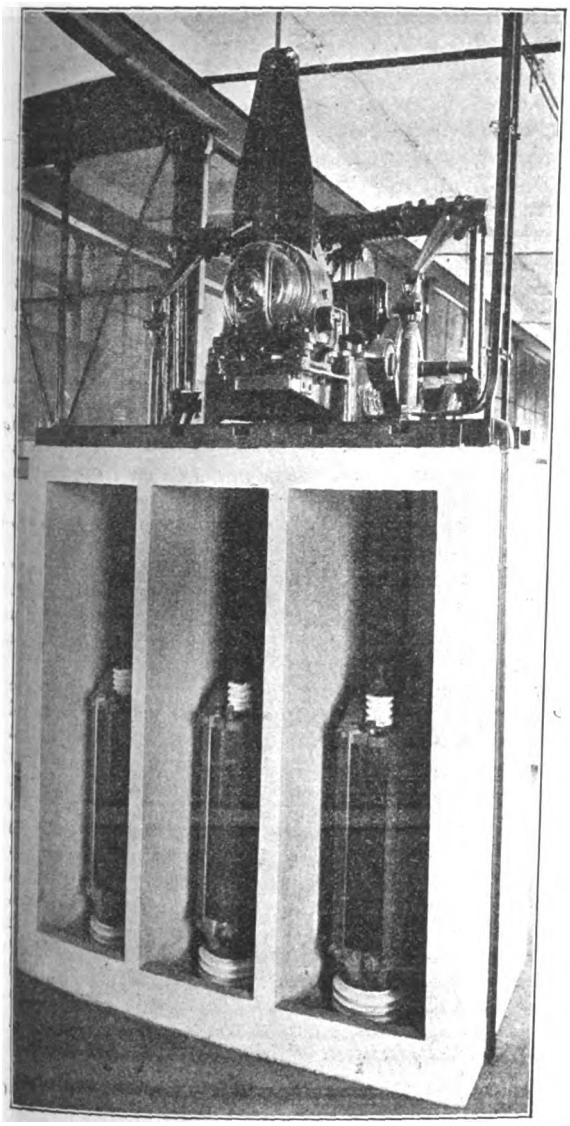

Fig. 17.—30,000 kw. 'Bus-Bar Sectionising Switch.

In the engine room, as mentioned above, there is, in addition to the switchgear already described, a 500-ampere neutral isolating switch and resistance equipment for each generator; and a set of emergency tripping gear for operating the main oil-break switch in the switch house in case of serious emergency. Interlocked with this there is also an extra field switch. On the wall of the engine room there is an indicating ammeter opposite to each generator. Each generator also has its own unit transforming set in the transformer annexe in the engine room. The leads for this transformer do not pass through the switch house but are taken direct from the generator terminals through ironclad switchgear of the Reyrolle type in chambers on the northern side of the engine room to the transformers.

Conclusion.

The above description shows sufficiently, we consider, that while no more money has been spent on architectural features than is absolutely necessary, every care has been taken with the engineering work at Dunston station to ensure that it shall carry out satisfactorily the work it has been designed to do. The design of the switchgear is a distinct advance on usual practice, as it will enable the operator to pay full attention to the work he has in hand, undisturbed by anything that may be going on in the engine room. We have to thank Messrs. Merz and McLellan, the consulting engineers, and the officers of the Newcastle-upon-Tyne Electric Supply Co., for giving us the opportunity of describing this interesting plant.

At the formal opening of the Dunston power station on Wednesday last week, visitors were given an opportunity also of inspecting the Carville power station of the Company. Subsequently the party proceeded to Tilley's Rooms, Newcastle, where luncheon had been provided, Dr. J. T. Merz presiding.

After the royal toast had been duly honoured, the chairman introduced Mr. S. Z. de Ferranti, who, he said, had devoted his life more than anyone else to the problems connected with power transmission.

Mr. Ferranti, in proposing the toast of "Electric Power Supply," remarked that in looking over the district of the Tyne and finding hardly a single smoky industrial chimney, they had seen the signs of what he believed was the greatest industrial development that had taken place in any country since the introduction of factories. The Newcastle Electric Supply Co.'s undertaking was a model to the rest of the country of the way in which they should proceed in their industrial and commercial development. Electricity was the greatest labour saver; the net result should be a higher standard of living and more spare time for the worker.

The Chairman acknowledged the toast and then proposed "The Mining Industry," coupling with it the name of Mr. A. Pease, J.P., who, in reply, said that the one redeeming feature in the mining industry was the prospect of getting cheaper electricity.

CONFERENCE ON EDUCATION AND TRAINING OF ENGINEERS, 1911.

(*Continued from page 505*).

SECTION III (Practical Training).

The following Paper by Mr. W. H. Allen was also read:—

THE REQUIREMENTS OF PRACTICAL TRAINING IN WORKS, WITH THE NECESSARY COMPLEMENT OF SCIENTIFIC STUDY.*

BY W. H. ALLEN.

During recent years we have seen a great change in ideas as to the value of engineering apprenticeship. The obvious cause of this change is the now generally-recognised principle that the period of apprenticeship must be combined with a period of college training, either before or after apprenticeship. The original idea of a seven

* Abstract.

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years' apprenticeship in a workshop only lapsed in the 'sixties. Since that time a period of five years has been considered as usually desirable, but now that it has become necessary for a young man to devote a considerable period, in addition to his apprenticeship, to scientific study at college or the university, it has been found necessary to curtail the period of works' apprenticeship.

I think it is now fairly certain that no man can expect in future to take a good position in life as an engineer without having equipped himself for his work by taking advantage of the best that our age can offer in the way of scientific training and opportunities for scientific study, as well as by a period of apprenticeship in practical engineering under commercial conditions. If he has not done so he will find it exceedingly difficult to compete with the man who has thus availed himself, and who has gained a clearer insight into those principles which form part of his work, and also developed those faculties of clear thinking and accurate reasoning which are so invaluable to an engineer.

In spite of this very important development one must not disparage the value of the workshop apprenticeship, as it is so often the lot of the engineer to have to deal with quantities of which we have, as yet, very little accurate knowledge. Problems of this nature are of almost daily occurrence in practical work; hence experience of them at the present state of knowledge must be gained by personal contact with them. In this connection it should be remarked that much of the value of scientific training and study for the engineer is more of an indirect nature than the mere acquisition of certain mental tools and equipment, and consists very largely in the value of such studies as a means to mental development, so as to enable the engineer to face any difficulty with an open mind, whose power of insight has been sharpened, and which has been trained in methods of accurate reasoning and logical deduction.

One is often asked, in the case of a student determining to go both to college and to works, which he should enter first. My views on this point are that a schoolboy coming direct to the works does not succeed so well or stand the same chance as the one who has been to college first. The latter has been better broken in, as it were. He has been formed in character by association with others of the same age in like pursuits, has learnt the value of time, and to recognise the serious side of life, and those qualities which tend to manliness, and has also received training in mental development. Much economy in time is also effected by preserving the continuity of study. I should, therefore, say that the man who sets himself the task of obtaining his degree before entering the works stands a much better chance of securing a higher and more responsible position in life than the one who is trained in the reverse order. The former not only takes a greater and more complete interest in the works and workshop life, but makes the most of his time, and grasps ideas and their principles much more readily than the man who comes to the works with merely a public school training.

Another question frequently asked is, "How much study should a pupil undertake during the period of his practical training?" In my opinion, if a young man conscientiously does his duty from 6 o'clock in the morning until 6 in the evening, he will find that as much as his health can stand, without burdening it by further serious study at night. At the same time, unless some attention is paid to the work which has been done at college, this part of his studies is apt to lose its freshness and interest for him, his attention being concentrated purely on his daily task to the exclusion of everything else. My custom has been not to make this a compulsory part of the training, but to give lectures weekly explanatory of the actual work being carried on in the shops, thus greatly increasing interest in and adding to the knowledge of the work being done.

It must be remembered that the workshop to-day, involving as it does so many different classes of measurement, the use of instruments, and more elaborate styles of drawing—all necessitating a much higher educational standard throughout the works—requires a man of more thoughtful age and education to enter fully into his workshop apprenticeship than was formerly the case. A college training, moreover, must inculcate that habit of accuracy of thought which cannot be obtained in any other way.

As regards the requirements of workshop training, there seems little doubt that a period of three years—the actual time depending on the previous education of the subject—comprising a year in the drawing office, should be spent in the works in a not too specialised manner—that is to say, it should cover work in some or all of the branches of mechanical and electrical practice, which may be found in some of our better establishments. So long as this part of an engineer's training has to be carried out under commercial conditions, so long will it be more or less dependent on the state of trade and other local conditions. This is not altogether a disadvantage, for the alternating periods of exceptional activity in trade, and the reverse, will carry their own important lessons to the observant student.

It will always be difficult, if not impossible, to lay down a plan either for scientific study or works' apprenticeship which will suit all, and each individual case will require consideration on its merits: at any rate, whatever plan is arrived at will have to be very elastic as regards the arrangement of details. I think we are inclined at present to attach rather too much importance to the direct value of scientific study as being the means of providing the student with certain mental tools for use in after life, and too little to the indirect side to which I have already referred—*i.e.*, the development of the mental faculties generally, and the cultivation of a true scientific insight. Without a systematic training, sole reliance must be placed either on continued experiment or on a highly developed instinct of discernment, in order to diagnose what must then be invariably regarded as phenomena.

Papers by Mr. W. B. Worthington and Sir H. F. Donaldson, K.C.B., were next considered. An abstract of them is given below:—

PRACTICAL TRAINING IN WORKSHOPS OR ON WORKS OF CONSTRUCTION, WITH SPECIAL REFERENCE TO TRAINING IN THE ENGINEER'S OFFICE.

BY W. B. WORTHINGTON, B.SC.

Practical training for the man who is to become an engineer—a member of a profession—necessarily includes two distinct things. On the one hand, during that part of his training spent upon works, he must, by observation and by taking some part in the work, acquire a knowledge of engineering operations, of economical methods of carrying them out, and of the time required for the purpose, as well as of the qualities and disposition of materials most suitable to meet varied circumstances. While so engaged, although he cannot, of course, during the short period of his training acquire anything approaching a sufficient knowledge of this side of his professional work, he will, if he is afforded fair opportunities and makes full use of them, lay a sound foundation on which further experience may be built up. Upon works of construction it is not necessary for the young engineer to do actual manual work, as is required of him if he is to gain a proper knowledge of the making of machines, but by availing himself of his opportunities of observation he will acquire that practical knowledge of construction which is essential to him in projecting and designing works.

Engineering as an art and profession is based upon the matter of design. It is true that even large works may be carried out by rule-of-thumb or by blindly following tradition, but the engineer in carrying out such works will make them the realisation of a pre-conceived and carefully regulated design.

There is some danger, possibly arising out of the very practical attitude adopted in this country towards engineering works and our national preference for results as compared with projects, that the importance of training in designing works under practical conditions may be lost sight of. It is with a view to check any tendency in this direction that the Institution has recently drawn attention to the necessity for every young engineer spending a substantial part of his training period in the engineer's office as well as in or upon the works. However good a man's training and experience on constructional works or in the shops may be, it will not, without experience in the engineer's office, make him a civil engineer, although it may make him a good mechanic or contractor. Mr. Ellington—dealing with the mechanical branch of the profession—in his presidential address to the Institution of Mechanical Engineers, illustrated most excellently the need for the combination of the works training with office training in the education of the engineer. He says:—"The great difficulty is to distinguish between a mechanical engineer and a good artisan on the one hand and the commercial man on the other. A very large number of men are employed in various capacities as managers, draughtsmen, engineers-in-charge, foremen and others who have really no ground for being considered mechanical engineers, but who in considerable numbers seek admission into our Institution."

During his term of office training, whether he be there as a pupil or as an assistant under agreement to serve for a term of years, the man who is to become a civil engineer should have the opportunity of becoming familiar with as great a variety of work as possible. He must gain experience in draughtsmanship and design, specifying, costs and estimating. On the other hand, the mere fact of being a member of the staff in an engineer's office will not train a man to be an engineer. He must, while in the office, see and deal with as many aspects and varieties of the work as possible, and he must, above all, have his training in or upon works, otherwise he may become a draughtsman, surveyor, clerk or commercial man, but will not become a civil engineer; just as, on the other hand, he may spend his time of training on or in works, and may become a skilled mechanic or a resourceful contractor, but without varied office experience he will not become a civil engineer.

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PRACTICAL TRAINING IN WORKSHOPS OR ON WORKS OF CONSTRUCTION, WITH SPECIAL REFERENCE TO TRAINING IN THE ENGINEER'S OFFICE.

BY SIR H. F. DONALDSON, K.C.B.

With regard to general education anterior to the definite commencement of theoretical and practical courses, the author desires to touch on one or two points such as the importance of knowledge of modern foreign languages, for which he is of opinion that Latin forms an excellent groundwork; geography, physical, geological and ethnological; history, both of the world and of our own country; and literature, the love of which will frequently be found to be not only very valuable from a professional point of view, but extremely so for purposes of relaxation. To these he would add the more or less scientific study of accounting and book-keeping and allied commercial subjects.

The time available for the acquisition by a young engineer of his theoretical and practical education must very largely determine the completeness of these studies. The author thinks it cannot be properly effected in less than six years, or perhaps it would be safer to say seven years—that is, three years for theoretical study and three or four years for practical training. There should be no specialisation in the study of the theory, as such education should be as wide as possible. The question of specialisation does, however, make itself apparent in regard to practical training, because shortness of time available is so large a factor in the case. This fact may help in arriving at a decision on a subject so often discussed as to the precedence to be given in point of time to theoretical study or practical training. From this point of view, manifestly the theoretical study should precede the more or less specialised practical work. There is much to be said in favour of the proposal put forward by the Committee presided over by Sir W. White, that there should be a preliminary year on practical work directly after leaving school, followed by theoretical study for three years, returning to practical work again for two or more years. On the other hand, it may involve a break in the continuity of mental activity during the preliminary year's practical work, which in some cases it takes time to recover before the student is fit to take his place in the university lecture room. Matriculation before leaving school and evening work during that year would largely correct the mental atrophy suggested, but it is not always easy to give effect to such an intention. Whatever the sequence of the acquisition of knowledge, the author is strongly of opinion that six years represents the absolute minimum period necessary adequately to equip a young engineer, in some, if not most, classes of engineering. This minimum must, in order to comply with the Institution by-laws, be extended to seven years, of which four should be practical and office work.

Assuming, then, that the theoretical work should be taken first, after a year in the workshops, and that it will last three years, there remains the apportionment of the three or four remaining years out of the six or seven years to be considered. To do this it will perhaps be advantageous to consider the divisions of the practical course for each of the leading branches of the engineering profession, taking mechanical engineering, constructional engineering, electrical engineering and shipbuilding and naval architecture, as typical. The author places mechanical engineering first because, in his opinion, workshop practice is essential for all branches of engineering, and he puts the minimum for this course at three years, either all after theoretical knowledge has been acquired, or one year before and two years after that period. For a mechanical engineer he suggests the following apportionment of time:—

Machining	9 months
Fitting	9 ,,
Boiler-shop, erecting, mill wrights, electrical appliances for workshops	9 ,,
Pattern-making	3 ,,
Foundry	3 ,,
Smithy	3 ,,

This, it will be seen, occupies the full three years and is none too long, but it allows no time for office work, either drawing-office or otherwise, and leaves that part of the education to be taken as an extension to the workshop course. In order partially to meet the requirements of the by-laws, the author has arranged the distribution of three years for the young men joining the establishment which he has the honour to direct, as follows:—

Machining	8 months
Fitting	7 ,,
Erecting, millwrights, electrical appliances	8 ,,
Pattern-making	3 ,,
Foundry	3 ,,
Smithy	4 ,,
Drawing-office	3 ,,
	3 ,,

The sequence in which the various shops are taken should, of course, be arranged to suit not only the young man himself, but the nature of the work which is done at particular times in particular shops, and it is to be noted that in the second distribution mentioned, the time in the foundry has been increased by one month, based upon the author's experience of young men serving with him.

A young man so trained is, however, according to the strict letter of the by-laws, ineligible for election as an associate member, because he is unable to show 12 months' employment in an office. The author cannot but feel that a young man trained in the college and through such a course as he has referred to, is likely to become at an earlier stage a more useful assistant than one who has not had so complete a period of workshop practice, and he is unable to see how, with any shorter time, the same result is to be attained in the interests of the individual, the profession and the Institution. The strict reading of the by-laws does not appear to allow the Council much discretion in favourably considering an application from a man so trained who has only reached this stage in his engineering training by the time he is 25. The author understands that the Council have, on occasion, treated such cases somewhat specially, but he hopes that they may be able, in future, to widen such treatment, even to the point of extending the period during which a young man may remain a student sufficiently to allow of his securing the transfer to associate membership without cessation of connection with the Institution.

In the case of constructional engineering, or as it is too frequently called, civil engineering, the author would, in addition to the theoretical education, allot at least 18 months to the shops, with an additional six months for the acquisition of practical electrical experience, and arrange that he should pass into the office for a period of 12 months, or into an office combined with work on construction, which it is assumed would be regarded by the Council as complying with the by-laws. This apportionment of time in the individual shops should, in the author's opinion, follow the same ratio as the period sketched for the mechanical engineer's training, so that some knowledge at least of the requirements of the different shops would be acquired. In this case the young man would comply with the by-laws, but he would be in no really stronger position as an assistant than the young man undergoing the first suggested course for mechanical engineering.

As regards the electrical engineer, the author considers that besides three years' theoretical study, four years' practical training is required—that is to say, two years in the ordinary mechanical workshops, one year in electrical workshops, followed by one year of office experience. Here again the division of time in the mechanical workshops should be made on the basis of the complete mechanical engineer's course. There is in this case the same disability with anything short of four years' practical course as to election to associate membership as in the case of the mechanical engineer.

The same would apply to the Naval architect, where, however, the author would suggest one year in the mechanical workshops, six months in electrical workshops and two years on shipbuilding design, moulding loft and construction. Here again the time in each shop should be proportionate to the total period allowed for this part of the education.

DISCUSSION.

Prof. A. BARR (Glasgow) said every engineer should have a thoroughly good general education.

Mr. A. T. WALMISLEY (London) said in regard to civil engineering it was distinctly advantageous for an apprentice to have some actual workshop experience which he would not get in constructional works.

Prof. G. FORBES, F.R.S. (London) agreed that civil engineers should have workshop experience. Much of the real work of civil engineers was taken out of their hands by mechanical engineers, because of the latter's knowledge of metals and materials. He did not think that a definite time for each branch of training could be arrived at. As to the care of apprentices in the works it required someone above the ordinary workman and he (Prof. Forbes) thought the works manager was the best man to undertake this work. He was strongly in favour of the sandwich system, and, whatever was done at the university, a practical training in a workshop was absolutely necessary.

Sir WM. WHITE, K.C.B. (London) said that in Germany they had started technical training with the idea of sending the lad direct from the secondary school to the university. Ultimately, however, they had come to the conclusion that it was most desirable to break the course of theoretical study and to interpose a minimum period of one year in mechanical engineering workshops. In France the theoretical training was continued up to the age of 21 or 22 and the workshop experience followed, so that the engineer really never caught up the practical side, and most of them now agreed that it would have been better to have taken some practical training earlier.

Prof. LAMBERT (Glasgow) said a mistake could be made in trying to teach the apprentice too much on the technical side.

Mr. E. B. ELLINGTON (London) said they were apparently agreed that a practical workshop course was requisite in the training of an engineer,

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no matter to what branch of the profession he might ultimately attach himself; and even with civil engineering some workshop experience was necessary. The only point at issue was when the practical training should be taken. Taking all the circumstances into consideration it would appear preferable for a lad to go to college first and to the works afterwards. A point that had not been dealt with and which should not be overlooked was that the important point in engineering was economy, and all apprentices should have a practical insight into production cost.

Mr. C. P. Hogg (Glasgow) said from the civil engineering point of view he had for years been considering how best to give a young man a practical training, but had not come to any conclusion. As a matter of fact it depended principally upon the young man himself. It was undoubtedly a great advantage to take the practical training concurrently with the scientific side. Those who went entirely through their college course before going to the workshop did not take kindly to the drudgery of that work.

Mr. A. P. Trotter (London) said the sandwich system presented marked advantages. The profession was constantly changing, and what was advisable in the past might not be the ideal at the present time. The advantage of taking the works course after the college was that the young man was in touch with his work and stood a better chance of finding a job than would a man from college who had taken his practical training previously. As to the principles of prime cost that could, he thought, be taught in the colleges.

Mr. F. O. Everard (Birmingham) said the sandwich system so far as he had tried it had been particularly successful. Otherwise he had found that a college course first followed by a workshop training to be the best for students.

Mr. J. W. Wilson (London) said a great deal depended on the early training of the lad, and this should be followed by a combination of theoretical and practical training.

Thursday, June 29th.

The proceedings on the second day commenced by a joint meeting of Sections II. and III., over which Dr. W. C. Unwin, F.R.S., presided. The meeting opened by some remarks from the chairman, of which we give an abstract below :—

It has been thought desirable by the Council to impose on the chairman of a section the duty of saying some introductory words. I think it may be taken for granted that it is now agreed that engineering training should include scientific instruction and practical and commercial experience. But very divergent views are held as to the relative importance of the different components of such a training and as to the order and duration of each. We must recognise at once that the field of engineering employment is a very wide one, and that different capacities are required in different parts of that field. It is therefore in no way surprising that persons, whose opportunities of observation give them every right to express a definite opinion as to what is best for one special branch of engineering, have arrived at conclusions very different from those held by others, whose field of work has been in a different branch. No system of engineering training can be arranged to meet all special demands, and it is the object of such a Conference as this to find out what is most essential in all courses of training and what modifications are practically possible to meet different cases.

First of all, I think it must be assumed that the engineering education we are specially charged to consider is that of young men whose aim it is to arrive ultimately at a professional status, such a status as membership of this Institution implies. Their hope is to be employed ultimately in the design and control and direction of engineering work. Of course, some of them may fail in capacity or may lack opportunity, and may drift to one of the many commercial occupations allied to engineering, and even there the knowledge they have acquired will be a valuable asset. But at the outset a professional career is aimed at, and the system of engineering education must be arranged to meet that condition. It is probably only by educating many that the few can be found who have the capacity and character necessary to achieve considerable advances and to do work of national importance.

Now, very few young men at eighteen can foresee into what line of employment they may be driven, and consequently the first or undergraduate stage of education must be broad, so as to fit students for widely different spheres of work. Perhaps the greatest defect of engineering education at present is the want of more provision for the higher and more specialised education of the few students of real capacity, discovered in the sifting process of an undergraduate course. In spite of the general acceptance of the view that a study of scientific principles and their application is a necessary preliminary to a practical course in field or workshop, a certain jealousy of college education is still obvious in some practical engineers. While conceding in words that some scientific education is necessary to an engineer, they would, in fact, confine it to very elementary matters. They would greatly restrict the time given to it, and they are disposed to depreciate the value of any higher teaching and even to regard it as mischievous and likely to unfit a man for the strenuous life of the manufacturing workshop.

I believe the idea that a college course unfits a man for practical work is a wholly mistaken one. There may be students who prove unfit for practical work in spite of college education. They would equally fail if their education was purely practical. There may be college courses—I am afraid it must be said there have been college courses—badly arranged, and teachers in colleges less competent than is desirable. But such things are inevitable. Nothing is more certain than that there has been a great improvement of college teaching of applied science in the last 20 years.

An employer who takes into his works college students is, I think, often disposed to expect from them an immediate availability which is unreasonable. It is not the main object of a college course to make a student acquainted with the details of any particular business; that is the proper object of the first year or two of practical work. It is not the main object of a college course to fit students specially for such work as will fall to them while in the lowest rank of the profession. The college course must contemplate the fitting of a student for his whole career and provide him with an intellectual equipment which will only gradually become useful as he rises to higher rank in his profession. The view of the employer who looks only to the immediate usefulness of the student is a short-sighted one.

Nevertheless, a college course is an unpractical and badly designed one if, at the end of it, a student is not more capable and useful from the first, in any type of workshop, than a lad without such a training. The college discipline is bad if he has not much more character and energy than the raw lad. His training has been a failure if he does not pick up the specialised details of any business to which he may be put far more rapidly than an untrained lad. I should like to suggest to those practical engineers who are implicitly if not openly hostile to college training, who would, at any rate, greatly restrict it and who advocate lengthened periods of workshop apprenticeship that they exaggerate the value of such workshop experience as an ordinary apprentice gets. I am not, of course, considering artisan apprentices, but young men expecting to rise to positions of trust. Here and there are works where special trouble is taken with apprentices; but in general apprentices are left to pick up what knowledge they can with very little help, and in many cases, I think, a good deal of their time is absolutely wasted. Some skill of handicraft is no doubt acquired. But the engineer works with his head, not with his hands, and manual skill is of use to him only in very exceptional cases.

I hope I do not in any way underrate the value, to mechanical engineers especially, of that kind of knowledge of materials, of tools, of processes, and of cost, which can only be learned in the workshop. But I think practical engineers forget how little of this valuable knowledge really comes to the works apprentice. The engineer of higher rank who discusses matters with foremen and draughtsmen, who has responsibility for design and cost and who is in a position to know the reason of all decisions, is learning in the workshop all his life, and naturally sets a high value on the knowledge slowly acquired by years of constant and close observation. So high a value that perhaps he ignores the importance of the scientific knowledge which was, somewhere and by some one, applied in bringing his business to a state in which it can be carried on successfully as a mere manufacture. But the knowledge which comes to those in responsible positions is not open to the ordinary apprentice and he learns slowly, if at all, unless he brings to the works such knowledge of principles and methods that he can interpret for himself what he sees. No system of workshop apprenticeship can, I think, be considered satisfactory unless someone is specially charged with care of the apprentices, whose duty it should be to make sure that they have opportunity of seeing a great variety of work and helping them over their difficulties.

I believe employers will find—some of them have found already—that they owe a debt to the colleges, and that the college-trained student will prove, with a minimum of special experience, a valuable assistant, and in some cases the originator of a real advance in practice. I should like to plead that in return the employer might be a little more ready to give college students a year or two years' run of the works, either without remuneration or with a small remuneration just enough for disciplinary purposes. I do not think there would be any loss in the case of a properly trained student, and the employer would in many cases find an assistant worth keeping and promoting.

Next two short Papers were read by Mr. J. W. Horne and Prof. J. E. Petavel, F.R.S., in introducing the morning

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subject for discussion. The following is an abstract of Mr. Horne's Paper:—

THE RELATION OF ENGINEERING EMPLOYERS AND COLLEGES FROM THE POINT OF VIEW OF THE PRACTICAL TRAINING OF COLLEGE STUDENTS.*

BY J. W. HORNE, B.SC.

The Report of the Committee on Engineering Education and Training of 1906, has exerted a very effective influence in improving the system of engineering education and training, and, as a result, the engineering training of the university and college type of to-day is a great improvement on apprenticeship practice existing some years ago. The university and college type of trained engineer is of recent creation, and in every field of engineering his influence is being felt. This type has undoubtedly come to stay, and will be produced by these institutions in ever-increasing numbers.

The consensus of opinion among engineers of experience and standing of the present day appears to be that the youth who wishes to become an up-to-date engineer and have a successful career in the profession, having reached matriculation standard at school, should preserve the continuity of theoretical study and proceed at once to university or college for two or more years. Many engineering employers, during the last few years, have recognised that systematic scientific education of the modern university and college type is very essential to the future progress of engineering science, and in consequence have extended sympathetic assistance to college students by granting them facilities to obtain practical experience in their workshops, in order that they might have the opportunity to build up that "engineering instinct" which is so necessary to become a successful engineer. The authorities of the universities and colleges, also recognising the necessity for this workshop period after the completion of the college course, endeavoured, and with very considerable success, to arrange with a number of engineering firms in the industrial centres in which they are situated to co-operate with them in granting college students the privilege of this workshop training. But what strikes one, after a careful study of the apprenticeship schemes as arranged by the college authorities, is that the co-operation between college and employer is not sufficiently definite, as will be seen from the following, taken from the scheme of one of our best organised colleges:—"Students who desire to serve their apprenticeship with one of the after-mentioned firms must communicate direct with the firm and make their own arrangements." By this system it is possible, and, as a matter of fact, in my own experience in many instances it has happened, that suitable students, possessing the necessary personality and "engineering instinct," will lose much time, after leaving college, through having been unable to make arrangements to proceed to their practical training at once, and that others will have promising engineering careers blighted by being unable, through lack of influence and means, to arrange for their practical training. It is an undoubted fact that only a certain proportion of engineering students who finish their college course successfully are suitable to proceed to the workshop for practical training, and the purpose of this note is to suggest an arrangement to ensure that engineering employers shall be asked to give facilities for the practical training of only the most suitable students.

The professors of engineering subjects in the universities and colleges are, as a rule, qualified engineers, who have had considerable experience of works' practice, and, in consequence, they are in a unique position, after three years' close contact with the students, to select the most suitable, from the point of view of ability, personality and grit, to take full advantage of their years of workshop practice, and this method of selection would ensure that want of influence, poverty, or social circumstances, would be no bar to a suitable student completing his engineering training. The selection could be made before the completion of their course and arrangements made so that no time should be lost.

In the provincial industrial centres it would seem to be a not very difficult problem to arrange for a close and definite co-operation between the engineering employers and the heads of the engineering departments of the colleges on the above lines, in view of the fact that the "civic" universities, such as Manchester, Birmingham, &c., and the technical colleges, such as Glasgow, have been built and richly equipped by contributions from the local captains of industry, who in this way have shown a living interest in the advancement of scientific training. The governors of these provincial colleges, in order to have the education thoroughly in keeping with the advance in industrial methods, have adopted a liberal policy in their methods of management, and in order always to be in close contact with the various industries in their district, they have adopted the wise policy of co-opting leading representatives of the various firms to act on the committees of each department. It would appear, therefore, to be a simple matter for each centre to form a strong committee, in connection with the college, composed of these influential representatives and the heads of the engineering departments. The duties of this committee would be:—To consider the selection of students made by the professors; to make arrangements with the firms who are willing to grant facilities for practical training to start these immediately on the conclusion of the college course; to arrange that recommendation 9 of the Report is carried out as far as possible; and to induce a still greater number of firms to grant such facilities.

The question of an arrangement on the same lines between the colleges and polytechnics in London and engineering employers is much more complicated and more difficult to solve. In London a number of unconnected colleges and polytechnics came into existence during the latter part of the nineteenth century, due in a great measure to the subsidising of engineering training by the wealthy and generous City companies, with the result that there is not as yet any central governing body who could act in unison with the various colleges and with engineering employers in London and the provinces to arrange for the practical training of all the most suitable students educated in the London colleges. In consequence of this condition of affairs, each college has had to make its own arrangements, with the result that many capable students have been unable to arrange for their practical training. The Imperial College of Science and Technology has now been in existence for some years, and has nearly completed its equipment in all departments of science, an equipment which, I believe, is second to none, and will soon be in a position to produce students of the very highest standard of college training, for whom the very best facilities for workshop training must be found. Why should united action not be possible between the Imperial College of Science and the polytechnics? Why should not a central committee be formed with its headquarters at the College of Science, composed of the heads of engineering departments of these unconnected colleges, and representatives from the London managers of engineering employers and manufacturers to work on lines already suggested in the case of the provinces? This committee would be in a position to ensure that all the most suitable students in London would obtain their practical experience.

There is still another important problem which is worthy of mention in this note, a problem which has arisen in England during the last few years owing to the advance made in general education, and which is now pressing for solution. I am personally most deeply interested in it, and I consider this conference a most favourable opportunity to bring it to the notice of college authorities and the representatives of county education committees in England. During the last few years, engineering firms in this country have developed a very keen interest in the better education of the engineer's apprentice who starts his apprenticeship at 16 years of age. Every encouragement is given to him to attend evening continuation classes, and several firms allow the best of them to attend classes one or two afternoons a week. The result of this interest is that a certain proportion of these have, by means of such facilities, been able to reach a standard of education which qualifies them to proceed to a fully-equipped college for two or three years of specialised study in the day time. Want of means and lack of an adequate system of scholarships with maintenance allowances, however, prevent them from proceeding further in their ambition. These apprentices, trained in this manner, are a very valuable asset to the nation, and I would suggest to the education authorities that they should adopt a scheme whereby the best of them would derive the benefit of systematic scientific education in the day time at one of the fully-equipped colleges. The organisation of such a scheme must ensure that poverty or social circumstances shall not prevent access to the highest forms of training that the community can provide.

(To be continued.)

* Abstract.

Competitive Illuminants.—In a report on this subject presented at the recent Convention of the National Electric Light Association it is mentioned that not more than from 60 to 70 per cent. of the laboratory rating of candle-power can be obtained from gas lamps under service conditions, this statement being borne out by tests by gas engineers. In general, a tungsten lamp having two-thirds the mean spherical candle-power shown by an incandescent gas lamp in a photometric test, will, under service conditions, produce an equivalent or greater illumination than the gas lamp, provided that the distribution of light from the two units is equally favourable.

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"THE ELECTRICIAN" INDUSTRIAL SUPPLEMENT.

With "THE ELECTRICIAN" for Sept. 14, 1906, was issued the first of a series of "Industrial Supplements," to be published from time to time with "THE ELECTRICIAN." The fifty-third issue of the Supplement published (Gratis) with the number of "THE ELECTRICIAN" for September 23, 1910, was the last of the monthly issues. "THE COMMERCIAL AND INDUSTRIAL SUPPLEMENT" to "THE ELECTRICIAN" is now issued weekly (Gratis). It will be found towards the end of the present issue.

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THE EDUCATION CONFERENCE.

The Education Conference recently held by the Institution of Civil Engineers resulted in a representative gathering and the presentation of numerous Papers. In fact, the number of Papers (although they were short) was so large, and the discussion so considerable, that we have found it necessary to continue the account of the Conference in several issues, and thus a further instalment of the proceedings will be found in the current number. In a sense it may be said that very little that was new was brought forward, but it is almost inevitable that this should be the case. There was the same conflict of opinions as there has been for many years; but, nevertheless, we think it may be said that a more definite policy is beginning to shape itself.

In regard to elementary education, there is no longer any question as to the value of science, but it will perhaps be admitted that those who have the cause of science at heart have not made out a thoroughly good case for the abolition of classics. In fact, most all-round men will probably agree that a classical education is desirable up to a certain age; and it seems to be the case, which is somewhat remarkable, as mentioned by Dr. JAMES GOW, that boys who have been given a classical education take more readily to science when they are given the opportunity than do boys who have merely been on the modern side. Perhaps this is due to the instructional methods being better in classical education than in other branches, and that consequently the boys are taught to learn classics in a better way than modern languages or science. To teach a boy how to learn should certainly be one of the primary objects of education. After a certain

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age, however, we think there is no question that science and modern languages should take precedence of classics. Modern languages are increasingly important, and it is not sufficient to have a mere school-boy knowledge by which sentences in a foreign language can be translated with a dictionary, or to have an accent which no foreigner can possibly understand. A serviceable conversational knowledge is most important.

As to science in elementary education, we do not think there is any question of the correctness of Prof. S. P. THOMPSON's view that the aim of the teacher should be to awaken interest. A broad knowledge is what is required, and no boy can get much knowledge worth having if his interest in the subject is not evoked. The much-talked-of heuristic method may be all very well in moderation, but it is liable to be deadly dull, and, in our opinion, the teacher should make use of this method with extreme caution. Apart from this dullness, the time available is often insufficient. When speaking of methods, however, it is rather necessary to bear in mind that teachers cannot teach to the best of their ability if they are hampered by inspections and an examination syllabus.

Passing from the school to the college, there is the question whether any specialisation should take place, and whether the matriculation should be a test of general education or of specialised knowledge. We agree with Prof. SCHWARTZ and Prof. A. BARR that there should be no specialisation in the school, nor should there be specialisation in the college, for the simple reason that men seldom follow the initial line on which they start their profession. Many men have suffered from over-specialisation which has made it impossible for them to turn from one branch of the profession to another. Opportunities sometimes arise which render it very desirable to change from one line of work to another; this, however, cannot be done without breadth of training, but if the breadth of view has been sufficient a change from one branch to another is often extremely advantageous.

There was, of course, a good deal of discussion as to the position that should be taken by shop training. Sir H. F. DONALDSON gave what he considered a suitable syllabus for this part of the training with the length of time in each of the shops, the programme depending on the line desired by the student. The syllabus laid down necessitates spending three years in the shops, but we very much doubt whether this is in any degree necessary or desirable. Take, for example, fitting. It is certainly advantageous that the engineer should have a general knowledge of the work comprised under this term, but whether he can use his file as a trained fitter or whether he fails to file a reasonably true surface to the end of his days, it will make little difference to his professional career. The fact is that it is not necessary for the engineer to be a trained turner, or fitter or pattern maker, but it is very desirable that he should have a general knowledge of the methods followed in fitting, turning and pattern making, and in the other shops comprised in an engineering works.

Another subject which caused a good deal of discussion was the "sandwich" system. Mr. YARROW pointed out the disadvantages that surrounded pupils living in the Midlands away from home influence during the time they spent in the shops, and he suggested that if the summer six months could be spent in the shops and the winter could be passed at college the social conditions would be very much better. We do not doubt that this would be so, and it would be a great advantage if such an arrangement could be made, but it is difficult to see how this could be done, both from the point of view of the works and from that of the college.

There certainly seems to be a consensus of opinion in favour of the sandwich system. The fact must be faced, however, that no workshop can be expected to take pupils in for short intervals, such as three months at a time, and we doubt even if six months would be acceptable. It appears to us that by far the best arrangement is for the student to spend, say, a year at college, then a year at the works, followed by another year or two at college, with a further year in the shops, if desirable, sandwiched between those two years at college. A system of this kind has been in vogue for years at Faraday House, and we believe the result has been satisfactory. The subject is one of great importance, because there is no question that workshop training is a distinct advantage; but most students after they pass through college often feel the temptation to accept a salaried post, if such is to be found, too great for them to go into the shops in receipt of nothing. We hope that our colleges may be induced to look into this question further with a view to seeing if a satisfactory solution cannot be found.

REVIEWS.

(Copies of the undermentioned works can be had from THE ELECTRICIAN Office, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.)

Encyclopédie Electrotechnique. By L. BARTILLON. Parts 38 and 39: Regulation des Groupes Electrogènes. (Paris: L. Geisler) Pp. 165 and 127. 25 fr. per part.

The subject of the regulation of electrical generating sets is one which, in a general sense, is of interest to a large number of engineers; in fact, it should be of interest to all station engineers. The mathematical treatment of the subject will, however, only appeal to a few—probably to engine and dynamo designers. In the two parts of the "Encyclopædia of Electrotechnics" devoted to this subject the treatment is entirely of a theoretical and mathematical nature, so that the treatise under review will appeal rather to the specialist and designer than to the average station engineer.

Dealing first with the treatise as a whole, the work is a fairly complete treatment of the problems relating to the speed and voltage regulation of generating sets. The text is well illustrated by a large number of clearly-drawn diagrams. There are relatively very few typographical errors; a few such errors are to be expected in the first edition of a work containing a large number of mathematical proofs. The treatment throughout is clear, but mathematical.

The subject-matter is divided into 11 chapters, of which six are included in the first part. The early chapters are of a general nature, being devoted to a study of the voltage regulation of dynamos, the speed regulation of prime movers, in particular the reciprocating steam engine. The function and action of flywheels and governors are clearly set forth. Typical turning moment diagrams for various engines are given, and the harmonic analyses of the various curves set out in tabular form. The isochronism, stability and sensibility of governors are all discussed at some length.

Two chapters are given up to an analytical and graphical treatment of direct-acting centrifugal governors under various conditions of generator load. The first part of the work is

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concluded by a chapter on speed control by means of relay governors.

Of the five chapters included in the second part of the book, the first is devoted to the study of various forms of governors. The second chapter deals with the calculation of flywheels for troubled conditions of working. The next chapter is a full analytical treatment of the action of governors, and includes the method of obtaining the various curves connected therewith. This is, of necessity, a chapter containing many mathematical proofs. The section which follows is of quite a different nature, and deals more particularly with the purely electrical branch of the subject; it is devoted to voltage regulation at constant speed. The concluding chapter relates to the variations in speed of a generating set in which the speed and voltage are both regulated. There is also an appendix dealing with the theory and operation of Routin's automatic regulator.

The subject-matter is confined to problems connected with reciprocating steam engines and water turbines. In view of the present use of steam turbines, gas engines and oil engines as prime movers for generating sets, we think some space might well have been devoted to problems affecting the speed and voltage control of generators driven by such engines.

For so cheap a book, however, the work is quite a good one, and can be recommended to those who wish to understand fully the theory of the subject. The book will not appeal, however, to those who have no taste for mathematics.

Exercises in Electrical Engineering. By T. MATHER, F.R.S., and G. W. O. HOWE. (London: Edward Arnold.) Pp. 71. 1s. 6d. net.

Technical exercises may be roughly divided into two classes. Those which produce facility in the application of certain principles or formulæ, and those which "give furiously to think." Old students of the Central Technical College will remember that the latter were great favourites with the late Prof. Ayrton, and his "take it as an exercise" sounds familiarly in our ears when we read this little book, in which Profs. Mather and Howe have thoroughly kept up the traditions of the College. The subjects dealt with cover a very wide field of both theory and practical application, and a student who has thoroughly worked through it should have few terrors in store for him in practical problems. Especially good are the questions dealing with electromagnetism and induction, which are too often slurred over in ordinary books, and in which subjects so many pitfalls are found.

The subjects dealt with commence with units, Ohm's law and energy calculations, and thence pass to magnetism and electromagnetism, forces on conductors, inductance, instruments, and dynamo and motor problems, including starters. This takes up the first 36 pages, and we then have 14 pages of alternate-current exercises in which some searching questions concerning capacity are found, as well as fundamental questions on alternators, transformers and motors. Here one might have liked to see a little amplification, notably as regards the bringing-out of the distinction between total and leakage inductance, which gives rise to so much confusion. Electric traction, secondary cells and lamp problems complete the series.

There can be no doubt that in this little book Profs. Mather and Howe have produced a set of exercises many of which will be of considerable assistance to other teachers, and which will help towards that clear thinking and appreciation of fundamental principles which is so frequently and painfully lacking at the present time.

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from *The Electrician* office, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published under 2s., and 5 per cent. for books published nett. Add 10 per cent. for abroad or for foreign books.]

"Matriculation Directory" (No. 58, June, 1911.) (Cambridge and London, University Correspondence College.) 1s. net.

"A Treatise on Wireless Telegraphy and Wireless Telephony." By Toshinojo Mizuno. (Tokyo, 1911: The Maruzen-Kabushiki-Kaisha.)

"Les Lampes Electriques." By H. Pécheux. (Paris: Gauthier-Villars.)

SOME RECENT DEVELOPMENTS IN RAILWAY TELEPHONY.*

BY G. BROWN.

The requirements which have to be met by the telephone to render it suitable for train-despatching as carried on in the United States are the following: Ability to signal any one of 50 or more stations on a 250-mile line, and ability to signal the despatcher from any of the stations. Arrangements whereby any number of stations can simultaneously listen in. Means for quickly testing and patching any portion of the circuit which gets into trouble.

In addition to the above requirements, the telephone owing to its greater flexibility can be arranged to permit of other operating advantages not possible with the use of the telegraph. Among these are the following: Provision whereby officials who are not telegraph operators, but who are directly interested in the movement of traffic, as, for instance, train masters, yard masters, division superintendents, &c., can listen on the wire and keep in touch with traffic conditions. Arrangements permitting the signalling of stations without interrupting conversation. This feature results in saving a considerable amount of time. Automatic notification to the dispatcher that the station he is calling is receiving the signal. As regards signalling to any one of 50 or more stations, this is a condition which is not met with in ordinary practice. The instrument used is known as a selector, and is so designed that the despatcher can at will cause any selector to operate, and ring the bell at any particular station. This is at present done in three ways. A certain number and sequence of long and short impulses may be sent to which only the instrument at a particular station will respond; a number of instruments may be set to work in synchronism, the despatcher's sending device being so arranged that at a pre-determined instant one impulse is sent out on the line which at this instant is provided with a path through one selector only; step-by-step instruments which operate together by a succession of impulses from the despatcher's office may be used.

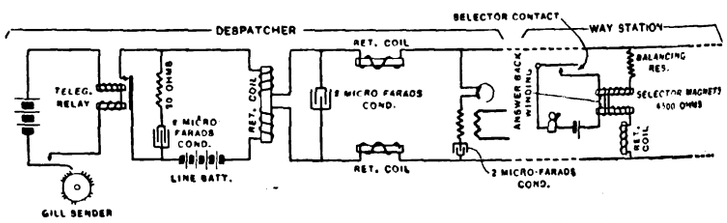

FIG. 1.—NEW ARRANGEMENT OF LINE CIRCUIT. GILL SYSTEM.

A typical instrument in the first class is the Gill, which consists essentially of a ratchet wheel, an electromagnet whose armature is arranged to step the wheel forward, a retaining pawl to retain the teeth stepped, and a mechanical time element whose function is to permit the retaining pawl to assume either one of two positions according to the length of the impulse of current. The time element consists of a metal wheel fastened to a small diameter shaft so arranged that it can roll down an inclined rod. This shaft will reach a lower hunting position if the impulse last long enough. The teeth are cut away, and in order that the retaining pawl may hold each tooth stepped of a given selector, its position with relation to the face of the teeth must be such that at no time does it rest against a position of a tooth face that has been diagonally cut away. This condition is brought about only in the case of a selector which is being operated by its proper sequence of long and short impulses, and this is the only selector that will close its contact and signal its station.

The latest type of circuit used with this arrangement is shown in Fig. 1. In this arrangement there are no earths on the line and no line relays used. The selectors are wound to 4,500 ohms, and are placed directly across the line. In series with the selectors is placed the proper amount of tapering resistance, so that the amount of signalling current through each bridge will be the same. The answer back is obtained by including, in series with the selector contact bell and battery, a secondary winding on the spools of the selector. As the bell vibrates it induces current in the selector windings which produces a tone in the despatcher's receiver. With this circuit arrangement the normal current for the operation of the selectors is 10 m.a. The current, however, can fall considerably below this without affecting the operation of the selectors. The retardation coils and condensers at the despatcher's end of the line are used to cut down the peak of the current wave to such a point that the noise in the receivers while the signal is being sent is not enough to interfere with conversation. In this circuit it is necessary

* Abstract of a Paper read before the American Institute of Electrical Engineers.

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to introduce a condenser in series with the receivers across the line in order that the signalling current may not be shunted through the talking bridges.

In the second arrangement the master selector consists of a standard clock-work mechanism, to the second hand of which is attached a contact arm. In the path of this contact there are 30 insulated segments which are arranged so that any one of them can close battery current through a relay when the contact arm engages with this particular segment. The despatcher depresses locking push buttons, and then operates the key mechanism. This mechanism is merely a retardation device arranged so that when operated a contact is made for a length of time sufficient to operate the relays which start the master and all the station clocks. The sub-station selector is similar to the despatcher's clock mechanism except that each station is equipped with but one contact arranged to engage with the revolving arm. These contacts at the various stations are adjusted at different angular displacements from the normal position of the contact arm. When the despatcher has started all the clocks simultaneously, it is evident that the contact arm on the master selector will have reached, say, its tenth point at the same instant that the tenth selector has reached its point. At this instant there are no other selectors which are on their contact point, and due to the fact that the tenth point on the despatcher's clock is connected by means of a locked push button to cause current to flow on the line, the signalling mechanism at the desired station will be operated. Fig. 2 shows the circuit arrangement at the despatcher's office and at the way-station. When properly adjusted this selector has given satisfactory service. It, however, requires one minute to call the thirtieth station.

The third class, or step-by-step selector, is probably the simplest and quickest. It consists of two electromagnets connected in series and mounted in a brass frame. Each magnet is equipped with two

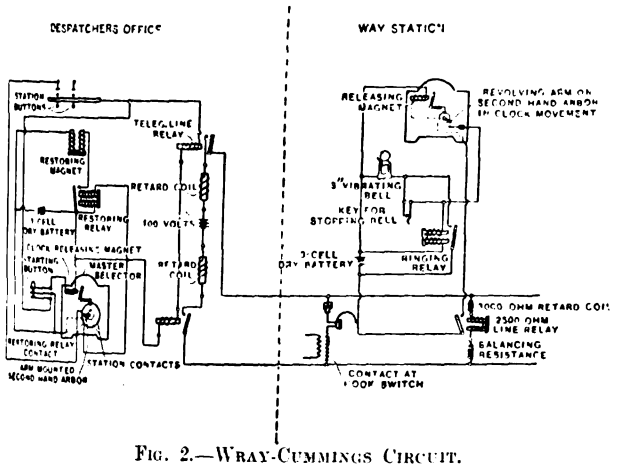

FIG. 2.—WRAY-CUMMINGS CIRCUIT.

spools, the cores of one of the magnets being covered with copper sleeves to produce slow action. Upon the fast-acting lever is mounted a stepping pawl, A, designed to engage with a ratchet wheel to which is fastened a platinum pointed arm (Fig. 3). Mounted on the framework is a retaining pawl, B, designed to retain the teeth as they are stepped. Attached to the slow-acting armature are two fingers designed to engage with the two pawls in such a way that when in the normal position of the slow-acting armature, the two pawls will be held out of engagement with the wheel, while in the operated position the fingers will permit the pawls to engage with the wheel. This selector is operated by first placing on the line an impulse of current which operates both magnets. There is then placed on the line a succession of short impulses, which cause the stepping magnet to oscillate back and forth and step the wheel around the desired number of steps. The speed with which these impulses are placed upon the line, however, does not permit of the slow-acting magnet releasing. When the desired number of steps are taken, the contact is made and current is held on the line, thus ringing the bell. As soon as current is removed from the line the slow-acting magnet releases, which raises the pawls and permits the wheel to fall back to normal position under the influence of its retractile spring.

The foregoing description covers in general the means used by the despatcher for signalling the various stations. The tower operator, when he wants to communicate with the despatcher, listens in to learn whether the line is busy, and if it is not, he merely says "despatcher" in the transmitter. The despatcher wears a head receiver and central office type of chest transmitter, and is on the line all the time.

At first, with the instruments used, the joint impedance of the parallel paths was very low and the transmission correspondingly difficult between widely separated stations. The first step towards overcoming this difficulty was to raise the impedance of the talking bridge by the use of a different induction coil, wound with a low primary and a high impedance secondary. This bettered matters somewhat as the higher resistance bridges produced a more even distribution of the talking current from the despatcher's office, and would give better outgoing transmission from the sub-stations. Although the despatcher's voice currents were undoubtedly better distributed among the bridges with this arrangement, still, due to the fact that the bulk of the impedance in the bridges was in the secondary of the coil, the transmission gain was very slight.

The next obvious step was to maintain the high impedance in the talking bridge, but put as much of this impedance as possible in the receiver. If this were done, however, the high impedance receiver in series with the secondary of the induction coil would reduce the outgoing transmission from the sub-station to an objectionable extent. It was then determined that the best results, both for receiving and transmitting, would be obtained by installing a switching arrangement at the sub-station so that when the switch was in one position the circuit was in the best possible condition for receiving, and when in the other position was in the best possible condition for transmitting. The circuit developed is shown in Fig. 4, the circuit to the left representing the despatcher's station and to the right the way station.

It will be noted that a non-locking push button is located at the way station and in its normal position the bridge across the line consists merely of a 700-ohm receiver and a 1 mfd. condenser. The impedance of this receiver is about 2,500 ohms, and as the total impedance of the bridge is all in the receiver it is all effective for receiving purposes.

When the operator wishes to talk he depresses the push button or in some cases a foot switch which closes his local transmitter

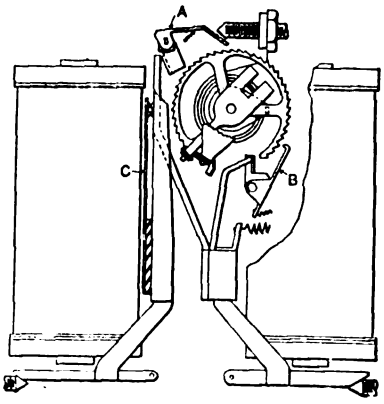

FIG. 3.—LEVER MOVEMENTS OF W. E. SELECTOR.

battery circuit and also connects the secondary of his induction coil to the line. The voice currents generated in the secondary have a path directly across the line in series with the condenser and also a shunt path through the retardation coil and receiver in series. This retardation coil is of about 6,000 ohms impedance, and is placed in series with the receiver in the manner shown, in order that the despatcher may break in if it is necessary for him to interrupt an operator while talking. The impedance values are such that the amount of side tone is just sufficient for the operator to distinguish the despatcher's voice if he interrupts, and he will release his button in order to understand clearly what the despatcher is saying. The outgoing transmission of this circuit is, therefore, the best possible consistent with the fact that we must arrange to permit the despatcher to interrupt the operator's conversation when necessary. The induction coil used in the way-station and also the transmitter are especially designed for railway work. The transmitter button is of medium resistance, and while not taking excessive battery current still varies the current through a large range and gives good volume and articulation with a battery of three cells.

When the receiver is off the hook, this circuit reduces the transmission by about one mile of cable for stations beyond that are receiving from the despatcher. 130 miles (209 km.) No. 9 copper being the average length of despatcher's line, the line transmission loss at 16 miles of wire to one mile of cable will be eight miles of cable, leaving an equivalent in transmission of 22 miles of cable that can be used in the bridges before we reach 30-mile transmission for the last station. Thus it will be seen that on a line of this kind 22 operators can be listening in and good transmission can be maintained. It is practically never necessary that this number be on the line, 15 being a liberal estimate of the number of receivers that will be off the hook at one time. If, however, emergencies should arise

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making it necessary for 25 or 30 operators to listen in, transmission will be sufficiently good for the transaction of business, even though it is beyond the 30-mile limit.

The requirements of the despatcher's circuit are somewhat different from those at the towers. He must be on the line all the time, and the transmission and receiving of his set must be as good as possible, without resorting to the use of a push-button for talking and listening, as his time is too fully occupied to permit him to use this device.

The circuit is shown at the left of Fig. 4. A 70-ohm receiver is used in series with the secondary of the same type of induction coil, as is used at the sub-stations, and a 1 mfd. condenser in series. The

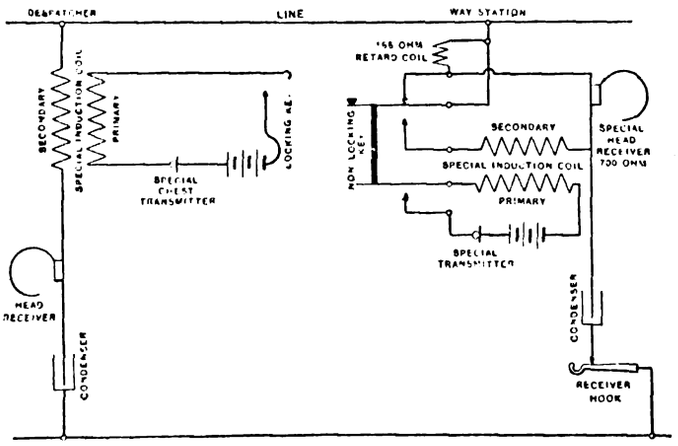

Fig. 4.—W. E. Train Despatching Wayside Station Circuit.

impedance of this bridge is about 650 ohms, and it being the lowest on the line, the receiving will be good. This value also permits good transmitting. The switch shown in the figure is of the locking type and opens the battery circuit when the set is not in use.

CORRESPONDENCE.

THE NOMENCLATURE OF PRIMARY AND SECONDARY SOURCES OF LIGHT.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I may have made a slip, as Mr. Murphy suggests, in my letter on page 384, where I stated that "one candle-power is therefore the luminous flux per steradian"; but I do not propose to plead guilty unconditionally. I was endeavouring to contrast the simple vector magnitudes which I prefer, with the flux magnitudes which I consider, in general, to contain redundant dimensions. For definitions of the flux magnitudes I turned to American writers, for not only in photometric work but in magnetic work it is common in America to use flux quantities, the magnetic line being seldom used.

I endeavoured to boil down the definitions of the Progress Report* of the Sub-Committee of the Illuminating Engineering Society of New York, submitted at the Baltimore Convention on Oct. 24, 1910, signed by A. Blondel, A. E. Kennelly, E. L. Nichols, E. B. Rosa, and C. H. Sharp, and if I have misrepresented it in the expression "one candle-power is therefore the luminous flux per steradian," I acknowledge my error, but I share my guilt with, at all events, one member of that Committee, and him I propose to incriminate. In a Paper by Dr. E. B. Rosa on Photometric Units and Nomenclature, "Bulletin" of the Bureau of Standards, Washington, Vol. VI., No. 4, I find these words: "I is called the *intensity of the source*, and is equal to the flux per unit of solid angle." I borrowed the unfamiliar term "steradian" from another American source.

Some people might argue that the coulomb is the essential and fundamental magnitude, and that current is a derived one. A certain lamp may be said to take 1,800 coulombs per hour. Other people would say, you have a redundant dimension, why not say that the lamp takes a current of half an ampere? I will not say that that would suit English ideas, nor, seeing with whom I am in controversy, British ideas, but it would, I think, suit most English-speaking people. On the other hand, an accurate Frenchman would object. To a Frenchman "current" is a phenomenon; an ampere is not the unit of current, but it is a physical quantity and is the unit of intensity of current. The genius of the French language is a serious matter, which must be respected. Prof. Blondel abhors "candle-power." If it will conduce to simplicity and accuracy, I will try to abandon the use of the expression candle-power, and follow the American committee in using "candle" as the unit; but it will be difficult.

I disagree with Mr. Murphy's proposed nomenclature.—I am, &c.,

London, July 8. A. P. Trotter.

* *See* p. 538 of this issue.

CHEAPENING SERVICES FOR ELECTRICITY SUPPLY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The article by Mr. W. A. Vignoles in your issue of the 23rd is an interesting contribution to a branch of the mains engineer's work which is of growing importance in view of the enormous number of small connections which are likely to be made to existing networks in the near future. I hope that the following observations may induce others interested in the subject to contribute some items of experience or expressions of opinion.

The writer points out the difficulty of charging for service cable on private property in view of the fact that the gas suppliers seldom make any charge, and in many instances will completely pipe new buildings free if there is risk of electricity being introduced. I would suggest that the usual limit of 40 ft. to 60 ft. of free service cable might be increased now that the cost of service cable is being reduced by a natural fall in prices, and by the fact that the average service cable need not be so heavy as formerly.

It would appear preferable to increase the limit of free distance rather than reduce the charges which are made for cables beyond that distance, so reducing the number of cases where a few feet have to be paid for. Consumers who have not absolutely decided to use electricity are sometimes discouraged in this way, failing to realise how small is the importance of the charge made in comparison with the value of the supply to them.

It is also bad policy to insist upon meters being placed in the nearest position to the mains, which may be, and often is, an inconvenient one to the consumer, who feels that he is entitled to the free 20 yds., or whatever the limit may be, and is annoyed to find that, whilst he is nearer to the service cable than some of his neighbours, the suppliers begrudge the expenditure upon a few yards of cable in order to meet his convenience, whilst in other cases they are obliged to give it by reason of their own bye-laws.

With regard to fuse boxes for lighting and heating, the practice of using two fuses and one solid link, or one heavier fuse in place of two-way double-pole boxes, is increasing, and appears to be entirely satisfactory, whilst reducing cost.

The connection fittings in boxes and cut-outs for tailing the outer conductors of concentric cables have always been a source of some trouble, and many ingenious mechanical devices have been produced. It is doubtful, however, whether any mechanical connection is advisable when buried in insulating compound.

On large cables the concentric cone connectors can be made so massive that when properly tightened up the outer conductors are more or less crushed into the metal of the connector, and thus a permanent connection results; but where small fittings are used, or where the position makes it difficult to screw them up, trouble is likely to arise owing to the compound slowly insinuating itself between the conductor and the connector. This may take a considerable time, but in the end bad connection and heating will often result, so that, speaking generally, it appears doubtful if soldering soundly carried out can be improved upon for buried work.

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The use of twin and multi-core cable greatly simplifies mains work and tends to reduce faults.

The writer's statement that the extra cost of service cable, twin over concentric, is 1d. per yard, I venture to suggest may be intended for 1d. per *foot*, that amount more nearly representing 10 per cent. on the cost of the average service cable, unless reference is intended to a cheap and possibly unarmoured type.

Lamp-post services when made upon large existing distributors do appear costly in comparison with their importance, but there can be no doubt that it is a grave mistake to spare expense in making them thoroughly, owing to the importance of the other connections on the distributor, the strongest link of which may easily be the least of the lamp-post services attached to it.

Where the posts served are very close to the distributing cable a simple connection may be made by running twin rubber-insulated lead-covered cable out of the tee-box and in troughing of the "Howard" type directly up the post to the lamp switch, without further joints, the troughing being made to enter the tee gland of the joint box at the one end and to enter the base of the lamp-post at the other, the whole being made solid with compound and covered with bricks, or asphalted over in the manner directed by the makers of the troughing.

The looping of services is a very useful method of lowering the average cost of connection. Precautions are necessary to prevent the spread of fire through any holes or tubes put into party walls for cables, and this should be seen to, as fire insurance policies frequently contain a clause with reference to cutting party walls.

The chief objections to the device appear to be that in some cases service cable which is directly connected to the mains network without fuses may run for some distance under floors of private premises, and also that a fault occurring at the loop-in-point at one house would interfere with the supply of the next or further houses connected to it, and might, if the first house were closed, be somewhat difficult to deal with.

It is not usually difficult, as the writer states, to obtain permission to make these subsidiary connections on private property, but one is always apt to have trouble subsequently if the property is divided and falls into different hands, and where it can be arranged it is more satisfactory and safe to run separate cables to each consumer beyond the nearest point in the road over which the public authority has control.—I am, &c.,

Tunbridge Wells, July 8. J. W. BEAUCHAMP.

EXPERIMENTS IN IMPACT EXCITATION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with great interest Mr. G. W. Nasmyth's article which appeared in your issues of June 16th and 30th, and perhaps I may be allowed, as an engineer under the late Lepel Syndicate, to make a few comments in your columns.

One cannot read Mr. Nasmyth's article without highly appreciating the care and patience with which he has carried out his tests, under conditions familiar to the writer as being far from the ideal for quantitative measurements. It is, therefore, a matter for regret that the experimenter, like others, seems to have been uninformed as to the conditions which obtain in the everyday working of a Lepel station. Nevertheless, the information compiled has great scientific interest, and in many cases bears directly upon station conditions. But it is disappointing that these experiments were not carried out wholly under these latter conditions, when perhaps some light might have been thrown upon other problems which still await definite solution.

It is by no means an uncommon error to assume that the gap is, in itself, the one primary factor in the production of highly damped impulses, and that the constants of the shunt circuit are of almost secondary importance. This is by no means the case. Efficient spark quenching is greatly dependent upon these values, in addition to which the radiating properties of the antenna play an important part. And in this latter connection it must be mentioned that Mr. Nasmyth's account shows no evidence of radiation being represented, either by the introduction of an antenna or the substitution of adequate secondary resistance.

Now it is perfectly feasible that a Lepel generator circuit fed by such currents, and including the inductance and capacity values employed by Mr. Nasmyth, should have produced forced undamped oscillations as distinct from the free oscillations produced in actual practice by Lepel stations; provided, of course, that the proper relation existed between the oscillation constants, and especially when relieved from its normal load, a radiating antenna. But, in order to show the wide variance between Mr. Nasmyth's arrangements and those most favourable to "impact excitation," may I be allowed briefly to discuss the latter?

Prof. Wien advocated the employment of a highly damped spark whose period of activity should last only until the associated antenna might have built up its maximum intensity. At that instant the primary spark was to be completely quenched and the antenna left to oscillate free from the reaction of the primary. Now all conditions in the transmitter must contribute in order to achieve this object.

With regard to the spark-gap, the rapid cooling of the electrode surfaces and the short distance between them, the hermetical sealing of this space containing the hydrogenous atmosphere produced by the paper, and multiplication of the gaps, all serve rapidly to de-ionise the gap after disruption.

In the second place the antenna must rapidly and completely absorb the energy of the primary circuit and efficiently radiate this into the surrounding medium. A tight coupling and good radiation properties are, therefore, essential.

And, perhaps most important of all, in order to give the necessary "dead beat" characteristics to the primary oscillations, the ratio of primary capacity to primary inductance must be as great as is practicable. Primary inductance must be reduced to as low a value as is consistent with tight coupling, and capacity increased to the utmost limit, defined only by the value when the act of closing the feed circuit fails to "start" the generator.

Moreover, reverting to the gap, the spark group frequency must be kept low in order to give the cooling arrangements there a fair opportunity of performing their work.

An estimate of the capacity range which would have enabled Mr. Nasmyth to cover the same ground with his circuit arranged for the best quenching effects may be taken as 0·02 mfd. to 0·25 mfd., and the primary inductance of 14,300 cm. was many times too large.

A probable reason for the non-employment of capacities of the above order is obviously that large high frequency condensers do not form part of an ordinary laboratory's equipment; and it is possible that this may alone account for many existing misconceptions as to the functions of these generators.

Turning to the article itself, I should like to draw attention to Fig. 6. If the two curves, "Lepel arc with oscillations" and "Lepel arc without oscillations," are compared, the influence of a secondary load upon the primary characteristics is clearly indicated, and this will bear out my plea for an antenna or representative resistance.

And it must be admitted, after study of Fig. 7, that increasing oscillation intensity as the feed current is reduced is clearly shown by the rising tendency of the whole family of curves. Is not this ample demonstration that, with the capacities employed, maximum intensities (*i.e.*, "working conditions") lie in the unexplored region of smaller current values, or, conversely, that larger capacities were required for the current values used?

The marked affinity, disclosed by Mr. Nasmyth, between the characteristics of an uncoupled Lepel gap, shunted by large inductance and small capacity and fed by a large current, and those of the Poulsen arc, have much interest; and the exhaustive examination of the change of frequency with feed current should prove of great value. Moreover, in conclusion, I, for one, should welcome a later account of the same experimenter's further researches on the Lepel generator under "station conditions."—I am, &c.,

London, July 10. F. J. CHAMBERS.

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UNDERLOADED THREE-PHASE INDUCTION MOTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In an article in your Mining Issue of May 12th a contributor refers to the fact that, after a mine has been equipped with electric drives, it is often found that many of the motors are very considerably underloaded, and that, as a result of the bad power factor following upon this, trouble is encountered in dealing with the wattless current the generator is called upon to supply. The article attributes this mainly to a desire to limit the number of different ratings in the motors employed.

In my own experience the choice of a much too large size has been generally due to the estimate of the necessary output having passed through the hands of several different persons, none of whom has had the pluck to back his real opinion. The consequence is that each successive estimator has taken his predecessor's figures and multiplied them by a factor which he calls a factor of safety, but which I think might be better termed a "*factor of timidity*." If many nervous people have a hand in the matter it is very easy to get a 50 H.P. motor where one of 15 would do the work.

At the same time, it must not be overlooked that cases often arise where, though the immediate demand is 15 H.P., an expected increase in the future output may make it advisable to put in at once a 50 H.P. motor.

Whatever may be the reason, it often happens, as your contributor says, that motors are found to be very considerably underloaded, and a bad power factor results.

To deal with the difficulty he suggests the purchase of smaller motors or of over-excited synchronous machinery, where this can be supplied.

It seems possible to me, therefore, that it is not generally known in England that there sometimes exists another way, which has the advantage of not adding to the capital expenditure. If the underloaded motors happen to be mesh-connected and very considerably underloaded, as in some of the cases he quotes, the alteration of the terminal connections to star will generally have the effect of greatly improving the power factor of the existing motors, usually to the benefit also of their efficiency.

This alteration really amounts to converting the motors into others which can only give, as maxima, torques equal to about one-third of the maximum torques of the original motors. The construction of the Heyland diagram for each case will at once make this plain.—I am, &c.,

Johannesburg, June 17. H. J. S. HEATHER.

FARADAY SOCIETY.

At the meeting held on June 13 at the Institution of Electrical Engineers, Victoria Embankment, Mr. G. T. BEILBY, F.R.S., in the chair, Prof. ERNST COHEN, of the University of Utrecht, delivered a lecture on—

"Allotropic Forms of Metals."

The property of a chemical element to occur in different modifications is called allotropy, a word introduced into chemistry by Berzelius in 1841. Only a few elements were presumed to show allotropy, but the researches of the last few years make it probable that all elements show it. We have to seek for the conditions which enable them to take different forms. The lecturer pointed out that the conceptions which the physical chemistry of the last quarter of a century has brought us enable us to bring allotropy under the head of equilibrium phenomena.

He discussed enantiotropy, monotropy, and dynamical allotropy, and outlined the results of some of the investigations carried out in these directions by himself and his collaborators, Prof. Katsuji Inouye and Drs. Collins, van Eyk, Goldschmidt, Kröner, Olie and Strengers, during the last twelve years.

As a striking illustration of enantiotropy, he referred to the transformation of tin into a grey form (*tinpest*), a phenomenon that has great importance for the technical use of this metal, seeing that the transition point between the white and grey forms is at 18°C., and that below that temperature all ordinary tin is in a metastable condition. Some striking examples of the gradual transformation that had taken place in old tin vessels were exhibited, and the phenomenon of "infection" was likewise discussed.

Monotropy was illustrated by the consideration of "explosive antimony," a mysterious form of antimony discovered in 1854 by Dr. Gore, of Birmingham, and prepared by electro-deposition from the haloid solutions of the metal. Unlike in the case of tin, there is here no transition equilibrium temperature; at every temperature the metastable form of antimony changes to the stable form, becoming therefore less and less explosive as time goes on.

As typical cases of dynamic allotropy, white and violet phosphorus, as well as tellurium, were cited, although the researches on the latter element are still going on in the lecturer's laboratory.

Prof. J. A. EWING asked whether there was any connection between the slow process of recrystallisation that went on in metals after strain and the phenomena described in the lecture.

Dr. W. ROSENHAIN referred to the allotropic forms of iron known as α, β, and γ iron. It might be that the β form was a case of dynamic allotropy, and there was a possibility of mutual solution of the two forms within certain limits of temperature. The "infectious" nature of "tinpest" was of great interest and importance; analogous phenomena were to be found in the case of severely-strained steel and in other instances. The volume-changes accompanied by disintegration that took place in some of the aluminium alloys were probably to be ascribed to allotropy.

Prof. T. TURNER likewise drew attention to the possibility of allotropic forms existing in other metals, such as lead and zinc.

Mr. J. W. HINCHLEY said it would be of great interest to know whether there were any retarding agents that would prevent the metastable from passing to the stable states. He thought that lead acted in this way towards tin.

Mr. G. T. HOLLOWAY asked whether tin could be prepared so pure that "infection" would not take place in it.

Mr. W. R. BOUSFIELD remarked that spongy platinum deposited from a chloride solution containing only $\frac{1}{40}$ per cent. of lead was black and velvety. This might possibly be an allotropic form. He thought that in the case of antimony one did not have allotropy but a solid solution of minute quantities of chloride in the body of the metal.

Dr. H. BORNS believed that foreign substances had been found in the explosive form of antimony.

Dr. E. FEILMANN referred to the mysterious giving way of lead sheet in acid chambers, which might be due to allotropy.

Prof. E. COHEN replied briefly to the discussion. He did not think the recrystallisation referred to by Prof. Ewing had anything to do with allotropy. Replying to Mr. Holloway, he had experimented with tin containing only $\frac{1}{100}$ per cent. impurities. He could not answer Mr. Bousfield's question. The two forms might merely be different states of division, but he would look into the matter. Replying to Dr. Borns, there were always traces of the acid of the solution from which it was deposited in explosive antimony. It was often overlooked that electro-deposited substances almost always contained traces of the solution mechanically enclosed.

METROPOLITAN ASSOCIATION OF ELECTRIC TRAMWAY MANAGERS.

A meeting of the members of this Association was held on the 5th inst., at the offices of the London United Tramways (Ltd.), High-road, Chiswick, W., when there were present:—Messrs. A. H. Stanley (managing director, London Electric Railways and London United Tramways), chairman of the Association, A. Coveney (Erith), C. Mittelhausen (Bexley Heath), F. Schofield (Leyton), W. C. Ullmann (East Ham), W. Murray (Walthamstow), A. Balfour (Dartford), W. E. Hammond and A. H. Pott (Metropolitan Electric Tramways), A. V. Mason (South Metropolitan Tramways), and T. B. Goodyer (Croydon), hon. secretary. Apologies for absence were received from Messrs. H. E. Blain (West Ham), H. Howard (Barking), and A. De Turckheim (secretary, Tramways and Light Railways Association).

The party travelled in the company's parlour car to Isleworth, where they inspected, and were much interested in, the Falk system of rail welding, which is now being extensively carried on. On returning to the Chiswick depot, and after tea was partaken of, a business meeting was held, and various matters discussed, the hon. secretary being requested to give effect to the same on the lines expressed. Following an inspection of the repair shops and car sheds, and in respect of which information on many points of interest was kindly given by Messrs. Knapp and Rozier, the party journeyed to Hammersmith, and entrained for Earl's Court station, where they were afforded the opportunity of inspecting the work in progress in connection with the movable staircase which is being constructed for the London Electric Railways. After an amount of careful stepping and ladder climbing, and *terra firma* being safely reached by all, the party proceeded to the Welcome Club at the Earl's Court Exhibition, where they were kindly entertained to dinner by Mr. Stanley, and where also, they were joined by M. James Devonshire, managing director of the Metropolitan Electric Tramways.

In expressing his regret at not being able to join the party earlier, and proposing a hearty vote of thanks to Mr. Stanley for his hospitality in entertaining the members to dinner, and whose great kindness to the Association is so much appreciated, Mr. Devonshire stated, that the visits of inspection which had been so kindly afforded that afternoon, could

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only result in much good to the members, and the respective tramway systems they managed. Thanks, also, were due to Messrs. Knapp and Rozier, for the ready assistance and information they afforded.

General regret was expressed at the absence of Mr. Blain, it being the first occasion, since the formation of the Association some years ago, that he had been absent.

Mr. STANLEY, in replying, stated he was always glad to meet the members of the Association, and hoped they might profit from the inspection that had been made. He understood that that was the last meeting at which they would have the pleasure of having Mr. Balfour (Dartford) with them, he having accepted another appointment, and he desired to convey, on behalf of the members, their hearty good wishes for his future success.

Under the guidance of Messrs. Knapp and Rozier, the party subsequently made a tour of the Exhibition.

A NEW CURRENT GAUGE.

Although the portable ammeter is a handy form of instrument it is apt to be expensive. On networks and large installations it is often useful to be able to ascertain the current in a particular feeder or cable under certain conditions of load. In such cases a portable

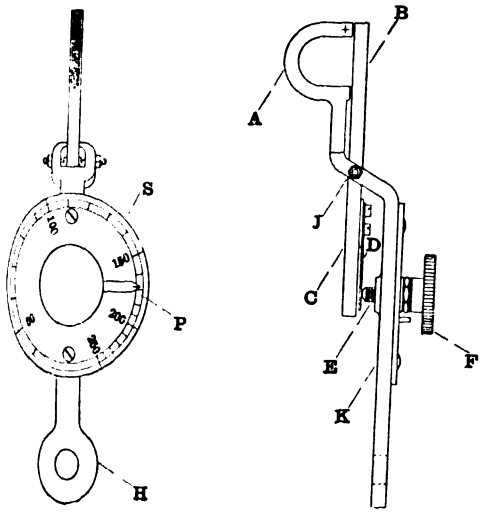

FIG. 1.—DRAKE & GORHAM CURRENT GAUGE (FRISBY'S PATENT).

instrument can only be connected in circuit with some loss of time and difficulty. Messrs. Drake & Gorham are putting on the market a portable current gauge (Frisby's patent) which need only be

FIG. 2.—DRAKE & GORHAM CURRENT GAUGE IN USE AT FEEDER PILLAR.

clipped on to a cable and a small adjusting screw turned to obtain a fairly accurate register of the amount of current passing. Details of the device are shown in Fig. 1, which illustrates plan and side views. It will be seen that it comprises a U-shaped magnet A at the end of a long arm K, and an arrangement whereby a centrally pivotted armature B can be adjusted in respect to the poles of the magnet. This consists of an adjustment screw E, which is turned by a large milled head F, there being a pointer P under the head which moves over a disc S graduated to read in amperes. An eyelet H is provided for hanging up the gauge. In actual use the U-shaped magnet is passed round the cable, and the armature pressed against the poles to which it will adhere by reason of the attraction set up by the current passing through the cable. D is a stiff spring on the armature against which the adjustment screw rests, and this screw is turned round until the armature is forced away from the poles. When this has been done, the reading on the scale under the pointer shows the approximate current. Fig. 2 shows how the device can be used over the fuses in a feeder pillar to obtain a reading of the current passing. The instrument is made at present to read up to 250 amperes, but larger sizes are in preparation.

OLYMPIA ELECTRICAL EXHIBITION.

The following revised preliminary list of exhibitors at this exhibition, which will be held at Olympia (London, W.) between Sept. 23 and Oct. 21 next, has been issued by the organisers:—

	STAND NO.
Abbey Electric Co.	5
Adams Manufacturing Co.	107, 108
Aerators, Ltd.	77
Alexander, Geo. H.	295
Allen & Simmonds	229
Armorduct Manufacturing Co.	120, 121, 138, 139
Aster Engineering Co.	243
Auto Recorder Co.	228
Barker (John) & Co. (Kennedy Bending Machine)	280
Bastian Electric Heating Synd.	173, 190
Bastian Meter Co.	173, 190
Bat Meter Co.	83
Bell, Heslop	276
Benjamin Electric (Ltd.)	151
Bennis (E.) & Co.	200, 215
Berry Construction Co.	30, 31
Berry, Skinner & Co.	129, 130
Bonella (D. H.) & Son	198, 217
Boosey (W. E.) & Co. (Trident Co.)	281
Braun & Co.	259
Bristol Co.	3
British Aluminium Co.	266
British Electric Transformer Co.	30, 31
British Metal Engraving Co.	261
British Prometheus Co.	197, 218
British Thomson-Houston Co.	124, 135
British Vacuum Cleaner Co.	174, 189
Brook, E.	245
Brook, Hirst & Co.	153
Bruce Peebles & Co.	119, 140
Brunner, Mond & Co.	260
Brush Electrical Engineering Co.	84, 89
Buckton (Joshua) & Co.	122, 137
Bullers Ltd.	118, 141
Burton (C. W.), Griffiths & Co.	205, 210
Callender's Cable & Construction Co.	196, 219
Cassier (Louis) Co.	282
Cateaux (J. L.) & Co.	23, 38
Chamberlain & Hookham	156, 157
Churchill (Chas.) & Co.	85, 88
Concordia Electric Wire Co.	270
Consolidated Pneumatic Tool Co.	50, 73
Corona Lamp Works Co.	244
Coventry Chain Co.	251
Credenda Conduit Co.	156, 157
Crypto Electrical Co.	57
Dorman & Smith	59, 64
Dowsing Radiant Heat Co.	161
Drake & Gorham	61, 62
Duerdill (J.) & Co.	238
Dussek Bitumen Co.	242
Eastman & Son	236
Eastman & Warne	236
Ebonestos Manufacturing Co.	226
Edison & Swan United Electric Light Co.	15, 16, 45, 46, 98, 117
Efandem Co.	4
Electric Ordnance & Accessories Co.	80, 92
Electrical Apparatus	24, 37
THE ELECTRICIAN	180
"Electrical Engineer"	277
"Electrical Engineering"	152
"Electrical Press"	1, 265
"Electrical Review"	227
"Electrical Times"	26, 35
"Electricity"	13, 48
Electromotors	126, 133
Elliott Bros.	54, 69
Emanuel (A.) & Sons	195, 220
"Engineer"	284
Engineering Instruments	49, 74
Escarè & Denelle	145, 166
Everett, Edgcumbe & Co.	66
Evershed & Vignoles	168
Eyre Smelting Co.	263
Falk, Stadelmann & Co.	79, 93
Famous Diamond Steel Co.	258
Ferranti Ltd	102, 113
Foster Engineering Co.	194, 221
Galsworthy Ltd.	244
Gambrell Bros.	290
Geipel (W.) & Co.	204, 211
General Electric Co.	103, 112, 125, 134
Gent & Co.	169
Globe Electric Co.	120, 121, 138, 139
Goodchild (G. W.) & Partner	237A
Hands, A. C.	12
"Hardware Trade Journal"	274
Hart Manufacturing Co.	76
Hawkes (O. C.), Ltd.	19, 42
Henley's (W. T.) Telegraph Works Co.	178, 185
Hervé, L.	278
Hill, Siffken & Co.	264
Hoffmann Manufacturing Co.	149, 162
Holmquist Electric Co.	225
Holophane, Ltd.	199, 216
Hopkinson (J.) & Co.	170, 193
Hornsby (R.) & Sons	9
Imperial Electric Co.	164
Imperial Lamp Works (Brimsdown)	100, 115
Imperial Lighting Co.	233
"Iron and Coal Trades Review"	52, 71
"Ironmonger's Chronicle and Hardwareman"	271
Isenthal & Co.	20, 41
Jacobs, W. & R.	296
Jandus Arc Lamp & Electric Co.	105, 110
Johnson & Phillips	123, 136
Laing, Wharton & Co.	56, 67
Lancashire Dynamo & Motor Co.	122, 137
Lanston Monotype Corporation	264
Le Carbone	95
Lea Recorder Co.	27, 34
Leskole Co.	222
Linolite Co.	143
Lister (R. A.) & Co.	11, 12
Litholite Ltd.	201, 214
London Decorative Metal Works	291
Longstreths Ltd.	167
Lucy (W.) & Co.	96
Lundberg (A. P.) & Sons	90
Major & Co.	142
Marconi's Wireless Telegraph Co.	154, 246
Marryat & Place	150
Mawdsleys Ltd.	49, 74
Medway's Safety Lift Co.	171, 192
Metalite Ltd.	176, 187
Morgan Crucible Co.	144
Muirhead & Co.	86, 87
Nalder Bros. & Co.	86, 87
Nalder Bros. & Thompson	86, 87
National Telewriter Co.	146, 269
Nelson Bros.	18, 43
Nicholson (W. J.) & Clipper Co.	234
Oliver Arc Lamp Ltd	58, 64
Ozonair Ltd.	53, 70
Pape, Richard	196, 219
Parmiter, Hope & Sugden	81, 91
Parsons (C. A.) & Co.	203, 212
Paul, R. W.	240
Phillips' Commutator Grinder Co.	7
Phillips, J. W. & C. J.	3
Phœnix Dynamo Manufacturing Co.	59, 64
Pinchin, Johnson & Co.	155, 158
Pirelli Ltd.	172, 191
Pooley & Austin	49, 74
Pope's Electric Lamp Co.	207, 208

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Post Office London Telephone Service	29, 32
Post Office Telegraphs	283
Premier Electric Heaters	244
Proctor, Jas.	23, 38
Purcell & Nobbs	159
Rapid Magnetting Machine Co.	10
Reavell & Co.	232
Renold, Hans	250
Reyrolle (A.) & Co.	147
Rhodes (J.) & Sons	14, 47
Ronald Manufacturing Co.	248
Ruhl, O.	224
St. James' & Pall Mall Electric Light Co.	106, 109, 128, 131
Samuel Bros.	292
Schaffer & Budenberg	21, 40
Ship Carbons, Ltd.	58, 65
Siemens Bros. & Co.	179, 184, 206, 209
Silver Replating Powder Co.	287
Simmonds Bros.	160
Simplex Conduits Ltd.	148, 163
Slingsby, H. C.	279
Smith, J. Ciceri	239
Spagnoletti Ltd.	49, 74
Sterling Telephone & Electric Co.	127, 132
Stern-Sonneborn Oil Co.	28, 33
Stone (J. B.) & Co.	230
Sunbeam Lamp Co.	55, 68
Sunderland Forge & Engineering Co.	99, 116
Sun Electrical Co.	104, 111
Synchronome Co.	223
Tackley (W. C.) & Co.	286
Tella Camera Co.	—
Thomas, Bertram	22, 39
Tucker (J. H.) & Co.	78, 94
Unbreakable Pulley & Mill Gearing Co.	25, 36
Union Cable Co.	181, 182
Union Electric Co.	101, 114
Vedovelli, Priestley & Co.	56, 67
Venner & Co.	156, 157
Vickers Ltd.	241
Walker, Horrocks & Co.	231
Wallach Bros.	28, 33
Wandsworth Electrical Mfg. Co.	244
Watson (Duncan) & Co.	60, 63
Waygood (R.) & Co.	75, 97
Weil (L.) & Reinhardt	224
West, Allen & Co.	202, 213
Western Electric Co.	51, 72
Westinghouse Brake Co.	6
Westinghouse Cooper-Hewitt Co.	82
Westminster Engineering Co.	165
Whipp & Bourne	183
Wiggin (H.) & Co.	247
Willcox (W. H.) & Co.	177, 186
Wright & Wood	129, 130
Wright (Alex.) & Co.	237

The managers direct special attention to Rule 5, as follows :—

"Exhibitors, the nature of whose displays necessitates their showing goods of other manufacturers, agree not to advertise such makers' names either upon the article shown or upon their stands, unless such goods are manufactured by a fellow-exhibiting firm or are specified on the space contract. Any contravention of this rule will render the offending exhibitor liable for any damage that the Committee or the management may incur."

LEGAL INTELLIGENCE.

National Telephone Co. v. Postmaster-General.

The Railway and Canal Commission (Mr. Justice A. T. Lawrence, the Hon. A. E. Gathorne-Hardy, and Sir James Woodhouse) on Friday continued the hearing of this case.

Mr. F. Gill was re-examined by Mr. Danckwerts. Referring to the fire at the Bank exchange some years ago, caused by the switching on of the current on the District Railway, he said that there was no fuse at the time; the work had not been finished, and the men had not completed the work of moving the telephone cables. The railway company turned the current on as a result of a misunderstanding, and he thought he was right in saying that they accepted the liability and paid the damage caused. The telephone company especially protected circuits in close proximity to power wires and rails. It was effected by an adequate system of fuses. In the case of overhead wire there were two ways of protecting the telephones. The first to make it so that the telephone wires could not come down on the bare tram or electric power wire, and in the second place to prevent such an occurrence by means of fuses, so that if they did come in contact there would be no danger. There was really no danger in the face of these precautions in erecting telephone or telegraph wire near overhead power systems; in fact, the P.O. had taken compulsory powers to attach their telephone and telegraph wires to the trolley poles of the tramway and electric railway systems. There are advantages in overhead wires for telephone work, chiefly on account of clearness in transmission. He was referring to open cables. The audibility was not affected by reason of the cable being underground.

Mr. Wm. Cook, assistant engineer-in-chief of the National Telephone Co., said he recollected no case of trouble arising owing to an electric power cable coming into contact with a telephone wire except the instance of the Bank exchange. A number of the company's lines were laid in proximity to electric railways, but no trouble ever arose. In the notices of rejection given by the P.O. against lines laid along electric railways, there was no mention of tramways or light railways. As a matter of fact, he said, there were numerous lines or cables near electric tramways. Where the wires were bare wires carried on the trolley poles of a tramway or light railway it was not only protected in itself but there was a Board of Trade regulation that the tramway or light railway company should guard its wires from any contact with the telephone wires. He could only remember one case of fire originating from telephone wires falling on trolley wires and that was at Liverpool. The dangers of accident from plant laid along an electric railway was no greater than from that laid along an electric tramway or light railway. His company had 7,235 miles of circuit along the City & South London Electric Railway; between Westminster Station and the L.C.C. subway 2,667; and between the Borough and London Bridge 3,138. The crossing over or lying along an electric railway, he thought, was possibly less dangerous than crossing or passing along tramways or light railways. The lines laid along or near railway lines were suitable for the Post Office telephone service. He said that every call was responded to in an average of 5·5 seconds, and he should be greatly surprised if the Post Office could equal that. He thought it was possible that the carriage of cables and wires along underground tunnels could be carried to excess, and the P.O., he thought, was doing so. They were giving notice to "scrap" much material which would be useful to the P.O., some of it immediately, and other parts that merely wanted a little adaptation. There seemed no doubt to witness that the laying of lines along electric railways was quite safe if every possible precaution was taken to prevent the contact of the telephone wire with cables carrying current of higher tension.

Mr. H. F. Parshall, D.Sc., gave evidence in support of the company's contention that any part of their works and plant adaptable to the service of the P.O. should be taken over and compensated for. He thought it would be quite wrong to scrap things which could by any means be made useful.

Mr. S. Z. de Ferranti, President of the Institution of Electrical Engineers, expressed the opinion that the most economical way and the most efficient way of taking over the work of the company would be on a purely engineering basis, and, he thought, that should be done by a process of gradual absorption of the exchanges and works of the company. He admitted that much of the plant objected to could not be profitably taken over by the P.O., but contended, from his examination of several rejected and other exchanges, that much of the material in those exchanges could be profitably taken over by the P.O. He confirmed the view that there was a certain percentage of the plant in all the condemned exchanges which might be made useful by the P.O. and should not be rejected.

Sir Alex. B. W. Kennedy, consulting engineer, said he had listened to all the evidence in the case. There was some part of the condemned plant with which the P.O. could not dispense. From his experience he gave illustrations of the difficulty of effecting even comparatively small changes in electrical distribution, although the change was effected very gradually, and from that deduced that a great disturbance would be effected if the P.O. suddenly took over all the company's business in one day.

In answer to the Attorney-General, Witness said there was no difficulty in connecting the wires to one exchange and disconnecting them from another.

Mr. Justice Lawrence asked Mr. Danckwerts what was the position of the Company in the matter?

Mr. Danckwerts said the Company would ask the Court to say that the whole of the notices of the P.M.G. covered suitable plant and none of the exchanges of the Company should be condemned.

Mr. Justice Lawrence: We are in a difficulty. It seems to me that until we know what the Post Office scheme is, it is impossible for us to come to a conclusion upon the matter. You are rather putting the cart before the horse.

The Attorney-General said, unfortunately, they had decided to put the cart before the horse when the case started.

His Lordship said he did not think the Attorney-General should delay in bringing the case for the Post Office before the Court at the earliest possible moment.

Sir Jas. Woodhouse said, in his opinion, private wires must be taken over as a whole on the terms of the agreement—that was so far as they were suitable for the actual requirements of the Post Office service.

The Attorney-General said he had objected to the contention that if a cable contained one private wire and 599 other wires the Post Office must take over the whole cable whether the 599 other wires were good or bad. If he would meet the difficulty the P.M.G. was prepared to pay for the private wire or its value or such wires in a cable as were good. But the only thing the Court had to deal with, he submitted, was whether the plant objected to was suitable for the P.O. service or not. The Court could not say that a cable with one good wire and 99 bad ones was a cable suitable for the Post Office service.

Witness said it was not possible to separate good cables from bad ones. There was no question of unsuitability.

Mr. Hammond V. Hayes, of Cambridge and Boston, Mass., U.S.A., said he was employed by the Bell Telephone Co. in 1895, and until 1907 carried out their experimental work and scientific investigation. In 1902 witness was appointed assistant chief engineer to the American Telegraph & Telephone Co., and he held that position until July, 1907. He was responsible largely for the types and styles of equipment to be employed by the telephone companies in America using the Bell system. Since 1907 he had been in private practice, but he still retained connection with the American company as general expert. With regard to the system adopted in America, witness said they began with an overhead system, but telephony had developed to such an extent in the United States that in the centres of the large cities they had had to put their cables underground. From the centres the cables extended outwards in main arteries laid underground, and then emerged for distribution purposes to aerial cables, running along the sides of houses, the fencings of buildings, &c. In this manner, while some of the system was underground a very large proportion of it was overhead. There was no difficulty in working that combination of underground cables with overhead wires. They considered it a standard system and there were very few places in America where it did not prevail. They preferred it on account of its cheapness. Their overhead system was very similar to the method of construction here. His company had about £6,000,000 invested in overhead lead-covered cables. That figure did not include the cost of poles, &c., supporting those cables. A completely underground distributing system was a rarity in the United States of America. In regard to the common battery and magneto systems, witness said that in America the number of switchboards with local battery installations were diminishing in the large and crowded areas; in fact in such areas the local battery exchange had practically ceased to exist. That was due to the large increase in the number of subscribers, and the economy of time which might be effected in operation under the central battery system. It was really brought about by the necessity of putting in large switchboards in the place of old

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ones in the big exchanges. When that was done they, of course, installed the common battery switchboard. They had never scrapped any serviceable apparatus. He might say that within the last five years there had been more local battery apparatus manufactured and installed in the telephone service than ever before, even in the days when the local battery was the only system in use. The reason of that was that the business of telephony had developed in the outlying small towns and areas to such an extent that they not only needed all the local battery apparatus which they set free from the large exchanges to supply those small towns, but they also had need to manufacture a great deal more of it. In the small offices they used the local battery system practically exclusively. Of course, apparatus out of date or not serviceable through wear was scrapped but they had regulated their changes from the local battery to the common battery system in the large exchanges, so as to set free the local apparatus as it was wanted in the country districts. The switchboards had been in service for years. The majority of the local battery switchboards had had to be replaced because they had become too small to meet the demands of business pressure, and they had had to be replaced before they were worn out. In such cases they were used at small stations.

Mr. MORTON: Do you think it economical to effect a substitution from the local battery system to the common battery system in the London exchanges at one time rather than to do it gradually?

The ATTORNEY-GENERAL submitted that that was not relevant to the point which the Court had to consider. It was not a question of what was the most economical system.

His LORDSHIP: But is that not one of the elements which we have to take into consideration when deciding a question of suitability? Surely commercial suitability is a thing which comes into the matter?

The ATTORNEY-GENERAL submitted that it was not relative to the consideration of the Court. The question was not what commercial men would do under the circumstances of the amalgamation of two companies. That was an entirely fallacious way of approaching the case before the Court. The only question really was whether the P.M.G. was justified in the opinion he had formed that the plant in question was not suitable for the actual requirements of his service on a certain date.

His LORDSHIP thought that surely the question of economy was one which the P.M.G. must properly take into consideration before making up his mind.

Witness, continuing, said in his opinion, it could be an extremely wasteful and almost wicked thing to scrap apparatus which was useful and could be used in connection with the service simply because it did not happen to be wanted at a particular time.

Counsel was proceeding to question witness with regard to the suitability of telephone lines in the close proximity of high power cables when

The ATTORNEY-GENERAL said he did not propose to contend that that particular objection was one which could be maintained. Subject to the condition that proper precautions for protection were taken, he agreed he did not think the objection could be insisted upon. He would suggest that if any difficulty arose between the parties afterwards as to whether or not any particular cable was properly protected, some engineer agreed upon between both sides should view it and decide the matter. The P.M.G.'s attitude was that he was bound to take precautions to ensure that any plant which he took over was properly and sufficiently safeguarded. If that were done he would not raise any further point about cables or wires laid along, over, &c., electric railway lines and other electric power systems.

Some discussion ensued, and on the suggestion of Sir RUFUS ISAACS the Court decided to make a declaration that all telegraph lines in the proximity of high power cables were suitable, leaving it to the P.M.G. to point out any specific cases which might arise in which he was not satisfied with the precautions taken.

Mr. HAYES, further examined, said that in America they had overhead tramway systems throughout the country, and in connection with their telephone system they had to make frequent crosses over the bare traction wires in order to get their telephone wires from one side of the street to the other, &c. To avoid the risk of contact with the high-voltage traction wires they covered their telephone wires with rubber and their cables where they crossed the traction line were supported in such a way that the possibility of contact was reduced to a minimum. They also had protecting apparatus identical to that used in this country installed in the exchanges and that afforded complete protection against an outside current causing injury to the switchboard or telephone apparatus. He knew of no case where the protective apparatus had failed in its function.

Cross-examined by the ATTORNEY-GENERAL, Witness said that in America they avoided the use of the overhead system for the main arteries in the large cities. He had seen the Avenue exchange, and its system of overhead wires. They had nothing like that in America now, but they had when he began business 22 years ago. There was a city ordinance against the use of overhead cables in the crowded centres of America. For their overhead distributing service they used lead-covered cables for the most part. They also used indiarubber cables, which were quite satisfactory as lead-covered cables for short lengths. He did not agree that the lead casing was for giving greater protection. Their overhead lead-covered cables were identical with the cables used for their underground system and it was interchangeable, the object being to carry the system on practically as a unit as far as it was possible. He did not agree that indiarubber casing for cables deteriorated rapidly in the air from evaporation and chemical action because the indiarubber covering was wrapped round two or three times with another material. (Two papers were here put in by the Attorney-General which had appeared in an English electrical journal. The witness described as "Very highly interesting indeed." He had not himself seen anything quite like them.) He did not agree that rubber-cased cables were more dangerous owing to fire than lead-cased cables. His experience of fires was that in the case of a rubber-covered cable the fire might run a few inches and then go out. There had never been any question raised by the insurance companies with regard to the inflammability of these cables. In the American cities, generally speaking, his company obtained wayleaves and ducts free of charge. The people were only too glad to get the telephone system laid on. All the telephone exchanges in New York were on the common battery principle. They used to be on the local battery system, but they began to be changed about 14 or 15 years ago. He thought the last one was converted about four or five years ago, but the change had been a gradual one. All the telephones in New York were under one company, and there was no competition in the city. So far as he knew the power of the telephone company in New York to carry on its business was unlimited. He could not tell whether they had to apply to the Legislature of New York State for a licence, but he should say that probably throughout all the States of America it was necessary for the telephone company to get a licence from the ruling authority in each State. Taking the affiliated systems of his company, he should say they had about 10,000,000 subscribers' stations.

In answer to his LORDSHIP, Witness said that with regard to spare wires the practice of his company was to put down a cable containing as many wires as they thought there would be subscribers for at a given point. Then canvassers went round to endeavour to get the number of subscribers estimated. Frequently, so energetic were these canvassers, the company had to supplement the cables.

Mr. JAMES SWINBURNE said he did not think it was possible to make a sudden change-over from the Telephone Company's system to that of the P.M.G. It was difficult enough to do it in the case of a large exchange, but when it was proposed to do it in the case of all the exchanges the difficulties were increased enormously. To carry out such a change properly some time must be taken over the process.

The hearing was here adjourned.

On Tuesday there was a consultation which lasted three hours, after which,

The ATTORNEY-GENERAL stated in Court that the parties had agreed upon the form of the declaration to be made. It would not be necessary to trouble the Commissioners with the details, but the Court would be asked to make a declaration in the form agreed by the parties. That would dispose of everything before the Court—everything that had to be dealt with—preparatory to valuation being made at the end of the year. As to the degree of suitability under clause 4 of the purchase agreement, that point was still open to be taken before the Court.

Sir ALFRED CRIPPS said he understood the arrangement was that they should leave clause 4 as it was. It did not affect the agreement.

Mr. Justice A. T. LAWRENCE said he was extremely pleased that they had been able to come to terms. The Court trusted the terms would enable the matter to be worked out upon the valuation without further difficulty. There will be an order in the terms drawn up.

London Electric Supply Corpn. v. Westminster Electric Supply Corpn.

The Court of Appeal on Monday commenced the hearing of this appeal by plaintiffs from a judgment of Mr. Justice Joyce (reported in THE ELECTRICIAN for March 10 and April 14).

The action arose out of a dispute between the two companies as to the construction and effect of an agreement entered into by them relating to the management and working of the Westminster portion of plaintiff's undertaking. Both companies were competing companies, plaintiff company supplying alternating and defendants continuous current. Under the agreement (dated May 4, 1910) which was sanctioned by the Board of Trade, defendant company, for the consideration mentioned, took over the working of plaintiff company's undertaking in the Westminster area until it was purchased by the local authority. Plaintiffs wished to restrain defendants from attempting to induce any consumer in the Westminster area who took alternating current to cease to take same and in lieu thereof to take defendant company's continuous current, and secondly for a declaration that according to the true construction of the agreement, defendants were bound to supply electric energy by means of plaintiff company's alternating current to any consumer in the Westminster area who might apply to plaintiff company for a supply by alternating current. Mr. Justice Joyce held that defendants, by the agreement, purchased the right to work and take the profits of plaintiff's undertaking in the Westminster area, and that there had been no breach by defendants of any of their obligations under the agreement. Hence the present appeal of plaintiffs.

Sir A. Cripps, K.C., Mr. Gore Brown, K.C., and Mr. Austen Cartmell appeared for appellants; and Mr. C. A. Russell, K.C., Mr. Younger, K.C. and Mr. S. Kennedy for respondents.

Sir A. CRIPPS said the sole question in the case was the construction of the agreement. There were formerly stringent conditions against companies in the same area assisting one another, as it was thought they might by doing it be acting to the detriment of the public. In 1908 an act was passed by which powers were given to electricity undertakers in London to come to terms as to stand-by supply and also to make arrangements as to management and working in districts where two companies had powers. It was in virtue of that act that the two companies came to terms as to the Westminster area. The question in the case was whether defendant company were entitled to refuse to supply alternating current through their mains when it was demanded by con-

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sumers. Mr. Justice Joyce had held, in effect, that upon the construction of the agreement there had been a sale by plaintiff company of their undertaking in the Westminster area and that plaintiffs had really no interest in the Westminster area. Whereas, the fact was that plaintiff company still had large powers and rights in that area. The plaintiff company, by the agreement, had to be paid by defendants in proportion to the amount earned by defendant company by the supply of alternating current in the Westminster area and plaintiff's case was that defendants were not entitled, under their powers under the agreement, to destroy the plaintiff's chance of earning profits by the supply of alternating current. He contended that the learned judge had put a wrong construction on the agreement and that plaintiffs were entitled to the relief claimed.

Mr. CARTMELL having followed on the same side,

Mr. C. A. RUSSELL on behalf of defendants supported the judgment in the Court below.

At the conclusion of the arguments of counsel, the MASTER OF THE ROLLS gave judgment, and having referred to the material clauses of the agreement and sections of the Act of 1908, said that the agreement having been approved by the Board of Trade it was not open to either party to say that it was ultra vires. Speaking generally, what the agreement provided was that the entire management and control of plaintiff company's undertaking, so far as the Westminster area was concerned, should be vested in defendants, who should take all sums payable by customers of plaintiff company within the area, and that defendants should pay plaintiffs a fixed sum calculated on the takings of a prior year, which he would call in round figures £21,000 a year, and also guaranteeing that at the expiration of plaintiff's Parliamentary powers, and the public authority acquired the undertaking of plaintiffs, that there should be at least £100,000 for the plaintiff company. There were also provisions as to the prices to be charged by plaintiffs for electrical energy supplied by plaintiffs to defendant company, but there was nothing to be done in the Westminster area by plaintiff company. Before Mr. Justice Joyce plaintiffs contended that defendants ought not to solicit or attempt to induce any consumer in Westminster who took alternating current to cease so to do, and the defendant company had no right to compete with them. That contention seemed untenable, and his lordship considered that it was not a case were defendants were to be deprived of right of competing with plaintiffs. There was nothing from beginning to end in the agreement which said it was not to be open to defendants to say to any customer "you had better take the continuous current." He was quite satisfied that the judgment of the learned judge upon that point was right. Upon the second point raised he felt that Mr. Justice Joyce was also right, and that the appeal should be dismissed.

Lord Justice FARWELL delivered judgment to same effect.

Lord Justice KENNEDY, while feeling more difficulty upon the second point raised as to the declaration, did not see his way to differ from the conclusion arrived at by the other members of the court.

The appeal was, therefore, dismissed, with costs.

Smith v. Clothier.

At Liverpool Assizes on Tuesday, before Mr. Justice Horridge and a special jury, Wm. Smith, electrician, formerly employed by Bootle Corporation, sued Mr. T. D. Clothier, the borough electrical engineer, for damages for libel.

The alleged libel was contained in a report made by Mr. Clothier to his Electric Lighting Committee, and attributed to plaintiff's neglect a breakdown which occurred in the Bootle electric supply on Nov. 9 last year. Plaintiff's case was that the report led up to his being ultimately dismissed from the post of switchboard attendant, which he had held for nine yars. Defendant pleaded that the report was not defamatory, that it was true and that it was written without malice and on a privileged occasion.

Mr. MILLER, for plaintiff, said that the breakdown occurred in the afternoon of Nov. 9, at a time when defendant and his assistant engineer (Mr. Hudson) were present at a mayoral luncheon at the town hall. The breakdown lasted for half an hour. Plaintiff spent some time, without effect, in trying to ascertain the cause of the trouble, and the defect was ultimately located in the "balancer switch" by Mr. Hudson. Plaintiff's contention was that he was in no way responsible for the mishap.

PLAINTIFF said that when he was reprimanded he addressed a letter to the Electric Lighting Committee defending himself, but this letter was not read.

In cross-examination he said he had told Mr. Clothier he would make some revelations about the electricity station, but he did not intend that as a threat. Mr. Clothier secured him an opportunity of making the revelations he had spoken of, but on his solicitor's advice plaintiff did not go before the Committee when he was summoned.

JAMES B. HUDSON, assistant electrical engineer at Bootle, said that the switchboard was in a defective condition at the time of the breakdown. About 12 months previously it had given trouble. It ought then to have been effectively repaired, but he could not say whether that had been done. In witness's opinion plaintiff had done the best he could with the materials at his command to deal with the breakdown.

Replying to a question from his LORDSHIP, Witness said that in normal circumstances plaintiff was a competent man for his work, but owing to his excitable and erratic nature he was not resourceful in an emergency.

Mr. B. WOLFENDEN, a member of the Electric Lighting Committee, said that when plaintiff's letter was received by the Committee Mr. Clothier objected to its being read.

In cross-examination, he said that plaintiff had been dismissed because he failed to attend the special committee called to consider the complaints he had made against Mr. Clothier.

On Wednesday, the jury intimated that, having heard all the witnesses for plaintiff, they did not require to hear evidence for the defence, and were agreed that a verdict for the defendant should be returned.

His Lordship said that there was nothing against Mr. Clothier. It was simply an action against the Corporation. Judgment was then entered for defendant with costs.

Hartlepool Electric Tramways (Ltd.) and Others v. West Hartlpool Corporation.

The Court of Appeal on Wednesday decided on the application of defendants to expedite this appeal and the 17th inst. has been fixed for the hearing of the appeal of the defendants from the decision of Mr. Justice Bray, reported in THE ELECTRICIAN of June 30 (p. 477).

Jones v. Reorganisation & Control Syndicate and Another.

In the City of London Court on Wednesday Mr. S. A. Jones sued the Reorganisation & Control Synd. (Ltd.) and Mr. Demetrius J. Delyannis (otherwise De Lyann), editor of the "Cosmopolitan Financier," for the return of £45. Delyannis did not appear.

Mr. S. GOODMAN, for plaintiff, said his client had paid defendant company £45 for 40 shares (at 22s. 6d. each). It appeared that the London Electrobus Co. (Ltd.) was taken over by defendant company. Plaintiff had a considerable holding both in shares and debentures in the Electrobus Co., which ran seven or eight omnibuses in the London streets between 1906 and 1909, and in the latter year got into difficulties. In July, 1909, defendant syndicate was registered with a capital of £10,000 in £1 shares, without any articles of association. The chief promoter was Mr. Delyannis or De Lyann, who sent out a circular inviting the old shareholders of the Electrobus Co. to subscribe to defendant syndicate. Delyannis, who was managing director of the defendant company, spoke of the "splendid results" of the three months' working of the omnibuses.

Mr. OSBORN, for defendant company, said plaintiff might have a case against Delyannis, but there was not the shadow of a case against the company. Defendant company bought the omnibuses from the trustee for the debenture holders, and they ran them until the High Court stopped them. If plaintiff won all the other shareholders could bring similar actions.

Judge RENTOUL, K.C., said he could not help that. He had no doubt whatever there were material misrepresentations, and he found for plaintiff with costs. Whether the judgment would be worth anything or not he did not know.

PARLIAMENTARY INTELLIGENCE.

COAL MINES BILL.

The Grand Committee of the House of Commons, presided over by Mr. E. Wason, has continued the consideration of this Bill.

On Tuesday, clause 41, which deals with the means of signalling in shafts, was amended by the substitution of 25 yds. for 50 yds., so as to provide that every working shaft, and every shaft in the course of being sunk should, if exceeding 25 yds. in depth and not exempted in writing by the inspector of the division, be provided with some proper means for communicating distinct and definite signals from and to the bottom of the shaft, and from and to every entrance for the time being in use between the surface and the bottom of the shaft to and from the surface.

Clauses 42 to 46 were postponed and clause 47, relating to apparatus on haulage roads was, with some amendments, agreed to, clauses 48, 49 and 50 were also passed.

On Wednesday the Committee disposed of clauses 51, 52, 53, 54, and 56. These clauses relate to signalling, telephonic communication, fencing of machinery, &c., and were agreed to after some amendment.

Corporation of London (Bridges) Bill.—On Tuesday the House of Commons Committee to which this Bill has been re-committed commenced the reconsideration of the Bill, which seeks authority to construct the St. Paul's Bridge over the Thames and a thoroughfare north and south of the bridge, with tramways, and engineering and architectural evidence was given on behalf of the Dean and Chapter of St. Paul's.

On Wednesday Mr. M. Fitzmaurice, chief engineer to the London County Council, said he considered the width proposed for the new bridge and its approaches was adequate, and that the centre of the roadway was the best position for the tramway.

The Chairman subsequently announced that the Committee were of opinion that the scheme for the construction of the bridge, including the approaches, was, both in respect of architectural design and convenience of traffic, the best adapted to public needs and the best suited to the character of the site, and the Committee would report to the House accordingly.

Telegraph Construction Bill.—The Select Committee on this Bill will include Mr. Harwood-Banner, Sir Henry Norman and Mr. Herbert Samuel.

Winchester Corporation (Electric Supply) Bill.—This Bill has been read a third time in the House of Lords. The measure has to go through the House of Commons.

Sidmouth Gas & Electricity Bill.—This Bill was read a third time in the House of Commons on Wednesday.

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COMMERCIAL AND INDUSTRIAL SECTION.

MUNICIPAL, FOREIGN & GENERAL NOTES.

BRITISH NOTES.

Ashburton.—Messrs. Ferguson & Co. have intimated to the Council that they will apply for a provisional electric lighting order for supplying electricity in the district.

Barnet.—The agreement between the Council and the North Metropolitan Electric Power Supply Co. has been revised as follows: This agreement to be for eight years, an annual sum of £685 to be paid in respect of the lamps mentioned in the schedule, and the clause as to the lighting without extra charge during Barnet Fair to be excised. In the event of a reduction taking place in the charge to ordinary consumers, a proportionate reduction is to be made in the charge to the Council who will consent to the erection of feeder pillars; all matters in dispute to be disposed of by arbitration, the clause as to free wiring contained in the existing agreements to be abrogated. The Council will apply for a provisional order for Arkley, and will then transfer it to the Company, which will pay all expenses incidental to the application.

Barrow.—The electric supply mains are to be extended to the Bigger Bank district, at a cost of £407.

Beckenham.—The salary of the resident electrical engineer (Mr. J. E. Tapper) has been increased from £300 to £350 per annum.

Birmingham.—In consequence of the passing of the Greater Birmingham Bill the Tramways Committee are considering a comprehensive scheme of tramway extensions and improvements.

Bradford.—On Tuesday the Corporation decided, on the recommendation of the Tramways Committee, to apply to the Board of Trade for a provisional order authorising the Corporation to use rail-less trolley vehicles on two routes within the city.

The general manager of the tramways is to consider and report as to what districts of the city might be profitably served by the rail-less trolley system, dealing particularly with certain suggested routes.

The Chairman of the committee (Mr. R. Priestley) said that all suggestions for trackless routes would be carefully considered. It was the hope of some members of the Committee that a circular route might be established, opening out more of the general system. The rail-less system was only in its infancy, but the Committee were satisfied that the vehicle in use was running satisfactorily, and that there was a good future for the system.

The Electricity Committee propose to extend the supply mains from Eccleshill to Amberley Bridge at a cost of £4,145.

Brighton.—The Council have adopted a recommendation of the Tramways Committee to appoint a deputation to visit Bradford and Leeds to inspect the rail-less trolley system of traction.

Carnarvon Castle.—In connection with the Investiture of the Prince of Wales yesterday (Thursday), Carnarvon Castle had undergone various improvements and repairs, including the installation of the electric light. Current is taken from the mains of the local electricity works. The total candle-power provided throughout the castle is 10,000, and nearly all the lighting arrangements are intended to be permanent. There is also a complete telephone and bell installation. The whole of the work was entrusted by the Office of Works to the National Electric Construction Co., and was carried out by Mr. D. O. Evans, the company's manager and engineer for North Wales.

Cheltenham.—The Corporation will apply for a provisional electric lighting order for the parishes of Bishop's Cleeve, Southam and Brockhampton and Woodmancote.

Doncaster.—An inquiry was held on Wednesday into the application of the Corporation for sanction to borrow £12,000 for extensions of the electricity works.

The Town Clerk (Mr. Tovey) said that the outstanding loans on the electricity works amounted to £47,400.

The inspector (Mr. T. C. Ekin) remarked that some of the works for which the additional loan was asked had been commenced. He asked if any of the work was outside the area under the order.

The Town Clerk said that some of the work had been commenced, and some had been done outside the area of the order. £337 had been spent on lighting Bentley-road, the reason being that there was a large colliery work a mile and a half from the borough boundary on the Bentley side. Pressure was brought to bear on the Corporation by Doncaster Rural Council, and they had in view that some time Bentley would be part of the borough. Of the £12,000 a sum of £1,899 was for excess of expenditure, and the balance was for generating plant, mains, meters, &c. £8,210 was required for a new turbo-generator, alterations to coal bunkers, &c.

The inspector said he did not think the Board would sanction borrowing powers for meters. They strongly objected to the excess expenditure, and he had no doubt the Corporation would receive a strong letter from the Board about it.

Dover.—The salary of the borough electrical engineer (Mr. L. W. Woodman) has been increased from £425 to £475 per annum. Mr. Harpur, mains superintendent, and Mr. Smith, works superintendent, have been granted increases of £25 per annum.

Electrical Trades' Benevolent Institution.—The following subscriptions and donations were received from 31st May to 30th June 1911:—

	Subscriptions.	Donations.
J. Y. Fletcher	£1 1 0	—
Eckstein, Heap & Co.	—	£5 5 0
Brook, Hurst & Co.	1 1 0	—
J. & H. Grevener	—	3 3 0
J. W. Mumby	—	0 6 0
H. Lotery & Co.	—	2 2 0
Gillespie & Beales	—	1 1 0
Frederick Smith & Co.	2 2 0	—
T. W. Lench, Ltd.	—	2 2 0
Morgan Crucible Co.	—	1 1 0
Brown Bayley's Steel Works	—	1 1 0
Robert Kearsley & Co	—	1 1 0
J. Yates & Co., Ltd.	—	1 1 0
Vacuum Oil Co.	—	1 1 0
Joseph Breeden & Co.	2 2 0	—
Martin, Earle & Co.	—	3 3 0
Walter Scott, Ltd.	—	2 2 0
Brecknell, Munro & Rogers	—	1 1 0
R. Lynen	1 1 0	—
Pritchetts & Gold	1 1 0	—
	£8 8 0	£25 10 0

Folkestone.—The Council is to enter into an agreement with Folkestone Electricity Supply Co. as to the electric lighting of the roads on the West Cliff estate, at £3. 15s. per lamp per annum when the total does not exceed 20, and £3. 10s. when the total exceeds 20.

Hendon.—The agreement between the Council and the North Metropolitan Electric Power Supply Co. for the electric lighting of High-street, Edgware, has been sealed by the Council. The surveyor has been instructed to report as to the total cost of lighting the hospital by gas and by electricity.

Hornsey.—The Council have adopted a recommendation of the Electric Supply Committee to appoint an electrical engineer to advise the Council as to the type of plant to be adopted for the proposed extension of the electricity works.

Inquest.—An inquest was opened at Swalwell on Tuesday into the death of Robert Cragg, an electrician, who was killed at Swalwell Colliery, near Newcastle, on Saturday last.

William Oloman, joiner, said that he and deceased were preparing to start the motor which worked a pump in the Brockwell seam. Deceased had not put the switch on, but he touched the switch casing, and received a shock which proved fatal. Witness tried artificial respiration without success. Deceased had india-rubber gloves with him. He had the left-hand glove on. At the time of the occurence witness thought deceased would be opening the door of the switch to find what was the matter. Deceased should have had both gloves on.

Arthur G. Booker, electrician, stated that the voltage of the current was 440 alternating. He noticed that the back of the switchboard was off and no earth wire was conneced to the pillar, and one of the contacts was askew.

The Coroner said that as it was possible that H.M. electrical inspector of factories might desire to attend the inquiry he would adjourn the inquest for a week.

Islington (London).—London County Council have agreed to sanction £5,500 of the £6,500 loan recently applied for by the Borough Council.

Leyburn.—The Rural Council have authorised Mr. Sykes of Middleham, to erect poles and wires for the supply of electricity for public and private lighting in Middleham.

Linlithgow.—Mr. Geo. Balfour has given notice of intention to apply for a provisional order.

Llanelly.—The Llanelly and District Electric Light & Traction Co. will apply for an electric lighting order to extend their area of supply to Burry Port and Pembrey, and to Loughor and Dafen.

London County Council.—On Tuesday the Parliamentary Committee reported that, presuming Part II. of the National Insurance Bill was applicable to the Council's staff who came within the definition of workmen, there were 10,694 drivers, conductors, motor men, &c., who would come Tithin Part I. of the bill and 3,094 who would come within Part II., and as an employer the contributions would cost the Council £7,000 a year.

East India Dock-road Tramways.—The Highways Committee recommended a capital expenditure of £21,300 for the extension of the tram-

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ways in East India Dock-road to the county boundary at Barking-road, bridge. It is proposed to instal the conduit system.—*Postponed.*

Seven Sisters-road Tramways.—The same Committee also recommended the expenditure on capital account of £18,150 for the adaptation of the underground conduit system of electric traction of the tramways between Stroud Green-road and Green-lanes, and the construction of a junction line.—*Adjourned.*

Marylebone (London).—The whole of the public lamps in the borough have now been converted to electric light.

The Electric Supply Committee report that, subject to notice, the period of the Council's agreement with Mr. Arthur Wright, consulting engineer to the Council, would terminate at the end of March next, and they had decided (subject to the usual sanction) to give notice to Mr. Wright accordingly. The Council would still be able to have the benefit of Mr. Wright's advice in a consultative capacity if desired.

Oulton Broads.—Some time ago the Council decided to enter into an agreement to take a supply of electricity in bulk from the East Anglian Ice Co., but this resolution has been rescinded in favour of a scheme for the purchase of the undertaking of the Oulton Broad Electricity Co., which is supplying current in the district. The purchase price of the plant (without the generating station) is £1,300, and the company undertake to supply the Council with electrical energy at 230 volts at the following rates: Up to 20,000 units per annum at 2¼d.; 50,000, 2¼d.; 100,000, 2d.; 200,000, 1¾d.; above 200,000, 1¾d., the contract to be for 25 years, with an option to the Council to take over the generating plant at 15 years at a valuation. The company would accept payment of the £1,300 in instalments to be spread over 5¾ years.

Poplar.—The electrical engineer (Mr. J. H. Bowden) reports that an expenditure on feeders is necessary for next winter's heavy load, at a cost of £1,280. There will also be extensions of the distribution network, making the total cost of extensions for the year £6,635.

Rotherham.—The Board of Trade has issued an order giving the Council power to supply electricity in Greasborough.

Scarborough.—The Streets and Buildings Committee have approved the estimate (about £6,000) of the borough engineer (Mr. W. H. Smith) for taking up the rails and reinstating the highways now occupied by the electric tramway tracks, and the engineer was instructed to forward the estimate to the Trackless Tramways Co., who are negotiating with the local tramways company as to taking over the tramway service.

Sheffield.—The Tramways Committee recommend the City Council to obtain powers in their next Parliamentary bill to extend the tramways in eight directions, and also to run rail-less electric cars on roads connecting some of the outlying suburbs. The recommendations were accepted.

Owing to the increasing demand for electrical energy for power and lighting, the manager of the electric lighting department (Mr. S. E. Fedden) recommends the Council to sanction the expenditure of £61,000 on extensions of plant, &c.

Mr. Fedden states that the regular demand upon the works is from 8,500 to 9,000 kw. and there is an increase of 2,000 kw. each year. Next winter he anticipates that even with the new plant now under construction he will have no margin, and no time should be lost in placing the order for plant, which includes £16,800 for three new boilers and accessories, £2,500 for three economisers, 83,800 for pipework, £20,000 for one 4,000 to 6,000 kw. turbo-alternator, £4,600 for switchboard, £980 for machine cables, and £9,275 for buildings. The matter has been referred to the Finance Consultative Committee for report.

A proposal to employ overhead wiring in connection with the extension of street lighting to Attercliffe has been referred back.

Turton.—The Council have applied for sanction to a loan of £4,500 for distributing cables, house services, &c.

Wholesale Hardware Club.—We have received a copy of a booklet issued by this Club, which contains a short history of the Club, list of members and other information.

The President for 1911 is Mr. Chas. Churchill, and the honorary council for the current year include Messrs. K. Allwood (General Electric Co.), J. Scott Balfour (J. P. Craggon & Co.), F. A. B. Lord (W. F. Dennis & Co.), S. Ewart (Ewart & Son) and other gentlemen prominent in the hardware industries. The hon. secretary is Mr. Jas. Keeves and the secretary Mr. R. Cooper, and the offices are at Royal London House, 14, Finsbury-sq., E.C. The annual subscription is two guineas and the Club has departments to deal with insurance, debt recovery, legal work and other matters of considerable importance to the trades comprised in the hardware and allied industries. The social side does not appear to have been neglected, and meetings of the various sections are frequently held at the offices to discuss trade matters. No doubt the Club will serve a very useful purpose, and when properly organised should be of considerable advantage to its members.

Will.—Mr. E. Boulnois, chairman of the Central Electric Supply Co., and a director of the Westminster Electric Supply Corpn., and of the Calcutta Electric Supply Corpn., &c., left estate of the gross value of £55,157, of which the net personalty has been sworn at £43,941.

Wireless Patents Litigation.—With regard to statements that have appeared as to proceedings commenced against the Marconi International Marine Communication Co. (Ltd.) by the Lodge-Muirhead Wireless & General Telegraph Synd. (Ltd.), Messrs. Coward, Hawskley, Sons & Chance, solicitors to the Marconi Companies, notify that proceedings had been instituted by the Marconi Co. against the Lodge-Muirhead Synd. prior to the action taken by the Lodge-Muirhead Synd.

Wireless Telegraph Notes.—A wireless station has been erected at Swakopmund by the military authorities. Steamers of the German East African line have all been fitted with wireless apparatus and messages are frequently interchanged between these vessels and Swakopmund.

It is reported that negotiations are proceeding between the Australian Wireless (Ltd.) and the Federal Government for a licence to allow the syndicate to establish and operate for commercial purposes a temporary wireless station in Melbourne. The rates to be charged for wireless messages received in or to be sent to Australia are (it is further stated) under consideration. A fixed minimum fee for each message is suggested, probably a minimum of about 5s. for a message of four or five words, with an extra charge of 1s. or 1s. 3d. for each additional word.

At the Investiture of H.R.H. Prince Edward as Prince of Wales at Carnarvon yesterday two wireless telegraph stations were established, equipped with Marconi sets. One was situated within the precincts of Carnarvon Castle and the second in the neighbourhood of the Yeomanry camp. These stations were also in communication with the Royal yacht and the vessels of the Fleet stationed at Holyhead, and with the camp of the Western Division. The sets of apparatus are the property of the Westmoreland and Cumberland Yeomanry, and are similar to the sets which are now in general use in military operations in this country.

The Postmaster-General has issued a notice that radiotelegrams can now be handed in at any telegraph office in the United Kingdom for transmission to ships equipped with wireless telegraph apparatus, at a charge of 10½d. per word without a minimum, or 2½d. with a minimum of 2—1, or 5d. with a minimum of 2—6, in each case, for messages to ships making Atlantic voyages. When ships have passed out of range of the Post Office stations they are accepted for transmission through the Marconi Co.'s long-distance station at Poldhu at 3s. a word without a minimum. Radiotelegrams are also accepted for transmission to ships through wireless stations abroad. Information on the subject can be obtained at any telegraph office.

York.—The Council in committee have adopted recommendations to construct tramways to the Bishopsthorpe-road district at £16,440, and to Heworth at £25,263.

Electro-Harmonic Society.—The W. E. Lane Testimonial Fund.—The presentation to be made to Mr. Lane in recognition of his long and excellent services to this Society will be made on the occasion of the first concert of the ensuing season. The action of the executive committee in proposing this testimonial to Mr. Lane has received the cordial approval of the members when making their donations.

Outing.—The employés of Messrs. Bruce Peebles & Co. selected Crieff this year for their annual outing. The party numbered over 400 and was favoured by the best of weather. Sports and prizes, drives, walks, golf, &c., were enjoyed, the outing proving most successful.

COLONIAL AND FOREIGN NOTES.

Argentina.—The "Review of the River Plate" says the Cia Electrica del Norte has applied to the Municipality of Santiago de Estero for an electric tramway concession.

Mendoza Government has approved plans for electric tramways in the city of Mendoza, under the concession held by the Electric Light & Power Co., and the concession for water power has been increased to 1,600 h.p.

The Government have accepted the proposal of the Lacroze Tramway Co. (Buenos Ayres) to extend their lines to Campo de Mayo.

The Cia Franco-Argentina de Electricidad has applied to Government for authority to increase the capital from $3,000,000 to $10,000,000 (paper), and to issue debentures (in gold or paper) in Argentina or abroad. The company was formed a few months ago to purchase the electricity supply works at Salta, and has since purchased the Lemoussin concession for a station at La Plata, the construction of which will shortly commence. It is stated that it has also acquired a controlling interest in the Anglo-Argentine Electricity Co., which owns stations at Concordia, Gualeguay, Uruguay, Gualeguaychu (gas and electric), Chascomus and Tandil

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Philipp, Holzmann & Co. have obtained a contract from the Anglo-Argentine Tramway Co. for the construction of the underground railway between Plazas Once and Mayo (Buenos Ayres).

Australasia.—Continuing its sittings at Melbourne, the Metropolitan Traffic Commission took evidence from Mr. W. J. C. Riddell, chairman of the Melbourne and Metropolitan Board of Works.

Mr. RIDDELL said he was in favour of municipal, as against State control of tramways. Surpluses from the tramways should be retained for tramway uses, and should not be divided amongst the municipalities. After a sufficient sinking fund had been built up the remainder of the surpluses should be devoted to reducing fares. He thought the supply of electric power for all public services in Melbourne should be carried out by one authority.

Mr. J. TURNBULL (superintending engineer of the Melbourne Tramway & Omnibus Co.) said electrical machinery could be used to drive the company's cable cars, but he could not see what economy there would be. With steam power the speed could be increased, but the machinery would have to be altered. The company's lease expired in 1916.

Mr. W. CALDER (civil engineer to Prahran Council) said there were three street miles of cable trams and two of electric trams in Prahran. He was opposed to centre poles, and to overhead wires in the principal streets, and he favoured municipal as opposed to State control.

The Commission subsequently visited Sydney, where Mr. JOHN KNEESHAW (tramway traffic superintendent and member of the Tramway Advisory Board) said, in evidence, that the Board dealt with tramway proposals involving a less expenditure than £20,000. All the purely tramway lines in N.S.W. were controlled by the State, except two miles from Rockdale to Brighton-le-Sands. The tramways in Sydney and suburbs were equal to 184¾ miles single track, mostly electric, and the question of converting the 17 miles of steam tramways on the outskirts of Sydney was under consideration. The revenue was £1,000,000 last year and the debt outstanding was £4,335,000. There was 5 per cent. return on the capital. The electrical system overcame a rush of traffic more readily than the cable system, being more flexible.

Austria-Hungary.—The "Oesterreishischer Zentral-Anzeiger" states that Budapest municipal authorities intend to establish an electric power plant with a capacity of 10,000 kw., at a cost of about £416,000, and the owners of the Budapest Electric Railway have applied to the local authorities for permission to extend their generating station on the bank of the Danube.

A syndicate has been formed at Göiz to erect electric power works. Herren Ignaz Rüsch and Leopold Rhomberg, of Dornbirn, have submitted to the Water Rights Commission a project for the use of the falls of the Leiser between Gmund and Seebach for the generation of electrical energy at Spittal (Carinthia).

Chili.—Señores Juan Bersano and Natalio Farinelli have secured a 10 years' concession for the construction and working of an electric tramway in Valdivia.

Customs Duties.—A recent supplement to the Australian Customs Tariff Guide states that the following duties are leviable on imports into the Commonwealth:—

Electric bells (brass or gunmetal) 30 per cent. (British goods 25 per cent.) ad val.; brush holders for dynamos, 20 per cent. (British or other).

According to a recent decision, paper tape (in rolls) for use with telegraph machines is subject, on importation into British South Africa, to import duty of 3 per cent. ad val., under the General Tariff. British goods are subject to 3 per cent. rebate.

France.—Consular reports state that work in completion of the Bassin Loubet at Boulogne has slackened. The quays (900 metres in length) are to be supplied with 20 electric cranes.

In the Lyons district the factory system has, in great measure, superseded family looms, but at St. Etienne and adjacent districts the family workshop holds its own. Here electric power can be adapted to the ribbon looms with little disturbance or reconstruction of the machinery, while in the case of piece goods the rebuilding of the entire loom mechanism is said to be necessary. A trimming (passementerie) hand loom can be converted into a power loom for £12, the conversion of a piece-goods loom being from £56 to £60. This accounts for the modest success that has attended the efforts in Lyons of a society formed for the purpose. The number of small power looms at Lyons has only increased from 343 in 1906 to 381 in 1909, whereas at St. Etienne the conversion has been successfully carried on. In the Loire and Haute Loire there are about 35,000 looms, of which 5,000 are in large works, while the remainder are in small private workshops. Of these 28,000 looms about 12,000 are driven by electricity. The operation of the law of March 30, 1900, relating to hours of labour is said to inflict some hardship on the silk industry dependent for their motive power on electricity generated by water, as storms, low water or frosts sometimes interfere with the flow of the water and cause a stoppage of work for several hours. The law, however, not only restricts the working day to 10 hours, but makes it obligatory on the factory owner to fix beforehand and post up on his premises the hours during which his works are open and the various intervals for rest, with the time at which they begin and end. These irregular stoppages affect adversely those who depend on the hydro-electric works for their power. Many factory owners have agreements with the electric power companies for a term of years, and some ingenuity has been expended in devising expedients by means of which they may make up time lost by these stoppages of current while keeping within the law. It is hoped that the regulations may be amended by increasing the number of overtime days per year, or by allowing such hours as have been lost owing to the interruption in power supply to be made up on a certain number of subsequent days without being reckoned as overtime.

The building of steam engines for industry purposes has been declining for some years, owing to the growing competition of electricity generated by water power in the Alps and transmitted to Lyons by overhead cables. The manufacture of electric cables and wire is in a flourishing condition.

Electricity has been substituted for steam as the motive power of the Lyons waterworks.

There has been considerable opposition to the scheme for the construction of a barrage across the Rhône at Genissiat, below Bellegarde, a lake covering 900 acres and extending to the Swiss frontier, and a waterfall with a fall of some 220 ft., to generate 170,000 H.P. of electrical energy, which it is intended to transmit to Paris. Two rival schemes have been formulated, and are receiving considerable support locally. One was presented by the French company who are actually using the natural fall of the Rhone at Bellegrade (50 ft.) for generating electrical energy which they distribute to consumers in the Departments of the Ain and Savoie. This scheme involves the construction of a large barrage on the site of the existing dam, above the Perte du Rhone, which would not be destroyed as in the Genissiat scheme. Power houses would be constructed at Coupy, close to the barrage, and at Elvise, and these, with the existing station at Bellegarde, would be capable of generating nearly 200,000 H.P. in summer and 100,000 H.P. at low water in winter. The second scheme, formulated by another French company, is more in the nature of a complement to the first, and contemplates the construction of another barrage creating a second smaller lake 3 miles in length, below the larger one, and forming a fall some 65 ft., capable of generating a minimum of 30,000 H.P. The energy thus produced would, it is thought, lead to the erection of electro-metallurgical and electro-chemical works in the area served. These alternative projects are regarded with more favour locally than the Genissiat scheme.

The Government will shortly erect, at an estimated cost of £40,000, a large power house on the River Drac (Isre) for generating electricity required for working a new railway to be constructed by the State from La Mure, the coal mining centre, to Gap (Hautes Alps) on the Paris, Lyons and Mediterranean Railway from Briançon to Marseilles, connecting up the coalfields directly with the chief French shipping port.

The experimental installation at Lyons of the Lorimer automatic telephone system, originally designed to last 12 months, was prolonged for another year, and only came to an end towards the close of 1910. It is stated that "the unqualified success of the experiment after so thorough a trial was signally proved by the reluctance displayed by the 200 persons who had been provided with the automatic apparatus to return to the ordinary service. There does not, however, appear (according to the report mentioned) to be any immediate prospect that the State will adopt the Lorimer system, though the question is still under consideration.

Experiments are being made by one or two of the colliery companies in the district in the generation of electrical energy by low grade coal.

There is a tendency towards the creation of small home workshops in the country districts round Roanne, with electricity as their motive power.

German South-West Africa.—A consular report states that land-line telegraphic communication (at 3d. per word) has been opened from the Union of South Africa to German South-West Africa. In the other direction the charge is about 3.d. per word. There is a good telephone system in the Protectorate, embracing about 50 towns and villages.

India.—"Indian Engineering" states that the Jamalpore locomotive workshops of the East Indian Railway are now manufacturing a three-phase auto-transformer in three units, and an e.h.t. single-phase tranformers for use in the testing and calibration of electricity meters, &c.

The South Indian Railway Co. have purchased a 25 H.P. motor for driving machinery in the boiler shop at the Negapatam workshops.

Telephone communication is being provided between stations on the East Indian Railway from Lillooah and Khana Junction.

Italy.—The Soc. Varesina per Impress Elettriche have obtained a concession for the construction of an electric tramway from Varese to Bizzozgero.

The Municipality of Rome decided on Tuesday to consider a scheme for the construction of an underground electric railway in the city, which would embody certain features of the London and Paris lines.

Spain.—H.M. Legation at Madrid reports that under the law for the suppression of the "consumos" or octroi duties, the duties are suppressed from July 1, 1911, in such towns as are not bound by contract to farm out the duties after that date. In other towns the duties will be abolished at various times before Jan., 1921. The chief sources of municipal revenue will in future include a surcharge on the State tax on the consumption of gas and electricity.

Switzerland.—A concession has been granted to Messrs. Masson (Veytaux), Gilliéron (Vevey) and Chenaux (Villeneuve) for the construction of an electric railway, on the rack and pinion principle, from Glion to Sonchaux, with a branch to Caux. The line will be nearly 3 miles in length, and the cost is estimated at £64,000.

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ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Burnley.—The capital expended on the electricity undertaking at March 31 was £117,450, an increase of £5,208 over 1910.

The net income from the sale of current was £24,613, and meter and motor rental, &c., brought the total to £25,127. The total costs were £11,034, leaving a gross profit of £14,092. Interest absorbed £2,723. 10s., sinking fund £4,384, depreciation £1,468, and after paying interest on consumers' deposits (£17) the balance (£5,500) was devoted to relief of rates. The works costs were 0·535d. (against 0·621d.) and total costs (including capital charges) 1·228d. (against 1·392d.) per unit sold. There are 1,157 consumers (998), and the total connections in 32-watt lamps are equal to 82,605 (72,908), and the motors connected are equal to 841¾ (710¾) B.H.P. The maximum load was 2,100 kw. (1,772 kw.) and the load-factor 19·28 (20·93) per cent. 3,547,985 (3,249,387) units were sold, including 1,099,965 (972,549) for private lighting, power, &c., 7,522 (7,522) public lighting, and 2,440,498 (2,269,325) for traction.

Darwen.—The total income of the tramways department for the year ended March 31 was £13,790, including £13,548 from traffic receipts.

The total expenses (including £1,050 for depreciation) were £9,721. Interest required £2,069 and sinking fund instalments £2,186, leaving a deficit of £390. The total capital expended is £85,725. 2,601,007 passengers were carried and 250,064 car-miles run.

Glasgow.—The accounts of the electricity supply department for the year ended May 31 show gross revenue £260,526, against £245,960 in 1909-10.

The working expenses were £109,547, against £105,138, and after paying interest (£58,605), sinking fund (£41,142) and allowing for depreciation (£44,552) there was a net surplus of £6,680 (against £191) which has been transferred to reserve. The ratio of increase in working expenses to increase in revenue is regarded as particularly gratifying as 5,826,409 units more were generated. The average cost per unit has been reduced 0·1005d. The other expenses are much the same as last year, but an increase of £1,007 is shown in rates, taxes and assessments. The capital expenditure for the year was £80,833, making the total capital expenditure £1,889,715. During the year domestic consumers obtained energy for cooking, heating and other domestic uses at 1d. per unit compared with 3d. per unit for lighting, without separate wiring. The number of consumers already benefiting by this scheme, which was only started in Oct. last, is 300. With the above modification the committee recommend that the rates be the same as last year. The number of consumers at May 31, 1911, was 21,166, compared with 19,489, an increase of 1,677.

Gloucester.—The capital expenditure on the electricity undertaking for the year ended March 31 was £867, making the total £91,906.

The total revenue was £13,609, including £10,316 net from sale of current and £2,508 from Light Railways Committee. The total expenditure was £6,876, leaving a balance of £6,734 to meet interest (£2,776), sinking fund, &c. (£2,881), and out of the surplus from the working of the last two years a sum has been applied in paying for meters and other items, leaving £941 to be carried forward; 832,313 units were sold to private consumers for light and power, and 199,527 supplied for public lighting and 601,832 for traction. The total maximum supply demanded was 770 kw. for light and power and 476 kw. for traction.

In the report of the electrical engineer (Mr. F. H. Corson) it is stated that the output for lighting and power increased by about 177,000 units and the current sold for industrial power was more than double in amount that of 1909-10. There are 745 consumers an increase of 55, and the equivalent of 71,538 30-watt lamps is connected, an increase of 6,971.

Hull.—The accounts of the tramways department for the year ended March last show capital expenditure (including £2,485 on motor 'buses) £491,418 (increase £7,000). The total amount contributed to sinking fund is £89,109 and to reserve fund £51,558.

On the tramways the revenue was £143,340, working expenses were £95,509, gross profit was £47,830. After paying interest on capital, loan instalments, contribution of £2,528 for street widening, and £1,844 income-tax, and taking into account £5,121 deficit on the motor omnibuses, there was a surplus of £13,251. Car miles run (on the tramways) were 3,695,281, passengers carried were 37,415,152 and units used 4,444,335. Traffic revenue was 9·22d. per car mile and working expenses (with power) were 6·39d.

The accounts of the electricity supply department (which made a profit of £8,347 on the year's working) were abstracted in THE ELECTRICIAN for June 30 (page 480).

Newcastle-under-Lyme.—The capital expenditure on the electric light department for the year ended March 31 was £9,793, an increase of £82 over 1910.

The income from sale of current was £1,882, and with meter rental, &c., the total was £1,945. The working expenses were £769, and after allowing £12 for bad debts the gross profit was £1,164. Interest required £315 and repayment of principal and sinking fund £407, leaving a net profit of £441, against £83. The units sold were 83,262 (72,221 for lighting and 11,041 for power). The maximum load was 107 kw.

West Ham.—The total income of the tramways department for the year ended March 31 was £128,408, including £129,659 (10·138d. per car-mile) traffic revenue.

The working expenses were £91,209, leaving a gross profit of £37,199. Interest and stock dividends absorbed £14,199, interest on mortgage loans £3,958, hire of tramcars £31, contributions to loans and sinking funds £11,030, and of the unappropriated balance £8,513) a sum of £1,590 has been devoted for top covers to cars and to adapting cars for through running on conduit system, and £6,923 placed to reserve. The capital expenditure is £533,245, an increase of £619. During the year £8,718 was spent on track maintenance, against £3,429; 12 additional tramcars were delivered, bringing the total to 118, and another 20 of the old cars are being fitted with top covers by direct labour. The consumption of electrical energy for traction amounted to 5,182,257 units (1·69 unit per car-mile) and the cost was £20,513. Meters have been fixed on some cars and the average consumption per car-mile by these cars was 1·26. It is, therefore, proposed to extend the use of meters. Experiments with metal filament lamps for car lighting have been made with encouraging results. 37,297,992 passengers were carried against 36,846,649, and 3,069,324 car-miles run, against 2,907,805.

TRADE NOTES AND NOTICES.

TENDERS INVITED

BRADFORD Corporation invite tenders for the supply and erection of two water-tube boilers, stokers and superheaters, and one 12-ton electrically-operated overhead travelling crane. Copies of specification, conditions of contract and forms of tender from the city electrical engineer and manager, Mr. Thos. Roles, Electricity Offices, Town Hall, Bradford. Tenders to the Town Clerk, Mr. Frederick Stevens, by 10 a.m. Tuesday, July 25. See also an advertisement.

WOLVERHAMPTON Electricity Committee invite tenders for the supply, delivery and erection of a 264-cell, 6,000 ampere-hour storage battery together with a motor-driven regulating switch; two motor-driven boosters (approximately 150 kw. output each) and switchgear and instruments. Specifications from the borough electrical and tramways engineer, Mr. C. E. C. Shawfield, M.I.E.E. Tenders, addressed to the Chairman of the Electricity Committee, Town Hall, Wolverhampton, must be in by 10 a.m. July 31. See advertisement.

Tenders are invited for supplying plant and materials and the erection of electric supply station buildings for lighting the DUNDALK Urban District area, under its Electric Lighting Order, 1897. The plant includes generating station buildings, gas producing and generating plant, balancer and booster, switchboard, storage battery, mains (overhead and underground) electricity meters and travelling cranes. Copies of specifications, general conditions, &c., may be seen at the offices of the clerk, Mr. Mathew Comerford, Town Hall, Dundalk, or at the offices of the consulting engineers, Messrs. T. L. Miller, Wilson & Pegg, Donegall-square, Belfast, 709, Tower-buildings, Liverpool, or 19, Brazenose-street, Manchester. Tenders to the town clerk, Dundalk, by 10 a.m. July 24. See also an advertisement.

Tenders are invited up to Aug. 23 for the supply of telegraph and telephone material to the Postmaster-General's Department in SOUTH AUSTRALIA. Specifications, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W. See also an advertisement.

Tenders are invited up to Aug. 16 for cable, conduits, c.i. pipes, iron poles, insulators, wires, &c., for the Postmaster-General's Department in QUEENSLAND. Specifications from the Commonwealth Offices, 72, Victoria-street, London, S.W. See an advertisement.

Tenders are invited (up to Aug. 15) for the supply of (*a*) 80,000 insulators and (*b*) indiarubber covered wire to the Postmaster General's Department in VICTORIA, and (up to Aug. 23) for the supply of letter box fronts to the Postmaster-General's Department in QUEENSLAND. Tender forms and specifications from the Commonwealth Office, 72, Victoria-street, London, S.W. See also advertisements.

LONDON County Council require tenders by 11 a.m. July 18 for supply of steel tyres for tramcars—6,000 for driving wheels and 4,000 for pony wheels. Specifications, &c., from the Chief Officer.

LONDON County Council also require tenders, by 11 a.m. July 1 for supply of tramway track insulators until April 30, 1912. Specifications from the Chief Officer.

LONDON County Council also require tenders by 11 a.m. July for roadwork and platelaying of conduit system tramways in Gree lanes, Mildmay Park and Southgate-road and Seven Sister's-roa and for the construction of a tramway from Brixton to Herne H on the overhead system and for paving works and street widenin Specifications from the Chief Engineer.

The Urban District Council of ESHER and the DITTONS inv tenders for the installation of a system of wireless alarms in Than Ditton and Long Ditton wards of the district. A plan of the distr may be seen at the Surveyor's offices, where particulars may obtained. Tenders to the clerk, Mr. E. A. Everett, Council Offic Thames Ditton, by July 24.

YORK Corporation want tenders by noon July 17 for about 2,000 of h.t. 3-ph. underground mains laid solid, and for erection of a batte

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room at Foss Islands electricity works. Specifications for cables from the City Electrical Engineer and for battery room from the City Engineer.

WALTHAMSTOW Council require tenders by noon July 21 for feeder cables and stoneware conduits. Specifications, &c., from Mr. G. R. Spurr, Electricity works, Walthamstow.

ILFORD Education Committee want tenders by noon July 15 for wiring and supply of fittings at Cleveland-road School, Ilford. Specifications from Mr. A. H. Shaw.

ERDINGTON Tramways Committee require tenders for construction of permanent way (copper bonding, wood paving, &c.) of about 1¼ miles of double track tramways, and for laying about 10,000 yds. super. of Jarrah wood paving between the permanent way and the kerb. Particulars from the Engineer.

Committees of BACUP Council invite tenders for wiring and fitting premises (General Works Committee), court house, police buildings and fire station (Watching and Fire Brigade Committee), and wiring and fitting the baths.

WEDNESBURY Corporation require tenders by mid-day July 24 for supply of 150-cell battery (470 amperes at 1½ hour rate of discharge), about 2,400 yd. 0.25 sq. in. concentric lead-covered paper-insulated cable, and joint boxes. Specifications, &c., rom the Engineer and Manager of the Electricity Department.

SOUTHAMPTON Corporation require tenders by 11 a.m. July 19 for supply of a motor generator and a condenser. Specifications, &c., from the Borough Electrical Engineer.

PONTYPRIDD Council require tenders by July 18 for supply of an additional unit at their Treforest refuse destructor. Specifications from Mr. J. E. Teasdel, Treforest.

Tenders are required by 10 a.m. July 24 for wiring work, &c., at the County Hall, The Castle, WINCHESTER, where forms can be obtained.

Tenders are invited up to July 18 for the supply of 4 tons 6 cwt. bare hard-drawn copper cables to the City of MELBOURNE, Australia. Copies of specification, tender forms, &c., from the agents for the City Council (McIlwraith, McEacharn & Co. Ppty., Ltd.), Billiter-square-buildings, London, E.C.

Tenders are invited up to Aug. 9 for the supply of letter-box fronts to the Postmaster-General's Department in NEW SOUTH WALES and for four motor cars (petrol) complete and for the supply of letter box fronts to the Postmaster-General's Department in SOUTH AUSTRALIA. Tender forms and specifications from 72, Victoria-street, London, S.W.

Tenders are invited up to July 23 for 12 sections of a branching multiple magneto lamp signalling switchboard, &c., or one automatic or semi-automatic switchboard, &c., to the Postmaster-General's Department in VICTORIA; up to July 31 for telegraph and telephone material for the Postmaster-General's Department, HOBART (Tasmania); up to Aug. 8 for measuring instruments, telephone instruments and parts, trembling bells and gong to the Postmaster-General's Department in VICTORIA; and up to Aug. 23 for telegraph, telephone and electric lighting material to the Deputy Postmaster-General in NEW SOUTH WALES. Specifications, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W.

Tenders are invited up to Aug. 30 for the supply of porcelain insulators, copper wire, sleeves, &c., to the Postmaster-General's department in SOUTH AUSTRALIA. Specifications, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W.

Tenders will be received at the Post and Telegraph Office, Paris, until July 18 for supply of rubber insulated electric cables, &c.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.) are prepared to receive tenders for the supply, delivery and erection at the site of their Cossipore station, Calcutta, of auxiliary plant, and pipework. Copies of specification, drawings, &c., from the Secretary of the company, Mr. Francis R. Reeves, Salisbury House, London Wall, London, E.C., to whom tenders by 10 a.m. July 24.

The time for the receipt of tenders by the Ministry of Public Works, Constantinople, for an electric power and tramway concession for JERUSALEM, is extended to Sept. 13. Specifications (in French) may be seen at 73, Basinghall-street, London, E.C.

The Metropolitan Water and Sewerage Board, Albert-street, BRISBANE, Queensland, want tenders by noon Jan. 30 next for supply and erection, of one, two or three complete units, each consisting of power generating plant and pump or pumps to lift not less than 6,000,000 gallons per day. Particulars from the Secretary.

MORTLAKE (Victoria) Butter & Cheese Factory Co. require tenders by noon Aug. 14 for supply of dynamo and booster, storage batteries and accessories, switchboard, cables, &c. Specifications from Messrs. F. A. McCarty & Co., 31, Queen-street, Melbourne.

WELLINGTON (N.Z.) Corporation require tenders by 4 p.m. Aug. 24 for supply of a motor power waggon and accessories for the electric tramways department. Gonville and Castlecliff Tramway Board, Ridgway-street, WANGANUI (N.Z.) require tenders by 4 p.m. Aug. 14 for supply of overhead tramway material, feeders, &c. Conditions, &c., can be seen at 73, Basinghall-street, London, E.C. Representation in New Zealand is necessary.

STAVROPAL (Caucasus) Municipal Council invite tenders until Aug. 14 (O.S. Aug. 1) for the construction and working of an electric tramway.

Tenders will be received at the Town Hall, SYZRAN, Russia, on Oct. 14, for the construction of an electric tramway and the supply of electrical energy for lighting.

PHILIPPOLIS (Bulgaria) Municipality require tenders by Aug. 4 for a 50 years' concession for electric or gas lighting and for the provision of electric tramways. A deposit of £6,800 is required.

TENDERS RECEIVED AND ACCEPTED.

London County Council have received the following tenders for the supply, &c., of four car-traversers for the Cressy-road, Streatham (extension), Camberwell (extension) and Hammersmith (third section) car sheds :—

Brush Electrical Engineering Co. (*accepted*)	£2,297
Dick, Kerr & Co.	2,452
Hurst, Nelson & Co.	2,525
Cowans, Sheldon & Co.	2,592
S. S. Whiteley & Co.	2,768
S. H. Heywood & Co.	2,780
Heenan & Froude	2,962
Stothert & Pitt	3,822

Chief officer's estimate, £2,900.

The Brush Co. are to be allowed to sub-let to A. Hickman (Ltd.), the Shelton Iron, Steel and Coal Co., the Lilleshall Co., or Stewarts and Lloyds, the rolled steel sections and plates; to F. H. Lloyd & Co., or Rennies Steel Castings Co., the general steel castings; to Hadfield's Steel Foundry Co., the steel castings (wheel centres); to Cammell, Laird & Co., the tyre forgings; to J. Baker & Co., the axle forgings; to F. W. Rowlands, the case-hardened pinions and gear wheels; to Samuel Buckley & Sons, Hall and Pickles, or William Robertson, the bright rolled or drawn shafting; to T. A. Ashton, or R. Hunt & Co., the turned shafting; J. Crowleys & Sons, or Jonas Wells, the malleable iron castings; and the Anti-Attrition Metal Co., the pedestal bearings.

London County Council have also received the following tenders for (*a*) weighbridges for the Greenwich-road permanent-way depot for weighing permanent way materials, sand for cars, &c.; and (*b*) (in place of an existing weighbridge) for Old Kent-road central stores depot, in connection with the electric transport vehicles :—

	(*a*)		(*b*)
Ashworth, Son & Co., (*acc.* for (*a*))	£133	.....	£130
W. & T. Avery (*acc.* for (*b*))	142	.....	122
Day & Millward	140	.....	145
H. Pooley & Son	154	.....	140
Bartlett & Son	155	.....	139

Chief officer's estimates, £145 and £130.

Ashworth, Son & Co. are to be allowed to sub-let to Walter Scott (Ltd.) the steel girders for the weighbridge for the Old Kent-road depot.

London County Council have also accepted the tender of Hadfield's Steel Foundry Co. for cross-over for Victoria Embankment tramways, £563. 13s. 6d.

West Ham Corporation recently obtained competitive schemes and prices from four firms for the extension of the e.h.t. switchgear. Of the schemes, the best in the opinion of the electrical engineer (Mr. H. H. Couzens) were those submitted by the British Thomson-Houston Co. and the British Westinghouse Co. The two firms were subsequently asked to quote for an extended scheme, which would allow of the re-arrangement of all the Council's switchgear as follows :—(1) converting the old British Thomson-Houston 6,000-volt board for 2,000-volt working, and transfer the existing feeders to the new board, replacing them by those on the Ferranti board, the last mentioned to be used for works supply and pioneer work where required. (2) The feeders at present connected to what is known as the "stop" switchgear, viz., that situated on the elevated platform to be replaced by the step-up transformers, which are to be re-arranged. The quotations received were :—British Westinghouse Co., £1,885; British Thomson-Houston Co., £2,031. In Mr. Couzen's opinion the tender of the British Thomson-Houston Co. should be accepted because of the better general design, greater immunity from breakdown, and the apparatus more accessible. He also suggested that a provisional sum of £150 be included in the contract to cover cost of adding "arresters," &c., subject to the settlement of detail. These recommendations were agreed to by the Council.

The tender of F. Smith & Co., has also been accepted for supply of trolley wire, &c., at £3. 11s. 2d. per cwt., less 2½ per cent.

Woolwich Electricity Committee have received tenders for supply of "Association" grade small wires :—

W. T. Glover & Co., £1,452. 5s.; Baxendale & Co., £1,452. 6s.; Siemens Bros. & Co., £1,415. 19s. 6d.; New Gutta Percha Co.,

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£1,221. 2s. 6d.; Sun Electrical Co., £1,182. 16s. 3d.; C. A. Macintosh & Co., £1,097. 10s. 2d.; Liverpool Electric Co., £1,074. 9s.; General Electric Co., £907. 15s. 7d.; W. Geipel & Co., £892. 2s.; Aubert, Grenier & Co., £836. 8s.; Pirelli (Ltd.), £826. 17s.; Adnil Electric Co., £739. 5s.

The Committee reported that the tenders related to 13 sizes of cable, to be ordered in quantities as required, the prices being for lengths of one mile. Having regard to the tenders as a whole, they were of opinion that the General Electric Co.'s was the most advantageous, and recommended that this tender be accepted to a value of £1,000.—Agreed.

Hull Tramways Committee have accepted the following tenders:—Brush Co., 18 or 24 car bodies, £347 each, and trucks, £37. 10s. each; Siemens Bros. Dynamo Works, 18 or 24 pairs 33 h.p. motors, £180 per tram, and controllers, £49. 10s. per tram; John Baker & Co., wheels and axles, £10. 10s. per pair; Bricknell, Munro & Rodgers, trolleys, £6. 5s. each; W. Boydell & Son, resistances, £9. 5s. per pair.

The City of London Guardians have accepted the tender of Pinching & Walton for six dozen "Z" lamps, 50 c.p. 240 volts, at 36s. per dozen, also six dozen lamps, 16 c.p. 240 volts, at 39s. per dozen.

Keyasham Council have accepted the tender of the local electric light company for continuing the lighting of the present number of lamps, and new lights are to be considered where a recommendation is brought forward by the Lighting Committee.

Walsall Council have accepted the tender of the Rees Roturbo Mfg. Co. (at £1,295. 3s.) for supplying and erecting pumps, motor and electrical equipment required at the sewage disposal works. Nine other tenders were received.

St. Helens Council have accepted the tender of Ferranti Limited for switchgear for 2,000 kw. turbo-alternator and that of Babcock & Wilcox for a steel chimneystack.

Stockport Council have accepted the tender of McClure & Whitfield for alterations of the electric light installation at Hollywood Park Schools.

Hornsey Council have accepted the tender of E. Lawrence & Sons (£3,513) for work in connection with the extension of the electricity station buildings.

Stepney (London) Council have accepted the tender of G. Weston & Sons for wiring the St. George's Town Hall at £272.

Richmond Council have placed an order with Jas. Simpson & Co. for a duplicate electric pumping plant at Petersham Well for £124.

Doncaster Electricity Committee have placed an order with Willans & Robinson for a steam generating set.

Blackburn Council have placed orders with the British Westinghouse Co. for a 2,000 kw. turbo-generator and two rotary converters, and with John Stirk & Sons for a lathe.

"Indian Engineering" hears that the D.P. Battery Co. have an order for supply of 504 13-plate and 1,320 17-plate accumulators for the North-Western (India) State Railway.

BUSINESS NOTICES.

The Benjamin Electric (Ltd.) announce that Mr. Guy Campbell, formerly sales manager of Holophone (Ltd.) has joined their company. New offices and show rooms have been opened at 117, Victoria-street, Westminster, S.W., but the works and warehouse remain at 1A, Rosebery-avenue, E.C., as before. The Benjamin Co. have purchased the stock and goodwill of Mr. C. F. Trippe, of 36, Brooke-street, Holborn, and all communications should be sent to the new offices, at 117, Victoria-street, S.W. The Benjamin Co. intend to manufacture (among other products) specialities necessary for efficient industrial lighting.

Messrs. Baxendale & Co., Miller-street, Manchester, inform us that their business has been registered as a private limited company, and will in future be carried on under the style of Baxendale & Co. (Ltd.) This step has been taken for purely family reasons, and the limited company will consist solely of the partners in the firm, who will devote to the management and the interests of the concern the same attention as hitherto.

The Newcastle-on-Tyne offices and stores of Messrs. Gent & Co. have been removed to 52, Blackett-street.

The Prescot works of the British Insulated & Helsby Cables (Ltd.) will be closed from noon Saturday, Aug. 5, to 8 a.m. Monday, Aug. 14, for the annual overhaul, and the Prescot offices will be closed from noon Saturday, Aug. 5 to Wednesday, Aug. 9.

Patents Development.—The owner of patent No. 16,183/1908, for "Improvements in or relating to telephony and telegraphy," desires to negotiate for the granting of licences thereunder. Particulars from Messrs. Lloyd Wise & Co., chartered patent agents and consulting engineers, 46, Lincoln's Inn Fields, London, W.C.

The proprietor of patent No. 13,163/1905 for "Improvements in dynamo electric machines," desires to dispose of the patent rights or to negotiate for the granting of licences. Particulars from Messrs. G. F. Redfern & Co., patent agents, 15, South-street, Finsbury, London, E.C.

The proprietors of patents No. 18,408/1906, for "Improvements in electric insulators for high-tension conductors," and No. 23,878/1900, for "Improvements in process of and mechanism for separation of conductors from non-conductors" desire to enter into arrangements for exploiting same in this country. Applications to Messrs. Haseltine, Lake & Co., Patent Agents and Consulting Engineers, 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

The proprietor of patent No. 10,577 (1908), relating to "Alternating current regulators, more particularly for incandescent lamps," desires to license British manufacturers to work same in Great Britain. Applications to Messrs. Boult, Wade & Tennant, patent agents, 111-112, Hatton-garden, London, E.C.

Reduction in Prices of Wires and Cables.—The India Rubber, Gutta Percha & Telegraph Works Co. have issued a circular notifying that the prices quoted in their price list No. 40 (of Oct., 1910) for Association grade 2,500 megohms, 600 megohms, 300 megohms, 600-volt, C.M.A. and Association pure india rubber flexibles are subject to 27½ per cent. discount as from July 10.

W. T. Henley's Telegraph Works Co. announce that they have made substantial reductions of the prices in their trade list.

We are informed that all the firms belonging to the Cable Makers' Association are making similar reductions.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during June, 1911, and (*b*) during the current year from Jan. 1 to June 30, with the increases or decreases compared with the corresponding periods of 1910:—

Electrical machinery (*a*) £83,724 (increase £37,374), (*b*) £545,302 (increase £265,870); telegraph and telephone cables (*a*) £26,241 (increase £15,073), (*b*) £188,666 (increase £116,219); telegraph and telephone apparatus (*a*) £15,599 (increase £1,175, (*b*) £79,827 (decrease £9,275); other electrical wires and cables, rubber insulated (*a*) £7,545 (decrease £22,778), £43,403 (decrease £55,912); with other insulations, (*a*) £2,401 (increase £663), (*b*) £18,430 (increase £3,855); carbons (*a*) £7,835 (decrease £2,338), (*b*) £63,941 (decrease £4,092); glow lamps (*a*) £15,247 (decrease £26,508), (*b*) £153,755 (decrease £115,810); arc lamps and electric searchlights (*a*) £156 (decrease £96), (*b*) £753 (decrease £1,048); parts of arc lamps and searchlights (other than carbons), (*a*) £9,273 (increase £3,878), (*b*) £55,613 (increase £19,970); primary and secondary batteries (*a*) £2,560 (decrease £763), (*b*) £22,453 (increase £1,882). Total of electrical goods and apparatus, other than machinery and telegraph and telephone wire (*a*) £98,990 (decrease £29,305), (*b*) £688,520 (decrease £32,307).

Exports.—The exports of electrical machinery, material, &c. (*a*) during June, 1911, and (*b*) during the current year from Jan. 1 to June 30, and the increases and decreases compared with the corresponding periods of 1910, are as follows:—

Electrical machinery (*a*) £133,308 (decrease £17,402), (*b*) £831,615 (increase £112,192); telegraph and telephone cables (*a*) £71,921 (increase £42,148), (*b*) £367,880 (decrease £532,214); telegraph and telephone apparatus (*a*) £22,860 (increase £6,756), (*b*) £132,397 (increase £50,430); other electrical wires and cables, rubber insulated (*a*) £37,139 (increase £10,156), (*b*) £204,005) increase £4,642); with other insulations (*a*) £26,947 (decrease £4,040), (*b*) £193,400 (increase £48,409); carbons, (*a*) £1,024 (decrease £225), (*b*) £9,422 (increase £760); glow lamps (*a*) £12,366 (increase £1,044), (*b*) £77,756) (increase £14,939), arc lamps and searchlights, (*a*) £2,395 increase £741), (*b*) £10,131 (increase £711); parts of arc lamps and searchlights (other than carbons) (*a*) £1,780 (increase £752), (*b*) £8,056 (increase £1,317); primary and secondary batteries (*a*) £9,410 (decrease £2,439), (*b*) £69,489 (inecease £16,323). Total of electrical goods and apparatus, other than machinery and telegraph and telephone wire, (*a*) £236,287) increase £68,121), (*b*) £1,354,433 (decrease £338,361).

BANKRUPTCIES, LIQUIDATIONS, &c.

The first meeting of creditors of Cuthbert Fenton Lindop, electrician, lately trading at 62, Dale-street, Liverpool, will take place on July 19 at 35, Victoria-street, Liverpool, and the public examination on July 24 at the Court House, Victoria-street, Liverpool.

A meeting of the creditors of Wm. Tully, mica merchant, 16, Water-lane, Gt. Tower-street, E.C., was held on 5th inst. The statement of affairs showed unsecured liabilities £466, assets £44. O.R. continues to act.

A meeting will be held at 11, Ironmonger-lane, London, E.C., on Aug. 9 to receive an account of the winding-up of the Electro-Peat Coal Co. (Ltd.)

A meeting will be held on Aug. 14 at 2, Coleman-street, London, E.C., to receive an account of the winding up of the Buchholtz Reversible Turbine Synd (Ltd.) (In liq.)

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COMPANIES' MEETINGS AND REPORTS.

BOMBAY ELECTRIC SUPPLY & TRAMWAYS CO. (LTD.)—The report for 1910 states that the total revenue for the year (including amount represented by sale of current to the tramways) was £219,317, an increase of £21,469. The total expenditure amounted to £192,139, an increase of £7,007. The net receipts from the year's working (£97,177) showed an increase of £14,482, or 17·5 per cent. After deducting £32,383, proportion of debenture interest chargeable to revenue, and £629, appropriated to sinking fund in lieu of interest on debenture stock cancelled in 1909 and 1910, there remains £64,164, which with £4,567 brought forward makes £68,731. The directors recommend that £15,000 be placed to depreciation and £6,000 to sinking fund for capital redemption, carrying forward £11,748. The traffic receipts from the tramways amounted to £144,182, against £134,153. The working expenses in Bombay amounted to £73,488, compared with £70,596, leaving a balance of £73,222, compared with £65,918. Of the 10 new single truck cars which it was decided to construct last year, six were brought into operation before the close of the year, the remaining four being completed early this year. The directors have decided to add 12 more single truck cars during the present year. The gross receipts from electricity supply (including sale of current to tramways) amounted to £66,921, compared with £57,552. The working expenses were £43,897, against £40,934. The balance of £23,024 compares with £16,618 for 1909. The Bombay Municipal Council has agreed to a tariff of flat-rate charges for the supply of electrical energy to all consumers, except for power purposes, in substitution for the maximum demand system. The work of erection and equipment of the generating station at Kussara has been proceeded with, and it is expected that the new power house will shortly be completed. The capital expended during the year in connection with the new Kussara power station, on new mains and the further equipment and improvement of the tramways amounted to £129,882.

CORDOBA LIGHT, POWER & TRACTION CO. (LTD.)—At an extraordinary meeting on Wednesday it was decided to increase the capital of the company to £1,000,000 by the creation of 200,000 new shares of £1 each. The chairman (Sir Irving Courtenay) said it was not the board's intention to issue shares, but they proposed to make use of the further borrowing powers which the increase of the share capital would automatically give them to raise the money required in the course of the next few months or so by means of short-dated notes. The business gave promise of such results after the new hydraulic installation of the Light and Power Company was in full working and the tramways were now completed that they were not disposed to load the company with further long-dated debenture debt. They considered it more advantageous to be able to review the situation in the course of a few years' time. The new tramway concession accounted for the greater part of the increase in the money required, as they wanted further plant and rolling stock for the larger service. They had provided all the reserve steam plant which the concession definitely called for up to April 1, 1914, but the Government were entitled to insist upon the installation of certain further steam plant when they thought it was required. In view of the rapid expansion of the business and the fact that in time of severe drought they would not be able to supply all their customers with their present steam plant, they had decided to anticipate the requisition of the executive and install further plant now. The combined results of the subsidiary companies for the year to March 31 compared with those of the previous year gave an increase of £6,000 in the surplus over working expenses, in spite of an additional expenditure of some £15,000 on the working of the steam plant.

ELECTRIC CONSTRUCTION CO. (LTD.)—The net profit for the year ended May 31, after payment of £7,612, 18s. 6d. for debenture interest and crediting £5,000 as formerly to depreciation account, is £15,041, 17s. The sum brought forward is £6,416, 9s. 8d., and the amount available for distribution is therefore £21,458, 6s. 8d. The directors recommend payment of the dividend of 7 per cent. on the preference shares (£4,294, 12s.), a dividend of 2½ per cent. on the ordinary shares (£5,625), transfer to general reserve (which will then amount to £25,000) of £5,327, 8s., leaving £6,131, 6s. 8d. to be carried forward. The directors are pleased to report a better demand for electrical machinery, and a marked increase in net profit during the past year. Little improvement has taken place in prices, but, in consequence of the increased volume of business, the costs of production have been reduced, and if the present demand be maintained the directors view the future with confidence. During the year a portion of the company's holding in the Madras Electric Tramways (1904) (Ltd.) was disposed of and part of the proceeds applied in redeeming the balance of £10,000 of the second mortgage debenture stock and £17,300 of the first mortgage debenture stock. The net deficit arising from these transactions has been debited to general reserve. The reduction of the debenture stock, besides strengthening the financial position, has effected a considerable saving in standing charges.

GREENWOOD & BATLEY (LTD.)—At the meeting on Saturday the chairman (Major-Gen. E. Micklem) said that the first half of the past year showed a very poor margin of profit, but in the second half of the year they made a fair profit in the face of great competition, although not sufficient to prevent the results for the whole year being somewhat disappointing. The textile, tool, electrical and turbine departments had all turned out a fair amount of work, while there was a satisfactory increase in the orders received in other departments. The total orders received were about £17,000 in excess of those received in 1909-10, while the total sales were about £43,000 in excess of that year.

ELECTRICITY SUPPLY TABLES AND DATA.

This Valuable Set of Tables and Engineering Data relating to Electricity Supply and to Electric Traction on Railways and Tramways in the United Kingdom, the Colonies, and some important places abroad, is now ready, and can be obtained complete in handy book form, price 6s. 6d. post free, or on very hard paper for rough or constant use, price 8s. 6d. post free. A complete Index is included.

JAMES KEITH & BLACKMAN CO. (LTD.)—At the meeting on Wednesday the directors reported that for the year ended March 31 the amount of business done was considerably in excess of that of any previous year. After providing for debenture interest and making sufficient allowance for depreciation and reserves against doubtful debts, the net profit was £10,556, making with balance forward (£2,389) £12,946. In addition to the preference dividend an ordinary dividend was declared of 6 per cent., £5,000 was placed to reserve, and £2,081 carried forward. The continued growth of the business necessitated further extensions at both works, and additional capital will be required. Shares are offered to the existing shareholders.

MARCONI'S WIRELESS TELEGRAPH CO. (LTD.)—The directors' report for the year ended Dec. 31, 1910, states that during the year the company's business has shown considerable extension, the gross trading profit for the year having amounted to £127,452, 13s. 1d. and the nett profit to £60,513, 0s. 3d. The directors do not think it prudent to continue to set out the figures in the form submitted in 1909. The large sum due from the Canadian Company remains to their debit, and the arrangements contemplated this time last year, which would have enabled that company to liquidate its indebtedness, were deferred owing to the prosecution in the United States of directors and officers of the United Wireless Telegraph Co., which for the time being disturbed the financial atmosphere in all matters concerning wireless telegraphy throughout the North American continent. This prosecution recently concluded with the conviction and sentence of the accused. The total par value under the heading "Patents and shares and debentures in Associated Companies" stands in comparison with last year at a reduced figure. This is due to a reduction in the face value of the shares in the Marconi Wireless Telegraph Co. of America. The number of shares, however, remains the same, and this Company's interest in the American Company is unchanged. The amounts appearing in the balance sheet at the end of the year under "Loans from bankers and sundry creditors" have since been mostly, and are about to be entirely, paid off, except as regards current trading accounts.

The successful working of the trans-Atlantic service has demonstrated beyond question the great practical value of wireless telegraphy for long-distance telegraph service. Application has been made by Commendatore Guglielmo Marconi on behalf of this Company for patents for a new, and what is believed to be a very valuable, invention, consisting of a new duplex system adapted to wireless telegraphy. This invention has been submitted to a practical and thoroughly successful test at the Clifden trans-Atlantic station.

In the early part of 1910 the directors commenced an action against one of the infringing companies, resulting in a declaration of the validity of the Company's patent No. 7,777. This patent is of paramount importance, embracing syntonisation, and with it dated the real practical commercial utility of wireless telegraphy. The directors are advised and believe that no wireless station of any practical utility can be erected without infringing this patent. It will be the policy of the directors vigorously to maintain your rights both at home and abroad. As a result of this action substantial benefit accrues to the Company in the form of compensation and in other ways.

Shareholders will have appreciated the significance of the resolution adopted at the Imperial Conference to construct an Imperial chain of wireless telegraph stations. The business of the Associated Companies continues to show marked improvement, and will continue to develop with the ever-increasing application of wireless telegraphy. An important contract has been entered into with the Canadian Government, by which the Canadian Company will work under a considerable subsidy a large number of coast stations in Canada and be entitled to retain also the whole of the telegraph receipts therefrom. The Argentine Company will proceed with the erection of a long-distance station to communicate with Europe, and every endeavour will be made and all assistance given by this Company to assure its early completion.

It is confidently anticipated that the large sums of money which in the past have been expended by this Company in experimenting and developing long-distance wireless telegraphy will be well rewarded. This Company alone has succeeded in erecting long-distance stations able to conduct day and night commercial wireless telegraph service. The future policy of the Company lies mainly in this direction, and negotiations of an important nature are pending to erect and work, or be interested in the working of a chain of wireless telegraph stations around the world. Numerous negotiations are pending with Governments, and some important agreements have been entered into; the directors consider, however, that it would not be in the interests of the Company to give further information upon this subject at this moment.

The Belgian Company has paid dividends for the year, 1910, amounting to 50 fr. per capital share (10 per cent.) and 24 fr. per founder share. The French Company has paid a dividend for the past year of 5 per cent. The Marconi International Marine Communication Co., whose business also is growing extensively, has declared for the year, 1910, its first dividend at the rate of 5 per cent. This Company owns 200,182 fully-paid shares in the International Company of a total capital issued of 204,056 shares.

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Owing to the strenuous competition and other circumstances which obtained in Germany an agreement has been entered into by the Belgian Company, with this Company's consent and approval, under which all the mercantile vessels in Germany flying the German flag, fitted with either the Telefunken or Marconi system, were transferred to a new company entitled the Deutsche Betriebsgesellschaft für Drahtlose Telegraphie m.b.H. Neither this Company nor the Telefunken Company will in future fit any mercantile vessels flying the German flag; this business will be carried on exclusively by the new company, who now hold the licences from both the Telefunken and Marconi Companies for this purpose; the system installed will be known as the "Debeg." The arrangement embraces the German mercantile marine only. The Belgian and the Telefunken Companies hold the shares of the "Debeg" Company, and the board is composed of members of those two companies and include Commendatore G. Marconi and Mr. G. C. Isaacs. The Company's business generally continues to show substantial increase, and the directors have pleasure in recommending payment of the cumulative 7 per cent. dividend upon the preference shares to the end of 1910, which will absorb £16,599. 13s. 2d. There will thus remain to the credit of profit and loss account £49,119. 4s. 8d., which will allow of, and the directors will recommend, the declaration of a dividend on the ordinary shares. Subject to the approval by the general meeting of the payment of dividend on the preference shares, it is the intention of the directors to immediately declare an interim dividend on the preference shares for the half-year ending June 30 at the rate of 7 per cent.

Since the last meeting, Commendatore G. Marconi has resigned his position as joint managing director and Mr. Godfrey C. Isaacs was appointed sole managing director. The lamentable death of Sir Charles Euan-Smith left a vacancy on the board. Mr. Hammersley Heenan retires by rotation, but as his business occupations at a distance from London do not allow of his devoting such time to the Company's business as he would desire, he does not offer himself for re-election. Col. Albert Thys and M. Maurice Travailleur, for years intimately associated with the Company's business, have been elected members of the board.

MELBOURNE ELECTRIC SUPPLY CO. (LTD.)—At an extraordinary meeting on Monday a resolution was passed authorising the directors to raise any sum of money not exceeding £100,000. Additional capital is necessary owing to the rapid increase in the applications for light and power.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

HALLS, BUILDERS (LTD.) (116,633.)—Reg. July 4, capital £1,000 in £1 shares, to take over the business of builders and decorators carried on as Hall & Co., and the business of electrical engineers carried on by C. Wainwright. Private company. First directors: A. C. Edwards and H. H. Trendler. Reg. office: 5, Blackstock-road, Finsbury-park, London, N.

LAUNCESTON & DISTRICT ELECTRIC SUPPLY CO. (LTD.) (116,654.)—Reg. July 5, capital £10,000 in £1 shares, to carry on at Launceston and elsewhere in Cornwall the business of an electric light company in all its branches. First directors: C. H. Gillbard, T. B. Hender, J.P., J. Kittow, W. Prockter, J.P., R. B. Rogers, W. H. Symons and T. P. Trood, J.P. Office: Westgate, Launceston.

METAL DEPOSITING SYND. (LTD.) (116,614.)—Reg. July 3, capital £1,500 in £1 shares, to carry on the business indicated by the title and that of founders, engineers, metal workers, &c., and to adopt an agreement with H. A. Harvey and G. P. M. Lee. Private company.

STATUTORY RETURN.

UNION ELECTRIC CO. (LTD.)—Return to May 18 gives capital as £25,000 in £1 shares. 24,250 shares taken up. £1 per share called up on 4,250 and 1s. per share on 19,500. £5,225 paid. £500 considered as paid on £500 shares. Mortgages and charges, nil.

MORTGAGES AND CHARGES.

GILBERT ARC LAMP CO. (LTD.)—Mortgage, dated June 30, to secure £500 and further advances, charged on company's book debts. Holders: Engineering & Arc Lamps (Ltd.).

IMESON, FINCH & CO. (LTD.)—Debenture, dated June 28, to secure £800, charged on company's undertaking and property, including uncalled capital. Holders: Hanson, Brown & Co.

RUSHMORE LAMPS (LTD.)—Particulars of £2,000 debentures, created April 3, 1911, have been filed, amount of present issue being £1,000. Property charged: Company's undertaking and property, present and future. No trustees.

SIMMS MAGNETO CO. (LTD.)—Issue, on May 31, of £2,500 debentures, part of a series of which particulars have already been filed.

STANIAR, CLEGG & CO. (LTD.)—Debenture, dated June 13, to secure £170, charged on the company's undertaking and property, present and future, including uncalled capital. Holder: H. D. Staniar.

RECEIVERSHIP.

KRAMOS (LTD.)—S. P. Jackson, C.A., Bank-chambers, Bath, ceased to act as receiver and manager on July 3

CITY NOTES.

MEMORANDA (July 13).—Bank rate 3 per cent. (March 9, 1911.) Price of silver, 24⅜d. per oz. Consols 78½—78¾ for money and for account. Consols Pay Day, Aug. 2; Stock and Shares Continuation Days, July 26 and Aug. 14; Ticket Days, July 27 and Aug. 15; Pay Days, July 14 and 28; Mining Shares Carry Over Day, July 25.

PRICES OF METALS (London).—*Copper*, cash, 57⅛; three months, 57⅜. *Lead*, English, 13⅝—13¾; Foreign, cash, 13⅝—13⅞, three months, 13⅝—13¾. *Spelter*, 24¼—25. *Tin*, English, 192—194; Foreign, cash, 195¼; three months, 188—188¾. *Iron*, Cleveland, cash, 46/10½, three months, 47/7½.

AN ELECTRICAL COMBINATION.—A powerful combination of financiers, contractors and electrical engineers has, we are informed, been effected to undertake the finance, design, construction and operation of large electrical works in all parts of the world. Among those interested are leading French and English institutions. The London board of management consists of Messrs. J. Norton Griffiths, M.P. (president), E. P. Powles, R. D. McCarter and J. Kerr Bock. The name of the company is Griffiths Electric Contractors (Ltd.). The London agents are at Griffiths House, London Wall, E.C., with branch offices in East and, West Canada, South America, Australia, New Zealand, South Africa, Spain, Turkey, &c.

BOURNEMOUTH & POOLE ELECTRICITY SUPPLY CO. (LTD.)—The directors have declared an interim dividend on the 4½ per cent. preference and 6 per cent. second preference shares, and also an interim dividend on the ordinary shares at the rate of 5 per cent. (less tax) for the half-year ended June 30.

CITY & SOUTH LONDON RAILWAY CO.—The accounts for the half-year ended June 30 last show a balance after providing for debenture stock interest, dividend on preference stock, and the transfer to renewal fund of £1,500 and £800 for general purposes, sufficient to allow the payment of a dividend on the consolidated ordinary stock at the rate of 1¾ per cent. per annum, carrying forward £2,798. The dividend for the corresponding period last year was at the rate of 1¼ per cent. per annum, carrying forward £1,634.

Mr. J. F. S. Gooday, late general manager of the London, Brighton & South Coast and Great Eastern Railways (and now a director of both companies), has been elected a director of the City & South London Co.

CLONTARF & HILL OF HOWTH TRAMROAD CO. (LTD.)—An interim dividend has been declared at the rate of 3 per cent. per annum (3s. per share) for the past half-year.

DIRECT UNITED STATES CABLE CO. (LTD.)—The board have resolved to pay a final dividend of 2s. per share, together with a bonus of 1s. per share (both tax free), such dividend and bonus to be payable on and after 31st inst., and making with the three interim dividends already paid, a total distribution of 5 per cent. for the year ended June 30. The transfer books will be closed from 11th to 25th July inclusive.

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.)—Interest on this company's 4 per cent. mortgage debenture stock for the half-year ending 31st inst. will be paid by warrant on Aug. 1. The stock register will be closed from 27th to 31st inst. inclusive.

KALGOORLIE ELECTRIC TRAMWAYS (LTD.)—This company's traffic receipts for June were £3,649 and the aggregate from Jan. 1 is £20,464.

MEXICO TRAMWAYS CO.—The directors have declared a dividend of 1¾ per cent. for the quarter ended June 30.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY CO. (LTD.)—The directors have resolved to pay interim dividends of 2½ per cent. on the Preference shares and 2 per cent. on the Ordinary shares.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed July 20 a special settling day in $850,000 5 per cent. bonds, 1925 (London issue) of the *Bell Telephone Co. of Canada* (*Ltd.*), and have granted quotations to $2,000,000 capital stock of the *Kaministiquia Power Co.* (*Ltd.*), £1,188,300 5½ per cent. first mortgage debentures of the *Lima Light, Power & Tramways Co.* (*Las Empresas Electricas Asociadas*), a further issue of $600,000 7 per cent. cumulative preference stock of the *Mexican Light & Power Co.* (*Ltd.*), and a further issue of £21,000 4½ per cent. first mortgage prior lien gold bonds of the *Montreal Water & Power Co.* The Committee have been asked to appoint special settling days in and grant quotations to £100,000 5 per cent. debenture stock of the *Adelaide Electric Supply Co.* (*Ltd.*) and fully and partly paid scrip for $3,500,000 first mortgage 5 per cent. 40-year Gold bonds of the *Mississipi River Power Co.*, and to grant quotations to a further issue of £30,000 5 per cent. second mortgage debentures of the *Bombay Electric Supply & Tramways Co.*, a further issue of £200,000 5 per cent deferred ordinary, £200,000 preferred ordinary and £200,000 5 per cent cumulative perpetual preference stock of the *British Columbia Electric Railway Co.* (*Ltd.*), $285,500 first mortgage 33-year sinking fund gold bonds of the *Cascade Water, Power & Light Co.* (*Ltd.*), £441,620 5 per cent. first mortgage convertible bonds of the *Cuban Telephone Co.*, and $5,664,200 additional common stock of the *Mexico Tramways Co.*, and 467,000 £10 fully-paid shares of the *Underground Electric Railways Co. of London* (*Ltd.*).

TELEGRAPH CONSTRUCTION & MAINTENANCE CO. (LTD.)—The transfer books will be closed from 10th to 20th inst. inclusive, preparatory to payment of interim dividend of 12s. a share.

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[illegible]CTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount. £	Inc. or Dec. (a) £	Aggregate. No. of weeks.	Aggregate. Amount. £	Aggregate. Inc. or Dec. (a) £
[illegible] Corporation	July 5	1,580	+ 52	5	8,049	+ 615
[illegible]drie	June 30	206	− 20	26	5,610	− 19
Anglo-Argentine	July 8	47,567	+ 1,435	27	1,328,374	+ 134,235
Ashton-under-Lyne	„ 8	407	+ 9	15	6,286	+ 488
[illegible] Corporation	„ 8	369	− 49	8	2,402	− 165
[illegible]rnsley	June 30	165	+ 7	26	4,671	+ 276
Barrow	„ 30	297	− 26	26	6,895	+ 434
Bath Electric Trams, Ltd.	July 5	905	+ 63	27	21,382	+ 659
Birmingham Corporation	„ 1	7,427	+ 642	13	96,741	+ 7,113
Birmingham & Midland	June 30	2,894	− 13	26	25,176	+ 1,714
Blackpool and Fleetwood	July 8	1,391	+ 469	1	1,391	+ 469
Blackburn Corporation	„ 5	1,124	+ 113	†15	17,435	+ 1,583
[illegible]ton Corporation	..	..	..	..	..	..
[illegible]bay	June 9	2,835	+ 211	23	65,816	+ 3,600
Bournemouth Corporation	July 5	1,763	− 273	14	24,389	+ 1,161
[illegible]dford Corporation	„ 8	5,612	+ 373	14	80,529	+ 7,277
[illegible]ghton Corporation	„ 9	1,180	+ 155	¶14	14,755	+ 1,356
Bristol Trams & Carriage	„ 7	6,750	+ 547	14	103,018	+ 9,802
[illegible]nley Corporation	„ 8	1,348	+ 127	14	19,209	+ 1,885
[illegible]rton Corporation	„ 9	287	+ 8	14	4,181	+ 388
[illegible]ry Corporation	„ 9	1,407	+ 153	¶14	17,173	+ 1,408
[illegible]tta Tramways Co.	„ 8	R59,676	+ R7,504	1	R59,676	+ R7,504
[illegible]	„ 6	159	+ 3	27	3,275	+ 18
[illegible]	„ 8	2,617	+ 158	14	35,666	+ 3,537
[illegible] Railway	„ 8	5,098	− 928	1	5,098	− 928
[illegible] & Dist. Lt. Rys.	„ 6	811	− 11	27	21,912	− 61
[illegible] South London Rly.	„ 9	3,177	+ 44	1	3,177	+ 44
[illegible] Birmingham	June 30	869	+ 5	26	71,163	+ 2,427
[illegible] Electric Trams Co.	July 6	583	+ 52	27	12,992	+ 212
[illegible]port & Dist. Trams	June 30	462	+ 51	26	11,915	+ 1,287
[illegible]	July 8	306	+ 64	14	3,588	+ 638
[illegible] Railway	„ 7	151	− 12	1	151	− 12
[illegible]ited	„ 7	7,630	+ 1,949	1	7,630	+ 1,949
[illegible]ourbridge	June 30	774	− 37	26	21,010	+ 1,743
[illegible]rporation	July 5	1,172	− 62	¶7	8,875	− 84
[illegible] Council	„ 8	1,160	+ 110	14	15,685	+ 991
[illegible]rporation	„ 7	374	+ 33	14	4,892	+ 379
[illegible] & Dist. Trams	June 30	958	− 23	26	26,459	+ 1,409
[illegible]rporation	July 8	19,352	+ 1,495	‡5	109,111	+ 8,341
[illegible]	„ 8	130	+ 15	27	3,256	+ 214
[illegible]	..	..	..	..	..	..
[illegible]	June 30	209	− 9	26	5,200	+ 107
[illegible] & City Rly.	July 8	1,438	+ 40	1	1,438	+ 40
[illegible] & Port Glasgow	June 30	755	+ 32	26	17,780	+ 2,350
[illegible]rporation	July 4	2,029	+ 240	†14	27,777	+ 2,943
[illegible] Tramways	June 30	258	− 21	26	6,359	+ 497
[illegible] Trams Co.	July 6	1,087	− 87	1	1,087	− 87
[illegible]	„ 8	$9,789	+ $636	1	$9,789	+ $636
[illegible]	„ 8	1,907	+ 168	14	27,966	+ 3,081
[illegible]	„ 8	2,797	+ 58	14	40,490	+ 2,084
[illegible]ncil	„ 8	603	+ 32	15	8,153	+ 472
[illegible]rict Council	„ 5	120	− 11	14	1,878	+ 96
[illegible]	„ 8	504	+ 61	14	6,335	+ 637
[illegible]	„ 8	1,144	+ 18	40	16,980	+ 810
[illegible]	June 30	105	− 17	26	3,291	+ 215
[illegible]y Corporation	July 6	196	+ 30	14	2,774	+ 274
[illegible]ster & District	June 30	116	− 1	26	2,708	+ 186
[illegible] Corporation	July 8	168	+ 14	8	1,250	+ 54
[illegible]rporation	..	..	..	..	..	..
[illegible] Trams Co.	„ 6	1,464	+ 58	27	37,266	+ 179
[illegible]ited	„ 5	1,489	+ 150	27	35,296	+ 852
[illegible]	June 30	166	− 42	26	4,004	− 7
[illegible]	July 8	7,773	+ 753	14	108,016	+ 8,624
[illegible]rporation	„ 8	2,588	+ 249	14	36,787	+ 3,630
[illegible]tion	„ 8	708	+ 1	‡8	5,251	+ 227
[illegible]ration	„ 8	144	+ 21	14	1,925	+ 183
[illegible]rporation	„ 1	11,708	+ 12	26	295,459	+ 10,399
[illegible] Overhead Rly.	„ 9	1,627	+ 170	1	1,627	+ 170
[illegible] Colwyn Bay Rly.	„ 7	454	+ 55	§31	6,237	+ 251
[illegible]ty Council	June 28	47,507	+ 5,315	‡13	577,261	+ 39,702
[illegible] Elec. Ry. Co.	July 8	13,290	+ 230	1	13,290	+ 230
[illegible]ited	„ 8	8,042	+ 1,542	27	172,403	+ 6,435
[illegible]ration	„ 8	226	+ 23	40	6,561	+ 412
[illegible]ration	„ 8	17,287	+ 1,016	15	232,888	+ 14,391
[illegible]	„ 8	1,871	− 12	1	1,871	− 12
[illegible]	June 30	198	− 37	26	5,248	+ 84
[illegible] Dist. Railway	July 8	12,048	+ 904	1	12,048	+ 904
[illegible] Elec. Trams	June 30	8,707	+ 1,157	26	219,957	+ 32,782
[illegible]ration	„ 30	306	− 23	26	8,441	+ 552
[illegible]	..	..	..	..	..	..
[illegible]on-Tyne Corp.	July 8	4,121	+ 327	14	61,794	+ 4,162
[illegible]	„ 8	750	+ 46	14	10,515	+ 780
[illegible] Corporation	„ 7	564	+ 60	14	9,838	+ 844
[illegible] & Hyde	June 30	523	− 40	26	14,467	+ 407
[illegible]rporation	July 9	2,030	+ 124	15	30,203	+ 1,692
[illegible] (B.) Corporation	..	..	..	..	..	..
[illegible] (A.) Elec. Trams	„ 7	1,537	+ 98	27	43,774	+ 2,230
[illegible]	June 30	129	+ 5	26	2,963	+ 205
[illegible] Corporation	July 8	2,661	+ 450	14	32,805	+ 3,983
[illegible]	June 30	1,903	+ 65	26	49,698	+ 4,830
[illegible]rporation	July 5	776	+ 50	14	11,121	+ 881
[illegible] Corporation	„ 6	641	+ 25	14	9,429	+ 870
[illegible]	June 30	236	− 54	25	3,071	− 143
[illegible]rporation	July 10	5,434	+ 460	‡14	72,072	+ 4,326
[illegible]	„ 5	$12,500	+ $1,480	1	$12,500	+ $1,480
[illegible]	June 30	51	− 3	26	1,207	+ 42
[illegible]rporation	July 9	6,397	+ 321	15	97,656	+ 6,631
[illegible]ire Trams	„ 8	$10,657	+ $433	1	$10,657	+ $433
[illegible] Metropolitan	June 30	895	+ 62	26	21,190	+ 670
[illegible]	„ 30	817	− 15	26	23,107	+ 1,929
[illegible]	July 5	1,355	+ 251	14	16,976	+ 2,004
[illegible] Corporation	„ 5	731	+ 43	14	8,914	+ 1,389
[illegible]	June 30	295	− 45	26	7,279	+ 200
[illegible] Lt. Bd.	July 8	769	+ 22	14	11,418	+ 1,139
[illegible]rporation	„ 9	1,459	+ 231	14	18,692	+ 2,266
[illegible] District	„ 5	494	+ 39	36	16,187	+ 1,216
[illegible] Trams	June 30	1,072	− 89	26	28,508	+ 1,891
[illegible]rporation	July 5	155	+ 27	14	2,201	+ 288
[illegible]	June 30	45	+ 2	26	1,055	+ 15
[illegible] District	„ 30	253	− 65	26	5,465	+ 84
[illegible] Trams Co.	July 5	344	− 35	1	344	− 35
[illegible]rporation	„ 8	1,233	+ 206	14	16,102	+ 2,828
[illegible]oration	„ 8	553	+ 24	27	14,966	+ 642
[illegible] Corporation	‖ „ 6	394	+ 34	14	5,630	+ 237
[illegible]rporation	„ 6½	2,839	+ 341	14	38,948	+ 4,254
[illegible]	June 30	212	− 2	26	2,315	+ 109
[illegible]	„ 30	404	− 50	26	11,330	+ 620
[illegible] Corpn.	July 6	973	− 283	14	14,164	+ 1,030
[illegible]	June 30	320	+ 10	26	7,162	+ 339
[illegible]	„ 30	95	+ 3	26	2,513	+ 62
[illegible] R. Trams	July 9	1,307	+ 88	28	35,643	+ 1,447
[illegible] Woollen District	June 30	950	+ 6	26	26,719	+ 1,890

(a) Comparisons are with the corresponding period last year. * Partly electrical. [illegible] 3 days. ‡ Minus 2 days. ‖ Plus 3 days. ¶ Plus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Share	Last Dividend	Name.	Price Wed., July 11.	*Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business 8 Days to July 11. Highest.	Lowest.
		Electricity Supply.					
10	6/0	Bournemouth & Poole Elec. Sup. Ord.	8 —9	6 9 6	Mar, Sep	..	—
10	4/6	Do. 4½ per Cent. Cum. Pref.	9 —10	4 14 6	Feb, Aug	..	—
10	6/0	Do. 6 per Cent. Cum. Second Pref.	10½—10¾	5 6 0	Feb, Aug	..	..
St.	4½%	†Do. 4½ per Cent. Deb. Stock (red.)	100 —102	4 9 0	Jan, July	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	8 —8½	6 1 0	March	..	..
5	3/6	Do. 7 per Cent. Pref.	7½—8	4 1 3	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Deb. Stock	98 —101	4 0 6	June, Dec	100½	99¾
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	3¾—4¼	5 2 6	Feb, Aug	4¼	..
5	2/3	Do. 4½ per Cent. Pref.	4¾—5¼	5 2 6	Feb., Aug	4⅞	—
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	94 —98	4 3 3	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	102 —104	4 7 0	..	..	..
5	2/3	†Do. City Undertaking 4½% Cum. Pref.	3¾—4¼	5 12 6	Jan, July	..	..
5	3/0	Chelsea Electric Supply Ord.	4 —4½	5 11 0	March	..	..
St.	4½%	†Do. 4½ per Cent. Deb. Stock (red.)	93 —100	4 11 0	June, Dec	99¾	..
10	8/0	City of London Electric Lighting Ord.	11¾—12¾	4 19 0	Feb, Aug	12¼	12 1/16
10	6/0	Do. 6 per Cent. Cum. Pref.	12 —13	4 12 3	Jan, July	12¼	..
St.	5%	†Do. 5 per Cent. Deb. Stock (red.)	119 —123	4 1 0	June, Dec	122	..
St.	4½%	†Do. 4½ per Cent. 2nd Deb. Stock (red.)	100 —103	4 8 6	Jan, July	..	..
St.	5%	†County of Durham Elec. P. D. 5% 1st Mort. Deb. Stk.	89½—91½	5 10 6	Jan, July	..	—
10	6/0	County of London Elec. Supply Ord.	7¾—8¼	6 3 0	Feb, Aug	7⅞	—
10	6/0	Do. 6 per Cent. Cum. Pref.	11⅛—11⅝	5 6 0	Mar, Sept	11¼	..
St.	4½%	†Do. 4½ per Cent. Deb Stock (red.)	108 —110	4 2 6	Jan, July	112	110½
St.	4½%	Do. Second Deb. Stock	99 —102	4 8 0	May, Nov	101	..
5	4/0	Folkestone Electricity Supply Co. Ord.	4½—4¾	5 19 0	April, Oct	..	—
5	2/6	Do. 5 per Cent. Cum. Pref.	4¾—5¼	4 15 3	Mar, Sept	..	—
St.	4½%	Do. 4½ 1st Deb. Stock (red)	97 —100	4 10 0	Feb, Aug	..	..
5	5/0	Hove Electric Lighting Ord.	6¾—7¼	6 4 0	April, Oct	..	—
St.	4½%	Isle of Wight E. L. & P. Co. Deb. Stk.	88 —91	4 19 0	..	..	—
5	5/0	Kensington & Knightsbridge Ord.	7 —7½	5 16 0	Feb, Aug	—	..
5	6%	Do. 6 per Cent. 1st Pref.	5¾—6	5 0 0	Jan, July	..	—
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	93 —95	4 4 0	..	—	—
St.	4%	Kensington & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	96 —99	4 1 0	April, Oct	—	—
St.	4½%	Kent Elec. Power Co. Irred Deb. Stk.	80 —84	5 7 0	Jan, July	—	—
3	1/2¾	London Electric Supply Ord.	1¾—2¼	2 17 0	Mar, Sept	1⅞	—
5	3/0	Do. 6 per Cent. Pref.	4¾—5¼	5 17 0	Mar, Sept	..	—
St.	4%	Do. 4 per Cent. 1st Mort. Deb	89 —92	4 8 0	Jan, July	90½	..
5	3/0	Metropolitan Electric Sup. Ord.	3¼—3¾	6 18 0	April, Oct	3½	3½
5	2/3	†Do. 4½ per Cent. Cum. Pref.	4¼—4¾	4 17 0	Jan, July	4½	—
St.	4½%	†Do. 4½ per Cent. Deb. Stock 1st Mort.	100 —105	4 7 6	June, Dec	..	—
St.	3½%	†Do. 3½ per Cent. Mort. Deb. Stock (red.)	84½—87½	4 1 6	Jan, July	85	84½
..	4½%	†Midland Elec. Corp. for Power Dist, 4½ 1st Mort. Debs.	96½—98½	4 12 6	..	..	..
5	2/6	Newcastle Elec. Supply Ord.	3½—4	4 14 0	Feb, Aug	..	—
5	2/6	Do. 5 per Cent. non Cum. Pref.	4 —4½	5 11 0	Feb, Aug	—	—
100	4½%	†Do. 4½ per Cent. 1st Mort. Deb.	97 —99	4 12 0	Jan, July	..	..
100	5%	North Metro. Elec. Power Sup. 5 Morts.	101 —104	4 17 6	..	..	..
1	6%	Northampton Elec. Lt. & P. Ord.	1¼—1 5/16	4 11 6	Feb, Aug	..	..
1	5%	‡Do. 5% Pref.	1 3/16—1 5/16	4 6 0	Feb, Aug	..	—
St.	4%	Do. 4% Debs.	99 —101	3 19 0	June, Dec	..	—
10	6/0	†Notting Hill Electric Ord.	..	5 17 6	March	..	—
5	4/3	Oxford Electric Ord.	6¼—6¾	5 13 9	March	..	..
St.	4%	Do. 4% Deb. Stk.	93 —96	..	..	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	9 —9½	5 8 0	Feb, Aug	9¼	—
5	3/6	Do. 7 per Cent. Pref.	6¾—7¼	4 16 6	Feb, Aug	7¼	..
St.	3½%	†Do. 3½ per Cent. Deb. Stock (red.)	84½—86½	4 2 0	Jan, July	..	—
5	..	Smithfield Markets Electric Sup. Ord.	1¼—1¾	..	Feb.	..	—
5	4/0	South London Electric Supply Ord.	2 13/16—3 3/16	6 3 0	April	..	—
St.	5%	†Do. 5% 1st Mort. Stock (red.)	98½—101½	5 0 6	..	..	—
1	0 8¾	South Metrop'n Elec. Lt & Power 7% 1st Pref	1⅛—1¼	5 18 0	Feb, Aug	..	—
1	0/7½	Do. 6 per Cent. 2nd Pref.	⅞—1	6 17 0	Feb, Aug	..	—
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	97 —100	4 11 6	April, Oct	..	..
5	1/3	Urban Electric Supply Ord.	½—1	..	April, Oct	..	—
5	1/3	Do. 5 per Cent. Cum. Pref.	2½—3	8 6 0	April, Oct	2⅝	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	87 —89	5 2 3	April, Oct	89	88
5	5/0	Westminster Elec. Sup. Ord.	7¾—8¼	6 3 6	Mar, Sept	8 1/16	..
5	2/3	†Do. 4½ per Cent. Cum. Pref.	5 —5½	4 3 6	Jan, July	—	..
		Electric Railways and Tramways.					
1	..	Bath Elec. Trams Pref. Ord.	½—⅝	..	April	..	—
1	0/6	†Do. 5 per Cent. Cum. Pref.	½—¾	6 13 6	Jan, July	..	—
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	79 —83	5 8 6	April, Oct	..	—
St.	4½%	†B'ham & Midland Trams 4½ 1st Deb. Stock.	89 —91	5 0 0	Jan, July	90½	..
10	4%	Bristol Tramways & Carriage Ord.	6½—7	5 10 9	Feb, Aug	—	—
10	4%	†Do. Cum. Pref.	7 —7½	5 10 0	..	..	—
St.	4%	†Do. 4 per Cent. Debs.	100 —101	3 19 6	Feb, Aug	..	..
10	..	British Electric Traction Ord.	⅞—1⅛	..	June, Dec	1⅛	⅞
10	..	Do. 6 per Cent. Cum. Pref.	3¾—4¼	..	Feb, Aug	4	3¾
St.	5%	Do. 5 per Cent. Perpetual Debs.	96 —99	5 2 6	April, Oct	97½	96
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	77 —81	5 14 0	May, Nov	79½	78
St.	3%	Central London Ordinary Stock	71 —73	4 3 0	Feb, Aug	72½	71
St.	4%	Do. 4 per Cent. Pref. Stock	87 —89	4 10 0	Feb, Aug	88½	..
..	..	Do. Pref. Scrip 50% pd	63½—64½	..	..	64½	..
St.	2%	Do. Deferred Stock	55 —57	3 11 6	Feb.	..	..
100	4%	Do. 4 per Cent. Debs.	104 —106	3 16 0	Jan, July	..	..
5	2/6	City of Birmingham Trams, 5% Cum. Pref.	4 11/16—5 1/16	4 19 6	April, Oct	5 1/16	—
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 18 9	April, Oct	..	..
St.	1½%	City & South London Rly. Con. Ord.	32 —33	4 12 3	Feb, Aug	32½	31½
St.	5%	Do. 5 per cent. Perp. Pref. (1891)	109 —111	4 10 0	Feb, Aug	..	—
St.	5%	Do. (1896)	105 —108	4 13 0	Feb, Aug	..	..
St.	5%	Do. (1901)	104 —107	4 15 0	Feb, Aug	..	..
St.	5%	Do. (1903)	103 —106	4 15 6	Feb, Aug	105½	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	102 —104	3 17 9	May, Nov	104	..
10	6/0	Dublin United Trams, 6 per Cent. Pref.	12½—13½	4 10 6	Feb, Aug	..	—
10	12/0	Gateshead and District Trams Ord	8¼—8¾	6 10 0	..	..	..
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	¾—1	..	Feb, Aug	13/16	..
5	..	Hastings & District Elec. Trams, 6% C. P.	..	..	Mar, Sept	..	..
St.	4½%	Do. 4½ Deb. Stock	75 —80	5 10 0	April, Oct	..	..
10	..	Imperial Tramways Ord.	3 —3½	..	Mar, Sept	..	..
10	..	‡Do. 6 per Cent. Pref.	4 —4½	..	Mar, Sept	..	..
St.	4½%	†Do. 4½ per Cent. Debs.	72 —74	6 3 6	Jan, July	..	—
..	2/6	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	2¼—2¾	5 0 0	Mar, Sept.	..	—
St.	4%	†Do. 4 per Cent. Deb. Stock	77 —82	5 1 0	Jan, July	..	..
10	6/0	Lanarkshire Tramways	10 —10½	5 12 3	Feb, Aug	10¼	10¼
St.	5%	†Lancs Utd. Trams, 5% Prior Lien Deb. Stk.	79 —82	6 4 0	Jan, July	..	..
St.	4%	†London Electric 4% Deb. St.	96 —98	4 2 6	..	97½	97½
St.	4%	Do. 4% Pref.	85 —86	4 14 0	..	85½	85
10	..	London United Trams, 5% Cum. Pref.	3½—4½	..	Jan, July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	74 —77	5 6 0	Jan, July	76	74
St.	..	Mersey Con. Ord. Stock	6 —8	..	Feb, Aug	—	..
1	1/1½	Metropolitan Elec. Tramways Ord.	[illegible]	6 0 0	..	[illegible]	..
1	..	Do. Deferred	[illegible]	..	April	—	..
1	0/6	Do. 5 per Cent. Cum. Pref.	[illegible]	5 0 0	Feb, Aug	[illegible]	[illegible]
St.	4½%	†Do. 4½ per Cent. Deb. Stock	99½—101½	4 9 6	Jan, July	101½	100
St.	5%	Do. 5 per Cent. Db. Stk	102½—104½	4 16 6	[illegible]	104	[illegible]
St.	1½%	Metropolitan Railway Consolidated	48½—49½	2 16 3	[illegible]	[illegible]	[illegible]
St.	2½%	Do. Surplus Lands Stocks	68 —70	3 19 6	[illegible]	[illegible]	[illegible]
St.	3½%	Do. 3½ per Cent. Preference	90 —92	[illegible]	[illegible]	[illegible]	[illegible]
St.	3½%	Do. 3½ per Cent. "A" Preference	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
St.	3½%	Do. 3½ per Cent. Convertible Pref.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
St.	3½%	Do. 3½ per Cent. Debenture Stock	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

* No allowance ha[illegible]

† Ex Dividend. ‡ The L[illegible]

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shares	Last Dividend	Name	Price Wed., July 11.	*Rate per cent. Yielded.	Dividend Due.	Business 8 Days to July 11. Highest.	Lowest.
		Electric Railways and Tramways—*Continued.*	£ s. d.				
St.	3½%	Met. Rly. 3½ per Cent. "A" Deb. Stock..	92 –94	3 14 6	Jan, July	..	..
St.	..	Metropolitan District Railway Ord.....	28½–29	..	Feb, Aug	29	26⅛
St.	3½%	Do. 4½% First Pref.	88 –90	4 19 6	Feb, Aug	..	..
St.	3½%	Do. Assented Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	76 –78	4 10 0	Feb, Aug	..	..
St.	3%	†Do. 3 per Cent. Consolid. Rent-charge	76 –78	3 18 0	Jan, July	..	..
St.	4%	†Do. 4 per Cent. Midland Rent-charge	102 –104	3 17 9	Jan, July	..	..
St.	6%	†Do. 6 per Cent. Perp. Deb. Stock.....	145 –147	4 2 0	Jan, July	..	..
St.	4%	†Do. 4 per Cent. Ditto.....	96 –98	4 2 6	Jan, July	97½	..
1	4½d.	Potteries Electric Traction Ord.	½ –⅝	5 6 9	April, Oct	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.....	⅞–1	8 6 8	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock.....	88 –91	5 0 0	May, Nov	..	..
1	1/2½	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	⅛–⅜	10 2 0	..	..	..
St.	4%	†Dc. 4 per Cent. Deb. Stock.....	73 –78	5 6 0	Jan, July	..	..
100	5%	Sunderland Dist. Elec. Trms. 5% 1stMtDb.	..	8 4 0	Jan, July	66	65
—	10/0	UndergdE.Rys.Lon.6% 1n. bds with coup 7	65 –67	1 10 0	June, Dec	..	..
—	5%	Do. 5% Prior Lien Bonds.....	100½–101½	4 19 0	..	99⅛	..
—	4½%	Do. 4½% Bonds Ex coup. 7	99 –101	4 10 0	..	..	..
5	4%	Do. 4 per Cent. 1st Power Ho. Dbs. ..	101 –103	3 18 3	..	..	..
5	—	Yorkshire (W.R.) Elec. Trms. Ord.....	⅛ ⅜	..	March ..	..	..
6t.	..	Do. 6 per Cent. Cum. Pref.....	2⅛–2⅜	..	..	..	..
6t.	4½	†Do. 4½ per Cent. 1st Debs.....	82 –85	5 8 0	Jan, July	..	..
		Electric Manufacturing, &c.					
St.	4½%	†Anchor Cable Co. 4½ % Deb. Stock	98 –100	4 11 0	—	..	..
1	1/2½	†Aron Electricity Meter Ord.....	⅛–⅜	..	..	⅜	⅛
1	0/7½	†Do. 6% Cum. Pf.	⅛–⅜	7 10 0	April, Oct	⅜	⅛
1	3/2½	Babcock & Wilcox Ord.	5⅛–5⅜	4 11 0	April, Oct	5⅛	5⅛
1	0/7½	Do. Pref.....	1⅛–1⅜	4 0 0	..	..	..
5	6/0	British Insulated & Helsby Cables Ord...	6⅛–7⅛	6 15 6	July, Feb	6⅛	..
5	3/0	Do. 6 per Cent. Pref.....	6 –6⅛	4 12 3	Jan, July	..	..
St.	4½%	†Do. 4½ per Cent. 1st Mort. Deb. (red.)..	100 –102	4 9 0	Jan, July	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt.Db.	96 –99	4 11 0	Mar, Sept	..	..
5	..	British Westinghouse 6 per Cent. Pref....	⅜–½	..	Feb, Aug	..	..
100	6%	Do. 6 per Cent. Prior Lien Dbs. (rd)..	102 –104	5 17 0	..	..	..
St.	4%	†Do. 4 per Cent. Mort. Deb. Stock.....	59 –62	6 6 6	Jan, July	61	..
St.	4½%	BrushE.Eng. Co. 4½% Perp. 1st Deb.Stock	57 –64	7 0 6	Mar, Sept	..	..
St.	4½%	†Do. Perpetual 2nd Deb. Stock.....	39 –44	10 10 0	Jan, July	9⅛	8⅛
5	10/0	Callender's Cable Con. Ord.	8⅛–9⅛	8 2 0	Jan, July	..	..
5	2/6	†Do. 5 per Cent. Cum. Pref.....	4⅛–5⅛	4 17 6	Jan, July	..	..
St.	4½%	†Do. 4½ per Cent. 1st Mort Debs. (red.)..	101 –103	4 8 0	Nov, May	3⅜	3⅛
1	1/6	Castner-Kellner Alkali Co.....	3⅛–3⅜	5 7 3	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)..	104 –107	4 2 6	Feb. Aug	1⅛	1⅛
1	1/0	†Chadburn's (Ship) Telegraph Ord.	1⅛–1⅜	5 19 0	March ..	..	..
1	0/8½	Consolidated Electrical Co.....	⅛–⅜	10 0 0	August ..	..	..
1	0/6	Consolidated Signal Co.....	⅛–⅜	6 13 6	April, Oct	—	..
1	0/7½	Do. 6 per cent. Cum. Pref.....	¼–⅜	7 6 6	April, Oct	..	..
3	..	Crompton & Co (Nos. 1 to 85,000)	⅛–⅜	..	Jan, July	..	..
100	5%	†Do. 5 per Cent. 1st Mort. Debs. (red.)..	57⅛–67⅛	8 0 0	Jan, July	..	..
5	1/0	Dick, Kerr & Co. Ord.....	⅛–⅜	5 14 0	Sept.	..	..
5	0/7½	Do. 6 per Cent. Cum. Pref.....	⅛–⅜	5 6 0	Sept	..	..
St.	4½%	†Do. 4½ per Cent. Deb. Stock.....	95 –98	4 13 3	Jan, July	..	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	⅛–⅜	..	Feb, Aug	..	..
	..	Do. (£5 paid)	1⅛–2⅛	9 3 0	Feb, Aug	..	..
St.	4%	†Do 4 per Cent. Mort. Deb. Stock (red.)	67 –71	5 16 0	June, Dec	..	..
St.	5%	Do 5 per Cent. 2nd Deb. Stock.....	78 –81	6 3 6	Mar, Sept	..	..
..	..	Edmundson's Elec. Corp. Ord.....	⅛–⅜	..	Jan, July	..	..
5	..	Do. 6 per Cent. Cum. Pref.....	2⅛–2⅜	..	May, Nov	..	..
St.	4½%	Do 4½ per cent. 1st Mort. Deb. (red)..	86 –89	5 1 0	Jan, July	87⅛	..
2	..	Electric Construction Co.....	⅛–⅜	..	Jan, July	..	..
2	2/9½	Do. 7 per Cent. Cum. Pref.....	1⅛–2⅛	7 0 0	July	..	..
St.	4%	Do. 4 per Cent. Perp. 1st Mort. Debs..	75 –80	5 3 0	Jan, July	75	..
10	5/0	†General Electric (1900) 5% Cum. Pref. ..	8⅛–9	5 14 0	June, Dec	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.....	88 –93	4 8 6	Mar, Sept	..	..
5	10/0	Henley's Telegraph Works Ord.....	12⅛–12⅞	5 16 6	Feb, Aug	12⅛	12⅛
5	2/3	Do. 4½ per Cent. Pref.	4⅛–5⅛	4 10 0	Feb, Aug	5⅛	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	100 –103	4 4 6	Mar, Sept	..	..
10	15/0	India Rubber, Gut. Per., &c., Works....	11⅛–13⅛	6 0 0	Feb, Aug	13	—
10	5/0	†Do 5 per Cent. Cum. Pref.	10⅛–10⅞	4 17 0	..	10⅛	..
100	4%	Do. 4 per Cent. Debs. (red.)	90 –95	4 1 6	April. Oct	..	..
1	..	National Elec. Construction Co.....	⅛–⅜	..	April	..	..
1	..	Richardsons, Westgarth & Co., Ltd. Ord.	⅜–⅝	..	Nov	..	..
1	..	Do. 6 per Cent. Cum. Pref.	⅛–⅜	..	May, Nov	..	..
St.	4½%	†Do. 4½ per Cent. Perp. Deb. Stock....	77 –80	5 14 6	Jan, July	..	..
5	..	Simplex Conduits 6 per Cent. Cum. Pref.	4⅞–5	..	..	..	..
12	36/0	Telegraph Construction & Maintenance..	35⅛–38⅛	5 16 3	Mar, July	37	36⅛
100	4%	†Do. 4 per Cent. Deb. Bonds (1909)	99 –101	4 0 0	Jan, July	..	..
1	1/0	Vickers, Sons & Maxim, Ltd., Ord.....	2⅛–2⅜	4 14 0	..	2⅛	2⅛
1	0/6	Do. 5 per Cent. non-Cum. Preference..	1⅛–1⅜	4 3 0	..	..	—
St.	5%	Do. 5 per Cent. non-Cum. Preferred ..	105 –112	4 11 0	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Db. Sk. (red)	99½–101⅛	3 19 9	June, Dec	101⅛	99⅛
100	4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.)	102⅛–104⅝	4 7 0	June, Dec	..	..
100	5%	Do. 5 per Cent. 3rd Mort. Debs Scrip...	103 –105	4 16 0	..	104	104
10	12%	†J. G. White & Co. 6% Cum. Pref.	15 –16	6 15 0	..	15⅛	..
1	..	Willans & Robinson Ord.....	⅛–⅜	..	Apr, Oct	..	..
5	..	Do. 6 per Cent. Cum. Pref.....	¼–1	..	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.....	55 –65	6 3 0	May, Nov	..	..
		Telegraphs.					
10	..	Amazon Telegraph	7⅛–7⅜	..	June, Dec	99⅛	..
100	5%	†Do. 5 per Cent. Debs. (red.)	93 –100	5 1 0	Jan, July	69	..
St.	15/0	Anglo-American	69 –71	4 4 6	F,My,Ag,N	..	..
St.	30/0	Do Preferred	113½–114½	5 6 0	F,My,Ag,N	114	113
St.	30/0	Do. Deferred	25 –26½	5 1 0	F,My,Ag,N	26⅛	26⅛
St.	4%	†Commercial Cable 4 per Cent. Deb. Stk...	87⅛–89⅛	4 10 6	Jn,Ap,Jy,O	89⅛	87⅛
10	6/0	Cuba Submarine Ord.	10 –10⅛	4 17 6	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	17⅛–18⅛	5 13 0	Feb, Aug	17⅛	..
5	2/0	Direct Spanish Ord.	3⅛–4	5 0 0	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.....	8⅛–8⅞	5 16 0	April, Oct	..	..
50	4½%	†Do. 4½ per Cent. Deb.	99 –101	4 10 0	Jan, July	..	..
10	2/0	Direct United States Cable.....	7⅛–8⅛	6 16 0	Ja,Ap,Jy,O	7⅛	7⅛
100	4½%	†Direct West India Cable 4½% Rg.Db.(rd.).	93 –100	4 11 0	June, Dec	..	..
St.	65/0	Eastern Ordinary xd and bonus	137 –140	5 11 6	Ja,My,Jy,O	138⅛	137⅛
St.	17/6	Do. 3½ per Cent. Pref. Stock.....	84⅛–85⅜	4 2 0	Ja,My,Jy,O	85⅛	84⅛
St	4%	Dc. 4 per Cent. Mort. Deb. Stk. (red.)..	101 –103	3 18 3	May, Nov	101⅛	..
St	6/6	Eastern Extension	13⅛–13⅞	5 4 0	Ja, Ap, Jy, O	13⅛	13⅛
10	4%	Do. 4 per Cent. Deb. Stock	101 –103	3 18 3	Feb, Aug	..	102
25	4%	Eastern and S.Af., 4% Mauritius Sub.Debs	99⅛–101⅛	3 19 0	May, Nov	..	..
10	5/0	G.N (of Copenhagen), Ex Coupon 82	31 –32	5 14 3	Jan, July	31⅛	..
25	52/6	Indo-European	55⅛–56⅛	5 6 6	May, Nov	56⅛	..
100	5%	Mackay Companies Common	92 –94	5 5 0	Ja,Ap,Jy,O	..	..
100	4%	Do. Preference	75 –77	5 2 0	Ja,Ap,Jy,O	..	..
1	..	Marconi's Wireless Teleg. Co.	2⅛–2⅜	..	April	2⅛	1⅛
100	4%	†Pacific & Europe'n Tel.4%Guar.Dbs.(red.)	99 –101	4 0 0	June, Dec	100	..
2½	1/3	West Coast of America	1⅛–1⅜	5 0 0	May	..	..
100	4%	†Do. 4 per Cent. Debs.	97⅛–99⅛	4 1 6	Jan, July	..	..
10	1/6	West India & Panama	2⅛–2⅜	5 5 0	May, Nov	2⅛	2⅛
10	6/0	Do. 6 per Cent. 1st Pref.	10⅛–10⅞	5 16 6	May, Nov	10⅛	..
10	6/0	Do. 6% 2nd Pref.	9⅛–10	6 4 6	May, Nov	..	..
10	6/0	Do. 6 per Cent. Debs.	101 –103	4 18 0	Jan, July	..	..
100	5%	†Do 5 per Cent. Debs.	13⅝–14	5 2 0	Mr,Jn,O,D	13⅛	13⅛
10	3/0	Western Telegraph	99 –101	4 0 0	June, Dec	—	—
St.	4%	†Do. 4 per Cent. Deb. Stock (red.)	105 –108	3 14 0	..	—	—
..	4%	Western Union Telegraph, $1,000 4% Bds	99⅛–102⅛	4 9 3	..	—	—
..	4½%	Do. $1,000 4½% Fdg. & Rl. Est. Gd. Bnds	..	..	..	..	..

Shares	Last Dividend	Name	Price Wed., July 11.	*Rate per cent. Yielded.	Dividend Due.	Business 8 Days to July 11. Highest.	Lowest.
		Telephones.		£ s. d.			
100	2$	Amer. Telephn. & Telegh. Cap. St.	141 –143	5 13 0	..	..	..
..	4%	†Do. Coll. Trust $1,000 4 per Cent. Bds.	94 –90	4 4 0	Jan. July	..	..
St.	4%	Do. 4% Cons. Bonds 1936	116 –119	3 9 0	..	..	..
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101 –103	4 17 0	Mar, Sept	..	..
5	3/0	Chili Telephone	7 –7⅛	4 4 6	August ..	..	..
1	0/7½	Monte Video Telephone Ord.....	⅞–1	6 0 0	Nov	..	..
1	0/6	Do. 5 per Cent. Pref.	⅜–½	5 11 0	May, Nov	..	..
St.	6%	National Co. Pref. Stock.....	104½–105½	5 15 0	Feb, Aug	..	..
St.	6%	Do. Def. Stock	116 –119	5 2 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 1st Pref.....	10 –10⅜	5 11 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.....	10 –10⅜	5 11 6	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.....	5⅛–5⅜	4 13 0	June, Dec	..	..
St.	3½%	†Do. Deb. Stock 3½ per Cent. (red.)....	98 –100	4 1 0	Jan, July	..	..
St.	4%	†Do. 4 per Cent. Deb. Stock (red.).....	98 –100	4 1 0	..	..	..
..	4½%	New York Telephone Co. 30 yr. Bnds.....	102½–103⅛	4 7 6	April, Oct	..	..
1	1/0	Oriental	1⅛–1⅜	4 18 0	April, Oct	..	..
1	0/7½	Do 6 per Cent. Cum. Pref.	1⅛–1⅜	4 16 0	April, Oct	..	..
St.	4%	†Do. 4 per Cent. Red. Deb. Stock.....	86⅛–86⅝	4 11 6	Jan, July	..	..
St.	4½%	†Telephone Co. of Egypt 4½%Db.Stk.(red.)	98 –100	4 11 0	Jan, July	..	..
5	3/0	United River Plate Ord. (1—150.000) ...	7⅛–7⅜	5 3 0	July	..	..
5	4½%	Do. (150,001—190,000).....	7⅛–7⅜	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅛–5⅜	4 13 0	June, Dec	..	..
St.	4½%	Do. 4½ Deb. St. Red.....	101 –103	4 8 0	Jan, July	..	..
		Financial, Investment, &c.					
5	3/0	†Elec. & Gen. Investment 6% Cum. Pref...	4 –4⅛	7 1 0	Jan, July	..	..
10	6/0	†Globe Telegraph & Trust	10⅛–11⅛	5 8 0	Sp,DcMr Ju	..	..
10	3/0	†Do. 6 per Cent. Pref.	13 –13⅛	4 10 9	Sp,DcMr Ju	..	..
10	6%	Submarine Cables Trust (Cert.)	131 –134	4 9 6	April, Oct	..	..
		Colonial and Foreign Electric Railways, Tramways, &c.					
5	2/9	Anglo-Argentine 5% Cum. 1st Pref.	5 –5⅛	4 17 6	April, Oct	..	..
5	2/9	Do. 5% Cum. 2nd Pref.....	4⅛–5⅜	5 1 6	Jan, July	..	..
St.	4%	Do. 4% Deb. Stock	93 –95	4 4 6	June, Dec	..	..
St.	4½%	Do. 4½% Deb. Stock	99 –101	4 10 0	..	..	..
St.	5%	Do. 5% Deb Stock	100 –102	4 19 0	..	..	..
St.	5%	†Auckland Elec. Trams. 5% Deb. (red.)....	102 –104	4 17 6	Jan, July	..	..
5	4/0	Brisbane Electric Trams. Invest. Ord	6⅛–6⅞	6 1 0	May	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 –5⅛	4 17 6	May, Nov	..	..
St.	4½%	†Do. 4½ per Cent. Db. Prov. Certs.....	102 –105	4 7 0	Jan, July	..	..
St.	8%	British Columbia El..Rly. Pf.Ord.	146½–150½	5 8 0	Mar, Sept	..	..
St.	6%	Do. Pref. Ord. Stock	128 –132	4 12 3	May, Nov	..	..
St.	5%	Do. 5% Cum. Perp. Pref. Stock.....	111 –113	4 9 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs.....	100 –103	4 7 6	April, Oct	..	..
40	4½%	Do. Vancouver Power Debs.	103 –106	4 6 0	Jan, July	..	..
100	4½%	Do. 4½% Perp. Con. Deb. St.	101½–103½	4 2 6	..	..	..
St.	4½%	Buenos Ayres Lacroze Trams 1st Mt. Db.	99⅛–101⅛	4 19 6	Mar, Sept	..	..
St.	5%	Buenos Ayres Port & City Tram, 1st Mt. Deb. Stock	95 –99	6 4 0	Feb, Aug	..	..
St.	6%	Calcutta Tramways (1 to 137,610).....	5⅛–6⅛	4 19 6	Mar, Sept	..	..
100	2/6	†Do. 5 per Cent. Cum. Pref.	5 –5⅛	4 17 6	Jan, July	..	..
1	4⅛%	†Do. 4⅛% 1st Deb. Stock (red).....	101 –104	4 8 0	Jan, July	..	..
St.	..	Cape Electric Tram Shares	⅛–⅜	..	..	..	..
5	1/3	City of Buenos Ayres Trams Co. (1904) Sh.	5⅛–5⅝	4 5 0	F,My,A,N	..	..
St.	4%	†Do. 4 per Cent. Deb. Stock.....	94 –97	4 4 0	June, Dec	..	..
5	2/6	Colombo Tr. & Ltg. 5% 1st Mt. Db.....	95 –100	5 2 6	May, Nov	..	..
100	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	101½–103½	4 17 6	Feb, Aug	..	..
100	5%	Hong Kong Tramways Co. 5 per Cent. 1st Mort. Debs.	77 –81	6 6 6	June, Dec	..	..
..	..	Kalgoorlie Elec. Trams Sh.	⅛–⅜	..	..	..	..
100	5%	Do. 5 per Cent. "A" Deb. Stock.....	92 –95	5 7 0	Jan, July	..	..
100	5%	Do. 6 per Cent. "B" Ditto	63 –67	8 15 0	Jan, July	..	..
5	6%	Lisbon Elec. Trams. Ord.	1 –1⅛	4 16 0	July	..	..
5	0/6	†Do. 6 per Cent. Cum. Pref.	1 –1⅛	4 16 0	Jan, July	..	..
100	0/7½	†Do. 5 per Cent. Reg. Mort. Debs.	97 –101	5 1 0	Jan, July	..	..
St.	5%	†Madras Elec. Trams. 5% Deb. Stk.	93 –98	5 3 6	Jan, July	..	..
100	5%	†Manaos Trams and Lt. Co. 5% Debs	93½–93⅞	5 8 6	..	..	..
..	5%	Manila Elec. Ry. $1,000 Gold Bonds.....	99⅛–101⅛	5 0 0	Feb, Aug	..	..
100	$1⅛	Mexico Trams Co. Com. St.	122 –124	5 14 0	..	..	..
..	5%	Do. Gen. Con. 1st Mort. 5% Gold Bds.	93 –97	5 3 6	..	..	..
St.	6%	†Do. 6% 50 yr. Mort. Bds.....	93 –100	6 1 3	—	..	..
St.	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922) (Nos. 601 to 2,000)	101 –103	4 7 6	Feb, Aug	..	..
		Do. do. (Nos. 1 to 4,600)	102 –104	4 7 6	..	..	..
1	0/6	Perth Elec. Trams Ord.	⅛–⅜	2 13 6	May	..	..
1	5%	†Do. 1st Mt. Db. Stock	101½–103⅛	4 17 6	Jan, July	..	..
100	5%	†Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	5⅛–5⅜	5 8 0	—	..	..
St.	4½%	†Do. 4½% 1st Mort. Deb. Stk.	97 –100	4 11 6	—	..	..
St.	$1⅛	Rio Janeiro Tram, Lt. & P. Co.....	114½–115½	4 6 0	—	..	..
100	5%	†Do. 30 yr. Gold Bnds.	103⅛–101⅛	4 19 0	—	..	..
100	5%	Do. 50 yr. Mt. Bnds	93⅛–97⅛	5 3 3	—	..	..
100	$2⅛	Sao Paulo Tramway, Light & Power Co. $100 Stock	182 –185	5 8 3	..	..	..
..	5%	Do. 5 per Cent. 1st Mt. $500 Db.	102 –104	4 17 0	June, Dec	..	..
100	4½%	Toronto Ry. Co 1st Mt. 4½% Ster. Bonds	93 –100	4 10 0	Feb, Aug	..	..
		Colonial and Foreign Electricity Supply, &c.					
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.....	5⅛–5⅜	5 8 0	Mar, Sept	..	..
10	5/0	Bombay E.S. & T. 6% Cm. Pf.....	10⅛–11⅛	5 5 6	..	..	..
St.	4½%	†Do. 4½ per Cent. Deb. Stk. (red).....	96 –98	4 12 9	Jan, July	..	..
5	5%	†Do. 5 per Cent. 2nd Mort. Deb. Stock..	96½–98½	5 2 6	..	..	..
100	5%	Calcutta Elec. Supply Ord.	6⅞–7⅛	5 19 6	April, Oct	..	..
100	7/2½	Do. 5% Cum. Pref	4⅛–5⅜	4 13 0	..	..	..
100	$3⅛	†Calgary Power Co. 5% 1s Mort. Bnds....	95⅛–97⅛	5 3 6	..	..	..
100	5%	Canadian Gen. Elec. Co. Com. St.	103 –111	6 8 0	..	..	..
100	$3⅛	Do. 7% Cm. Pf. Stock	120 –123	5 15 0	..	..	..
500	5%	†Castner Electrolytic Alkali Co (of U.S.A.) 1st Mort. Stl. Debs.	94 –97	5 3 6	Jan, July	..	..
500	5%	Elect Davelopment Co. of Ontario.....	84½–85⅛	5 17 0	..	..	..
5	5%	†Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	84½–87⅛	5 4 0	Jan, July	..	..
10s	..	Indian Elec. Sup. & Trac. Co.	1 –1⅛	..	..	..	..
100	8/2½	Kalgoorlie Elec. Power & Ltg. Ord.	⅛–⅜	..	April, Oct	..	..
St.	5%	Do. 6 per Cent. Cum. Pref.	⅜–½	8 6 6	..	..	..
St.	£10	†Kaminatiquia Power Co.5% Gold Bnds...	101 –103	4 18 0	..	..	..
St.	6%	Madras E. S. Corp. Ord.	2⅛–3⅛	..	..	..	..
St.	5%	Melbourne E. S. Co. Cons. Ord. St.....	36 –41	..	..	..	..
500	5%	Do. 5% 1st Mortg Deb. Stock	95 –97	5 4 0	..	..	..
	5%	†Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	85⅛–87⅛	5 14 9	..	..	..
St.	$1	Mexican Lt. & Power Co. Com. St.	82 –84	4 16 6	..	..	..
500	$3½	Do. 7% Cum. Pref. St.	105⅛–107⅛	3 5 9	..	..	..
100	5%	Monterey Rly. L. & P. Co.1st Mort.Db.Stk.	95⅛–95⅞	5 4 6	..	..	..
100	8/2½	Montreal Lt. Ht. & Power Co. Cap. St.	90⅛–92⅛	5 9 6	F,My,A,N	..	..
St.	5%	Northern Lt. Power & Coal 5% Gd. Bds ..	173 –177	5 14 0	..	..	..
St.	£10	River Plate Electricity Co. Ord. Stk.	45 –47	10 15 0	April	..	..
5	6%	Do. 6 per Cent. non-Cum. Pref. Stk. ..	218 –228	4 7 9	May	..	..
100	5%	†Do. 5 per Cent. Deb. Stock	107 –114	5 5 0	Jan, July	..	..
100	$1⅛	Shawinigan Water & Power Co.Ca.....	101½–103⅛	4 17 6	..	..	..
100	5%	†Do. 5 per Cent. Bds.	119 –122	4 3 0	Jan, July	..	..
100	4%	Do. 4½ Per Cen. Mt. Db. St.	107 –109	4 12 6	..	..	..
100	5%	Toronto Power Co. 4½% Db. St.	103 –105	4 6 0	—	..	..
100	4½%	†Victoria Falls Power Co. Pref.	11 –85	4 8 0	Jan, July	..	..

‡ for accrued interest or redemption. † Ex Dividend. ‡ The London Stock Exchange [illegible]

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NOTES.

Testing Induction Motors.

Many motors, especially large motors, built at the present time, are of the induction type with slip-rings. The reasons for this are many and weighty. Such machines can be safely built for high pressures, they give no trouble at starting nor when running, and they are very efficient over a wide range of load. A simple method of measuring the efficiency of such machines, therefore, is very desirable, especially when only one unit is available. Now it frequently happens that though the necessary supply is at hand, suitable means of absorbing the power are wanting. Arranging a dynamometer or brake is not always an easy matter, especially on site, nor is it always sufficiently accurate to absorb the power by driving an electric generator.

In such cases it is possible to take advantage of the transformer properties of the induction machine and absorb the power supplied to the stator by loading the *clamped* rotor electrically. Corrections are necessary, of course, to allow for the mechanical losses and the increased copper and iron loss. In our present issue we publish a short article in which Mr. H. J. S. Heather points out the possibility of using such a method and describes how the corrections are made. Though the author does not deal with the problem exhaustively, nor append comparative test results, the necessary refinements will at once be clear to those conversant with the working of these machines, and we have no doubt that such a method can be made to do reliable service.

The Education Estimates.

In introducing the Education Vote last week in the House of Commons, Mr. Runciman seemed by no means cheerful as to the position of technical education in this country; in fact, he stated that in his opinion it was in the field of higher technology that we had most leeway to make up. Nevertheless, he had to admit that a number of large bequests had been made during the past year and this certainly must be taken as a most important preliminary step to efficient education. For example, the University of Liverpool has recently founded a professorship of naval architecture and a department for the study of problems in town planning. The study of aeronautics has not been neglected and a professorship has been founded at Leeds for the study of questions connected with the gas, coal and fuel industries, and the Clothworkers' Company has given £50,000 to the University at Leeds to provide instruction in wool combing and spinning. Further, in the North of England £35,000 has been applied to the teaching of mechanical engineering, and in three universities sums of £30,000, £50,000 and £70,000 respectively have been provided for the promotion of chemical science. Without wishing to minimise in any way the gratitude which all should feel towards these generous donors for their efforts to help on education, we cannot help thinking that the Government themselves might do more, or rather might give more, than they do at present. A matter of national importance should not depend so much on private individuals.

Although there is much yet to be done we think it will be admitted that the above are satisfactory signs of an

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awakening to the value of technical education, but what appeared to trouble Mr. RUNCIMAN most was the fact that there are only 16,000 students in the universities of England as compared with 63,000 students in similar institutions in Germany. Even taking into account the difference in the population there is no doubt that these numbers do not compare satisfactorily, assuming that the figures are strictly comparable. On the other hand, it must not be forgotten that a certain amount of education is necessary to teach the public fully to realise the advantages of technical education. Further, as pointed out by Sir PHILIP MAGNUS in the debate, the higher technical institutions of Germany have been established for much longer than the similar institutions in this country. Moreover, there has always been a lack of funds, and in this connection there may be a good deal in the view expressed by Sir PHILIP MAGNUS that the Board of Education should take steps to ensure that grants to secondary schools should not be given exclusively to the pupils, but some part should go to increasing the income of the schools. It is also worthy of note that the Treasury grants to universities will, in future, be administered by the Board of Education. This makes the Board the only Government Department to deal with the universities. In order that the grants may be properly administered a small advisory committee has been appointed, and we hope that they will approach their work with more open-mindedness than has always been the case in the past.

General Electric Progress.

THE annual meeting of the General Electric shareholders took place on Monday. The directors' report which was presented to the meeting contained many points of interest to electrical engineers, and was submitted with all the cheery optimism of the chairman (Mr. HUGO HIRST). He fittingly referred to the late chairman and founder of the company, Mr. GUSTAV BYNG. It is quite clear that much of the success of the General Electric Company's work is due to Mr. BYNG'S early efforts. His place on the board has been filled by the appointment of one of his sons. It is satisfactory to note, turning to the balance-sheet, that the trading profits amount to £107,858, an increase of £16,728 over last year's working, and that good-will and patents have been written down to £1. The company has continued its old policy of financing manufacturing concerns by investing its surplus funds in concerns which act as feeders to the general business. In this way the British General Electric Companies of China and Australia have recently been founded and financed, and it is foreshadowed that similar undertakings will soon be established in India and the Argentine.

PERHAPS the most interesting point in the directors' report is that which deals with the National Insurance Bill. The scheme of contributions by employers outlined in that Bill must prove a serious matter to all large manufacturing and distributing firms and one which will require careful consideration. Ethically an employer is to some extent responsible for his employes, and the General Electric Co.'s directors are able to support this view, notwithstanding the heavy charge it entails. Mr. HIRST, in the course of his remarks, said the Bill would "carry in its train benefits which will improve the discipline, independence, character and happiness of the working people, and therefore will be worthy of sacrifice on the part of every section of the community." This is a statement of the case which we can but hope the future will justify.

Provisional Electric Lighting Orders.—The Board of Trade have issued their report respecting the applications to and proceedings of the Board under the Electric Lighting Acts, 1882 to 1909, during the past year.

There were 28 applications for orders (11 by local authorities and 17 by companies or persons), butt wo applications (by Bognor Urban Council and Uxbridge and District Electric Supply Co.) were not proceeded with. In the case of the application of Bermondsey (London) Borough Council for an order for the remaining portion of the Borough an inquiry was held by the Board, and after consideration of all the circumstances of the case they refused to grant the order. The local authority refused to consent to the application of the New Electricity Co. of Macclesfield for Macclesfield borough, and after consideration of the circumstances the Board dispensed with the consent, and granted the order. In all other cases the applications were granted (either for the whole or part of the scheduled areas), and confirmatory bills were introduced.

The bills to confirm the provisional orders granted by the Board of Trade last year were passed, and all received the Royal Assent.

Since the date of the last report the Board have approved deeds transferring the powers, duties and liabilities of five orders, viz., the Caerphilly, Church, Dawlish, Dunfermline and District and Southgate Orders.

The Board have given their consent under sec. 2 of the Electric Lighting Act, 1909, to the construction of generating stations on certain specified land for the purposes of six orders (Bispham, Carmarthen, Dawlish, Glasgow, Llanelly and Swinford); and the Board have also made 23 orders under sec. 6 of the same Act permitting the undertakers to supply electrical energy to certain specified premises outside their prescribed areas of supply.

No applications for licences have been entertained by the Board since the date of the last report.

Telephone Administration.—Correspondence has passed between the Liverpool Cotton Association and the Postmaster-General in regard to a scheme for the creation of a central advisory committee in connection with the future management of the telephone and telegraph services of the country. It was proposed that this advisory committee should consist of representatives of the chief commercial bodies of the United Kingdom, and that it should be under the chairmanship of the Postmaster-General.

In a letter dated June 21st, the Secretary of the G.P.O. (Sir Matthew Nathan), on behalf of the Postmaster-General, states that Mr. H. Samuel is of opinion that a small advisory committee would fail to be completely representative of all the special interests which should be kept in view in the administration of the telephone and telegraph services, and that a thoroughly representative committee would be so large as to make it impossible to ensure full consideration of the numerous questions in which the majority of the members would not be directly interested. On the other hand, the Postmaster-General sees no serious difficulty in securing the objects which the Liverpool Association have in view by the adoption of a proper system of administration by the Post Office. On several occasions recently he has explained his intention of decentralising the administration of the telephone service, and of entrusting responsible officers in different parts of the United Kingdom with a considerable measure of executive control. It will be the duty of these officers to keep in touch with commercial bodies and with local authorities in their provinces and districts, and it will therefore always be possible to secure free discussion between representatives of the Post Office telephone service and the bodies who may require special developments of the service to meet their needs. Commercial bodies, such as the Liverpool Cotton Association, Chambers of Commerce, Chambers of Trade, Chambers of Shipping, or the Committees of Stock Exchanges, will thus have frequent opportunities of making special representations, and whenever necessary the assistance and advice of local committees will be sought in dealing with problems in which they are concerned. Their views will always receive full consideration by the Postmaster-General, and, if necessary, can be personally discussed with him, or with the principal officers of the Post Office. In this way a simple and effective method of dealing with all special requirements may be arranged without difficulty, and Mr. Samuel therefore considers it unnecessary to appoint a general advisory committee, or to ask the House of Commons to hold a special inquiry on the subject.

The Liverpool Association has accepted the situation outlined in this reply.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair
Assab—Perim	July 8, 1909 ...	—
Malta—Tripoli	April 20, 1910 ...	July 18, 1911
Latakia—Palura	May 26, 1910 ...	—
Zanzibar—Mombasa	July 11, 1911 ...	—
Bathurst—Bissao	July 11, 1911 ...	—
Guam—Manila	July 12, 1911 ...	

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Medico-Mechanical Institute.—Mr. Edgar Allen (of Edgar Allen & Co., Ltd.) has presented a Medico-Mechanical Institute to the city of Sheffield. The institute has been fitted with a complete set of Zander apparatus, and Mr. Allen will bear the whole cost of maintainence (£1,500 a year) for the next three years. By that time he hopes the institute will be supported with the hospitals, in conjunction with which it will be worked. The institute is intended for the free treatment of wage-earners suffering from limb troubles.

Automatic Telephone Exchanges.—In our last issue we announced that the Post Office proposed to instal an exchange at Epsom working on an automatic system. We have now received the following information from the engineer-in-chief of the Post Office confirming this and amplifying the details. It appears that as a result of visits recently paid to America by the engineer-in-chief and other headquarter officers of the Post Office the Postmaster-General has decided to introduce experimentally into this country some of the systems of automatic exchange working which are now installed in several cities of the United States. Three or four different systems are in use in America and these have all been investigated both in their electrical and economic aspects. The automatic system represents a radical departure from the existing general method of exchange working, and it is felt that in order to keep abreast of telephone progress the time has arrived for giving these systems a practical trial in Great Britain. The mechanical and electrical problems involved have now to a great extent been satisfactorily solved, and it remains to be decided whether such systems will be economical, and further whether they will be popular with the British public. Negotiations are now in hand for the installation of an automatic exchange on the "Stronger" principle at Epsom, and for another on the "Lorimer" system at Caterham. Each of these exchanges will be equipped with about 500 lines at the outset, and will probably be installed within the next six or eight months. The exchange serving the official departments at St. Martin's-le-Grand is also to be converted to the automatic system, and will include about 400 lines. The development of "semi-automatic" exchanges is also being closely watched. These exchanges utilise the ordinary type of subscriber's telephone, as used on the existing common battery manual exchange system, and the method of working is identical so far as the subscribers are concerned. The installation of a trial exchange of the semi-automatic type would merely test the efficiency of the exchange apparatus, and would give no information as to whether the public is prepared to accept, and successfully operate, the full automatic system of working. The experimental equipments about to be installed are expected to yield all the information necessary to determine the future policy of the department.

Current Topics.

Subjects of current interest dealt with in this issue include the following:—

An article by Mr. H. J. S. Heather deals with a new method of determining the efficiency of slip-ring induction motors.

Mr. G. L. Addenbrooke contributes an article on Selenium. or Selenion, as he prefers to call it, by analogy with silicon and boron.

We publish an article dealing with the various phases in the development of the De Laval steam turbine.

In a Paper (of which we give an abstract) read before the Tramways and Light Railways Association, Mr. Gerald Hooghwinkel puts forward some reasons why, in his opinion, electric street traction is not developing in this country at the present time and is not so satisfactory financially as on the Continent.

We continue our account of the Papers and Discussions thereon delivered at the Education Conference recently organised by the Institution of Civil Engineers.

An abstract of an article by Mr. R. Rudenberg on the stability of three-phase machines gives a further account of the researches the author has been making up on this question.

Birmingham Corporation are recommended to purchase the remaining interests of the City of Birmingham Tramways Co. in the local tramways and to obtain powers to construct several additional lengths of line.

Parliamentary.—The Telephone Transfer Bill was read a second time in the House of Commons on Friday.

Standing Committee B of the House of Commons on Wednesday passed, with amendments, Clause 60 of the Coal Mines Bill, which deals with the use of electricity in mines.

Companies' Meetings and Reports.—The report of the directors of the Electric & General Investment Co. sets out an amended scheme for the extinction of the founders' shares.

The directors' report of the South Brazilian Railway Co. states that the company has acquired the local tramways (which are to be converted to electric traction) and also the electricity supply undertaking.

The report of the directors of the City & South London Railway Co. shows a satisfactory increase in the number of passengers carried and in receipts for the half-year to June 30 compared with the corresponding period of 1910, the passengers having increased by 1,000,000 and the receipts by over £4,000. The dividend for the half-year is 1¾ per cent., compared with 1¼ per cent. for the corresponding period of 1910. The vacancy caused by the death of Mr. Harvey Rankin has been filled by the appointment of Mr. J. F. S. Gooday, well known as a former general manager of the Great Eastern and Brighton Railways, and now a director of both those companies.

The accounts of the National Telephone Co. show that the amount paid to the Post Office for royalties for the half-year to June 30, 1911, was £173,424. 7s. Out of the net profits of £436,886. 13s. £200,000 is put to reserve. The company have spent on capital account during the half-year £211,121. 15s. 10d. in the erection of 15,675 additional exchange and private stations and in the construction of underground works. The total income for the half-year is £1,807,871. 13s. 3d., an increase of £129,559. 14s. 10d. over the corresponding period of 1910. The percentage of working expenses to net income was 64·74 compared with 64·09 in 1910, and the highest on record. The rentals carried forward for unexpired terms amount to £1,577,419.

OBITUARY.

R. B. Goodyer.—We regret to report the death, which occurred on the 15th inst., from heart failure, of Mr. R. B. Goodyer, at his house in Newport-road, Cardiff, at the age of 73 years. The late Mr. Goodyer had a long connection with tramway systems, having held managerial appointments with the Edinburgh Street Tramways Co., the Rothesay Tramways Co., the London Road Car Co., the Continental Metropolitan (Paris) Tramways, while for over 20 years he was manager of the Cardiff branch of the Provincial Tramways Co. Mr. Goodyer's son is tramways manager to the Croydon Corporation.

Prof. W. Spring.—The death is announced of Prof. Walter Spring of the University of Liége. The deceased was well known for his researches both in organic and inorganic chemistry.

PERSONAL NOTES.

Mr. Benjamin Deakin, M.I.M.E., M.I.E.E., who for many years occupied a responsible position on the engineering staff of the City and County of London Electric Supply Companies and subsequently as engineer and manager in Australia for the British Insulated & Helsby Cables (Ltd.) and the Electric Supply Co. of Victoria, has joined the firm (with a seat on the board) of Horrocks, Roxburgh, Ppty. (Ltd.), Melbourne, who are agents for Hadfield's Steel Foundry Co., Brown Bayley's Steel Works, William Cooke & Co., of Sheffield, and other firms. Mr. Deakin was the engineer who designed and constructed the Ballarat and Bendigo electric supply and tramway undertakings, from the management of which he has just retired. He is visiting England in the interest of his new firm, and his address in London will be c/o the National Bank, 5, Bishopsgate, London, E.C.

Sir Joseph Swan, F.R.S., has been elected president of the Literary and Philosophical Society of Newcastle-on-Tyne.

Mr. C. W. Hill, manager of the Bournemouth tramways, has tendered his resignation in order to take up a business appointment in London.

APPOINTMENTS VACANT AND FILLED.

A lecturer in electrical engineering is required at the East London College (University of London) for September next. Workshop experience essential. Commencing salary £180. Particulars from Prof. J. T. Morris. Applications to the Registrar of the College by Monday, July 31. See advertisement.

An assistant lecturer and demonstrator is required in the mathematics and mechanics department of Sunderland Technical College,

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Salary £150. Applications to Mr. Herbt. Reed, 15, John-street-Sunderland, by July 31.

A demonstrator or assistant lecturer is required in the physics department of the University College of Wales, Aberystwyth. Salary £150. Applications to the Registrar by Aug. 24.

Battersea (London) Council require an additional commercial assistant for their electricity department. Salary £2 per week and commission. Applications by noon July 24.

The Governors of Heriot-Watt College, Edinburgh, require an organiser of technical education. Salary £300 per annum. Applications to the Clerk, 20, York-place, Edinburgh, by July 24.

An assistant science master is required for Waterford Central Technical Institute. Salary £100, rising to £130. Particulars from the Principal. Applications by noon, July 29.

Appointment Wanted.—Mr. A. H. Seabrook, general manager of the Marylebone electric supply department, writes as follows:—

Probably many supply engineers have been in the position that I have been in myself in requiring a suitable man for a certain post, and really not knowing where to turn to obtain one. If at the present moment any supply man is looking round for a first-class boiler house and steam plant superintendent, I can recommend to him a man whose capabilities I do not believe can be excelled.

Taunton Council have appointed Mr. Appleby, of Smethwick, assistant engineer at the electricity station in succession to Mr. C. B. Lewis, who is leaving for Australia.

Mr. Hugh Maclean, foreman at the locomotive works of the G.N.S. Railway at Inverurie, has received an appointment with the Chloride Electrical Storage Co. in the Argentine.

Mr. H. Love has been appointed fourth engineer at the Hammersmith electricity works.

INSTITUTIONS AND SOCIETIES.

Royal Society of Arts.—The Council of this Society attended at Clarence House on Friday last, when the president, H.R.H. the Duke of Connaught, K.G., presented its Albert Medal to the Hon. Sir Chas. A. Parsons, K.C.B., F.R.S. As already announced in THE ELECTRICIAN, this medal was awarded to Sir Charles "for his experimental researches into the laws governing the efficient action of steam in engines of the turbine type and for his invention of the reaction type of steam turbine and its practical application to the generation of electricity and other purposes."

Association of Consulting Engineers.—Since the draft rules drawn up by the provisional committee were circulated in December last, a large number of council meetings have been held to deal with points that have been raised by various engineers, and a number of important negotiations have been in progress. It was hoped that these negotiations would have been completed in time to call a general meeting to consider the rules and formally enroll members during the present month. Unfortunately, owing to the large number of interests to be considered and the complexity of the considerations involved, this has been found impossible, but the committee hope to be able to call the meeting after the holidays. Meantime, Mr. Dykes, the honorary secretary, would be obliged if all letters were sent to his new address, 11, Victoria-street, Westminster, S.W.

British Association.—The British Association meeting this year will be held from August 30 to September 6, Portsmouth being the meeting place for the first time in the society's history. In his presidential address to the Association, Sir Wm. Ramsay will deal with the increasing need of scientific training with a view to future as well as to present-day requirements. He will also touch upon the necessity of conserving our national resources. Prof. H. H. Turner will consider, in his opening address to Section A, the lessons taught by the observational sciences, *e.g.*, magnetism, as regards methods of work. Sections A and G will hold a joint meeting for the discussion of "The Problems of Mechanical Flight," which will be opened by Mr. H. E. Berriman, editor of "Flight." In Section B, Prof. McWilliam will present a report on "Electric Steel Furnaces." In Section G there will be a discussion on the respective merits of superheated steam engines, suction gas plants and Diesel engines. Papers on these subjects will be contributed by Captain H. R. Sankey, Mr. Tookey and Mr. C. Day. It is hoped that Prof. G. W. Howe will be able to show some experiments on wireless telegraphy, and that Capt. Sankey will be able to exhibit a portable wireless telegraph equipment. Several Papers relating to ships will be presented, dealing with recent improvements, such as the "Gyro-Compass," by Mr. G. K. B. Elphinstone, "Electrical Steering," by Mr. B. P. Haigh, "Electrical Drives for Ships' Propellers," by Mr. H. A. Mavor, and "Marine Engines adapted for burning Crude Oil," by Mr. J. H. Rosenthal. Other Papers are those on "Smoke Abatement," by Dr. J. S. Owens, the "Origin and Production of Corrugation on Tramway Rails," by Mr. Worby Beaumont, and "The Vibragraph," by Mr. W. P. Digby. Among the social functions which have been arranged are a reception by the Mayor and Mayoress of Portsmouth on the South Parade Pier, and a municipal garden party in Victoria Park. The Bishop of Winchester will preach in Portsea Parish Church on September 3rd, when the President and Council of the Association will attend. H.M. Dockyard will also be visited and there will be a display at the Gunnery School on Whale Island.

New Club House of the Whitehall Club.—An interesting ceremony was performed yesterday (Thursday) at the new building which will, when completed, form the new home of the Whitehall Club. A commemorative stone was laid by Mr. Alexander Siemens, President of the Institution of Civil Engineers, assisted by Mr. E. B. Ellington, President of the Institution of Mechanical Engineers, and Major O'Meara, Vice-President of the Institution of Electrical Engineers. Inserted in the stone was a box containing a number of mementoes of the occasion. Mr. C. Midgley Taylor, chairman of the club, presided over the ceremony, and also took the chair at the luncheon which followed it. About 120 members of the club and their guests sat down to luncheon, the company including Sir Henry Tanner, Sir Robert W. Perks, Mr. G. N. Abernethy, vice-president of the club, and a large number of club members. At the luncheon the presidents of the three Institutions spoke of the useful position of the new building and of the facilities for social intercourse which its accommodation would afford to engineers. Mr. Midgley Taylor, in responding to the toast of the club, said that it had been arranged to elect as honorary members of the club engineers from the Dominions overseas who were recommended to them by the presidents of the professional institutions from which the club made up its own members. This course would ensure an appropriate welcome being extended to prominent men visiting this country from the Colonies. The new building, which is from designs by Mr. H. Chatfeild Clarke, F.R.I.B.A., will accommodate 500 town members. Mr. J. Hodgkin is the secretary of the club, and from him full details of membership can be obtained at 2A, Whitehall-court, London, E.C.

EDUCATIONAL NOTICES.

University of Sheffield.—The faculty of applied science comprises the departments of engineering, metallurgy, coal mining and architecture. The courses in engineering or in metallurgy extend over three years and prepare respectively for the degree of B.Eng. or B.Met. of the university. The lecture courses commence Oct. 4, and the technical laboratory courses on Sept. 18. Prospectuses and other particulars from the registrar, Mr. W. M. Gibbons.

University of Manchester.—Prospectuses giving full particulars of the lectures and laboratory courses in physics preparing for both the ordinary and honours degrees, will be forwarded on application to the Registrar.

City and Guilds Technical College.—This college provides a scientific training for students preparing to become electrical and mechanical engineers or chemists, and for engineering pupils who desire to supplement their practical training by a two years' course of instruction in the principles of engineering science. The instruction is mainly given in the various laboratories, most of which have been recently re-equipped. The subjects of the entrance examination are mathematics and English, but the matriculation of any British University is accepted. The courses in electrical and mechanical engineering cover a period of two years and those in chemistry three years. There are also arrangements for three-year courses in engineering. Particulars at the college, Leonard-street, City-road, London, E.C., or from the City and Guilds of London Institute, Gresham College, Basinghall-street, London, E.C.

In consequence of the rebuilding of Gresham College the head offices of the City and Guilds of London Institute have been removed temporarily to 3, St. Helen's-place, London, E.C.

ARRANGEMENTS FOR THE WEEK.

THE LONDON ELECTRICAL ENGINEERS.

Officer Commanding, Col. H. M. Leaf.

The following orders have been issued for the current week.

Monday, 24th .....
Tuesday, 25th.....
Wednesday, 26th...
Thursday, 27th.....
Friday, 28th .....
} Headquarters will be open from 10 a.m. to 4 p.m.

Saturday, 29th .... Falmouth detachment will parade at Headquarters at 8:30 a.m. Weymouth detachment will parade at Headquarters at 11 a.m. Dress for the above detachments will be: Service dress, drill order, with water bottles and haversacks. Arms will be issued before each parade.

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THE STABILITY AND COMPENSATION OF THE THREE-PHASE SERIES COMMUTATOR MACHINE.*

BY R. RÜDENBERG.

Summary.—The author continues his investigations into the characteristics of the series commutator motor with unequal numbers of turns on stator and rotor. The limit of stable speed can be made as low as desired by reducing the number of rotor turns, whilst compensation is obtained by increasing the rotor turns. Both properties only depend on the brush displacement and the ratio of the turns.

In a previous article† the chief characteristics of the three-phase series commutator motor were deduced for an ideal machine. Under the assumption of the same number of effective turns on both stator and rotor, two remarkable results were established, viz., that exact phase compensation only exists at double synchronous speed—below this speed the current would lag, above it, lead—and, secondly, that at low speeds, especially with large brush displacements, there was a

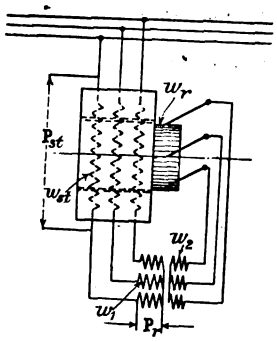

FIG. 1.—DIAGRAM OF CONNECTIONS.

limit of stability for the speed, below which the machine could not work as motor. It was then shown that both these factors could be varied by altering the ratio of stator to rotor turns. To obtain good phase compensation at a lower speed, the number of rotor turns must be increased, whilst to obtain stability at low speeds a decrease in the number of turns on the rotor is necessary.

Taking again the ideal motor, we can now continue the study of these properties by placing an ideal transformer between stator and rotor, as shown in Fig. 1. The effective stator and rotor turns are denoted by w_{st} and w_r, and the primary and secondary turns of the transformer by w_1 and w_2 respectively.

I.—STABILITY.

The working of the motor will depend on the double ratio

$$x=\frac{w_r}{w_{st}}:\frac{w_2}{w_1}=\frac{w_r w_1}{w_{st} w_2}. \quad . \quad . \quad . \quad . \quad . \quad (1)$$

The case $x=1$ corresponds to equal effective turns on stator and rotor. The pressure diagram of the motor is shown in Fig. 2. The

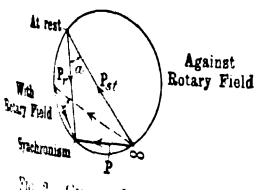

FIG. 2.—CIRCLE DIAGRAM OF PRESSURE.

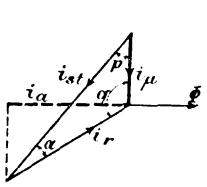

FIG. 3.—CURRENT SYSTEMS IN THE MOTOR.

applied pressure P is the geometric sum of the stator pressure P_{st} and the rotor pressure P_r, which are displaced in phase by the brush angle α, where α is taken from the "short-circuit position," in which the stator and rotor currents directly oppose. The diagram is drawn for $x<1$, so that there are fewer turns in the rotor than in the stator. The rotor pressure is reduced to the external circuit and can be directly measured on the primary side of the transformer. The rotor pressure depends on the ratio x. At rest, $P_r=P_{st}$ when $x=1$. When running, of course, P_r varies with the slip s relative to the synchronous speed n_0 of the motor:—

$$P_r=xP_{st}\cdot s=xP_{st}\left(1-\frac{n}{n_0}\right) \quad . \quad . \quad . \quad . \quad . \quad (2)$$

or

$$\frac{n}{n_0}=1-\frac{P_r}{xP_{st}}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

whence the speed can be directly obtained from the pressure diagram.

The space diagram of the current systems in the machine is shown in Fig. 3, also drawn for $x<1$, the rotor ampere turns denoted by i_r being only x times the stator ampere-turns i_{st}. The two current systems are at the brush angle α and form the resultant magnetising current i_μ which produces the main flux Φ of the motor. It might be pointed out that even with $\alpha=0$ the main flux does not completely vanish, because with

$$i_r=xi_{st} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

a magnetising current still remains, even when i_r and i_{st} directly oppose one another. In this case, however, Φ is at right angles to the current systems, in space, and cannot produce a torque.

The shape of the current triangle is completely determined by α and x. The magnitude of the magnetising current is then

$$i_\mu=\sqrt{i_{st}^2+i_r^2-2i_{st}i_r\cos\alpha}$$
$$=i_{st}\sqrt{1+x^2-2x\cos\alpha}. \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Further, when no saturation is present,

$$i_\mu=C_1\Phi. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

The torque is proportional to Φ or i_μ, and the energy component i_a of the stator and rotor currents (i_a is shown dotted in Fig. 3). Thus, in Fig. 3, the torque

$$D=C_2i_\mu i_{st}\sin p=C_2i_\mu i_r\sin q. \quad . \quad . \quad . \quad . \quad (7)$$

This, of course, is the same for stator and rotor, but in opposite directions, since the energy components of the currents are equal and opposite.

Further, we have

$$\sin p=\frac{i_r}{i_\mu}\sin\alpha=x\frac{i_{st}}{i_\mu}\sin\alpha,$$

and the torque is then

$$D=C_2xi_{st}^2\sin\alpha$$
$$=C_2i_\mu^2\frac{x\sin\alpha}{1+x^2-2x\cos\alpha}. \quad . \quad . \quad . \quad . \quad (8)$$

Now the flux and stator pressure are always proportional,

$$P_{st}=C_3n_0\Phi, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

so that we get for the torque

$$D=CP_{st}^2\frac{x\sin\alpha}{1+x^2-2x\cos\alpha}, \quad . \quad . \quad . \quad . \quad (10)$$

where all the constants are combined in C.

Lastly, to replace the variable stator pressure P_{st} by the applied pressure P, we have, from Fig. 2,

$$P^2=P_{st}^2+P_r^2-2P_{st}P_r\cos\alpha$$
$$=P_{st}^2+(1+x^2s^2-2xs\cos\alpha). \quad . \quad . \quad . \quad (11)$$

Hence, for the torque, we get finally,

$$D=CP^2\frac{x\sin\alpha}{(1+x^2-2x\cos\alpha)(1+x^2s^2-2xs\cos\alpha)}. \quad . \quad (12)$$

The constant C can be replaced by the normal torque D_0 at the normal pressure P_0 at synchronism, $s=0$, with the brush angle α_0 (*e.g.*, $\alpha_0=30°$) and $x=1$, whence

$$\frac{D}{D_0}=\frac{P^2}{P_0^2}2\tan\frac{\alpha_0}{2}\frac{x\sin\alpha}{(1+x^2-2x\cos\alpha)(1+x^2s^2-2xs\cos\alpha)}. \quad (13)$$

It has already been shown that the three-phase series motor possesses a limit of stability for the speed, below which the motor cannot work, because an increase of speed corresponds to an increase of torque. In the limiting position itself the torque does not alter with the speed, whilst above it the torque decreases as the speed rises, that is, the motor is stable. To find this limiting position we must find the maximum torque with respect to the speed. This is when $1+x^2s^2-2xs\cos\alpha$ is a minimum.

By differentiating we get for the equation of stability

$$xs=\cos\alpha$$

or

$$\frac{n_s}{n_0}=1-\frac{\cos\alpha}{x}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (14)$$

This position is entirely independent of the saturation. The position of stability can also be found from the pressure diagram, as shown previously. This happens when the stator pressure P_{st}, or the flux, is a maximum. P_{st} is then the diameter of the circle and the pressures form a right-angled triangle, whence

$$P_r=P_{st}\cos\alpha$$

from which equation (14) follows (cp. equation 3).

* Abstracted from an article in the "E.T.Z." Recently several valuable articles by the present author have appeared in the "E.T.Z." and "El. M." on the three-phase series commutator machine, and its self-exciting properties as generator. We much regret that pressure on space prevents our doing justice to these also.

† An abstract of this article recently appeared in THE ELECTRICIAN, April 7, 1911. A knowledge of this article is assumed in what follows.

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It is seen that the limiting position only depends on x and a, and is independent of the pressure and torque. By making $x<1$, that is, by using fewer ampere-turns on the rotor than on the stator, we can make the stable position as low as we like. In Fig. 4 the stability curves are shown for different ratios x as function of the brush angle a. It is clear that stability at low speeds is easily attained with small brush angles but not with large.

The only way to obtain a better range of stability is to vary x and a together. For this the simplest relation is

$$x = x_0 \cos a. \quad \ldots\ldots\ldots \quad (15)$$

In Fig. 4 the stability limits are shown dotted for different values of x_0 in the short-circuit position—these are constants and entirely independent of the working of the motor. Each value of x_0 corresponds to a minimum speed attainable in working and is given by

$$\frac{n_s}{n_0} = 1 - \frac{1}{x_0}. \quad \ldots\ldots\ldots \quad (16)$$

Hence x and the ratio of the windings can be at once found for any required conditions.

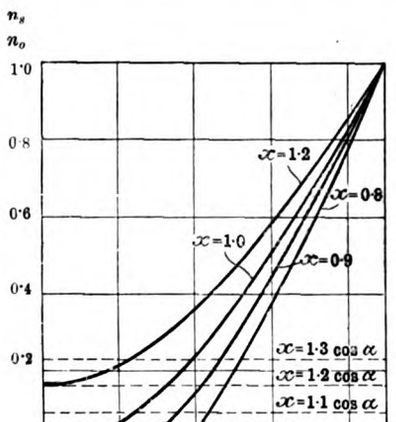

Fig. 4.—Limit of Stability.

If the motor, therefore, has to work at very low speeds, then $x_0>1$. With $x_0=1$ and, therefore, $x=\cos a$, the motor is perfectly stable and the formula for the torque becomes (from equation 13)

$$\frac{D}{D_0} = \frac{P^2}{P_0^2} \frac{2\tan\frac{a_0}{2}}{\tan a(1-s(2-s)\cos^2 a)}. \quad \ldots\ldots \quad (17)$$

The starting torque ($s=1$) with normal pressure is

$$\frac{D_a}{D_0} = 2\tan\frac{a_0}{2}\frac{\cos a}{\sin^3 a}, \quad \ldots\ldots \quad (18)$$

whilst for the normal unstable motor with $x=1$ and $s=1$, the starting torque is

$$\frac{D_a}{D_0} = \tfrac{1}{4}\tan\frac{a_0}{2}\frac{\cos\frac{a}{2}}{\sin^3\frac{a}{2}}. \quad \ldots\ldots\ldots \quad (19)$$

With the normal brush angle $a_0=30°$, the curves representing equations (18) and (19) practically coincide for all values of $a<60°$.

The variation of the ratio x can be made directly by altering the number of effective turns in the stator or the auxiliary transformer. The simplest way, however, is to provide two brushes for each phase—these brushes being movable relative to one another,

II.—Compensation.

We shall now investigate the effect of the ratio of transformation x on the power factor of the three-phase series motor. In Fig. 5 the current diagram of the effective ampere-turns is given, and in Fig. 6 the pressure diagram of the stator and rotor windings. Splitting up the stator current, i_{st}, into its watt component i_a and its wattless (magnetising) component i_μ, we get the angle ϕ_0 between i_a and i_{st}. The same angle occurs in the pressure triangle between the watt component P'_{st} and the total stator pressure P_{st}. The latter pressure, P_{st}, is displaced from the applied pressure P by the angle a, whilst the current I is in phase with the watt component P'_{st}, hence the power factor of the motor is

$$\cos\phi = \cos(\gamma+\phi_0) = \cos\gamma\cos\phi_0 - \sin\gamma\sin\phi_0.$$

Further from the current diagram and equations (4) and (5), we have

$$\left.\begin{aligned}\cos\phi_0 = \sin p &= \frac{x\sin a}{\sqrt{1+x^2-2x\cos a}}\\ \sin\phi_0 = \cos p &= \frac{1-x\cos a}{\sqrt{1+x^2-2x\cos a}}\end{aligned}\right\} \quad \ldots \quad (20)$$

$\cos\phi_0$ is the power factor of the stator or the power factor at synchronism, for at this point $\gamma=0$.

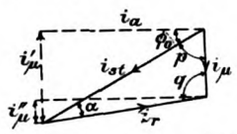

Fig. 5.—Space Diagram of Currents.

From the pressure diagram and equations (2) and (11) we get similarly

$$\left.\begin{aligned}\sin\gamma &= \frac{xs\sin a}{\sqrt{1+x^2s^2-2xs\cos a}}\\ \cos\gamma &= \frac{1-xs\cos a}{\sqrt{1+x^2s^2-2xs\cos a}}\end{aligned}\right\} \quad \ldots \quad (21)$$

whence we get for the power factor, finally

$$\cos\phi = \frac{1}{\sqrt{1+\left(\frac{1+x^2s-x(1+s)\cos a}{x(1-s)\sin a}\right)^2}} \quad \ldots \quad (22)$$

Thus the power factor depends on the speed, the brush angle and the ratio x, and is unaffected by the saturation.

For $x=1$, the power factor is

$$\cos\phi = \frac{(1-s)\cos\frac{a}{2}}{\sqrt{1+s^2-2s\cos a}}, \quad \ldots\ldots \quad (23)$$

as also shown in the previous Paper.

For complete stability, *i.e.*, $x=\cos a$, we get

$$\cos\phi = \frac{1}{\sqrt{1+\left(\frac{\tan a}{1-s}\right)^2}}. \quad \ldots\ldots \quad (24)$$

This latter value is always considerably smaller than that for unstable motor. This is best seen for synchronism where we h

$$\text{for} \quad x=1, \qquad \cos\phi_0 = \cos\frac{a}{2},$$
$$\text{for} \quad x=\cos a, \quad \cos\phi_0 = \cos a.$$

The meaning of this is that in the latter case the current tria in Fig. 5 is right-angled, and the whole magnetising current is plied by the stator, whilst with $x=1$ and an isosceles current

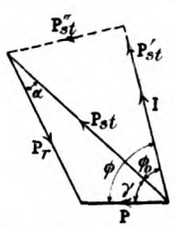

Fig. 6.—Time Diagram of Pressures.

angle, half is given by the stator and half by the rotor. Thus complete stability ($x=\cos a$), complete compensation ($\cos\phi=$ not possible.

For unity power factor, the term in the brackets in equatio must vanish. Since the denominator cannot become infinite, the condition for $\cos\phi=1$

$$1+x^2s = x(1+s)\cos a, \quad \ldots$$

whence

$$s = 1-\frac{n_k}{n_0} = \frac{\cos a - \frac{1}{x}}{x-\cos a} \quad \ldots\ldots$$

is the slip or speed n_k for which $\phi=0$. At lower speeds ϕ l higher speeds it leads. From the curves drawn to represe relation, it is at once clear that at low speeds and large bru placements x becomes very large and over a certain range co compensation becomes impossible. The working range of the therefore, is usually chosen with small brush angles.

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A NEW METHOD OF DETERMINING THE EFFICIENCY OF SLIP-RING INDUCTION MOTORS.

BY H. J. S. HEATHER.

The machine usually called the induction motor may be looked upon as the most general form of the transformer. It has the power of transforming both frequency and voltage in any desired (though not independent) ratio ; it is also able to change electrical into mechanical energy and *vice versa*. If the primary (or stator) of such a motor is connected to a source of alternating current supply, and the rotor clamped so that it cannot turn, the secondary (or rotor) may be made to give out, from its slip rings, currents of the same periodicity as the supply. The mechanical control of its movement results in its acting wholly as a transformer, and its mechanical output is zero. If, on the other hand, its electrical output is reduced to zero by short-circuiting the slip-rings, its whole output takes the mechanical form and the rotor rotates at a speed depending only on the torque opposing its motion. Between these two extremes any number of intermediate conditions may obtain in which the output is partly electrical and partly mechanical, the proportion between the two parts being dependent upon the torque the machine is compelled to give out mechanically and the resistance between the slip-rings from which the electrical output is derived. If there were no losses in the machine, the total output at a fixed current input would be absolutely constant, whether this output was wholly electrical, wholly mechanical, or partly electrical and partly mechanical.

There must, however, be losses, and these losses come under the following headings :—

Primary iron loss.
Primary copper loss.
Secondary iron loss.
Secondary copper loss.
Friction loss.

The secondary output, plus the above losses must be equal to the primary input.

Now, suppose that the primary is taking in a certain fixed current from a constant-potential supply. Then, of the above losses, the primary iron loss, primary copper loss, and secondary copper loss, remain unaltered whether the machine operates wholly as transformer, wholly as motor, or partly as one and partly as the other. The only losses that change, therefore, through altering the function of the machine from transformer to motor are the secondary iron loss and the friction loss.

If, therefore, we can ascertain what changes these two losses undergo in changing the machine from a transformer to a motor, the machine's mechanical output as a motor can be determined by measuring its electrical output as a transformer and applying the correction demanded by the changes in the above-mentioned losses, viz., those in friction and in the secondary iron. The fact of the existence of slip will be taken into account by this procedure, as the slip corresponds to the current used and the rotor copper losses will not be included in the electrical measurement of the output.

This correction can be found quite simply. The machine can be run as a motor without load and with its rings short-circuited, and the watts and current input can be measured. The secondary current will be small enough to be negligible (though it can be measured if it is thought necessary), and so will the secondary iron loss for the secondary periodicity is practically zero. The watts input *minus* the primary copper loss are consequently equal to the primary iron loss *plus* the friction loss.

Next, the rotor can be clamped with its rings open-circuited and the primary switched on to the mains. The clamping is necessary because eddy currents in the iron may be sufficiently large to start the machine as a motor. The watts and current input are then measured as before. The watts input *minus* the primary copper loss are now equal to the primary iron loss *plus* the secondary iron loss at standstill.

The two tests above described are carried out under the same conditions of applied voltage, periodicity and magnetic circuit, and the two currents are almost identical, so the induced as well as the applied voltages are practically the same. Consequently the fluxes and the primary iron losses must be the same. The difference, therefore, between the watts input *minus* the primary copper loss in the first test and the watts input *minus* the primary copper loss in the second test will give us the difference between the friction loss at full speed and the secondary iron loss at standstill.

Now, whenever the machine is acting purely as a motor, its slip will be so small that we can regard the friction loss as constant and the secondary iron loss as negligible at all loads. The error introduced by each of these inaccuracies is, of course, only a very small percentage of the total losses, and, moreover, the errors are not cumulative but in opposite directions. The difference found above between the friction loss at full speed and the secondary iron loss at standstill can, therefore, be applied at all loads as a correction to the value of the electrical output as a transformer in order to arrive at the mechanical output as a motor.

In order to get at the electrical output as transformer, it is only necessary to clamp the rotor, insert a high resistance between the slip-rings, and after switching on the stator, to reduce this resistance until the current going into the stator is that at which the efficiency is required to be determined. Wattmeter readings of the primary input and the secondary output are then taken. The output is then corrected as indicated above to determine the mechanical output as motor, and the ratio between this and the input is the efficiency.

The method above suggested has the advantages of requiring electrical measurements only, and the use of only one motor and no belts. Both in simplicity and accuracy it appears to compare favourably with any previously described process.

THE DE LAVAL STEAM TURBINE FOR DRIVING LOW OR MODERATE SPEED MACHINERY.

SOME STEAM TURBINE PROBLEMS.

[COMMUNICATED.]

Summary.—After referring to the problems involved in the design of steam turbines—namely, the efficient utilisation of the energy in the steam and yet a comparatively low speed of rotation—a description is given of the latest type of De Laval turbine and reducing gear.

THE PROBLEMS INVOLVED.

On the whole, the large size steam turbine has so far found application only for the driving of alternators and the propulsion of ships. Little progress, comparatively, has been made in its adaptation for driving direct-current generators, and for direct connection to other machinery of moderate speed, such as centrifugal pumps and blowers, or for the driving of machinery by means of ropes or belts. While the suitability of the turbine for these purposes, because of its simplicity, small weight and space requirements, good steam economy and in recent years lower price, is apparent, the engineering world has, nevertheless, awaited until now the practical solution of the problem of driving such machines by steam turbines.

The nature of the difficulty is at once apparent from a simple statement of the velocities, &c., involved. The expansion of 1 lb. of steam from 150 lb. pressure (164·7 absolute) to a 28 in. vacuum renders available for conversion into work 325 B.Th.U., equal to 252,850 ft.-lb. of energy. If the expansion be accomplished in one nozzle having unit efficiency, the resulting velocity of the steam will be 4,040 ft. per second.

If the jet of steam impinges upon a bucket standing still, it will exert a force upon the bucket equal to the flow expressed in mass units per second multiplied by the velocity with which the steam strikes the bucket, while the jet leaving the bucket will also be the cause of a reaction equal to the mass per second multiplied by the velocity with which the steam leaves the bucket. Although a pressure is exerted no work will be done upon the bucket so long as the bucket stands still. If the bucket moves, however, the forces exerted upon the bucket will, as before, be equal to the mass per

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second multiplied by the relative velocity with which the steam strikes the bucket and the mass per second multiplied by the relative velocity with which the steam leaves the bucket and the work done per second will be equal to the components of the forces in the direction of motion times the distance travelled per second, that is, times the velocity of the bucket.

If the bucket velocity increases until it be equal to the velocity of the steam in the direction of motion of the bucket, it will be apparent that no force can be exerted upon the bucket, since the relative velocity of the steam striking the bucket will be zero. Between this extreme and the condition when the bucket is standing still, there is a velocity of bucket that will utilise the greatest amount of energy per pound of steam.

If there be no change in the relative velocity of the steam while traversing the bucket, this velocity of the bucket is one-half the velocity of the steam in the direction of motion of the bucket, a fact with which engineers are familiar in connection with impulse water wheels and the like. Assuming that the steam strikes the bucket in a direction tangential to the line of motion, this calls for a bucket travelling at a speed of 2,020 ft. per second, and, if the bucket be mounted upon a wheel 3 ft. in diameter, for a speed of 12,850 revs. per min.

As a matter of fact, the direction of the steam jet cannot be tangential to the line of motion of the bucket, since that would imply zero area of nozzle, and, as a practical matter, 20 deg. is found to be the least angle that is suitable. Again, the velocity of the steam leaving the nozzle is only about 97 per cent. of the velocity indicated by the thermodynamic theory, and the relative velocity of the steam leaving the bucket is, due to frictional and other losses while traversing the bucket, only about 80 per cent. of the relative velocity of the steam striking the bucket. Making allowances for the necessary entrance and leaving angles and for the losses due to friction, we find that the most efficient speed for the assumed case would be about 1,960 ft. per second.

As this, however, would still be somewhat greater than the safe limit imposed by the strength of the material of the wheel, the velocity actually used in wheels, properly designed for high speeds, is about 1,400 ft. per second, under which conditions about 73 per cent. of the energy of the expanded steam will be transferred to the wheel. This wheel velocity, however, still corresponds to a speed of 9,520 revs. per min. for our assumed 3-ft. wheel, which would be usable for very few purposes.

All the different types of steam turbines now on the market arise from the attempt to solve the problem involved in reducing this speed to speeds of practical use. A simple means of reducing the speed would be to increase the size of the wheel. This suggestion has been made repeatedly. Actually, however, the wheel required is of prohibitive size from the standpoints of space occupied, strength of materials and efficiency, since the large wheel would consume a considerable amount of power on account of skin friction and windage of buckets.

The next solution in the order of simplicity is to use gears to reduce the speed of the turbine wheel to the speed of the driven machine as was done by De Laval over 30 years ago. This has proved eminently satisfactory in sizes up to about 750 H.P., and has resulted in the production of the most efficient type of turbine within this range of size, giving, furthermore, low speeds that are practically unattainable by other means, and enabling the turbine to be directly connected to machinery of all kinds and to be used for belt and rope-driving.

The third method of speed reduction is by "multi-staging," which has been carried out in three ways. The most simple is the use of so-called "velocity stages"—that is, the wheel, instead of travelling approximately half as fast as the steam, travels, let us say, at one-eighth of the velocity of the steam, so that the rebounding steam will possess three-quarters of its original velocity upon leaving the first row of buckets. A stationary row of buckets then redirects the steam upon buckets carried by the next wheel, which abstracts another quarter of the velocity, and so on through four rows of moving buckets, which would, theoretically, abstract all the velocity. However, as pointed out above, there is a loss of velocity in traversing buckets, whether stationary or moving. If the velocity coefficient of the buckets is 80 per cent., the velocity would be so far expended at the end of the second row of stationary buckets that it would not exercise any propulsive effect upon the third row of moving buckets. In other words, the velocity of the steam soon runs down, and the efficiency of a wheel carrying so many rows of moving buckets would be very low. Steam turbines of this type are improved in efficiency by a partial adoption of the pressure stage method of compounding.

This consists in the use of pressure stages instead of velocity stages. That is, the total pressure range, or rather energy, is divided up into parts, which are utilised in what are really independent turbines. The steam first experiences a partial pressure drop through a nozzle and then impinges upon a row of moving buckets, after which it passes through a second nozzle and impinges upon a second row of buckets, and so on. Inasmuch as the velocity of the moving steam varies as the square root of the energy converted into motion, dividing the energy drop into four parts, would reduce the velocity only to one-half, and to reduce the speed of the wheel to one-quarter, as in the preceding example, will require 16 stages, in stead of four. This method of speed reduction is also subject to losses of energy, for one thing by the skin friction of the greater number of discs rotating in steam, some of which is at comparatively high pressure, and for another, the shaft carrying the wheels must pass from one chamber to another and leakage will take place along the shaft where it passes through the diaphragms.

The remaining method of speed reduction is one of the oldest, having been developed almost contemporaneously with the De Laval gear. It differs from the multicellular type just discussed, in that the drop in pressure is not confined to the stationary nozzle, but there is a drop in the pressure of the steam while passing through between the moving buckets. In fact, as far as the relative action is concerned, it would be immaterial whether the casing stood still and the shaft rotated, or the shaft stood still and the casing rotated. This is the reaction turbine, so called because the steam enters the buckets with nearly zero relative velocity in the direction of motion of the bucket, and the entire propulsive force is obtained from the reaction of the jets of steam escaping from the buckets on the low-pressure side. The buckets should move with the velocity of the spouting steam, but as each pair of stationary and moving buckets gives in reality two pressures stages, the total energy drop is divided into twice as many parts as there are moving rows of buckets. Since the buckets move as fast as the spouting steam, and since the buckets in the single impulse wheel with which we started moved half as fast as the steam, if we are to get a speed reduction of 4 to 1 as in the other cases discussed, it will be necessary that the spouting velocity of the steam be one-eighth of the spouting velocity obtained where all the energy is converted in one pressure stage and, since the spouting velocity varies as the square root of the energy drop, the energy drop

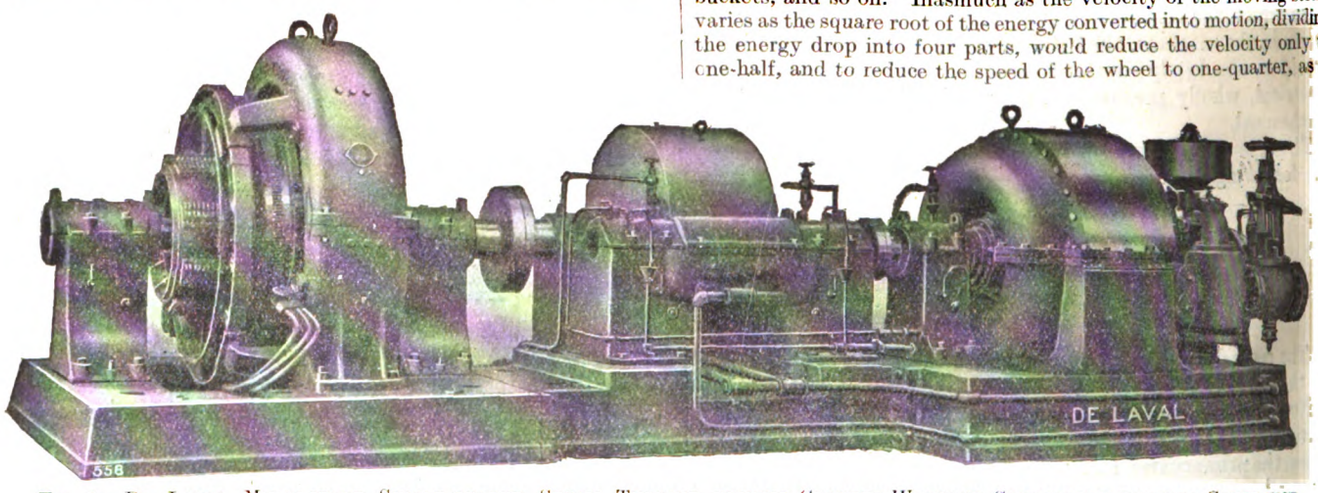

FIG. 1.—DE LAVAL MULTI-STAGE SINGLE-GEARED STEAM TURBINE, DRIVING CROCKER-WHEELER CONTINUOUS-CURRENT GENERATOR. Capacity 500 kw., Speed 500 revs. per min., High-pressure Type.

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per stage should be only $\frac{1}{64}$ of the whole. However, since there are two pressure drops for each row of moving blades in this type of turbine, the number of rows of moving blades required will be 32.

Besides the great number of rows of buckets the reaction type of turbine suffers from other disadvantages which are much more serious, especially with high-pressure steam. The principal of these is that, since there is a difference of pressure on the two sides of every row of blades, whether stationary or moving, there is necessarily a leakage through the clearance over the ends of the blades, and further, since the large number of rows of blades calls for a long shaft, the clearance must be considerable in order to take care of possible vibration, distortion due to unequal expansion by heat, &c. Again, if the same angles are preserved throughout, the length of the blades increases directly as the volume of the steam, and since steam in expanding adiabatically from 150 lb. gauge to 28 in. vacuum, increases in volume in the ratio of 1 to 93, it will be seen that the low-pressure blades will either be extremely long or the high-pressure blades extremely short. This difficulty has been met to a certain extent by mounting the first rows of blades on a drum of smaller diameter, which, however, by reducing their velocity increases the number of rows required.

The difficulty of providing for the increasing volume of steam is easily overcome in the case of multicellular turbine, where there is no objection to using partial admission in the high-pressure stages, while with the reaction turbine, such partial admission would result in subjecting the wheel to alternations of pressure during a revolution which might set up serious vibration, and which would, in any case, be accompanied by leakage of steam tangentially along the wheel from points of admission to points of no admission and by consequent steam shock and loss of energy.

We have then the following figures to secure a speed reduction of 4 to 1:—

For the pure velocity stage turbine, four rows of moving buckets will be required. For the multicellular type of turbine, 16 rows of *moving buckets* will be required; while for the reaction type of *turbine*, 32 rows of moving buckets will be required.

To illustrate the foregoing, suppose the problem is to obtain a driving speed of 600 revs. per min. from steam at 150 lb. gauge exhausting to a 28 in. vacuum, that the admission angles are 20 deg. throughout and that the blade coefficient is 100 per cent. The single-wheel turbine will be 62 ft. in diameter. If a 3 ft. wheel is used with gear reduction, a gear ratio of 21 to 1 will be required. If velocity stages are used on a 3 ft. wheel there must be 21 of them. If they are divided into two groups with pressure drop between, each will need to contain 14 velocity stages. If they are divided into three groups of pressure stages, each will need to contain 12 velocity stages. The multicellular turbine with pressure stages throughout will, neglecting the fact that the friction loss in one stage is available as heat for the next stage, contain 440 stages. The reaction turbine will contain 1,760 stages—that is, 880 rows of moving buckets.

The single-stage wheel, without gears, may be left out of the discussion because of its size and the difficulty of construction. The single-stage geared wheel is entirely suitable in sizes up to about 750 H.P. as stated, but in sizes above that it will be found that, unless the blades are made quite long or unless the angle of entrance is increased, the power of the wheel is strictly limited by the available area for the nozzle outlets and it must be remembered that at the outlets these nozzles must have an area corresponding to the final volume of the steam expanded down to 28 in. vacuum. Further, if the nozzle area is increased by increasing the length of the blades, the latter soon reach their limit of strength at the root for the speed employed, and, as a third limitation at high powers, the speed of the shaft in its bearings would be excessive, considering the thrust which they would be called upon to withstand in transmitting the power to the gear, although this one objection may be obviated by the use of double gears, wherein the downward thrust of one upon the pinion is balanced by the upward thrust of the other, so that little, if any, pinion thrust is transmitted to the bearings.

When we come to consider the multi-stage turbines, it is at once seen that they are out of the question for any such speed as that named—that is, the number of stages is so great that the shafts would be very long and subject to vibration, and difficulties in regard to clearance, both from springing of the shaft and from unequal contraction and expansion of shaft and casing, not to mention the great cost, low efficiency, would arise. For this reason it has been the common practice to give over the attempt to force down the speed of the turbine after a certain point and instead to endeavour to bring up the speed of the driven machine.

In the case of alternators this has been fairly successful, even though the speeds ordinarily adopted—viz., from 1,500 to 3,000 revs. per min—for sizes below 5,000 kw. require long rotor drums, introducing difficulties of mass balancing, vibration of the shaft through unsymmetrical distribution of the magnetic field, high velocity in the bearings, insufficient space for coil windings, insulation and ventilating ducts, special difficulties in insulation peculiar to high speed and resulting from compression of dust by centrifugal force, drying out of insulation, permitting the conductors to move in a radial direction, difficulties in making allowance for expansion and contraction of copper, difficulties in regulation due to too high saturation of the field magnets, &c.

It is with the direct-current generator, however, that the case becomes most serious. Among the many disadvantages of high-speed direct-current machines may be mentioned the following:—

Proper commutation involves carefully designed construction, as the diameter of the commutator is limited by the allowable peripheral speed; it is usually necessary to use a double length commutator in order to obtain the requisite area and keep down the current density within satisfactory limits; the number of commutator bars and the distance required between brushes limit the number of poles which may be used; with very long commutators or with two commutators in tandem, there is difficulty in securing uniform distribution of current between the different brushes of each brush arm; very careful shop work is required; the increased length of shaft necessary to accommodate the commutator increases trouble from vibration, which, in turn, interferes seriously with the commutation, especially if carbon brushes are used; while it is difficult to compute the critical speed of a direct-current armature, it is very important that that speed be not approached, also that the commutator and armature be in perfect balance; due to drying out or other change in the insulation after the commutator and windings have been assembled, there is generally a displacement of the centre of gravity which will give rise to vibration; the necessity of limiting the

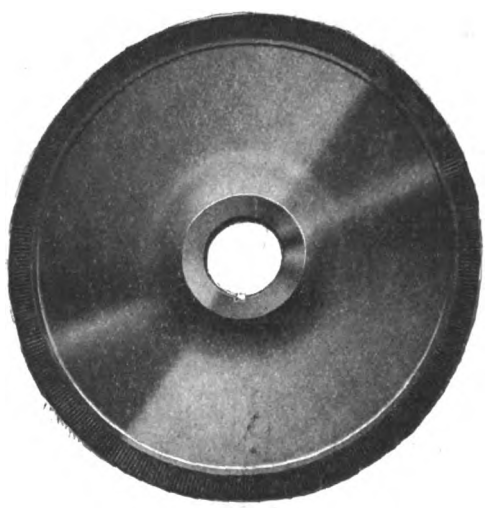

Fig. 2.—Single Wheel with Buckets.

diameter of the armature restricts the space available for insulation and for armature winding, so that it will be doubtful if the increased windage, iron losses and friction will be neutralised by a decrease in the purely electrical losses, which might be expected from the more compact construction and greater activity of the armature conductors; due to the very high speed at which the armature must run and the necessity of passing a large amount of air through in order to keep it cool, there is a great tendency for the collection of dust, including carbon dust from the brushes, and it is found that under high-speed conditions this dust assumes a very compact form, which frequently results in short-circuits or earths; finally, while the standard speed electrical generator is entirely familiar to the ordinary operating man, who can make such small repairs as may be required, the repair of the high-speed generator is entirely beyond both his knowledge and his facilities. In fact, the majority of dynamo designers appear to be of the opinion that direct-current units of 1,000 kw. should not exceed a speed limit of 600 revs. per min., and this speed has, in fact, been found most suitable also for smaller machines, even down to 500 kw. These speeds, however, are altogether too low for the ordinary turbine, for, as pointed out, they involve an excessively long turbine, or otherwise the efficiency must be greatly sacrificed, and, moreover, a turbine of four to six times this speed would, on account of its shorter shaft and other factors, be easier, as well as cheaper, to build with a given factor of safety.

The De Laval Multi-stage Geared Turbine.

In view of the pressing nature of the speed-reduction problem, the turbo-generator which we are about to describe possesses considerable theoretical and great practical interest.

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Helical reduction gears were adopted by De Laval almost at the inception of his work on the steam turbine, and have proved entirely satisfactory under service conditions, while having many exclusive advantages over the other methods of speed reduction. While there is a general and natural objection to the introduction of gears where their use can be avoided, still if by special design and methods of construction gears can be made at a reasonable expense that will be reliable, efficient and long-lived, while eliminating the several undesirable features inseparable from a great number of stages, their use becomes the logical engineering procedure. The efficiency of the double helical gear as made by the De Laval companies has been found to lie between 98·5 and 99 per cent., while the life of the gears is equal or superior to the wearing parts of reciprocating engines, as shown by the fact that all the gear cutters fitted for producing De Laval gears could not replace the gears now in use once in five years if operated day and night continuously.

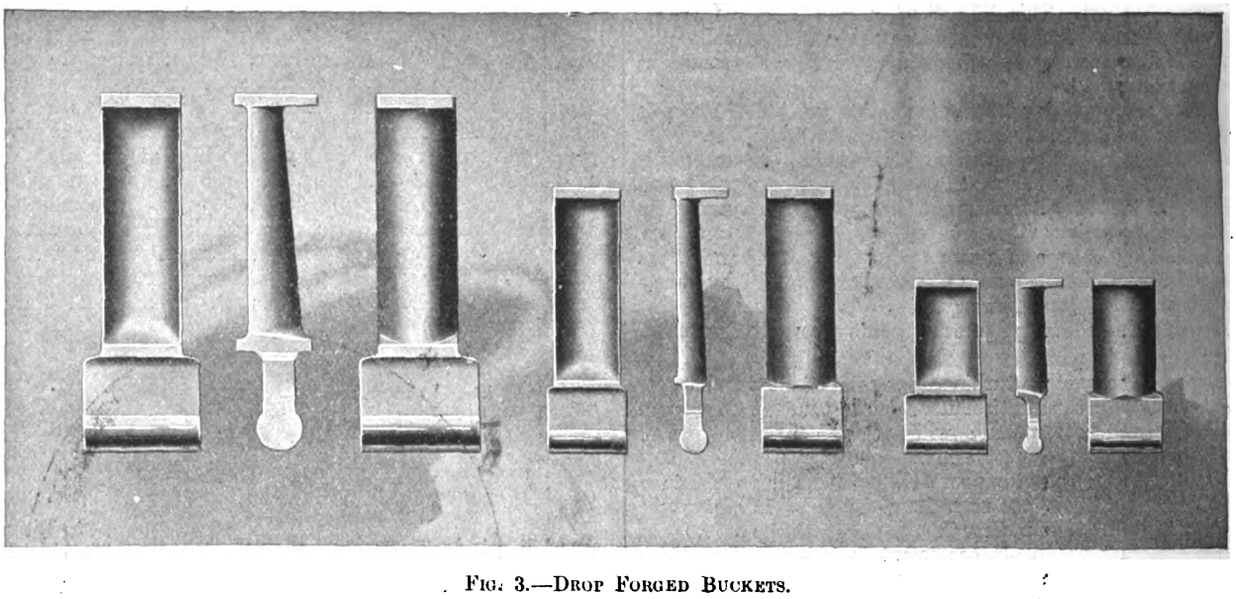

Fig. 3.—Drop Forged Buckets.

The fact, however, that the capacity of the De Laval single-stage turbine is limited, as pointed out in a preceding paragraph, has led to the assumption on the part of many that the limitation lies in the gear. This is not the case, and over five years ago the De Laval Company, of Sweden, instituted experiments with a view to the development of a high-power single-gear reduction and about the same time offered to instal a 550 H.P. gear for driving the steamer "Atland" by steam turbines.

Experimental work was nevertheless continued on large gears for stationary turbines, including not only the gear itself, but also suitable machinery for the accurate production of the gears. The need of special effort in this direction is exemplified by the fact that several months of continuous work by a skilled machinist were required for the correction of a lead screw purchased from one of the best shops in this country, before it was considered sufficiently accurate to be used in the gear-cutting machine on which were produced the gears of the machine that we are about to describe.

This unit, shown in Fig. 1, consists of a multi-stage turbine driving a standard-speed, direct-current Crocker-Wheeler generator through a pinion and single gear, the speed of the turbine shaft being 3,600 revs. per min., and the speed of the generator shaft 500 revs. per min. The illustration gives a good idea of the compact nature of the construction of a turbine, the maximum capacity of which is 1,200 H.P.

The main casing consists of cast-iron and is approximately cylindrical in shape, being split horizontally so that the top half may be lifted off to give access to the revolving and stationary members of the turbine. The casing is supported on a level with the centre of the shaft by two pedestals rising from the bedplate, one on each side, and is bolted down only at one end, being free to expand and contract in an axial direction between steel guides. As the endwise position of the shaft is also determined by a thrust bearing at the same end, the results of axial expansion are largely compensated for.

Steam is admitted to the turbine first through a strainer case and then through a combined trip and throttle valve, to be seen at the extreme right; next through the adjacent governor valve and then, after passing through steam nozzles of the standard De Laval type, impinges upon the blades of the first-stage wheel. Partial admission is used in the first stage, but full admission in later stages. The wheels, as will be seen from Fig. 2, are of the standard De Laval type, made of such section as to give great strength throughout; this type of wheel is exceedingly strong and is capable of withstanding high speed, as exemplified in the De Laval single-stage turbine. In order that no danger may be anticipated from the wheel if it should break, it is completely surrounded by steel armour, as will presently be explained.

The buckets are set in the rim by a peculiar form of dovetail, as illustrated in Fig. 3. The buckets are drop forged from solid bars of non-corrodible metal and are allowed to retain the original smooth, glossy finish imparted by the drop-forging process. Such buckets, it is found, wear much more satisfactorily than machined buckets, since they present a smoother surface initially, and if they receive only dry steam their life is almost unlimited. The use of a special metal also avoids the rusting which has been the cause of serious annoyance with steel buckets and even with mild nickel steel buckets, whereas high nickel steel buckets have shown a tendency to become brittle and to break unexpectedly.

The wheels are mounted upon the shaft by split taper sleeves drawn tightly into place by internal nuts in the wheels, and after the wheels are assembled, a lock nut on the shaft serves further to secure them, while rotation of the wheels about the shaft is prevented by a key. The greater blade length required by the increased volume of the steam as it proceeds towards the exhaust is secured both by reducing somewhat the diameters of the wheels and by increasing slightly the bore of the casting.

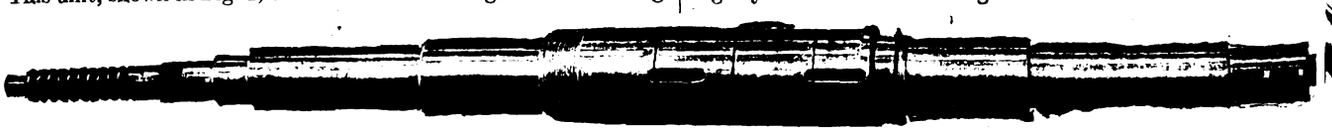

Fig. 4.—Turbine Shaft.

The entire shaft is seen in Fig. 4, where the positions of parts so far described may be plainly discerned. To the right and the left of the portion on which the wheels are mounted may be seen a smooth space where the shaft passes through the packings at the high-pressure and low-pressure ends of the turbine respectively, while the smooth spaces of smaller diameter beyond these are the parts of the shaft running in the bearings. The reduced section at the right having two small key-ways for Woodruff keys receives one-half of the flexible coupling, by which the high-speed shaft is connected to the pinion or to other driven machinery. The short length of shaft having a place for one Woodruff key at the left end is for the reception of the worm driving the worm wheel on the vertical governo

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shaft, while the ringed portion at the extreme left is the marine thrust bearing which determines the endwise position of the shaft.

Upon rebounding from the moving blades the steam again expands by passing between the guide vanes placed all round the periphery of the diaphragm between the first stage and the second stage. These blades are made of "extruded" metal and are fitted on to the cast-iron diaphragm. The diaphragm itself (Fig. 5) is slightly dished in order to increase its strength to withstand pressure, and to complete it a solid steel band is shrunk over the tips of the guide blades. The steel band is slightly wider than the blades and diaphragm, and as

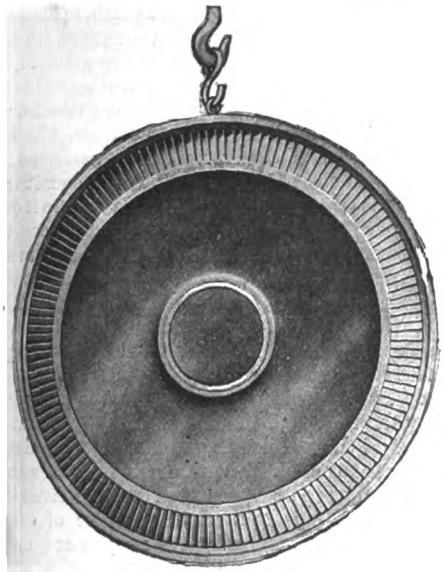

Fig. 5.—Diaphragm and Guide Vanes.

adjacent bands touch each other, a complete steel casing is formed which would effectually prevent the possible penetration of parts in case of rupture of the wheels. The centre of the diaphragm is perforated for the passage of the shaft and leakage of steam is prevented by a labyrinth packing.

The packings surrounding the shaft at the high-pressure and low-pressure ends are more elaborate. The high-pressure packing, which is called upon to withstand a pressure of about 25 lb. per square inch, consists of a long labyrinth, followed by four carbon packing rings. Any steam leaking by the labyrinth packing is piped to one of the intermediate stages of the turbine and utilised, while any steam leaking by the first carbon ring is taken to the exhaust outlet. The packing at the exhaust end of the turbine consists of three carbon rings,

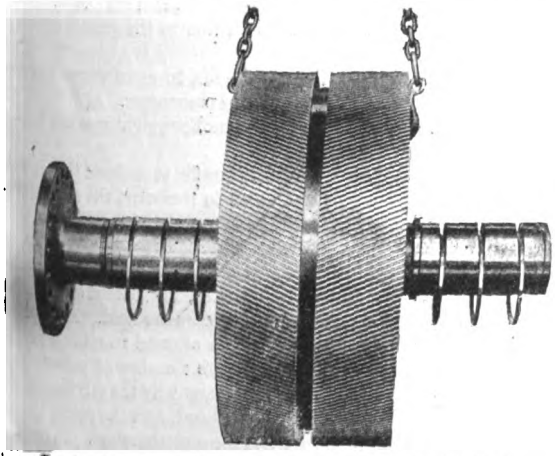

Fig. 6.—Reduction Gear of Single-geared Turbine.

steam at reduced pressure being led in between the first and second ring from the outside, which is also done at the high-pressure end. This ensures that any leakage into the exhaust when vacuum is carried, will be of steam, not of air.

The bearings of the turbine proper are of the split Babbit lined type and are supplied with oil through sight-feed oilers from the pump above mentioned.

The pinion and gear, perhaps the most important and interesting part of the construction, are shown in Figs. 6 and 7. As will be noticed, the gear is of the double helical or herring-bone type, differing from the standard gears supplied with De Laval turbines only in size and the fact that but a single gear is used for the largest capacities. The pinion is cut from a solid bar of steel and is carried in plain Babbited bearings supported in a rigid cast-iron frame, which also supports the gear bearings. The pinion bearings are lubricated by sight-feed oilers from the pump system before referred to, the excess oil overflowing to the wells of the gear bearings, which are ring oiled. The gear consists of a solid cast-iron centre upon which are shrunk two steel rings. The hub is mounted on a stiff shaft, which carries at one end a half of the flexible coupling for connection to the driven machine. The gear, complete with shaft, bearings and coupling may be also seen in Fig. 6.

The lubrication of the gear and pinion teeth is accomplished by jets of oil directed at the line of contact on the entering side. This

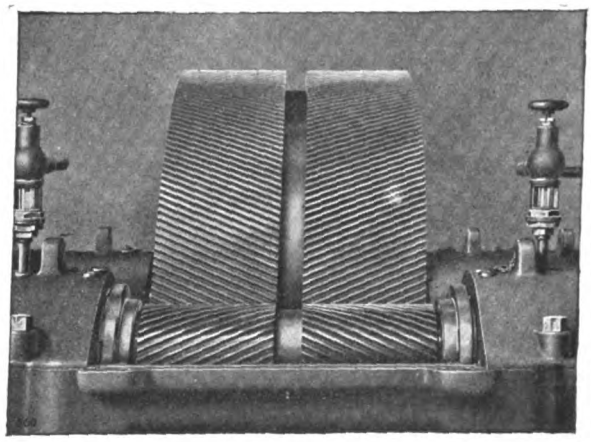

Fig. 7.—Gear Wheel and Pinion.

oil after use is passed through an oil strainer located in the base of the turbine, then through a cooling and settling chamber and then to the oil well, from which it is again pumped through the circuit.

The governing mechanism, Fig. 8, is in duplicate, that is, there is a speed regulating governor and a speed limiting or emergency governor. The former is mounted at the top of a vertical shaft driven by a worm gear from the turbine shaft. It is of an extra heavy, substantial type and controls, through a system of two bell-crank levers and a connecting rod, the movement of a vertical double-seated poppet valve similar to that used on standard De Laval turbines, as shown in Fig. 9. In order to prevent damage to the valve by overtravel of the governor, a spring is inserted in the connecting rod, as

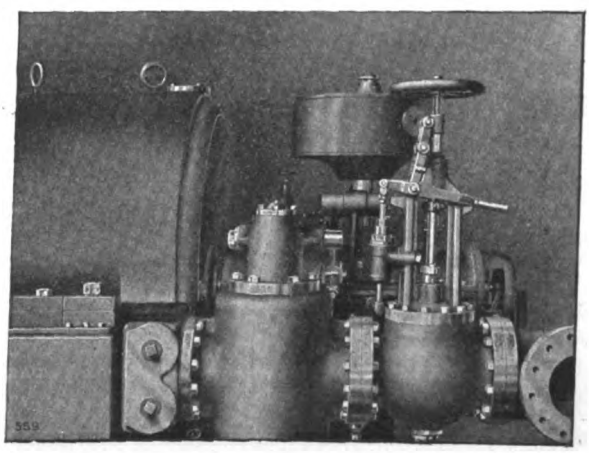

Fig. 8.—Governor Mechanism.

seen in Fig. 8. The same worm which meshes with the worm wheel on the governor shaft, meshes with another worm wheel driving the tachometer, which is supplied as a permanent and regular part of the equipment. The lower end of the governor shaft is connected to an oil pump, supplying the bearings of the machine and the pinion and gear.

The emergency governor is located in the end of the turbine shaft itself and is ordinarily not in contact with the trip. Upon touching the latter steam pressure is at once released from underneath a piston, by means of which a toggle gear is released, allowing the combined

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trip and throttle valve to close under the pressure of the steam in the supply pipe. This trip may also be sprung by hand, if desired, while the valve spindle is also furnished with a hand wheel and is threaded, so that it may be used as a throttle valve independently of the trip.

The generator is of the standard engine type adapted for the speed of 500 revs. per min., which is the same as could be used for a belted machine of this capacity. The field consists of eight main poles and eight auxiliary or commutating poles, the commutating poles being connected in series with the armature circuit.

The operation of the turbo-generator above described is remarkably free from vibration and noise, and as it stands in the test room, supported upon small screw jacks without other steadying means, it is impossible to tell from a few yards away whether or not the turbine is running without noting the moving parts. There is no vibration and no noise that may be overheard at a short distance. The quiet running is attributed to several causes, chief among which is a specially designed gear-cutting machine and the adequate method of lubrication employed.

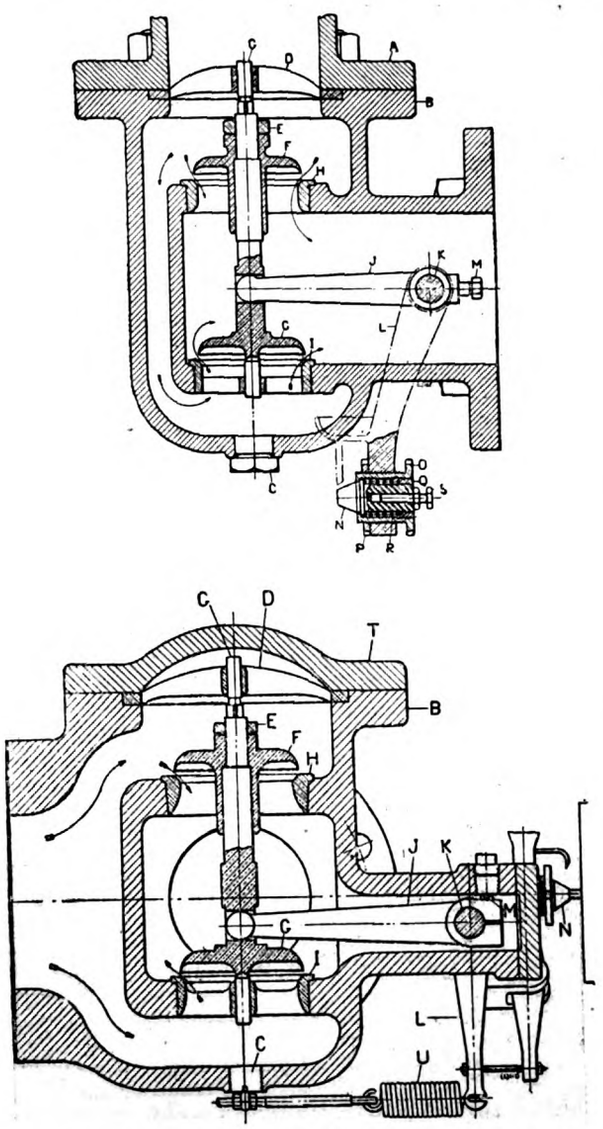

FIG. 9.—CROSS SECTION OF GOVERNOR VALVE SHOWING REMOVABLE DISCS AND SEATS.

It might be mentioned in passing that the determination of the efficiency of such gears within reasonable limits of accuracy is a comparatively simple matter and does not require the use of cumbersome and expensive hydraulic brakes or similar mechanisms. Since all energy lost in friction in the gear must be converted into heat, the measurement of the heat emanating from the gear case will give an accurate measure of the loss of energy in the gears. Such measurement of the heat is not difficult. The radiation from the casing can be determined accurately for any given temperature by observing either the rate of cooling under fixed conditions or by keeping the casing warm by means of hot water or steam. The amount of heat removed from the gears by the lubricating oil is even more easily determined by measuring the inlet and outlet temperatures and the weight of oil used per minute or per hour.

A FEW REASONS WHY ELECTRIC TRACTION IN ENGLAND REMAINS STATIONARY.*

BY GERALD H. J. HOOGHWINKEL.

Summary.—The author discusses the reasons why tramway enterprise does not pay in this country as it does on the Continent. He suggests that if small tramway undertakings are to pay, many alterations must be made, including the adoption of the bow collector, light single-deck cars, and a more elastic form of track construction.

The author brings forward some points which, in his opinion, must be radically altered if private capital and enterprise are to look again at the exploitation of electric tramways favourably. There is no reason why such enterprises should not pay here as well as in Germany and France. There are, of course, many other reasons, such as bad roads and streets and large factory populations, which, as against purely agricultural districts, &c., have a preponderant influence on the results; but seeing that these conditions are equal in many towns and districts of the countries mentioned above, there is only one conclusion to be drawn, and that is that our tramways cost too much to construct and to run. The question of our low fares and unremunerative special class services has already been exposed by abler critics.

For the present, therefore, the writer will only deal with the cost of construction, which, in his opinion, will have to be entirely altered if tramway business is once more to become the safe and popular investment which it is in most other European countries.

As track and permanent way construction is solely influenced, or should be, by the nature of the tramway traffic, the weight of cars, and the nature of the soil, let us consider how the ideal permanent way should be constructed. The traffic depends, of course, upon the number of passengers to be transported during a given time, and this can be done either by using a smaller number of cars carrying a large number of passengers, or by using a greater number of lighter cars. This brings us to the adoption of light single-deck cars, instead of the existing heavy double deckers. The former method is followed practically all over the world, and its adoption assures the following advantages:—

1. Lighter, cheaper and more flexible track construction.
2. Quicker, and therefore more convenient and more popular service.
3. More frequent service, and therefore more profitable use of the money spent on the permanent way and rolling stock.
4. Less noise and less disfigurement of our streets.
5. Greater ease in adapting the sliding bow, which, in its turn cheapens and simplifies the overhead construction.
6. Better supervision by the conductor.

The disadvantages, or rather the apparent objections, which have been urged against the adoption of the light single decker (and trailer when required by rush traffic) in our crowded cities are:—

1. The greater length of train or car required to carry a fairly large number of passengers (more room in streets and car sheds).
2. Possible wear and tear of track, due to the greater number of cars passing.
3. Possible heavier traffic costs, owing to more wages, and more power required for the same number of passengers.
4. Absence of seating capacity for smokers, sightseers and lovers of fresh air (if no open trailers are used).

The claim that in this country the traffic is so dense that it would be impossible to run enough small cars to transport the number of attending passengers does not hold good in view of the published traffic returns. In large towns, such as Berlin, Dresden and Lyons, the traffic per mile of route is even more intense than in the corresponding towns of London, Dublin and Manchester, and, except on some of the trunk lines in these cities, single-truck cars are used. An important point is, that elsewhere passengers are allowed to ride on the platforms, and this accounts for the large number of passengers per single-truck car. There is no valid reason why the carrying capacity of our smaller cars should be thus reduced, and the sooner this mistake is rectified the better it will be for our tramways. In almost all of our larger towns a single truck can be used with an overall length of 25 ft. to 30 ft., on a 6 ft. to 10 ft. wheel base, carry 36 to 50 passengers inside and on the platforms, thus reducing the weight of the fully-loaded car from 9 to 12 tons. The effect of more but lighter cars on the track will be found to be entirely on the credit side, as the weight hammering the joints which ruins the track, and also the wear of the rail surface.

The heavier wages bill caused by the larger number of drivers and conductors is another of those imaginary drawbacks which is in no way substantiated by evidence. It is true that a few more men

* Abstract of a Paper read at the Congress of the Tramways and Railways Association at Edinburgh, July, 1911.

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be employed, but their number will prove much less than anticipated on account of the cars performing more work, stopping less, and therefore easily earning the increased wages bill. It has been the writer's experience in running tramways abroad, that the objections 2 and 3 are not confirmed by actual practice, provided passengers are allowed to ride on the platforms. The last objection is the only real one, and one on which it is difficult to argue. Riding on the platforms may help towards contenting some of the grumblers on short sections. For longer trips, a semi-convertible car, and cars with open smoking compartments will go a long way. Incidentally, the writer may be allowed to again refer to the use of trailers, so common on the Continent. No one will, of course, contend that their use should be encouraged indiscriminately, but the veto of the Board of Trade is a far too drastic measure, and is one of the reasons why our tramways do not pay. They certainly are not beautiful, but they

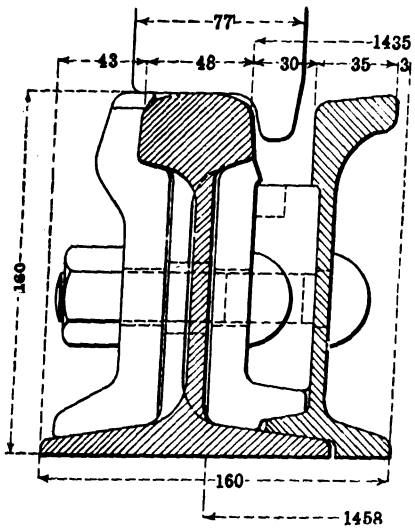

FIG. 1.—RAIL SECTION, AMSTERDAM TRAMWAYS.

are useful; they are far less objectionable, if properly used (in towns, not more than one), than top covered double deckers. They are not more dangerous if provided with proper side guards, and they are dividend earners. Moreover, they are a necessity at special rush hours, on Saturdays, with workmen's cars, &c., and they should certainly be allowed where their introduction can be substantiated, especially on suburban lines.

The writer is quite willing to concede that in general the double decker has a smaller deadweight per *seat*, that with trailers an extra conductor is required, and that the current consumption per seated passenger may, under certain circumstances, be slightly greater. Also that with the double decker more weight is available for adhesion and that thereby quicker starting and accelerating are obtained. These differences, however, are only very small, and they need not tell in favour of the double decker at all, as the following reasoning will show. The weight on the track is more evenly distributed, hence much less wear at the joints. The double deckers must be of

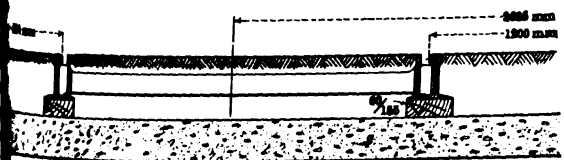

FIG. 2.—TRACK CONSTRUCTION OF AMSTERDAM TRAMWAYS.

heavier construction, their centre of gravity being high. They require a wider gauge than single deckers for the same reason, hence the absence in this country of the much cheaper metre gauge. They also prevent the use of platforms for carrying passengers, and their adoption precludes short radius curves.

The writer holds that these many disadvantages are of far more importance than the insignificant drawbacks of the single-deck car mentioned above, and, moreover, he contends that one conductor in case of heavy traffic with double-deck cars is not sufficient. The chief advantage claimed for the light single truck single decker is the reference to the track. Our track construction is, in the writer's opinion, the reverse of what it should be. It is costly, the latest being on the London United Tramways costing over £13,000 per mile of double track, but it is also unsuitable. Our heavy double cars have been largely instrumental in producing this evil.

The entire construction of heavy rigid trucks riding on rails resting on a "would-be" rigid bed is faulty. That this is not yet recognised by leading tramway men is shown by the efforts to make the contact between rails and bed still more rigid, by introducing anchors or other metal in the concrete at a prohibitive cost. The writer is inclined to think that the return to an improved flexible track is an urgent matter which should not be further delayed. It will be found in many cases on opening up the concrete under the joints that hardly any concrete is left, it having been pounded into a powder and washed away by the surface water. The action of the anchors, and other sole-plate combinations, has only accentuated this evil. It is also a fact that the concrete carries no weight except when cars are passing. Lighter cars will alleviate this to a certain extent, but more is needed. Wooden sleepers laid on about 4 in. to 6 in. of concrete form an ideal track, but in many cases, where the ground is favourable, the concrete and sleepers may even be omitted. Paving difficulties have, of course, interfered with this type of track construction, but they can easily be overcome.

As to damage by abnormally heavy traffic, the Board of Trade might issue regulations that traction engines and carts over a certain weight should not be allowed to use the tramway tracks.

Moreover, the movement of the rails on cross-sleepers is much smaller than is generally accepted. In Chicago, careful and frequent measurements disclosed a maximum horizontal deflection of only $\frac{1}{64}$ in., and a maximum vertical deflection of $\frac{5}{64}$ in., with sleepers at 4 ft. centres, and tie plates under the rails. It was also observed these figures were not influenced by the speed but by the weight of the cars only. There was no movement in the paving at all.

Longitudinal wooden sleepers, cut away under the joints, have also often been used with success. In one of the latest large tramway

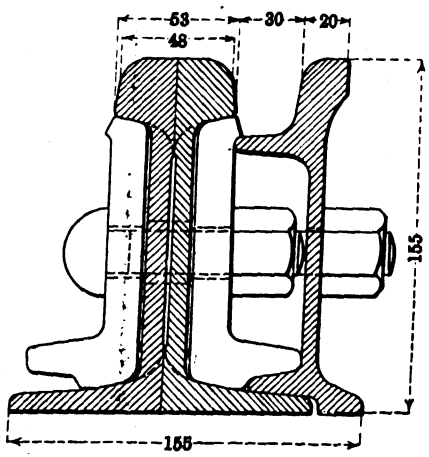

FIG. 3.—RAIL SECTION, THE HAGUE TRAMWAYS.

undertakings abroad, where the writer acted as consultant, a heavy rail of the double or "Haarman" type was adopted weighing 126 lb. to the yard, and simply laid in trenches filled with sand and well rammed; concrete being only used under the special work and in asphalted streets. This construction was in soft and bad ground, but it has stood well for over six years. The joints were sprung and slanting. Where concrete stringer construction is used, no concrete should be put under the points, which may be either of the combined sole plate type, or welded. The weight of the rails should not be decreased, but the flange might be slightly widened. Near the joints two cross sleepers will form a flexible support.

Light cars are, however, a *sine qua non*, and apart from their other advantages, they should be introduced on the score of facilitating a cheaper and better track construction. A track of this type should not cost more than £3,000 per mile of single track, exclusive of paving. It is, of course, a well-known fact that paving is the heaviest item in our tramway construction costs, and it is difficult at present to reduce the amount expended under this head in the busier and larger towns. There are many smaller towns, however, and it is to these that one has to look for further tramway development.

Some of the other advantages are evident. A quicker, and therefore more convenient and popular service can be given, and thus a more profitable use of the sums spent on the permanent way and rolling stock. Less noise and less disfigurement of our streets will be evident to all those of our engineers who have visited towns such as Frankfort, Dresden, The Hague, Amsterdam, Lyons, Cologne, &c. Although the cars pass along the streets in a continual file there is a total absence of the deafening noise which accompanies the progress of our heavy cars. This is not a sentimental point but a very real one, having regard to property owners along the routes.

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Table I.

——	Cost per kilometre.	Type of overhead equipment.	Cost per kilometre.	Maintenance of track per car kilometre.	Maintenance of overhead equip. per car km.
Vienna	£2,000 without paving.	Sliding bow, steel pole and rosettes (50%).	£500.	...	...
Amsterdam	£2,205 including paving	Sliding bow, steel poles.	£637.	0·1d. without paving and cleaning.	0·02d.
The Hague	£1,264 including paving	Sliding bow, Mannesman poles.	£500.	0·08d.	0·04d.
Dresden	£1,250-£1,500 without paving and concrete.	Sliding bow, steel poles and rosettes (50%).	£500 to £1,000 varying with type of poles.	...	...
Liverpool	Total, includ. track, overh'd equip. feeders & power sta'n, £18,563	Trolley wheel with steel poles.	...	0·7d.	0·37d.
Brighton	£15,992.	Ditto.	...	0·48d.	0·056d.
Dublin	(5ft. 3in. gauge) £19,940.	Ditto.	...	...	...

Table II.—*Single-Deck Cars (Continental).*

2 Trailer-car Kms. equals 1 Motor-car Km.

——	Car km. per annum.	Power costs per motor-car km.	Weight of motor-car, tons.	Capacity per car.	Receipts per car km.	Working costs per car km.	Per cent. Working costs.	No. of passengers per car km.
Vienna	75,992,821	0·687d.	9·7	50	4·88d.	2·99d.	62·5	3·42
Amsterdam	13,391,614	0·482d.-0·577d.	10	35	4·2d.	2·9d.	69	4·4
The Hague	7,982,025	0·420d.	10	35	4·48d.	2·8d.	62·5	3·78
Dresden	29,500,000	...	9·7 (full)	...	...	...	...	...
Leipzig	29,500,000	0·532d.	...	36	4d.	2·24d.	55·9	3·44
Double-Deck Cars (England).								
Liverpool	19,500,000	1·18d.	...	56	7d.	4·9d.	70	6·25
Brighton	1,780,000	1·06d.	11 (full)	...	6·45d.	4·6d.	77	6·03
Dublin	12,400,000	0·905d.	...	...	5·64d.	*3·2d.	57	4·25
			*Very low power costs.			English average.....	68	

As the author hopes to prove further on, the adoption of the sliding bow is one of the points which would also favourably affect the construction and running of our tramways. On single deckers the bow can be fixed so as to obviate the necessity of swinging it over at the end of the trip, and no heavy standards and long arms are required, thus greatly cheapening the whole construction. Another advantage, which up till now has not received much attention, is the power consumption at the power station. With many light cars the power curve at the power station will approach more nearly to the straight line than with fewer heavy cars requiring a heavier starting current. Examination of one of the power curves of one of the large Continental power stations will disclose a far more equal appearance than those, for instance, of the one of the Glasgow sub-stations.

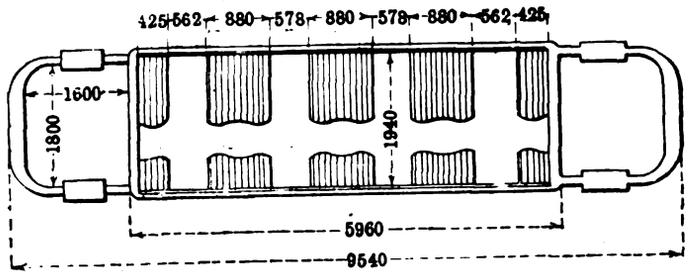


FIG. 4.—VIENNA TRAMWAYS MOTOR CAR SEATING 24, AND 20 STANDING. (Plan, dimensions in millimetres.)

It is true that the more extensive use of batteries on traction loads on the Continent is primarily responsible for this in most cases, but even in stations where no traction batteries are used on account of the great number of cars, the difference is at once evident. This means, of course, smaller units running at their most economical loads, and therefore at a better steam consumption.

The tables give comparisons between a few Continental towns and more or less corresponding towns in England. In the towns mentioned the number of trailer-car kilometres run was about half that of the motor-car kilometres, except in Vienna, where the numbers were about equal. On an average, therefore, each car may be considered to consist of one motor-car plus half-trailer, or a capacity of well over the capacity of our standard double-deck car, viz., 56. The power consumption, however, is much less, as two trailers are taken as being equal to one motor-car kilometre. If we take, therefore, 1½ motor-car kilometres, we get about 0·625 units for Amsterdam, 0·525 units for The Hague and 0·665 units for Leipzig, or a little more than half our figures with the double-deck cars. This is not entirely due to the lighter cars, but also to the wider rail groove used abroad. The passengers carried on the platforms are, of course, includ... calculating the capacity of the cars, as standing room is the m... sought-after accommodation abroad, and this seems to have be... lost sight of by our experts when discussing this point.

The few figures given with reference to track and overhead equ... ment maintenance also go to support the writer's remarks under th... heads. The Continental figures for passengers per car-kilome... must also be increased by 20 per cent. for the trailer cars, and w... then be found to differ but little from their British equivalents.

The latest convert to the flexible track is the city of Munich, wh... a recent International Tramway Congress was held. The rea... given by the authorities is that the removal of the concrete ... reduces the noise and prevents corrugation. The writer would c...

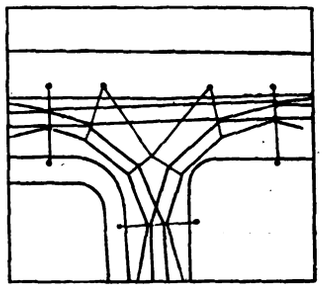
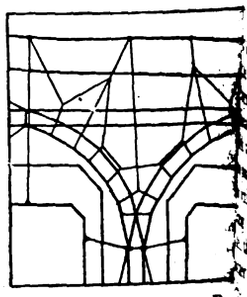


FIG. 5.—BOW SYSTEM AT DRESDEN.



TROLLEY SYSTEM AT BE...

plete these claims by adding reduced repairs on track and car... and equipments (commutators). In Munich the track is being... in all paved and macadamised streets on pine sleepers saturat... carbolineum, at intervals of 4 ft. embedded in gravel. Hea... are, of course, used (120 lb. per metre). The two axle single ... on this track are 29 ft. long overall, with a capacity of 20 sitt... 20 standing passengers. The weight of this type of car is onl... unloaded. This car with closed-in platforms is, in the ... opinion, admirably suited to English conditions.

An extremely light car has been introduced on the Vienn... ways, the weight unloaded being only 5 tons and the overa... 27 ft. The total seating capacity is 22 passengers. The eq... consists of two 25 H.P. motors giving a speed of 26 km. per h... two trailers. The current consumption is 25 per cent. less t... the other cars on that system, and the beneficial influence on ... of the track need not be questioned.

There are, of course, quite a number of details which ... introduced with advantage in our car building, all calculat... crease the weight of our cars, a point which, in the writer's ...

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has been rather neglected by those responsible for the management of our tramways undertakings. A few might be mentioned here :—

(*a*) Aluminium side panels, by which a saving of 300 kg. (6 cwt.) can be obtained.

(*b*) The use of steel side *members*, and metal cross pieces.

The weights so reduced would, if radial trucks were adopted, give about 28 seats of 500 kg. (10 cwt.) per seated passenger ; or 275 kg. (5½ cwt.) per standing passenger with 0·25 sq. metre (2½ sq. ft.) on the platforms.

(*c*) The use of the sliding bow, with corresponding overhead construction.

(*d*) The use of wall rosettes where possible.

(*e*) The use of a flexible truck (Warner type or other).

(*f*) The introduction of " pay as you enter " cars.

(*g*) The use of trailers where possible.

The frequent service in our larger cities and the many lines in the centre of these cities have caused the use of heavy contact wire, and numerous frogs, crossings and switches. Also many poles, bracket-arms, insulators ; in short, the unsightly ironmongery ware which disfigures our public squares and main thoroughfares can be traced to the blind following of trolley wheel practice. This heavy gear and the excessive upward pressure of the trolley boom are responsible for the adoption of heavy and unsightly poles duly standardised as embodying our views on modern tramway construction. It is also admitted that nearly 80 per cent. of the accidents on our electric tramways are caused by the trolley wheel in its evolutions on and off the wire.

A third point is the quick wear of the trolley wire, especially at the points of suspension and on curves. The wear of the trolley wire, as far as ordinary tramways are concerned, has been proved to be much less with the sliding contact, of course due to the lower pressure and aluminium lubricated lining of the bow. The total absence of hammering action at the points of suspension, and of cutting flange action, also account for the increased life of the contact wire.

Curiously enough, this is about the only point on which the critics have pronounced judgment, and probably simply on the score of rubbing friction against rolling friction, the judgment has been adverse. The joint experience of over 50 Continental tramway systems is, however, entirely in contradiction. The writer has in his possession a piece of wire taken from the Dresden tramways and cut out from one of the curves after nine years' use at a spot where nearly 500 cars pass daily. This only shows a slight flattening at the lower side.

From personal experience the writer would go as far as to say that on busy lines a life of 9 years is quite normal with the bow and 000 wire. That is evident in view of the methods of suspension with the sliding bow system, and the absence, if figure 8 or other profile wire is used, of all hammering at the points of suspension. The life of the trolley wire being governed by the condition of the wire at the ears only, for that reason alone, be considerably longer than with the trolley wheel.

The continual bending of the wire at the ears is a trouble that has been due to the fact that the trolley heads are heavy and have increased in weight ever since they were first introduced. The pressure with which they are held against the wire is about five times as much as with the sliding bow, which is a light construction, especially the top part. The trolley head is therefore a real hammer striking each time with vigour and pressing the wire upward with great force when nearing the ears. On account of the heavy ears, crossings, frogs, &c., the wire is dropped again heavily after the passing of the trolley, another evil which occurs in a far less degree with the much lighter overhead construction used with the sliding bow.

Briefly, therefore, the advantages of the sliding bow may be briefly stated as follows :—

Absence of overhead switches, frogs and crossings.

Far lighter overhead construction, such as small mechanical ears for insulators ; use of lighter poles and brackets, &c., owing to the small upward pressure (7 lb. to 9 lb.) and to the absence of heavy ears at suspension points.

Fewer suspension points and poles, owing to the absence of the necessity of following the centre of the track. It is true that with us the trolley does not require to follow the centre of the track, but the trolley with its heavy swivelling head is a source of trouble.

The possibility of the bow to de-wire.

Ease with which it can be reversed at terminals.

Smaller wear and tear on the trolley wire (greased aluminium lining) and decreased maintenance costs due to the absence of hammering effect at the ears, and consequent absence of sparking. Figures for maintenance of the bow in Vienna and Dresden is 0·1 penny per car kilometre.

As a flexible truck, the Warner truck is undoubtedly a step in the right direction towards the realisation of the idea of a flexible truck (flexible in relation to car body).

With regard to pay-as-you-enter cars, in Montreal the receipts have increased by 31 per cent. on these cars. Of course, the more uniform fares in the States make the adoption of this system easier than in our case, but the large preponderance of penny fares and of uniform fares on our suburban lines do not offer any serious objection. The average running speed seems to have increased 13 per cent. in Montreal since the introduction of the new cars.

The question of higher fares is of course the only recognised source of increased net revenue. The writer ventures to make the following suggestions to meet this difficult point. One penny to be the minimum fare, but only obtainable by the use of strip tickets bought in advance, and a universal twopenny fare for any distance under 5 miles, and giving the right to one change of car.

The writer has tried to show in the foregoing remarks that some alterations in our methods of constructing and working electric tramways are urgently required if the industry is to be placed on a firm basis from the point of view of the private investor. Large additions to the mileage of our suburban and inter-urban tramways are waiting development, but unless cheaper, and, let us say, better adapted methods of construction are introduced, new tramway business will be exceedingly difficult from a financial point of view, to the great detriment of our electrical industry, and of the dwellers in our small towns.

CONFERENCE ON EDUCATION AND TRAINING OF ENGINEERS, 1911.

(*Continued from page 547*).

Prof. Petavel's paper was as follows :—

THE RELATION OF ENGINEERING EMPLOYERS AND COLLEGES FROM THE POINT OF VIEW OF THE PRACTICAL TRAINING OF COLLEGE STUDENTS.*

BY PROF. J. E. PETAVEL, D.SC., F.R.S.

A good general education, a wide scientific knowledge, and a sound practical training constitute qualifications essential for success in the engineering profession. The engineering employer and the university teacher are therefore co-partners jointly responsible for the success of the educational work ; and it follows that some close co-operation is eminently desirable. Any discussion of the relationship between employers and teachers must be primarily based on some definite understanding with regard to the aim of university teaching and the qualifications attainable by the average college student. On both these questions a considerable divergence of opinion exists, and it is merely with the object of providing, as briefly as possible, a basis for systematic discussion that the following apparently somewhat dogmatic statements have been drafted.

1. A boy intending to qualify as a civil or mechanical engineer would pass the university matriculation examination at the end of his school career and afterwards spend a year in a mechanical workshop before entering the university.

2. The university teaching should be scientific in its nature and wide in scope. A reasoned discussion of present practice and future possibilities should take precedence over merely descriptive treatment. The student should be taught to understand fundamental principles and make an intelligent use of mathematical analysis, not to memorise unimportant details and empirical formulas. Finally, early specialisation should be discouraged. The educational work of the university is brought to a successful termination when the student has been taught how to learn.

3. The object of the engineering laboratory is to afford illustrations of the principles referred to in the lectures, to familiarise the student with the methods of testing materials or machines, and to prepare him for the practical training which it cannot replace.

4. The university degree implies a certain standard of work, knowledge and intelligence, but the ultimate success of the graduate as an engineer will depend primarily on his personal characteristics, and secondarily on the opportunities offered him during and after his practical training. The engineering employer cannot anticipate that a university graduate would be of much assistance during the first few months, but should require him to reach a satisfactory standard of efficiency before the end of the first year, and expect him to deserve some reasonable remuneration during his second year.†

5. The head of an engineering department is always glad to select and recommend a man suitable for any position which is offered.

6. The engineering employer can co-operate in the educational work of the university by a frank and friendly criticism of the methods

* Abstract.

† The second year after graduation as explained in paragraph 1, the third year of practical experience.

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adopted. By offering to take college gradutes on a six months' trial he can form a personal judgment of the qualifications of the men and select those best suited for the work he requires.

Mr. ALEX. SIEMENS (London), speaking as an employer, dealt with the last two points raised by Mr. Horne. Manufacture was essentially carried out for profit and for this reason pupils could not be taken into works regularly and educated. His firm took pupils when they had a vacancy, but not otherwise. It was impossible owing to works organisation for apprentices to go to school two afternoons a week; they might as well leave altogether. But for bright boys of this kind bursaries had been established by the Commissioners of the 1851 Exhibition.

Prof. G. KAPP (Birmingham) said the bursaries mentioned by Mr. Siemens were for graduates alone. The system advocated by Mr. Horne was already being carried out in Birmingham for boys from secondary schools. He was a believer in the sandwich system, but the trouble was that the slices were too thin. Many employers would take boys into works even for short periods, and the result was good in that they made the student more receptive. Four years at works and then three years at college made the slices too thick; the best way would be to have a year at works then one year at the university, another year at the works, another year at the university, a third year at the same works; and, lastly, a third year at the university.

Mr. F. ZUR NEDDEN, comparing English and Continental methods, said that 12 years' experience in Germany had shown that a year at works preliminary to college training was a satisfactory arrangement. A code of rules had been formed with this end in view. These were signed by the manufacturers who declared themselves willing to take the students. Where the trouble occurred was that the universities had money for training purposes, while engineering firms had no such funds and had besides to make money. More combination between the universities and factories was required. As a recompense for the facilities he received the student agreed to serve all his apprenticeship at one works and at the end of his studies to remain in the shops six months to give the manufacturer an option on his services.

Mr. J. F. C. SNELL (London) thought any break between school and university was undesirable, and that the sandwich system was at best a compromise. It would be better to take the university course first and then the shops, as workshop knowledge was more easily absorbed when the student was older. He thought that not sufficient stress had been laid on the importance of drawing-office work. He considered it would be a good thing if the Institution appointed a committee to confer with the educational authorities and manufacturers on this question, and to watch over and help the students.

Mr. B. HALL BLYTH said that the civil engineer worked for his employers and not for students. He objected to the idea that when a student left college he was a fully qualified engineer; and four years was not overlong for practical work.

Principal J. WERTHEIMER (Bristol) wanted to know why it was that every student turned out of the Boston and Massachusetts School of Technology was sure of a salaried post at once. Perhaps it was because our system of education was not so successful as in the United States. Unsuccessful undergraduates should not be encouraged to go on with their course. The Bristol City Council were providing bursaries for such artisans as desired to prepare for the engineering degree.

Sir WM. WHITE (London) thought the conditions here and in the United States were essentially different. The reason that young men did not get work here was not due to the teaching, for if they went out to the United States they at once got posts. Some means were necessary to discover whether a boy was suitable for an engineer. That was why the year's preliminary training in works had been recommended. Practical experience must be paid for by the student.

Mr. H. J. SPOONER (London) thought that a good case could be made out for the college workshops, as a great deal of useful work could be done there. It was also a relief from the brain work, and the technical side of many mechanical operations could be taught.

Prof. S. P. THOMPSON, F.R.S. (London) said he had not found practical engineers against college training as Dr. Unwin had. They were, in fact, more eager to get college-trained pupils than to pay them. He differed, too, from Mr. Snell, in that he preferred to have a boy who had been a year at works before coming to college. He was of more use then. To him the two years' course at Finsbury seemed ideal. It could easily be interposed between the school and workshop, or after the school and workshop. Many pupils were glad to take a two years' course, and there was the further advantage that all striving for degrees was thrown over.

Mr. W. H. PATCHELL (London) thought it was demoralising to a boy to make him a supernumerary in works, and that was what occurred if he went there in three monthly spells. He considered more funds could be obtained if the money now available was spent more judiciously. Not enough was spent on the better boys.

The joint meeting then adjourned, and Section II. held a meeting in the library under the chairmanship of Mr. W. H. Maw, when the following Papers were read and discussed:—

THE VALUE OF A UNIVERSITY DEGREE IN ENGINEERING SCIENCE IN RELATION TO PROFESSIONAL COMPETENCE.

BY PROF. S. M. DIXON, M.A.

The competent engineer is one who can deal effectively with materials and men. While it cannot be claimed that three or four years' good work at an engineering school gives this competence, still it can be shown that for the ordinary man it is the best method of obtaining the necessary preliminary training, and so the university degree becomes the first step of a long ladder leading to eminence in the profession.

The training of the engineer may be divided into theoretical and practical, but this is merely for convenience in discussion, because the two divisions can never be separated entirely. Speaking broadly, however, the theoretical part, or basis, of the engineer's education is that which is more or less complete, as far as most men are concerned, when they receive the degree in engineering. The practical part of his education beginning at college should continue as long as the engineer remains in practice.

While it has been said that both sides of the engineer's training begin at college, there is no doubt that the work carried out for the degree must deal mainly with principles, and should be as broad as possible. Details of current practice will be noticed only as illustrations of principles. In dealing with materials the engineer needs a knowledge of mathematics, physics, and chemistry, and if he is to avoid mistakes his knowledge must be very exact and at his fingers' ends. The courses in mathematics, physics, and chemistry naturally lead to those in surveying, stresses in structures, and properties of materials. All these are technical subjects, it is true, but they can be far better and more easily taught in the class-room, field, laboratory, and drawing office of a university than in the engineer's office. When the student has a sound knowledge of the principles involved in the study of these subjects he will make rapid progress in the details of practice.

Instruction in the above subjects, important as it is, should form only part of the general education of the young engineer, if he is to be fitted to hold more than a subordinate position in the engineering profession, for, as stated earlier, the engineer must deal with men as well as materials.

A liberal education is essential: literature, history, philosophy, all subjects which tend to broaden a man's outlook should be studied, and this is even more necessary in the case of engineering students than in the case of those who intend to follow other professions. Of course, unless a university education leads to further reading and research, one of the most desired objects is not obtained: but, owing to the nature of his employment, the engineer frequently has for several years few opportunities for reading outside his work, and so should make up for this by the keenness of his interest in these so-called "outside subjects" while at college. We take it for granted that the successful man in any other of the professions will be one who has already made his mark at the university, and it is certain that the success in a great measure is due to the trained ability which enables the possessor to influence his fellow-men. The general culture which comes from college life as well as from college study is an asset in the engineering profession not to be despised and not easily obtained. The man who leads his fellow students in the class-room, in sports, or in the debating society, is equipped in a very real way for success in his profession.

The work done at engineering schools is serious and painstaking. Much has been written lately about examinations and degrees in engineering, but those familiar with the work of engineering colleges can testify that the profession has no reason to fear that the status of the civil engineer will not be upheld by the graduates in engineering. The final examination is but a very small part of the requirements for a degree. Three or four years of solid work under personal teaching sifts out a large proportion of those entering on the courses, while at the same time few students who possess industry and average ability should fail to satisfy the present requirements in the specified time.

No system of education is above criticism. If we take an interest in the objects of the system we should see that our criticism is fair and helpful. At present the university method is recognised as the only generally applicable method in every country but our own. The objections to the system in this country may be found stated by two classes of engineers: those who have in their early days entered university courses and then dropped them before grasping the meaning of the instruction offered, and those who have risen to eminence in their profession before university training in this country became general. The former are answered by the fable of Æsop of the fox who tried to make the best of a serious accident; the latter are reminded that competition in the profession is becoming keener every day. English engineers now find in every country friendly rivals who have spent a large part of their time at engineering colleges, and it would be unjust to the rising generation if they were not able to start with advantages equal to those of their competitors. It is not long since it was usual to find, in some of the larger engineering schools in America, English students attracted by the superior equipment and facilities for research. At present our students are more fortunate. At home they can, at well-equipped colleges, receive instruction which is admitted to be efficient and

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up to date. In fact, the stream of students from newly-developing countries without engineering schools of their own is being in part diverted from the United States to this country.

In arranging this discussion on engineering education by members of the profession who have already attained eminence in its practice, the council of the Institution had evidently in view the one difficulty which exists for the moment in England. While in other professions a university degree is regarded as the first requisite, and so leads directly to employment, there is still a feeling in some quarters that the university graduate is rather in the way in an engineer's office. Matters, however, in this way are improving. Once engineering firms recognise the advantage of having assistants thoroughly trained in the principles underlying practice, and whose training also specially fits them for adopting new ideas rapidly, they will only be too glad to co-operate with the universities in completing the education of the engineer. A method already adopted on some railways in the United States and in Australia has been in work for some time on at least one railway at home. In this case we have the principle of co-operation firmly established, by which the college graduate obtains his practical experience in the best way possible. Entering the service of the company under a small but gradually increasing salary, the graduate in engineering is under agreement to stay a specified time. During this period the engineering staff of the company consider that there is an obligation on their part to see that the duties of the junior assistant are so arranged as to give him a wide experience. One railway company in the United States reports that the services of men so trained by them are so eagerly sought by other companies that they cannot satisfy the demand. This principle of co-operation might be extended largely, and the greatest gainers in the end will be the employers, while at the same time the status of the junior engineer will be greatly improved; and not only this, but by the interest thus taken in engineering colleges by engineers in practice, modifications in the courses may be suggested, and students will be encouraged by the knowledge that the training, the successful conclusion of which is indicated by a degree, is recognised by the leaders of the profession as the right and necessary preliminary to practice.

THE VALUE OF A UNIVERSITY DEGREE IN ENGINEERING SCIENCE IN RELATION TO PROFESSIONAL COMPETENCE.

BY PROF. C. F. JENKIN, M.A.

In order to estimate the value of a degree in engineering science it is necessary to understand clearly what the possession of the degree means. It means that the graduate has spent some years in passing through a carefully arranged course of study in those fundamental subjects which should form the basis of engineering education, and also that he has attained a certain standard of proficiency in them, as far as that can be tested by examinations.

It is no longer necessary to urge the importance of theoretical training. Engineering education should consist of three parts: a basis of general scientific study; a middle structure of applied science, that is of science specialised, extended and adapted with a view to its bearing on professional practice; and lastly, that kind of knowledge of practice which can be gained only by coming directly in contact with it. This is now recognised by the Institution of Civil Engineers, which requires proof that applicants for admission shall have had both theoretical and practical training. The latter can only be obtained by an apprenticeship or its equivalent, and I sincerely hope that the Institution will always maintain its requirements in this respect, and not accept a knowledge of college workshops as equivalent to a knowledge of real practice, which it can never be. I am aware that much that is useful can be taught in college workshops, but I believe that it is better for the student to learn these things in the real shops, where he will at the same time acquire a fund of practical experience which he cannot in college.

The first part of the training—the theoretical part—with which we are specially concerned, can be obtained more or less efficiently in various ways. It is this part which the entrance examination is intended to test, but a degree is a very much better proof of the possession of a good theoretical training than any examination can be. This is the first reason I would bring forward for regarding a degree as of value. That an examination is, in general, a poor expedient for ascertaining a student's proficiency is becoming more widely recognised every day; it is, however, less unsatisfactory when held on the completion of a definite course of study than when it is used as a test for general scientific knowledge. Further, the degree course contains much that cannot be included in the examination at all; for example, much of the student's time is spent in the laboratory learning how to measure accurately all sorts of physical quantities, and to carry out tests on all sorts of machines—steam, electric, hydraulic, &c. The value of laboratory training, which can only be obtained in a college, is very great; to quote my father's words, "There is no teaching more practical, more immediately fertile in results than that which can be given by the man of science in his laboratory." Again, there is the teaching in the drawing office where the student learns to use his theory in the preparation of actual designs, and the field course of surveying, during which he learns to handle his instruments skilfully and accurately. These are all implied in the degree, but it is almost impossible to take any account of them in an examination.

The value of a degree may be considered from another point of view. What training is best for the boy when he leaves school—best in a wide sense? Is it better for him to go to college or not, for this is what the degree implies? To spend some years at a university is an education in itself and will be a permanent asset in the boy's life. This general cultivation is the feature of all university life—especially perhaps in the older universities. It is a matter on which we may congratulate ourselves that the two oldest universities now open their gates to engineering students.

The value of a degree may be considered from a third point of view. Sir James Inglis, in his presidential address in 1908, said: ". . . it ought to be laid down as a principle that all public money derived from rates and taxes should be, so far as it is applied to engineering construction, expended under the direction or control of definitely qualified engineers, as is already the case in many countries." If the engineering profession is to be brought under State control, as medicine is, and also the law—in a modified sense—it would appear to be wise to make the basis of qualification as broad as possible by recognising the engineering degrees of the universities as a necessary qualification rather than a certificate by a single institution, even though that institution were our own.

An engineering degree then may be looked at in three lights: As a guarantee that the holder has had the best theoretical training and has profited to some extent thereby; as the final step in that type of liberal education at the universities of which England is justly proud; as a broad basis on which State recognition of our profession may be founded. The regulations drawn up by the Institution for the admission of students and members are wisely framed at present so as to recognise many different types of training, but if the reasons I have advanced in favour of the engineering degree are valid, it would be well for us to look forward to a time, not too far distant, when the possession of a degree shall be a necessity in engineering as it is in medicine.

DISCUSSION.

The CHAIRMAN, in opening the discussion, hoped that employers would give their views on the value of a degree to the student. In his opinion the value was at present small. The commercial value of a man depended on many factors, not all connected with college work. A graduate might be expected to advance more quickly than a man without a degree, or if he did not there was something wrong with the training, or he had spent too long at it.

Prof. J. A. FLEMING, F.R.S. (London), said that the value of a degree was at present small. Its essential vices were that it was too largely obtained by passing examinations which took place in three-hour sections without books and whether the student was well or not. Not enough attention was paid to practical work. In life, an engineer's efficiency did not depend on his memory for facts or on his ability to work against time. The qualities which a student had to cultivate to pass examinations were not the qualities he would afterwards want. There was too much working for the degree, in which there was no value as an end in itself. Education ought to tend to the development of qualities of reliability, resource, accuracy, and towards making good with imperfect means. Only first principles should be taught and *viva voce* and practical examinations should be cultivated. Letters as a sign of graduation should be abolished, a diploma taking their place.

Mr. DUGALD CLERK, F.R.S. (London,) said his experience with graduates was not so bad as Prof. Fleming's. He agreed, however, that they were not much good in works at first. Many so-called practical men had really a good scientific education, at any rate as far as his own work was concerned. A university man was often difficult to get on with as he was likely to be conceited, but he was useful when he had been broken in. Engineering work in the past had been very efficient, but not of a very high order.

Mr. A. P. TROTTER (London) thought no degree ought to be given for professional work. He had been on the Board of Studies of the London University, but he soon became quite out of sympathy with them. Their ideas were too "post-graduate." General principles only should be insisted upon at universities, such as physics, mathematics, chemistry and geology specialised to engineering requirements.

Col. B. R. WARD, R.E. (Chatham), thought a good sound general education was of importance to the engineering student. Engineering subjects by themselves provided only half an education and not too much stress should be laid on the technical side.

Mr. JAS. GLOVER (Lowton) thought general principles only should be inculcated at a university, for lack of principles could never be made up afterwards. A degree was of value and was worth working for.

Prof. S. P. THOMPSON, F.R.S. (London), said a degree had no face value, its worth depending on the work behind it. In London the running after degrees was a curse and was doing great harm. An A.R.S.M. or A.C.G.I. ought to carry ten times the weight of any degree.

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Dr. W. C. Unwin, F.R.S., then took the chair, and the following Papers, of which we give abstracts, were read :—

THE POSITION AND USES OF ENGINEERING LABORATORIES IN RELATION TO EDUCATION AT COLLEGE.

BY PROF. W. E. DALBY, M.A., B.SC.

The outstanding feature of our modern system of scientific education is the laboratory. It is now recognised as an essential instrument in all branches of scientific education. The reason is not far to seek. In a lecture room a student hears things, but in a laboratory he does things ; and a normal student remembers what he does and forgets the greater part of what he hears. A youth anxious to become an engineer is generally born with a desire to do things ; and thus the material which we have to train in our engineering colleges is peculiarly susceptible to laboratory teaching. Through the work he does in the laboratory comes the desire to hear rightly in the lecture room.

An engineering laboratory may be designed from the two distinct points of view of teaching and research. The two ideas are complementary to one another rather than antagonistic, and both must be kept in view in the general design of the laboratory of a great school. From the point of view of teaching, the individual items of the apparatus provided should be numerous, typical and small, so that there may be plenty of experiments for small groups of students to carry out for themselves. For example, five 20 H.P. steam engines, each properly equipped with measuring apparatus, are better than one 100 H.P. engine. Later in the course a student may form one of a large group testing a large steam engine, but his early work on the smaller plant will enable him to perform his part with a comprehensive knowledge of what is being done by the other members of the group. He will thus do the work more intelligently. In an engineering laboratory the students must do the job and not look on while the job is being done by the professor on a large and expensive piece of apparatus too costly to be entrusted to them.

From the point of view of research, the chief provision to be made is space, time and a workshop in which apparatus can be made to supplement the apparatus, often of an expensive kind, provided for research. Any of the apparatus provided for the instructional course may, from time to time, be made the subject of a special investigation ; but, in such an event, it must be withdrawn temporarily from the routine work of the laboratory.

The equipment of an engineering laboratory cannot be specified without a clear idea of what it is that we aim to teach. Amongst the many things that may be put down, three, I think, stand out clearly—namely, the fundamental principles on which engineering science is based, the physical properties of the materials of construction, the methods of measuring energy in the many guises it assumes.

The fundamental principles upon which engineering practice is based are few in number, but their applications are almost infinite. A principle can only be thoroughly grasped through a study of its applications. Hence to engineering students a principle should be taught by means of applications selected from those which have a bearing upon engineering. The engineering teacher has a vast and interesting field of applications from which to make his selection, and the suitability of his choice will depend largely upon the extent of his scientific knowledge and practical experience.

All students of engineering should gain some familiarity with the physical properties of steam and gases and with the materials of construction. There should be a complete equipment of small testing machines in order to provide for numerous individual experiments simultaneously, together with some large machines for research work. The fundamental principles of thermo-dynamics should be taught through their applications to estimate the efficiency of heat motors of all kinds. There should be a full equipment of heat motors, each motor being small enough to be entrusted to a group of two or three students, together with a few large engines and typical steam plant for the more extended study of the subject.

Time prevents me from enlarging on the educational value of the work in the electrical laboratory. The elusive nature of the agent with which electrical energy is associated makes the work both fascinating and absorbing.

Above all, in passing through the course, the student should catch something of the spirit of research which should brood over every engineering laboratory, from the smallest to the greatest.

THE OBJECT AND USES OF ENGINEERING LABORATORIES IN RELATION TO EDUCATION AT COLLEGE.

PROF. J. GOODMAN.

It is well at the outset to recognise that the equipment and scope of an engineering laboratory differ essentially from that of a college workshop. The work carried on in the latter is mainly for the purpose of teaching the art or trade of engineering (as to whether such workshops should be attached to colleges or not is a much debated point upon which very definite opinions on both sides are held), but the work done in the former has the sole object of teaching the principles which underlie that art or trade.

However able a teacher may be, it must often happen that students do not get a thorough working knowledge of a subject from attending a course of lectures ; if, however, properly-schemed laboratory work can be arranged to run concurrently with the lectures, the student is brought more closely into touch with the concrete side of his subject, and thereby not unfrequently discovers his own shortcomings.

Amongst other important phases of laboratory work the following appear to be worthy of special note : The engineering laboratory affords the student an excellent training in the carrying-out of experiments for the purpose of obtaining accurate data, and he cannot fail to be early impressed with the paramount importance of keeping all the conditions of the test constant except the two variables under consideration. He, moreover, discovers that absolute accuracy in data is rarely, if ever, attainable, and therefore the use of many significant figures is not only absurd but tends to deception.

In certain cases the laboratory work is valuable in showing how far theory and experiment agree, but great care is necessary in order to prevent students jumping to the conclusion that there is actual disagreement because their own imperfect, inaccurate experiments do not give the results that the theoretical treatment would lead them to expect. It is, however, believed that it is a mistake in the first instance to insist on students worrying about minute accuracy.

Before purchasing apparatus for the equipment of an engineering laboratory it is of great importance that a general scheme should be drawn up, setting forth definitely and clearly the lines on which the proposed work is to proceed ; in the author's opinion the aim should be to make all apparatus as simple as possible, and each piece should be designed to bring out clearly one particular point, all unnecessary complication being dispensed with.

The experimental steam engines found in college laboratories are frequently fitted with a maze of intricate appliances for the purpose of enabling the engine to be worked under a great variety of conditions, with the result that students are very liable to get erroneous ideas as to the essentials of any given type of engine. Such engines are necessarily not stock articles, hence they have to be specially constructed for the purpose, and are therefore very costly. The author suggests that it would be better in every respect to purchase two or three commercial engines of different types for testing purposes rather than crowd so much complication on to one experimental engine.

In all tests where a great variety of conditions may prevail, it is impossible, on account of time, for one group of students to work under each set of conditions, therefore it appears to be desirable that a definite scheme of testing should be drawn up, which may possibly take years to complete ; then, as each result is obtained, it should be plotted on a squared paper chart exhibited in the laboratory, thus enabling each group of students to benefit by the results previously obtained. If isolated tests are made under random conditions they are robbed of much of their educational value, and the results obtained are of little or no permanent value.

The extent to which stereotyping should be allowed in the work of an engineering laboratory is one well worthy of the most earnest discussion ; all will be agreed that it is an utterly bad system to have the apparatus required for each experiment set out permanently in working order, and to give printed detailed instructions and log sheets to each student, which he mechanically follows. The following of such a system entirely crushes all originality, and makes the student into a mere machine. In the early stages of the laboratory course some approach to this system may be tolerated perhaps—that is, during the period in which the student is learing to take and book observations ; but after he has once got over the initial stage he ought to rig up his own apparatus, check it for accuracy, make out his own log sheets, and reduce his results. Of course, he requires more supervision when working under such conditions, but he certainly gains experience of a far more valuable character than under a stereotyped system.

The staff of an engineering laboratory usually consists of a director with one or more assistants and skilled mechanics. It is of vital importance that the director should be a man familiar with practical work, or he may unwittingly encourage students to play with unreal problems, which tend to divert their attention from the actual difficulties that arise in the life of an engineer.

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THE POSITION AND USES OF ENGINEERING LABORATORIES IN RELATION TO EDUCATION AT COLLEGE.

BY PROF. B. HOPKINSON, M.A., B.SC., F.R.S.

The position of the engineering laboratory as an instrument of education is not quite the same thing as its position in relation to research, but is closely related to it. In a discussion, some 20 years ago, on the proposal to establish an Engineering School in Cambridge, it was pointed out by way of justifying the innovation to that ancient University that it was as good an education thoroughly to test a steam-engine as to determine the velocity of light. It might well have been said that it was better, for in the engine-trial the student is introduced to phenomena under conditions which in their complexity resemble those of real life, and which can only partially be controlled. He can vary steam-pressure, load and perhaps speed, but he cannot within the limits of an ordinary trial control such important factors as the dryness of the steam supply, or the temperature of the cylinder walls. Thus he learns in a simple way to use his judgment in interpreting data, and to recognise how in a complex mechanism it is impossible to vary a single element without at the same time affecting a number of others. This training of the faculties of criticism and observation is valuable to anyone, whatever profession he is going to follow, and it cannot be obtained in the same degree from the experiments ordinarily performed by students of similar standing in a physical laboratory. To the engineering student there is the additional advantage that he sees the application of scientific principles to things of the same sort as he will meet with in after life.

These considerations, together with a frank recognition of the fact that by no possibility can the conditions of practical work be completely reproduced in the engineering laboratory, lead to a fairly definite conception of its position and uses. In the first place industrial apparatus, even of a simple character, is too complicated to be used as a means for demonstrating elementary physical laws to students who are quite ignorant of their working. Hence work in the engineering laboratory proper should be preceded by a short course of ordinary physical experiment under the simplest possible conditions. Provision is made for this in nearly all college courses, and it is unnecessary to discuss it in detail. Assuming that he has thus acquired a knowledge of the fundamental scientific principles, the student's work in the engineering laboratory will be directed largely to tracing their operation under more complex circumstances. For this purpose small units of plant of a simple character are quite adequate. Everything that such a student can learn in an engineering laboratory in the time at his disposal he can get from a 10 H.P. engine, from a 5-ton testing machine, and from plant on a similar scale in the other branches of his study. A triple-expansion engine teaches him no more than a compound; a four-cylinder petrol motor little, if anything, more than a single-cylinder gas-engine. In fact, the smaller and simpler machines are better for his purpose, because they are more easily handled, and he can be left more to himself. The author remembers seeing in a technical school an engine of several hundred horse-power, which was being tested by some 15 or 20 students. They were taking readings according to a set scheme, one reading a thermometer, another a pressure-gauge, and so on, and all the readings were being entered on a beautiful printed sheet. On the same day he happened to speak to a schoolmaster, who described how he was in the habit of setting his boys two or three at a time to indicate the laundry engine at his school, and test its steam consumption with an improvised condenser. There cannot be much doubt that the schoolboys learnt more than the students, and that the money paid for that large engine would have been better spent on 20 small engines.

But, though small, the machines in the engineering laboratory should be real commercial machines, such as are bought and sold in the ordinary course of business, and the students should use them under ordinary working conditions. This is, of course, quite consistent with the use of the most elaborate measuring arrangements that the ingenuity of the professor or demonstrators can devise, provided that they are such as a commercial user of the machine would tolerate. Extreme variation of conditions is necessary for the purpose of research; but the ordinary student is not doing research, nor is it his object to learn in detail about the working of a special machine. His use for the engineering laboratory is to learn generally how to extract from an experiment conducted under severe limitations all the information that it is capable of affording. In doing so he will consolidate the knowledge of natural laws, which he is supposed to have acquired previously in an ordinary physical laboratory, and will learn their limitations; he will also pick up many facts about the working of machines which may or may not be of direct use to him, according as he meets with these particular types in after life or not. But these are by-products, and in the author's view the engineering laboratory should be designed and organised with a single eye to the primary educational use which has been indicated.

DISCUSSION.

Mr. R. S. BALL (London), in opening the discussion on these Papers, agreed with Prof. Hopkinson that the laboratory equipment should not be too elaborate. Good experience was obtained from partially erected engines. Laboratory equipment might be multiplied, but should be kept simple. The laboratory had been as great an aid to engineering as the ocean in the Irishman's opinion was to navigation.

Mr. D. CLERK, F.R.S., thought students ought to have control over any machines they tested, and for this reason small engines were more suitable than large ones. He, as a manufacturer, appreciated the work that had been done on gas engines both from the teaching and research points of view in engineering laboratories.

The CHAIRMAN (Dr. W. C. Unwin, F.R.S.) thought no positive rules on the question of laboratory equipment could be laid down. Apparatus could not be standardised. Some must be large and some small. It was valuable for students to make tests on a large scale owing to the feeling of reality that it gave.

(To be concluded.)

TESTS ON CERTAIN ELECTRICAL INSULATORS AT HIGH TEMPERATURES.*

BY W. W. STIFLER.

This work was undertaken in an attempt to find a substance which could be used to insulate a small coil at temperatures above 1,000°C. The insulators tested were mica, asbestos board, sodium silicate, a paste of magnesium oxide and alcohol, and a patent compound sold under the name of "cæmentium" or "liquid porcelain." The general method was as follows: The test sample was placed in a horizontal platinum resistance furnace and heated to 1,100°C. At convenient temperature intervals its resistance was measured, the temperatures being read by means of a platinum resistance thermometer and Whipple indicator.

The test samples were made as follows: Two nickel wires of sufficient length to reach to the centre of the furnace were joined at one end by means of the insulator to be tested.

No attempt was made to prepare samples of uniform size, and the readings taken were meaningless except as showing the behaviour of the particular samples. Hence all the results were reduced to percentages.

The condition of the samples after heating is worthy of notice. The asbestos had lost its fibrous structure to a great extent, and was quite crumbly. The mica was somewhat deformed, had become opaque, and was quite brittle. It could easily be crumbled between the fingers. The cæmentium and sodium silicate were baked hard, much like porcelain. The magnesium oxide seemed unaltered.

The results are shown graphically in curves in the Paper. While the data are too meagre to permit of any very general conclusions, we may draw a few inferences.

1. The insulating power of asbestos breaks down sharply at about 900°C. On cooling, it rapidly recovers its insulating properties.

2. Mica seems to remain an insulator up to about 1,000°C. It then breaks down very rapidly with increase of temperature. On cooling, the insulating power is recovered quite slowly down to 700°C., but below this temperature it recovers rapidly. On heating again, it follows the curve of recovery.

3. Magnesium oxide is an excellent insulator up to 800°C. When heated above this temperature, it becomes quite conducting, but recovers its insulating power on cooling.

4. Sodium silicate breaks down rapidly above 200°C. or 250°C.

5. The behaviour of cæmentium is quite irregular. Apparently heating to 1,000°C. improves its insulating properties to some extent, though it cannot be relied upon much above 500°C.

The results in the cases of sodium silicate and cæmentium were to be expected from the fact that glass and porcelain conduct electrolytically at high temperatures.

Telephones at Los Angeles.—The "Electrical World" mentions that in a recent address in Los Angeles, Mr. K. B. Miller, who was retained as an expert by the Board of Public Utilities, in fixing telephone rates, said that Los Angeles, with its two telephone companies, had over 80,000 telephones, or one to every four inhabitants. There were 750,000 daily calls, or two for every man, woman and child in the city. It is claimed that Los Angeles is better "telephoned" than any city of its size in the United States.

* Abstract of an article in the "Physical Review."

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THE PRESENT POSITION OF ELECTRIC TRAMWAYS.

It has been only too evident during the last few years that electric tramways in this country have ceased to mak any satisfactory headway. Indeed, so incapable of growt does the industry appear to have become under presen conditions, that an outsider might well think the require ments of the country had been met as regards locomotion This, however, is by no means the case, as may be judge by the eagerness with which rail-less traction has bee welcomed as a possible solution of the present problem Whether this new means will facilitate progress remain for the moment to be proved. There is no doubt that co siderable interest has been aroused by the experiment installations at Leeds and Bradford, and the experience these towns with the new system will be of much more th local value.

At the Congress of the Tramways and Light Railwa Association at Edinburgh last week, Mr. G. H. J. Hooc WINKEL discussed some of the reasons why electric tracti in England remains stationary. Confining himself main to one aspect of the problem, *viz.*, the comparatively hi cost of construction compared with that in other countri the author attributed this primarily to the heavy doub deck cars that have here found favour, necessitating expensive track; and he discussed the various objectio that have been raised against the adoption of light, sing deck cars, with trailers if necessary at times of peak lo The main objection—the greater number and length vehicles required—is not considered by the author to

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serious in most cases, and he mentions that although the traffic per mile of route is greater in Berlin, Dresden and Lyons than in London, Dublin and Manchester, single-deck cars are used except on some of the trunk lines in these Continental cities. It must not be forgotten, however, that it is customary for the cars to travel at a higher speed than is permissible, or always possible, in this country, so that the greater number of vehicles is more easily dealt with. An important difference, moreover, is that passengers are allowed to ride on the platforms of the cars. We do not agree with the author that the type of cars generally adopted in this country should be so used, unless provision were made for passengers to stand by curtailing the seating accommodation. In another Paper presented at the Congress last week, Mr. C. W. MALLINS urges the claims of the single-truck car as against the bogie-truck car, and draws attention to the longer wheel bases now possible. This certainly seems to be a more desirable type, and by reducing the weight should lessen the wear and tear of the track.

There are several other points of interest dealt with by Mr. HOOGHWINKEL, among which may be mentioned bow-collectors, flexible trucks, "pay-as-you-enter" cars, and trailers. It is a curious fact that Continental engineers have gone in strongly for the bow form of collector, whereas we in this country have favoured the trolley wheel. It must be admitted, from the point of view of ease of working, the bow collector has a distinct advantage. There is no chance of its leaving the overhead line at a critical moment, no overhead switch points are required, and the overhead construction need not be carried out with such care in regard to alignment. With such a rival it is difficult to see why the trolley wheel has been favoured so strongly in this country. This appears to be due to the idea that the wear and tear with the wheel is less than with the bow. Actually, however, such does not seem to be the case, provided, of course, that suitable collectors are used. With greased aluminium collectors the wear appears to be extremely small, and as the tension on the bow is less than that which is usually put on the boom carrying the trolley wheel, the pounding at the ears carrying the trolley wire is not so marked. This point is of some importance, because all the serious wear in the trolley wire takes place at the ears.

With regard to flexible trucks, there seems to be much common sense in the view that some form of radial or adjustable truck in the case of four-wheel trucks might be used with advantage, the wear and tear of the track being considerably reduced thereby. Possibly tramway managers have found these advantages more than compensated by disadvantages, for the fact remains that such trucks have not been seriously taken up, and consequently the rigid type of truck, which from the point of view of adapting itself to the curves in the track is essentially bad, continues to be used extensively.

Mr. HOOGHWINKEL lays some stress on "pay-as-you-enter" cars and upon trailers. It is a little doubtful if a very good case can be made out for the former; at least, they would probably have to be used very judiciously to deal with certain classes of rather light traffic. So long as the traffic were light, no great difficulty would result, but we can imagine that at times of heavy traffic there might be difficulties. Passengers would not care, particularly on a rainy day, to be kept waiting whilst some old lady fumbled about to find half-a-crown and was then uncertain about the exactness of the change. Some years ago a special type of car without a conductor was run between Vauxhall and Camberwell, and the driver had the duty of seeing that the passengers put their fares into a box, and he also had to supply change when required. We do not know whether the result was found to be satisfactory. Possibly some modified form of this kind might be adapted to present-day conditions, but we think it must be quite clear that only light traffic could be handled in this way.

With regard to trailers, there does not seem to be the same necessity for these with double-deck cars as with the more usual single-deck cars found on the Continent. By using trailers with single-deck cars a very much better distribution of weight is obtained on the track, and there is a flexibility which is very advantageous for meeting the fluctuating conditions of traffic. Of course, it is essential in such cases that means should be provided for efficient braking. This might introduce a difficulty on our own tramways, as air brakes are practically not used in this country, and such brakes are far the most easily adaptable to trailer conditions.

A curious feature of the cost of construction to which attention is drawn by Mr. MALLINS in the Paper to which we have referred is the large variation in the cost per mile of single track on different undertakings in this country. Thus, taking 12 typical undertakings, the cost per mile varied from £9·9 to £3·3 in the case of the track and from £2·8 to £0·6 for the overhead construction. The cost of maintenance of the track showed an even greater variation, viz., from £300 to £21 per annum per mile of single track. As no idea, however, is given of the age of the respective undertakings, too much stress should not be laid upon these figures; but, nevertheless, we think it has been shown by both these authors that there is good ground for looking into the whole question of tramway construction and tramway running with a view to the lessening of cost.

REVIEWS.

(Copies of the undermentioned works can be had from THE ELECTRICIAN Office, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.)

Cours Elémentaire d'Electricité Industrielle. By P. ROBERJOT (Paris, 1911: Dunot & Pinat.) Pp. xii. + 352. fr.4.50.

This elementary treatise has been written to cover the syllabus for the French Schools of Commerce and Industry as laid down by the Ministerial Decree of 1909.

The official syllabus is given in full and occupies five pages, and it is interesting to note how the decree specifies in great detail not only the matter that is to be treated but also the manner in which it is to be illustrated by particular experiments. On reading through it one can almost picture to oneself the teachers throughout France setting out on the same day at the same hour to perform the same experiment before their respective classes and the Government inspectors on their rounds carefully comparing the lectures given with the official syllabus.

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A slight stretch of imagination enables us to look into the future and see the text of each lecture issued by the Government to the teacher, who will have nothing to do but to impart it to his class at the specified time.

Throughout this book the treatment is remarkable for its clearness and accuracy, and care has been taken to confine it to an exposition of essential principles only, so that the work may be said to be admirably adapted for the use of elementary students. The subject-matter includes the resistance of variously grouped conductors, primary and secondary cells, generators and motors for continuous-current and alternating-current, electric heating and lighting and a short chapter on telephony.

In order to be able to discuss important matters that depend on theorems that would involve somewhat difficult proofs the author does not hesitate in some instances to state without proof the theorems required. For instance, the calculation of magnetic circuits and the lifting power of electromagnets is introduced by a statement of the connection between ampere-turns, reluctance, flux and lifting power. The author is perhaps not quite consistent in carrying out this process, and we find that in the chapter concerning alternating-current theory, although he sets out by stating the relations that hold between the maximum, average and effective values of a sine function, he investigates the properties of alternating-current circuits at considerable length and one cannot help thinking that the investigations here carried out will present more difficulty than the ones which he has excluded in other parts would have done.

In conclusion we might point out that in Fig. 17 the current I_1 is shown flowing in the wrong direction, in Fig. 346 a ring is shown with a two-phase winding that would not produce any external field as the coils are connected so as to give rise to lines of force closing inside the ring instead of across its diameter, and lastly that there is an unfortunate misprint on page 329, line 18, where "synchronous" is written for "asynchronous."

A. J. M.

Steam Turbines. By R. Rankin Kennedy. (London: Whittaker & Co.) Pp. 104. 4s. 6d. net.

This volume is intended to give engineers and students an insight into the methods employed for calculating the leading dimensions of steam turbines.

The author's fundamental distinctions between types are somewhat confused. In the first paragraph reference is made to pure pressure turbines, but it is not clear what design this refers to, as the remarks on the first and second page endeavour to explain the Hero type as not being a pure pressure turbine, but on page 4 the author contradicts this statement and defines a pressure turbine as a reaction turbine. It would be better not to introduce the term pressure turbine at all. Then again, in stating that turbines are usually differentiated into action and reaction turbines, the author explains that the latter term refers to pure reaction turbines. It should be explained to the student that the term reaction is generally used in connection with the Parsons type, which is not a pure reaction turbine.

The first chapters deal with theoretical considerations of design, and contain some simple calculations. Then follow illustrations and descriptions of standard designs. The following explanation of the Rateau turbine is not very lucid (p. 48): "If we can imagine a number of De Laval turbines placed side by side with the wheels in parallel planes, and if we imagine a large number of nozzles extending from the exhaust side of one wheel through the casings to the steam side of the next wheel, we have in principle a Rateau turbine."

The author gives extracts from Papers by Mr. Gerald Stoney and by Mr. Speakman dealing with some condensing plant problems. The author states that it is less expensive to produce a jet effect mechanically, as in a Le Blanc condenser, than by means of a steam jet as used in a Parsons augmentor. No figures are produced to prove this statement, and to the best of our knowledge the question is quite open and has never been thoroughly investigated.

The astounding statement is made on the same page that jet ejector condensers cannot be employed as main condensers, "for the condensed steam which forms good feed water for the boilers is lost, being mixed with the condensing water." The following paragraph is quite unintelligible (p. 68):—"A recently-installed Parsons exhaust turbine of 250 kw., working with steam between 2 and 2¼ lb. absolute pressure, consumed only 34·4 lb. per kilowatt hour, giving an efficiency of 57 per cent. compared with the Rankine cycle." Steam consumption results are given for a Zoelly 6,000 kw. turbine, and 14·6 lb. per kilowatt hour are converted into 20 lb. per horse-power hour.

The volume is only a small one, but the above examples will suffice to show that its contents are neither precise nor accurate.

R. J. Kaula.

Eléktrische Beleuchtung. By Dr. Berthold Monasch. (Hanover, 1910: Dr. Max Janecke.) Pp. xvi. + 102.

In the author's preface to this work on "Electric Illumination" there occurs a sentence which well deserves the close attention of all interested in electric lighting. It runs:—"It should not be forgotten that it is quite useless to regard the *intensity* of a light source as the criterion of the *efficiency* of a lighting installation; the real determining factor is the *illumination* produced." This sentence is also reproduced to convey some idea of the mode of treatment of the subject by the author, whose book is an earnest and successful endeavour to set forth and examine critically the various features which have to be taken into account when considering a light source, whether inherent to the source itself or totally independent of it, in order to arrive at a correct estimate of the relative value of the different electrical sources of light for this or that purpose.

The first edition appeared in 1906 and comprised Part I. only. Owing to the remarkable developments which have taken place in electric lighting since that date the present edition has been enlarged by the addition of Part II., dealing with the improvements in arc lamps and metal filament lamps during the years 1906-1910. Part II. has also been amplified.

Part I. contains eight chapters. After a few introductory remarks on the production of electric light by incandescence and luminescence, the author deals with the subject of photometry in chapter I. The principles of photometry and photometric measurements are excellently explained, and descriptions of some of the best-known photometers are included, together with several useful curves and tables. Chapter II. is on arc lamps and comprises sections on the electric arc, electrodes, arc lamp types, series, shunt and differential arc lamps. Incandescent lamps are next fully considered in chapter III.—carbon filament, metal filament, metallic oxide lamps (the Nernst lamp), as well as the metallised carbon filament lamp. Chapter IV. gives the methods of running arc and incandescent lamps, and the installation and attendance are explained in chapter V. Chapter VI. is on light distribution. It contains sections on the colour of light sources, the distribution of light from arc lamps for direct and alternating currents illustrated by curves, the effect of globes, &c., with similar sections on incandescent lamps. It is both instructive and interesting. The efficiency of electric light sources is well discussed in chapter VI., the table on page 194 giving the mean spherical Hefner candle-power of various sources of light being of great interest. A short but very able chapter on illumination then concludes Part I.

Part II. gives a survey of the improvements during the years 1906-1910 in photometry, arc lamps, mercury vapour lamps, tantalum and tungsten filament lamps, and contains very valuable information relating to the physical properties, dependence of candle-power on voltage, light distribution and efficiency of these lamps. Each part is furnished with a separate index.

We can strongly recommend the book to all connected with electric illumination, but, of course, a very fair acquaintance with technical German is necessary for English readers.

Viertalig Electrotechnisch-Werktingkundig Woordenbock. By G. J. van de Weill. (Amsterdam: Scheltema & Holkema's Boekhandel.) Pp. vi. + 441.

This book is divided into four parts in the first three of which are given the Dutch equivalents for certain English, French and German electrical terms. In the last part the English, French

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and German equivalents of the Dutch terms are given. The work seems to be, on the whole, well done, though, like other similar books, it suffers from the fact that not enough attention is given to idiomatic equivalents. On the other hand, plenty of phrases, *e.g.*, "to remove a fault," are translated in full, but the translation is absolutely literal.

ON SELENIUM.

BY G. L. ADDENBROOKE.

Summary.—An account is given of a number of researches on the physical properties of selenium, more particularly its specific resistance and specific inductive capacity.

The writer has headed this article "Selenium," but he finds that leading authorities have lately been calling this element "Selenion," thus classing it with boron and silicon, which he conceives as more correct on our present knowledge and therefore he will in the body of the article and for the future adopt this form of the word.

Most of the literature on Selenion deals with its very interesting property of altering its resistance with variations of the strength of a beam of light falling on it, which has found applications in various ways and would find many more if the effect was more under control and more constant in different specimens. So far it appears to have been used chiefly in the form in which it is procured from the chemist, but it seems probable that if the material were better understood and if its fundamental properties were clearly recognised, it might be possible to prepare it in slightly different forms in which its characteristic action would be more under control and would have a larger range and be more rapidly responsive.

Selenion has also other interesting attributes. It is one of the few elements which can be described as an insulator, and it is chiefly on this account that the writer's attention has been directed to it. He has not so far performed any experiments on it personally which are worthy of the name; but, having collected together what information he could from a number of scattered sources in order to find out what the known characteristics of the material were, he has come across so much discrepancy and so many interesting points that it may be worth while bringing the particulars together and drawing attention to them.

In the first place Selenion exists in two or more allotropic forms, the vitreous and crystalline, the first having a density of about 4·3 and the second of 4·8. On heating it turns first to a sort of stiff pastey mass, which can be spread or smeared with some difficulty in fairly thin films, and in which state it is most frequently used when its property of changing its resistance as light falls on it is to be employed. If it is heated more, and this is a little difficult to avoid unless precautions are employed, gritty crystals form in the material which make it difficult to spread in a thin even film of any size; and if it is heated further with the object of liquifying these, sublimation begins to take place and a purple-looking powdery deposit, consisting in air of the oxide, is formed on cold objects near to it. If air is excluded then the element itself is deposited. For fuller particulars the article in the "Encyclopedia Britannica" may be consulted.

After the discovery of the light action on Selenion by Willoughby Smith and his assistant, an investigation of its electrical properties was made by Prof. W. G. Adams and Mr. R. E. Day, the account of which was presented to the Royal Society in 1876, and a pretty full abstract of which will be found in that useful work—Gordon's "Electricity and Magnetism." Now, in Gordon's abstract the resistance of Selenion is put down as 60,000 ohms. per cubic centimetre. In Lupton's Tables this is given at the same figure, but qualified by the fact that the result is for crystallised Selenion at 100° C. Why the result is given for this temperature I do not know, since the resistance would certainly be much higher at ordinary temperatures if Selenion follows the ordinary properties of dielectrics.

Now the writer recently purchased some Selenion (stated to be pure) from a leading firm of chemists, and which he gathered came from Germany. Since there is not much Selenion used it seems probable that this firm prepare most of what comes on the market and that this may be taken as a fair average specimen of that which is usually employed. It was in the form of sticks having a good many bubbles in them. Having charged an electroscope, a stick was held against the plate when the leaves at once fell. A pint Leyden jar was then connected to the electroscope and the two charged together. This is a method the writer often finds convenient for rough insulation tests of materials. The jar has a capacity of about 1/750 of a microfarad. On touching the plate of the electroscope with the Selenion rod again the leaves at once fell, though not quite so quickly as before; from this test the writer gathered that the resistance of his specimen was somewhat of the same order as the Selenion employed by Adams and Day, and that this represents the characteristics of that usually made use of at the present day. That such figures have, however, very little to do with the real resistance of Selenion the following will make clear.

In return for a long Paper on the electrical properties of pure sulphur the Royal Society gave a grant to Prof. Threlfall for the purpose of enabling him to attempt a similar investigation on Selenion. In his Papers "On the Conversion of Energy in Dielectrics," in the American "Physical Review" for 1897, he gives some particulars of his experiments. Having cast an ellipsoid or small bar of Selenion he held this to a charged gold leaf electroscope and found that the leaves fell perceptibly in 30 seconds. The bar the writer used above would have a much larger section, but having regard to the conditions, in the two cases, it would appear as if the resistance of Threlfall's specimen was much higher than that obtained by the writer. This is not unlikely, as Threlfall ordered 100 lb. at one time, and the manufacturers having such an order and knowing it was intended for investigation purposes may have taken unusual pains to secure a purer product. Threlfall succeeded in purifying further some of this Selenion which he found to contain as he received it about half a per cent. of impurities, chiefly copper and glass (*see* his Paper in the Royal Society's "Proceedings," 1907.) He does not appear to have been able to carry on his electrical investigations further, but this has been done by some of his successors at the University of Sydney. These are embodied in a Paper by Messrs. Mason and Vonwiller (Royal Society "Proceedings," 1907, or 10 years later.)

These observers prepared a thin flat plate of vitreous Selenion which they say was free from holes, and was part of Threfall's specially purified product. They state that they had difficulties in getting the resistance at first owing to a thin film of oxide which they found greatly lowered it, and in connection with which the writer's remarks above may be noted. On carefully taking off this film with glass paper they found themselves unable to get sufficient deflection on a sensitive galvanometer with a battery of 900 volts to enable an estimate of the resistance to be made, they having first covered the opposite faces of the plate with gold leaf to secure good contact. They were therefore obliged to fall back on an electrometer; with this they determined the resistance to be at 20°C. $2{\cdot}2\times3\ 10^{16}$ ohms per cubic centimetre and $6{\cdot}5\times10^{15}$ ohms at 25°C. This makes the resistance of pure Selenion about half that of the generally accepted resistance of paraffin, our best insulator. If this result can be accepted, and the writer thinks it can from other internal evidence in the Paper, pure Selenion is an insulator of very high character. With such a high resistance it is pretty obvious that the special sensitiveness to light of Selenion must be greatly reduced, but it was still found to exist sensibly. From this evidence it seems safe to conclude that the sensitiveness of Selenion to light must be due more to impurities contained in, or in combination with the Selenion than to the pure element itself.

Let us turn now from the resistance of Selenion to its capacity, or dielectric coefficient. Threlfall, in the Paper abvoe referred to, states that he tested a sample by the ordinary method with a galvanometer and condenser and got a coeffi-

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cient of about 30, which he thinks should only be treated as provisional, and it is clear that this method is not applicable with commercial Selenion. Threlfall does not seem to have been aware of Boltzmann's earlier results obtained by his beautiful method of comparing the attraction of two balls of the dielectric, two to secure equal weights and size, one coated with gold leaf to act as a pure conductor, and the other of the natural dielectric alone. This, which the writer thinks the most pertinent and suggestive method he knows, seems never to be described in text-books, although it is fully noted in Gordon, for whom also Boltzmann wrote a special memorandum showing the mathematical steps by which he was able to arrive at the capacity from the relative attractions. Now Boltzmann, or rather his pupils, Romich and Nowak, made two determinations of the capacity of Selenion, not long after Willoughby Smith's discovery, in apparently the same series of experiments, in which the former discovered the rapid apparent increase in capacity of dielectrics with time when continuous currents are used for the determination, a point which was very prettily further demonstrated by Dr. Thornton in a Physical Society Paper last year, and which Paper has also not attracted the attention which the writer thinks it deserves. These two determinations of Boltzman of the electrical capacity of Selenion were each made in two ways, first with a rather rapidly varying current and next with a continuous current, or rather pressure, in each case. The first of these determinations makes $K=10{\cdot}2$, the second $K=8{\cdot}4$; and in the second case the rise in apparent capacity with a continuous pressure is much less than in the first case, from which in the writer's experience he would unhesitatingly have chosen the second as likely to be the more accurate. Nevertheless, 10·2 is the capacity for Selenion, which has been quoted in the text-books for 30 years and is taken as the accepted capacity for long waves in an important Paper which will be referred to below.

The above two results, as far as I can make out, remained unchallenged until 1903, when Pirani, in an Inaugural Dissertation at Berlin, which is referred to by Messrs. Mason and Vonwiller, made a new determination for commercial Selenion, getting a result of about 7·58 or rather less. Unfortunately I cannot find this Paper from the reference, and although there is the name of Pirani in "Science Abstracts" about the right date, the extract referred to seems missing in the body of the book, and I am therefore unable to give the method by which it was obtained. Lastly, Messrs. Mason and Vonwiller took up the subject in the Royal Society Paper already quoted from, and with some of the Selenion specially purified by Threlfall and which he had left at Sydney when returning to England.

Working with an alternating current of 50 periods, they made the capacity of vitreous Selenion about 6·14, and they refer to a previous determination by some Melbourne physicists, in which with the same purified Selenion a capacity of 5·78 was obtained, which they think too small. They also tested this Selenion with a very high frequency current and got practically the same result as at 50 periods, a point which made the writer doubt the accuracy of the result for some months after he found Messrs. Mason and Vonwiller's Paper, as he did not at first reading grasp the very high insulation obtained with this purified Selenion, and which, as pointed out above, approaches that of paraffin. Under these circumstances similar readings might be obtained for the capacity at two very widely different periods. There is, however, another piece of evidence in favour of Messrs. Vonwiller and Mason's figure from quite a different source, which is one of the chief reasons which has led the writer to pen this article, and which seems to have escaped attention by these experimenters, or they would certainly have quoted it. The writer thinks this point has much theoretical interest besides possibly practical importance later.

On February 28, 1902, Prof. R. W. Wood, of Wisconsin, who at present happens to be in London and was lecturing recently at the Royal Institution, read before the Physical Society a most delightful Paper on the optical properties of Selenion. In this he shows that there is a very strong absorption band in the visible spectrum, so that the refractive index rises to 3·14, the highest known, and falls off both ways. It seems clear that the action of light on Selenion is due to the presence of this absorption band. I need hardly refer to the relation of the square of the refractive index to the dielectric capacity which formed the basis of Maxwell's theory. Taking a value of the refractive index in a part of the spectrum free from absorption, at the end of his Paper Wood proceeds by the latest optical formula to calculate its equivalent for long waves such as are used in ordinary electrical work. His result brings the capacity of Selenion to 6·05, a result almost identical with that obtained by Mason and Vonwiller. Wood goes on to quote the received value of the capacity of Selenion as 10·2, and there leaves the matter. Five years later, and in ignorance apparently of Wood's prediction, almost the identical value is arrived at by Messrs. Mason and Vonwiller.

The writer would like to draw the attention of electricians specially to this. We electricians are apt almost to take it for granted that scientific advances will come from the electrical side, but a perusal of some of the work in the optical field the last few years will show how much leading workers in this field have, so to speak, trespassed into the electrical field, and the writer would not be at all surprised if some of the next great advances in the development of electrical theory came from that direction.

Looking back on the facts above, it is fairly clear that the Selenion used by Wood must have been of the commercial character, and that if he had used some of the pure product, while he might have got similar effects, it is probable that they would have been greatly reduced in intensity, perhaps more of the character of the similar effects as regards change of resistance to light which have been recently found in paraffin oil by a French observer. It would be very interesting if the effect could be further investigated. Such an investigation would probably clearly establish the fact that the peculiar behaviour of Selenion to light is due to the presence of a small amount of impurity, whether in combination or mechanically diffused through it. In this case it seems hardly possible that nature has already mixed just the right amount of the very best substance required to produce this effect in the most intense form, and it would certainly seem as if careful research might possibly result in producing a material with considerably enhanced powers which might find many applications of commercial as well as of a scientific importance. Anyway, the whole of the evidence the writer has collected seemed so interesting and suggestive that he thought it was worth putting together and embodying in a single article.

CORRESPONDENCE.

PATENT PROCEDURE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your editorial note on "Patent Procedure" raises some very interesting points, but I hardly think the suggestion made by you will cure the defect which arises from the delay in hearing appeals from the Comptroller to the Law Officer. Your suggested remedy will certainly not, in my opinion, benefit what you refer to as the "poor working man" inventor. I think the best remedy for the delay will be the appointment of more Law Officers. The appeals to the Law Officers have a great advantage in that the procedure is very economical and a special day and time are appointed for hearing the case. A Patent Agent may (and very often does) attend on behalf of his client before the Law Officer, the employment of Counsel being a matter of discretion and expense. When the Law Officer gives his decisions, the costs given against the losing party are quite nominal, and it has been a feature of patent practice that both parties pay the best part of their own costs, with the result that the costs to both have been very nominal in comparison with cases in the High Court.

If, as you suggest, the appeals from the Comptroller were taken before a judge of the High Court the expense would be greatly increased, for it would be necessary to employ a Patent Counsel in every case, as the Patent Agent who conducted the

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case whilst in the Patent Office could not appear before a judge of the High Court. The appeal would be entered in the list in the ordinary way, and the applicant might have to wait about in uncertainty for days, expecting the case to come on at any minute. In appeals to the Law Officer a time is appointed, greatly to the convenience of the parties and adding greatly to the reduction of cost.

Whilst on this subject, I might raise another point, of far greater importance. Why should not procedure in relation to patents be divorced from the High Court altogether, and questions of infringement be heard in a special Patent Office Court consisting of a Board of Judges with technical knowledge, or better still, have two Boards, a Board of first instance and a Board of Appeal? If any alteration in the procedure is to be made to benefit the inventor, it must be by way of maintenance or increase in the efficiency of the Court which gives the decisions on technical subjects, and a method of procedure by which the burden of enormous costs will not be possible.

Incidentally you state that a patent is not so readily saleable now as it was before the passing of the Act. I think you are wrong. If the patent is good, it bears on the face of it evidence of its novelty, and to this extent is more saleable; but if the patent is thin in novelty it also bears the fact on the face of it and is not so readily saleable. The fact really is this: the success of a patent is not always dependent on the quality; it is dependent on the man behind it, and whether the invention meets a real want or not. If the owner of the patent is blessed with commercial ability, money is often made, even though the patent, from a legal point of view is very thin.

I understand that the Law Officer is now giving special time to the appeals from the Comptroller with a view to working off the arrears.—I am, &c.,

Chancery Lane, W.C., July 18. H. Allen Pryor.

[The object of our notes was to draw attention to the delay in hearing appeals from decisions of the Comptroller-General and to suggest a remedy. The cost of an appeal to a judge in chambers should not be greater than the expense involved in the present procedure, and patentees could be represented by patent agents and solicitors, or by counsel, as the circumstances required. However, the suggestion made by us was only put forward tentatively. We consider it a good one, but any alternative, such as the appointment by the Board of Trade of a lawyer with good experience in patent law and procedure and technical training, would be equally acceptable to us.

Our correspondent raises another interesting, but somewhat difficult, point as to the procedure in actions for infringement. We admit that the present system has many disadvantages, as many of the judges do not possess the necessary technical knowledge, but the difficulty would be to find men with the necessary legal and technical training and experience to constitute the suggested Boards. We may say, however, that any proposal for improving and cheapening patent procedure will have our support.—Ed. *E.*]

OERLIKON PORTABLE INSULATION CUTTER FOR COMMUTATORS.

In order to obtain a really good contact between the brushes and commutator of a direct-current machine it is essential that the insulation between the individual commutator segments, whether it be mica or any other material, should not protrude above the circumference defined by the commutator metal. In fact, it is preferable that the insulation material be slightly recessed.

It very often happens that in time the insulation gradually protrudes, either due to the fact that the copper is worn down quicker than the insulation material—which is particularly likely to occur if the latter is hard mica—or due to dampness or expansion differences between the commutator metal and the insulation material.

In such cases it is necessary to scrape out the insulation material between the individual commutator segments. This is done, as a rule, by means of an ordinary scraper, a three-edged file, saw, or such like tool. The result is usually a badly scratched commutator and unevenly scraped out insulation, resulting in the necessity of grinding up the commutator afresh.

This recessing of the insulation is done very much better and more quickly by means of the transportable cutter built by the Oerlikon Co. (Fig. 1). The apparatus consists of a bronze bow, B, provided with two handles. In the recess of the bow a small cutter or mill is

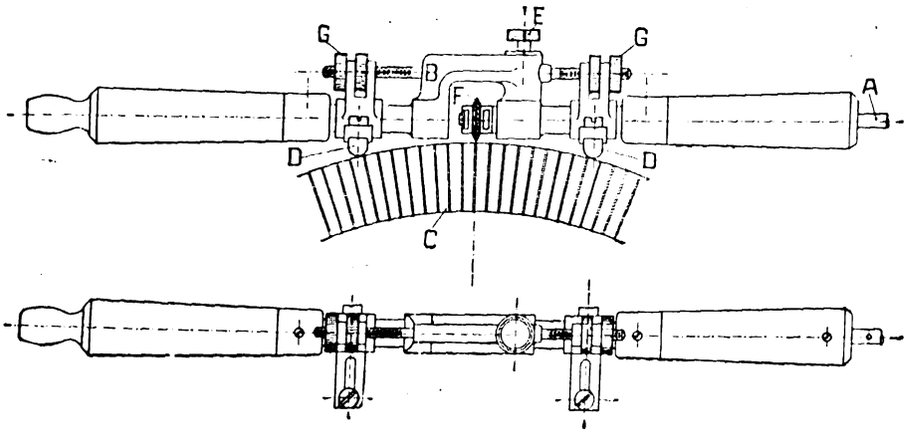

Fig. 1.—Portable Cutter for Commutators.

arranged, fitted on to a small shaft, A, passing through the right-hand handle of the bow. The whole apparatus rests on the commutator at the supports D, the distance between which is adjusted by the screws G. This device permits the accurate adjustment of the cutter or mill to the requisite depth, so that the milling out of the insulation material between the commutator segments is carried out to the same extent all round the commutator.

In order that the apparatus may be used for commutators of different diameters, the supports D are made exchangeable, supports of different height being supplied with the apparatus. The height necessary depends on the diameter of the commutator, and is tabulated below. The apparatus can also be used quite easily for very much larger commutators.

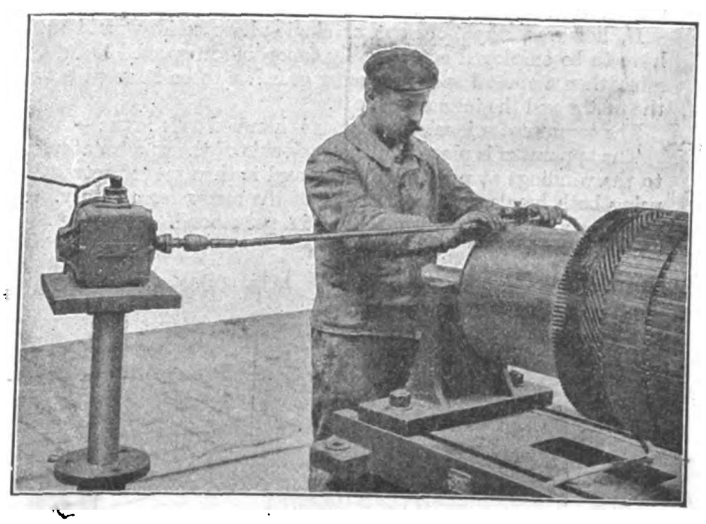

Fig. 2.—Portable Insulation Cutter in Operation.

Each apparatus is provided with five different pairs of supports. The following table shows the correct size of supports to use for different sizes of commutators:—

(*a*) With cutter of 20 mm. diameter. (*b*) With cutter of 25 mm. diameter.

Diameter of commutator in millimetres. (Approx.)	Guide supports. Dimensions in millimetres. (Approx.)	Diameter of commutator in millimetres. (Approx.)	Guide supports. Dimensions in millimetres. (Approx.)
60— 170	⌊⌋ 9×26	80— 200	⌊⌋ 9×26
171— 300	⌋⌊ 9×26	201— 450	⌋⌊ 9×26
301— 500	7	451— 700	7
501— 700	5	701—1,400	5
701—1,200	4	1,401—3,000	4

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The cutter, or mill proper, is run at a speed of 500-700 revs. per min., and is driven by means of a $\frac{1}{8}$ H.P. motor through a telescopic shafting, adjusted between 500 mm. and 800 mm., this shafting being fitted at each end with a universal link.

If the apparatus is used extensively, it may be found desirable to draw off the dust and waste insulation. This can be done by connecting the handle on the left side of the apparatus to a vacuum cleaner, condenser air pump or such-like apparatus, as this handle is made hollow, and permits the drawing off of the dust direct from the mill. The lubricating medium for the shaft A is pressed into the bearings of the latter by tightening up the screw E. Either a direct-current, single, two or three-phase motor may be used.

As the speed of a standard hand-drill motor for two or three-phase

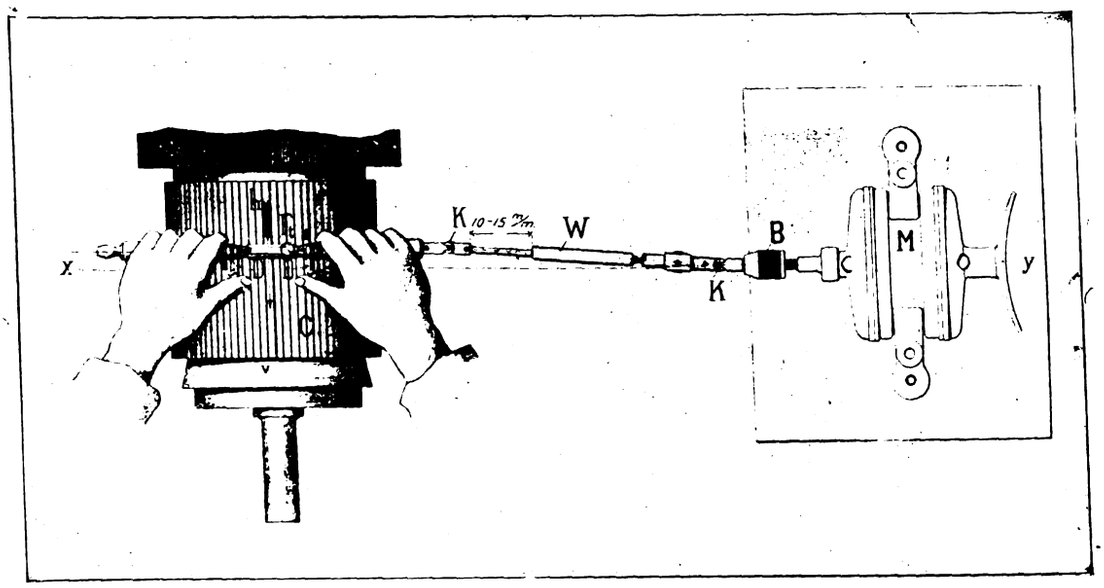

FIG. 3.—PORTABLE INSULATION CUTTER FOR COMMUTATORS WITH DIRECT-CONNECTED MOTOR.

current lies between 500 and 700 revs. per min., it is possible to couple up the telescopic shaft of the insulation cutter simply by inserting the pin of the universal link into the self-centring cone of the drill motor, as shown in Fig. 3.

If, however, direct-current or single-phase series-wound motors have to be employed considerably exceeding in speed 700 revs. per min., then a special speed-reducing gear has to be inserted between the motor and the telescopic shaft.

The commutator insulation cutter is handled as follows :—

The apparatus is placed on the back side of the commutator, next to the windings at point *h* (Fig. 3), and is then moved forward, by using both hands, in the direction of the arrow from *h* to v. The motion should be limited to about $\frac{1}{2}$ in. per second.

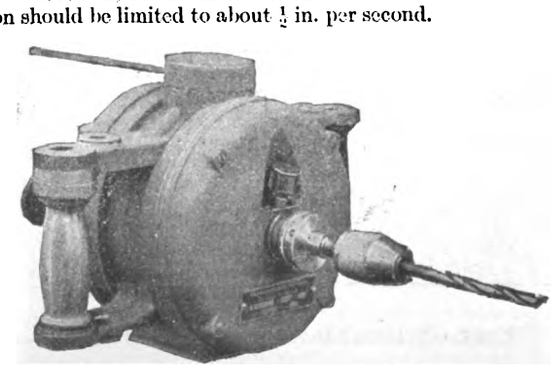

FIG. 4.—STANDARD DRILL MOTOR.

In order to guide the apparatus accurately and to ensure steady cutting, experience shows that it is advisable to place the thumbs on the one side on to the two supports D, whilst also pressing them slightly on to the commutator surface.

The whole operation is particularly easily carried out if the workman stands immediately in front of the commutator, as indicated in Fig. 2. If the insulation cutter is not constantly in use for the purpose for which it is designed, the motor can conveniently be employed as a portable drill, as shown in Fig. 4. A standard may also be supplied if required, so that the drill may be used as a stationary unit. The weight of the complete apparatus, inclusive of telescopic shaft, but exclusive of motor, is approximately 3·3 lb.

PARLIAMENTARY INTELLIGENCE.

TELEPHONE TRANSFER BILL.

In the House of Commons on Friday, on the order for the second reading of this bill,

Mr. S. ROBERTS expressed satisfaction at the fact that an arrangement had been come to between the National Telephone Co. and the Postmaster-General on the points which were raised in the bill. He then withdrew his motion to refer the bill to a Select Committee.

Mr. JOYNSON-HICKS said he had seen a deputation of the staff two nights ago, and they informed him that they had been met by the Postmaster-General and the Assistant Postmaster-General with great kindness, and that they had every reason to hope and believe that their claims would be met with justice. He understood the Postmaster General did not give his decision on some outstanding points, but tha he had given the staff the assurance that he would shortly put befor them a Memorandum. There was one point with regard to the senio staff he wished to mention. There were 12 members of the National sta in receipt of salaries of upwards of £700 a year. Those gentlemen, wh had really made the Telephone Company, and had been in its service fo many years, were not at present to be taken over by the Postmaste General. Speaking from the point of view of the public interest, I could not see how the Government could really take over that vast unde taking unless they came to some arrangement with at least a fair propo tion of those 12 senior members. As far as he could gather, the Pos master-General was not averse from taking some of them into his servic but there seemed to be a difference of opinion on the question of salar Those gentlemen were in receipt of larger salaries than those which t heads of the Post Office were receiving, but he suggested that no questio of dignity on either side should be allowed to stand in the way of a sat factory arrangement in the public interest.

Mr. WATT said Glasgow Corporation wished to be assured that by t passage of the bill nothing was being done or would be done to prejudi the existing rights of local authorities to apply to him for a licence carry on, under the terms of the Telegraphs Act, 1899, a telephone unde taking in their respective areas.

Mr. H. SAMUEL stated, in reply, that they had been able to arrive at understanding with the representatives of the National Company wi respect to two or three points that were outstanding. He thought the outstanding points were really the result of misunderstanding rath than of disagreement. The company appeared to have formed t opinion that he was anxious to vary the terms of the agreement enter into with the company in 1905 by the Postmaster-General of that d to the company's disadvantage, and to bring in the Legislature to al that agreement. Any such thought was very distant from his min After a personal discussion with the representatives of the company, th had been able to arrange that the wording of the bill should be alter in order that there should be no room for doubt that the bill did ta with the agreement, and that certain matters, such as the right of acc to the plant for inspection, should be arranged by a mutual interchan of undertakings rather than by a clause in the bill. Those points wo settled in a quarter of an hour, and the House would not be troubl with them.

With respect to the staff, it was, of course, his desire to do full justi to the members of the staff and to secure that their status should properly safeguarded, and the new employés of the Post Office would treated on the same terms as the old employés doing the same kind work. In many respects the position of the company's employés wou be greatly benefited by the transfer, for about 10,000 of them would h the first time have pensionable rights, which was no small advantag

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Several points of detail had been under discussion between the Staff Transfer Association, which was very representative of the company's staff, and himself, and he had been in communication with the Treasury with respect to several of them. Many of them had been already settled, one or two were still not quite completed. He would be able to establish a considerable proportion of those classes of the staff whose position was previously unsettled, and with regard to the rest an equitable allowance would be made to safeguard them against loss. In regard to the question of the 12 senior officers of the company receiving salaries of over £700 a year, the company was unwilling to part with five, as they would need their services in the preparation and prosecution of their case before the Board of Arbitration. Some of the others had nearly attained the age of 60, which was the ordinary age of retirement of Civil servants, and it would not be considered desirable to take into the employment of the State men who had very nearly reached the age of retirement. With respect to the others, they certainly hoped to be able to bring some into the Post Office, and they would be very glad indeed to have the advantage of their large experience and their capacity. The final arrangements, however, were not yet completed. There was nothing in the bill which would prejudice the position of municipalities to undertake telephone systems if they so desired in the future. The Act of 1899, which empowered municipalities to conduct a telephone business if they desired to do so remained, and it was not affected by the new measure. His own inclinations and opinions, as he had made quite clear to the House, were opposed to the municipalisation of telephones, and he thought expert opinion throughout the country was opposed to municipal telephones. As a matter of fact, he had received no request from any local authority to embody any system of municipal telephones in the bill, nor had the Association of Municipal Corporations approached him. Nor had Glasgow Corporation passed a resolution on the subject, although some individuals in Glasgow who were interested in the matter desired that nothing should be done to prejudice municipal ownership in the future.

Lord H. CAVENDISH-BENTINCK said that the Corporation of Nottingham had asked him to find out their position with regard to wayleaves, for which substantial sums had been paid in the past. It was assumed that the Postmaster-General would have the privilege of them without payment, and he hoped the Corporation would obtain their instalments at a lower rate.

In reply, Mr. H. SAMUEL said he was afraid he was unable to give the desired assurance. The Postmaster-General did not pay for wayleaves to local authorities either for telegraphs or the existing telephone service, and it would create a great inequality if with regard to the new system he paid certain towns for wayleaves. The telephone service was a public service for the benefit of the community at large, and to pay the local authorities would be to give the ratepayers a certain advantage, while the subscribers to the telephone service would have to find the money. With regard to granting telephones at a lower rate to certain people who granted wayleaves, that would give rise to great difficulties. If local authorities received that concession, private individuals who granted wayleaves would require their telephones at a cheaper rate, and if they failed to get them might threaten to terminate the agreement.

Capt. NORTON stated, in reply to Mr. Burdett-Coutts, that it had already been decided that the sum to be paid should be referred to the arbitrators.

The bill was then read a second time.

EDUCATION ESTIMATES.

On Thursday last week the House of Commons went into Committee of Supply on the Education Vote, when Mr. RUNCIMAN made a lengthy statement as to the policy of the Board of Education. After a reference to the work of the Imperial Education Conference, which was held in the spring of this year, to the International Conference on Mathematics, and to the Conference of the Universities of the Empire which will be held next year, Mr. Runciman announced that he had arrived at an agreement with the British Museum Trustees which would give them the land required for the Science Museum, and which would not interfere with the development of the Natural History Museum. He regretted to say that from all he had learnt of the work done in the provinces and of the work done on the Continent he had to confess that it was in the field of higher technology that they had most leeway to make up. It was true that in many directions large sums of money were being devoted to the endowment of technological chairs in almost every modern university. Great progress had been made during the past year. The University of Liverpool had recently founded a Professorship of Naval Architecture, largely owing to the generosity of Mr. Elder. They had also created a department for the study of the problems of town planning—a new and interesting department. There were at the present time at least two departments in modern universities for the study of aeronautics. A professorship has been founded at Leeds for the study of the gas, coal and fuel industries. In the same university instruction was being provided in woolcombing and spinning, for which the Clothworkers' Company had given £50,000, making, he believed, the school at Leeds one of the most valuable technological schools in Europe. In the North of England £35,000 had been provided for the teaching of mechanical engineering, and in three universities sums of £30,000, £50,000 and £70,000 respectively had been provided for the promotion of chemical science. In London £60,000 had been set apart by the University Association for the training of women in the study of the science of the household. Great progress had been made in the departments of metallurgy and chemistry in the North. In the sciences at the Imperial College great improvements had been made in the last 12 months, and he believed now that the leaders of the great industries were well alive to the fact that in the development of higher technological work lay much of the hope for their future commercial success. In the 11 modern Universities of England at present there were 9,600 full-time students, with 7,000 at Oxford and Cambridge of under and post graduates, a total of 16,600 students. In Germany there were 63,000 students in similar institutions.

In regard to university grants the most important departure made in the administrative work of modern universities was to be found in the change in distribution of the Treasury grant. The Government had decided to transfer the distribution of this annual grant to the Board of Education, and now the only Government department modern universities had to deal with was the Board of Education. That met with the approval of modern universities, and in the many conferences he had had with their representatives they had shown the desire to do their best to work with them for the common end. He could not pretend to say that the Board of Education was at present sufficiently equipped to do the whole of the work undertaken by the advisory committee appointed by the Treasury. He had, therefore, set up a small advisory committee to deal with the distribution of these grants. He had secured the service of Sir William McCormick as chairman, and associated with him were Sir J. A. Ewing, C.B., F.R.S., Sir Wm. Osler, M.D., F.R.S., Miss Emily Penrose, Sir Walter Raleigh, Sir John Rhys and Sir Arthur Rücker.

The secondary education work of the Board had shown a remarkable growth during the last few years. At present there came under the purview of the Board 1,060 secondary schools and all but 90 of these received grants from the State. The amount asked for had risen from £647,000 three years ago to £770,000 for 1911-12. That amount covered 161,000 scholars, of whom just over half were boys. One fault he had still to find with secondary schools all over the country was that the children came in too late and went out too early.

In the course of the discussion, Sir PHILIP MAGNUS said he gathered that Mr. Runciman was not altogether satisfied with the higher technological work which was being done in this country, but the only fact mentioned to illustrate the cause of that dissatisfaction was that the number of students in German technological institutions was much greater than in this country. No doubt that was so; but it should be borne in mind that the higher technical institutions of Germany had been established almost as many decades as institutions of a similar character in this country had been established years. One of the reasons why higher education in this country did not compare favourably with that in Germany was that the grants provided were much smaller here than in Germany. He looked with confidence to the Board of Education to give higher grants to the new universities in this country. He appealed to the Board to take such steps as might be necessary to ensure that when grants were made to secondary schools these grants should not be given exclusively to the pupils, but that some part should go to increasing the income of the schools so that more efficient and better qualified teachers could be appointed.

Sir WM. ANSON referred to the statement by Mr. Runciman that we were behind Germany in the higher technology, but the obvious reason for that was that our older universities were remote from the centres of industry, and he looked for a remedy in the new universities, notably those of Leeds and Sheffield, which would come into closer relations with the industries in their neighbourhoods.

TELEPHONE CALLS.

In the House of Commons last week the Postmaster-General was asked whether the registration of calls on the telephone exchanges was absolutely automatic, or whether such calls were recorded by the operators; and what guarantees subscribers had as to the correctness of the number of calls registered.

In reply, Mr. H. SAMUEL said that in the large Post Office exchanges, where the calls were registered by means of meters connected with the subscribers' lines on central battery switchboards, no call could be registered on any line unless it were connected with another line. The registration was not entirely automatic, as it did not take place unless the operator depressed a key which controlled the meter. The objection to an entirely automatic register was that it would not distinguish between calls which resulted in effective conversations and those which were non-effective, and should, therefore, not be charged for. Meters of the same form as those in use by the Post Office were in general use in all the large exchanges in the United States, and the results were considered satisfactory. He was obtaining samples of a device which would register all calls automatically, but would allow the cancellation of ineffective calls, the subscriber being informed of the cancellation at the same time, and if that apparatus proved satisfactory it might be possible to allow subscribers the option of having it fixed on their lines at the small extra cost involved by its use. He had seen a statement in a newspaper article that operators, when reported to the supervisor, were in the habit of taking revenge by charging fictitious calls, but he had not heard it from any other source, and had no reason to believe that there was any truth in it. He would make inquiries.

COAL MINES BILL.

On Tuesday Standing Committee B of the House of Commons, presided over by Mr. Eugene Wason, passed, with certain amendments, clauses 58 and 59 of this bill. The following provision, moved by the Solicitor-General for Scotland, was inserted in clause 58: "No internal combustion engine shall be introduced underground in any coal mine after the passing of this Act."

An amendment to clause 58, moved by Sir A. Markham, to limit the hours of colliery enginemen (with certain exceptions) to a maximum of eight hours out of 24, was carried by 18 votes to 12.

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Clause 60 (1) in the bill reads: "Electricity shall not be used in any part of a mine where* on account of the risk of explosion of gas or coal dust the use of electricity would be dangerous to life, and if the owner of a mine, on being required by an inspector of the division not to use or to desist from using electricity in the mine or any part thereof on such ground as aforesaid, refuses to do so, the question as to the application of this section to the mine or part thereof shall be settled in manner provided by this Act for settling disputes." Mr. Stephen Walsh proposed to add after the word "where" (at the place marked *) "safety lamps are in use and where." Mr. Walsh said the use of electricity should be prohibited in places where there was danger of inflammable gas.

The SOLICITOR-GENERAL FOR SCOTLAND said the hon. member's amendment would absolutely prohibit the use of electricity in any mine where safety lamps were required. He did not think he appreciated the fact that that might necessitate the taking out of a great number of installations which had been put in the mines with the approval of the Home Office, and the expenditure entailed by taking them out might lead to the ruin of a considerable number of enterprises without accomplishing any good purpose. Clause 32 provided that if there had been one ignition causing any personal injury within 12 months that would necessitate the use of safety lamps. The use of electricity was dealt with best by departmental regulations, and would be dealt with by very specific regulations.

Mr. T. RICHARDS said he and his friends were sincere in pressing the amendment because of the real alarm that had been felt in regard to the use of electricity in mines. It had been proved over and over again that the best experts could not account for the vagaries of electricity. Until they knew more about electricity and could control it better than they could at present the Home Office should be very jealous in sanctioning its extended use. There had been brought to his notice evidence that electrical coal cutting machines and conveyors gave off sparks when high-tension currents were used. They would have to ask the Home Office to tighten up its regulations.

Mr. HARVEY said it had been proved that electricity had caused explosions, and much electrical machinery had had to be removed from mines because of the sparking that had taken place. It was inconsistent to put electrical apparatus into mines where safety lamps were used.

On Wednesday Mr. WADSWORTH said the workmen were justified in their fears of working by electricity in fiery mines. The inspector of the Yorkshire district had said in 1909 that electrical engineers were not always good mechanics, and did not seem to have realised the danger of introducing electricity in fiery mines. On the surface the electrical plant was not subject to the rough usage that occurred underground. The Departmental Committee came to the same conclusion as he (Mr. Wadsworth) when they said the main directions in which the requirements needed to be strengthened were by prohibiting the use of electricity where, on account of the risk of explosion, such use would be dangerous.

Mr. LAURENCE HARDY said if the amendment were passed either the safety lamps or the electricity would have to come out, and it might be the lamps. It was in consequence of the reports of the inspectors in 1908 and 1909 that the Departmental Committee was appointed in 1909, which reported early this year. They said experience had shown that the use of electricity could not be regarded as mechanically unsafe, and that it possessed some characteristics of great value in underground conditions. The regulations had been made much stronger by the Committee, they had guarded as much as possible against the dangers, and the regulations now in force had the backing of the chief inspector, Mr. Redmayne. He had an extract from an expert's opinion stating that the danger from safety lamps was greater than that from electricity. The amendment would abolish the use of electricity in mines.

Sir ARTHUR MARKHAM said the amendment was impracticable, and if it were passed Parliament would be bound to reverse the Committee's decision. There were mines in which safety lamps were used although the gas did not exceed ½ per cent., and there would be cases where either safety lamps or the electricity would have to be taken out, and in the majority of such cases the safety lamps would be taken out. There was water in many pits, and pumps worked electrically were used with perfect safety, as there was no gas or dust, yet under this amendment every pumping plant would have to be closed down, or practically all of them. He did not know how one could work in a deep pit bottom without electricity. If the amendment were accepted half the electrical plants in mines in the country would be taken out. He only knew of one case where electricity had ignited dust, and that was not in a pit bottom, but in a coal bunker. There was no more danger in using electricity at the bottom of the downcast pit than there would be in using it in that room.

Mr. JOHN WILSON did not agree that there could not be explosions without gas. Such explosions had occurred at Altofts, Wingate and Westhoughton. The Westhoughton explosion was caused purely by electricity. He would refer Sir A. Markham to the West Stanley case.

Mr. EDGAR JONES thought the use of electricity for coal cutting should be absolutely forbidden, without any reservation. With regard to its use for haulage, in the last few years, especially during the boom, when tremendous profits were made, the colliery owners in South Wales put in new electrical machinery. It became a fever, and huge power stations were built. The colliery that first of all installed heavy electrical machinery underground were at present clearing it out as fast as they could. The manager told him it was going to be a tremendous loss to his company. He gave him examples of flashes of flame, feet in length, having occurred, and said he could hardly sleep at night for the fear of what might happen before he had cleared the electricity out. He was told the other colliery companies in South Wales had also to drop electric haulage machinery. The question of coal dust would not be tested by using the safety lamp, so he thought they might rule that out. He thought the inspector would say there was risk in every colliery in South Wales at the present time, and the inspector should have the right to forbid the use of electricity. That would obviate the necessity of passing a new Act if the development of the next few years made the use of electricity safer. He thought it would be better to say "You shall not use electricity unless you have the definite consent of the inspector."

Mr. BRACE said there could be no doubt that electricity could be, and was, the first cause of explosions where gas was absent altogether. At West Stanley it was found that coal dust between the terminals was the cause of an explosion. That was close to the bottom of the shaft. Neither colliers nor colliery owners preferred to work with safety lamps, and there must be good reason before they used them. So it might be assumed that a mine in which they were used must be a dangerous mine in the opinion of the collier, the colliery owner and the inspector, and that was the reason for putting forward the amendment under discussion. If the Committee thought it safe to light the pit bottom electrically, they could add to the clause "save at the pit bottom."

The SOLICITOR-GENERAL FOR SCOTLAND said the clause carried out the recommendations of the Departmental Committee, who recommended alterations in the regulations, and they were going to have new regulations. According to the expert opinion of gentlemen who reported, there had been no accident due to the use of electricity that was not a preventable accident, and the prevention might be accomplished by altering the regulations and the conditions under which electricity was used. He thought the proposed amendment would curtail the area of prohibition.

Mr. LEIF-JONES said the amendment would not increase the safety. He preferred the clause without the amendment.

Mr. S. WALSH thought the Committee had misjudged the application of the amendment. It read: "Where safety lamps are in use, *and where*." That meant that in any part of a mine, even where safety lamps were used, if, in the opinion of the inspector, of the district, there was no attendant danger of explosion from gas or coal dust, he thought even then electricity could be used. There had already been most effective regulations for the control of electricity, but what had happened? There was no doubt the Home Office experts had worked their best under the best regulations they could devise, but there had been enormous loss of life in the last few years. Four of the greatest disasters of modern times had happened, not because of the regulations, but in spite of them. Therefore he thought when colliery owners apprehended danger and put in safety lamps, electricity should not be used.

It was agreed to alter the word "and" in the proposed amendment to "or."

Mr. WM. HARVEY said if there were another catastrophe like West Stanley "electricity would have to be taken out of the mines," because the men would not have it.

Sir ARTHUR MARKHAM said he and others used safety lamps where there was no gas, simply to prevent timber being fired. He had never known any case where electricity had ignited coal dust, unless it was associated with disturbance. It had never been suggested by any expert or proved to be otherwise. Mr. Wilson had been speaking of shot firing. That had nothing to do with the question they were considering. At West Stanley the evidence showed that the explosion occurred simultaneously with the engine stopping. It was caused by a cloud of dust being set up and associated with the electricity.

The amendment was rejected by 26 votes to 13.

Sir ARTHUR MARKHAM had put down three proposed additions to clause 60, but announced that he had decided only to move the one set out below and to leave the others (which dealt with technical matters) to be dealt with in regulations.

Clause 60, page 31, line 17, at end, insert: "If in any place of a mine, or part of a ventilating district of a mine, the amount of inflammable gas in the air current exceeds ½ per cent. or upwards, the use of electricity shall at once be discontinued in such place or part of such ventilating district where the inflammable gas exists till the air current is clear of the same, or shall not exceed ½ per cent. A hydrogen or other type of safety lamp approved by the Secretary of State, in which low percentages of gas can be readily observed, shall be provided and used for testing for inflammable gas at least twice during every working shift by a competent person appointed by the agent or manager at the place or places where electricity is used, and a daily record, signed by the aforesaid competent person or persons, shall be kept at the mine of all such tests and the occasions on which, in accordance with this rule, it has been found necessary to discontinue the use of any electrical plant."

In moving the above amendment Sir A. MARKHAM said where there was electricity there was always a liability to open sparking, and he asked the Committee to set the standard of ½ per cent. of gas. There were many places where gas was present and where electricity was being used.

The SOLICITOR-GENERAL FOR SCOTLAND said the desire for a precise standard was commendable, but there were considerations which weighed against the acceptance of the amendment as presented. In the preceding clause there was a classification of mines, and they might probably find by the classification of mines a means of arriving at an exact standard, but the effect of the amendment as proposed would probably mean prohibition, not only where safety lamps were concerned, but also where naked lights were concerned. The Home Office were advised that the presence of ½ per cent. of inflammable gas in the air current was not necessarily dangerous. The amendment would be almost impossible to enforce, because those working at the face would not have means readily available for detecting ½ per cent. of gas, and if it were detected all use of electricity would have to cease. It was not desirable to have an act in that stiff and precise form unless it was certain that it could

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be enforced without unnecessarily inconveniencing the management and those working at the face.

Mr. EDGAR JONES thought the amendment might limit the power of the inspector to have electrical plant removed. At present a man might refuse to go on working a coal-cutting machine if it was sparking, but if the machine were tested, say, twice a day, the man might be more careless, and the conditions might be less safe than heretofore. No decent colliery manager would work electricity where there was ½ per cent. of gas.

Sir ARTHUR MARKHAM then withdrew the latter part of the above amendment, retaining only the first portion, ending "½ per cent." in the sixth line.

The amendment thus altered was carried by 15 votes to 12.

Mr. ADAMSON moved in clause 60, page 31, line 17, at end, to insert: "Pending the result of the arbitration proceedings, electricity shall not be used in a mine or part thereof respecting which objection has been taken to the use of electricity by the inspector of the division."

The SOLICITOR-GENERAL FOR SCOTLAND said the general rule with regard to arbitration was that the status quo remained until the decision of some competent authority had been given.

Mr. BRACE and Mr. C. EDWARDS thought the use of electricity should be discontinued pending the arbitration, as explosions might occur in the interim.

Ultimately Mr. Adamson withdrew his amendment in favour of the following, which the Solicitor-General for Scotland agreed to insert: "When any question under this section has to be referred to arbitration, the owner shall, pending the settlement of the question, comply with the requirements of the inspector, subject to an appeal to the chief inspector."

Clause 60 as amended was then passed.

TRAMCAR TRAILERS IN LONDON.

In the House of Commons on Monday Sir A. Griffith-Boscawen asked the President of the Board of Trade whether London County Council, in April, 1909, asked the Board of Trade for permission to run coupled tramcars, to enable it to cope with the heavy tramway traffic on the tramways during the busiest hours of the morning and evening; that the Board agreed, in Jan., 1910, to the experimental use of single-deck cars on the Euston to Hampstead tramway route, subject to their not being run between 10 a.m. and 5 p.m.; that the Board, in July, 1911, further restricted its consent by limiting the running of the cars to the hours between 7 and 9 in the morning and after 7 in the evening; that the Board had declined to allow double-deck cars to be used as coupled cars on any suitable routes or to permit smoking in one of the single-deck coupled cars; whether he was aware that coupled or trailer cars were extensively used on tramways in Europe and America; and whether the President was now prepared to grant fuller facilities to the Council to carry out this system, in order that the congestion of traffic might be relieved, and workpeople might be able to get more expeditiously to and from their work.

In reply, Mr. S. BUXTON said the facts were mainly as stated. In the special circumstances of London traffic, it appeared to the Board of Trade that, before the question of any general permission to use coupled tramcars could be considered, some experience of their use should be obtained, and an experimental service was permitted, after consultation with the Chief Commissioner of Police, and restricted to hours fixed upon representations made by him. The police, as responsible for the control of the traffic, were necessarily concerned in the matter. The Board were advised that double-decked cars should not be permitted to be coupled together, in view of the great weight of those vehicles, and they had suggested to London County Council that the question of allowing smoking in one of the coupled single-deck cars might be deferred until it was settled whether a general consent could be given to the running of coupled cars. Some further experience was desirable before the matter could be finally decided.

Corporation of London (Bridges) Bill.—On Tuesday this bill was read the third time in the House of Commons.

LEGAL INTELLIGENCE.

Thermal Synd. Ltd. v. Silicaware Ltd.

On Monday Mr. Justice Swinfen Eady commenced the hearing of an action for an injunction to restrain an alleged infringement of letters patent for an improved electrochemical plant for working silica.

Mr. Walter, K.C., with Mr. A. B. Shaw, appeared for plaintiffs; and Mr. Bousfield, K.C., and Mr. Colefax were for the defence.

Defendants denied infringement and pleaded prior knowledge.

Mr. WALTER, in opening, said the letters patent, dated 1904, related to improvements in the manufacture of silica. Silica was a body very difficult to fuse. Mixed or combined with potash of soda or lead it had been known for years in the form of silicates, as in ordinary glass. The fusing point of glass was 800 deg. One of the great difficulties in the working of silica was that the difference between the melting point and the solidifying point. The material was worked at an enormous heat—viz., 1,800 deg.—and the workmen had to be enveloped in asbestos. Owing to the small difference between the melting and solidifying temperatures it was impossible to work silica by the same process as that used in glass manufacture. Silica had to be worked immediately, because it solidified 16 times more rapidly than glass. When it was in a soft condition it skinned over almost immediately. The patentees of plaintiffs' device were Mr. J. F. Bottomley and Mr. Arthur Paget, now Sir Arthur Paget. After many experiments they discovered a method of working silica commercially as follows: They mounted a carbon rod between two electrodes of an electric furnace. This was surrounded by sand. By working to a temperature rising to 1,800°C. a melting action took place, which eventually formed a cigar-shaped piece of silica round the carbon resistance of the furnace. It was here that the gases which were thrown off by the process were used in a curious manner. As they were thrown out from the carbon core they formed an envelope between the core and the silica, enabling the former to be withdrawn. No one hitherto had believed that this material, except in the furnace flame could be dealt with, because the heat disappeared rapidly and a skin formed immediately. The patentees, however, discovered that when sufficient force had been used to break this outer skin there remained underneath a plastic mass which could be easily worked like glass. That was what the plaintiffs' patents embodied, and counsel produced great vessels which as the result of the discovery had been blown in silica, and were specially suitable for the storage of strong acids; also silica tubes, beakers, morters and pestles, &c. The current used in the process was roughly 1,000 amperes at 15 volts for half an hour. The result of the discovery had been to reduce the price of silica from £20 to 1s. a pound. Defendants were a company who were manufacturing similar articles in silica abroad, and were selling them on the English market. From enquiries they had made, plaintiffs had come to the conclusion that defendants were infringing their process

Mr. DUGALD CLIRK said he had examined plaintiffs' plant, and had studied the past history of silica working. He was convinced that there was nothing in earlier specifications similar to plaintiffs', which was undoubtedly a useful invention.

The hearing was adjourned.

Aktiengesellschaft Mix & Genest v. H. Oppenheimer.

This case came before Mr. Justice Eve on Friday on a motion by plaintiffs, asking the Court to substitute their nominee for the receiver appointed by the Master in chambers.

Mr. DANCKWERTS, K.C., said plaintiff company, who are manufacturers of electrical goods at Berlin, and defendant entered into an agreement in September, 1905, under which a certain electrical business that was being carried on in London under the title of the International Electric Co. was declared to be the property of plaintiffs. Defendant was to act as manager and plaintiffs were to furnish all the materials with which the business was to be carried on. It was also agreed that all disputes should be settled according to German law in the German Courts. There was also a provision that if the profits in any two years did not exceed 20,000 marks the agreement should be determined. At the beginning of the present year the agreement was determined, but the *status quo* was kept up for a short time by arrangement. In February last plaintiffs commenced an action in order to get possession of the premises in London and the assets, and they also claimed an injunction to restrain defendant from preventing plaintiffs from entering upon the premises. Defendant retaliated by moving that the action should be stayed pursuant to the agreement. Plaintiffs had no answer to that, and the only thing left for them to do was to protect the property in the interim. That point was recognised by counsel, and an order was agreed on Feb. 1 by which a receiver was to be appointed, and all further proceedings stayed, defendant undertaking to carry on the business with due diligence and to give plaintiffs access to the premises. Mr. Pixley was appointed receiver in pursuance of that order. Eventually an action was commenced in Germany by Mr. Oppenheimer, in course of which plaintiffs asked for an interim order in the Lower Court, which was refused, but granted on appeal. Mr. Danckwerts said what he wanted the Court to do was to make a parallel order here for the purpose of carrying out the German order. He could not have brought an independent action on that order of the German Court, and he only put it forward as an interlocutory order, and to say that such Court was the one to which the parties by agreement had said should settle their disputes. The findings of the German Court were that Mr. Oppenheimer did not deny that the assets of the firm in London belonged to plaintiffs and that defendant set up that the goodwill of the International Electric Co. belonged to him and not to plaintiffs. The International Co. dealt in the manufactures of plaintiffs, and could not get on without them. The Court further decided that plaintiffs were entitled to the assets of the London business, subject to certain conditions. Mr. Pixley asked for £150 per month for his remuneration, and that was a material fact to be taken into account. If plaintiffs' nominee was appointed receiver there would be no expense for remuneration.

Mr. Justice EVE: You seek to discharge Mr. Pixley and appoint someone else?

Mr. DANCKWERTS: Yes, one of our directors is over here, and could be appointed. We contend that plaintiffs carry on business in England as the International Electric Co.

Mr. Justice EVE: What position are the German proceedings in now?

Mr. DANCKWERTS: The action is proceeding on the point as to whether or no Mr. Oppenheimer is the owner of the goodwill.

Mr. LAWRENCE, K.C. (for Mr. Oppenheimer), pointed out that up to the present the proceedings in Germany were merely interlocutory, and that there were no pleadings, and also that the appointment of a receiver was left to the Master in chambers, and he appointed Mr. Pixley.

Mr. Justice EVE: What has happened to show that I ought to make a change? The only thing that weighs with me is that Mr. Danckwerts asks for a receiver who will act without salary.

Mr. LAWRENCE submitted that no ground had been shown for going behind the appointment of Mr. Pixley. He did not admit that the

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capital of the International Electric Co. belonged to plaintiffs, as his client had a substantial interest in it.

In giving judgment Mr. Justice Eve said that the only thing that made him hesitate was his desire to pay proper respect to the Court of a friendly nation, and if he saw his way to make any order which would secure defendant as well as plaintiffs, adopting the decision of the German Court, he would have been relieved. But he must treat the matter strictly. Defendant had asserted his right to go to Berlin for the ascertainment of some position between him and the company, and in the course of the proceedings the German Court thought that plaintiffs should be put in possession of the assets of the London business subject to Mr. Oppenheimer's right to have security amounting to 150,000 marks deposited by plaintiffs to answer any possible damage that Mr. Oppenheimer might suffer. Plaintiffs were willing to do that, and also to treat themselves as managers of the business for whoever it might ultimately turn out to belong. He was impressed with the fact that the continuance of Mr. Pixley's receivership would involve a claim for remuneration, but on the whole he did not think the circumstances warranted him in acceding to the application which would, therefore, be dismissed, with costs.

Leave to appeal was granted.

Electricity Supply Works Assessment.

At the County of London Sessions last week the Westminster Electric Supply Corpn. appealed against the assessment of their undertaking by the Assessment Committee of the St. George's, Hanover-square, Strand and Westminster Unions, in the parishes of St. Margaret and St. John the Evangelist.

Mr. Clavell Salter, K.C., M.P., and Mr. A. B. Shaw appeared for appellants, and Mr. W. Ryde, K.C., and Mr. Konstam for respondents.

Appellants were assessed for their undertaking in the parishes of St. Margaret and St. John the Evangelist at £34,900 gross and £17,449 ratable. The Assessment Committee reduced the figures to £33,650 gross and £16,825 rateable, but the company appealed from the latter amount. Before the Assessment Committee the principal point at issue was whether the calculation of the annual value should be based upon the actual receipts and expenditure for 1909, or whether the hypothetical tenant would base his calculation on the probable receipts and expenditure for the ensuing five years. In 1905 appellants decided to make a large reduction in the price for electric current, and they prepared an estimate of the balances that would probably be shown by the revenue account during each of the ensuing five years. Owing to the effect of metal filament lamps on the consumption of electric current the expected increase did not take place. The estimated balance in Dec. 1905, was £75,000, actual balance £74,409; 1906, £80,000, actual £72,267; 1907, £85,000, actual £66,429; 1908, £90,000, actual £76,507; 1909, £95,000, actual £76,676. Following this experience appellants estimated that in the five years from 1910 to 1914 the balance on revenue account would be respectively £65,000, £56,000, £52,000, £54,000 and £57,000. As a matter of fact the balance in 1910 was only £60,330. Under these circumstances they estimated that there would be a diminution of their balances during the next five years, as the enormous increase in the use of metal filament lamps had made a serious difference in the sale of the units for lighting. The effects of the increased competition of the gas companies would compel them to further reduce prices, and the number of empty houses in the area of supply was still large and increasing: the chief houses were now supplied, and, therefore, the ratio of increase could not be the same as that before 1905. The receipts for 1909 were £4,400 below the estimate, and 1910 had shown the decrease was continuing. Appellants therefore asked that the amount in the parish of St. Margaret and St. John should be reduced from £33,650 gross and £16,825 ratable to £27,450 gross and £10,625 ratable. In regard to St. George's, Hanover-square, the grounds of objection were the same. The assessment in that case was first made at £65,150 gross and £32,574 ratable. On objection before the Assessment Committee the amount was reduced to £61,350 and £30,675 respectively. The company now asked that the amounts should be further reduced to £50,050 gross and £19,375 ratable.

Evidence was given by Mr. Humphrey Davies and Mr. H. H. Fuller.

For respondents it was stated that in 1905 the rating in the Hanover-square district was £73,980 gross and £36,990 ratable. Since then a new transformer house had been built, despite which the assessment had been reduced to £61,350 gross and £30,675 ratable, and they contended that in so reducing the assessment they had allowed sufficiently for any change that might have taken place in the value of the property and that the circumstances did not warrant such an estimate of decrease in profits as that anticipated by appellants.

After hearing evidence for respondents the appeals were dismissed, with costs.

Bartlett v. Boot.

At the Westminster County Court on Monday, before Judge Woodfall, Mr. Geo. Bartlett, solicitor, sued Mr. Horace Boot, consulting engineer, for £21 as a fee which he claimed was due to him for introducing defendant to members of the Chichester Council in connection with an electric lighting scheme.

Counsel for plaintiff said his client was a member of Chichester Council for some years. Early in 1900 the Council was contemplating an electricity scheme. Ultimately the Council became anxious to transfer their provisional order to a company, and plaintiff and defendant, who had known each other for some years, meeting at Tunbridge Wells, the latter suggested that plaintiff should introduce him to the chairman of the Electric Lighting Committee of the Council. Plaintiff accordingly introduced defendant to Councillor Aylmore, and negotiations led to the provisional order being transferred to a company. Much correspondence passed between plaintiff and defendant, and in one of his letters plaintiff wrote: "I shall be pleased to do all I can for you in the matter of introducing your company on the understanding of the usual *quid pro quo*." In a letter from defendant to plaintiff at a later date, the former said: "I need scarcely inform you that if you obtain the provisional order your position will be well looked after." When, however, plaintiff sent in a claim for 20 guineas for obtaining the introduction defendant denied that there had been any promise of a fee, but offered to transfer 20 £1 shares of the company to plaintiff. This offer was declined, and the present action brought.

Plaintiff gave evidence, and said he thought 20 guineas a moderate fee for obtaining the introduction. He had been told that 100 guineas was not an unusual fee to be paid under such circumstances.

For the defence Mr. Boot said there was never in his mind any question of a fee being paid to plaintiff when the early negotiations were entered into. Plaintiff told him that the transfer of the provisional order to a company would be of great benefit to the ratepayers, and would also benefit himself, and witness understood that he was anxious for the transfer to take place because he was one of the Council who had recommended the obtaining of the order. Witness also understood that plaintiff would be able to find money for the company and would have a seat on the board, which would have constituted a *quid pro quo*. He did not arrange to pay him a commission. He offered to give him shares because at the time he was worrying him, and being an old personal friend and related to a mutual friend, he thought it would be better to give him 20 shares and have done with it.

His Honour, in giving judgment, said the expression "the usual *quid pro quo*" might have meant money or it might have meant plaintiff being made a director or being appointed solicitor to the company, and the words in defendant's letter "if you obtain the provisional order your position will be well looked after" were equally ambiguous. There was no evidence to prove that there was an agreement to pay money, and under those circumstances there must be judgment for defendant, with costs.

Light Railways.—An inquiry was held at Birmingham on Friday into the application of the Corporation for a light railway order.

Mr. Hutchinson, K.C., said the matter arose out of an application of the Hales Owen Light Railway Co. for power to construct a railway under the Hales Owen Order of 1902. Birmingham Corporation opposed as half the proposed railway was within the city. Smethwick and Oldbury also opposed, and desired that the application of the Corporation should be acceded to. The Commissioners granted the application partially and the inquiry was adjourned. In May, 1910, there was a further hearing in London, and the result was that the Commissioners—on the undertaking of the Corporation to construct the railway and introduce certain provisions—came to the conclusion that the Corporation should make the railway. Certain technical difficulties arose, and in February last another application was made by the Hales Owen Co., and in the result the Commissioners acceded to the application of the Corporation on condition that they should submit to the Commissioners and the company, a clear statement of the nature of the undertaking they gave. Therefore, he presented to the Commissioners the order for the construction of a double line of railway upon a road intended, in the main, to be 80 ft. wide, between Balden-road and the termination of the authorised Hales Owen railway, and the termination of the tramway which belonged to the Birmingham & Midland Tramway Co.

After hearing evidence, the chairman (Col. G. F. O. Boughey) said the Commissioners were prepared to grant the order irrespective of any schemes which might be in the background, and with which they were not concerned.

Olympia Electrical Exhibition.—The management of this exhibition have made arrangements for an elaborate display of cooking demonstrations in the galleries at Olympia from Sept. 23 to Oct. 21, and manufacturers who are exhibiting have had space granted to them without rental charge, and a free supply of current provided they supply the demonstrations in question during the exhibition. It is considered that this arrangement will be of great public interest. We are informed that one of the large firms of house furnishers and electrical contractors have secured a large block of space in the galleries where they are erecting a model electrical home of elaborate description and worthy of a great international exhibition. There is also to be a garage, an electric laundry, electric kitchens, country house lighting and a series of living rooms equipped to show the advantages of electricity in the home.

Our Canadian Visitors.—England, and London especially, has been the rendezvous for many hundreds of Canadian visitors during the past two or three months, and surprise has been expressed by our visitors at the absence in our streets of electric telegraph poles and wires. It is notorious that in some parts of Canada and the United States it is difficult to "see the forest for the trees"—that is, it is difficult to see the houses on the footpaths for the numerous wires, posts, poles, &c., which disfigure the streets. The "Canadian News" of Toronto advises the local authorities of Canada to follow the example of the old country.

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COMMERCIAL AND INDUSTRIAL SECTION.

MUNICIPAL, FOREIGN & GENERAL NOTES

BRITISH NOTES.

Acton.—The Metropolitan Electric Supply Co. (Acton District) Act, by which the Metropolitan Electric Supply Co. take over the municipal electricity undertaking at Acton, contains two interesting clauses to the effect that if the local authority wishes to purchase at the end of the term of 42 years, for which the company have obtained powers, they must give three years' notice of purchase instead of the usual six months. If such notice is not given the local authority cannot return to the subject. Moreover, during this period of three years, any capital required for the extension of the undertaking is to be supplied by the local authority.

Baildon.—The Council will oppose a proposed application of the Wharfedale Electric Light & Power Synd. for a provisional electric lighting order.

Birmingham.—The Corporation will consider on Tuesday next an important report of the Tramways Committee, recommending the purchase of the outstanding interests of the City of Birmingham Tramways Co. and the British Electric Traction Co., and also various extensions and improvements of the local tramway system.

In their report the Committee state that it is so obviously desirable that the whole of the tramways within the existing city, and the areas to be included within the city on Nov. 9 next, should be under the control and jurisdiction of the Council that they had been in negotiation with the City of Birmingham Tramways Co. with a view to the purchase of their interests and the interests of the British Electric Traction Co. As a result of these negotiations the committee are now in a position to state that the City of Birmingham Co. are willing to sell after Nov. 9 next, subject to confirmation by the Council of the enlarged city, the whole of their interests and those of the British Electric Traction Co., including the rolling stock (except 21 cars), lands, buildings, generating stations, appliances and apparatus, for £151,500. This amount includes payment due from the Corporation in respect of rolling stock, &c., in connection with the Bristol-road route, and payment from King's Norton Council in respect of the rolling stock, &c., in connection with the Pershore-road route. It is part of the arrangement that the stores at Yardley and Bournbrook depôts shall be taken over by the Corporation from the City of Birmingham Co. at a valuation. Provisional arrangements have also been made for working by the City of Birmingham Co. on behalf of the Corporation, as from June 30 last, of the tramways proposed to be acquired.

The Committee also recommend that powers be obtained for constructing 16 new tramway lines and for carrying out various improvements of the system.

Conway.—The Rural Council have consented to the supply of electricity by Colwyn Bay and Colwyn Council in a portion of the parish of Lydiate.

Customs Duties.—A special customs agreement between Germany and Japan came into force on Monday (July 17), and so far as the rates fixed by the Agreement represent reductions of the rates of the new Japanese General Tariff, and the existing German Tariff, such reduced duties will be applicable to British goods sent to Germany or Japan.

The following are some of the duties specified in the agreement for imports to Japan, the duties fixed by the new Japanese Tariff, and hitherto in force, being shown in parentheses :—

Gas, petroleum and hot air engines, between 5,000 and 50,000 kilogs, 4·50 yen per 100 kin = 7s. 9d. per cwt. (5 yen); between 50,000 and 100,000 kilogs 4 yen = 6s. 11d. per cwt. (5 yen); over 100,000 kilogs 3·50 yen = 6s. per cwt. (5 yen); dynamos with gas, petroleum or hot air engines between 10,000 and 50,000 kilogs 5·50 yen per 100 kin = 9s. 6d. per cwt. (5·80 yen), between 50,000 kilogs and 100,000 kilogs 5·20 yen = 9s. per cwt. (5·80 yen); over 100,000 kilogs 4·90 yen = 8s. 6d. per cwt. (5·80 yen).

Ealing.—The charge for electricity for power, heating and cooking has been reduced to 1d. per unit.

G.P.O. Flower Show.—The Central Telegraph Office Amateur Gardening Association, which now numbers nearly 400 members, held its annual flower show on the 18th inst. in one of the rooms of the old G.P.O.

There were 193 entries, divided into 29 classes, and all the competitors were members of the Association. The exhibits are declared to have reached in many cases a high standard of amateur gardening.

Hastings.—The Clive Vale and Tower Schools are to be wired by the Education Committee.

Ilford.—The Council have received sanction to a loan of £8,070 for mains, meters, switchboards, &c.

Inquests.—On Monday an inquest was held at Penge (London) on Richard Archer, a telegraph linesman, who was killed at the Crystal Palace low-level station on the 13th inst.

Evidence was given that deceased was engaged with another linesman named Stephenson in making an estimate for electric signalling. Deceased mounted an iron ladder of a signal with a steel measuring tape in his hand, witness holding the other end. Deceased had reached the platform of the signal when he received a severe shock from an overhead wire, which was conveying current at 6,000 volts, and he was thrown to the ground.

Dr. SCOTT TURNER said that death was due to a fracture of the base of the skull. His left hand was burned as though he had received an electric shock on the hand, and the steel tape which was used showed plainly at one end that it had touched the electric wire.

A verdict of accidental death was returned.

An inquest was held at Jarrow last week into the death of Robert Anderson, jointer, who was killed at the Jarrow sub-station of the County of Durham Electrical Power Distribution Co.

The father of deceased said that he was assisting him to uncover an oil switch. They had completed the work and deceased stepped upwards and upon an angle bar. Witness suddenly saw a flash from above where they had been working. He ran to the other end of the chamber, and when he returned he saw his son lying on the floor. Deceased had been working at the sub-station about seven years.

Mr. H. A. MYLES, senior assistant engineer at the power station, said when the oil tank was removed he examined the switch and told deceased to file the contacts.

In answer to Mr. W. Lauder, factory inspector, witness said he did not put in the protecting tray to protect the terminals as he did not think it was necessary. If the tray guard had been in position deceased could have climbed on to the top of the oil switch and would have been protected from the live terminals. He also admitted the regulations in regard to making dead conductors in the cell when work was being carried out had not been complied with.

Mr. JOHN MCLAREN, district engineer of the company, admitted that when work was being done in a cell the tray when in position was a safeguard. He did not look into the cell to see if the tray was in position.

It was stated that deceased received a shock from current of about 12,500 volts.

The jury returned a verdict of accidental death, and expressed the opinion that the accident would not have occurred if the regulations had been complied with. Mr. Burton, on behalf of the company, expressed sympathy with the relatives.

London County Council.—On Tuesday the adjourned recommendation of the Highways Committee to expend £21,300 on the extension of the tramways in the East India Dock-road, and £18,150 on adapting a portion of the tramways in the Seven Sisters-road for electrical working, were agreed to.

Electricity Loan.—In May Stepney Council applied for a loan of £15,710 for laying feeder mains, and requested that the amount, which ordinarily would be subject to repayment over 30 years, might be granted with the proviso that no repayment should take place during the first three years. They further asked that all loans in respect of machinery and mains for electricity account should be subject to a three years' suspension of repayment. The County Council would not agree, and the loan was granted on the usual terms. The Borough Council were not satisfied, and after considering a memorandum by Mr. Gordon, the Finance Committee now reported that they considered a case had been made out for concession. The Committee, however, had dealt with the case solely on its merits, and desired it to be understood that their recommendation must not be held to have committed them to approving the principle of generally allowing a postponement of repayment of loans for electricity mains and machinery. The reasons given by the Committee for their decision are (i.) The work in respect of which the loan is required (laying a large feeder main) is part of a large scheme for the supply of electricity over the whole of the borough, the present requirements and anticipated demands for current having rendered it advisable for the Borough Council to undertake large extensions and to change the whole system of generation of current; (ii.) it is estimated by the Borough Council that the feeder main in question will not be fully productive of a revenue until 15 years have elapsed; (iii.) it is urged nevertheless that it is more economical to do the whole of the work at one time rather than to do it in stages as the demand grows. In order to meet the exceptional circumstances of the case the Finance Committee advised the Council to sanction the repayment of the loan by equal instalments of principal within the last 27 years of a period of 30 years from the date of the borrowing.

Luton.—An inquiry was held here last week into the Council's application for sanction to borrow £13,497 for extensions of the plant at the electricity works and for laying mains, &c.

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Margate.—The Council have entered into an arrangement with the Isle of Thanet Tramways & Lighting Co. for supplying and erecting 24 Osram lamps of 300 c.p. each on the Lower Foot Promenade and approaches at a cost of £101. 10s. per annum. Ten of the lamps are to be summer lamps only at £3. 3s. per lamp per annum.

Oldbury.—The Urban Council have instructed the Electricity and Tramways Committee to consider the possibility of arranging for a service of trackless trams or other suitable motor traction for passengers between Oldbury and Blackheath and Langley.

Public Library Lighting.—At the last meeting of Stoke Newington Council the Mayor (Coun. H. J. Beavis, J.P.) announced his intention to pay the whole cost of the electric light installation for the public library, and also the cost of lamps, estimated at £30, total £210.

Radcliffe.—The Council have consented to Bury Corporation supplying electrical energy to the Co-operative Wholesale Society's weaving shed in Dumer's-lane.

Torquay-Paignton Tramways.—Major Pringle made an official inspection of the Torquay-Paignton tramway on Monday and the line was opened for traffic.

Sales Managers' Association.—There was a meeting of this Association at the Holborn Restaurant last evening, when, after dinner, a number of speeches of interest to salesmen and sales' managers were dealt with. We are informed that Mr. F. R. Jones, Audrey House, Ely-place, London, E.C., will furnish particulars of the association.

Sheerness.—The Council have made an arrangement with the Sheerness & District Electric Power & Traction Co. for the electric lighting of five thoroughfares.

Smoke Abatement.—A meeting of the Advisory Committee of the Manchester and Salford Smoke Abatement Exhibition, which will be held on Nov. 10 to 25 next, was held at Manchester on 13th inst., and among those present were Councillor G. Howarth, chairman of Manchester Electricity Committee, and Mr. S. L. Pearce, electrical engineer to Manchester Corporation.

Councillor Kendall read a list of exhibitors who had booked space to date, and the following gentlemen were elected to the Advisory Committee: Councillors Wm. Kay and W. Dagnall, and Mr. E. D. Simon, secretary of the Smoke Abatement League of Great Britain. After the general business of the meeting, Councillor Howarth promised, on behalf of Manchester Electricity Committee, that domestic electrical appliances sold at the exhibition would be fixed and wired by the Corporation free of charge. It was proposed by Mr. Councillor Kay and seconded by Mr. S. L. Pearce that a letter should be sent to the National Electrical Manufacturers' Association with a view of obtaining their active support. Satisfaction was expressed at the success which is now assured to the exhibition, and also the prominent and influential part electrical appliances and electricity for power purposes will take in the exhibition and in smoke prevention.

Southport.—Application has been made for sanction to a loan of £1,500 for laying a duplicate electric cable to Crossens.

Wolverhampton.—On the recommendation of the borough electrical engineer (Mr. C. E. C. Shawfield) important extensions of the electricity undertaking are to be carried out at an estimated cost of £19,700 and the Council have applied to the L. G. Board for sanction to a loan of £11,000.

Mr. Shawfield, in a lengthy report, stated that the extension scheme was intended to deal with the present and future requirements of the generating station, with a view to providing that accommodation in the way of workshop and store-room facilities which were urgently necessary for the satisfactory and economical working of the station, and also to provide such additional means of meeting the present and future demands for current as was suggested by the experience of the largest and most successful generating stations. The estimated cost of buildings, &c., is £4,900, electrical machinery and switch gear, £3,000; overhead travelling crane and steel work for sub-station, £540, workshop equipment, £400, contingencies, £160—total £9,000. Various fittings and other items amoulting to £700 are charged to revenue, and £10,000 for supply, delivery and erection of a storage battery is charged to reserve. Mr. Shawfield urges the necessity of replacing the amount proposed to be taken out of reserve as quickly as possible, and he thinks that, if the profits of the undertaking allow, a sum of not less than £4,000 a year should be placed to reserve until it reaches the statutory amount of 10 per cent. of the capital.

Sports, &c.—At Bradford Hospital Fund sports on Saturday Hull Corporation tramwaymen's tug-of-war team won the Masham and the Herbert Gill Challenge Cups.

At the annual Hospital Carnival at Ilford on July 8 two cars equipped by the Council's electricity department, respectively demonstrating the advantages of electricity in the cottage and in the mansion, took part in a procession. An occupant of the latter car was a leisurely "slavey" (doubtless on the lines of the "That's done it" poster) and six attendant sprites represented different makes of lamps. These two cars, which were arranged by Mr. A. H. Shaw (electrical engineer to the Council) and some of his staff, took two out of four certificates.

Wedding.—On Tuesday the marriage took place at the Friends' Meeting House, Westminster, of Mr. Thomas E. Harvey, M.P., to Alice Irene, youngest daughter of Prof. Silvanus P. Thompson.

COLONIAL AND FOREIGN NOTES.

Australasia.—The "Australian Mining Standard;" says a meeting of telephone subscribers was held at Sydney recently, the Postmaster-General (Mr. J. Thomas) being present.

Several speakers complained that the service was defective, and Mr. Watt suggested that an automatic system might be useful.

Mr. Thomas said the present plant was admittedly not all up to date. When the Federation took control there was not a single metallic circuit in use, but 64 per cent. of the subscribers' lines were now metallic circuits. Only 24 out of 346 junction lines remained on single wire, and the work of changing them would not be stopped until the whole of the service was metallic. There were 30,000 subscribers, compared with 10,000 in pre-Federation days. In 1906-7 the expenditure on the system was £84,064, and this year it was estimated at £229,000. The staff in the city and central exchanges had increased from 247 in 1910 to 336 in 1911, and in the metropolitan area the staff increased from 503 in 1910 to 766 in 1911.

Mr. John Hesketh (chief electrical engineer to the Commonwealth Government) said he found from analysis of all the complaints received that the department was only responsible for 2½ per cent. of them.

The Official Year-Book of the Commonwealth of Australia contains statistics regarding the electricity supply works in the Commonwealth States in 1909. The heads of the particulars are: (A) number of stations, (B) number of employés, (C) horse-power of engines employed, (D) value of land and buildings occupied, (E) value of plant and machinery (F) wages paid during year, and (G) value of out-put. The figures are as follow:—

—	A	B	C	D	E	F	G
N.S.W.	103	769	40,479	£349,663	£1,047,680	£100,906	£620,478
Victoria	13	442	13,293	161,911	577,403	54,621	207,95
Queensland	6	90	4,517	15,429	74,797	9,865	44,149
S. Australia	1	149	5,068	28,030	262,710	17,175	...
W. Australia	18	218	84,632	64,586	452,230	42,198	265,215
Tasmania .	7	159	8,564	7,825	106,984	17,180	65,400
Total ...	148	1,827	86,583	627,414	2,521,804	241,945	1,143,201

The value of output in South Australia was not disclosed.

British North Borneo.—At the meeting last week the chairman (Sir West Ridgeway) said that there were in the State 625 miles of telegraph and 313 miles of telephone line. They had also sanctioned a scheme of telephone communication between the different estates and district headquarters on the West Coast, the cost of which will be practically defrayed by the contributions of the companies interested.

France.—A great extension of the outer part at Nice harbour is being pushed forward and expected to be completed in 1912. The quays are lighted electrically, and four new electric cranes have been ordered.

Germany.—A report states that new issues of stock and shares (municipal and companies') in Germany amounted to £120,000,000 in 1910, and £27,000,000 worth of foreign scrip was also floated on the market. Electricity and gas companies raised their share capital by nearly £4,000,000, compared with £1,000,000 in 1909.

Imports of iron, iron goods and machines in 1910 were valued at £7,735,000 and exports of the same classes of goods were £65,700,000.

All electrical works have made rapid progress and have developed phenomenally, though the returns and dividends do not show corresponding rise, owing mainly to severe competition. One of the largest electrical firms increased the number of its hands from 33,056 in 1909 to 41,663 in 1910, and turned out 72,460 electrical machines compared with 47,351 in 1909; it also turned out 174 steam turbines of 363,188 H.P. in 1910 against 152 engines of 226,507 H.P. in 1909; its insulating material turnover increased by 60 per cent.; the sale of metal filament lamps increased 100 per cent.; it turned out motors of 350,000 H.P., but the company only increased its dividend from 13 to 14 per cent.

A report from the Grand Duchy of Baden says trade in machinery and tools for factories was satisfactory, the exports especially increasing. However, electric power being substituted for steam is influencing the trade to some extent. An increased import duty on machinery is suggested. British competition, especially in the north, where freight cost is lower, is said to be detrimental to German industry. Mannheim firms, for example, are said to have greater freight expenses to the north of Germany than British firms.

Madeira.—A consular report states that the Madeira Electric Light Co. during 1910 extended its mains in many directions.

The company is substituting Diesel oil engines for steam plant, and the distribution system will be gradually changed to the three-wire system.

The project for the installation of a telephone service appears to have been abandoned. It is considered that a telephone service would be a great boon if the charges were not too high.

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Russia.—Ekaterinoslav Municipality have been authorised to borrow about £274,000 for tramway and other works.

Spain.—An electric tramway is being constructed from the northern end of Barcelona across the mountain of Tibidabo (at an elevation of 1,500 ft.) to the manufacturing town of Rubi. The work is proceeding slowly as the authorities have insisted on the company increasing the width of the road by 2 metres.

The large works, known as La Industria Electrica, have passed into the hands of Siemens-Schuckert Co., who have built an up-to-date factory in Cornella, a suburb of Barcelona, and it may now be considered that nearly the entire electrical manufacturing business there is in the hands of German makers.

Imports into Barcelona in 1910 included electrical material 260 tons (compared with 1,434 tons and 444 tons in 1909 and 1908) of which total the United Kingdom supplied 7 tons (against 26 tons in 1909). Machinery imported from the United Kingdom was 3,985 tons (against 3,218 in 1909), from Germany 1,437 tons (against 1,250 tons) and from the United States 525 tons (380 tons).

A telephone exchange having been installed at Mercadel, all the towns in the island of Minorca can now communicate with each other either by telegraph or telephone. Electricity supply in Cindadela and Villa Carlos (Minorca) was inaugurated in 1910.

United States.—The British Consul at St. Louis states that of 110 makes of passenger motor cars made in the district 10 are driven electrically. The electric cars are generally used and driven by ladies.

The wages of workmen in the electrical industry are said to be 65c. per hour in St. Louis, 50c. in Kansas City, 34⅜c. in St. Joseph and 28c. to 45c. in other towns. The charges for electrical energy for lighting in St. Louis are 12c. per unit up to 100 units and 5c. per unit for all over 100 units. 4s. 2d. is the minimum charge per month. Large consumers for power, are, it is said, given a rate as low as 2c. In some large office buildings the electric company holds contracts for lighting the building, and to obtain this have included the heating. This has been done to induce the owners not to put in a plant of their own.

A large dam is being built across the Missippi at Keokuk, Iowa, and current will be brought thence in a year or two, when the present plants will be shut down, or kept as a stand-by.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Bradford.—The income of the tramways department for the year ended March 31 was £270,965, including £256,063 traffic revenue, and £8,257 from parcels department.

The working expenses (£176,002) included £63,822 for traffic and £22,965 for general expenses, £32,287 for general repairs and maintenance and £47,717 for power. The gross profit was £94,964, and after paying £21,200 for interest, £2,530 income tax and £4,137 rent of leased lines and £30,695 for repayment of loans and sinking fund, £20,000 was voted to relief of rates and £19,374 placed to reserve. The total capital expended is £944,928, an increase of £14,814. The car-miles run amounted to 5,461,562, and 52,919,559 passengers were carried.

In the report of the general manager (Mr. C. J. Spencer) it is stated that there was an increase in traffic revenue of £10,380 over 1910, and in expenses of £5,302, and in gross profit of £5,966. The total nett profit was £39,374, against £32,365. The revenue of the department has been steadily increasing for years and the expenditure has not increased in the same ratio. The advent of the rail-less trolley system will, it is anticipated, open up a new field for extension purposes.

At present investigation is being made as to the possibility of adopting a new form of truck so as to minimise oscillation.

During the year Mr. Spencer gave evidence as to their practice in painting cars before the Home Office Committee which is investigating the question of lead substitutes in the painting of tramcars, &c., in lieu of white lead.

The through service of cars between Leeds and Bradford has proved very popular, and 256,407 through passengers were carried during the year. A dispute between Leeds and Bradford Corporations as to the allocation of fares has been referred to arbitration.

Norwich.—On Tuesday the chairman of the Electricity Committee (Mr. E. Wild) presented to the Council the annual report on the working of the electricity undertaking.

The report stated that there was an increase of 704,215 units in the output, or 17 per cent. increase over the 1910 figures. For private lighting 2,179,767 units were sold (against 2,008,167), public lighting 61,473 units (against 42,598) and power 2,576,172 (against 2,062,432). The income was £41,729, an increase of £4,097, and the expenses were £18,326, an increase of £4,340, but some special items were included. The gross profit was £20,866, a decrease of £243. Interest and sinking fund absorbed £15,122, compared with £15,146, leaving a nett balance of £5,744, compared with £5,963, a decrease of £218. With £3,728 brought forward the total available was £9,472. 17s. 10d., off which had been deducted £1,032, or amount expended to March 31 on public lighting. The balance (£8,441) was carried forward to be available for further expenditure on public lighting, and, among other things, a new battery of accumulators, which, with additions to the building and special machinery, would cost £5,100. The cost of new meters during the year was £198, and the cost of special renewals of mains amounted to £2,338. The increase in the cost per unit of coal was accounted for by an advance in price. It was anticipated that there would be a reduction in cost, but owing to the non-delivery of the new Willans-Siemens turbine set that was not obtainable. However, the total cost per unit showed a reduction from 0·943d. to 0·913d. The total length of distributing mains was 49 miles, an increase of 3½ miles. Some of the trunk mains in certain streets were relaid at a cost of £2,338. Those mains had been in use 17 to 18 years and were not sufficiently reliable or adequate for present requirements. They consisted of bare copper strip laid in culverts, and had now been replaced by cables drawn into conduits, provision having also been made for further cables as required. It will be necessary from time to time to relay other mains, and the committee anticipate having to spend further considerable amounts for the purpose. Work on the large new storage battery at Duke's Palace Wharf was proceeding, but it was not expedient to go to the L.G. Board for a loan, as the Board would only sanction seven years for repayment of loans for accumulators, and the Committee decided that it would be better to pay the cost out of revenue. A considerable number of the gas lamps have now been converted to electric lighting and the remainder of the first section will be completed by Sept. 30 next. The total cost of altering the lamps in the section will be about £5,000, and the Committee propose to pay this out of revenue.

Poplar (London).—The accounts of the electricity supply department for the year ended March 31 have been issued and show a net profit of £3,877, against £4,426 in 1910.

The net income from the sale of current was £45,953, an increase of £3,702. The working expenses were £25,248, an increase of £3,412, leaving a gross profit of £20,705, an increase of £289. After providing for interest on loans (£8,989) and repayment of loans (£8,595) the balance was £3,122. After making provision for small charges (£89) and adding income from property, sale of lamps, &c. (£844), the net balance was £3,877 (decrease £549), making with £5,337 from previous year's accounts a total surplus of £9,213. The engineer and manager (Mr. J. Horace Bowden) recommends that £2,386 be applied in paying for services and meters during the year and other work, leaving £6,828 to be carried forward. The new loans raised during the year amounted to £8,910, but £8,595 was paid off, leaving a balance of £250,269. During the past three years the output has increased 73·6 per cent. and the capital only 5·45 per cent.; the net profits have increased by 45·5 per cent. but the charges for supply have been reduced 25 per cent. Extensions of buildings and plant are proposed which will increase the capital to £320,000 and the generating plant by 6,000 kw. The cost of coal per unit sold rose from 0·291d. to 0·31d., but the total cost of production was reduced from 0·665d. to 0·659d. and the total charges from 1·156d. to 1·098d. There was an increase in the output for power of 25¾ per cent. and in private lighting of 2 per cent., but in public lighting a drop of ½ per cent.

West Ham.—The accounts of the electricity undertaking for the year ended March 31 show total capital expenditure of £503,357, an increase of £46,495.

The total income was £93,497 (against £79,454), and included £26,581 from sale of current for private lighting (against £22,928), £37,823 from power supply (£29,179), £21,593 from traction (£20,165), £6,619 from public lighting (£6,589) and £252 from heating (£163). The expenses were £55,858 (against £48,814), and included £32,662 for generation, £4,649 distribution, £1,889 public lamps, £6,620 rents, rates and taxes, £5,307 establishment charges, £4,170 special charges and £514 net deficit on sales department. The gross profit was £37,639 (against £30,640), and after providing for contribution to sinking fund (£23,626) and interest on and repayment of mortgage loans (£7,404), making for provision of stores (£2,100) and special works (£3,070), including £1,413 for meters and £754 for depreciation of motors, a sum of £1,758 was applied for paying the capital debt on accumulators and arc-lamp rectifiers, and £2,229 the outstanding debt on transformers, &c. 22,690,266 units were sold (against 19,156,399), including 2,253,904 for private lighting (increase 15·6 per cent.), 14,518,555 for power and heating (increase 24·2 per cent.), 5,182,257 for traction (increase 7·6 per cent.) and 735,550 for public lighting (increase 5·4 per cent.). The average price obtained per unit was the same as in 1910; there was a record increase in the sale of current for private lighting, due to metal filament lamps. The percentage of capital repaid to capital expended is 27. There was a slight increase in cost of coal, due to increased price, decreased load factor and other causes, and the total cost per unit decreased from 0·93d. to 0·888d. The results of the sales department show an improvement, but owing to the heavy capital charges (the period of the loan being only three years) the department is somewhat handicapped. The schemes for the hire of arc lamps and motors also show improvement.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

HAMMERSMITH (London) Council invite tenders for supply of h. and l.t. feeder cables and stoneware ducts. Specifications and forms of tender from the borough electrical engineer (Mr. G. G. Bell), 85, Fulham Palace-road, W. Tenders to town clerk (Mr. H. Thompson), Town Hall, Hammersmith, W., by 4 p.m. July 26. See also an advertisement.

Tenders are invited for supplying plant and materials and the erection of electric supply station buildings for lighting the DUNDALK Urban District area, under its Electric Lighting Order, 1897.

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The plant includes generating station buildings, gas producing and generating plant, balancer and booster, switchboard, storage battery, mains (overhead and underground) electricity meters and travelling cranes. Copies of specifications, general conditions, &c., may be seen at the offices of the clerk, Mr. Mathew Comerford, Town Hall, Dundalk, or at the offices of the consulting engineers, Messrs. T. L. Miller, Wilson & Pegg, Donegall-square, Belfast, 709, Tower-buildings, Liverpool, or 19, Brazenose-street, Manchester. Tenders to the town clerk, Dundalk, by 10 a.m. July 24. See also an advertisement.

Tenders are invited by the FARNHAM GAS & ELECTRICITY Co. for the supply and erection of two high-speed Diesel oil engines coupled to two 90 kw. alternators with direct-coupled exciters, piping, tanks, overhead traveller and accessories, and main high-tension switchboard. Specifications, drawings and forms of tender may be seen at, but not obtained from, the offices of the consulting engineers (Messrs. Handcock & Dykes), 11, Victoria-street, Westminster, S.W., and copies of the specifications, drawings and form of tender may be obtained from the Secretary of the company, Mr. Arthur E. Saville, to whom tenders are to be sent by noon of Aug. 16. See also an advertisement.

Tenders are invited for the supply of 530 a.c. meters, 495 d.c. meters and 133 maximum demand indicators to the City of MELBOURNE, Australia. Copies of specification, conditions of contract and form of tender from the agents for the City Council (Messrs. McIlwraith, McEacharn & Co. Propy. Ltd.), Billiter-square Buildings, London, E.C., to whom tenders are to be sent by noon Wednesday, Aug. 9. See also an advertisement.

Tenders are invited up to Aug. 23 for the supply of telegraph and telephone material to the Postmaster-General's Department in SOUTH AUSTRALIA. Specifications, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W. See also an advertisement.

LONDON County Council require tenders by 11 a.m. Aug. 1 for installing about 250 lamps at Great College-street elementary school, Rochester-place, N.W. Specifications, &c., from the Chief Engineer, Spring Gardens, S.W.

LONDON County Council also require tenders by 11 a.m. July 25 for roadwork and platelaying of conduit system tramways in Green-lanes, Mildmay Park and Southgate-road and Seven Sister's-road, and for the construction of a tramway from Brixton to Herne Hill on the overhead system and for paving works and street widenings. Specifications from the Chief Engineer.

BRADFORD Corporation invite tenders for the supply and erection of two water-tube boilers, stokers and superheaters, and one 12-ton electrically-operated overhead travelling crane. Tenders to the Town Clerk, Mr. Frederick Stevens, by 10 a.m. Tuesday, July 25.

WOLVERHAMPTON Electricity Committee invite tenders for the supply, delivery and erection of a 264-cell, 6,000 ampere-hour storage battery together with a motor-driven regulating switch; two motor-driven boosters (approximately 150 kw. output each) and switchgear and instruments. Specifications from the borough electrical and tramways engineer, Mr. C. E. C. Shawfield, M.I.E.E. Tenders, addressed to the Chairman of the Electricity Committee, Town Hall, Wolverhampton, must be in by 10 a.m. July 31.

ANNFIELD PLAIN Industrial Co-operative Society (Ltd.) require tenders by noon July 24 for electric lighting of branch stores, Chopwell. Specifications, &c., may be seen at the architect's office, 22, Durham-road, Blackhill.

The Knowles Oxygen Co. (Ltd.), WOLVERHAMPTON, want tenders for the erection of a complete station with plant to generate 440-volt d.c., with an output of 1,000 kw.

PEMBROKE (Ireland) Council require tenders by July 31 for installation of electric light in new artisans' dwellings and new streets. Specifications, &c., the Clerk.

Tenders are invited (up to Aug. 15) for the supply of (*a*) 80,000 insulators and (*b*) indiarubber covered wire to the Postmaster-General's Department in VICTORIA,; up to Aug. 16 for cable, conduits, c.i. pipes, iron poles, insulators, wires, &c., and up to Aug. 23 for the supply of letter box fronts to the Postmaster-General's Department in QUEENSLAND.

Tenders are also invited up to Aug. 8 for measuring instruments, telephone instruments and parts, trembling bells and gong to the Postmaster-General's Department in VICTORIA; and up to Aug. 23 for telegraph, telephone and electric lighting material to the Deputy Postmaster-General in NEW SOUTH WALES. Specifications, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W.

Tenders are invited up to Aug. 30 for the supply of porcelain insulators, copper wire, sleeves, &c., to the Postmaster-General's department in SOUTH AUSTRALIA. Specifications, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W.

The Metropolitan Water and Sewerage Board, Albert-street, BRISBANE, Queensland, want tenders by noon Jan. 30 next for supply and erection, of one, two or three complete units, each consisting of power generating plant and pump or pumps to lift not less than 6,000,000 gallons per day. Particulars from the Secretary.

MORTLAKE (Victoria) Butter & Cheese Factory Co. require tenders by noon Aug. 14 for supply of dynamo and booster, storage batteries and accessories, switchboard, cables, &c. Specifications from Messrs. F. A. McCarty & Co., 31, Queen-street, Melbourne.

WELLINGTON (N.Z.) Corporation require tenders by 4 p.m. Aug. 24 for supply of a motor power waggon and accessories for the electric tramways department. Gonville and Castlecliff Tramway Board, Ridgway-street, WANGANUI (N.Z.) require tenders by 4 p.m. Aug. 14 for supply of overhead tramway material, feeders, &c. Conditions, &c., can be seen at 73, Basinghall-street, London, E.C. Representation in New Zealand is necessary.

STAVROPAL (Caucasus) Municipal Council invite tenders until Aug. 14 (O.S. Aug. 1) for the construction and working of an electric tramway.

Tenders will be received at the Town Hall, SYZRAN, Russia, on Oct. 14, for the construction of an electric tramway and the supply of electrical energy for lighting.

PHILIPPOLIS (Bulgaria) Municipality require tenders by Aug. 4 for a 50 years' concession for electric or gas lighting and for the provision of electric tramways. A deposit of £6,800 is required.

Tenders will be received at the State Railway Offices, STANISLAUS, Austria, on Aug. 1 for supply of five electric motors.

The Ministry of Marine, Rio de Janeiro, will receive tenders until Aug. 21 for supply and fixing of an electric lift and an electric crane at the Naval Depot on the Island of COBRAS. Local representation is necessary.

Tenders will be received at the Ministry of Public Works, Rio de Janeiro, until Sept. 25 for supply of electric light fittings, fans, lamps, conductors, &c., for the new Postal Telegraph building, PORTO ALEGRE. Upset price £3,100. Local representation is necessary.

TENDERS RECEIVED AND ACCEPTED.

Bolton Tramways Committee have accepted the following tenders: Foster Engineering Co. and W. E. Burnand & Co., single-phase transformers; Ferranti Ltd. and British Westinghouse Co., three-phase transformers; British Insulated & Helsby Cables, surface and cable boxes, &c.; British Thomson-Houston Co., incandescent lamps; British Insulated & Helsby cables, insulated cables; British Westinghouse Co., Bat Meter Co., Chamberlain & Hookham and Electrical Co., meters; Ferranti Ltd., motor starters; British Westinghouse Co., continuous-current motors.

London County Council have accepted the tender of Dick, Kerr & Co. (at £2,180. 11s. 10d.) for laying stoneware ducts on Brixton to Herne Hill tramways, and that of Le Carbone (Ltd.) (at £49. 5s.) for motor and generator brushes.

Islington (London) Council have accepted the tender of Allen & Simmonds (at £124. 8s. 6d.) for supplying new pistons to an engine at the generating station.

At the last meeting of Stoke Newington (London) Borough Council the tender of Messrs. W. J. Fryer & Co. was accepted for the installation of electric lighting, wires and fittings at the Public Library, Church-street, N., for £180. 5s.

Buckingham Council have accepted the tender of the local electric light company for street lighting for five years at £140. 7s. 6d. per annum.

Swinton and Pendlebury Council have placed an order with Callender's Co. for overhead cables to the Moorside works.

Heston and Isleworth Education Committee have accepted the tender of G. N. Virgo for wiring three schools at £92. 18s.

The D.P. Battery Co. have secured the contract from Aberdeen Corporation for the renewal of the Cults sub-station battery.

Dover Council have placed orders with the Brush Co. for three car bodies, at £303 each, and with the British Thomson-Houston Co. for electrical equipments at £272 per car.

Dewsbury Council have accepted the tender of Cowans Limited for a feeder switchboard, and that of Callender's Co. for a feeder cable.

Foot's Cray (Victoria) Council have accepted the tender of the Union Electric Co. for 30 Excello arc lamps and patent swinging centre-pole carriers and high and low-tension switchboards.

Eaglehawk (Victoria) Council have accepted the tenders of W. McLean & Co. for supply of cables, wires and insulators for their electric lighting scheme at £1,293, and that of R. Hornsby & Sons, for 81 M.B.H.P. engine and suction gas plant, at £943. 5s.

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BUSINESS NOTICES.

The Armorduct Mfg. Co. have opened a depot at 137A, Suffolk-street, Birmingham, where stocks of the company's specialities will be kept. The company's representative is Mr. H. B. Done.

The partnership between Ebenezer Ryan and Geo. Bristow (trading as W. M. Ryan & Son), electrical engineers, 2, Church-lane, Leytonstone, and 16 and 17, Devonshire-square, London, E.C., has been dissolved. Debts by Mr. Ryan, who continues the business.

Patents Development.—The proprietors of British patents No. 14,304/1899 and No. 16,489/1902, relating to "Improvements in and the application of electric motors for automobile vehicles," desires to enter into arrangements for developing same in this country. Inquiries to Messrs. W. P. Thompson & Co., patent agents, 285, High Holborn, London, W.C.

The proprietor of patents No. 16,577/07 and 13,837/08, relating to "Improvements in frames for supporting electric conductors in the open," desires to grant manufacturing licences. Particulars from Mr. Clement Lean, 231, Strand, London, W.C.

"Stannos" Wiring.—Messrs. Siemens Brothers & Co., Caxton House, Westminster, S.W., notify that, owing to increased manufacturing facilities and the reduced price of rubber, they have increased the discounts off the price of "Stannos" wire and fittings as from 17th inst. Particulars will be supplied on application.

BANKRUPTCIES, LIQUIDATIONS, &c.

A meeting of creditors of the Bombay Hydro-Electric Synd. (Ltd.) will be held at 208, Gresham House, Old Broad-street, London, E.C., on July 24, and claims are to be sent to Mr. F. J. Horne, 214, Gresham House, by Aug. 14.

A receiving order has been made against Alfd. Sitch, electrical engineer, &c., 77, Brecknock-road, London, N.W. First meeting of creditors at Bankruptcy-buildings, London, W.C., on July 26, and public examination on Sept. 5.

Cuthbert Fenton Lindop, electrician, 62, Dale-street, Liverpool, has been adjudicated bankrupt.

A receiving order has been made against Wm. Hy. Ridpath (trading as Ridpath & Wells), electrical engineer, 20, Bath-street, Ilkeston.

First meetings of creditors and contributories of J. G. Childs & Co. (Ltd.) will be held on Aug. 1 at 33, Carey-street, London, W.C.

COMPANIES' MEETINGS AND REPORTS.

Telegraph Construction & Maintenance Co. (Ltd.)

The half-yearly general meeting was held yesterday under the presidency of the Right Hon. the EARL OF SELBORNE, K.C., chairman of the company.

The SECRETARY (Mr. C. W. Clarke) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, I have very little to trouble you with on this occasion. Your business is progressing satisfactorily, and the usual interim dividend has been declared. On the occasion of the Naval Review the "Colonia" went down to Portsmouth, and we took that opportunity of inviting to meet on board, not our private friends, but those who are concerned mainly with your business—the representatives, rather, of other businesses with which your business is brought into contact; and although we certainly enjoyed ourselves greatly, yet I think that the occasion was not amiss in your interests, because it enabled all those who are connected with the manufacture and the use of cables to meet in rather an unusual manner, know each other, and discuss matters. On the last occasion of this half-yearly meeting, you yourselves, gentlemen, expressed a doubt whether there really was any occasion to hold it. Let me remind you how our meetings at this time of the year originated. Forty years ago, when the business of the Company was not exactly in the position in which it is now, certain of the shareholders desired to have this half-yearly meeting, at which no accounts would be presented, but which would enable them to come into contact with the Directors, to ask questions, and to ascertain how the business of the Company was progressing. Now, I would ask you, does the same occasion exist to-day for this half-yearly meeting as existed 40 years ago? The shareholders' doubts on this point are shared by the Directors, and I give notice of our intention, at the next annual general meeting, to propose to the shareholders to omit for the future this half-yearly meeting. That is really all I have to say to you to-day.

Mr. H. S. S. CROFT: There certainly does not seem to be the same reason which prevailed many years ago for holding this meeting: and if that is the feeling of the board—and I imagine it is shared by the majority of the shareholders—then the board would be quite justified in suggesting that this meeting should be dispensed with. At the same time one cannot, of course, help feeling that occasions sometimes arise in the interval between the meetings which would make it interesting for the shareholders to know exactly the position of things. I do not see that there could be any necessity for presenting accounts—that, of course, has never been done at this meeting—but there might sometimes arise some unprecedented circumstance which would make it rather important for the shareholders to know what the state of things was. For instance, on the present occasion, I should like to ask whether the strike which, as we know, has been operating so very disastrously in the shipping trade has affected this Company in any way. You have alluded to the presence of one of our ships at the Naval Review, and I know, from other sources, that some of the large steamers were actually prevented from taking passengers in consequence of the strike, which, as I say, has had rather as disastrous effect elsewhere.

The CHAIRMAN: I would remind you, gentlemen, that it is in your power to have a meeting summoned if you wish it, and I think that that meets the point which has been referred to. I am glad to say, as to the relations between the Company and its employees on the telegraph ships, that the strike at Southampton did not affect us. I cannot, of course, say what is going to take place in the future, but we have every reason, from our experience in the past, to suppose that the existing relations between us will continue. That concludes our business.

A cordial vote of thanks to the Chairman and directors terminated the proceedings.

Electric Construction Co. (Ltd.)

The eighteenth annual general meeting was held yesterday, Mr. WALTER S. B. MCLAREN, M.P., presiding.

The SECRETARY (Mr. David Willock) having read the notice convening the meeting and the report of the auditors,

The CHAIRMAN then said: Gentlemen, I am pleased the forecast of an increased demand for electrical machinery and of increased profit I made last year, has been fulfilled. We have not been engaged on large contracts, but the number of machines supplied for industrial purposes at home has been greater than in any previous year. We have experienced a diminished demand for electrical machinery for mining purposes, but I am glad to think that the questions which have arisen under the new Mines Regulations are now in a fair way of being solved. After several years' experience of the use of electrical machinery in some of the largest collieries in the country, I can say that, where reasonable and proper care is exercised, mining operations can be carried on with probably a greater degree of safety than with the older appliances. The demand for our plant for Colonial markets continues to expand, and during the year we have opened up new connections.

The resumption of dividends on the ordinary shares depends upon overturn. This view has been fully demonstrated during the past year. Our plant and tools have been fully employed during the greater part of the year, but our standing charges were not materially increased. Moreover, we obtained the full use of the up-to-date tools which we had installed, and our low prime cost per kilowatt produced proves conclusively the wisdom of the management in recommending such expenditure, and of the Board in authorising it—at a time when the outlook for the industry was not encouraging. The result of the year's working is that we are able to recommend a modest dividend of 2½ per cent. on the ordinary shares—the first since 1904. It is a poor return for all the capital employed and all the skill and energy exercised in the conduct of the business, but it is something to find ourselves once more in a position to recommend a dividend, however small. We have commenced the new financial year with a larger amount of work on hand than last year, and, as stated in the Directors' report, we view the future with confidence if the present demand be maintained. I wish to emphasise this condition, however, because the capacity for production at home has not diminished, nor has the keen competition among British and foreign manufacturers in all parts of the world relaxed.

As indicated in the report, we have disposed of our holding of ordinary shares in the Madras Tramways. Our holding is now represented exclusively by 6 per cent. cumulative preference shares, and, as the traffic receipts are still developing, and the extensions (to which I referred last year) have now been sanctioned, our investment will yield a steady and satisfactory return. With part of the proceeds from the sale of these shares we have redeemed the remaining £10,000 second mortgage debenture stock and also £17,300 of our first mortgage debenture stock. During the past two years, therefore, we have redeemed £67,300 of debenture stock and the amount now outstanding is £182,700 only. This reduction has strengthened the financial position of the Company, reduced the charge for interest, and established a more equitable relation between the amount of our mortgages and the amount of share capital issued. As I informed you last year, the whole of the stock redeemed will be kept alive for the purpose of re-issue, if required, but we do not expect this will be necessary.

A net deficit of £18,827 arising out of the sale of the Madras tramway shares less the surplus on the redemption of our debenture stock has been debited to general reserve fund; but I would remind you that the sum of £10,000 was credited to this fund last year out of the surplus arising from the redemption of the first portion of the second mortgage debenture stock, and, therefore, the net debit to general reserve fund for the whole series of transactions has been £8,827 only. We have always recognised this fund as a reserve against realisations of shares in other companies, and the sum of £25,000 which will remain at the credit of the fund, if you adopt our recommendations to-day, is a very substantial reserve against our reduced holdings, which now amount to £73,331. 17s. 6d. There was an increase in gross profit on manufacturing and contracting of £8,075. Interest and dividends received show an apparent reduction of £434, due to an alteration in the period for which one of the dividends has been

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calculated. On the other side of the account there has been a reduction in debenture interest of £1,813, and an increase in general charges of £1,203, due chiefly to the increased volume of business transacted. In common with others, our investments show some depreciation. They are entered this year at the market value, £277 having been written off. I am pleased to be able to inform you that the judgment in our favour in the action brought against us by a German concern for alleged infringement of a patent (which I reported last year) was unanimously confirmed by the Court of Appeal. We have not heard whether the plaintiffs intend to prosecute the matter further.

In conclusion, I wish to put on record how greatly the Board appreciates the patience and confidence of the shareholders during the past seven years. I also wish to record how much the improved position of the company is due to the untiring zeal of its staff, and how greatly we have been helped by the amicable relations which have at all times existed between the company and its workmen. I now move the adoption of the accounts and report and the recommendations therein.

Mr. JAMES GRAY (managing director) seconded the resolution.

In replying to shareholders,

The CHAIRMAN said that the item of shares in other companies were taken at par value, and although they were shown in the accounts, everybody knew that they were not worth par. On the other hand, the general reserve fund was deliberately car-marked to set against the depreciation in the price of the value of those shares.

The resolution was then agreed to.

The retiring directors, Mr. McLaren and Sir Irving Courtenay, were then re-elected, the retiring auditors were re-appointed, and a vote of thanks terminated the proceedings.

Chili Telephone Co. (Ltd.)

The twenty-second ordinary general meeting was held yesterday. Mr. GEORGE KEITH presided.

Mr. EDMUND PETLEY (the Secretary) read the notice calling the meeting and the certificate of the auditors.

The CHAIRMAN said: Gentlemen, ever since the earthquake disaster in 1906 our business year by year has been making steady progress. Last year the Chilian Centenary was celebrated, and it has also been a year of activity and progress in Chili, in which our business has largely participated. The currency revenue in Chili has increased about 10 per cent. during the year. This improvement was due to the general expansion of all classes of our service throughout the country. Whilst by far the larger part of the revenue is collected in annual subscriptions payable quarterly or half-yearly, the measured rate or toll system has for some considerable time been introduced for inter-town communications, which has resulted during the past year in a satisfactory increase in the revenue derived from that service. The working expenditure in Chili has also increased, but not in the same proportion as the revenue, and comes out at 48 per cent., or a decrease for the year of about 2 per cent., which may be principally attributed to the lower maintenance expenses produced by the transfer of overhead lines to the underground cables in the City of Santiago. The rate of exchange has also been favourable. The average rate for the previous year was 10·49d., and for the past year 10·90d. The income in Chili, converted into sterling, shows an increase for the year of £7,946. Interest and transfer fees are about £258 more, while the expenses in London show an increase of £126 due to small increases in salaries and office expenses. Income tax is also £204 more. Altogether the result of the year's business is a credit balance of £46,144, which after providing £22,805 for the reserve and £9,900 for the interim dividend paid in January, enables the Board to recommend the payment of a final dividend of £13,200, making with the interim payment a total distribution for the year of 7 per cent., free of income tax, and to increase the balance carried forward to next year's account by £238 to £3,225.

Turning to the balance-sheet, the issued share capital has been increased to £330,000 by the issue of new shares made last November. The reserve account stands at £52,300, and investments at cost £34,784. Altogether, I think I may congratulate the shareholders upon the result of the year's operations. A large amount of new construction has been carried out during the year. In addition to the ordinary work of joining up new subscribers to the existing exchanges throughout the country, the trunk line communication has been greatly increased and extended to a number of small towns where offices have been opened. The new districts of Tocopilla in the North and Malleco in the osuth have been developed, and offices opened in their principal towns. Over 1,900 miles of new overhead wire have in all been erected and equipped during the year. The work of placing the lines undergound in the City of Santiago has been progressing satisfactorily in advance of the paving of the streets. The overhead wires are being removed as the underground cables are laid, and a considerable improvement is beginning to show itself in the maintenance and service. As regards the current year, the business conditions in Chili continue to improve. Several sections of the Longitudinal Railway, which is to join Santiago with Iquique, is now in course of construction, and the works for the improvement of the Valparaiso and other ports are being carried out, all of which is in favour of the trade and commerce of the country. The dividend we now propose, making 7 per cent. on the increased capital, is a much larger distribution than we paid last year, and if our business continues to expand as it has been doing up to the present, I have every hope we shall be able to return next year to an 8 per cent. basis, although we may have to deduct the income tax.

The highly satisfactory condition and progress of our business reflects great credit on the management in Chili and the staff generally, to whom I have great pleasure in expressing our appreciation and thanks for their successful services during the past year. I now move the adoption of the report and accounts.

The Hon. HERBERT T. ALLSOPP seconded the motion, which was carried unanimously.

Resolutions approving the dividend, re-electing the retiring director and auditors, and according a hearty vote of thanks to the chairman and directors terminated the proceedings.

United River Plate Telephone Co. (Ltd.)

The twenty-fifth ordinary general meeting was held on Tuesday, under the presidency of Sir IRVING COURTENAY, Kt., M.A.

The SECRETARY (Mr. David Smith) having read the notice calling the meeting and the auditors' report,

The CHAIRMAN then said: Gentlemen, the result of our year's operations is, I think, highly gratifying, especially when we remember that the prosperity of the Argentine generally has not this year been so great as it might have been. In spite of disturbing factors the business goes on increasing, and a most satisfactory feature is that, although the large additions to our subscribers have entailed a severe strain on the staff and on our equipment, the service, I am glad to say, steadily improves. I mentioned last year how abnormal was the demand on our general service owing to the unusual influx of visitors from all lands into Buenos Aires. We got through that time of unusual pressure very well, and in August last we inaugurated a new common battery board in the Avenida Exchange, our most important exchange in Buenos Aires. Warm congratulations on this improvement have been received from all quarters. Two other exchanges transformed to the common battery system are just on the point of being opened, while important extensions to three of the already existing common battery exchanges have been carried out during the year, as well as extensions to several of the magneto exchanges. We have also completed and opened a common battery exchange in the Sanchaks district of Rosario, and as soon as we can come to terms with the municipality of Rosario we hope to instal a full common battery board in our central exchange in that city. In Bahia Blanca we have a common battery board undergoing its final test, and doubtless one of our duties in the near future will be the joining up of that city to Buenos Aires by trunk lines. The distance is about 500 miles, and the operation will be a somewhat costly one, but traffic between the two places is ever growing. There appears some probability that the Government will build large docks for warships in Bahia Blanca, and in that case communication with the federal capital will be an absolute necessity. In the city of La Plata, the provincial capital of Buenos Aires, we have, since I last met you, been granted a concession to put our plant underground. This concession came after years of constant and strenuous effort. We have been much hampered in La Plata by the fact that the lines were aerial and liable to damage by every severe storm, and the plant was somewhat old-fashioned, but until we got the concession we were helpless to improve matters. Now, however, the necessary plans for a new board and building will be taken in hand. We are engaged in building a new line between La Plata and Buenos Aires with creosoted pine poles carrying 20 circuits of different gauges to take both long and short distance traffic, the extensions having been rendered necessary by the continual growth in the number of messages between La Plata and other parts of our system. The city of Cordoba also claims attention, and already we have had plans prepared for a new building, and a new and modern switchboard will before long be necessary. In some of the smaller towns we have had to enlarge our boards during the year as the number of subscribers increased, while we have opened up in several towns where we had not hitherto been established. In most cases these smaller towns are connected up to the nearest large town, while in other cases through and direct communication with Buenos Aires has been necessary. You can thus see that we have been exceedingly busy during the year, notwithstanding that our operations were constantly hindered at the end of last year and the beginning of this by a series of storms and floods unprecedented in our experience. One satisfactory feature of the business is the increase in toll line receipts We have during the last few years extended the toll lines in many directions. The country, and especially the province of Buenos Aires, is developing rapidly, and it is our ambition to be worthy of our responsibilities. So far as possible we desire, of course, the development of the district and the development of our lines to proceed contemporaneously but we recognise that we have obligations to our subscribers as well as to our shareholders, and sometimes we find it necessary for a variety of reasons to build a line even before it would, taken by itself, be what one might call a payable proposition; but it gives me great pleasure to state that the growth of the toll line receipts has during the last year or two increased in the most gratifying way, and has more than justified the expenditure.

Another branch of our business to which we are looking with great expectations is the private branch exchange. In Buenos Aires we have already installed 73 of those exchanges, controlling 2,114 instruments through 265 exchange lines in banks, public offices and large business establishments, and their convenience has appealed to the commercial community. These private branch exchanges afford us an opportunity of gradually introducing the message rate, which system we hope to make universal, in the large cities at any rate. Owing to the constantly increasing demand for female labour in Buenos Aires we experience some difficulty in keeping the ranks of our operating staff fully supplied. We are, therefore, installing an operators' school in connection with the Avenida exchange on the most modern lines, and here in the future we shall train the girls. The directors record with deepest regret the death during the year of Mr. R. Inglis Runciman, chairman for many years of our local committee, one of the most universally respected members of the

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British community in the Argentine. We have been fortunate in securing in his place Dr. Luis Drago, a lawyer of international repute. He was, as you will remember, one of those who took part in the arbitration at the Hague Conference. We have also secured as a member of the committee Dr. Federico Pinedo, a gentleman of the highest reputation in the Argentine. The Board in London has been strengthened by the addition of Mr. Eustace Quilter, an addition of real advantage to the company. From what I have said you will realise that the extensions which we have in hand and in contemplation necessitate fresh capital, and we propose to make an immediate issue of 40,000 new ordinary shares, offered to the ordinary shareholders at par.

There are one or two points in the accounts upon which I will comment briefly. The nominal capital has been increased by the 100,000 £5 shares authorised at the general meeting last year, and the new issue of 40,000 shares has been brought into the accounts, making our paid-up capital £1,150,000. The reserve is increased by the amount of the appropriation last year, and reserve for renewal of plant, &c., has also been increased, for we have this year charged direct to revenue the provision for renewal of plant, which hitherto we have only dealt with by means of an appropriation from profit. You have doubtless noticed that the expenditure on plant of all kinds is £1,376,539. Now telephone plant is unique. Its life at the best is comparatively short, and much of it, such as outside lines, poles and the like, is, from its nature, of a rapidly deteriorating character, although the use of cables and underground ducts in cities is modifying this to some extent. We propose, as you will see, to add a further appropriation of £25,000 to maintenance account. On the credit side our expenditure for the year is £177,821 on capital account and £23,011 in connection with the special replacement account, this latter account being opened to deal with the special expenditure in conduits, cables, boards, &c., necessitated by the change over from magneto to the common battery system in Buenos Aires. This work is now practically completed, and this year we have written off the balance, and in future all replacements of this nature will be debited against renewal of plant. Real estate has increased by £25,930, representing new buildings and sites for exchanges, &c. The increase of £30,000 odd in sundry debtors is owing to increase in business generally, and also represents sums paid as the work proceeds on account of jobs being done under contract. There is practically no change in the amount of our securities, and it is satisfactory to state that the market value is well in excess of the figure appearing in the accounts. Our stock of materials is £17,269 more than last year, the result of a general growth of the business. Profit and loss figures represent increases in receipts and expenses in the Argentine of £64,885 and £60,658 respectively, due to the fact that we have this year included our provision for the renewal of plant under the heading of "Maintenance." The profit for the year is £129,854, against £123,557 in the previous year. There is a proposal that £2,000 shall be voted to the staff provident fund, which promises to be a great help to the staff. It was started a year ago with 744 members and already the membership has increased to 1,444, with a monthly income from staff subscriptions of about $1,900. The directors recommend a final dividend of 5 per cent. on the ordinary shares, making 8 per cent. for the year (tax free). I now move the adoption of the report and accounts and the declaration of the dividend set out therein.

Mr. FREDERICK GREEN seconded the motion, which, after a brief discussion, was carried unanimously.

The re-election of Sir John Gavey, Kt., C.B., was then approved, as was that of Mr. Eustace Quilter. The retiring auditors, Messrs. Welton, Jones & Co., were re-appointed.

A vote of thanks to the Consultative Committee in the Argentine, to Mr. Parker, the general manager, and his staff, and to Mr. David Smith, the secretary, and the staff in London was proposed by the Chairman, seconded by Mr. E. Quilter, and carried unanimously.

A cordial vote of thanks to the chairman and the directors brought the proceedings to a close.

CHATHAM & DISTRICT LIGHT RAILWAYS CO.—The revenue for the half-year ended June 30 amounted to £21,444. 12s. 8d. and the expenses to £12,514. 4s. 2d., leaving £8,930. 8s. 6d. Deducting rent of Rochester Corporation lines (£1,871. 16s.), debenture interest (£1,234), &c., and adding amount forward (£633. 10s. 4d.) the balance is £6,236. 12s. 6d. The directors recommend payment of the preference dividend and a dividend at the rate of 3 per cent. on the ordinary shares, carrying forward £1,705. 12s. 6d. Traffic receipts show a small increase and expenses a small decrease, compared with the corresponding half-year of 1910.

CITY & SOUTH LONDON RAILWAY CO.—The report of the directors for the half-year ended June 30 states that receipts from all sources amounted to £93,873. 7s. 4d., and the cost of working was £42,738. 3s. 10d., leaving a profit of £51,135. 3s. 6d. Including balance forward, net revenue shows an aggregate total of £52,923. 4s. After making provision for debenture stock interest, rent charge, and the transfer to renewal fund of £1,500 and £800 for general purposes, a balance remains available for dividend of £36,049. 2s. 11d. The directors recommend payment of the full preference stock dividend and a dividend at the rate of 1½ per cent. on the consolidated ordinary stock for the half-year, leaving £2,797. 19s. 11d. to be carried forward. Inclusive of the estimated number of season ticket journeys, 13,318,622 passengers were carried, against 12,800,719 in the December half-year and 12,357,324 in the June half-year, 1910. The receipts were £87,591 against £86,103 and £83,413 respectively. The directors state with much satisfaction that the enormous number of passengers using their railway during the Coronation celebrations were carried without a single mishap or delay of any kind whatsoever. The high level subway, connecting the public subways of the Central London Railway and the booking hall of the company's Bank station was opened by the Lord Mayor in May, and its utility and convenience have been since amply demonstrated by the free use of the subway made by large numbers of the public. The directors announce with deep regret the death of their esteemed colleague, Mr. Harvey Ranking. The vacancy thus occasioned has been filled by the election of Mr. J. F. S. Gooday, formerly general manager of the London, Brighton & South Coast and Great Eastern Railways and now a director of both companies.

EAST LONDON RAILWAY CO.—In the report for the half-year ended June 30 the directors state that they had hoped to be in a position to make a definite statement as to the scheme of electrification which they had reason to believe would be adopted by the lessee companies. Owing, however, to unavoidable delay, the lessees have been unable to arrive at a final decision on the scheme prior to the issue of the report. At the same time the directors anticipate that the chairman will be prepared to make a satisfactory statement on the subject at the meeting.

EDMUNDSON'S ELECTRICITY CORPN. (LTD.)—Mr. P. D. Tuckett stated at the meeting last week that the gross trading profits had increased by £2,335, but the expenses were £517 more. The net profit (£5,369) was satisfactory in a year which had proved by no means favourable to electric supply undertakings. The increased loss on working the local authority undertakings was the one unsatisfactory feature of the accounts but was not so unsatisfactory as would appear at first sight, since £980 of the increase was due to additional interest and sinking fund charges. The output had increased by nearly 2,000,000 units, the private lighting output having increased 6 per cent., compared with 4 per cent., while the power output had increased 16 per cent., compared with 19 per cent. The lamp connections had increased by the equivalent of 107,298 33-watt lamps, against an increase of 88,935. The metal filament lamp was undoubtedly tending to stimulate new connections, while they might now consider that they had felt the worst of its adverse influence on revenue.

ELECTRIC & GENERAL INVESTMENT CO. (LTD.)—The gross profit on the transactions for the year ended May 31 was £11,848. 9s. 5d. After deducting all general charges and the interim dividend already paid on the preference shares, and providing for the proportion of the final dividend accrued on the preference shares to May 31, there remained £4,175. 17s. 10d. As a further reserve to meet depreciation in investments the directors have carried £2,975. 17s. 10d. to contingencies fund, thereby raising this fund to £78,924. 2s. 7d., leaving a balance of £1,200. The directors recommend that this £1,200 be distributed by payment of a dividend of 6 per cent. on the paid-up capital on the ordinary shares for the year. The warrants for the dividend on the ordinary shares will be posted on 27th inst.

In June, 1907, a scheme for the reconstruction of the company in order to extinguish the founders' shares was submitted to the shareholders, but the scheme had to be adjourned sine die as it was found impossible at the time to obtain the necessary majority of holders of founders' shares in its favour. The directors now submit an amended scheme, which they hope will meet with the approval of all classes of the company's shareholders. The proposals are to the effect that the existing 100 fully-paid founders' shares of £5 each be converted into 10,000 fully-paid deferred shares of 1s. each; that the investments deposited with trustees on behalf of the holders of the ordinary and founders' shares respectively, be capitalised by the creation and issue of £22,500 five per cent. redeemable debenture stock and of 30,000 fully-paid deferred shares of 1s. each, making in all 40,000 deferred shares of 1s. each; that there be issued to the holder of each founders' share £125 in 5 per cent. debenture stock, 200 deferred shares of 1s. each fully paid (of which 100 shares will represent the converted founders' share), and a cash distribution of £7; and that there be issued to the holder of each ordinary share 10s. in 5 per cent. debenture stock, and one deferred share of 1s. fully paid, and a cash distribution of 6d. The holders of the present founders' shares will receive 20,000 of the deferred shares, and the holders of the ordinary shares will receive the remaining 20,000 deferred shares, thus preserving the existing equities and rights of the two classes of shares.

GENERAL ELECTRIC CO. (LTD.)—At the meeting on Monday Mr. H. Hirst referred to the loss sustained by the company through the death of their late chairman and managing director (Mr. G. Byng). The company was evolved out of a small business which Mr. Byng started in the early eighties. Mr. Byng was at all times a brilliant business man, a deep thinker, thorough organiser and hard worker. Mr. L. G. Byng, who has been for a number of years actively engaged in the firm, has joined the board, Mr. Ernest Byng fills the position vacated by him—namely, the vice-chairmanship. Mr. M. J. Railing (a director since 1900), who had been nearly 20 years with them in different departments, and who during recent years managed their Witton works so successfully, joined them at the head office as general manager, and Dr. A. H. Railing, who enjoyed a brilliant engineering experience outside their firm, and who had been for the last four years the speaker's chief assistant in London, in order to add to his commercial and financial experience, went to Witton to take over the works management. The trading profits for the year (£107,858) showed a healthy increase of £16,728. Their depreciation was about £5,000 more than last year. During the present company's 10 years existence they had written off £186,000, not taking into account the £92,000 which they appropriated this year for writing off goodwill, and he was not making a sanguine estimate if he valued their assets at a considerably higher figure than they appeared in the balance-sheet. Their reserve account amounted to £202,103. This year they had been able to satisfy a long-cherished wish by writing down goodwill and patents to £1, which still left the reserve account at £110,000. Their investment account

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was the same as last year, but it yielded £7,000 more, owing to the successful working of the British General Electric Co. in South Africa, and the satisfactory results of the Peel-Connor Telephone Works. They had recently formed the British General Electric Co. of Australia and the British General Electric Co. of China, and similar arrangements for India and the Argentine were under the directors' consideration. Those subsidiary concerns were practically departments of the company in the shape of limited companies so as to limit their responsibilities, and they were managed principally by selected members of their staff trained at their head office and works. Their engineering works at Witton turned out every description of motor and dynamo, from small motors for fans to turbo-generators of 5,000 kw. They installed lighting power plants for tramway companies, electric light stations, mines and country houses. They equipped factories and steamships and carried on every kind of electrical engineering work for Government departments, municipalities and trading concerns. The Robertson lamp still sold in very large quantities and the Osram lamp continued its great career. At present they were engaged in serious litigation for establishing the patents of the latter. Their carbon works—the only works of the kind in the country—had been a great loss to them in the past, but they had this year arrived at zero point. They were grateful to the Admiralty and Government departments, who did their best when ever they could to insist on the supply of British-made carbons. At present their works were fully occupied and extensions were being carried out.

INDO-EUROPEAN TELEGRAPH CO. (LTD.)—At an extraordinary general meeting on Monday, under the presidency of Mr. T. Herbert Tritton, the special resolution passed at the meeting on June 28 was confirmed. The resolution cancelled the existing articles of association and substituted a new set, which had been approved by the shareholders.

NATIONAL TELEPHONE CO. (LTD.)—The income accrued in respect of the business of the half-year ended June 30 amounts to £1,807,871. 13s. 3d. compared with £1,678,311. 18s. 5d. for the corresponding period of 1910, an increase of £129,559. 14s. 10d. The working expenses amount to £1,058,169. 6s. 9d., compared with £971,914. 6s. 2d., an increase of £86,255. 0s. 7d. The net result (after deducting P.O. royalties amounting to £173,424. 7s.) is a profit balance of £576,277. 19s. 6d. compared with £544,516. 7s. 9d., an increase of £31,761. 11s. 9d. The rentals carried forward for unexpired terms of running contracts amount to £1,577,419. 0s. 10d., against £1,482,179. 1s. 8d., an increase of £95,239. 19s. 2d. Out of the available balance of £436,886. 13s. the board will recommend payment for the half-year of a dividend at the rate of 6 per cent. per annum on the first and second preference shares, 5 per cent. per annum on the third preference shares, 6 per cent. per annum on the preferred stock, and 6 per cent. per annum on the deferred stock, less tax in all cases. The board also propose to transfer £200,000 to reserve, and to carry forward the balance of £18,136. 13s. On March 20, 1911, the directors invited tenders for the repayment of part of the 3½ per cent. debenture stock, and up to May 31 last the amount of stock which had been thereby extinguished was £336,972. The sum of £211,121. 15s. 10d. has been expended on capital account during the half-year in the erection of 15,675 additional exchange and private stations and in the construction of underground works.

MARCONI'S WIRELESS TELEGRAPH CO. (LTD.)—At the meeting yesterday the chairman (Commendatore G. Marconi) moved the adoption of the report. He said the figure on the credit side of profit and loss account of £127,452, representing balance of contract and trading account, showed in itself the magnificent progress of the business. It had not been considered prudent to continue to set out the figures of the profit and loss account in the same form as submitted last year, but the accounts were treated in their books exactly the same as theretofore, and no profits had been taken into consideration on account of contracts in course of completion. There was no truth in the suggestion that the trading account embraced any sums received by way of compensation resulting from the patent action. He referred to the satisfactory working of the trans-Atlantic services, which had been opened in April last year. They had had, and would continue to have, some trouble owing to the mutilation of code words by the land-lines, but they had arrangements in view which would eliminate that trouble, and it was possible that at an early date they should carry into effect their intention of accepting plain English messages at 4d. per word, which should bring them in a great many messages in plain English which were now sent by code at 7½d. per word. He was engaged at the moment in introducing their duplex system at Clifden, and thereafter at Glace Bay, which should double the capacity of their service with a very small increase of running expenses. The work completed during the year included two stations in Brazil for the Madeira Maore Railway. Other important contracts entered into included the erection of stations in Italy, Turkey, Greece, Spain and the Canary Islands, while a first agreement made with the Eastern Extension Telegraph Co. for the erection of a station at Cocos Island was the first of a series of coast stations extending to Hong Kong, Singapore, Malta and Gibraltar, which should materially assist their international maritime business. Important negotiations had also been carried on with the French Government, which had resulted in a working arrangement between it and the affiliated Marconi companies, while a press agency had been organised upon the high seas. He also referred to a development from a scheme they had submitted to H.M. Government to put all British possessions into wireless communication with each other. The Imperial wireless scheme introduced by Sir J. Ward at the recent Imperial Conference would seem to have originated in that idea. They would have preferred to have carried out the scheme they themselves had proposed, but quite appreciated the attitude of the Government, and would be equally satisfied if eventually they erected the stations on terms which would compensate them for the large sums of money and the immense amount of work which the company had devoted to the development of long-distance commercial wireless telegraphy. No other company than their own had been able to erect stations for long-distance commercial radio-telegraphy, and they might recollect that they had succeeded in receiving messages between Glace Bay and Buenos Ayres, a distance of over 6,000 miles. They were engaged in negotiations with foreign Governments for the erection of other long-distance telegraph stations outside the British Empire. The judgment obtained against the British Radio-Telegraph & Telephone Co. had materially strengthened their position, and they were setting aside a substantial sum of money for vigorously protecting their patent rights throughout the world. They regretted that after the report was drafted they had found it incumbent to issue a writ against the Lodge-Muirhead Wireless & General Telegraphy Syndicate, who had, in turn, issued a writ against the Marconi International Marine Communication Co., and they should not hesitate to take further legal proceedings whenever it became incumbent. In regard to dividends, he said the board was unanimous in contenting itself for the present with the declaration of an interim dividend on the ordinary shares for the six months ended June 30 at the rate of 10 per cent. per annum.

SOUTH BRAZILIAN RAILWAYS CO. (LTD.)—The directors' report states that the concession and undertaking of the urban and suburban tramways of Curytiba, capital of the State of Parana, had been transferred to the company by the Empreza Ferro Carril Curytibana. Contracts had been entered into with Mr. E. Fontaine de Laveleye for converting the lines to electric traction. The contractor has undertaken to deliver the whole of the tramway system in working order not later than Jan. 22, 1912. During the period of electrification the contractor was working the public service, all receipts and outgoings during that period being for his account. The company had also purchased from the Empreza de Electricidade de Curytiba the electric lighting enterprise. Contracts had also been entered into with Mr. E. Fontaine de Laveleye, under which he would improve and extend the electric lighting system of the city and district, and also erect a hydro-electro plant at the Caiacanga waterfall, the concession for which had been acquired by the company. The contractor further undertook to connect such hydro-electric works with the distributing plant in the city. The company had also obtained from the Municipality of Curytiba the sole concession for the supply of electrical energy in the city. To provide for the acquisition of the electric lighting enterprise and the carrying out of the new works the capital was increased to £300,000 by the creation of a further 37,500 shares of £4 each. The board have also created a further 25,000 5 per cent. debentures of £20 each (second series), secured by a first charge on the electric lighting undertaking and a second charge on the tramway undertaking. Arrangements have been made with the contractor for carrying on the undertaking during the construction period.

CITY NOTES.

MEMORANDA (July 20).—**Bank rate 3 per cent.** (March 9, 1911. **Price of silver,** 24¼d. per oz. **Consols** 78⅞—79 **for money and to account. Consols Pay Day,** Aug. 2; **Stock and Shares Continuation Days,** July 26 and Aug. 14; **Ticket Days,** July 27 and Aug. 15; **Pay Days,** July 28 and Aug. 16; **Mining Shares Carry Over Day,** July 25

PRICES OF METALS (London).—*Copper*, cash, 56⅛; three months, 57⅝ *Lead*, English, 13⅛—14⅛; Foreign, cash, 13⅜—13½, three months 13¼—13⅛. *Spelter*, 24¾—25. *Tin*, English, 190—192; Foreign, cash 188½; three months, 182½. *Iron*, Cleveland, cash, 47/0, three months 47/9.

ANGLO-AMERICAN TELEGRAPH CO. (LTD.)—The directors have declared an interim dividend for the quarter ended June 30 of 15s per cent. on the ordinary stock and £1. 10s. per cent. on the preferred stock (less tax), payable on 1st prox.

BRITISH COLUMBIA ELECTRIC RAILWAY CO. (LTD.)—A circular has been issued by the directors inviting applications from existing stockholders for £600,000 new capital. Owing to the continuous increase in the trade and population of the cities and districts served by the company, a further development of the railway, light and power systems is necessary. The receipts for the 11 months ended May 31 increased over the corresponding period of 1909-10 by $1,110,733, or 41 per cent.

A dividend has been declared at the rate of 5 per cent. on the preferred ordinary stock for the half-year to June 30, together with an additional dividend at the rate of 1 per cent. per annum for the same period.

MADRAS ELECTRIC TRAMWAYS 1904 (LTD.)—This Company's traffic receipts for the fortnight ended July 16 were R.23,048 (increase R.3,672). Aggregate from Jan. 1, R.284,339 (increase R.22,891).

METROPOLITAN RAILWAY CO.—A half-yearly dividend is announced at the rate of 2 per cent. per annum, £4,000 being carried forward, against 1½ per cent. and a carry forward of £6,000 in June, 1910.

ST. JAMES' & PALL MALL ELECTRIC LIGHT CO. (LTD.)—The directors have declared an interim dividend on the preference shares at the rate of 7 per cent. per annum and on the ordinary shares at the rate of 10 per cent. per annum for the half-year ended June 30. The share transfer books will be closed from July 22 to Aug. 4 inclusive.

STOCK EXCHANGE NOTICE.—The Stock Exchange Committee has granted a quotation to 467,000 £10, fully-paid shares of *The Underground Electric Railways Co. of London (Ltd.)*

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TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	July 12	1,612	+ 189	6	9,661	+ 804
Airdrie	„ 7	222	+ 6	27	5,832	— 14
Anglo-Argentine	„ 15	48,707	+ 3,218	28	1,377,081	+ 137,453
Ashton-under-Lyne	„ 15	429	+ 15	16	6,715	+ 503
Ayr Corporation	„ 15	505	— 28	9	2,908	— 193
Barnsley	„ 7	172	+ 8	27	4,843	+ 284
Barrow	„ 7	328	+ 24	27	7,224	+ 458
Bath Electric Trams, Ltd.	„ 12	1,025	+ 71	28	22,406	+ 730
Birmingham Corporation	„ 8	9,271	+ 2,518	14	106,012	+ 9,631
Birmingham & Midland	„ 7	899	+ 38	27	24,093	+ 1,750
Blackpool and Fleetwood	..	..	..	..	..	..
Blackburn Corporation	„ 12	1,275	+ 68	†16	18,704	+ 1,676
Bolton Corporation	„ 16	2,547	— 14	16	39,977	+ 3,140
Bombay	June 16	2,787	+ 90	24	68,603	+ 3,690
Bournemouth Corporation	July 12	1,903	— 1,999	15	26,292	— 837
Bradford Corporation	„ 15	5,869	+ 302	15	86,398	+ 7,579
Brighton Corporation	„ 16	1,189	+ 133	¶15	15,945	+ 1,483
Bristol Trams & Carriage	„ 14	7,293	+ 838	15	110,311	+ 10,640
Burnley Corporation	„ 15	1,294	— 4	15	13,503	+ 1,881
Burton Corporation	„ 16	292	+ 21	15	4,473	+ 409
Bury Corporation	„ 16	1,292	+ 50	¶15	19,874	+ 1,459
Calcutta Tramways Co.	„ 15	R58,020	+ R4,098	2	R117,696	+ R11,602
Cambrne-Redruth	„ 15	126	+ 9	28	3,401	+ 27
Cardiff Corporation	„ 15	2,966	+ 483	15	38,632	+ 4,020
Central London Railway	„ 15	4,870	— 803	2	9,968	— 1,731
Chatham & Dist. Lt. Rys.	„ 13	949	+ 76	28	22,862	+ 138
City & South London Rly.	„ 16	3,122	+ 112	2	6,299	+ 155
City of Birmingham	„ 7	1,094	— 1,756	27	72,257	+ 671
Cork Electric Trams Co.	„ 13	622	+ 41	28	13,614	+ 253
Devonport & Dist. Trams	„ 7	547	+ 147	27	12,463	+ 1,434
Dover Corporation	„ 15	285	+ 45	15	3,874	+ 686
Dublin & Lucan Railway	„ 14	201	+ 16	2	352	+ 4
Dublin United	„ 14	12,147	+ 5,748	2	19,773	+ 7,679
Dudley-Stourbridge	„ 7	850	+ 60	27	21,871	+ 1,803
Dundee Corporation	„ 12	1,209	— 26	¶8	10,084	— 111
East Ham Council	„ 15	1,120	+ 46	15	16,806	+ 1,026
Exeter Corporation	„ 14	404	+ 30	15	5,296	+ 409
Gateshead & Dist. Trams	„ 7	1,051	+ 60	27	27,511	+ 1,468
Glasgow Corporation	„ 15	20,356	+ 1,963	§6	129,467	+ 9,089
Grimsby Trams	„ 15	131	+ 15	28	3,387	+ 230
Gloucester Corpn.	„ 12	327	+ 114	2	638	+ 132
Gravesend-Northfleet	„ 7	216	+ 19	27	5,446	+ 126
Great Northern & City Rly.	„ 15	1,413	+ 48	2	2,851	+ 88
Greenock & Port Glasgow	„ 7	862	+ 32	27	18,642	+ 2,332
Halifax Corporation	„ 11	2,225	+ 264	†15	30,003	+ 3,207
Hartlepool Tramways	„ 7	301	+ 15	27	6,660	+ 512
Hastings Elec. Trams Co.	„ 13	1,230	+ 55	2	2,317	— 32
Hong Kong	„ 15	$9,975	+ $433	2	$19,764	+ $1,069
Huddersfield Corpn.	„ 15	2,082	+ 197	15	30,048	+ 3,279
Hull Corporation	„ 15	2,900	+ 196	15	43,390	+ 2,281
Hurst District Council	„ 15	576	+ 7	16	8,729	+ 480
Ilkeston District Council	„ 12	138	+ 5	15	2,017	+ 101
Ipswich Corporation	„ 15	507	+ 32	15	6,841	+ 681
Isle of Thanet Co.	„ 15	1,236	+ 5	41	18,216	+ 815
Jarrow	„ 7	128	+ 3	27	3,419	+ 218
Keighley Corporation	„ 13	215	+ 16	15	2,989	+ 290
Kidderminster & District	„ 7	139	+ 8	27	2,848	+ 194
Kilmarnock Corporation	„ 15	202	+ 39	9	1,452	+ 93
Lancaster Corporation	..	..	..	..	..	..
Lancashire Trams Co.	„ 13	1,510	+ 18	28	38,776	+ 196
Lancashire United	„ 12	1,518	+ 60	28	36,837	+ 965
Leamington	„ 7	234	+ 68	27	4,238	— 62
Leeds Corporation	„ 15	8,256	+ 904	15	116,272	+ 9,524
Leicester Corporation	„ 15	2,675	+ 209	15	39,462	+ 3,839
Lincoln Corporation	„ 15	799	+ 114	†9	6,051	+ 339
Liverpool Corporation	„ 15	121	+ 4	15	2,049	+ 192
Liverpool Overhead Rly.	„ 18	12,597	+ 1,116	27	308,056	+ 11,515
Llandudno&Colwyn Bay Ry.	„ 16	1,675	+ 228	2	3,302	+ 498
London County Council	„ 14	534	+ 71	§32	6,771	+ 322
London Elec. Ry. Co.	„ 5	47,341	+ 4,965	†14	624,602	+ 44,669
London United	„ 15	13,000	+ 810	2	26,290	+ 1,040
Lowestoft Corporation	„ 15	7,831	+ 493	28	180,234	+ 6,923
Manchester Corporation	„ 15	244	+ 4	41	6,805	+ 453
Met Railway	„ 15	16,934	+ 802	16	249,822	+ 14,885
Metropolitan Dist. Railway	„ 7	214	..	27	5,462	+ 184
Metropolitan Elec. Trams	„ 15	11,693	+ 1,067	2	23,741	+ 1,971
Middlesbrough Corporation	„ 7	10,146	+ 2,600	27	230,103	+ 35,382
Midland Corporation	„ 7	359	+ 41	27	8,800	+ 603
Middlesbrough Corporation	„ 15	202	+ 34	§15	2,786	+ 579
Newport (Mon.)	„ 15	4,226	+ 429	15	66,020	+ 4,891
Northampton Corporation	„ 15	769	+ 74	15	11,285	+ 854
Oldham, Ashton & Hyde	„ 14	576	+ 67	15	8,414	+ 911
Oldham Corporation	„ 7	579	+ 28	27	15,046	+ 435
Oldham (M.S.) Corporation	„ 16	2,040	+ 71	16	32,243	+ 1,763
Oldham (W.A.) Elec. Trams	„ 12	205	+ 31	8	1,594	+ 137
Plymouth	„ 14	1,627	+ 98	28	45,401	+ 2,322
Portsmouth Corporation	„ 7	357	+ 153	27	3,320	+ 358
Preston	„ 15	2,638	+ 350	15	35,462	+ 4,332
Reading Corporation	„ 7	2,062	+ 267	27	51,761	+ 5,097
Rotherham Corporation	„ 12	818	+ 55	15	11,939	+ 936
Rotherham	„ 13	664	+ 35	15	10,093	+ 915
Rotherham Corporation	„ 7	398	— 67	27	3,469	— 211
Rotherham	„ 17	4,926	+ 124	§15	76,998	+ 4,440
Rotherham	„ 12	$12,250	+ $795	2	$24,750	+ $2,275
Rotherham Corporation	„ 7	72	+ 20	27	1,279	+ 62
Rotherham Trams	„ 16	6,500	+ 523	16	104,165	+ 7,145
Rotherham Metropolitan	„ 15	$10,635	+ $465	2	$21,292	+ $898
Rotherham Shirts	„ 7	1,037	+ 208	27	22,227	+ 878
Rotherham	„ 7	870	+ 32	27	23,976	+ 1,961
Rotherham Corporation	„ 12	1,405	+ 250	15	18,382	+ 2,274
Rotherham Tramways	„ 12	819	+ 93	15	9,734	+ 1,482
Rotherham Hyde&c., Jt. Bd.	„ 7	403	+ 78	27	7,683	+ 280
Rotherham Corporation	„ 15	845	+ 40	15	12,263	+ 1,178
Rotherham District	„ 16	1,469	+ 267	15	20,161	+ 2,533
Rotherham Trams	„ 12	467	+ 61	37	16,654	+ 1,277
Rotherham Corporation	„ 7	1,175	+ 34	27	29,683	+ 1,925
Rotherham	„ 12	169	+ 40	15	2,370	+ 338
Rotherham and District	„ 7	46	+ 3	27	1,101	+ 17
Rotherham Trams Co.	„ 7	349	+ 15	27	5,814	+ 99
Rotherham Corporation	„ 12	542	+ 86	2	885	+ 51
Rotherham Corporation	„ 15	1,242	+ 135	15	17,344	+ 2,962
Rotherham Corporation	„ 15	565	+ 33	28	15,532	+ 675
Rotherham Corporation	„ 13	400	— 12	15	6,023	+ 219
Rotherham-Mare	..	..	..	..	..	..
Rotherham Co.	„ 7	234	+ 38	27	2,609	+ 147
Rotherham Corpn.	„ 7	441	— 7	27	11,770	+ 623
Rotherham	„ 12	1,153	+ 110	15	15,317	+ 1,140
Rotherham	„ 7	352	+ 46	27	7,515	+ 386
Rotherham W.R. Trams	„ 7	107	+ 13	27	2,620	+ 75
Rotherham Woollen District	„ 17	1,229	+ 37	29	36,872	+ 1,484
Rotherham	„ 7	1,057	+ 97	27	27,777	+ 1,987

* comparisons are with the corresponding period last year. * Partly electrical.
† Minus 3 days. ‡ Minus 2 days. § Plus 3 days. ¶ Plus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Secs	Last Dividend	Name.	Price Wed., July 19.	*Rate per cent. Yielded.	Dividend Due.	Business Week to July 19. High est.	Business Week to July 19. Lowest.
		Electricity Supply.		£ s. d.			
10	6/0	Bournemouth & Poole Elec. Sup. Ord.	8 —3	6 9 6	Mar, Sep	8½	—
10	4/6	Do. 4½ per Cent. Cum. Pref.	9 —10	4 14 6	Feb, Aug	..	—
10	6/0	Do. 6 per Cent. Cum. Second Pref.	10½—10¾	5 6 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	100 —102	4 9 0	Jan, July	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	8 —8½	6 1 0	March....	..	..
5	3/6	Do. 7 per Cent. Pref.	7½—8	4 1 3	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Deb. Stock	98 —101	4 0 6	June, Dec	..	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	3¾—4¼	5 2 6	Feb, Aug	4⅛	3⅝
5	2/3	Do. 4½ per Cent. Pref.	4½—5¼	5 2 6	Feb., Aug	5	—
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	94 —98	4 3 3	Jan, July	..	..
St.	4½%	†Do. 4½ per Cent. Deb. Stock (red.)	100 —102	4 8 3	..	..	..
5	2/3	†Do. City Undertaking 4½% Cum. Pref.	3¾—4¼	5 12 6	Jan, July	4½	3⅝
5	3/0	Chelsea Electric Supply Ord.	4 —4¼	5 11 0	March ..	..	..
St.	4½%	†Do. 4½ per Cent. Deb. Stock (red.)	98 —100	4 11 0	June, Dec	..	..
10	8/0	City of London Electric Lighting Ord.	11¼—12¼	4 19 0	Feb, Aug	12½	12⅛
10	6/0	Do. 6 per Cent. Cum. Pref.	12 —13	4 12 3	Jan, July	..	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	119 —123	4 1 0	June, Dec	120⅛	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	100 —103	4 8 6	Jan, July	..	..
St.	5%	County of Durham Elec. P. D. 5% 1st Mort. Deb. Stk.	89½—91½	5 10 6	Jan, July	..	..
10	6/0	County of London Elec. Supply Ord.	7⅜—8¼	6 3 0	Feb, Aug	7½	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11¼—11¾	5 2 2	Mar, Sept	¶11⅛	..
St.	4½%	Do. 4½ per Cent. Deb Stock (red.)	108 —110	4 2 6	Jan, July	108½	..
St.	4½%	Do. Second Deb. Stock	100 —103	4 7 6	May, Nov	102½	101½
5	4/0	Folkestone Electricity Supply Co. Ord.	4¼—4¾	5 19 0	April, Oct	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4¾—5¼	4 15 3	Mar, Sept	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red)	97 —100	4 10 0	Feb, Aug	..	..
5	5/0	Hove Electric Lighting Ord.	6¾—7¼	6 4 0	April, Oct	..	..
St.	4½%	Isle of Wight E. L. & P. Co. Deb. Stk.	83 —91	4 19 0	..	89	..
5	5/0	Kensington & Knightsbridge Ord.	7 —7¼	5 16 0	Feb, Aug	..	..
5	6%	Do. 6 per Cent. 1st Pref.	5¾—6	5 0 0	Jan, July	..	..
St.	4%	†Do. 4 per Cent. Deb. Stock (red.)	91 —93	4 6 0	..	..	..
St.	4%	Kensington & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	96 —99	4 1 0	April, Oct	..	..
St.	4½%	†Kent Elec. Power Co. Irred Deb. Stk.	78 —82	5 9 9	Jan, July	..	..
3	1/2½	London Electric Supply Ord.	1¾—2¼	2 17 0	Mar, Sept	..	..
5	3/0	Do. 6 per Cent. Pref.	4¾—5¼	5 17 0	Mar, Sept	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb	89 —92	4 8 0	Jan, July	..	..
5	3/0	Metropolitan Electric Sup. Ord.	3¾—3¾	6 18 0	April, Oct	3¾	3½
5	2/3	Do 4½ per Cent. Cum. Pref.	4¼—4½	4 17 0	Jan, July	4½	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	100 —105	4 7 6	June, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	94½—87½	4 1 6	Jan, July	..	..
..	4½%	Midland Elec. Corp. for Power Dist, 4½ 1st Mort. Debs.	96½—93½	4 12 6	..	..	..
5	2/6	Newcastle Elec. Supply Ord.	3¾—4	4 14 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non Cum. Pref.	4 —4½	5 11 0	Feb, Aug	..	..
100	4½%	Do. 4½ per Cent. 1st Mort. Deb.	97 —99	4 12 0	Jan, July	..	..
100	5%	North Metro. Elec. Power Sup. 5 Morts.	101 —104	4 17 6	..	..	..
1	6%	Northampton Elec. Lt. & P. Ord.	1¼—1⅝	4 11 6	Feb, Aug	..	..
1	5%	Do. 5% Pref.	1⅛—1⅜	4 6 0	Feb, Aug	..	..
St.	4%	Do. 4% Debs.	99 —101	3 19 0	June, Dec	..	..
10	6/0	Notting Hill Electric Ord.	..	5 17 6	March	..	..
5	4/3	Oxford Electric Ord.	6¼—5¾	5 13 9	March	..	..
St.	4%	†Do. 4% Deb. Stk.	91 —94	4 5 1	..	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	9 —9¼	5 8 0	Feb, Aug	..	..
5	3/6	Do. 7 per Cent. Pref.	6¼—7¼	4 16 6	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	84½—95½	4 2 0	Jan, July	85½	..
5	..	Smithfield Markets Electric Sup. Ord.	1¼—1¾	..	Feb.	..	..
5	4/0	South London Electric Supply Ord.	2⅜—3⅛	6 3 0	April	..	..
St.	5%	†Do. 5 % 1st Mort. Stock (red.)	96½—101½	5 0 6	..	..	..
1	0 8½	South Metropl Elec. Lt & Power 7% 1st Pref	1¼—1¾	5 18 0	Feb, Aug	..	..
1	0/7½	Do. 6 per Cent. 2nd Pref.	⅞—1	6 17 0	Feb, Aug	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	97 —100	4 11 6	April, Oct	..	..
5	1/3	Urban Electric Supply Ord.	½—1	..	April, Oct	..	..
5	1/3	Do. 5 per Cent. Cum. Pref.	2½—3	8½ 6 0	April, Oct	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	87 —89	5 2 3	April, Oct	89	..
5	5/0	Westminster Elec. Sup. Ord.	7¼—8¼	6 1 8	Mar, Sept	7¼	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	5 —5⅛	4 3 6	Jan, July	—	..
		Electric Railways and Tramways.					
1	..	Bath Elec. Trams Pref. Ord.	⅛—¼	..	April	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	⅛—¼	..	..	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	79 —83	6 13 6	Jan, July	¼	..
St.	4½%	B'ham & Midland Trams 4½ 1st Deb. Stock.	89 —91	5 8 6	April, Oct	..	..
10	4%	Bristol Tramways & Carriage Ord.	6¾—7	5 0 0	Jan, July	..	..
10	4%	Do. Cum. Pref.	7 —7½	5 10 9	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Debs.	100 —101	5 10 0	..	..	..
10	..	British Electric Traction Ord.	3 19 2		Feb, Aug	..	..
10	..	Do. 6 per Cent. Cum. Pref.	⅛—⅜	..	June, Dec	⅛	..
St.	5%	Do. 5 per Cent. Perpetual Debs.	3¾—4¼	..	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	95 —98	5 2 0	April, Oct	95⅛	95¼
St.	3%	Central London Ordinary Stock	77 —81	5 14 0	May, Nov	..	..
St.	4%	Do. 4 per Cent. Pref. Stock	71 —73	4 3 0	Feb, Aug	72½	71⅛
..	6/4	Do. Pref. Serie 5)% pd	87 —89	4 10 0	Feb, Aug	88⅛	..
St.	2%	Do. Deferred Stock	63 —64	..	..	63⅛	..
100	4%	†Do. 4 per Cent. Debs.	55 —57	3 11 6	Feb.	..	..
5	2/6	City of Birmingham Trams, 5 % Cum. Pref.	102 —104	3 16 11	Jan, July	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	4⅛—5⅛	4 19 6	April, Oct	..	..
St.	1½%	City & South London Rly. Con. Ord.	99 —102	3 18 9	April, Oct	..	..
St.	5%	Do. 5 per cent. Perp. Pref. (1891)	33 —34	4 9 5	Feb, Aug	34	32⅛
St.	5%	Do. (1896)	110 —112	4 9 3	Feb, Aug	110⅛	..
St.	5%	Do. (1901)	105 —108	4 13 0	Feb, Aug	..	..
St.	5%	Do. (1903)	104 —107	4 15 0	Feb, Aug	107	..
St.	4%	Do. 4 per Cent. Perpetual Debs	103 —105	4 15 6	Feb, Aug	..	..
10	6/0	Dublin United Trams, 6 per Cent. Pref.	102 —104	3 17 9	May, Nov	104	103
10	12/0	Gateshead and District Trams Ord.	12½—13¼	4 10 6	Feb, Aug	..	..
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	8¼—9¼	4 10 0	..	..	..
5	..	Hastings & District Elec. Trams, 6% C. P.	⅛—1⅛	..	Feb, Aug	⅛	..
St.	4½%	Do. 4½ Deb. Stock	..	..	Mar. Sept	..	..
10	..	Imperial Tramways Ord.	75 —80	5 10 0	April, Oct	..	..
10	..	‡Do. 6 per Cent. Pref.	3 —3½	..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Debs.	4¼—4¾	..	Mar, Sept	..	..
10	2/6	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	72 —77	6 3 6	Jan, July	..	..
St.	4%	†Do. 4 per Cent. Deb. Stock	2¼—2¾	5 0 0	Mar, Sept.	..	..
10	6/0	Lanarkshire Tramways	77 —82	5 1 0	Jan, July	80⅛	..
St.	5%	†Lancs Utd. Trams, 5% Prior Lien Deb. Stk.	10 —10½	5 12 3	Feb, Aug	..	..
St.	4%	†London Electric 4% Deb. St.	79 —82	6 4 0	Jan, July	..	..
St.	4%	Do. 4% Pref.	96 —98	4 2 6	..	97⅛	97⅛
10	..	London United Trams, 5% Cum. Pref.	85 —86	4 14 0	..	85⅛	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	3¾—4¼	..	Jan, July	..	..
St.	..	Mersey Con. Ord. Stock	74 —77	5 6 0	Jan, July	..	..
1	1/1½	Metropolitan Elec. Tramways Ord.	6 —8	..	Feb, Aug	..	..
1	..	Do. Deferred	⅝—1⅝	6 0 0	..	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	⅜—⅝	..	April	⅝	..
St.	4½%	‡Do. 4½ per Cent. Deb. Stock	1¼—1⅝	5 0 0	Feb, Aug	..	..
St.	5%	Do. 5 per Cent. Deb. Stk.	99½—101½	4 9 6	Jan, July	..	..
St.	1½%	Metropolitan Railway Consolidated	102½—104½	4 16 6	..	103	..
St.	2½%	Do. Surplus Lands Stocks	49 —49¾	2 16 0	Feb, Aug	50	48½
St.	3½%	Do. 3½ per Cent. Preference	69 —71	3 18 4	Feb, Aug	70½	68½
St.	3½%	Do. 3½ per Cent. "A" Preference	90 —92	3 16 0	Feb, Aug	90	..
St.	3½%	‡Do. 3½ per Cent. Convertible Pref.	89 —91	3 17 0	Feb, Aug	90⅜	90
St.	3½%	†Do. 3½ per Cent. Debenture Stock	92 —94	3 14 6	Feb, Aug	90½	—
						94½	92½

* No allowance has been made for accrued interest or redemption.
† Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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Share	Last Dividend	Name	Price Wed., July 19.	*Rate per cent. Yielded (£ s. d.)	Dividend Due	Business Week to July 19: Highest	Lowest
		Electric Railways and Tramways—Continued.					
St	3½%	Met. Rly. 3½ per Cent. "A" Deb. Stock	92 —94	3 14 6	Jan, July	93	91½
St	..	Metropolitan District Railway Ord.	28½—29	..	Feb, Aug	29⅛	28⅝
St	3½%	Do. 4½% First Pref.	89 —91	4 18 11	Feb, Aug	90½	89½
St	3½%	Do. Assented Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	76 —78	4 10 0	Feb, Aug	77½	—
St	3%	Do. 3 per Cent. Consoltd. Rent-charge	76 —78	3 18 0	Jan, July	77½	..
St	4%	Do. 4 per Cent. Midland Rent-charge	102 —104	3 17 9	Jan, July	..	..
St	6%	Do. 6 per Cent. Perp. Deb. Stock	145 —147	4 2 0	Jan, July	..	..
St	4%	Do. 4 per Cent. Ditto	96 —98	4 2 6	Jan, July	..	..
1	4½d.	Potteries Electric Traction Ord.	¼—⅜	5 6 9	April, Oct	98	..
1	0/6	Do. 5 per Cent. Cum. Pref.	7/32—11/32	8 6 8	Feb, Aug	15/32	..
St	4½%	Do. 4½ per Cent, Deb. Stock	88 —91	5 0 0	May, Nov	—	..
1	1/2⅗	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	13/32—15/32	10 2 0	..	—	..
St	4%	†Do. 4 per Cent. Deb. Stock	73 —78	5 6 0	Jan, July	..	..
100	5%	Sunderland Dist. Elec. Trms. 5% 1stMtDb.	..	8 4 0	Jan, July	..	..
—	10/0	UndergdE.Rys.Lon.6% In. bds with coup 7	65 —67	1 10 0	June, Dec	66	65½
—	5%	Do. 5% Prior Lien Bonds	100½—101½	4 19 0	..	..	..
—	4½%	Do. 4½% Bonds Ex coup. 8	99 —101	4 10 0	..	100½	99½
..	4%	Do. 4 per Cent. 1st Power Ho. Dbs.	101 —103	3 18 3	..	..	..
5	—	Yorkshire (W.R.) Elec. Trams. Ord.	¼—¾	..	March ..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	2⅛—2⅝	..	..	..	..
St	4½	Do. 4½ per Cent. 1st Debs.	82 —85	5 8 0	Jan, July	—	..
		Electric Manufacturing, &c.					
St	4½%	Anchor Cable Co. 4½ % Deb. Stock	98 —100	4 11 0	—	..	..
1	1/2⅔	Aron Electricity Meter Ord.	⅛—¼	..	..	..	—
1	0/7⅕	Do. 6% Cum. Pf.	11/16—13/16	7 10 0	April, Oct	¾	—
1	3/2⅔	Babcock & Wilcox Ord.	5⅛—5⅜	4 13 0	April, Oct	5 7/16	5 5/16
1	0/7½	Do. Pref.	1⅛—1¼	4 0 0	..	..	..
5	6/0	British Insulated & Helsby Cables Ord.	6⅞—7⅜	6 15 6	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	6 —6⅛	4 12 3	Jan, July	..	..
St	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	101 —103	4 7 5	Jan, July	..	..
St	4½%	British Thoms'n-Houst'n 4½% 1st Mt.Db.	96 —99	4 11 0	Mar, Sept	..	..
5	..	British Westinghouse 6 per Cent. Pref.	11/32—15/32	..	Feb, Aug	..	..
100	6%	Do. 6 per Cent. Prior Lien Dbs. (rd.)	102 —104	5 17 0	..	..	..
St	4%	Do. 4 per Cent. Mort. Deb. Stock	59 —62	6 6 6	Jan, July	..	..
St	4½%	BrushE.Eng. Co. 4½% Perp. 1st Deb.Stock	59 —64	7 0 6	Mar, Sept	103½	..
St	4½%	†Do. Perpetual 2nd Deb. Stock	39 —44	10 10 0	Jan, July	60½	—
5	10/0	Callender's Cable Con. Ord.	8¾—9¼	8 2 0	Jan, July	..	..
5	2/6	Do 5 per Cent. Cum. Pref.	4⅞—5⅛	4 17 6	Jan, July	5 1/16	..
St	4½%	Do. 4½ per Cent. 1st Mort Debs. (red.)	101 —103	4 8 0	Nov, May	102½	101
1	1/6	Castner-Kellner Alkali Co.	3 7/16—3 9/16	5 7 3	May, Nov	3 17/32	..
St	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	104 —107	4 2 6	Feb. Aug	..	..
1	1/0	Chadburn's (Ship) Telegraph Ord.	1 1/16—1 3/16	5 19 0	March ..	—	..
1	0/8⅖	Consolidated Electrical Co.	⅞—1	10 0 0	August ..	..	..
1	0/6	Consolidated Signal Co.	11/16—13/16	6 13 6	April, Oct	—	..
1	0/7½	Do. 6 per cent. Cum. Pref.	⅞—1	7 6 6	April, Oct	..	..
3	..	Crompton & Co (Nos. 1 to 85,000)	⅛—¼	..	Jan, July	..	..
100	5%	Do. 5 per Cent. 1st Mort. Debs. (red.)	57½—67½	8 0 0	Jan, July	..	..
5	1/0	Dick, Kerr & Co. Ord.	11/16—13/16	5 14 0	Sept.	..	..
5	0/7⅕	Do. 6 per Cent. Cum. Pref.	31/32—1 1/32	5 6 0	Sept	..	..
St	4½%	Do. 4½ per Cent. Deb. Stock	95 —98	4 13 3	Jan, July	..	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	9/16—11/16	..	Feb, Aug	..	..
..	..	Do. (£5 paid)	1⅞—2⅛	9 3 0	Feb. Aug	..	..
St	4%	Do. 4 per Cent. Mort. Deb. Stock (red.)	67 —71	5 16 0	June, Dec	..	..
St	5%	Do. 5 per Cent. 2nd Deb. Stock	78 —81	6 3 6	Mar, Sept	..	..
..	..	Edmundson's Elec. Corp. Ord.	9/16—11/16	..	Jan, July	..	..
5	..	Do. 6 per Cent. Cum. Pref.	2 —2⅛	..	May, Nov	2½	2½
St	4½%	Do 4½ per cent. 1st Mort. Deb. (red.)	84 —87	5 3 4	Jan, July	86	..
2	..	Electric Construction Co.	⅜—⅞	..	Jan, July	..	..
2	2/9⅗	Do. 7 per Cent. Cum. Pref.	1 15/16—2 1/16	7 0 0	July	..	..
St	4%	†Do 4 per Cent. Perp. 1st Mort. Debs.	73 —78	5 2 8	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	8½—9	5 14 0	June, Dec	..	..
St	4%	Do. 4 per Cent. 1st Mort. Debs	88 —93	4 8 6	Mar, Sept	..	..
5	10/0	Henley's Telegraph Works Ord.	12½—12⅞	5 16 6	Feb, Aug	12 7/16	12½
5	2/3	Do. 4½ per Cent. Pref.	4⅞—5⅛	4 10 0	Feb, Aug	5 1/32	..
St	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	105 —108	4 4 6	Mar, Sept	..	..
10	15/0	India Rubber, Gut. Per., &c., Works	11½—13½	6 0 0	Feb, Aug	12	..
10	5/0	Do 5 per Cent. Cum. Pref.	10⅛—10⅜	4 17 0	..	10 3/16	10½
100	4%	Do. 4 per Cent. Debs. (red.)	96 —98	4 1 6	April. Oct	..	..
1	..	National Elec. Construction Co.	1/16—3/16	..	April	..	..
1	..	Richardsons, Westgarth & Co., Ltd. Ord.	9/32—11/32	..	Nov	..	..
1	..	Do. 6 per Cent. Cum. Pref.	⅜—7/16	..	May, Nov	..	..
St	4½%	†Do. 4½ per Cent. Perp. Deb. Stock	77 —80	5 14 6	Jan, July	..	..
5	..	Simplex Conduits 6 per Cent. Cum. Pref.	4⅞—5	..	..	..	..
12	12/0	†Telegraph Construction & Maintenance	35¾—37¼	5 18 0	Mar, July	36	..
100	4%	†Do. 4 per Cent. Deb. Bonds (1909)	99 —101	4 0 0	Jan, July	..	..
1	1/0	Vickers, Sons & Maxim, Ltd., Ord.	2 1/32—2 3/32	4 14 0	..	2 1/16	2½
1	0/6	Do. 5 per Cent. non-Cum. Preference	1 1/16—1 3/16	4 3 0	..	1⅛	—
St	5%	Do. 5 per Cent. non-Cum. Preferred	105 —112	4 11 0	..	109½	—
St	4%	Do. 4 per Cent. 1st Mort. Db. Sk. (red)	99 —101	3 19 2	June, Dec	101½	99½
100	4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.)	102½—104½	4 7 0	June, Dec	..	..
100	5%	Do. 5 per Cent. 3rd Mort. Debs Scrip	103 —105	4 16 0	..	103	..
10	12%	J. G. White & Co. 6% Cum. Pref.	14½—15½	7 14 10	..	15	14½
1	..	Willans & Robinson Ord.	⅜—⅝	..	Apr, Oct	..	..
5	..	Do. 6 per Cent. Cum. Pref.	¾—1	..	Apr, Oct	..	..
St	4%	Do. 4 per Cent. 1st Mort. Debs.	55 —65	6 3 0	May, Nov	..	—
		Telegraphs.					
10	..	Amazon Telegraph	7⅜—7⅞	..	June, Dec	..	..
10	5%	†Do. 5 per Cent. Debs. (red.)	98 —100	5 1 0	Jan, July	..	..
St	15/0	Anglo-American	69 —71	4 4 6	F,My,Ag,N	69½	..
St	30/0	Do. Preferred	113¾—114¼	5 5 11	F,My,Ag,N	114⅛	113¾
St	30/0	Do. Deferred	26⅛—26⅜	4 19 7	F,My,Ag,N	26⅛	26 1/16
St	4%	Commercial Cable 4 per Cent. Deb. Stk.	87½—89½	4 10 6	Jn,Ap,Jy,O	88½	87½
10	6/0	Cuba Submarine Ord.	10 —10½	4 17 6	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	17½—18½	5 13 0	Feb, Aug	17½	..
4	2/0	Direct Spanish Ord.	3½—4	5 0 0	April, Oct	..	..
4	3/0	Do. 10 per Cent. Cum. Pref.	8⅜—8⅞	5 16 0	April, Oct	—	..
5	4½%	Do 4½ per Cent. Deb.	99 —101	4 10 0	Jan, July	..	..
1	3/0	Direct United States Cable xd and bonus	7½—8	6 18 0	Ja,Ap,Jy,O	7 13/16	7⅞
10	4½%	Direct West India Cable 4½%Rg.Do.(rd.)	98 —100	4 11 0	June, Dec	..	..
St	25/0	†Eastern Ordinary xd and bonus	136 —139	5 12 4	Ja,My,Jy,O	139½	136½
St	17/6	†Do. 3½ per Cent. Pref. Stock	81 —85	4 2 10	Ja,My,Jy,O	85¼	84½
St	4%	Do. 4 per Cent. Mort. Deb. Stk. (red.)	101 —103	3 18 3	May, Nov	103	102½
St	2/6	†Eastern Extension	13¼—13¾	5 4 0	Ja, Ap,Jy,O	13⅝	13 7/16
10	4%	Do. 4 per Cent. Deb. Stock	101 —103	3 18 3	Feb, Aug	..	..
25	4%	Eastern and S.Af., 4% Mauritius Sub.Debs	99½—101½	3 19 0	May, Nov	100	..
10	5/0	G.N. (of Copenhagen), with Coupon 83	31 —32	5 14 3	Jan, July	—	..
25	52/6	Indo-European	56½—58½	5 6 6	May, Nov	—	..
100	5%	Mackay Companies Common	92 —94	5 5 0	Ja,Ap,Jy,O	..	..
100	4%	Do. Preference	75 —77	5 2 0	Ja,Ap,Jy,O	..	..
1	..	Marconi's Wireless Teleg. Co.	2 9/32—2 9/32	..	April	2 9/32	2
100	4%	Pacific & Europe'n Tel.4%Guar.Dbs.(red.)	99 —101	4 0 0	June, Dec	..	..
2	1/3	West Coast of America	1⅛—1¼	5 0 0	May	..	..
100	4%	Do. 4 per Cent. Debs.	97½—99½	4 1 6	Jan, July	..	..
10	1/6	West India & Panama	2¼—2¾	4 18 9	May, Nov	2½	2½
10	6/0	Do. 6 per Cent. 1st Pref.	10½—10⅞	5 16 6	May, Nov	10½	10
10	6/0	Do. 6% 2nd Pref.	9½—10	6 4 6	May, Nov	..	..
100	5%	Do. 5 per Cent. Debs.	101 —103	4 18 0	Jan, July	..	..
10	3/0	Western Telegraph	13¾—14¼	5 1 1	Mr,Jn,O,D	14 1/16	13⅞
St	4%	Do. 4 per Cent. Deb. Stock (red.)	99 —101	4 0 0	June, Dec	—	—
..	4%	Western Union Telegraph, $1,000 4% Bds	105 —108	3 14 0	—	—	—
—	4½%	Do. $1,000 4½% Fdg. & Rl. Est.Gd.Bnds	99½—102½	4 9 3	—	—	—

Share	Last Dividend	Name	Price Wed., July 19.	*Rate per cent. Yielded (£ s. d.)	Dividend Due
		Telephones.			
100	2$	Amer. Telephn. & Telegh. Cap. St.	142 —144	5 12 2	—
..	4%	Do. Coll. Trust $1,000 4 per Cent. Bds.	94 —96	4 4 0	Jan. July
St	4%	Do. 4% Cons. Bonds 1936	114 —116	3 9 0	....
St	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101 —103	4 17 0	Mar, Sept
5	3/0	Chili Telephone	6⅞—7⅛	4 4 4	August ..
1	0/7⅕	Monte Video Telephone Ord.	⅞—1	6 0 0	Nov ....
1	0/6	Do. 5 per Cent. Pref.	¾—⅞	5 11 0	May, Nov
St	6%	National Co. Pref. Stock	105 —106½	5 12 8	Feb, Aug
St	6%	Do. Def. Stock	122 —125	4 16 0	Feb, Aug
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	10 —10⅜	5 11 6	Feb, Aug
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10 —10⅜	5 11 6	Feb, Aug
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.	5⅜—5⅝	4 8 11	Feb, Aug
St	3½%	Do Deb. Stock 3½ per Cent. (red.)	98 —100	4 1 0	June, Dec
St	4%	Do. 4 per Cent. Deb. Stock (red.)	98 —100	4 1 0	Jan, July
..	4½%	New York Telephone Co. 30 yr. Bnds.	102½—103½	4 7 0	....
1	1/0	Oriental	1 1/16—1 3/16	4 18 0	April, Oct
1	0/7⅕	Do 6 per Cent. Cum. Pref.	1⅛—1¼	4 16 0	April, Oct
St	4%	Do. 4 per Cent. Red. Deb. Stock	87 —89	4 9 10	Jan, July
St	4½%	Telephone Co. of Egypt 4½%Db.Stk.(red.)	98 —100	4 11 9	Jan, July
5	3/0	United River Plate Ord. (1—150.000)	7¾—8	5 2 2	July ....
5	4½%	Do. (150,001—190,000)	7⅜—7⅞	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅛—5⅜	4 13 0	June, Dec
St	4½%	Do. 4½ Deb. St. Red.	101 —103	4 8 0	Jan, July
		Financial, Investment, &c.			
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4 —4¼	7 1 0	Jan, July
10	6/0	Globe Telegraph & Trust	10¾—11¼	5 6 8	Sp,DcMrJu
10	3/0	Do. 6 per Cent. Pref.	13 —13½	4 10 9	Sp,DcMrJu
10	6%	Submarine Cables Trust (Cert.)	131 —134	4 9 6	April, Oct
		Colonial and Foreign Electric Railways, Tramways, &c.			
5	2/9	Anglo-Argentine 5% Cum. 1st Pref.	5 —5¼	4 17 6	April, Oct
5	2/9	Do. 5% Cum. 2nd Pref.	4 13/16—5 1/16	5 1 6	Jan, July
St	4%	Do. 4% Deb. Stock	94 —96	4 3 4	June, Dec
St	4½%	Do. 4½% Deb. Stock	99 —101	4 10 0	..
St	5%	Do. 5% Deb' Stock	100 —102	4 19 0	..
St	5%	Auckland Elec. Trams. 5% Deb. (red.)	102 —104	4 17 6	Jan, July
5	4/0	Brisbane Electric Trams. Invest. Ord	6⅜—6⅞	6 1 0	May ....
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5¼	4 17 6	May, Nov
St	4½%	Do. 4½ per Cent. Db. Prov. Certs.	102 —105	4 7 0	Jan, July
St	8%	British Columbia El..Rly. Df.Ord.	140 —144	5 11 1	Mar, Sept
St	6%	Do. Pref. Ord. Stock	120 —124	4 16 10	May, Nov
St	5%	†Do. 5% Cum. Perp. Pref. Stock	107 —110	4 10 11	Jan, July
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	100 —103	4 7 6	April, Oct
100	4½%	†Do. Vancouver Power Debs.	101 —104	4 3 3	Jan, July
St	4½%	Do. 4½% Perp. Con. Deb. St.	101 —103	4 2 6	..
St	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	100 —102	4 18 0	Mar, Sept
St	6%	Buenos Ayres Port & City Tram, 1st Mt. Deb. Stock	95 —99	6 4 0	Feb, Aug
5	3/6	Calcutta Tramways (1 to 137,610)	5¾—6¼	4 19 6	Mar, Sept
100	2/6	Do. 5 per Cent. Cum. Pref.	5 —5¼	4 17 6	Jan, July
1	4½%	Do. 4½% 1st Deb. Stock (red)	102 —105	4 5 9	Jan, July
St	..	Cape Electric Tram Shares	⅜—7/16	..	..
5	1/3	City of Buenos Ayres Trams Co. (1904) Sh.	5⅜—5⅝	4 5 0	F,My,A,N
St	4%	Do. 4 per Cent. Deb. Stock	94 —97	4 4 0	June, Dec
..	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.	95 —100	5 2 6	May, Nov
1	5%	†Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	99 —102	4 18 0	Feb, Aug
100	5%	Hong Kong Tramways Co. 5 per Cent. 1st Mort. Debs.	77 —81	6 6 6	June, Dec
1	..	Kalgoorlie Elec. Trams Sh.	1/32—5/32	..	..
100	5%	Do. 5 per Cent. "A" Deb. Stock	92½—95½	5 4 6	Jan, July
5	6%	Do. 6 per Cent. "B" Ditto	63 —67	8 15 0	Jan, July
5	0/6	Lisbon Elec. Trams. Ord.	1 —1¼	4 16 0	July ....
100	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1¼	4 16 0	Jan, July
St	5%	Do. 5 per Cent. Reg. Mort. Debs.	97 —101	5 1 0	Jan, July
St	5%	Madras Elec. Trams. 5% Deb. Stk.	95 —98	5 3 6	Jan, July
100	5%	Manaos Trams and Lt. Co. 5% Debs	90½—93½	5 8 6	..
..	5%	Manila Elec. Ry. $1,000 Gold Bonds	99½—101½	5 0 0	Feb, Aug
100	$1½	†Mexico Trams Co. Com. St.	121 —123	5 13 1	..
..	5%	Do. Gen. Con. 1st Mort. 5% Gold Bds.	97 —98	5 2 3	..
St	6%	Do. 6% 50 yr. Mort. Bds.	99 —101	6 1 3	—
St	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922) (Nos. 601 to 2,000)	101 —103	4 7 6	Feb, Aug
St	4½%	Do. do. (Nos. 1 to 4,600)	102 —104	4 7 6	..
1	0/6	Perth Elec. Trams Ord.	⅝—⅞	2 7 2	May ....
St	5%	Do. 1st Mt. Db. Stock	101½—103½	4 17 6	Jan, July
5	3/0	†Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	5⅜—5⅝	5 8 0	—
St	4½%	Do. 4½% 1st Mort. Deb. Stk.	97 —100	4 11 6	—
100	$1½	†Rio Janeiro Tram, Lt. & P. Co.	116½—117½	4 5 1	—
..	5%	Do. 30 yr. Gold Bnds.	101 —102	4 18 0	—
100	5%	Do. 50 yr. Mt. Bnds	97 —98	5 2 0	—
..	$2½	Sao Paulo Tramway, Light & Power Co. $100 Stock	183 —186	5 7 3	..
..	5%	Do. 5 per Cent. 1st Mt. $500 Db.	103 —105	4 15 3	June, Dec
100	4½%	Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	93 —100	4 10 0	Feb, Aug
		Colonial and Foreign Electricity Supply, &c.			
10	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	5½—5¾	5 8 0	Mar, Sept
St	6/0	Bombay E.S. & T. 6% Cm. Pf.	10⅝—11⅜	5 5 6	..
..	4½%	Do. 4½ per Cent. Deb. Stk. (red)	96 —98	4 12 9	Jan, July
5	5%	Do. 5 per Cent. 2nd Mort. Deb. Stock	96½—98½	5 2 6	..
5	5/0	Calcutta Elec. Supply Ord.	6⅞—7¼	5 19 6	April, Oct
100	2/6	Do. 5% Cum. Pref	4⅞—5⅛	4 13 0	..
100	5%	Calgary Power Co. 5% 1st Mort. Bnds.	96 —98	5 2 0	—
100	7/2½	Canadian Gen. Elec. Co. Com. St.	110 —113	6 6 3	..
100	$3½	Do. 7% Cm. Pf. Stock	120 —123	5 15 0	—
500	5%	Castner Electrolytic Alkali Co. (of U.S.A.) 1st Mort. Stl. Debs.	94 —99	5 3 6	Jan, July
St	5%	Elect Development Co. of Ontario	£85½—88½	5 11 6	..
5	5%	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	84½—87½	5 4 0	Jan, July
10s	..	Indian Elec. Sup. & Trac. Co.	1 —1¼	..	..
1	..	Kalgoorlie Elec. Power & Ltg. Ord.	1/16—3/16	..	..
..	0/7⅕	Do. 6 per Cent. Cum. Pref.	13/32—15/32	8 6 6	April, Oct
5	5%	Kaministiquia Power Co. 5% Gold Bnds.	101 —103	4 18 0	..
St	..	Madras E. S. Corp. Ord.	2¾—3¼	..	..
St	..	Melbourne E. S. Co. Cons. Ord. St.	36 —41	..	..
500	5%	Do. 5% 1st Mortg Deb. Stock	95 —97	5 4 0	—
St	5%	Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	88 —89	5 12 4	—
St	$1	†Mexican Lt. & Power Co. Com. St.	85 —87	4 13 1	..
500	$3½	Do. 7% Cum. Pref. St.	107 —109	3 4 11	—
St	5%	Do 5% 1st Mort. Gold Bnds.	97 —98	5 2 0	..
100	5%	†Monterey Rly. L. & P. Co. 1st Mort. Db. Sk.	89 —91	5 9 10	..
100	8/2½	Montreal Lt. Ht. & Power Co. Cap. St.	173 —177	5 14 0	F,My,A,N
St	5%	Northern Lt. Power & Coal 5% Gd. Bds	43 —45	11 4 6	..
St	£10	River Plate Electricity Co. Ord. Stk.	218 —228	4 7 9	April ....
St	6%	Do. 6 per Cent. non-Cum. Pref. Stk.	107 —114	5 5 0	May ....
100	5%	Do. 5 per Cent. Deb. Stock	101½—103½	4 17 6	Jan, July
..	$1½	†Shawinigan Water & Power Co. Ca.	119½—121½	4 2 3	—
St	5%	Do. 5 per Cent. Bds.	107 —109	4 12 6	Jan, July
St	4½%	Do. 4½ Per Con. Mt. Db. St.	103 —105	4 6 0	—
—	4½%	Toronto Power Co. 4½% Db. St.	99 —101	4 8 0	—
1	11·85	Victoria Falls Power Co. Pref.	31/32—1 1/32	—	Jan, July

* No allowance has been made for accrued interest or redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

Electricity in Mines.

The debate in Committee on the Coal Mines Bill has been characterised by a certain want of knowledge on technical points. As an instance, we may mention the amendment proposed by Sir Arthur Markham to the effect that if in any place of a mine or part of a ventilated district of a mine the amount of inflammable gas in the air current exceeds one-half per cent. the use of electricity shall at once be discontinued in such places until the air current is clear or shall not contain more than the above amount of such inflammable gas. In order to make tests in regard to this point, safety lamps are to be provided which shall be capable of showing low percentages of gas, and such tests are to be carried out twice during every working shift by a competent person. Sir Arthur Markham evidently does not know much about gas analysis or he would not suggest a safety lamp as an instrument whereby to determine whether the amount of gas in the air is more or less than one half per cent. Apart from gas, there is the question of coal dust, so that a regulation of this kind would be practically unworkable. The Government objected that such a regulation would probably mean prohibition where safety lamps as well as naked lamps were used and that they could not enforce a condition of this kind without inconvenience to the management and to those working in the mine. Nevertheless, the amendment was mainly carried. It seems unfortunate that these matters should be arranged by people who are so ignorant of the technical points involved as an average member of the House of Commons.

The Education of Engineers.

In our correspondence columns this week Dr. Stanley P. Smith makes the somewhat startling assertion that the technical training of engineers in this country is by no means general; he goes on to state that in many of the departments of engineering faculties scarcely a dozen students reach the final year's course, and that in many colleges half this number would be nearer the figure. We scarcely think that this assertion can be maintained. Unfortunately, we have no means at our disposal for verifying such a figure; but as examples we may say that the average number of third-year engineering students in the City and Guilds (Engineering) College from 1906 to 1911, both inclusive, was 118, the lowest figure being 111 in 1906 and the highest 123 in 1909. At University College, the total number of students in engineering has seldom fallen below 100. Of course, there has been some falling-off in recent years in many cases, and this may be traced partly to the great multiplication of engineering faculties in provincial colleges and universities. This has very naturally had the effect of distributing the students more widely and diminishing them at some places, though probably the total number is larger than it was before. Further, the electrical industry has not been in a flourishing condition during the past few years, and this also must have produced some effect, at least in this particular branch of engineering.

We should certainly have thought that most engineers would by now have had some technical college training either at the City and Guilds Colleges, University College, King's College, Faraday House, the Northampton Institute, or some other technical school of University rank. On the other hand, when it comes to artisan apprentices, we think Dr. Smith is correct in taking the view that in Germany and other Continental countries the theoretical training is better than in this country. We believe that Continental

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foremen have a much better theoretical knowledge than our foremen, and are consequently able to deal with work on a broader basis.

WITH regard to engineering degrees, and generally degrees of any kind, we think that Dr. SMITH is right in saying that they carry little or no weight. The reason for this is not far to seek and has been emphasised by Dr. J. A. FLEMING on more than one occasion, but we may well recapitulate some of the points he has raised. Such degrees are awarded too much as the result of written examination work instead of on practical laboratory work. The questions set are generally academic instead of being concerned with really practical problems, and the questions have to be answered without reference to books and against time. The result is that the man with a good memory is at an undue advantage, whereas, in practical work memory does not play such an important part.

OWING to the fact that students are keen on degrees the decision arrived at by the University of London some few years ago to give degrees in engineering has reacted in an undesirable way upon the teaching in our technical colleges. Instead of ample time being given to laboratory work, this is now sacrificed to the acquirement of book knowledge which will be useful in the examination. Although a certain amount of such knowledge is very desirable, more harm than good is done by overloading the memory in this way, for in actual life it is more important to know where information is to be found than to carry it in the memory. Initiative and the power of overcoming difficulties in actual practice are the most important qualities in an engineer, but they are by no means developed by this class of work. We agree with Dr. FLEMING that if engineering degrees are to be given they should be awarded under more practical conditions, and then, no doubt, they would be accepted as being of practical value.

The Official Secrets Bill.

ELECTRICAL engineers, whose business it is to deal with the supply of energy for lighting and power, are, we suppose, in general too occupied with that business in times of peace to consider the possible importance of the plant under their charge in time of war. That our rulers are not however oblivious to the strategical importance of electric generating stations is shown by clause 3 of the new Official Secrets Bill, which was introduced the other day by Lord HALDANE. This clause defines a "prohibited place" under the Act; this may include, besides works of defence, arsenals, dockyards and ships, any railway, road, way or channel or other means of communication, by land or water, or any place used for gas, water or electricity works. Before, however, such a place can be placed under the working of the Act, it has to be declared "prohibited" by a Secretary of State, on the ground that information with respect thereto, or interference therewith, would be useful to an enemy. The communication of information or retaining unauthorised information regarding a "prohibited place" is a misdemeanour under the Act and is punishable by imprisonment for not exceeding two years, with or without hard labour, or by a fine, or by both fine and imprisonment. Any person who "for any purpose prejudicial to the safety or interests of the State," approaches or is in the neighbourhood of a "prohibited place," or "makes, obtains or communicates any sketch, plan, model, article, note or other document or information" which might be or is intended to be directly or indirectly useful to the enemy, is guilty of a felony punishable by penal servitude. A person may be punished under this Act without being proved guilty of any particular action, if from his known character it can be proved that his purpose was prejudicial to the State. Inciting a person to commit an offence under this Act is a felony or misdemeanour, as the case may be, while harbouring spies is also an offence punishable by imprisonment.

IN our opinion the military authorities are quite right in recognising the importance to the enemy of information regarding such places as generating stations. Nothing is more prejudicial to the success of surprise night attacks than good illumination, and before part of a modern town of any size were invested it would therefore be the object of any enemy to cut off the supply of artificial light. For this reason any details regarding the position of the station and the arrangement of the plant in it and, more important still, the roads along which the mains were laid would be of great utility. Supply engineers might, therefore, now be saddled with the further responsibility of keeping details regarding their system and plants from "anxious enquirers" of every nationality. On the other hand, the whole force of such an Act lies in the way it is administered and, if precedent is anything to go by, we do not anticipate it will press very hardly on the ordinary electrical citizen.

"Tramways and Light Railways Legislation of the Future."—The concluding Paper read at the recent Congress of the Tramways & Light Railways Association at Edinburgh was by Ald. Wm. Ivey, and dealt with the above subject. The author described past tramway legislation at great length, and showed how the existing Acts should be modified to meet present and future requirements. Among the improvements suggested the abolition of the local veto was insisted upon. In conclusion, a model Bill embodying several proposed new clauses was sketched out.

The London Telephone Service.—"The Times" announces that a telephone conference of municipal representatives in the London telephone area (over which the Lord Mayor has undertaken to preside) will be held at the Guildhall in October. The efforts of the conference will, it is said, be directed towards deciding whether a flat rate shall be demanded or whether the Postmaster-General shall be asked to institute some other tariff. If the conference decides for a flat rate, efforts will be made to secure a maximum subscription of £10 per annum. Resolutions will be submitted calling upon the Postmaster-General—[Query, the Government?—ED. E.]—not to permit the telephone to be controlled by a Government Department and asking that a Board, on the lines of the Port of London Authority, shall be established, such Board to include representatives of the Post Office, the municipalities, traders and private telephone users. It seems to us that the conference would be well advised to stick to one thing at a time. The question of a Board is the important point; the subject of tariffs cannot be understood by the average layman.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair
Assab—Perim	July 8, 1909 ...	—
Latakia—Palura	May 26, 1910 ...	—
Zanzibar—Mombasa	July 11, 1911 ...	—
Bathurst—Bissao	July 11, 1911 ...	July 22, 1911
Guam—Manila	July 12, 1911 ...	—

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Electrolytic Disinfecting Fluid at Poplar.—The report of Dr. F. W. Alexander, Medical Officer of Health to the Metropolitan Borough of Poplar, shows that 50,726 gallons of electrolytic disinfecting fluid were made by the department during 1910. This included the fluid distributed to private inhabitants at the various depôts and the amounts used at the public baths, the workhouses, farm colony, asylum, electricity works and County Council schools. The cost of material and manufacture was £98, of which £50 was for electrical energy at 1½d. per unit. The plant is in good working order.

University of Yale.—It is announced that Mr. Chas. F. Scott has been appointed professor of electrical engineering at this University. This appointment is another example of the American practice of appointing men thoroughly trained in the commercial side of engineering work to high scholastic posts. Mr. Scott, after studying at the Ohio and Johns Hopkins Universities, entered the test room of the Westinghouse Electric & Mfg. Co. In 1897 he was appointed the company's chief electrician and in 1904 he became its consulting engineer. He was president of the American Institute of Electrical Engineers in 1902-03.

Proposed Memorial to the late Prof. J. Joubert.—It has occurred to a number of old fellow-workers, pupils and friends of the late Prof. Joubert that the time has now come when a memorial to his memory should take some concrete form. The proposal has received the approval of the Union des Physiciens, L'Institut Pasteur, La Société Française de Physique and La Société Internationale des Electriciens, while L'Academie des Sciences and L'Ecole Normale have also given the idea their support. A committee to deal with the question has been formed, and has decided that the memorial shall consist of scholarships at L'Ecole Supérieure d'Electricité, Le Collège Rollin, Le Lycée Fénélon and Le Lycée de Tours. Subscriptions should be sent to M. Gauthier-Villars, imprimeur-éditeur, 55, Quai des Grands-Augustins, Paris.

Electric Power on the Rand.—Interest was created by a statement published in the "Financial Times" a few days ago to the effect that steam power was to replace electric power on the Rand, because the latter had failed to rise to the occasion. The statement having been traced to its source, it was found that a report issued by the Victoria Falls & Transvaal Power Co. stated that, owing to the enormous demand for power on the Rand the old steam engine plants had been commandeered to supplement the electric supply pending the installation of the larger electric units now in course of erection or on order. This is, of course, quite another story. The economies effected by the introduction of electric power into the mines in the Witwatersrand District of South Africa have been very large, and the remotest possibility of steam plant being more than assisting in tiding over a period of stress or serving as a standby may be at once dismissed. Mr. A. W. Judd, secretary of the Victoria Falls & Transvaal Power Co., states that the statement of the chairmen at the recent meetings of the General Mining & Finance Co., and of the New Goch Co., that the saving by the change-over from steam power to purchased electric power is equal to 7·28d. per ton milled forms a complete reply to the statement published by the "Financial Times."

Current Topics.

Subjects of current interest dealt with in this issue include the following:—

An article by Mr. J. R. Dick deals with the resonance effects that occur in cables and their influence on breakdowns.

In a Paper (of which we give an abstract) read before the Tramways & Light Railways Association, Mr. C. W. Mallins goes into the question of the variations in first cost and cost of upkeep that exist in tramways operating in this country under very similar conditions.

Mr. E. Shepherd, in a Paper read before the same Association, discusses the advisability or otherwise of adopting transfer fares on tramway systems.

We give the first part of a description of the electrical equipment on board the new White Star liners "Olympic" and "Titanic."

We give an abstract of a report on Prime Movers which was submitted by a Committee to the National Electric Light Association at their recent meeting.

We conclude our report of the recent Engineering Conference organised by the Institution of Civil Engineers.

We give a short description of the petrol-electric equipment which has been installed on the "Electric Arc."

An excellent report is made by the Portsmouth Electrical departments, a total profit of £11,000 being shown, £6,000 on the tramways, £4,500 on electricity supply, and £500 on the telephone department. £9,500 is contributed towards the rates.

Abstracts are given of the accounts of Bristol, Broughty Ferry, Hammersmith and Weymouth electricity supply undertakings, and the Cardiff electricity supply and tramway departments.

Budapest Municipal Council are advertising for tenders for turbo-generators, boilers, &c.

Birmingham City Council decided on Tuesday to enter into an agreement to purchase for £151,500 the whole of the interests of the City of Birmingham Tramways Co. and the British Electric Traction Co. in Aston Manor, King's Norton and Northfield and Yardley.

Parliamentary.—A Select Committee of the House of Lords has this week considered the Rotherham Corporation Bill, which seeks powers for tramway extensions, the running of rail-less trolley vehicles, &c.

A House of Lords Committee has been considering the Greater London Railway Bill this week.

The Telegraph Construction Bill has been before a House of Commons Select Committee this week.

The Gloucester Corporation Bill came before the Chairman of Committees in the House of Lords last week when the new model clause as to wiring was inserted, and the Bill ordered to be reported for third reading.

The Brighton, Hove & District Rail-less Traction Bill will now go forward unopposed.

A House of Lords Special Committee has passed the London, Tilbury & Southend Railway Bill, which authorises the electrification of the line.

A House of Lords Committee has ordered the London County Council (Tramways and Improvements) Bill to be reported with amendments.

Legal.—The proceedings in the Court of Appeal in connection with the West Hartlepool Tramway transfer are of more than passing interest. The Hartlepool Electric Tramways Co. (Ltd.) and Messrs. Sellon & Ashby, the promoters of the tramways, were again successful.

Mr. Justice Swinfen Eady concluded the hearing of the action by the Thermal Synd. (Ltd.) against Silicaware (Ltd.), and has reserved judgment.

Mr. Justice Swinfen Eady on Monday declined to grant an application by the Electrical Co. for a variation of the judgment in the patent action recently brought against them by the British Westinghouse Co.

The Court of Appeal has allowed the appeal of the Central London Railway Co. against a decision of Mr. Justice Swinfen Eady with regard to land tax on a portion of the Company's works or property under the public highway.

At the County of London Sessions the appeals of the Gt. Western & Metropolitan Railway Companies in reference to the assessment of the Hammersmith & City Joint line in Kensington and Hammersmith were allowed, and the assessments reduced.

The Lord Chief Justice, Mr. Justice Lawrence and Mr. Justice Avory on Friday granted a rule nisi for a mandamus to Islington Council calling upon them to show cause why they should not have five testing stations to their electric lighting undertaking.

Fines were inflicted upon the Newcastle & District Electric Lighting Co. in consequence of the fatal accident to Mr. Middleton on April 6 last.

Companies' Meetings and Reports.—The Directors of the Mersey Railway Co. are able to make another good report showing an increase in revenue and large decrease in working expenses.

In this issue are reports of the meetings of the National Telephone Co., City & South London Railway Co., the Madras Electric Supply & Tramways Co., the Metropolitan Railway Co., the Electric & General Investment Co., and abstracts of the directors' reports of the Anglo-American Telegraph Co., Crompton & Co., the London, Brighton & South Coast and Central London Railway Companies, the Dublin United Tramways Co., South American Light & Power Co., the Lanarkshire Tramways Co.

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OBITUARY.

ARTHUR STREET.—We regret to state that Mr. A. Street, assistant electrical engineer to Batley Corpn., received fatal injuries in a motor bicycle collision at Allwoodley on Monday morning. He was riding at the time with a friend, Mr. Arthur B. Chappel, of Shipley, and during a momentary turn to look back Mr. Street's front wheel caught the rear wheel of Mr. Chappel's machine. He fell over on his head, fracturing the base of the skull. He was at once driven to the infirmary near by, but succumbed to his injuries before reaching there. Mr. Street, who was much respected, leaves a widow and five children, the eldest only 11 years of age.

PERSONAL NOTES.

Mr. Gerald Hooghwinkel, M.I.E.E., M.I.M.E. (Messrs. Hooghwinkel Anthony Brown & Partners, and director of the San Luis (Mexico) Tramways, Ltd.), is leaving for Mexico and Cuba on 29th inst. on professional business, and also to prepare for the electrification of the San Luis Company's lines.

APPOINTMENTS VACANT AND FILLED.

Shanghai Municipal Council require for their electricity department an assistant clerk with experience in the office of a firm of electrical contractors. Three years' engagement. Salary about £24 per month. Free second class passage. Applications to Messrs. Preece, Cardew & Snell, 8, Queen Anne's-gate, London, S.W., by Aug. 3. See also an advertisement.

Test room assistants are required for adjusting and calibrating a.c. and d.c. ammeters, voltmeters and wattmeters; also for adjusting watt-hour meters. See advertisement.

The Rochester, Chatham and Gillingham Joint Higher Education Sub-Committee require a lecturer for engineering subjects. Commencing salary £150. Forms of application &c., from Mr. R. L. Wills, M.A., 2, Military-road, Chatham, to whom applications by Aug. 9.

A demonstrator or assistant lecturer is required in the physics department of the University College of Wales, Aberystwyth. Salary £150. Applications to the Registrar by Aug. 24.

York Electricity Committee have recommended the appointment of Mr. Rayner, of Rhondda, as charge engineer, at £91 per annum.

INSTITUTIONS AND SOCIETIES.

British Association.—We give below a list of Discussions and Papers which will be read before Section A of this Association at the forthcoming meeting at Portsmouth: Discussion on "The Principle of Relativity," opened by Mr. E. Cunningham; on "Stellar Distribution and Movements," opened by Mr. A. S. Eddington; and on "Mechanical Flight" (in conjunction with Section G), opened by Mr. A. E. Berriman. Papers on "Great Boundary Waves; Parallactic Tides set up in the Bottom Layers of the Sea by the Moon," by Prof. A. Petterson; "On the Infra-red Spectrum," by Major E. H. Hills, F.R.S.; "On Peculiarities in the Absorption of Salts by Silica," by Prof. F. T. Trouton, F.R.S.; "On the Reflection of Sound by Air Currents," by Prof. F. R. Watson; "On the Corpuscular Nature of Rays," by Prof. W. H. Bragg, F.R.S.; "On the Properties of the Radiation Producing Aurora Borealis," by Prof. L. Vegard; and "A Friction Permeameter," by Mr. W. H. F. Murdoch.

Associated Municipal Electrical Engineers (Greater London).—This Association held its annual general meeting at the Institution of Electrical Engineers on July 5, when the following executive officers were appointed for the Session 1911/1912. *President:* Mr. W. C. P. Tapper (Stepney); *Vice-Presidents:* Messrs. F. A. Bond (Battersea), L. L. Robinson (Hackney) and A. H. Shaw (Ilford); *Hon. Treasurer:* Mr. G. G. Bell (Hammersmith); *Hon. Auditors:* Messrs. J. G. Bruce (Willesden) and E. Calvert (Finchley); *Hon. Secretary:* Mr. N. Staniland (Hornsey); *Council:* Messrs. S. W. Baynes (St. Pancras), J. H. Bowden (Poplar); H. H. Couzens (West Ham), C. S. Davidson (Barnes), A. J. Fuller (Fulham), F. Hill (Hammersmith), W. Innes (Poplar), C. Newton Russell (Shoreditch), P. E. Rycroft (Heston), E. Sayer (Hampstead), A. H. Seabrook (St. Marylebone) and W. C. Ullmann (East Ham.)

EDUCATIONAL NOTICES.

University of Sheffield.—The faculty of applied science comprises the departments of engineering, metallurgy, coal mining and architecture. The courses in engineering or in metallurgy extend over three years and prepare respectively for the degree of B.Eng. or B.Met. of the university. The lecture courses commence on Oct. 4, and the technical laboratory courses on Sept. 18. Prospectuses and other particulars from the registrar, Mr. W. M. Gibbons.

University of Manchester.—Prospectuses giving full particulars of the lectures and laboratory courses in physics preparing for both the ordinary and honours degrees, will be forwarded on application to the Registrar.

City and Guilds Technical College.—This college provides a scientific training for students preparing to become electrical and mechanical engineers or chemists, and for engineering pupils who desire to supplement their practical training by a two years' course of instruction in the principles of engineering science. There are also arrangements for three-year courses in engineering. Particulars at the college, Leonard-street, City-road, London, E.C., or from the City and Guilds of London Institute, Gresham College, Basinghall-street, London, E.C.

In consequence of the rebuilding of Gresham College the head offices of the City and Guilds of London Institute have been removed temporarily to 3, St. Helen's-place, London, E.C.

University of Bristol.—Prospectuses and particulars of the faculties of arts, science, medicine and engineering (civil, mechanical, electrical and motor car) and of the secondary training department, day training colleges, evening classes, halls of residence, scholarships and bursaries will be sent on application to the registrar, Mr. James Rafter. The session in the faculty of engineering commences Sept. 15 and in faculties of arts, science and medicine on Oct. 2.

University of Durham.—Armstrong College, Newcastle-upon-Tyne.—The 1911-12 session commences Sept. 25. There are departments of mechanical, marine, civil and electrical engineering, naval architecture, mining, metallurgy, agriculture, pure science, arts and letters. Particulars may be obtained from the secretary, Mr. F. E. Pruen, M.A.

University of Birmingham.—The session commences Oct. 2. The full courses extend over four years and students who enter after matriculations and who pass successfully the examinations at the end of each year will be entitled to the degree of Bachelor of Science in the branch of engineering to which they devote themselves. The technical engineering classes are detailed, and a list of the professors, lecturers, &c., is given in an announcement on another page.

Northampton Polytechnic Institute, Clerkenwell, London.—The full day courses in the theory and practice of mechanical and electrical engineering, and in electro-chemistry will commence on Oct. 2, and entrance examinations will take place on Sept. 27 and 28, at which five entrance scholarships will be offered. The courses for mechanical and electrical engineering include periods spent in commercial workshops, and extend over four years, and they also prepare for the degree of B.Sc. in engineering at the University of London. There are also full and partial day courses in technical optics. Particulars from the Principal, Dr. R. Mullineux Walmsley.

University College, Nottingham, Engineering Department.—The College provides thorough courses of instruction (1) for the London University B.Sc. degree examinations in civil, mechanical and electrical engineering, and (2) for college and other diplomas in engineering and mining. The session begins Oct. 2. Prospectus from the Registrar.

Board of Education Grants.—A statement has been issued as to grants available from the Board of Education in aid of technology and professional work in universities in England and Wales.

The statement is prefaced by a memorandum of Sir R. L. Morant pointing out that the statement only applies to universities and to colleges forming constituent parts of universities and colleges in England and Wales. The day (but not evening) work of these institutions, with their post-graduate work (both evening and day), is thus removed from the purview of the Board's regulations for technical schools, &c.

ARRANGEMENTS FOR THE WEEK.

THE LONDON ELECTRICAL ENGINEERS.

Officer Commanding, Col. H. M. Leaf.

The following orders have been issued for the current week:—

Monday, July 31
Tuesday, August 1
Wednesday, August 2
Thursday, August 3
Friday, August 4
} Head Quarters will be open from 10 a.m. to 4 p

Saturday, August 5.—Falmouth Detachment (2nd Party) will par at Head Quarters at 8:30 a.m. Weymouth Detachment (2 Party) will parade at Head Quarters at 11 a.m. Dress for the sh Detachments will be:—Service Dress, Drill Order with Wat Bottles and Haversacks. Arms will be issued before each parade

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NOTES ON TRAMWAY PROBLEMS.*

BY C. W. MALLINS.

(General Manager, Liverpool Corporation Tramways.)

After referring to the difficulties that have to be faced by a local authority or company before powers to construct a tramway in any given district can be obtained the author goes on to deal with the cost of construction. This cost shows an amazing variation when different districts are compared. Conditions, of course, vary in different localities; the writer is, however, acquainted with a number of undertakings where the conditions are similar, and are, therefore, to a considerable extent comparable, and yet an extraordinary variation exists. Figs. 1 and 2 show, diagrammatically, the cost of construction of permanent way and overhead equipment per mile of single track on 12 typical undertakings (which are numbered). The cost

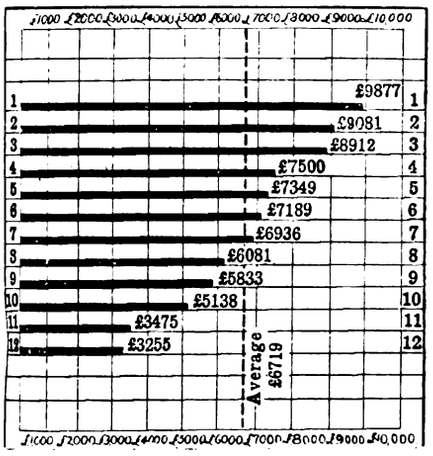

FIG. 1.—DIAGRAM SHOWING COMPARATIVE COST OF CONSTRUCTION OF TRACK PER MILE OF SINGLE LINE IN CONNECTION WITH VARIOUS TRAMWAY UNDERTAKINGS.

of maintenance of track is also a matter which deserves attention. Fig. 3 shows the cost of maintenance per mile of single track per annum on the same undertakings.

The question of road widening where tramways or light railways are about to be constructed has been found, in many cases, to present considerable difficulty, owing to the fact that some road authorities hold that, if tramways or light railways are to be constructed in public roads or streets which are not considered sufficiently wide, the cost of widening should be borne by the promoters. This is considered by most people to be unjust, and a real hardship, which should be abolished for the following reasons:—(1) It must be assumed that tramways and light railways are only constructed to meet a public

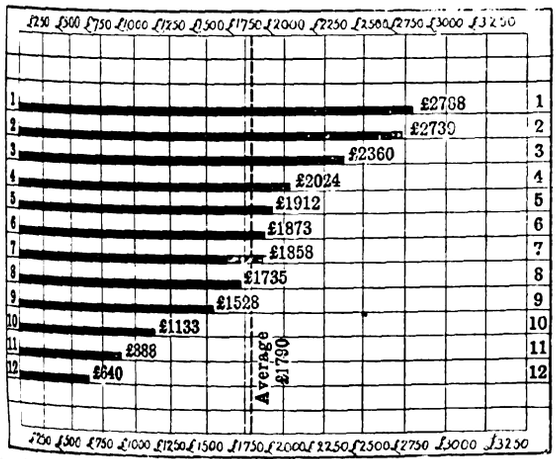

FIG. 2.—DIAGRAM SHOWING COMPARATIVE COST OF OVERHEAD CONSTRUCTION PER MILE OF SINGLE LINE IN CONNECTION WITH VARIOUS TRAMWAY UNDERTAKINGS.

requirement; therefore it becomes the duty of the road authorities to provide roads of sufficient width to deal with the volume of traffic of all descriptions using the road, including tramways and light railways. (2) Tramways and light railways are called upon to pay rates and taxes the same as any other user of the roads, and, therefore, should not be further penalised by being called upon to pay for road widening. (3) Tramways and light railways are compelled, under statutory obligation, to maintain the width of the two sets of rails, where double lines are in operation, and the space between, besides 18 in. outside the rails, which is undoubtedly a hardship, as this portion of the road is used by all other vehicles. In several places motor omnibuses are allowed to ply in competition with tramways or light railways, which have had to pay for road widening and maintenance of the portion of the road referred to, whilst the competing omnibus owners are not called upon to contribute anything. From these facts it will be apparent that an injustice is being done, and therefore some modification of the existing unfair conditions should be requested by all who are interested in the progress of the business.

The question of the best type of car for present-day requirements has often been discussed. Some persons advocate the bogey truck car, whilst others prefer the single truck. The claims of each have been pressed forward with equal vigour, but the writer is of opinion that, having regard to general experience in this country, the single truck car is undoubtedly the most suitable and economical for the following reasons: The carrying capacity of this type of car has now been so much increased as to make it possible, without much overcrowding, to get as many as 70 passengers on at one time, which is about as many as one conductor can reasonably attend to. Therefore, if the carrying capacity of the car is any greater, it is obvious that an assistant conductor would be necessary during the maximum hours of traffic, or otherwise a considerable percentage of the fares would be lost, which in either case would affect the financial result. The bogey car is certainly not the best type for dealing with the hours of minimum traffic, which we, unfortunately, have on most undertakings. It cannot be doubted, too, that the consumption of current on this type of car is greater than on the single-truck car, both during hours of maximum and minimum traffic. In addition, the maintenance of the car itself is heavier. For these reasons the single-truck

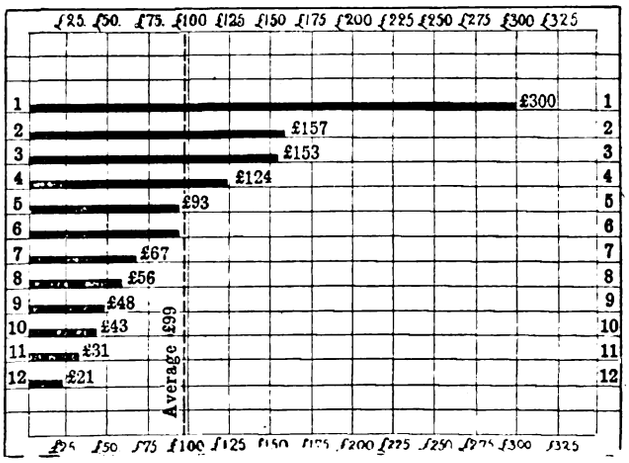

FIG. 3.—DIAGRAM SHOWING COMPARATIVE COST OF MAINTENANCE OF TRACK PER MILE OF SINGLE LINE IN CONNECTION WITH VARIOUS TRAMWAY UNDERTAKINGS.

car of the newer type, with 7 ft. 6 in., or 8 ft. wheel base, should be the car of the future for this country, as it has now been demonstrated that it is quite practicable to increase the length of the wheel base of single-truck cars without much disadvantage in operation. Two items of car equipment which are continually under criticism in courts of law are brakes and lifeguards, both of which have caused managers and engineers the greatest anxiety. Every conceivable improvement has been introduced in order to make these appliances as perfect as possible. It remains to be seen whether any further improvement can be made. If so, it would be welcomed by all.

The cost of current to undertakings which do not generate their own energy is a matter that deserves consideration, as the price charged varies so much that in some cases it means the difference between an undertaking proving remunerative or being worked at a loss. We know that the cost of production varies in different parts of the country, but not to such an extent as to justify the large disparity referred to; therefore, any expression of opinion by the Congress as to the correct charge that should be made for current would prove helpful to those who purchase current from other undertakings.

It need hardly be stated that it is the desire of all who are interested in tramways and light railways to give the best and cheapest travelling facilities possible to the public generally, and to the industrial classes in particular, consistent with business methods. That this has been accomplished on almost every system in the United Kingdom there can be no doubt, but the further demands which are being made by various sections of the public for cheaper fares is becoming one of the most serious problems in connection with management. Demands for preferential treatment to the working classes during certain hours of the day are continually being pressed forward,

*Abstract of a Paper read at the Congress of the Tramways and Light Railways Association at Edinburgh, July, 1911.

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and when such concessions are granted to labourers and artisans, various other classes of the community, such as shop assistants, clerks, &c., demand similar treatment, and certainly with some show of reason, because, if it be conceded to another class who are equally well paid for their labour, their requests cannot reasonably be refused. In addition, there are agitations for free travelling for certain sections of the community, with the result that about 60 per cent. of the travelling public plead for preferential treatment, or free travelling, on many systems where the general rate of fares is already so exceedingly low that if a close examination were made it would be found that they were not in as sound a position as could be desired. It has now been discovered by certain undertakings which have given preferential treatment on a large scale to various sections of the public that a tremendous loss has resulted on that portion of their business, seriously endangering these undertakings. Hence, great care should be exercised and a firm attitude adopted by those responsible for the management, or disastrous results may ensue. The general public in addition to the preferential treatment referred to, expect long penny stages, with twopenny and other stages correspondingly extended. Demands have also been made from time to time for ½d. fares and transfer tickets, contracts, &c., all of which tend in one direction, *viz.*, to imperil the financial stability of the business. It is the opinion of most persons who are intimately acquainted with this subject that even on the largest systems operating in the great centres of population the longest distance a passenger can be carried for 1d. with remunerative results is a fraction under two miles, and the distance should be proportionately shorter on the smaller systems operating in sparsely populated districts. To fully appreciate the advantage which the general public derive from this cheap method of transit it is only necessary to make a comparison between the fares charged by the railway companies throughout the United Kingdom and those charged by tramways and light railways. It is well known that 1d. per mile third class is the usual charge made by railway companies, together with the granting of contracts and cheap excursions, but these latter concessions are amply compensated for by the higher rate charged to first and second-class passengers. Although the writer has no actual data, it may reasonably be assumed that the railway companies derive an all-round rate of 1d. per mile per passenger. If tramways and light railways charged the same rate of fare, instead of the total revenue per annum being £13,077,901 as at present, it would amount to £19,616,851.

From the foregoing it will be observed that tramways and light railways, apart from the preferential treatment referred to, are carrying the general public at very little more than half the fares charged by railway companies. Those responsible should, therefore, consider very carefully the financial result which a haphazard method of charging fares may bring about, especially having regard to the difficulty of some struggling undertakings, which are, unfortunately, operated at a loss, and others whose income merely covers operating and other expenses, or yield but very small returns to the proprietors. Railway companies have found it necessary to fix some general basis of charging, with the result that 1d. per mile third class appears to have adopted as their standard. If a similar basis could be adopted by tramway and light railway proprietors—not necessarily 1d. per mile—there is no doubt that good would result, and the public would not, on the whole, suffer, as it is surely beyond cavil that the passenger should pay for his ride just as he expects to pay for any other service rendered to him. Whether the undertaking belongs to a municipality or to a company it involves its owners in responsibilities; the municipality to its ratepayers as a whole, and not to any particular section; and the company to its shareholders. For these reasons the business should be conducted on sound financial lines. Through the courtesy of certain colleagues, the writer has been able to ascertain approximately the annual loss to 29 tramway and light railway undertakings in the United Kingdom, *viz.*, £165,000, caused by the granting of preferential treatment in various forms, and free travelling to certain sections of the community, together with the running of unremunerative cars to meet the requirements of the industrial classes. The amount of loss would, of course, be proportionately great if the whole of the tramways and light railways in the United Kingdom were included. Tramways and light railways have practically no source of revenue other than the extremely low fares collected from passengers, which leave but a slender margin of profit between the total income and the total charges. They are not in the same position as ordinary railways which derive a large revenue from the carriage of goods.

The transport of merchandise by tramways and light railways has on several occasions been discussed, yet nothing has been done to develop this class of business on anything like a large scale in this country. The time has, therefore, arrived when the matter might be seriously considered. It must be recognised that there are certain difficulties in the way, but these difficulties, in the opinion of the writer, are not at all unsurmountable. A large business might be developed in the carriage of goods without encroaching upon what has come to be regarded as the exclusive domain of the existing railways. Tramways and light railways might, with advantage, be utilised for the transit of goods between ship and warehouse, and railway and warehouse, and *vice versa*, in the large manufacturing and distributing centres where an enormous quantity of merchandise is stored in warehouses from time to time, most of which is conveyed to and from ship and railway by animal traction at the very heavy cost of about 1s. 9d. per mile. The cost by tramway need not exceed 1s. and this class of traffic could be carried on at night without causing obstruction during the day time. Tramways and light railways would prove an ideal method of dealing with agricultural produce in a way the railways cannot do and they would thus obtain a very welcome addition to their income.

TRANSFER FARES.*

BY C. W. SHEPHERD.
(General Manager Edinburgh and District Tramways Co.)

I may preface this Paper by saying at once that I am in favour of penny transfer tickets, as used in Edinburgh. The ideal service, from the passenger's point of view, would, of course, be one that would take him from anywhere to anywhere else on one car. In a complex system of city tramways it is, however, practically impossible, and at any rate unprofitable, to run a service of cars from any one terminal point to all other terminal points of the system, and passengers commencing their journey on a car which only takes them a part of the way they desire to travel find themselves of necessity compelled at a certain point of their journey to change into another car. When a passenger can get to his destination by one car, I am averse to allowing him the use of two cars for one fare. Where a change of cars has to be made, the question of the cost of the divided journey arises. If the passenger be required to pay the fare of each car—especially on a system such as we have in Edinburgh, where halfpenny fares are not in vogue—he will of a certainty complain of having to pay 2d. for a distance not more, and possibly less, than he would be entitled to on one direct-route car for 1d. It may therefore be admitted by the manager of a system where 1d. is the minimum fare, and who wishes to be fair and to encourage travelling, that a transfer ticket at the cost of 1d. is desirable under certain conditions or restrictions; otherwise business might be lost, and, as every tramway manager knows, a very small fraction of a penny per car-mile lost in earnings often means all the difference between profits and bankruptcy. I may as well state here that on systems such as Glasgow, where halfpenny fares are in operation, I do not consider transfer tickets necessary or desirable.

Assuming that transfer tickets are to be adopted, the conditions of their issue have to be considered. The public are to be reasonably provided with the benefit they desire, but at the same time the tramway manager has to take every precaution that the privilege is not abused and fraud perpetrated. With regard to the possible abuse of transfer tickets—and cases are bound to occur—I am not in favour of the exchange ticket system; that is, the conductor of the second car collecting from the passenger the transfer ticket issued on the first car, and giving in exchange therefor an ordinary ticket punched to his destination. This involves the conductor returning the collected transfer ticket as part of his drawings, and gives the ticket a cash value. Passengers might make a habit of asking for transfer tickets, although not requiring them, and a traffic in them might be carried on with the conductors, who could substitute them for cash extracted from their bag. The method I advocate is that one ticket—that is, the transfer ticket issued on the first car punched as to date and destination—should do for the divided journey, the conductor of the second car, after satisfying himself as to the correctness of the date and destination, defacing it by tearing a piece out opposite the destination punch hole.

I am aware that in America an outcry has been made by the street railway companies against transfer tickets because of their abuse by the public. It has, however, to be borne in mind that in America the fares are not graded as in Britain. The rule in America is a uniform fare for any distance, short or long, and as transfer distances are thus often of several miles length, a temptation, which many people seem unable to resist is created to demand transfer tickets, although not wanted, and to carry on an illicit traffic in them to the companies' great loss. As used in Edinburgh, the distance covered by a transfer ticket does not, as a rule, exceed half a mile by each of two cars, so that, with the checks used, there is little

* Abstract of a Paper read at the Congress of the Tramways and Light Railways Association at Edinburgh, July, 1911.

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fear of malpractices. For some time we in Edinburgh indicated the hour within which a transfer ticket could be used. We still have printed on the ticket the words, "Good only for continuous journey on day of issue," but we have ceased to indicate the hour. We have done this in what I consider to be our own best interests.

A point about which there may be difference of opinion is whether the distance covered by a transfer ticket should be as great as that allowed for the same fare on one car. My opinion is that it should not. For example, if a penny ticket entitled a passenger to travel one and a half miles on one car, or, say, three half-mile stages, I would restrict the length of the 1d. transfer journey, except perhaps in a few special cases, to two half-mile stages—one by each car. One reason for this is that for the vast majority of journeys a direct service is available, and the provision of a full-distance transfer ticket could enable a passenger to break his journey on the way, make a call or transact business, and thereafter continue his journey, all for a penny, a thing which he could not do on a direct-service car. Another reason is that the company, having to provide two cars for him with their necessary staffs, the purchasing power of the passenger's penny should not be so great as when one car suffices to carry him.

In conclusion I am convinced that where transfers are judiciously placed they are remunerative to a tramway system, because it is an inducement to a passenger to take a penny transfer if he thinks he is getting good value for his money, even although in many cases the second portion of the journey is never completed.

THE ELECTRICAL EQUIPMENT OF THE S.S. "OLYMPIC" AND "TITANIC."

Summary.—In this article are described the various uses to which electricity is put on board the two latest White Star liners, the "Olympic" and "Titanic." These include, besides lighting, power for winches, cranes, fans, water-tight doors and stoking and helm indicators. The clocks and heating equipment are also electrically worked, while a complete telephone and wireless installation is to be found on board. The differences between marine and land practice are noted.

Introduction.

The tendency with Atlantic liners as with many other things has been towards increasing size. Ships which were considered monsters only a few years ago are now quite outclassed, and there seems no likelihood of the progress in this direction being checked yet a while. The latest ships to head the lists as regards size are the "Olympic" and "Titanic," the former of which made her maiden voyage from Southampton on June 14th last, while the latter will soon be completed. Both ships are products of Messrs. Harland & Wolff's famous yard at Belfast.

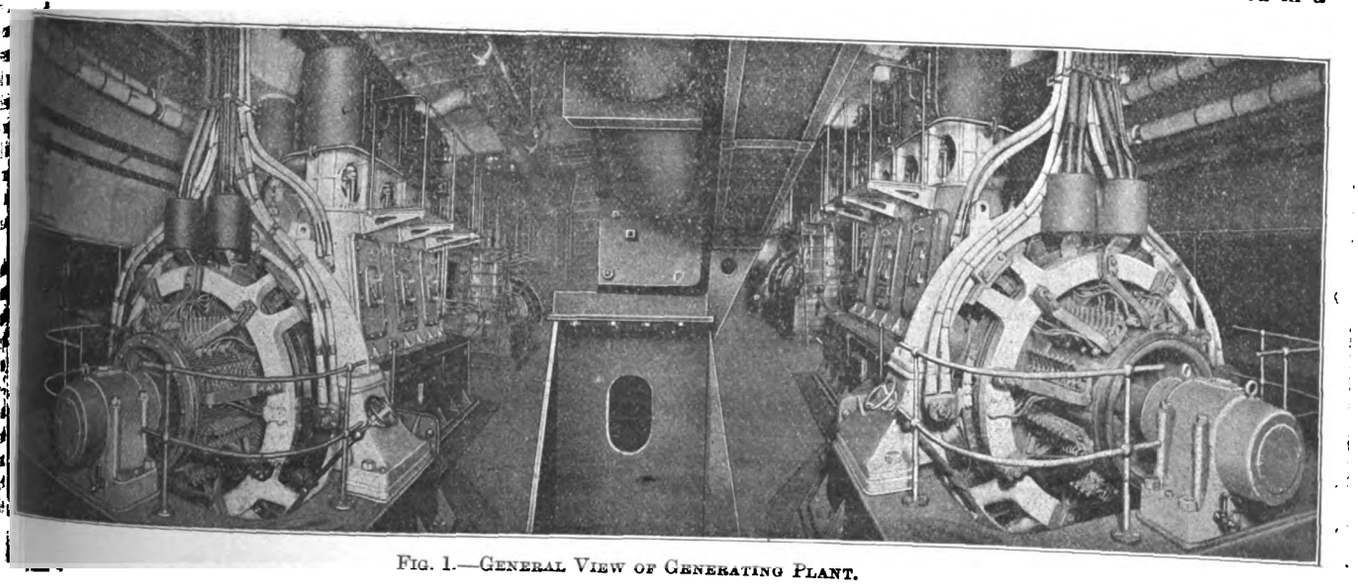

Fig. 1.—General View of Generating Plant.

Electricity is used in all departments of these mammoth ships, and before describing the large electrical installation in detail it will be of interest to the reader to enumerate the purposes to which electricity has been applied for power, quite apart from lighting. They are as follows:—Electric deck cranes, from 30 to 50 cwt.; cargo, boat and engine room winches; passenger elevators; stores, mail and pantry lifts; ventilating and stokehold fans; cabin fans; motors for cylinder lifting gear, turbine turning and lifting gear, and condenser sluice valves; pneumatic conveyor for Marconigrams; gymnastic apparatus; domestic machinery (such as ice rocker, dough mixers, potato peelers, roasters, knife cleaners, soup and sorbet machines, mincers); electric heaters and fires, hot plates, electric baths and irons; main steam whistles; sounding machines; stoking indicators; boiler room telegraphs; clocks; watertight doors; helm indicator; illuminated pictures and signs; chimes; bells; loud-speaking telephones and service telephones; submarine signalling; wireless telegraphy.

Generators.

The main generating plant, which is probably the largest electrical equipment that has been installed up to the present for marine work, consists of four 400 kw. engines and dynamos, manufactured by Messrs. W. H. Allen, Son & Co., of Bedford, and having a collective output of 16,000 amps. at 100 volts, thus exceeding in current capacity many electrical central stations. The sets are situated in a separate water-tight compartment aft of the turbine room at tank top level, their general disposition being as indicated in Fig. 2, one of the sets being illustrated in Fig. 3. The engines develop 580 B.H.P. each, and are of the vertical, three-crank, compound, forced lubrication type, running at 325 revs. per min., with one high-pressure cylinder 17 in. diameter, and two low-pressure cylinders each 20 in. diameter and 13 in. stroke. They are supplied with steam at 185 lb. pressure per sq. in., and exhaust either into a surface heater, when at sea, or to a condenser. Each engine is direct-coupled to a 10-pole compound-wound dynamo, fitted with interpoles.

The field magnets are of annealed cast steel of high permeability and are cast in halves, being divided on a horizontal plane. The ten main poles are cast in one piece with the yoke ring, and are fitted with laminated pole-shoes, the yoke ring being of specially rigid design. The interpoles are secured by

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bolts to facings on the inner surface of the yoke ring. The series coils are of flat copper strip wound on edge, as are also the series coils of the commutating poles, and in all the windings great care has been taken to ensure ample ventilation, and also facilities for rapid disconnection and replacement of the different sections.

The armatures are of the slotted drum type, built up of mild steel plates on a cast-iron hub, the "former-wound" coils being of flat copper strip. The commutators having to deal with an exceptionally large current are of exceedingly massive construction, and great care has been exercised in the design to ensure only a moderate degree of heating. The brushes are of carbon and graphite, and while giving good conductivity also run with small friction on the commutator, thus preserving the surface of the latter in good condition for long periods.

Besides the four main generating sets there are also two 30 kw. sets, situated in a recess off the turbine room at saloon deck level, well above the water-line. These may be connected by means of a separate steam-pipe to boilers situated in one of several boiler rooms, and will be available for emergency in case the main sets should be put temporarily out of action; the general features of their design are very similar to the main sets, but the engines are of the two-crank compound type, and the dynamos are not fitted with commutating poles.

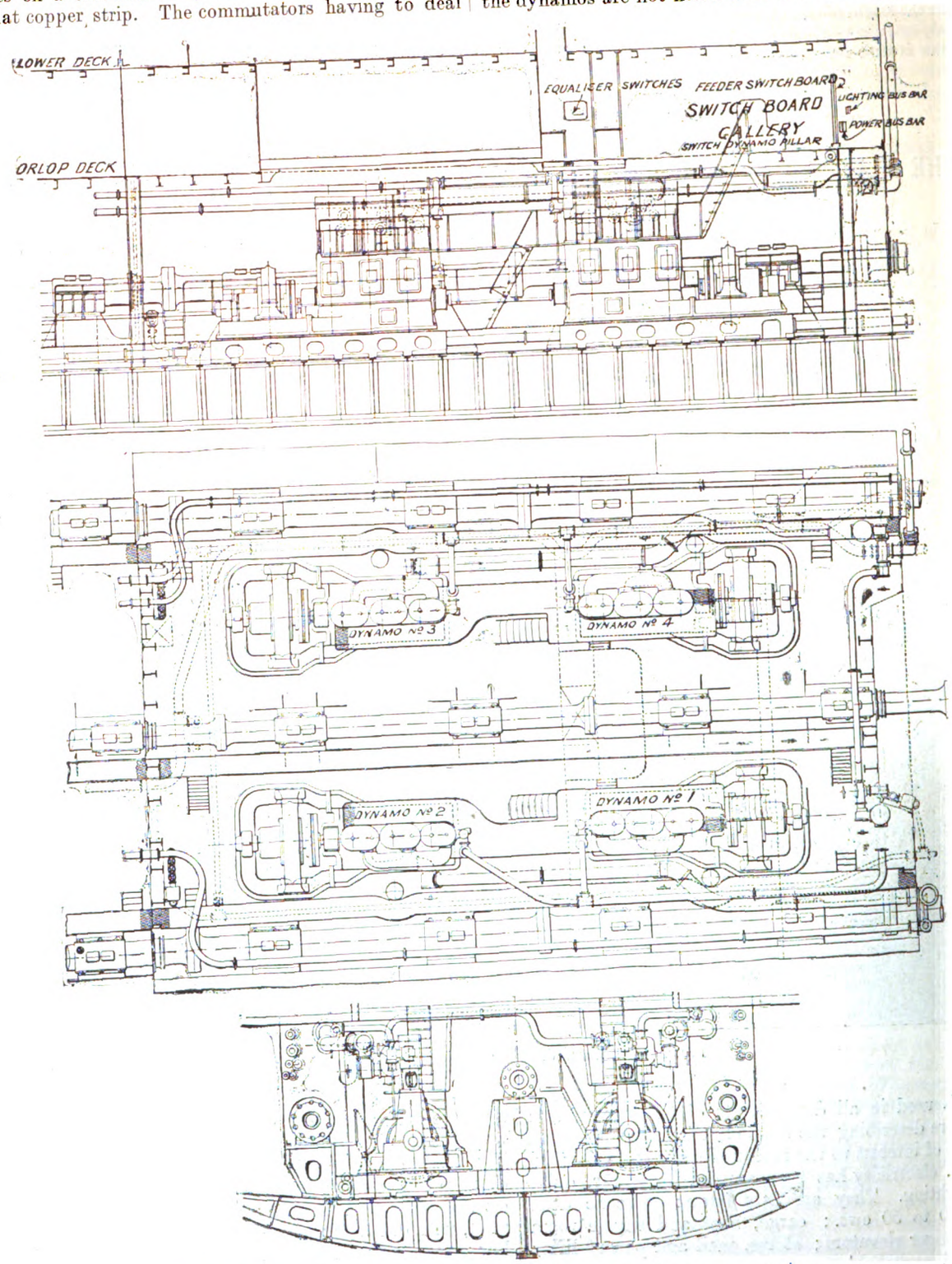

FIG. 2.—GENERAL ARRANGEMENT OF ELECTRIC GENERATING PLANT ON S.S. "OLYMPIC."

From Fig. 1, showing the general arrangement of the plant it will be seen that the four sets are arranged in pairs, one right-handed and one left-handed set, with the crankshafts in line and the stop valves inwards with a gangway passing between, and another pair immediately behind. It will also be noticed that the platform by which access is gained to the

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cylinder covers, &c., extends right across the two units of one pair, the stairway being placed in the gangway between the two units.

Switchgear.

Current is conveyed from the main dynamos by means of heavy rubber insulated cables, each 1·5 sq. in. in section and 2¼ in. in diameter, to the dynamo control switches situated on the front of the switchboard gallery.

The main switchgear which is arranged on somewhat novel lines has been manufactured by Messrs. Dorman & Smith. Nearly all the gear is placed on an orlop deck across the forward end of the generator room. It consists of four sets of main switchgear, each set controlling one of the four main generators, combined with a set of four pairs of equalising switches, and also of a main feeder switchboard of 25 panels equipped with gear for controlling two circuits on each panel, making 50 circuits in all, each of 600 amps. capacity. All the main circuit breakers and switches are capable of continuously passing 6,000 amps. Each of these circuit breakers is capable of being operated by hand release or by a Ferranti overload control with an inverse time element equipment. In designing the circuit breakers, very careful attention has been given to the question of reliability. Every possible detail, such as the throw-out springs, trigger springs, cushion springs, auxiliary metallic and carbon breaks, &c., has been arranged in duplicate, so that the breakage of any one part cannot spoil the working efficiency of the breaker.

In series with each circuit breaker is the main instrument shunt, which is about twice the usual size to ensure a low temperature rise, and also a pair of main selector switches, permitting each generator to be connected to either the power or lighting 'bus bars, or to both.

All the main generator switches, shunts and connections are carried on steel bars, insulated with hard micanite. The supporting bars are in turn carried on a steel frame casting, and the whole gear for each machine is enclosed in a neat steel casing, supported on a cast frame.

Each set of main switchgear is operated by a row of five interlocked handle levers (*see* Fig. 4). The two outer handles

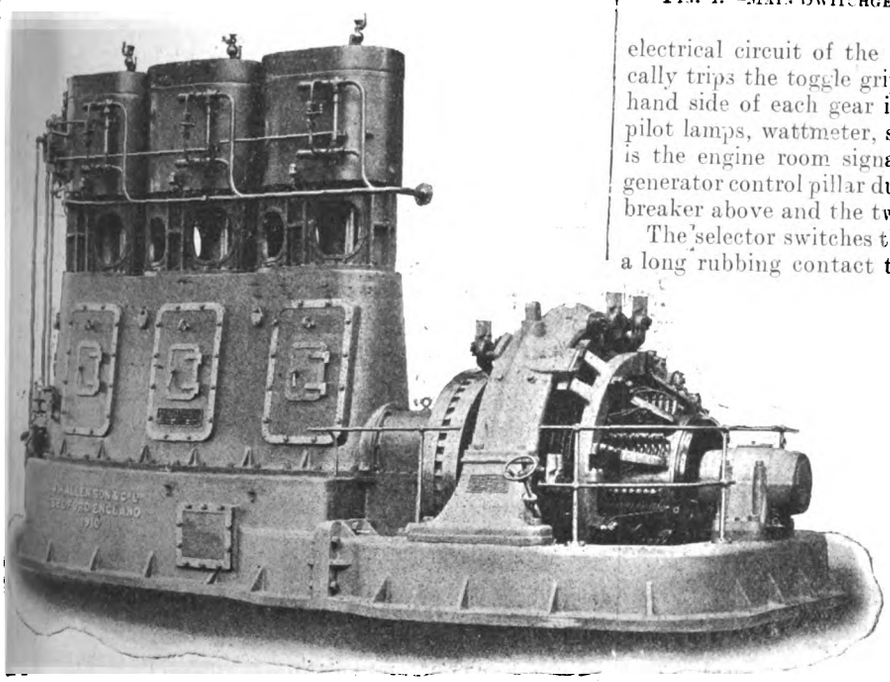

Fig. 3.—One of the Main Generating Sets, ss. "Olympic."

are connected mechanically with the lighting and power equalising switches, respectively, and are interlocked so that they must be closed before the next handles, which operate the lighting and power main 'bus-bar selector switches, can be worked. The central handle is for closing and gripping the circuit breaker, and is also interlocked with the selector switch handles, so that the circuit breaker can only be closed and gripped when the selector switches are both in the "off" position.

Fig. 4 shows the complete switchgear of dynamos Nos. 1 and 2. At the side of the casing are seen two devices for tripping the main circuit breaker; the top one closes the

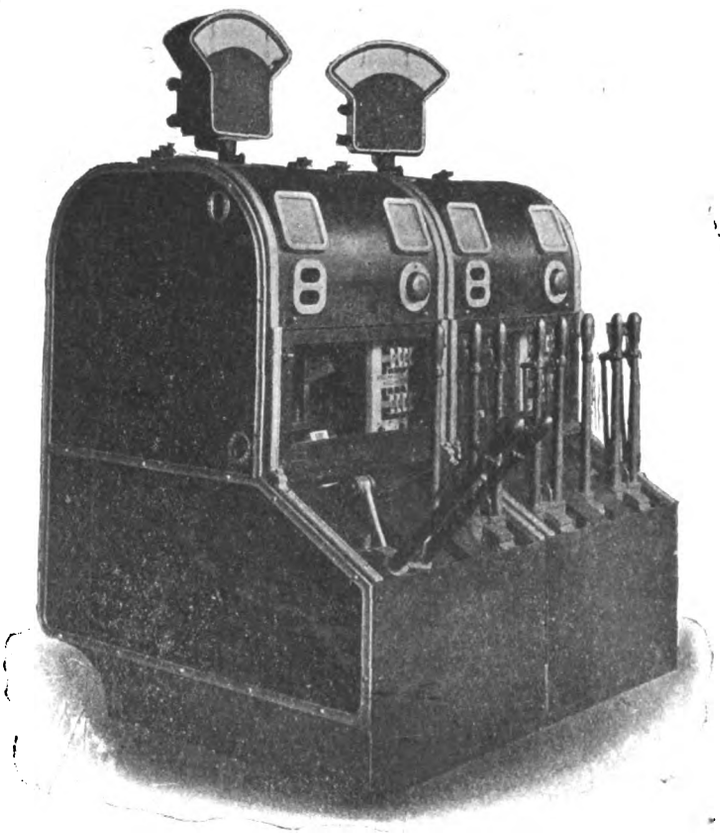

Fig. 4.—Main Switchgear of Dynamo No. 1 and Dynamo No. 2.

electrical circuit of the trip coil and the lower one mechanically trips the toggle grip and lifts the trigger. On the right-hand side of each gear is a small panel with the fuses of the pilot lamps, wattmeter, shunt, &c., On the upper right hand is the engine room signal knob. Fig. 5 is a view of a main generator control pillar during construction, showing the circuit breaker above and the two selector switches below.

The selector switches themselves are very massive, and have a long rubbing contact to avoid dirt being squeezed in under the contact faces. The section is 13·7 sq. in. and the contact surface 21 sq. in. The link connecting these switches to the operating lever handle is so arranged that no great effort is required on the part of the switchboard attendant.

Pilot lights are provided as follows: On any machine being excited the dial of the ammeter is illuminated; on closing a circuit breaker two pilot lights across the machine illuminate the inside of the casing containing the switchgear; on closing either a power or lighting selector switch two more pilot lights illuminate a bold sign at the back and front of the switchgear casing, intimating whether that machine is connected to the power or lighting 'bus bars.

The equalising switches called for very special consideration in their design. They are placed in the centre of the generator room and are as nearly as possible equidistant from the four machines. There is a power and a lighting equalising switch

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for each machine, and these are mechanically operated from the switchgear deck by levers interlocked with the other main switchgear, so that no machine can be connected to a power or lighting 'bus bar until after its equalising switch is connected to the power or lighting equalising bar respectively.

These switches are very compactly constructed for such heavy gear, being identical with the main selector switches in capacity and construction. The contacts are combined with the equalising 'bus bar, so that the minimum amount of space is taken up; and the whole eight switches and two 'bus bars are carried on a massive steel frame, being insulated therefrom with micanite. This frame is arranged so that it is bolted and stayed to the ship construction work. A neat sheet steel casing to protect the switches is built round the eight switches and forms part of the steel foundation frame. A view of the equalising switchgear is given in Fig. 6. The enclosing case is arranged to open in two parts, the left-hand half being here shown open. The connecting links of some of the switches are shown on the right-hand side.

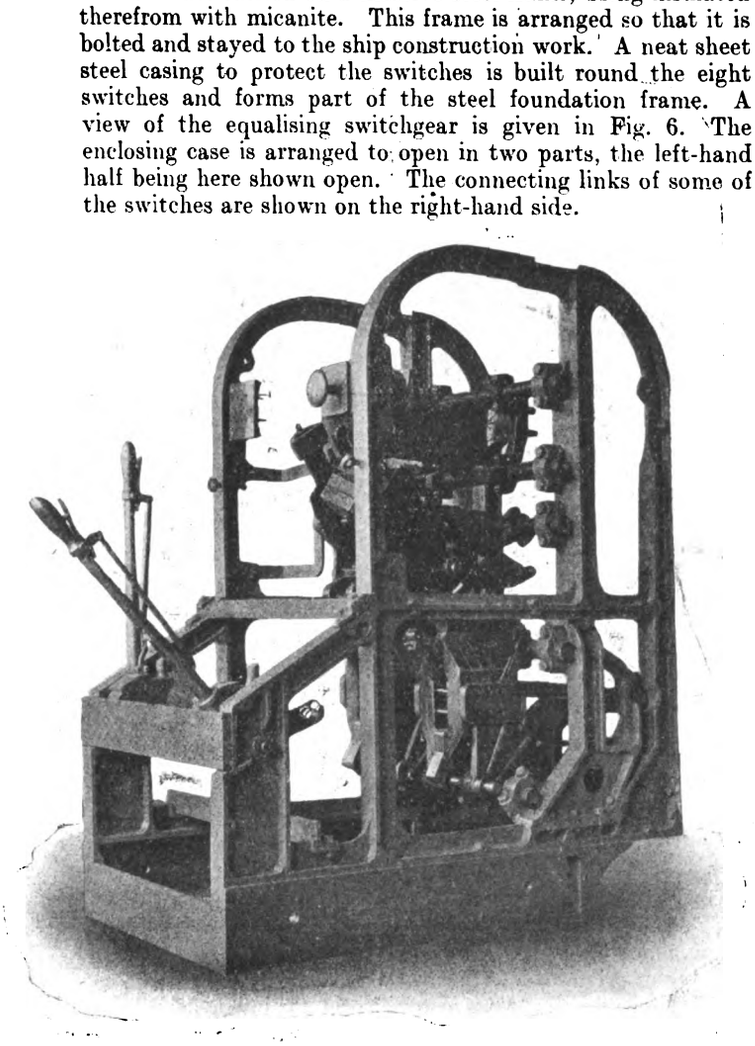

FIG. 5.—VIEW OF A MAIN GENERATOR CONTROL PILLAR DURING CONSTRUCTION.

The main voltmeters (Fig. 7), which are used also for paralleling, are carried on a cast-iron pillar amidships between the main dymamo control gear. The voltmeters themselves are mounted in pairs, each pair being arranged so that they can swing round through 220 deg.

The two outside instruments are used to give machine voltages and the two centre instruments 'bus bar voltages, the former being controlled from the plugging arrangements on the main dynamo panels, and the latter on the voltmeter pillar itself.

The voltmeter plugs are all three-pin and are fool-proof, so that machines cannot be put in parallel on to any one instrument. The third pin on each voltmeter plug is connected to the lamp circuit automatically illuminating a sign, so that the insertion of a voltmeter plug in any socket causes an indicator on the voltmeter pillar to be illuminated, intimating to the operator to what the voltmeter is connected.

Special attention has been paid to the transmitting of instructions from the switchgear deck to the engine attendant, and a signalling arrangement has been provided for this purpose. Placed in the centre of the engine room, where it can be easily seen and read from both sides, is an illuminated signal device. This can be operated from a control knob on each of the dynamo control gears. On turning the knob to the instruction required to be given, and pressing it, the corresponding sign is illuminated and a bell is rung, drawing the attendant's attention. The signs, reading "start," "raise speed," "lower speed" and "stop," combined with the number of the machine to which the signal applies, are visible in white letters on a red background when the lamps are illuminated by pressing a signal knob (Fig. 8).

SUPPLY SYSTEM.

From the main dynamo switches the current passes by insulated cables below the gallery to a massive feeder switchboard, which consists of 25 black polished slate panels for 50 separate circuits. Each circuit is controlled by a circuit-breaker and a large main "handle" type fuse. Each circuit has a moving coil ammeter, and each panel a pilot light bracket.

The main 'bus bars for the power circuit are of 8·4 sq. in. section, and for the lighting circuits 3 sq. in. section. The latter run the full length of the board, the power circuits being arranged on the centre panels, and the lighting circuits in two parts—at the port and starboard ends, respectively.

The main dynamo cable connections from the main selector switches are connected to the 'bus bars through massive copper connectors bolted up with steel clamps, and the surfaces of connection are spread along the central part of the 'bus bar, so that the current density is kept low.

From the feeder switchboard no fewer than 48 cables, ranging in size up to 61/12 S.W.G., radiate, passing vertically up

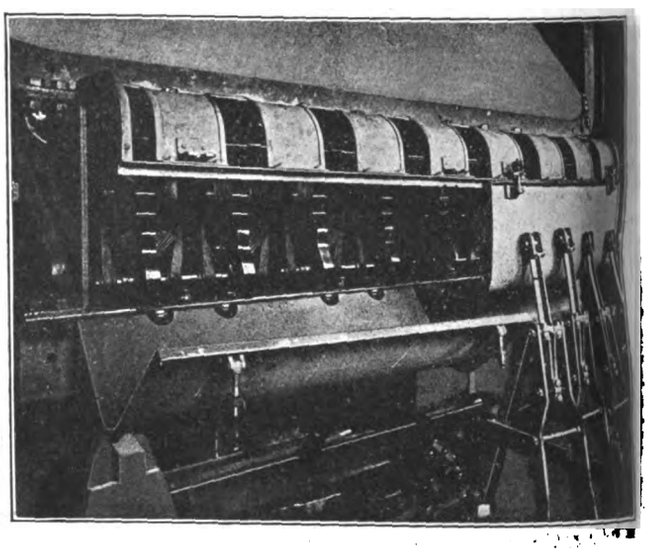

FIG. 6.—EQUALISING SWITCHGEAR.

two steel trunkways port and starboard and terminating in master fuse boxes on each deck, from whence branch the individual circuit cables. These ramify along the main passages of the different decks throughout the vessel and feed, in turn, distribution boxes. From these run branch cables supplying current to the individual lights, motors, heaters and other plant.

The system adopted is known as the single-wire, the returns being carried back, however, and bonded in such a way as to avoid stray currents. The power and heating can, if desired, be run entirely independently of the lighting, there being power and light 'bus bars on the switchboard, which can be paralleled if desired. The circuits are further so split up that passenger accommodation, saloons, crew, cargo, machinery spaces and individual motors or groups of motors, are independent, and can be switched on or off to suit the varying conditions when *en voyage* or in port. In addition, there are, of course, local switches in the cabins, and generally throughout the ship, for turning on or off individual lights or machines. The main cables and branch wires are of tinned copper covered with rubber and heavily braided, and in the machinery spaces are lead-sheathed, armoured and externally

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braided. In the boiler rooms they are run in steel pipes for protection against damp and mechanical injury. Considerably more than 200 miles of cable have been employed.

Fans.

An idea of the large demand for power will have been gathered from the numerous types of electrically-driven machinery already cited. A large proportion of this is taken by the fans, which number 76, and include 12 for the stokeholds from 40 in. to 55 in. diameter, and 64 for the ventilation of the accommodation, including both suction and delivery, the latter in some cases supplying warm air. The aggregate current taken for ventilating purposes amounts to 5,250 amps. The fans themselves are of Sirocco type throughout, manufactured by Messrs. Davidson & Co., and are driven by Allen motors, which latter are designed in accordance with Harland & Wolff's specification, calling not only for hand control but also for automatic variation of speed to correspond with the par-

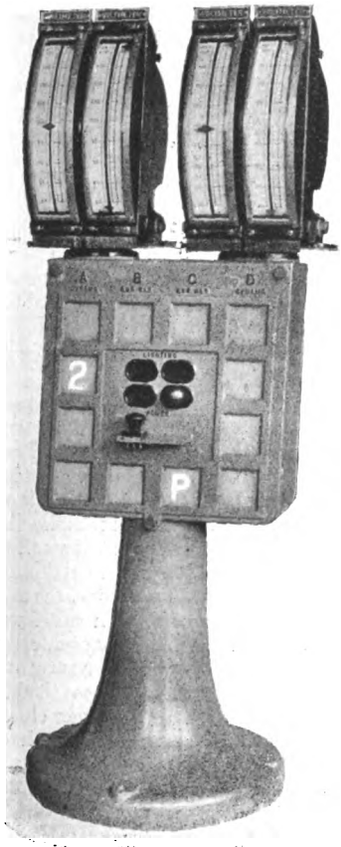

Fig. 7.—Main Voltmeter Pillar.

icular system of trunks to which the fans they actuate are nnected; this is very necessary, as, if running at a constant eed, they are liable either to be overloaded, or to fail to rise the demands made upon them as, owing to the varying conions, it is impracticable to determine beforehand the pre- e speed required for each fan.

The several stokeholds are supplied with air for boiler draught means of the electrically-driven Allen Sirocco fans menoned earlier.

Lighting.

The total number of incandescent lamps installed on board mounts to 10,000, of from 16 c.p. to 100 c.p., and for the most rt are of the latest Tantalum ship type. In the first-class ic rooms there are fitted sockets for electric portable mps or fans, and special dimming lamps with two filaments, that a light of small candle-power can be kept burning roughout the night, a feature which will appeal to nervous sengers. It may here be mentioned that in all passages, blic rooms, compartments and decks throughout the vessel e placed emergency electric lamps. These are on special circuits and derive current from the emergency dynamos previously referred to, so that in the untimely event of an entire extinction of the ordinary lighting, there would still be available illumination at all points where passengers and crew would congregate; in fact, anyone could find their way from one end of the vessel to the other lighted at night by this means.

Most of the electric light fittings in the passenger accommodation are of majolica, which does not tarnish like metal, and in the public apartments, main entrances and suite rooms the electric fittings are of a magnificent character, of style to suit the particular period of decoration employed, ranging from severe Italian Renaissance to elaborate Louis XVI. The main staircase fittings are after original French models, no pains or expense having been spared in their selection, some costing many hundred pounds apiece.

There are also a number of electric illuminated signs distributed through the first and second class accommodation, to direct passengers to the respective main entrances and public rooms, whilst on view in the gymnasium are attractive illuminated multi-coloured pictures of sections of the "Olympic" and "Titanic," and a map of the world with a network of the many White Star steamship routes, which circle the entire globe.

Lifts.

There are three passenger elevators at the forward first-class main entrance for conveying passengers between the upper and promenade and intervening decks. These are of Messrs.

Fig. 8.—Engine Room Signal from Switchboard.

Waygood's make, and accommodate 10 persons each. There is also an elevator in the second-class division running between the middle and boat decks. The necessity for these electric elevators will be apparent when it is recollected that the distance between the upper and lower decks served is 55 ft. The elevators are provided with interlocking safety gear, mechanical and electrical, of the most complete character, so as to ensure safety. The cages are guided by round turned steel runners, so as to give the smoothest possible movement. The controller is of their latest design for electric operation. It comprises a car switch in the cage and has a self-centring detachable handle. Special provisions are made to guard against overrunning in either direction in case of inattention on the part of the operator or any failure in the controller.

The other lifts are for the conveyance of stores, mail bags, and pantry supplies to the restaurant and officers' quarters; these are controlled by push buttons placed at the several entrance doors shown.

(To be concluded.)

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CENTRAL POWER PLANTS AND ELECTRICITY SUPPLY FOR TRUNK LINE RAILROADS.*

BY F. DARLINGTON.

The author believes that when central station power supply is established on the larger scale to which it is surely growing, the best interests of all concerned, including the public, will be served by railroads buying electric power and keeping their railroad business distinct and separate from the business of generating and distributing power.

There is one essential to railroad work that must be met to the fullest extent before central stations can hope to succeed in the general supply of electricity for railroad motive power. The railroads must be assured of its continuity of service under all circumstances. This implies a degree of permanency and a simplicity of construction that has not been generally attained by power transmission companies, but it is possible of achievement, and will be amply justified by the very large installations which will be needed when railroad power is extensively supplied by central stations.

Comparative Costs.—Let us assume that as the capacity of a central station generating plant increases, the various things that enter into the cost of power are reduced by generating current on a large scale in such proportion that, while for plants of 50 kw. the labour cost may be about 0·37d. per kilowatt-hour, for plants of 5,000 kw. it is about one-half of this amount. For very large plants working at a good load factor we may assume that it is about one-fifth of this amount, or, say, 0·075d. per kilowatt-hour; and the very largest plants working at a good load factor have reduced the cost to about 0·037d. per kilowatt-hour. We may anticipate that the labour cost will eventually be reduced, under favourable conditions, to from 0·025d. to 0·035d. per kilowatt-hour. The cost of fuel is likewise rapidly reduced as advantage is taken of the generation of power in large quantities. A few of the largest stations report coal consumption as low as 2 lb. or 2½ lb. per kilowatt-hour. Likewise, in the matter of installation cost of generating plants and of transmission and distribution lines, increased size leads to reduced cost of construction. Many central station plants with relatively small units are to-day costing to construct £20, more or less, per kilowatt, while large plants have reduced their construction cost to the neighbourhood of £14 per kilowatt, with good prospects that in the future this cost will be reduced for very large installations to less than £10.

The production of power in very large quantities also almost always results in good load factors. In the transmission and distribution of power still more striking advantages are gained in large operations. It would ordinarily be unprofitable to transmit 1,000kw. 25 miles, for it would not pay to secure 25 miles of right-of-way and put up pole lines, &c.; but if the amount of power to be carried is much larger, say, 20,000 kw. or 30,000 kw. or more, the profitable distance for transmission may easily be 50 or 100 miles.

Thus, the economy of electric power from large generating plants as compared with isolated steam engine plants and other small sources of power is based on cheaper operation and maintenance of the large electric plants and not on a smaller first cost.

Railroad Motive Power.—By the nature of their service steam locomotives are tied down to pretty nearly all the conditions which are recognised as objectionable in stationary power generating plants. These conditions offer opportunity for central stations to furnish railroads with power and thus to widen the scope of their own profit and usefulness. On the other hand, electric locomotives can do other and better railroad work than can be performed with portable steam engines.

Much has been said about the very great cost of electric power on railroads, and the existing instances where electricity is used in heavy traction are referred to, to demonstrate this great cost, which is believed by many to be always greater with electric than with steam locomotives, and to be justified only where other questions than economy make electrification necessary. To instal an entirely new motive power system for a few miles of operation must always be disproportionately expensive. But under suitable conditions electrification of trunk line railroads is advisable in many places for purely economical reasons. I do not mean by this that to-day it is economical or would be economical to electrify all railroads. There are many places where the conditions are unfavourable for doing so, where the density of railroad traffic is small, where the distances to be covered by trolleys or third-rails are very great relative to the amount of power to be served. Up to the present time trunk line railroad power has only been furnished in one single instance—namely, the Detroit River tunnel of the Michigan Central Railroad. In every other case the railroads are making their own power for trunk line service.

I will point out two examples which seem to me to be the logical solution of the power problem for certain territories. One is in the State of Illinois and the other in Eastern Pennsylvania, including part of New Jersey. I do not propose these as exact descriptions of the most advisable developments, but as indications of general plans to be followed.

Illinois Power System.—In the State of Illinois, excluding Cook County, there will probably eventually be three or four power centres which will be located in coal mining districts. When the power business grows to its natural, most economical plan for generation and distribution, it is probable that three large central stations (or possibly more) will supply the State and will be connected together with high-tension transmission lines from which will extend branches and feeders to reach smaller outlying districts, and that this network will include and serve all of the power business for every kind of work in Illinois. The system of transmission lines and feeders will network the State in much the same manner that the State is now covered with railroad lines, excepting that there will probably be less diversity of ownership and less competition than there is among the railroads. The advantage of the central stations for serving power will be so great as compared with individual corporations and enterprises, that the latter will not be in a position to afford to generate their own power, because it will be cheaper to go to the central stations and buy power than to make it themselves.

I would here like to say that the larger and more comprehensive the power systems of the country become the more the public may be expected to demand governmental supervision of such systems. They will require the right of eminent domain, and this right will properly be granted to them in their capacity as public service companies. That they will be treated by our law makers as our common carriers are treated is reasonable to expect, and probably the same methods of regulation that are found successful to govern railroads in matters of competition, rate making, &c., will be applied to power companies. It may prove advisable that they should be subjected to some of the same restrictions that apply to railroads in the control rates charged, the prohibition of rebates, &c.

Eastern Pennsylvania Power System.—The second centre instanced which seems to the writer to constitute a natural power supply centre is the district of the anthracite coal mines of Eastern Pennsylvania. There is a very large consumption of power in mining, cement manufacturing, lighting, railroad work, &c., that is within short transmission distance or within a radius of 75 miles of these mines. This power can be better made in central stations than in the small units now in use, and if the locomotives on the railroads within the district are added to the central station service, the relative advantage of central station supply compared with small steam plants will be further enhanced. Such a centre may eventually extend its service with profit to include much power as far away as New York City and Philadelphia. The transmission distances would be about 90 to 120 miles, but if the transmission to the larger cities is done on a large scale it would be profitable as compared with the central stations now existing in the cities. It does not seem at the present time that the best economy in power service for New York and Philadelphia can be had by serving the power for the cities exclusively from central stations at the coal mines, but rather by installing very large transmission lines to Philadelphia and New York capable of carrying, say, one-third of the total amount of power now produced in the big steam central station plants in these cities. These transmission lines could be utilised to carry the base load or long-hour service of the central-station plants in the big cities, and the existing city plants could be depended upon to take care of the peak loads and shorter hour service at the times of heavy or so-called peak-load demand. In this way central station plants of approximately one-third the maximum power of the city peak-load could supply something like three-quarters the total kilowatt-hours used, and thereby cut the business of transporting coal for these large power plants to nearly one-quarter of what it would otherwise be. There is also a large amount of distributed power consumed in Newark, Jersey City, Trenton and intermediate points between New York and Philadelphia, and a vast amount of railroad motive power which could be supplied by electricity. Transmission lines installed between New York and Philadelphia could be made a sort of 'bus bar connection, tying the two city power supplies together, and thus utilising the space capacity in either city for reserve power when demanded in either city. At the same time these lines could be employed for the local distribution of power between the principal points, making the main arteries a triangular connection with one point at the coal mines, one point in New York City and one point in Philadelphia. Into this great transmission system any economical power supply could be fed.

* Abstract from the "Electric Railway Journal" of a Paper presented at the Convention of the National Electric Light Association.

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REPORT ON PRIME MOVERS.*

BY THE COMMITTEE; I. E. MOULTROP, EDISON ELECTRIC ILLUMINATING CO., BOSTON, CHAIRMAN.

There were no important new developments in the field of power generation during the past year. The manufacturers of steam turbines have made a few minor improvements in design and construction which will affect the cost of maintenance more than efficiency of operation.

Balancing of Vertical Turbines.—The problem of securing a satisfactory running balance for Curtis vertical turbines was at one time a very serious one, but with experience in balancing it is now rare that trouble occurs due to serious vibration. The only rules laid down for balancing turbines appear to be, in general, "cut and try," balancing first the steam element and then later putting the field on the shaft and balancing the entire rotor. Examination of a large number of carefully kept records of balancing operations indicates that after the point of maximum eccentricity has been determined on the shaft the trial balance weight should be first applied at a point on the turbine 50 deg. away in the direction opposite to the direction of rotation.

Condenser Tube Troubles.—Troubles with condenser tubes, such as pitting, breaking, &c., are confined almost exclusively to those stations located on the sea coast and using salt water for the circulating medium. One large central station on the sea coast has reduced condenser tube troubles to a very nominal amount by using untinned Admiralty mixture tubes of most careful manufacture.

Some companies have reported that they are troubled with the condenser tubes creeping endwise, and in some instances the endwise movement of the tube has been sufficient to wear away the shoulder on the gland, and permit the tube to come out of the tube sheet. It would appear that this is caused by the high velocity of the steam entering the condenser, as the tubes which give trouble are those at the top of the condenser and receive the impact of the steam as it enters the condenser at a very high velocity. A suggested cure for this difficulty is to make a special gland for these tubes which will screw tight into the tube sheet, making a vacuum-tight joint without packing, with a groove on the inside of the gland next to the tube. The tube can then be rolled into the gland in a manner similar to the way a boiler tube is expanded in a boiler head. The other end of the tube may be packed in the ordinary manner.

Many central stations are so located that at certain seasons of the year the circulating water is very heavily laden with refuse and foreign matter of various kinds. The continuity of operation of the condenser then becomes a serious matter, as much of this refuse will pass through the usual screens, reach the tube sheets and clog up the tubes. One station has devised a remedy which is substantially an arrangement so that what was originally a multi-pass condenser is changed over to a single pass. The condensers were originally constructed for three-pass, and it was decided to cut away the first baffle, thus putting all the tubes in multiple with one another and making the condenser one-pass. When this change was made much less trouble was encountered by tubes stopping up. The tubes did become stopped up more or less, but with so many more tube ends exposed it took a much longer time to stop up a sufficient number of tubes seriously to affect the vacuum.

Cylinder Oil for Auxiliaries Using Superheated Steam.—Considerable diversity appears in the practice of different companies in the specifications for cylinder oil for this purpose. The viscosity reported varies from 145 to 240, and the flash from 531 to 660. One company reports oil compounded at 7½ per cent. of mineral oil, and another company no compounding at all. Prices reported range from 13·5d. to 20d. per gallon. The oils which should be avoided are those having an asphalt base, which tends to carbonise in the cylinders under the high temperatures.

Step Bearing Oil.—Although a few instances are reported where water is being used for step bearings, and with satisfaction, a light pure mineral oil is generally used for this purpose, and here again is found considerable diversity in specifications and price.

Feed-water Heating.—For heating feed water in steam turbine stations the general practice is to instal non-condensing steam-driven auxiliaries, and use the exhaust steam mainly in open heaters for heating the feed water. Quite a number of plants using open heaters report a feed-water temperature between 200°F. and 210°F., which is obtained without any other source of heating except that from the exhaust steam rejected by the auxiliaries. As a matter of fact, nearly all of the plants seem to have enough exhaust steam for heating the feed water, and only a few are making use of the expedient of taking a certain amount of steam from one of the intermediate stages of the turbine.

Ventilating Turbo-generators.—Most of the companies corresponded with have turbines of the enclosed self-ventilating type, and about one-half of them are taking fresh air from outside the buildings. None have installed any system of purifying the air, although in many instances the generator windings and ventilating slots rapidly accumulate a heavy coating of dirt, to the detriment of the machine. It would seem that a cheap and easily operated air-cleaning system would be of considerable value for many central stations.

A purification system about to be installed by one large company is located outside the turbine room, which contains four 12,000 kw. Curtis vertical turbines of the self-ventilating type, running at a speed of 750 revs. per min. and requiring 40,000 cubic ft. of air per minute each delivered at the inlet opening, or 160,000 cubic ft. of air per minute for the four units. After a careful study of the local conditions it was decided to place the air-cleaning equipment on the roof of the station, 70 ft. above the hoods of the units. The four units, which are located in a straight line on one side of the engine room on 20 ft. centres, have been connected to a common supply duct 8 ft. by 8 ft., of light sheet metal securely framed and supported on the wall 20 ft. distant from the units. The duct is carried through the north wall of the power station and rises vertically 70 ft. to the roof of the building, where the air cleaners are to be installed. Each unit is connected to the duct by a branch duct provided with self-closing damper. The main duct is provided in the engine room with a closed opening, which may be opened to admit air in severe weather to temper the cold air. The duct has been so designed that the velocity of the air in any part will be less than 2,500 ft. per minute, except at the inlet opening on the turbine, where the velocity becomes 2,700 ft. per minute.

One of the first propositions considered was a system of screens covered with a loose woven cloth, such as cheese cloth, but the screen area required to handle 160,000 cubic ft. of air per minute and the inefficiency of the cloth, together with the difficulty of keeping the screens clean, either with compressed air blown through the screens from the inside or a vacuum cleaner to remove the dirt from the face of the screen, caused the rejection of this type of cleaner at once.

A number of successful commercial systems of mechanical cleaning of air for ventilation of buildings by means of water spray for washing and cooling the air were investigated and found to be highly efficient and most satisfactory in removing dirt and soot and delivering clean cool air. Various makes were carefully examined, and it was decided that the straight spray system and a combination of the spray and sheet-cleaning surface were the two that offered sufficient merit for consideration.

The questions that are suggested in connection with the operation of an air washer are the danger of entrained water being carried through the eliminator; the regulation of the humidity in order that saturated air shall not enter the duct: also the degree of cooling of the air that may be reasonably expected in the summer and the protection against freezing of the water in the spray chamber in winter, and amount of steam required for tempering the coils. Large units have been successfully operated for years without the slightest trouble from entrained water being carried through, even in case of hard driving rains, when the velocity of the air passing through the eliminators has been increased several times. The humidity can be regulated so that there will never be an occasion for trouble from saturated air entering the turbines and depositing moisture.

The cost of a complete installation for thoroughly cleaning and cooling the air for large units will vary with local conditions, but the washer, eliminator, motor-driven circulating pump and housing should not exceed £160 for an equipment furnishing 40,000 cubic ft. of air per minute. For a 160,000 cubic ft. washer approximately 1,100 gallons of water per minute are required under ordinary weather conditions, which call for a 6 in. centrifugal pump, working under 12 lb. to 14 lb. pressure with a 15 H.P. motor. The amount of make-up water depends on the quantity of dirt and temperature of air, and cannot be estimated, though the total quantity should be small.

Large-sized Boiler Units.—Only one of the larger companies is seriously considering installing large-size boiler units. The Detroit Edison Co. has made an installion of some boilers, each having a capacity of 2,300 H.P. They are the largest single units reported up to date, and while they have not been in operation for any great length of time they are apparently quite successful.

The general tendency in building large plants is to provide for the possible installation of economisers at some future time, but they are not being generally installed at present.

* Abstract from the "Electric Railway Journal" of a report presented at the meeting of the National Electric Light Association.

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CONFERENCE ON EDUCATION AND TRAINING OF ENGINEERS, 1911.

(*Concluded from page 587*).

Sections II. and III. held a joint meeting under the chairmanship of Mr. R. Elliott-Cooper. The following Papers, of which we give abstracts were read :—

THE RELATION OF PRACTICAL TRAINING TO COLLEGE STUDY.

BY PROF. A. BARR, D.Sc.

In defining the topics with which the conference is to deal the council has used the words "education" and "study" in referring to college work, and avoided the term "instruction" and the much-misused expression "technical training." This is as it should be. The end to be kept in view in a college course is the education of the student, and the result is to be measured not by the amount of detailed knowledge he has gained but by the extent to which his mind has been developed, and by the insight he has gained into the principles underlying successful practice. The alternatives before the colleges are : (*a*) The offering to the student in a limited time at his disposal of a general course of study that may form a basis for practice in any department of our wide profession ; or (*b*) the provision of a number of courses, from among which the student may select the one that appears to bear most directly on the particular branch he expects to follow.

If I may state my own view, it is that little specialisation should be attempted, if for no other reason than that the young engineer, if he has the elements of success in him, cannot foresee the trend his career will take. The best college course is the one that is most educational, and this will be the course that gives the student the broadest outlook upon his profession. It need deal little with the details of specialised practice ; these can best be learned in the workshop, the field or the drawing office. Men who are successful in engineering practice seldom follow in later life the particular branch of work in which they have been trained ; and of two men, one of whom has a thorough grasp of general principles and the other a knowledge only of the details of one branch—however intimate that knowledge may be—the former is in a much better position to take advantage of such opportunities of advancement as may come within his reach. Moreover, the conditions of practice, even in one limited sphere, are constantly changing. The college course should, then, be on broad lines, and should aim at giving the student a thorough grasp of general principles, illustrated by examples of their application in various branches of practice.

The question as to the order in which the two sections of the engineer's training should be pursued is also one that admits of no general answer. What will be best for one man may not suit another. Much depends upon the special circumstances of the pupil in regard to his mental qualities and attainments, the facilities he can command for study, and the opportunities he may have for securing practical training when he desires to enter upon it. Moreover, other things being equal, a man who has had a practical training is better able to benefit by a course of study in engineering science ; and, on the other hand, a man who has had a sound training in science is in a better position to take full advantage of his apprenticeship or pupilage. But he cannot have it both ways. In favour of taking the college course first, and pupilage or apprenticeship after graduation, it may be urged, with good reason, that by securing continuity in the pupil's education, the danger of his losing the habit of systematic study, and his grip of what he has already learned at school, is avoided. Further, he will enter on his practical training with his mind disciplined and developed by his study of science ; and experience comes most quickly and with most lasting effect to one who can place each item as it presents itself in its proper place in a connected system of knowledge based upon general laws the workings of which he has learned to recognise.

Further, if the college course is entered upon after practical training is completed, the pupil severs his connection with those under whom he has been trained, and he may have to make a fresh start in life when he leaves college.

In favour of practical training following directly after school, it is urged, also with good reason, that the initial stages at least of apprenticeship or pupilage should be got over at an early age. A man who has gone through a complete course of study in a university or technical college will necessarily have reached an age at which he may take less kindly than the schoolboy will to the drudgery of initiation into the routine of practice in the workshop or the office. Again, the man who takes his apprenticeship or pupilage first goes up to college with such a knowledge of his needs as will enable him to appreciate the value of what is offered for his assimilation. Furthermore, any lengthened course of study without the correcting influence of experience of the requirements and limitations imposed by the conditions of practice is liable to make a man altogether too "theoretical" in his outlook and his attitude of mind.

The disadvantages of postponing the college course to a late period in the pupil's training can be mitigated, to some extent, by private study, or by attendance upon evening classes, during the period of practical training—and good results follow in the case of men of special ability and perseverance—but the time and energy at the pupil's disposal for evening work are very limited compared with those he could command in a complete course of day study at a university or technical college.

There is then something to be said for, and something against, each of the alternatives discussed. But one branch of the pupil's training need not be postponed until the other has been completed—they may be taken on the "sandwich system." It is sometimes assumed that the advocates of the sandwich system commit themselves to a particular disposition of the slices of study and practice and to some definite quantitative relationship between their volumes. No hard-and-fast specification need be made. What is here meant is any arrangement which permits of college study being begun at a time not too distant from the close of the pupil's schooldays, which provides that during the later part of his studies the student will have the benefit of some measure of experience in the actual conditions of practice, and which ensures that the latter part of the pupil's practical training will be taken after he has had his mind disciplined by a course of study in pure and applied science. Whether a short period of practical work—a year or so—should immediately follow school, or, on the other hand, the first year course at college (in pure science) should come first, depends, in my opinion, upon the circumstances of each pupil as regards his state of preparation for higher studies and the facilities he can command for entering upon practical work when he desires to do so. I do not think any rule should be laid down.

Many objections have been raised to the sandwiching of study and practice. One is that the usual college session of eight or nine months leaves too thin slices of practice if the college course is taken in consecutive sessions. I agree with this view. When the system is adopted the college session should be limited to six months, as is done in some universities and colleges. Another objection is that engineering firms will not be disposed to take men on for half-yearly periods, with breaks of equal duration. Any pupil who finds it impossible to get entry to practical work on these lines must take his training in some other way, but hundreds of students do find openings that permit of thus sandwiching their trainings. The system is not new : it is indeed the oldest followed by university students of engineering science ; it has been adopted by generations of students since the Glasgow Chair of Engineering was founded in 1840, and my own experience, gained in the 40 years during which I have been connected with its working, has given me the firm conviction that it affords the best system of training for the great majority of men entering the profession.

In conclusion, I would plead that the engineering institutions should allow a wide latitude in the systems of training that they will recognise. Let it not be forgotten that no two of the men who have made our profession what it is have entered it by the same path, and that many of the most eminent of them have had no training that would to-day be recognised as a normal one, either in respect to education or to practice. Men differ in natural qualities as much as wood and stone and steel, and the tools and treatments that will fashion a useful product out of one may make a sorry job of it when applied to others. Let the system of training differ in different districts if need be, and let the courses of study offered by colleges vary in substance and in method. We cannot dictate to members of the profession the terms and conditions on which they will take apprentices or pupils, and it will be destructive of much that is best in the influence a teacher may have on his students if he is forced, by any detailed regulations, to work upon lines inconsistent with this bent and contrary to the dictates of his own experience. There is need in the profession for men of widely different qualifications : let us not aim at turning out our recruits like so many forgings stamped in one set of dies.

THE RELATION BETWEEN PRACTICAL TRAINING AND COLLEGE EDUCATION FOR ENGINEERS.

BY PROF. H. LOUIS, M.A., D.SC.

In the discussion of this question, it seems advisable to determine in the first place what are the points upon which there is practically a general agreement. All agree, I believe, that every engineer must have practical training, and though there may be still some who hold that when he has this all knowledge of theory is superfluous, I venture to say that no engineer of any eminence holds that view to-day

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so that I shall commence with the assumption that training in both theory and practice is generally considered as indispensable to the engineer. As to the relative amounts of knowledge of either branch and the character of such knowledge there is a wide divergence of views. Possibly all will agree that there is nothing that has a greater influence upon the success of an engineer's career than the ability to deal with men. This is in many cases an innate ability, though it can undoubtedly be cultivated and developed. It is often said that one of the drawbacks of a college education is that it does not call out these traits of a young man's character, but in my opinion this charge is due to an imperfect appreciation of the scope of a college training. Mere attendance at lectures and laboratories will certainly not do much towards attaining this object, but it must be remembered that attendance at lectures and laboratories is only part of college life. In the relations between teachers and students, and still more in those among the students themselves, a British college forms one of the best schools in existence for teaching tact, good temper, honesty of purpose and that sportsmanlike sense of fair play, which form the best foundation for dealing with men of all classes. Participation in college societies, intellectual and athletic, as well as the large degree of self-government allowed to students' representative bodies, tend to foster a sense of order and responsibility, and to develop a power of administration which are of great value in after-life. Again, it has been sometimes urged that our colleges fall short in the matter of discipline; that in a works a young man will more readily acquire the all-important habits of punctuality and promptitude which in a college are not always inculcated with sufficient strictness. For this charge there may, I believe, be some foundation, but the defect is in no way essential to a college system; the remedy once pointed out is easy to apply, and I have every confidence that the importance of its application is becoming more and more generally recognised. Indeed, I think that it may fairly be argued that a college training is of quite as much value in the development of character as in the acquisition of knowledge.

There is no portion of the engineer's training upon which greater diversity of opinion exists than in respect of the manual training that should go towards making up the education of an engineer, and curiously enough this diversity is specially characteristic of the various branches of the engineering profession. Mechanical engineers, and to a lesser extent also electrical engineers, insist that a lengthy apprenticeship to the manual portion of the trade is indispensible, whereas the "civil" engineer looks upon it as wholly superfluous. The one insists that the pupil must learn how to use the hammer and the file, the other sees no reason why he should touch the shovel or the pick. For my part I cannot see why, if a man can build a bridge without being a skilled riveter, he must be a skilled fitter before he can build the engine that is to run over it. Still more curious is the anomaly in the two closely cognate branches of mining engineering; most metal-miners look upon practical acquaintance with the use of the miner's tools as an important part of the mining engineer's training, whilst the coal-miners hold that all such manual work is entirely unnecessary. Personally, I am inclined to think that this profound faith in the necessity of manual skill is to a great extent a piece of fetishism, a survival of the old apprenticeship system, which used to be the only avenue leading into any branch of the engineering profession. I will not go so far as to say that manual skill is useless to the engineer, but I am convinced that most of us rate it far too highly. It is pretty clear that the object cannot be the acquisition of manual dexterity for its own sake, but rather for the purpose of gaining familiarity with the properties and working of the materials which the student will have to employ for constructional work, though I should be hard put to it to explain why an architect should not be compelled to serve his time as a stone-cutter on precisely the same principle.

Where views as to the need for manual work diverge so widely, it is hopeless to attempt to lay down any rules generally applicable to the training in such work. This, however, does not apply to the whole of the subject of practical training, of which manual work is only one, and probably not the most important, part. If it be granted that actual technical experience amongst the men who are engaged in doing engineering work is essential, it will perhaps be fairly admitted also that the college is not the place to attempt to acquire such experience, and that any attempt to imitate works practice in a college is necessarily bound to result in failure. A college is the place to learn principles, and not practice. If this be admitted, it is not a very long step further to argue that the knowledge of principles ought to precede the study of their application, and that, therefore, college teaching should precede, and not follow, practical training. Whilst I hold this to be true, I also believe that many teachers will concur in my view that a moderate amount of practical training may be of use in the later stages of a college career, as giving more definiteness to the student's advanced work, and showing him more clearly the objective towards which his theoretical studies should be directed.

This is broadly the conclusion to which my experience is leading me. I do not find that the "sandwich system" in its true form—six months at college and six months in works—is satisfactory upon the whole, and think that it frequently results in both college work and practical work being badly done. On the other hand, after three or four years passed in the workshop, a young man usually finds it difficult to come back to his studies, and is not likely to make as good progress as if he had come to college straight from school. Of course, every teacher can quote numerous cases of highly successful students trained in one or other of these methods, but I am dealing here with average men and not with the more exceptional cases. I am inclined to think that the method now generally adopted for coal-mining students is one that embodies the soundest general principles: these students have often had a little experience of coal-mining or practical engineering of some kind before they come to college; they take a three years' college course, spending their long vacations at a colliery, where they are usually sent underground regularly with one of the officials, and thus get accustomed to seeing how work ought to be carried on, whilst they also spend a portion of their time in the drawing office and the colliery offices. After taking a college degree, the law insists that they shall have three years' practical experience underground before they are allowed to take the examination for a certificate as a colliery manager.

The above general system, suitably modified, would probably be applicable to all branches of engineering. Directly on leaving school, I would have the engineering student pass his matriculation examination, then go to a suitable works (using this word in its widest sense) for three to six months, then come to college for his three years' course, returning to the same or to a different works for some three months during each long vacation, and then finally serve a two or three years' apprenticeship. I think that any manual work is best done in the time between school and college. Many teachers will probably support my view that an engineering degree course should extend over four years instead of three as at present—a view which I have advocated for many years, and to which I find that general opinion is now gradually trending. Every branch of engineering has to-day assumed a high degree of complexity, and I do not think that seven years is too long a period to devote to the acquisition of the necessary technical knowledge, whilst I venture to think that this is best divided up in the manner I have indicated.

DISCUSSION.

Mr. H. ROLFE thought there was not enough of the commercial element in the training of students. Colleges dealt with the scientific point of view only, insufficient attention being given to such things as fine measurements, the using up of dies, and the avoidance of duplication in patterns.

Mr. W. B. WORTHINGTON (Derby) entirely agreed with Prof. Barr's last paragraph. It was absolutely impossible to lay down a hard-and-fast rule as to what was the best order of the college and practical training for every case. In his opinion it was best to take the college training before apprenticeship. A lad coming into his office was put on to structural steel work, so as to gain some practice in designing, and it was obviously better if the purely thoretical part of the college training had been obtained before he helped to make working drawings. He (the speaker) was assuming the lad had had a year in the workshop before going to the college. For the mechanical engineer the alternation was easier than for the strictly civil engineer. A year in mechanical works was self-contained, and could be broken off easily, whereas at the end of a year in the office a man had got into the swing of some work on which he was going out possibly, and if he then went to college for a year the thread would be lost, and he could not carry it forward so satisfactorily. Therefore, the sandwich system was not so applicable to the training of the civil engineer as it was to purely mechanical training.

Prof. THOS. TURNER (Birmingham) supported Prof. Barr's suggestion from another point of view. The question had been under discussion for many years, and no conclusion had been reached simply because the conditions varied so much. University students should have a certain amount of practical knowledge, so that they could understand what was being talked about; also a man going into the workshop should have a certain amount of theoretical knowledge so as to understand what was going on in the shops. The two kinds of knowledge should grow together. The ideal case was that which would be adopted by a man with a son to train, who owned works and also had plenty of money. There were many students of that character, and in such cases the whole of the vacation could if necessary be spent in the works. The sandwich system with three months' courses answered admirably. When the students met again it was very interesting for them to compare their experiences. A considerable amount of practical knowledge of the highest possible value was obtained in this way. There was no single road whereby practical knowledge could be obtained; so long as it was obtained they ought not to insist upon the particular method.

Sir ALEX. BINNIE (London) had not the slightest doubt that engineering education during the past 20 or 30 years had improved enormously. He was sorry to say, however, that the way in which students were pre-

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pared at the colleges was not conducive to their advancement as civil engineers. The training in the colleges was such as to make them purely mechanics. His experience as one of the committee selecting civil engineers for the Indian service was that while many were fully qualified from the academic point of view they had little knowledge of civil engineering. The words prevalent during the conference were "workshop," "going into the workshop." That was not civil engineering; they should substitute "going out into the world." Young men came to him practically ignorant of the history of the profession. They were very good mechanics, they had been no doubt in the workshop, but of the broader views of the profession and the history of the profession they were totally ignorant. Their minds were not wide, and they were not fit to be civil engineers. As to what the education should be it was not for him to point out: he was only telling them the results. The education should be broad and wide in scientific matters and in what the old colleges and universities would call natural philosophy. He wanted to see men intending to be civil engineers understand geology, surveying and the outdoor use of instruments. Let a man go to a college and gain the largest and widest experience he could in that college before he attempted to commence his practical course. Practical work in the workshop was exceedingly useful, but not absolutely necessary. Riveting was very useful and necessary, but it was not necessary that a young man should go into a shop and be a riveter. Sufficient learning to know when the riveting was well done or not well done could be acquired in very short time. Knowledge of actual masonry construction and earth-work was very important for civil engineers. The young men should study the works of their predecessors. They should visit many of the suspension bridges. They should read up the subject. They should study the Britannia Bridge, and see how Stevenson and Fairbairn had solved problems which met with success, also the Saltash Bridge, and there study the work of Brunel. They should also study the last masonry dams erected in this country. By studying the work of the masters of their profession they would themselves be seized with an enthusiasm for their work which could not be inculcated in any other way.

Sir FRANCIS RAEBURN said when they came to the question of the training of the ordinary constructional engineer he could not help thinking there was not time for all of them to go through the mechanical course. What was required was a good general education. They should not specialise. The larger part of them required university training, but whether they could take seven years over it, as Prof. Louis desired, was doubtful. There were advantages in going through the workshops for a short time, but everyone could not afford the time. He would not go so far as to rule it out entirely.

The three Papers, of which we give an abstract below, were taken as read, by agreement with the writers.

WORKSHOP TRAINING AS A PRELIMINARY TO OTHER TRAINING IN ENGINEERING.

BY J. ALEX. BRODIE, M.ENG.

In introducing this subject I have thought it well to assume that the youth about to take up engineering as a profession is of average ability and circumstances, about 17 years of age, that he has had a good general education, a superior mathematical training, and preferably an experimental knowledge of one science subject. He should also have been trained to think for himself, to express his views clearly and concisely in speech, and to report in writing on any matter which may be put before him. If he has been accustomed to act as schoolboy captain or to work to the orders of his captain in sports and athletics so much the better; and he should be encouraged to keep up his connection with healthy outdoor sports.

By some it is thought that training in school and college workshops is of considerable value, and whilst this is, no doubt, better than no training in workshops at all, I take the view that workshop practice, to be of real value to the engineer who proposes to advance in his profession, must be conducted under commercial workshop conditions in which considerations of time, money, discipline, organisation and enterprise are factors of importance.

At the age named, the youth should have sufficient strength of character and physique to take care of himself in the workshop atmosphere, and he is yet sufficiently young to adapt himself to the dirty conditions of work, the muscular exertion, and the somewhat rough-and-ready manners of the workmen with whom he must learn to work on a friendly footing if he is to obtain their help and assistance.

Probably all experienced engineers are to-day agreed that a period of practical training both in shops or works and drawing-office is of undoubted advantage to the engineer, much increasing the value of his services as an assistant, and adding to the weight of his advice and opinion at a later stage in his career. Important points for consideration are: (1) The class of workshop he should enter; (2) the class of work most likely to be helpful in his future career; and (3) the length of time which can be given to works and drawing-office training.

As the result of experience I am firmly convinced that the best type of workshop is one in which the materials used and the classes of work done should be as varied as possible. If repair and maintenance work is done so much the better. It will generally be found that in a comparatively small works the youth's ability will be more fully utilised, the necessity for quickness and accuracy more quickly brought home to him, and he will also have the advantage of being more directly under the eye of the master.

As against this view, it is often considered that training with a well-known firm more than counterbalances the advantages obtainable in a small general workshop, and it must be admitted that training in a great works, especially if followed by a pupilage or subsequent experience in one of the best offices, is still looked upon as a good introduction to the profession, particularly for those desirous of taking up work of a public character.

For the youth who does not propose to remain in the workshop it is not, I think, so necessary that he should learn to equal the workman in his knowledge and ability to execute any one class of work as that he should acquire an intelligent knowledge of the processes and methods of treatment of the various metals and other engineering materials. Perhaps of greater importance than anything else is the ability to form a correct opinion of the capability of the men in a workshop, a knowledge of their methods of thought and work, a study of the systems adopted to get work pushed through to completion, and generally such knowledge as will enable him to handle men advantageously when occasion requires.

The importance of obtaining some practical experience in a works' drawing-office should on no account be overlooked, as efficiency and speed as a draughtsman, combined with some ability to design, has been the first step in the rise of many men who have advanced to the higher positions in the profession.

It should also not be forgotten that the young engineer may at any time be called upon to proceed abroad to take charge of works under conditions wholly unknown in this country, and, speaking from my own experience, I can say that the knowledge of workshop practice in materials such as the metals, wood, stone and cement, together with drawing-office experience, have been of the greatest assistance in settling points of importance when away from the experienced and helpful friends who are generally available for consultation in this country.

With regard to the period of time which should be given to practical work at this stage in the young engineer's career, I would, wherever possible, allow for three years in works and drawing-office, especially if, as in many cases, it is necessary or desirable that the youth should, on the completion of the additional period of study, desire to get a start in an office or works in this country. It is my experience that a youth with three years' practical workshop training as a preliminary to his college education would have much less difficulty in getting a useful start in the profession than the youth who only had a college training. In the one case, having obtained his degree, he is probably well worth starting at once on a small salary and should pay his way on any class of work. In the other case, a considerable time will usually elapse before he settles down to real work, and it does occasionally happen that the University man's estimate of his own value as an assistant is not reached in practice for a considerable period.

What I understand to be the practical objection raised to the acquisition of practical experience before taking a college course is that young engineers are generally unable to keep up their ability to study or to improve their technical education during the practical training in workshops. I number amongst my friends a large number of men who obtained most of their theoretical training whilst working the full workshop and drawing-office hours at a time when the facilities for acquiring such knowledge were not by any means so general as they are to-day. I have consequently little sympathy with young engineers who cannot do so, or with those who think it necessary that young engineers should work a reduced number of hours in the workshop so that they may be able to give greater time to study and to improve their theoretical work. It used to be, and is, I believe, still, the almost universal workshop practice, not to give important work to short-time men, and, therefore, a youth working short time is seriously handicapped in obtaining practical experience of value.

Short hours should not be allowed as a general practice, and though it may be a good thing to allow additional time for study, this should be within the works or under some form of control. I am aware of many cases in which these well-intentioned allowances of time for study have been abused, and I believe that even after a day's hard muscular work mental training may with advantage be continued, especially during the winter months, when little in the nature of healthy outdoor exercise is possible.

It appears probable that if our youths of to-day cannot or will not stand the strain of the severe training which has in the past given good results, they will probably have to take a position behind those who are prepared to do so. It may on the whole be better that they should take up work better suited to somewhat easy-going methods, and it cannot be doubted that there are many lines of life in which

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young men can more easily and quickly acquire both money and position than in the engineering profession. Even with hard work, deep thought, foresight, organising power, a clear grasp of the situation, determination, and strong common sense, success in engineering is not always assured.

WORKSHOP TRAINING AS A PRELIMINARY TO PRACTICAL TRAINING IN VARIOUS BRANCHES OF ENGINEERING.

BY J. M. MONCRIEFF.

It will be of use to consider this question in the following form: What ought the student to learn during such a period of workshop training, and how does the knowledge to be gained during this period bear upon subsequent practical work in other branches of engineering than those concerned with the construction of machinery?

In dealing with this question it is only possible to touch upon some of the more important points in an introduction to a discussion.

1. The student will, or ought to, learn the value of discipline and the necessity of order, punctuality and continuity in work.

2. He will acquire a personal knowledge of the various materials used in the manufacture of machinery. This personal knowledge is entirely different from anything which can be obtained by any amount of reading or laboratory work. He will actually feel the materials as he works with them, and his knowledge, not only of what *can* be done, but of what can *reasonably* be done with them, will be greatly extended.

3. He will learn the use of hand and machine tools, and how much ought reasonably to be done *in a given time* with their aid under ordinary commercial working conditions.

4. He will see the order in and foresight with which work is distributed throughout the shops so as to ensure that the whole, though composed of innumerable units, shall all work to one common end with due regard to economy.

5. By working at the vice, the lathe, the pattern-maker's bench, in the smithy, in the foundry, or in the boiler shop or bridge yard, he will learn the various processes through which work passes, and he should become imbued not only with the scientific side, but, at this stage, still more importantly with the commercial side of engineering work.

6. By working side by side with workmen he will have the opportunity of studying their characters and modes of thought. The influence of an engineer who has had such personal contact is immeasurably superior to that of one who has merely had a bowing acquaintance with labour. The value of such personal contact is not confined to influence over workmen; it extends to subsequent business life when dealing with experienced engineers, whether consulting or manufacturing, and especially the latter, who, not seldom, make the criticism that such and such an engineer "has no real practical knowledge of the work. He is merely a paper man."

7. The student in the works should also begin to learn some of the limitations of the application of science to practical work. It is, or ought to be, common knowledge that that which on the surface appears scientifically desirable may be practically foolish and wasteful both of time and money.

8. If the student's mind be of true engineering bent he will unconsciously acquire a knowledge of the relative proportions of details of machinery and structure, and his eye and mind will be trained by the daily study of work which embodies the accumulated experience and extended study of others who are preceding him in the same walk of life.

9. A period of training in the practical side of mechanical engineering will impress on the student the great importance of accuracy.

10. By working actually at vice or bench or machine in a dividend-earning concern, the student is brought into personal touch with the money-value of time, labour and plant, and is forced to realise that without full recognition of such money-value success in everyday life will not be attained.

11. A thorough grounding in all this valuable experience and knowledge is to be gained within the gates of a mechanical or structural engineering concern, and all within an area of comparatively limited extent. No subsequent training on large works of construction can so fully and quickly and efficiently supply all the desiderata of training which has been outlined above.

12. What important engineering work was ever carried out without the use of mechanical appliances?

13. Further, what can be expected of a designer of machinery, ships, bridges, structural steel and ironwork, waterworks, gas works, electric plant or any other of the varied productions of engineering, if he has had no mechanical training? The answer may be given in the words of a works manager, who criticised the design of some of the details of dock gates which his firm were carrying out to a consulting engineer's designs, as follows: "The work might almost as well have been made of solid silver."

WORKSHOP TRAINING AS A PRELIMINARY TO PRACTICAL TRAINING IN ALL BRANCHES OF ENGINEERING.

BY PROF. J. J. WELCH, M.SC.

Since 1867 much has been done to emphasise the need of proper scientific training, and few will be found to question the wisdom of the council of this Institution in insisting upon a high standard of theoretical knowledge in those desiring membership. Also, and to at least an equal degree, their emphasis upon the need of practical training commands approval. The desirability and feasibility of preliminary workshop training are the subjects which it is desired to open up for discussion by means of this note.

In considering the latter subject the point of view of the employer must always be borne in mind, for, however desirable the training may be, it is the employer alone who can make it possible; and whole-hearted co-operation between the employer and the engineering colleges is essential if the best results are to be obtained, and if the course recommended by the Committee is to be generally adopted in practice.

In attempting to appraise the value of this preliminary training, it seems convenient to consider separately the case of those students who intend following up what may be summarised as general mechanical engineering, and those who intend to devote themselves to branches of engineering in which machinery is not so extensively employed. Dealing with the former case first, the student may, immediately after the period of preliminary training, desire to take up his college work, or he may continue his practical training in an office. In each case he would find the introductory workshop course helpful. Most colleges provide a course of study during the first year which is common to all sections of engineering, and the lectures on, say, applied mechanics are more easily comprehended by those students who have seen at close quarters, and handled, the machines and details taken for the illustration of the principles. It goes without saying that these students find one great advantage of the early training in the ease with which they can understand the allusions to technical details in the specialised courses.

If, on the other hand, the student after his preliminary course goes into an office, he will, in all probability, be early introduced to specifications of work, and here again he will find his early experience useful in understanding the terms used. Or he may be employed drawing out details and fixing sizes, and his work at the shop will enable him to appreciate dimensions and proportions much better than he could hope to do without that experience.

Further, the lad who enters the works at a comparatively early age gets into closer contact with the workman, and the workman seems more willing to teach him at that stage than after the college period is passed. This close association in the works enables the student to gain the point of view of the artisan, a point of some importance to those who may subsequently be placed in charge of men. Then, again, this immersion into a commercial atmosphere immediately after leaving school comes as a pleasant break in his scholastic studies, introduces him to new interests, and enormously widens his outlook by the time he is called upon to take up his college work; and he does so with a better appreciation of the goal towards which he is tending than is possible to one without such preliminary training. It should, perhaps, be added that this early workshop experience is occasionally useful in convincing some young men who thought of taking up engineering as a profession that they have mistaken their vocation; and they have been able to select some more congenial sphere without any important loss of time. The discovery of unfitness would probably not have been made so early had the college training been taken first.

For all these reasons, then, it is considered that an introductory workshop course for those intended for the general mechanical engineering profession is of distinct importance; and it is significant that a similar course is now insisted on for German shipbuilders and engineers before taking their theoretical course at a high school, although formerly students were allowed to get their high-school training without such practical experience.

The length of training recommended by the Committee of this Institution seems adequately to meet all requirements; and it has been found that periods very materially in excess of one year, interposed between school and college, tend to make it difficult for the student to pick up again the threads of his interrupted mathematical and other theoretical studies.

Considering next the case of "civil" engineers and others not so closely associated with the design and care of machinery, one speaks here with some diffidence on account of less intimate knowledge of all the conditions; but, remembering the increasing use of plant and machinery of all kinds in all branches of engineering, it seems that in this case also a preliminary workshop training must be of very distinct use, and it will be obvious, without special reiteration,

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that some of the advantages claimed above are equally relevant to the "civil" engineer. The preliminary course could be somewhat shortened, however, as compared with that for the mechanical engineer, and from six to nine months would furnish all the experience needed.

DISCUSSION.

Prof. J. M. MONCRIEFF (Newcastle-on-Tyne) said that young men had the impression that when they had completed their college career they could look forward to employment. College authorities should not allow them to have this idea. Getting a degree was not work; they must get some practical knowledge. Young fellows could not be taken into the office straight from the college. There was, so far as he was aware, no commercial feeling behind the teaching in the universities.

Mr. G. G. STONEY (Newcastle-on-Tyne) said the importance of preliminary work in the workshop was in weeding out wasters. They were not all engineers. In his mechanical and electrical works they had some 250 apprentices, and allowed as many as possible to go to college and come back. About half a dozen were away at a time. Of course, if all of them took such privilege they would not be able to allow it.

Mr. C. W. DARLEY (London) said it was a good thing for young men to get into the contractor's office as a contractor's engineer, and learn something of the practical carrying-out of large works, also of keeping accounts of the cost of works. They should have three or four years' practical training in England before going abroad.

Mr. R. J. G. READ (London) said in regard to civil engineering it was a great advantage for a boy to go into the civil engineer's office for a short time before going into the works. The boy should also have some college training before going into the office, and it would not then be necessary for him to be articled for so long as used to be the case.

The CHAIRMAN (Mr. R. Elliott-Cooper), in concluding the discussion, said if they all had to be experienced in all things life would not be long enough. However advisable it might be for a young engineer to be equipped with every possible advantage it was impossible to give him that detailed instruction and practice which some speakers had suggested. There was not time to become a mechanic if they had to work up the subjects necessary for a civil engineer. For the civil engineer who was going to devote his career to the construction of railways, harbours, docks, waterworks, municipal works and the like, mechanical knowledge only came in as an incident in the general practice. In regard to engineers going abroad, general engineering knowledge, a thorough scientific knowledge to commence with and a thorough English technical knowledge fitted a man for any work no matter in what part of the world he might be. The knowledge which an engineer got with a contractor was most valuable. In no engineer's office could be got that knowledge to deal with money and money values better than in the contractor's office. Several had spoken both for and against the sandwich system. He thought the college career ought to be taken before the practical career. It was practically impossible for a young engineer going into the civil-engineering branch of the profession so to dovetail the work from the college to the works and from the works back again to the college as really to enable him to gain any continuous knowledge either of the one or the other. The object of scientific education was to teach the natural philosophy which was to be put into practice later on in life. He did not go so far as to say that some practical training might not be sandwiched in.

The sectional meetings being concluded, the Conference then assembled in the Lecture Theatre, with the President in the chair.

Mr. A. F. YARROW said he did not propose the following as a resolution, but before the closing of the Conference he submitted that the Council might be asked, with advantage, to focus its attention upon the following points, which he had placed in the form of resolutions: (1) That the Council of the Institution be desired to use its influence in any way deemed practicable to secure a continuity of study between those public schools where the elements of science are taught and the universities and technical colleges, so that pupils leaving such public schools be suitably trained to follow at once a college course with advantage, so that, as it were, the college course may begin where the school training finished. (2) That with a view to facilitate the above, a closer connection between the masters who teach science in public schools and the Institution of Civil Engineers is desirable. (3) That the Council of the Institution should endeavour to induce the universities and technical colleges to adopt such terms of study, say, six months during the winter, so that the "sandwich system" can be adopted, if desired, which is not possible with the terms now customary. (4) That it is desirable that the Council should endeavour to produce some co-ordination between the college and the employers, by making a systematic inquiry from the employers as to the condition under which exceptional students properly qualified may be able to get practical training for a period of, say, 24 to 36 months on the "sandwich system" or not, when vacancies in such establishments occur.

Mr. ALEX. SIEMENS said that some teachers were at a loss as to what to prepare their students for. They had evidently forgotten the conference about six years ago to which the Institution had sent delegates. The conference was called by the Board of Education for the purpose of laying down the syllabus of a standard examination which should be accepted by the universities as an entrance examination, and also by the various professions. That came to nothing because the schoolmasters could not agree what the syllabus should be. He did not know whether it would not now be the time to try once more. He was encouraged in that idea because just now a conference of surveyors of the whole Empire was sitting, their object being to see whether surveyors could not be made interchangeable, as it were, between the various dominions. That conference came to the conclusion that such a complete interchange would not be quite possible, but had drawn up a syllabus of an examination showing what general education would be required for surveyors to practice anywhere in the Empire. He believed it was not impossible at the present time to draw up a syllabus for an examination showing the general education only, not specialised. A feature of their Conference was that all experienced people, teachers, employers and engineers, had warned them against specialisation. In regard to the scientific part of the education the object of that was expressed extremely well by Mr. Petavel in his second proposition. The fault of the young man who had a degree and who had come from college was that he knew everything better than the practical people to whom he came. He had to be convinced that he knew nothing, then he was of use. In closing the Conference he had great pleasure in thanking the members, and especially the friends who had come and helped them in joining in the discussions, for their presence. He also had pleasure in thanking the chairmen of the sections for the great trouble taken in conducting the meetings, and not less the honorary secretaries of the sections and those gentlemen who prepared introductory remarks for the various sections. He was perfectly certain he also spoke with their concurrence in thanking Dr. Tudsbery and the staff of the Institution.

Mr. Siemens then declared the Conference closed.

ELECTRIC DRIVING OF TEXTILE MILLS.

The receipt from the Westinghouse Company's publishing department of a little booklet on loom motors reminds us of the progress which has been made in recent years with the electric driving of textile mills.

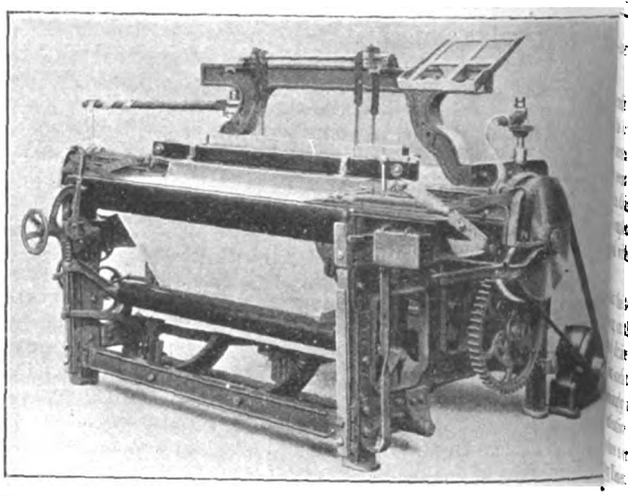

FIG. 1.—PLAIN OVERPICK LOOM FOR WEAVING SHORTING, CALICO, DOMESTICS, ETC., DRIVEN BY WESTINGHOUSE LOOM MOTOR, WITH SPRING BELT TIGHTENER AND PULLEY DRIVE.

For years electrical manufacturers tried hard to introduce the electric drive to the textile industry but without success. It was not that the textile manufacturers were ignorant of the claims put forward, or that they regarded them as chimerical. The real reasons militating against the adoption of the electric drive were quite other than these. There was first the fact that the wealth and success which were, and to some extent still are, such happy features of the industry had been built upon, and until recently were being maintained by the use of the steam drive.

The predominance held by the British textile industry, however, was threatened, on the one hand, by the appearance in the field of new competitors, and on the other hand, of old competitors equipped with the latest and best machinery. Its proud position was felt to be slowly but surely slipping away, and the familiar argument used in favour of electricity as against the mechanical form of drive—arguments hitherto unavailing—began to be effective when supplemented by the experience of American and Continental competitors who found that they were able to turn out better work and at less cost than with the old form of drive. But the application of electricity to textile manufacture in this country received an unfortunate setback at the outset of its career—a setback from which it was slow in recovering, and which had the effect of appearing to justify the more conservative manufacturers and of seriously disappointing the more advanced who had ventured to try the experiment.

When the first electric installations were put in British textile mills, a good many mistakes were made. The requirements of the industry had not been fully studied. The electrical engineers were

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more or less ignorant of the peculiar conditions under which textile mills are operated, while, on the other hand, textile engineers were more or less ignorant of the capacity and peculiarities of the electric motor. For instance, it was not generally recognised in the early days that it is impossible to run medium-sized, open-type motors in the interior of textile mills unless they are specially designed, and arrangements made for ventilation by a supply of fresh pure air, or, alternatively, unless housed in a separate part of the building. Similarly the necessity of keeping cotton waste, &c., from the interior of the motor was only partially realised.

The electrical firms found it necessary to give close study to the new conditions. The field was a large one, the prospects attractive,

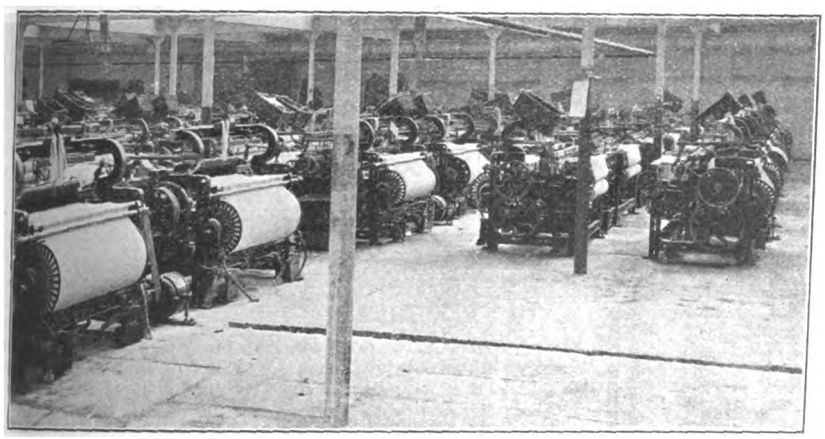

Fig. 2.—Another View of Weaving Shed showing ½-h.p. Loom Motors at Work.

and, to their credit be it said, they took it up vigorously, with the result that when the actual demands of the industry were known and catered for, success was instantaneous, and has been continuous; so that it really seems as if the resistance offered by the British textile industry to the claims of electricity, a resistance stubborn and prolonged, has completely collapsed, and one by one new mills are being equipped with, and old mills rapidly converted to, electric driving.

It is true that the textile manufacturer is very reticent to give the results following on the application of electricity; partly, no doubt, from a natural desire not to allow competitors the benefit of his experience; but such testimony as has been allowed to leak out has been overwhelmingly in its favour, and their very silence may be regarded as indicative of its efficiency, since unfavourable results would soon produce a crop of complaints.

The "Factory Times," a paper entirely devoted to the interest of the mill operatives, recently published the following note in connection with the equipment of a weaving shed belonging to Messrs. Edward Hibbert & Co., of Hyde, with individual electric drive for each loom.

"Electrically-Driven Looms."—The new shed recently built by Messrs. Edward Hibbert & Co., Greencroft Mill, is being driven by motors. The looms are running much quicker and steadier than they did under the ordinary system and the operatives are well satisfied with the alteration. The motors are so arranged as to use a short belt and the drive ensures smoothness of running and prevents slips.

Like the boy's beans in the fairy tale, electricity has extended itself immeasurably, and though the textile industry was not the first, and is hardly likely to be the last, to welcome the advance of electricity, now that its success has been fully demonstrated, and its claims carried to a triumphant vindication, there is very little doubt that the old cumbersome form of drive is doomed to displacement in favour of electricity, in the same way as the modern textile machine has displaced the primitive hand-loom, and for the same reason.

The first obvious advantage in the driving of textile factories by electric motors is naturally the elimination of the cumbersome gearing, the long lengths of shafting and heavy rope drives, and therefore the first step in advance from the old steam-driven factory was to instal motors of fairly large size driving groups of machines. This was called the "grouped drive" system. It was, however, found that for certain classes of work, notably ring spinning and weaving, it was possible to obtain far more satisfactory results by installing a separate small motor to each machine. This is called the "individual drive" system. In the case of many textile processes, some mill managers and others remain unconvinced as to the advantages of electrification, but in the case of weaving looms it is now an accepted fact that the best possible method is the individual electric drive. In the first place, it carries with it a great saving of power, since a standing loom uses no power, and everybody knows how frequently looms are standing and how the power required to run countershafting bears a very large proportion to that required to run the looms: the lighting of the shed is also greatly improved, as no overhead belts remain. Although this is the most immediate obvious advantage it is practically the least important.

When considering the individual drive as a business proposition, we can assume (although the assumption is not really in accordance with the facts) that the cost of power remains the same for the electrical and the mechanical drive; then the only way to increase the net earnings of the shed is by an improvement in the quality or in the quantity of the output, or both.

The British Westinghouse Electric & Mfg. Co., in the handy little booklet which they have issued on this subject, make the claim that the individual electric drives, properly installed, fulfils both these conditions; the motor speed is absolutely constant and thus gives that smooth and even running so much sought after by the weaving shed owner. This steady turning moment and even running is impossible of attainment with a belt drive from a countershaft, because with the latter there is always a certain amount of slip which is constantly varying, however steady the prime mover may be. To a lesser extent the same is true of the rope drive.

There is also with countershafting a certain amount of slip, dependent on the amount of power transmitted, which does not exist in the case of the electric drive. As a result, a better quality of fabric is obtained from the electrically-driven loom.

It is also pointed out that with the mechanical drive it is impossible to run the looms at the maximum speed the material would stand, because this maximum would be continually exceeded owing to the variation in the speed, thus resulting in breakages, whereas the electric drive enables a high speed to be attained and thus materially increases the output of the shed.

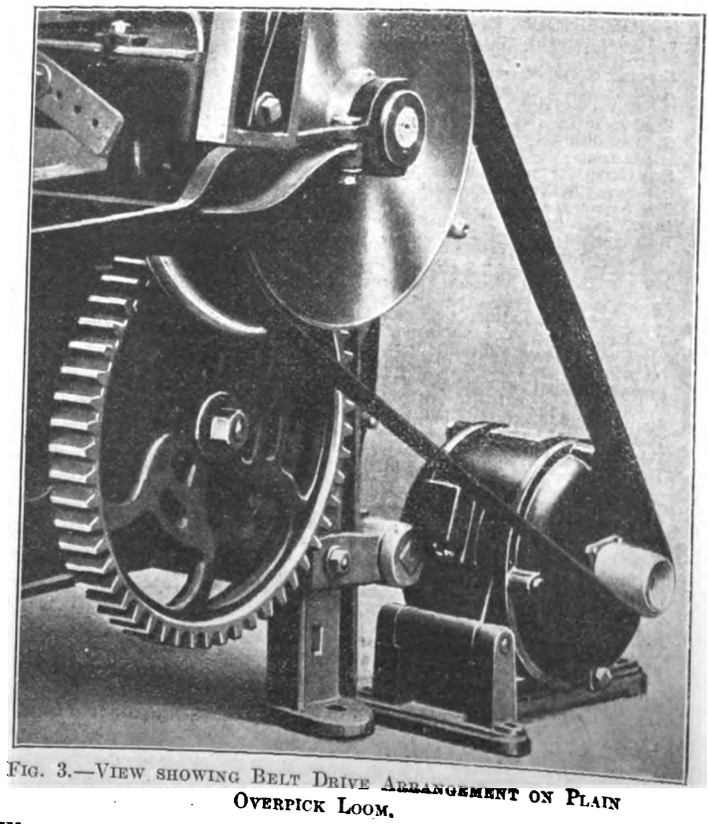

Fig. 3.—View showing Belt Drive Arrangement on Plain Overpick Loom.

We reproduce herewith three of the illustrations shown in the Westinghouse booklet, and any of our readers who are sufficiently interested can no doubt obtain a copy of this publication by applying to the British Westinghouse Electric & Mfg. Co., Trafford Park, Manchester.

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With "THE ELECTRICIAN" for Sept. 14, 1906, was issued the first of a series of "Industrial Supplements," to be published from time to time with "THE ELECTRICIAN." The fifty-third issue of the Supplement published (Gratis) with the number of "THE ELECTRICIAN" for September 23, 1910, was the last of the monthly issues. "THE COMMERCIAL AND INDUSTRIAL SUPPLEMENT" to "THE ELECTRICIAN" is now issued weekly (Gratis). It will be found towards the end of the present issue.

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POWER SUPPLY DEVELOPMENTS.

Electrical engineers are wont to look forward to a time when electrical power will be generated at a few mammoth generating stations—situated in this country adjacent to the larger coal fields, and in America and Africa, perhaps, near big waterfalls. Such schemes, however, up to the present time, have rarely been worked out in any detail, and when any attempt is made to draw up a definite scheme it has usually been assumed that the whole of the power required in the various industrial centres will be transmitted electrically. An interesting modification of this idea was suggested by Mr. F. DARLINGTON, of the Westinghouse Company, in a Paper, of which an abstract appears elsewhere in this issue, read a month or two ago before the National Electric Light Association.

In dealing with the power supply problem the author took, as an example, Eastern Pennsylvania, and considered that at the present time the best results—from the point of view of economy—could be obtained, not by transmitting the whole of the electrical energy required by the cities of New York and Philadelphia from the anthracite coal mines of Eastern Pennsylvania, but rather by installing overhead lines capable of transmitting only about one-third of the total demand for electric power in those towns. These lines would be used for supplying from the coal-fields the long-hour load, whilst the existing steam power stations in the cities would deal with the short hour or peak load. In this way Mr. DARLINGTON pointed out that three-quarters of the total output of units would be

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generated at the coalfields, thereby rendering unnecessary the conveyance of the greater part of the coal at present required by the existing stations.

The distances involved are from 90 to 120 miles, and are similar to those separating London from the nearest coalfields of this country. Here, too, the transmission of electric energy from the coalfields to the metropolis has been suggested, but so far there has been no practical result. The difficulty is to make out a case for transmission of energy as against transport of coal. If the whole of the energy is generated at the coalfield, then there will be a loss of, say, 10 to 20 per cent. in transmission. There will also be capital charges on the line, and there will be its maintenance. These losses and charges must show an advantage over the cost of carriage in the other case in which the station is placed in the industrial centre. A large station working with a good load-factor will require 3 lb. to 4 lb. of coal per unit, or will generate, say, 650 units per ton. Thus, for every shilling per ton spent on transit, the fuel cost will be raised by nearly 0·02d. per unit. This may be somewhere in the neighbourhood of 10 per cent. of the fuel item and counterbalance a considerable part of the transmission loss when the station is placed at the coalfields. There remain, however, the charges in regard to the line, and the cost of the additional generating plant to supply the line losses.

In the suggested arrangement of a station at the coalfields to handle the steady load, working in parallel with stations in the industrial area to take the peak load, the case is slightly different. Such a main station would be working at a very high load-factor and the coal per unit might fall to half the figure just given. Consequently, the units lost in transmission would be generated very cheaply. On the other hand, the peak load stations, owing to the character of their load, would consume a much larger amount of coal per unit, and although such stations would only generate, say, a quarter of the total number of units, the resulting inefficiency could not be neglected.

Of course, something will depend upon the size of the stations and upon the character of the load. London and Birmingham, for instance, would differ largely, leaving their positions out of account. The load in London is very largely of the residential type, whereas that in Birmingham would be more industrial. Looking forward, however, to the time when electrical energy will be very much more in use than at present, and when domestic applications are much more general, the question of peak loads will not be so important, for such loads will tend to disappear, and the main differences will be between night and day, or between summer and winter. The reason for the peak load station will then no longer exist.

In fact, it is not obvious that the splitting up of a station working under good economical conditions into two stations, one working with the highest economy and the other being run under poor conditions, will give very much improved results. Apart from fuel economy, capital charges become all-important when the load consists of peaks, the running cost being but a small part of the total cost of generation in such cases. By installing the whole of the plant in the industrial centre the plant capacity is reduced to a minimum, and although the fuel conditions may not be the most economical, it is difficult to make out a clear case for transmission under these conditions.

ABNORMAL PRESSURE RISES ON H.T. ALTERNATING CIRCUITS.*

BY J. R. DICK, B.SC.

Summary.—In this article the author deals with the conditions under which "resonance" appears in cables, and shows that most disturbances on networks are due to this cause. The oscillations which occur when the current is switched on or switched off are also considered.

Mechanical Analogies.

The expressions "resonance" and "capacity effects" are popularly employed when dealing with all phenomena of this nature, although resonance often plays but little part in their production. To the mains engineer their dangers are well known, and fortunately efficient safeguards are now available by which these dangers can be minimised.

To deal first with the question of resonance, properly so-called, it may be stated that it is not, as a rule, the chief source of trouble on alternating circuits. It is, however, capable of explanation in an elementary way with greater clearness than some of the other kinds of pressure rises, and will, therefore, be first considered. Even in this case, the true physical meaning of the electrical phenomenon cannot be appreciated, unless the general principle of resonance has been studied, in relation to other forms of energy, such as mechanical vibrations and sound waves.

In an electric alternating circuit the waves of E.M.F. and current produced by the generator are obviously of the nature of forced vibrations. Now, what are the natural vibrations? These are produced by the discharge of a condenser or a circuit containing capacity, under certain conditions as to the amount of inductance and resistance associated with it. A concentric or multi-core cable system acts, of course, as a condenser, and if the resistance is small, as it usually is, this condenser will have an oscillating discharge, with a natural period depending only on its own capacity and the inductance in circuit.

The algebraic relationship is

$$2\pi n = \frac{1}{\sqrt{LK}},$$

where n is the frequency of the natural oscillation, L the inductance and K the capacity in series with it.

When capacity and inductance in series neutralise each other, giving resonance, the pressure at the condenser terminals becomes much greater than the supply pressure. Fortunately in most high-tension lines this condition does not prevail, and the pressure rise due to resonance does not reach an infinite value, which it might do, if R were infinitely small. Another reason why resonance effects are the exception is that the value of n found from the equation $2\pi n = \frac{1}{\sqrt{LK}}$, for the usual values of L and K is so high—*i.e.*, of the order 300 to 2,000 periods per second. As alternating-current supply is now mostly given at a frequency from 25 to 50, resonance with the fundamental waves of the generator is practically impossible. But the alternator may not produce waves of exact sine form, as has been assumed in the explanation given above, and the actual waves may contain harmonics or overtones.

These harmonics are little ripples on the fundamental wave, and, although of small amplitude, their frequency may be 3, 7, 13, or any odd multiple of times greater than that of the fundamental, and hence one of them may have a value which satisfies the conditions of resonance.

Even when *exact* synchronism does not exist between the fundamental waves (or one of the harmonics) and the natural waves, resonance may still occur to a greater or less extent,

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depending on the nearness with which these two values approximate to synchronism. Frahm's frequency indicator illustrates this, as there are always some reeds near the one in actual synchronism, which vibrate with the same applied frequency, but to a much less extent.

The effect of load currents is to diminish the maximum values to which the voltage and current will attain under resonating conditions. This is not perhaps of great assistance to those who have to watch for possible breakdowns in the mains, as there will frequently be times of light load on certain circuits, which would offer favourable conditions for abnormal pressure rises. In a circuit feeding transformers through concentric cables, if the outer is not earthed or if the usual earth connection is accidentally broken and the switch on the outer conductor is opened, the capacity between the outer conductor and earth is then in series with the inductance of the alternator and transformer and, given appropriate values, resonance may result.

Prevention of Resonance.

The safeguards to prevent injurious pressure rises of the kind described are briefly as follows. Most of them belong more to the generating department, and are out of the control of the distribution staff :—

1. Employment of an alternator which gives practically pure sine waves and few or no harmonics.

2. Permanently earthing the outer at one or more places through a non-inductive resistance. This should be of such an amount, that the rush of current through it is just sufficient to blow the fuses or trip the circuit-breakers on the inner, when a resonance rise occurs.

3. When connecting an uncharged main to a separate generator, run up the latter to the speed of normal frequency before exciting the fields. This avoids the possibility of resonance with frequencies (or harmonics of them) less than the normal, through which the generator voltage passes in running up.

4. In connecting an uncharged main to the 'bus bars, to employ some form of charging gear such as that used at Deptford, or by gradually cutting out a non-inductive water resistance which has been first placed in series with it.

The best practical way of investigating the possibilities of the occurrence of resonance in any circuit is not to calculate the values of L and K, but to make use of the Duddell oscillograph, which will indicate for any conditions under which the mains are tested whether resonance is present in any degree, or whether it is likely to occur with any modification of the conditions.*

Pressure Rises produced on closing a Circuit containing Capacity and Inductance.

These phenomena are often loosely ascribed to resonance, which is misleading. To make use of a mechanical analogy, they are closely akin to the impact of a load on an elastic body. When a weight, w (Fig. 1), is applied gradually to the spiral spring suspended at P, it will produce an elongation equal to FA. The tension of the spring, equal to w, can then be represented by the ordinate AK, and at any other point, L, during the process of stretching the tension is given by LM. If now the weight w be *suddenly* applied its potential energy, as it falls, will be diminished proportional to $w \times$ FA at the point A, and this change of potential energy is represented by the rectangle AKEF.

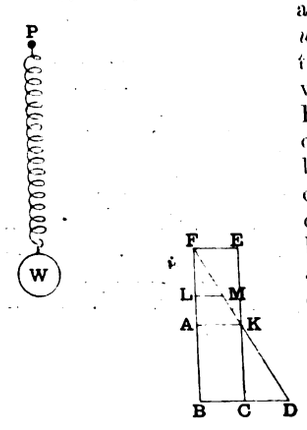

Fig. 1.

From Hooke's law the work done in stretching the spring a distance of FA is represented by the triangle AFK. There is thus a balance of the potential energy represented by FEK, which appears as kinetic energy, and if v be the velocity of the weight at the point A, this kinetic part will be $\frac{1}{2} \cdot wv^2/g$.

* The best English study of resonance from the theoretical and practical points of view is to be found in Mr. M. B. Field's Paper, "Journal" Inst. E.E., June, 1903, Vol. XXXII. (*See also* Electrician, Vol. L., p. 979).

The weight will then continue moving, but with gradually diminishing speed until it reaches B. At this point all the kinetic energy it possessed at A will have disappeared as part of the total work done in stretching the spring from A to B.

The fall of the weight from A to B is equivalent to a diminution of its potential energy of $w \times$ AB, represented by the rectangle AKCB. This is one part of the work done in stretching the spring, and the balance of the work done, shown by the triangle KCD = FEK, is supplied by the kinetic energy which the weight had stored up in it at A.

It will be seen from the diagram that the ordinate, which gives the tension of the spring at any point, is BD at B, and is equal to twice AK, which represented the normal tension due to a weight steadily hanging on the spring, and thus it can be stated generally that the tension produced by an impact or suddenly applied load is twice that due to a steady load.

In order to study the close resemblance which this mechanical example bears to the effect produced in a condenser when suddenly connected to a supply at constant potential, it is best to write down the equation representing the state of things when the weight in its fall has reached the point A. The law of conservation of energy gives at once the following relationship :—

Loss of potential energy at A = work done + kinetic energy.

Or if FA = x,

$$wx = \tfrac{1}{2}\mathrm{T}x + \frac{\frac{1}{2}wv^2}{g} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

As A is the normal position, when the weight is gradually applied T = w, and it follows that the kinetic energy, when the weight is travelling past that point, is equal to the work already done. At B the velocity $v = 0$, and, therefore, T = $2w$. The corresponding terms in the electrical analogue—*i.e.*, a circuit containing capacity and inductance suddenly connected to a source of constant E.M.F., are as follows :—

Weight, w = voltage of supply, E.
Tension, T = voltage on condenser plates, V.
Displacement, x = quantity of electricity, Q.
Velocity, v ($= dx/dt$) = current = dQ/dt = C.
Mass, w/g = inductance, L.

On application of the E.M.F., E, after a very small interval of time (so small that E may be supposed constant throughout, whatever its law of variation), the condenser will be charged to a pressure V, so that

$$\mathrm{EQ} = \tfrac{1}{2}\mathrm{VQ} + \tfrac{1}{2}\mathrm{LC}^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

by transposition of the mechanical terms in the equation (1).

At this stage of charging, the "potential or electrostatic energy" part is equal to the "kinetic or electromagnetic energy" part, and V = E, but the charging current C, then at its maximum, cannot stop suddenly, and only dies down to zero when the pressure V across the condenser is equal to twice the supply pressure E. This can be seen from equation (2), for, when C = 0, V = 2E.

In stating this possible maximum the resistance of the circuit has been neglected, so that, in practice, a less surge of pressure than 2E is to be expected.

The rise will also be less than twice the maximum voltage when an alternating current is employed, if the phase of the voltage, at the instant of switching on, is not passing through its maximum value.

Reverting to the mechanical example, it can be verified by experiment that the weight after its displacement to B will vibrate about the mean position A until frictional losses finally bring it to rest at A.

In a similar manner the pressure in the condenser will oscillate between zero and double the normal value, until it ultimately reaches the latter. These oscillations of pressure are very rapid, and have the *natural* frequency of the circuit.

This can be proved by reference to equation (2). At the mean position $\frac{1}{2}\mathrm{QV} = \frac{1}{2}\mathrm{LC}^2$, or electrostatic = electromagnetic energy, but since Q = KV, where K is the capacity in farads,

$$\tfrac{1}{2}\mathrm{KV}^2 = \tfrac{1}{2}\mathrm{LC}^2,$$

or,

$$\mathrm{C} = \mathrm{V}\sqrt{\frac{\mathrm{K}}{\mathrm{L}}} = \mathrm{KV}\sqrt{\frac{1}{\mathrm{KL}}} \quad . \quad . \quad . \quad . \quad (3)$$

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But the current C in a condenser of capacity K in a circuit whose frequency is n is

$$C = KV2\pi n. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Thus, to satisfy (3) and (4) it is necessary that $2\pi n = \sqrt{\frac{1}{KL}}$ which has already been shown to be true of the natural frequency n.

The preventive against the injurious effects of pressure surges of this kind is to switch concentric cables into live systems, gradually, through a non-inductive resistance.

Pressure Rises on switching off Heavy Currents.

These also are frequently spoken of as being due to resonance, but although oscillations are produced when a heavy current is broken, there can be no resonance as the original forced vibration has ceased with the breaking of the current.

The mechanical analogy is not quite so simple in this case. Returning to the spiral spring and weight, suppose the latter to have a forced simple harmonic vibratory movement, so that it was doing work against an external force conforming also to the S.H. law. If this force be withdrawn, when the speed is a maximum—that is, when the weight is passing through its mean position—the kinetic energy it possesses must find an outlet in stretching the spring. The amount of stretching will depend on the mass and the speed. If T is the final tension in the spring, when the mass comes to rest after a displacement, x, the work done, $\frac{1}{2}Tx$, must equal the kinetic energy stored up in the moving mass $\frac{1}{2}mv^2$. To utilise the energy equation $\frac{1}{2}Tx = \frac{1}{2}mv^2$ for an electric circuit, consider a large alternating current C, with a frequency n, passing through a circuit containing an inductance, L, and a capacity, K, and a resistance small enough to be neglected as a first approximation. An interruption of the current C corresponds to the withdrawal of the external force in the mechanical analogy, and should the phase value of the current happen to be at its maximum the electro-kinetic or electromagnetic energy it possesses may be very large, as it is proportional to the instantaneous value of C^2. Thus, the electromagnetic energy equal to $\frac{1}{2}LC^2$ has no outlet except in charging the condenser of capacity K, formed by the concentric conductors.

The condenser will finally be charged to a potential V, when all the electromagnetic energy is converted into the electrostatic or "potential" form. Its value corresponding to $\frac{1}{2}Tx$ above will be $\frac{1}{2}QV$ (and since $Q = KV$) $= \frac{1}{2}KV^2$. The amounts of these two alternative forms of energy must be equal—*i.e.*, $\frac{1}{2}KV^2 = \frac{1}{2}LC^2$, and they will oscillate from one form to the other with a frequency which is the *natural* frequency of the circuit.

It will now be clear that the phenomenon cannot be one of resonance, as the forced oscillations cease entirely when the circuit is broken.

A happy analogy of the effect produced by the stoppage of a large alternating current is that of striking a blow on a tuning fork. A large proportion of the work done by the blow will appear as vibrations of the tuning fork, which, of course, will have their natural period. In contrast with this is the resonance phenomenon of the sympathetic vibration of two tuning-forks of the same pitch when only one of them has been set into vibration.

The relation $\frac{1}{2}KV^2 = \frac{1}{2}LC^2$ is different to that found for the case of closing a circuit, inasmuch as C is now the independent variable—that is, it may have a wide range of values depending on the external energy it had been furnishing. Whatever value C may have,

$$V^2 = C^2 \cdot \frac{L}{K} \text{ or } V = C\sqrt{\frac{L}{K}},$$

and thus V, the *additional* rise in pressure on breaking the current, C, will be proportional to its value, and will depend also on the electric constants of the line. As already shown, when $\frac{1}{2}KV^2 = \frac{1}{2}LC^2$ is the condition characteristic of the circuit

$$C = KV\sqrt{\frac{1}{KL}} = KV2\pi n,$$

or, $2\pi n = \sqrt{1/KL}$—that is to say, n is the frequency of the natural oscillations of the line. These oscillations are quickly damped down by the losses due to resistance, hysteresis and eddy currents. Pressure rises of the kind described, being directly proportional to the current broken, may reach dangerous values when the current is very heavy, such as that produced by a short-circuit. It will also be recognised from the expression $V = C\sqrt{\frac{L}{K}}$ that the pressure rise will be accentuated the more the inductance and the less the capacity in the circuit. High inductance means greater electromagnetic energy, and small capacity means a high voltage when the electrostatic energy $\frac{1}{2}KV$ becomes equal to the electromagnetic. In underground systems with high capacity the dangers from this kind of pressure rise are less than on overhead lines, with small capacity and a good deal of inductance. The safeguard in breaking ordinary load currents lies in the use of oil break switches, which have the remarkable property of interrupting the circuit exactly at the moment when the current is zero, or when the energy is entirely in the electrostatic form. A condenser connected across a switch or fuse will tend to break the arc immediately, because the condenser behaves, until charged, as a momentary short-circuit to the arc; lead-covered cables may act as condensers in this way. On some of the long transmission lines in America it is found to be easier to work with high voltages than with those relatively lower, because the current, being less with the higher pressure, the effect of breaking the circuit is not so disastrous. To guard against the effects of a short-circuit is not such an easy matter, as a pressure surge is bound to occur. In order to prevent the high pressure due to this or to resonance from damaging the insulation between the inner and the earthed conductor, possibly at a number of points, some form of lightning arrester has to be employed.

ELECTRIC PROPULSION FOR SHIPS.

The trial trip of the "Electric Arc," mentioned in our notes a few weeks ago, marks an important step in the application of electric power to the propulsion of ships. The "Electric Arc" has been

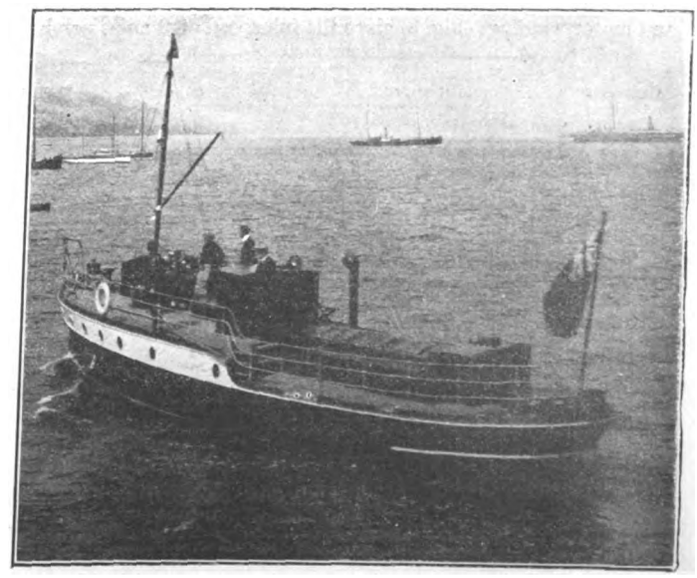

FIG 1.—THE "ELECTRIC ARC."

equipped by Messrs. Mavor & Coulson, and is fitted with alternating-current machinery, the system adopted being that devised by Mr. Mavor. The vessel, which has been constructed by Messrs. MacLaren Brothers, of Dumbarton, is shown in Figs. 1 and 2. It is 50 ft. long, its beam being 12 ft., its moulded depth 7 ft. 4 in. and its maximum draught 4 ft. 6 in.

The power equipment comprises a petrol engine of 35 B.H.P. which drives a three-phase alternator, whence current is supplied to an alternating-current motor on the propeller shaft. The vessel was

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constructed and equipped so that experience might be gained in details of application and in the handling of alternating-current apparatus before proceeding to instal electric propulsion on a larger scale, the designers claiming that alternating-current motors are alone suitable for transmitting large powers at sea. It may here be mentioned that the experimental equipment in every way came up to expectations.

The "Electric Arc," being intended for short trips on coastal service, only one engine and one propeller are used, and as the vessel is equipped purely for experimental purposes, the engine room is left open, and no other use is made of the accommodation aft.

The electric motor installed has no brushes or slip-rings, and is of the "multiple wound" type, 8-pole and 12-pole windings being used.

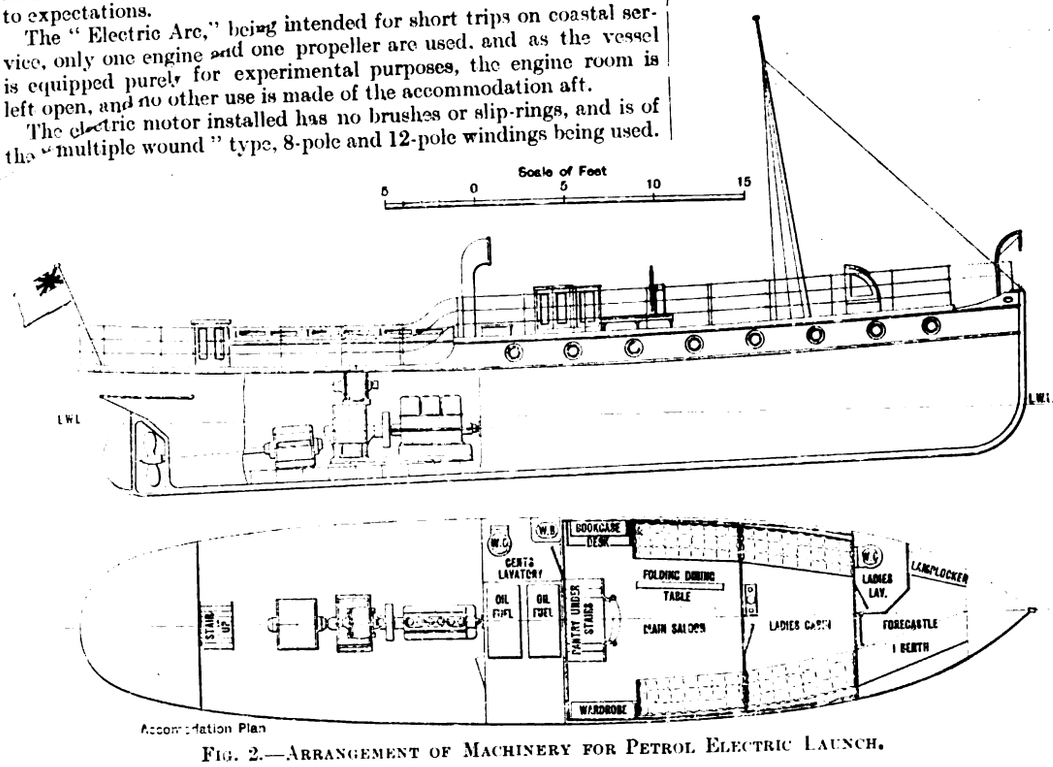

FIG. 2.—ARRANGEMENT OF MACHINERY FOR PETROL ELECTRIC LAUNCH.

The generator also has two windings (four-pole and six-pole) corresponding with those of the motor, and the various speeds are obtained by combinations of the windings (*see* article by Mr. Mavor in the Special Marine Issue of THE ELECTRICIAN). The exciter for the alternator is mounted on top of the latter, and is driven by belt from the main shaft.

The control gear is operated from the deck beside the switchgear, as well as from the engine room. The first combination of generator and motor windings (Fig. 3) gives the full speed of 8 miles per hour,

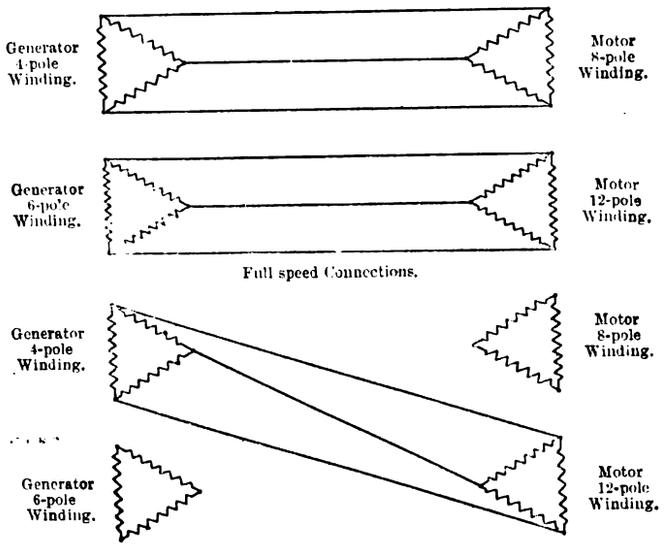

FIG. 3.—DIAGRAM OF CIRCUITS ON THE "ELECTRIC ARC."

and the second combination a speed of about 6 miles per hour. The control is by two switches, one varying the excitation of the alternator field, and the second, which is interlocked with the first mentioned, controlling the current supply to the motor windings, so as to give two speeds ahead and astern. These switches are operated directly by chain connection from the ship's telegraph on deck, so that the navigator actually performs the switching operations, the engineer merely attending to the running of the plant. An indicator is fixed in the engine room showing the position of the telegraph.

This method of control dispenses with resistances and auto-transformers for regulating the current and voltage supplied to the motor; the only resistance required is in the exciting circuit, where the current is comparatively small and the resistances are of a compact and simple character. Any exact adjustment of speed may be dealt with by controlling the speed of the engine or the exciting current.

The economy of the arrangement in the demonstration equipment was limited by the small size of the plant and by the shallow draught of the boat, necessitating a comparatively small propeller; notwithstanding those limitations, the efficiency of the electrically-driven propeller of large size and slow speed is, Messrs. Mavor & Coulson claim, such as to compensate for the loss in transmission as compared with the direct-application of the power to a high-speed propeller. In larger vessels the economy is more pronounced, and is important at full speed. At the lower speeds the economy is more conspicuous, and in cases where the ship is required to operate at widely differing speeds the economy resulting from the adjustment of the operating plant to the power required amounts to a saving in favourable cases of 50 per cent. of the fuel.

At the trial trip of the "Electric Arc" the mean speed attained for two runs over a measured mile was 8 miles per hour, and whereas the builders estimated that 45 H.P. would be necessary to drive the vessel at 8 miles per hour, the actual horse-power required from the engine was 35 B.H.P., giving 24·7 H.P. at the propeller, showing that although the loss in transmission at this low power is considerable it is more than compensated for by the saving in propeller efficiency. Stopping, starting, speed-changing and reversing were carried out very successfully, a feature being the ease and promptitude with which the vessel could be made to go ahead or astern at will, owing to the control of the machinery being in the hands of the navigator on the bridge.

Fears had been entertained that the manipulation of an additional group of machinery concerned only with transmission would complicate the engine-room operations, and consequently the time required for performing them, but, on the contrary, the operations were stated to be more simple than those at present necessary, the engineer's duties being more definite and continuous, in that his prime attention is devoted to keeping his machinery lubricated and running at a constant speed.

In the tests on the electric plant previous to its installation, when the motor was connected up to the generator, the two windings were found to divide the current between them approximately as expected —viz., four-pole 43 amps., six-pole 29 amps. The power factor as measured by wattmeter was found to be 0·79 for the 12-pole winding at about three-quarter load, and 0·88 for the eight-pole winding at about three-quarter load. The times taken to change the speed or direction of rotation of the motor were then measured, and were found to vary between 25 seconds from full speed in one direction to full speed in the opposite direction, to 8 seconds from rest to half speed, and 5 seconds from full speed to half speed in the same direction. It was found necessary to increase the exciting current from 39 amps. to 70 amps. in order to obtain these results.

Street Lighting in Chicago.—Figures given in the recent annual report of the department of electricity of Chicago show that the total number of public street lamps in service on December 31, 1910, was 37,994. Of these 12,366 were municipal arc lamps, 893 rented arc lamps, 11,990 gas-mantle lamps, 5,426 gas flat-flame lamps and 7,319 gasoline lamps. The cost of rented arc lamps is £15 a year and municipal arc lamps £12. 8s. a year

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PHYSICAL SOCIETY.

At a meeting held on June 30 at the Imperial College of Science, Prof. H. L. CALLENDAR, F.R.S., President, in the Chair,

A Paper on

"The Capacity Coefficients of Spherical Electrodes"

was read by Dr. A. RUSSELL.

Formulæ have been given by Poisson, Kelvin, Kirchhoff, Clerk Maxwell and others for the capacity coefficients of spherical conductors at appreciable distances apart. With the exception of Kirchhoff's formulæ, these formulæ are rarely, if ever, used in practice. The author shows how the remainder after computing a few terms of Kirchhoff's series formulæ can be easily found. The range of their usefulness is therefore considerably extended. This extension makes it possible to simplify very appreciably the author's formulæ for the case, when the spheres are close together. Hence he shows that the numerical computation of the capacity coefficients can be easily made in all cases. Applications showing how the potentials, the capacities and the capacity currents of spherical electrodes can be calculated are given. A simple method of making a variable air condenser whose capacity in every position can be easily calculated to any desired accuracy is also given.

An Exhibition of the

Benkö Primary Battery

was given by Mr. W. R. COOPER. Several types of the Benkö battery, the invention of Mr. Stephen Benkö of Buda-Pest, were exhibited. This battery depends essentially upon the use of a porous carbon electrode in the form of a pot (open at the top) which is surrounded by a closed lead shell. The electrolyte (a bichromate solution) is fed into this shell under a suitable head to give a flow of ¼ litre, or more, per hour per cell. It passes through the carbon to the zinc, whence it is removed by an overflow pipe. Polarisation is thus reduced to a minimum and remains constant for a given current, provided the cell is not overloaded. The size of cell referred to is 9¼ in. high overall, 6¼ in. long and 1¾ in. wide; it weighs about 10 lbs., excluding the tank for electrolyte, and will give a steady current (depending upon the strength of the electrolyte and rate of flow) up to, say, 25 amps. at 1·5 volts. The internal resistance is below 0·01 ohm. There is no "mess" and no difficulty in keeping the apparatus in order. The cell is therefore very suitable for laboratory use or work where the cost is not of prime importance. Various types are being made according to the work required, and these include cells which depend for their action upon diffusion as distinct from a steady flow.

Mr. G. L. ADDENBROOKE asked whether the contact between the lead and the carbon remained satisfactory over a long time.

The AUTHOR replied in the affirmative so far as his experience (extending over 15 months) had gone.

The PRESIDENT inquired as to the maximum number of watts that might be taken from the battery continuously, and whether, weight for weight, more power could be taken from it than from accumulators.

The AUTHOR replying to the first part of the question said about 25 to 40 watts, depending on the solution, and stated that, excluding the reservoir, 3 to 4 watts per pound could be taken from the battery as compared with ½ watt (8-hour rate) up to 2½ watts (automobile cells at 5-hour rate) for accumulators.

Mr. W. DUDDELL asked how the battery would compare with accumulators for giving a steady current of the order of 5 amperes to 1 part in 100 or so. Accumulators could only be relied on to keep steady to about 1 part in 1,000.

The AUTHOR said he could not reply definitely, but he would expect better result from the Benkö battery bulk for bulk. It would be necessary to maintain a constant temperature. Replying to other speakers he further stated that the E.M.F. of a diffusion cell began to fall after hours' use, and that the electrochemical efficiency of the zinc in a diffusion cell was about the same as in an ordinary primary cell.

CORRESPONDENCE.

THE EDUCATION AND TRAINING OF ENGINEERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is not my intention to attempt to raise a controversy on the discussion of this subject just held at a Conference of the Institution of Civil Engineers. I merely wish to draw attention to a matter that seems to have been taken for granted in the discussion, but which, in actual practice, has little real existence viz., the technical training of engineers.

Now, the technical training of engineers in this country is by no means general. True, there are numerous universities and colleges with properly-qualified staffs and well-equipped laboratories for imparting technical training in all branches of engineering, but what advantage is taken of them? Consider, for example, the university colleges alone. What is the average number of students attending lectures in any one of the engineering faculties? In many of the departments scarcely a dozen students reach the course in the final year, and in many colleges this number would have to be halved. Again, of those who do successfully pass through such a course, how many are able to find work in their own faculty—so little is the demand for college-trained men.

On the other hand, think how great in proportion is the number of men—fully qualified to go through a course of study—who take up the engineering profession by entering the works directly on leaving school and never trouble in the least about a technical training, except perhaps by attending a few evening classes. Under such conditions, does it not seem ludicrous to speak of technically-trained men in engineering?

If Germany be taken as an example, it may at once be asked what schoolboy in that country ever thinks of becoming an engineer without passing through a technical university? Even foremen and artisan apprentices frequently attend full-time courses at a technical school and receive a scientific training much superior to many in England who possess both means and ability to go through an academic course.

Now in the medical or legal professions there are prescribed courses which candidates are expected to go through. The engineer, however, reaches no such status—for him a technical training or even a practical one is not obligatory, though, since the latter usually appears more promising, it is mostly adopted, whereas a lack of the former seldom afflicts disabilities, and is generally neglected.

To sum up the position of the college-trained candidate for the engineering profession in England at the present day, it is little exaggeration to say that the college man usually gets a very poor return for his outlay. In competition with the non-college man, he is frequently at a disadvantage by losing three valuable years or so, unless he is lucky enough to fall in with some enlightened employer. The college training must often be regarded as an educational luxury, sometimes fashionable, seldom necessary. An engineering degree seldom carries any advantages with it, social or otherwise, except perhaps in teaching. Even the Engineering Institutions make little of academic attainments, or distinctions, except in so far as they accept them as certain standards of knowledge.

Until the demand for technical men increases, then, it must not be wondered at that so many engineering apprentices entirely neglect the scientific side of their training and content themselves with a few evening classes or private study and experience for obtaining the minimum of technical knowledge they require.—I am, &c.,

Birmingham, July 20. STANLEY P. SMITH.

[We refer to this letter in the Editorial Notes.—ED. *E.*]

CAPE OF GOOD HOPE ELECTRICITY SUPPLY ORDINANCE.

On June 7 last the Deputy Administrator of the Cape Colony promulgated an Ordinance regarding electricity supply, of which the following is a full abstract:—

1. In this Ordinance the following terms shall, unless the contrary intention appears, have the meanings hereby respectively assigned to them:

"Local authority" shall mean: (*a*) The council or board of commissioners of any municipality, borough or corporate town. (*b*) The board of management of any locality in which the "Villages Management Act, 1881," or any amendment thereof is in operation. "Undertaker" shall mean: Any local authority, company, body, or person supplying, employing, or distributing electricity for public purposes within the area of a local authority. "Public purposes" shall mean any public scheme or system providing for: (*a*) The application of electrical energy for lighting or other purposes to or in connection with any street, place, hall, building or structure belonging to or subject to the control of a local authority. (*b*) The supply of electric light or electrical energy for private purposes to consumers generally within the area controlled by any local authority

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(c) The application of electricity or electric current as a motive power for tramways, lifts, cranes and other like purposes within the area controlled by any local authority.

2. The supply and employment of electricity for public purposes shall in all respects be subject to the provisions of this ordinance and of any regulations in force hereunder.

3. Notwithstanding the provisions of any law to the contrary: (1) No undertaker shall supply or employ electricity for public purposes without the written consent of the local authority and the Administrator. (2) No local authority shall grant an electric lighting or power concession, or enter into or renew any agreement for or in connection with the supply of electricity for public purposes, without the written consent of the Administrator. (3) No posts or standards shall be erected in, nor wires laid across or under, any street whatever, within the area controlled by a local authority for the supply of electricity for public or private purposes without the consent in writing of such local authority. Provided that nothing herein contained shall affect or abridge any of the existing rights of the Government.

4. Before any proposed undertaking (or extension of or alteration to any existing undertaking) the total cost of which is estimated to exceed ½ per cent. on the total outlay on such undertaking, or where such amount is less than £100 for the supply of electricity for public purposes by an undertaker, is commenced within the area of any local authority other than the town council of Cape Town, the scheme, with proof of the consent of local authority, plans and specifications and all details of financial arrangements shall be submitted to the Administrator for his consideration and approval, and no work shall be done upon or in furtherance of any such proposed undertaking, extension or alteration until the Administrator shall have intimated in writing to the undertaker proposing such undertaking, extension or alteration, that he is satisfied that such scheme is suitable and the best practicable. The Administrator may at any time withdraw any condition imposed under the provisions of this section. If any condition imposed under the provisions of this section is not complied with, the approval of the Administrator may be withdrawn by him and any undertaker who, after notification of the withdrawal of such approval, shall wilfully perform any work in execution of such scheme, shall be deemed to be guilty of an offence against this ordinance and shall, on conviction, be punishable as hereinafter provided.

5. All charges hereinafter levied by any undertaker within the area of any local authority other than the town council of Cape Town for the supply of electric light or electrical energy for private consumers shall be in accordance with such tariffs and conditions of supply as may be approved of by the Administrator, and no charges levied under any tariff or conditions not so approved shall be recoverable. Such tariffs and conditions of supply shall be submitted for re-approval by the Administrator at intervals of not more than seven years. In respect of any building or premises owned or occupied by the Government within any area supplied by any such undertaker, the price and extent of the supply shall be subject to mutual agreement, but the rate shall not exceed the lowest charge to any private consumer within such area, or to any local authority. Provided that in considering charges, due regard shall be given by the Administrator to local conditions.

6. Subject to the provisions of this ordinance, any local authority may contract with any other local authority for a supply of electrical energy, or for public purposes, provided that when the boundaries of the contracting local authorities are not co-terminous, all work necessary to be done within the area of any intervening local authority or rural or divisional council shall be subject to any directions and conditions that may, with the approval of the Administrator, be given or imposed by such intervening local authority or rural or divisional council.

7. A local authority shall have authority, subject to the Administrator's approval, to purchase land for the purposes of providing for the supply of electricity for public purposes, and to borrow such money as may be required for the purpose of carrying out any scheme or undertaking or any alteration or extension of any existing scheme, for supplying electricity for public purposes, or for the purpose of acquiring the whole or any portion of any existing undertaking the property of another.

8. The Administrator may make, alter or repeal regulations in connection with the application by undertakers for approval of schemes for the supply or employment of electrical energy for public purposes, and the submission of schemes in connection therewith; the precautions to be taken to avoid interference with other electrical apparatus or works; and (save within Cape Town) the control of the execution and the carrying out of approved schemes by undertakers; the inspection of all works in use in connection with any undertaking for the supply of electrical energy for public purposes, and the holding of any inquiries for the purposes of this ordinance; and the conditions upon which consumers shall be entitled to a supply, and generally for the purposes of this ordinance.

9. Any local authority which is an undertaker, or in whose area an undertaker carries on operations, may make, amend or repeal regulations for the purpose of controlling within its area the distribution of electrical energy on private premises, with power to cut off the supply on failure to pay any charges due to the local authority in connection with such supply, or when such supply is no longer required, and to recover the expense of cutting off such supply, and providing for inspection; also where the local authority controls any tramway system, for the management of trams.

10. If electricity is supplied or employed for public purposes in contravention of the provisions of this ordinance, or if any act is committed in contravention of the same, any person or persons responsible for the offence shall each be individually liable to a fine not exceeding £100, and, in addition, to a penalty not exceeding £5 for each day during which the offence is continued, after notice thereof in writing has been given by the Provincial Secretary or by the local authority within whose area such undertaking is carried out. Any person who unlawfully and maliciously injures or interferes with any works connected with the supply of electricity for public purposes shall be guilty of an offence under this ordinance, and shall be liable to a fine not exceeding £100 or to be imprisoned with or without hard labour for any term not exceeding one year, or to both such fine and imprisonment. Any person who contravenes any regulations made by the Administrator or by the local authority shall be liable to a fine not exceeding £20, or, in the case of a continuing offence after due notice has been given, to a daily penalty not exceeding 40s., or where such fine is not paid to be imprisoned with or without hard labour for a period not exceeding three months, or in the case of a second or subsequent offence for a period not exceeding six months. Any person who fraudulently or maliciously abstracts, wastes or diverts, or causes to be abstracted, wasted or diverted, any electrical energy supplied for public purposes, or who consumes or uses such energy knowing the same to have been fraudulently abstracted or diverted, shall on conviction be punished in like manner as if he had been found guilty of theft.

11. In the case of existing undertakers this ordinance shall not apply until the expiration of 90 clear days from the date of promulgation, but, on the expiration of such period, all such undertakers shall become subject to the provisions of this ordinance and the regulations made by the Administrator hereunder: provided that the required consents shall be deemed to have been obtained to all schemes, contracts or agreements existing at the passing of this ordinance, but not to any renewals thereof whether contemplated in such contracts or agreements or not, and provided further that the provisions regarding the submission of schemes shall only apply to any further extension of or alteration to any existing undertaking the total cost of which is estimated to exceed one-half of 1 per cent. on the total outlay on such undertaking, or when such amount is less than £100: provided further that in the case of any agreement providing for the supply of electricity at a given price between an undertaker and a local authority, or between an undertaker and the Government, heretofore entered into, the above provisions as to charges for current shall not apply during the continuance of such agreement but shall apply to any renewals thereof whether contemplated in such agreement or not: provided lastly, the provisions of any law and of any regulations framed thereunder shall, unless amended or repealed, remain in force until the expiration of such period

12. The laws mentioned in the schedule hereto are hereby repealed, and any reference in any other law to "The Electric Lighting and Power Act 1895," or any regulations framed by the Governor thereunder, shall be deemed to be a reference to this ordinance and the regulations made by the Administrator hereunder.

13. The provisions of this ordinance shall not affect any company which has authority under any special act to work tramways by electricity within the area of a local authority: provided that if any such company desires to do anything not authorised by such act, the company may, after obtaining the consents required by this ordinance, do such thing, subject always to the provisions of this ordinance; and if the working of the undertaking of any such company shall at any time be transferred to a local authority, the special act relating to such company shall thereupon be repealed by the Administrator, and such undertaking shall thereafter be worked only under the provisions of this Ordinance and the regulations framed hereunder, without regard to any exemption granted to any local authority in the terms of this ordinance.

The following laws are hereby repealed in their entirety unless otherwise stated:—Electric Lighting and Power Act, 1895; Kimberley Borough Council Electric Lighting and Power Act, 1898; Cape Town Municipal Amendment Act, 1902 (sections 19 and 20); Green and Sea Point Municipal Amendment Act, 1902 (secs. 24 to 38 inclusive); Kalk Bay Municipal Council Electric Lighting and Power Act, 1904; Aliwal North Municipal Water and Electricity Supply Act, 1904 (sec. 29 to 41 inclusive, and sec. 6 and 7 of sec. 45); Port Elizabeth Electric Lighting and Power Private Supply Act, 1905; and Beaconsfield Electric Lighting and Power Private Supply Act, 1905.

The regulations to be made by the Administrator have not yet been published. Regulations in regard to the safety of the public will no doubt be made under this law, as the Mines Department of the Union of South Africa have decided to take charge of such matters referring to all kinds of machinery.

PARLIAMENTARY INTELLIGENCE.

GLOUCESTER CORPORATION BILL.

This bill, which contains some further provisions as to the electric supply undertaking, came before the Chairman of Committees in the House of Lords (Lord Donoughmore) on Tuesday last week. The Parliamentary agent (Mr. Browne) said that he understood their lordships were going to make an amendment to the wiring clause to secure that there should be no competition by the Corporation with local traders by the sale of wiring matters at less than cost price. The Corporation had introduced what was formerly the model clause in that respect, and the clause was agreed to in the other House as a result of opposition to the Bill. Therefore the Corporation must not be taken as assenting to any amendment their lordships made, and he asked that the clause should be allowed to stand.

His Lordship said the new model clause had been applied in several bills before that Committee this session, and no exception could be taken in respect to Gloucester. The bill, as amended, was ordered to be reported for third reading.

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ROTHERHAM CORPORATION BILL.

On Monday and Tuesday this bill was before Lord Lamington's Committee of the House of Lords.

The bill is to confer further powers with regard to tramways, street widening, &c.

Opposition (by the Midland and Great Central Railway Companies) was now confined to the tramway extensions and the rail-less trolley proposals.

Ald. WINTER gave evidence in support of the bill and Mr. J. B. HAMILTON, manager of Leeds Corporation tramways, gave particulars of the Leeds rail-less trolley vehicles, which were started last month. Revenue per car-mile had averaged 10·4d. and running expenses 4·5d. He considered the Rotherham routes were suitable and that the system would be self-supporting.

Other evidence in support of the bill having been taken, the Committee adjourned.

TELEGRAPH CONSTRUCTION BILL.

On Tuesday the Select Committee of the House of Commons presided over by Mr. Herbt. Samuel (Postmaster-General) sat to consider this bill.

Sir ROBT. HUNTER, solicitor to the General Post Office, said the bill was to enable the Post Office to carry telegraph lines across railways without the consent of the railway companies. It was not proposed to make alterations in payments already made to the companies.

Petitions against the bill were put in on behalf of some of the Scottish railway companies and the Committee adjourned.

LONDON COUNTY COUNCIL TRAMWAYS BILL.

On Wednesday the Committee of the House of Commons passed the principal proposals of this Bill, but refused to sanction a loop line from Seven Sisters-road along Blackstock-road, Finsbury Park, to a new road to be made, and then rejoining Seven Sisters-road.

The bill was ordered to be reported as amended.

GREATER LONDON RAILWAY BILL.

A Select Committee of the House of Lords, under the chairmanship of Lord Newton, commenced consideration of this bill on Wednesday.

The Hon. J. D. FITZGERALD, K.C., explained the objects of the bill, and said it was believed that the necessary capital (£3,307,000, or £4,409,000 with borrowing powers) could be raised. The estimate for works and land was £2,810,000.

Amongst the opponents were Middlesex County Council and Finchley Council and the Great Eastern, L. & N.W., North London and Midland Railway companies.

Evidence in support of the bill having been given on behalf of Walthamstow, Edmonton and Tottenham Councils, and shipowners in the Australian, New Zealand and Argentine trade, the Committee adjourned.

Brighton, Hove & District Rail-less Traction Bill.—Brighton Corporation have withdrawn their opposition to this Bill, which will now go forward unopposed.

Bristol Tramways Bill.—This Bill was read a third time and passed in the House of Lords on Thursday last.

East Kent Electric Power Bill.—This Bill was read a third time and passed in the House of Lords last week.

London, Tilbury & Southend Railway Bill.—On Thursday last a Select Committee of the House of Lords passed this bill, providing for the electrical operation of the line, the acquisition of lands as sites for generating stations, the raising of £750,000 additional capital, &c.

New Pacific Cable.—In the House of Commons on Friday last the necessary financial resolution authorising expenditure out of money voted by Parliament for the construction and working of a new Pacific cable, passed through Committee and was reported to the House.

LEGAL INTELLIGENCE.

Central London Railway v. Land Tax Commissioners for the City of London.

In the Court of Appeal on Monday the Master of the Rolls and Lords Justices Farwell and Kennedy heard an appeal from the judgment of Mr. Justice Swinfen Eady, reported in THE ELECTRICIAN for March 3, p. 835. Mr. Justice Swinfen Eady had decided that where land was exonerated from land tax at a time when it was in its ordinary normal condition as mere land, it was entirely exonerated, irrespective of the use to which it might in future be put. It was otherwise, however, where the land, at the date of redemption, was not in its ordinary normal condition, and special circumstances existed from which an intention to redeem a partial interest only could be inferred, as, for example, where the surface and open mines below were in different occupations and were separately assessed to the tax, and the price of redemption was arrived at upon the basis of one such assessment only. His Lordship further held that where the land tax had been redeemed on lands or houses abutting on a public street or highway the exoneration did not extend to the middle line of such street or highway. The railway company appealed. In the result the Court (Lord Justice Farwell dissenting) allowed the appeal.

The MASTER of the ROLLS, in the course of his judgment, said the question raised by the appeal was whether land tax was payable by plaintiffs in respect of so much of their tube railway as was beneath the half of certain streets in the City of London abutting on houses the land tax on which had been redeemed, it being agreed that land tax was not payable in respect of so much of the tube as was beneath the houses. The question was both difficult and novel. Land tax is charged upon all hereditaments of whatever nature or kind, and all persons "having or holding" any such hereditaments are to be charged with as much equality as possible by a £ rate. The tenants are required to pay the sums rated and to deduct out of the rent so much as the landlord ought to pay and bear. Where the tenant holds at a rack rent, the whole sum will thus be thrown on the landlord. When the tenant does not hold at a rack rent, the ultimate burden of the tax will rest on the landlord and the tenant according to their interests. Land tax may be redeemed according to the assessment and rate for the year. I agree that the only hereditaments exonerated by redemption are the hereditaments on which the tax redeemed was assessed. In my opinion this appeal should be allowed, the costs to follow the event.

Lord Justice KENNEDY delivered judgment to the same effect.

Lord Justice FARWELL disagreed, and delivered a lengthy judgment giving the grounds upon which he considered the appeal should be dismissed.

The appeal was allowed by a majority of the Court.

West Hartlepool Tramways.

An interesting question under the Tramways Act, 1870, was raised in the case of the Hartlepool Electric Tramways Co. (Ltd.) and Others *v.* the West Hartlepool Corporation, which came before the Court of Appeal (Lords Justices Vaughan Williams, Fletcher Moulton and Buckley) on Friday. (The proceedings in the original action have been reported in THE ELECTRICIAN.) Plaintiff company and Messrs. Sellon & Ashby, the promoters of a tramway undertaking in West Hartlepool, brought the original action claiming specific performance by West Hartlepool Corporation of a purchase agreement claiming £12,963, the sum fixed by an arbitrator as the value of the undertaking. Mr. Justice Bray gave judgment for the plaintiffs, holding that the original promoters were the owners of the undertaking, and that inasmuch as the Corporation had exercised their option to purchase, with notice that the transfer to the company had not been approved by the Board of Trade, they could not now be heard to say that the promoters were not the legal owners. The Corporation now appealed.

Mr. BALFOUR BROWNE, K.C., in support of the appeal said that his submission was that, inasmuch as the tramways were not constructed by the promoters, but by a company which had no authority either to construct or to work them, the provisions of sec. 43 of the Tramways Act of 1870 had not been complied with, and therefore neither the promoters nor the company had any legal ownership in or title to the undertaking. In those circumstances it would be ultra vires of the Corporation to purchase the tramways.

Lord Justice MOULTON: Is it your case that the Corporation ought to get these tramways for nothing?—No. It is that we cannot acquire a title.

Lord Justice BUCKLEY: You want to get out of your bargain?—We want the company to get out of the streets, because they are trespassers.

Lord Justice MOULTON: Then the tramways fall to you as the highways authority.—No, the company can take their tramways away.

Lord Justice VAUGHAN WILLIAMS reminded counsel that he was appearing for a public body, whose duty it was to act reasonably in the public interest. Was it right for the Corporation to rely upon mere legal technicalities?—It was entirely because he was appearing for a public body that he felt it necessary to press the point. The Corporation could only act according to statute, and if they purchased this undertaking when they had no right to do so, individual members of the Corporation would be liable to be surcharged. If the company would apply for a provisional order, and thus clothe themselves with the right which they at present did not possess, the Corporation were quite willing to pay for the undertaking.

Lord Justice MOULTON: The Board of Trade, apparently, have not objected to the assignment to the tramway company.—The Board of Trade have not given their sanction, and, therefore, the undertaking is not transferred to the company.

Lord Justice MOULTON: Then it belongs to the promoters.

Mr. MCCARDIE argued that the Corporation were not bound to perform the agreement of purchase under the Act of 1870. Replying to Lord Justice Moulton, counsel said the Corporation did not want to take the tramways, materials or rolling stock. They wanted the undertaking conveyed to them, but they did not want to have to take over the materials, rails, &c.

Lord Justice MOULTON said that it was really scandalous to suggest that because the company had made some irregularity in the formal transfer to themselves, the Corporation should have power to take the undertaking and not pay anything for it.

Mr. MCCARDIE said he was not there to argue points of municipal etiquette. The Corporation were not bound to take anything more than the statute compelled them to take. The Corporation were

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entitled to insist on their right to have transferred to them only the powers to run trams.

Mr. DANCKWERTS, K.C., for plaintiffs, submitted that the consent of the Board of Trade was not necessary, but if it were, then, in fact, it had been obtained.

The Court intimated that they had heard sufficient.

Lord Justice VAUGHAN WILLIAMS, in giving judgment, said the case for the Corporation failed for two reasons. In the first place, certain correspondence which passed between the Assistant Secretary of the Board of Trade and the company was only consistent with the recognition by the Board of Trade of the company being the transferees of this undertaking. Moreover, no written consent was necessary in respect of the powers given by the Tramways Order, and inasmuch as there was an assignment from the promoters to the tramways company, and that assignment required no written consent, the company became themselves the promoters by succession. This diplomatic action, by which the Corporation desired only to purchase a portion and not the whole of the undertaking of the company, therefore failed. He did not think that any great harm was done by the failure of the action, but rather that it would be in the public interest.

Lords Justices Buckley and Moulton concurred, and the appeal was dismissed with costs.

Thermal Synd. (Ltd.) v. Silicaware (Ltd.)

Mr. Justice Swinfen Eady continued the hearing of this case last week.

Mr. W. R. BOUSFIELD, K.C., for the defence, said the view that defendants took was that the gas pressure in connection with the working of the silica had nothing whatever to do with it, except perhaps to some slight extent to modify the shape of the cavity. It was perfectly obvious if special conditions were necessary they must be given in order that one might know what they were. If, however, the conditions came by themselves and quite unaided and could not be helped, then of course there was no invention. It was not a good specification if things material and things immaterial were so mixed up that the vital conditions could not be elucidated. So far as elucidation of conditions went under which one was able to get the result which plaintiffs called initial separation—so far as that went, where was the information? Assuming that it was the gas which gave the result, he submitted that the specification of plaintiffs wholly failed, because it did not set out any of the necessary conditions to enable one to produce the result which plaintiffs said was vital. As a matter of fact gas pressure played a very secondary part.

Mr. O. DOLLMANN, secretary to defendant company, said he remembered his firm selling silica goods to Messrs J. & G. Cox (Ltd.) The order was received about April 5 or 6, and the goods were delivered on April 25 with the exception of a crucible. There was no explanation as to why the crucible was not sent. The defendant company was incorporated on Nov. 18, 1909. Witness denied that the company was formed with the object of selling goods acquired from Beule. He could not say when they first commenced selling silica goods, but it must have been the early part of last year. They were still selling such goods, and would continue to do so unless stopped.

Is it a fact that since you commenced the sale of these goods you have continued to import silica goods, advertise and offer them for sale?—Yes.

How long did you continue to obtain supplies from Beule?—We ceased all connection shortly after July last year. A small quantity has been purchased since the issue of the writ.

Mr. SCHUEN, formerly technical director of the smelting department of the works at Beule, said he knew an attack was made in Germany by the Beule Co. on the Thermal Synd. on the ground that the gas layer was a natural phenomenon, and that the patent for blowing out could not be supported because it was a natural phenomenon.

FDK. WILHELM KUEHUÉ said he held a qualifying certificate for an officer in the German Navy. His profession was that of an engineer and he was technical director to some large electrical works in Zurich. Witness had been requested to make some experiments in connection with this action which had been carried out after the English specification. The hollow in the centre of the silica tubes was produced by natural causes and was not in any way due to gas pressure.

Mr. JAMES SWINBURNE gave evidence as to the interpretation of plaintiffs' specification. He was of opinion that the sausage shape of the fused silica was determined by capillary attraction and though the gas pressure might help, he thought it would take up the same shape without the pressure. There was no suggestion in the specification of inflating the tube by generating gas.

Witness was cross-examined as to certain experiments with silica made by the plaintiffs.

Witness was then cross-examined by Mr. Walter.

Re-examined by Mr. BOUSFIELD: The presence of gas under pressure in the actual condition of working did not affect the size of the hole inside the sausage of fused silica. Witness considered the gas pressure had nothing whatever to do with the size of the hole.

Mr. COLEFAX then addressed the Court on behalf of the defence. He pointed out that the plaintiffs had not attempted to offer any evidence at all as to whether they had endeavoured to make silica ware in a furnace such as they now knew the articles in question were manufactured in. They admitted that they had got particular conditions, but did not ever attempt to put forward any evidence as to what in fact happened if one were to work with a furnace such as the furnace in which the infringing articles were made. The two furnaces were absolutely different. He would ask his lordship to accept the evidence of fact as put forward by defendants' witnesses. He (counsel) submitted that not only did defendants not infringe but the patent was bad on account of insufficiency, and also in some respects for want of utility. There was nothing before the Court on which his lordship could find that defendants had in any way manufactured articles in accordance with the plaintiffs' specification. Their case was based on a fallacy from start to finish. In order to establish that the defendants had infringed, plaintiffs must show that in the manufacture of the alleged infringing articles, the defendants enclosed the gas that was produced so as to facilitate the separation of the carbon core from the fused mass of silica. The evidence, as a matter of fact, clearly showed that instead of retaining the gas, the defendants deliberately allowed it to escape.

Judgment was reserved.

Factory Act Prosecution.

Charges arising out of the death of Mr. Wm. Middleton, assistant works superintendent to the Newcastle & District Electric Lighting Co., were heard at Newcastle on Friday last. There were five alternative charges, and Mr. Meynell, for the company, stated that he would plead guilty to the third charge, which alleged that the company had neglected to protect certain bare conductors so as to prevent danger as far as was reasonably practicable, and that in consequence, one Thomas Cox, suffered bodily injury. On this charge a fine of £50 and costs was imposed.

Charges Nos. 1 and 5 were withdrawn.

On charges 2 and 4 fines were inflicted, 20s. and costs in each case.

Charge No. 2 was similar to No. 3, except that the name of Mr. Middleton was substituted, and in No. 4 the name of Wm. Greenwood.

Mr. MUNDAHL (for the prosecution) said the case was brought under sec. 136 of the Factory and Workshop Act. On April 6, Mr. Middleton was killed in the performance of his duties at the Close power station. A screw on the switchboard was found to be out of order, and Cox and Greenwood had gone to the board to do some repairing. Apparently the spanner was not kept straight, for in some way a cross-connection was established, and a slight flash occurred, which resulted in both men being injured. About an hour and a half later, Mr. Middleton went to examine the switchboard, and there was a loud report and a flash, and, running back to the switchboard, Cox found Mr. Middleton with his clothes on fire. He was badly hurt, and the shock proved fatal. There had apparently been a complete and extensive flash between the two faces of the metallic brackets, with the result that the edges were fused. In this case, said counsel, it was obvious that precaution was not taken, because, if the inch of space between the two brackets had been insulated, as could easily have been, with a piece of marble or slate, the accident could not have happened.

Mr. MEYNELL said the accident was one no human being could have foreseen. No one had ever suggested that the apparatus was not safe. It was not a case of economy, or a wilful breach of the regulations.

The CHAIRMAN of the magistrates said the full penalty was £100, but having regard to the fact that the company's attention had not been specifically directed to the switchboard by the Board of Trade, and the neglect was not wilful, they had decided to impose a fine of £50 and costs.

It was stated that since the accident the company had installed a new switchboard at a cost of £200.

Tramway Rating.

At the Lancashire Chancery Court on Friday, Fleetwood Urban District Council applied for the dissolution of an injunction against the Council granted by the Vice-Chancellor in Jan., 1908.

Mr. FIRTH, for the Council, said railways were only liable to be rated on one-fourth of their ratable value and tramways on the whole. The owners of the tramway in question (the Blackpool & Fleetwood Tramway Co.) had been advised to contend that it was a railway and they served notice of appeal against their assessment on the Thornton Urban Council, in whose district one-seventh of the line was situated. The Court of Quarter Sessions dismissed the appeal and a Divisional Court took the same view, but the Court of Appeal allowed the appeal, Lord Justice Kennedy dissenting. The Thornton, Bispham and Fleetwood Councils agreed to take the case to the House of Lords, but in Jan., 1908, an action was begun by the Attorney-General against Fleetwood Council to restrain them from proceeding with the agreement and expending public money upon it, and at the trial on Jan. 21, 1908, the Vice-Chancellor ordered that the Council should be restrained from carrying out their part of the agreement. An appeal was made to the House of Lords on the assessment question and the decision of the Court of Appeal was confirmed, so that the Company had to pay on one-fourth of the ratable value. The costs of Thornton Council were taxed and settled, and if the agreement were carried out, Fleetwood Council would pay £515, of which £150 had been paid, leaving £365 to be paid, if they were permitted to carry out the agreement.

The ATTORNEY-GENERAL had directed a public meeting of ratepayers which had been largely attended, and at which any opposition which there might have been to the payment of the £365 had been due to the fact that the ratepayers had not been consulted before the agreement was sealed. A resolution was finally passed at that meeting that the £365 should be paid out of the rates. Counsel therefore asked for a dissolution of the injunction. The Attorney-General was in favour of the application.

The Vice-Chancellor's deputy (Mr. Taylor) made an order that, the Attorney-General and the plaintiff consenting, the injunction should be removed, but directed that the order should not be drawn up till Sept. 1 to give any ratepayer an opportunity to intervene if he wished.

His Honour said that if there was any intervention in the meantime the order would not be drawn up.

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British Westinghouse Electric Mfg. Co. (Ltd.) v. Electrical Co. (Ltd.)

On Monday this case came before Mr. Justice Swinfen Eady. It was a patent action in which plaintiffs had succeeded and defendants now applied that the judgment be varied. The judgment ordered the delivery up to plaintiffs of arc lamps or parts of lamps in their possession and defendants asked that they should have the option, instead of delivery up, of destroying the lamps in the presence of plaintiffs or their agents. It was urged for defendants that where articles were made in infringement of a patent the property in the articles did not vest in the patentee, but remained in the person who had, though unlawfully, infringed the patent.

His LORDSHIP said the Court had jurisdiction either to order the delivery up of infringing articles or to order their destruction in the presence of the plaintiffs so as to prevent their being used. He had to consider what the order was that was made at the hearing. The plaintiffs asked for delivery up and the whole order proceeded on the footing of delivery up and defendants did not then ask for the alternative that there should be a destruction of the lamps or parts of lamps. It was, in his opinion, too late to ask for relief, and the motion to vary the order must fail.

Globe Electric Co. v. A. H. Brooking & Co.

In the City of London Court last Friday, before Judge Rentoul, K.C., plaintiffs sued Messrs. A. H. Brooking & Co., of Exeter, for £12. 15s. 8d. for six arc lamps supplied. It was said the order was given on July 22 last year, marked "Urgent."

The defence was that the lamps were never accepted and did not answer the description required, burning only intermittently. Defendants kept the lamps for four months before rejecting them, but it was pointed out that defendants had no opportunity of testing the lamps until four months after delivery. Carmarthen had no electricity supply available until then, and they could not be tested.

Evidence for the defence was given, and Mr. R. WARD, manager of the Carmarthen Amusements (Ltd.), said the lamps were unsatisfactory.

Judge RENTOUL, K.C., said that keeping the lamps for four months was fatal to defendants, and he found for plaintiffs, with costs.

Electric Lamp Trade Mark.

Yesterday (Thursday) Mr. Justice Warrington heard an application by Pope's Electric Lamp Co. (Ltd.) to be allowed to register the name "Pope" in connection with their incandescent lamps. The Board of Trade referred the question to the Court.

Mr. A. J. WALTER, K.C., said there was a large body of evidence that the word "Pope" had for many years been understood to indicate the applicants' goods.

The ATTORNEY-GENERAL (for the Board of Trade) asked the Court not to allow the name of a manufacturer to be deemed a distinctive trade mark.

His LORDSHIP said if the name of a manufacturer was not in its nature adapted to distinguish his goods from those of another manufacturer it could not become adapted by any amount of user. He must refuse the application.

Rating of Urban Railways.

At the County of London Sessions recently the chairman (Mr R. Wallace, K.C.) gave judgment in the appeals of the Great Western and Metropolitan Railway Companies against the Hammersmith and City Joint Line assessment in the parishes of Kensington and Hammersmith. Judgment was entered for the companies, with costs, reducing the rateable value of the railway in Kensington from £1,950 to £60, and in Hammersmith from £4,890 to £100. It was stated that, as a result of the competition of the tube railways, tramways and motor-buses, the Hammersmith and City line had now by the usual parochial method of valuation no rateable value, but the rating authorities contended that it had a contributory value as a feeder to the Great Western and Metropolitan systems, and that that was sufficient to support the assessments appealed against. The Court declined to accept this view, but offered to state a case for the High Court.

Electrically Operated Clocks.

At Westminster (London) County Court on Monday Miss Blackwood was awarded £25 damages and costs against John Walker (Ltd.), clockmakers, late of New Bond-street, for breach of contract.

Miss Blackwood said she was a member of the congregation at St. Columba Church, Pont-street, and presented a set of clocks to the church. Messrs. John Walker (Ltd.) undertook to fix three clocks in the turret of the church, a fourth in the pulpit, and three others in other parts of the building, all to be regulated electrically. The clocks acted satisfactorily for a time and then began to behave in a very eccentric manner, the dials registering different hours, and on one occasion one of the clocks was seven hours slow. Miss Blackwood consulted Mr. Hope Jones, and he took the matter in hand, with the result that the clocks afterwards kept satisfactory time. Mr. Hope Jones's charges amounted to £41. 2s. 6d., which Miss Blackwood paid, and this was the sum now claimed from Messrs. Walker, who had guaranteed the clocks for 20 years.

The defence was that the clocks were not at fault except when the works became affected by dust created by building operations and by severe weather freezing the oil.

Municipal Electricity in Islington (London).—On Friday the Lord Chief Justice and Justices Lawrence and Avory heard an application by Mr. Cecil Walsh for a rule nisi for a mandamus, on behalf of London County Council, to Islington Borough Council calling upon them to show cause why they should not have five testing stations to their electric lighting undertaking in accordance with the County Council's Regulations. After a statement by Mr. Walsh that Islington Council had been notified of the County Council's requirements as far back as July, 1907, the rule was granted.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

*NOTE.—The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application, an asterisk is affixed.*

May 19, 1911.

12,077 MEENAN. Variable ignition control attachments in connection with magneto-electric machines.
12,102 MUNRO & RAIL-LESS ELECTRIC TRACTION CO. Trolley bases for electrically-propelled vehicles.
12.104 MAJERT & GLADITZ. Welding the metal filament of electric incandescent lamps.*
12,117 SIEMENS BROS. & CO. (Siemens & Halske Akt.-Ges., Germany.) Semi-automatic telephone exchange systems.*
12.118 NICHOLSON & BROOKING. Electrically-controlled valves.
12,128 REGINA ELEKTRIZITATS G.M.B.H. Vacuum meters. (Convention date, 20/5/10, Germany.)*
12.134 CREESE & ARON. Electric motor arrangements for driving clocks and the like.
12.135 BHISEY. Automatic telephone instrument.
12,145 STERLING TELEPHONE & ELECTRIC CO. (Schaffler & Co., Austria.) Mine exploders.
12.162 HOLT. Rotary motors.*
12.163 HOLT & CONN. Rotary motors.*
12,164-12,165 and 12,166 HAUER. Rotary motors.*

May 20, 1911.

12.168 CASKIE. Ships' engine-room telegraphs.
12.175 ELLISON & JACOBS. Telephone signalling systems.
12.177 WALTER. Cord-grip electric lampholder.
12.197 MOLLOY. Dynamo-electric machinery.
12,200 BENNETT. Telephone mouthpieces.*
12.204 ROOM. Pliers used for electric wire jointing.
12.225 LUNDBERG, LUNDBERG & LUNDBERG. Plug and socket electrical connections.
12.234 STETTINER MASCHINENBAU ACT.-GES. "VULCAN." Transmission of power. (Convention date, 28.6.10, Germany.)*
12.254 and 12,255 HORNBY & MADGE. Transmitters for wireless signalling.

May 22, 1911.

12.278 HALSTEAD. Wall telephone.
12.295 SIEMENS BROS. & CO. (Siemens & Halske Akt.-Ges., Germany.) Electrical relays.*
12,319 SOC. ANON. DES ETABLISSEMENTS LACOUR-BERTHIOT. Telemeters. (Convention date, 23/5/10, France.)*
12.328 SHORTT. Escapement mechanisms and electric clocks.
12,369 RITTER. Electromagnetic ignition device for internal-combustion engines.*

May 23, 1911.

12.483 RUBEL. Dynamos. (Convention date, 2/2/11, Germany.)*
12,485 RENNERT. Automatic electric fire alarms. (Convention date, 23/5/10, Germany.)*

May 24, 1911.

12.536 SMITH & SOUTHALL. Electrically controlled weighing machines.
12.545 HEITMEYER. Conduits for cables. (Convention date, 25/1/11, Germany.)*
12.546 LINDENTHALER. Protective cap for telephones.
12.571 WATKINSON & PAYNE. Shade holders for incandescent electric lights.
12.574 WESTINGHOUSE. Power transmission mechanism. (Addition to 9,131/11. Convention date, 18/6/10, U.S.)*
12.579 and 12.580 B.T.-H. Co. (G.E. Co., U.S.) Electric signal systems.
12.585 EVANS. (A.E.-G., Germany.) Machine for continually welding seams.*
12,587 HADDAN. (George Herbert Whittingham, U.S.) Automatic starting devices for electric motors.*

May 25, 1911.

12.619 GILL & CHAVIARA. Dynamo and other electric machinery.

May 26, 1911.

12.708 COLLIS & JONES. Secondary cells.
12.730 MATTHEWS. Telephone instruments.
12,735 SIEMENS BROS. DYNAMO WORKS. (Siemens Schuckertwerke G.m.b.H., Germany.) Arc lamps.*
12.742 WHALTON. Electric hammers. (Convention date, 26/5/10, U.S.)*

SPECIFICATIONS PUBLISHED.

1910 SPECIFICATIONS.

7.141 TAYLOR. Automatic instantaneous switches for alternating and direct-current circuits. (Cognate applications, 7,414/10, 9,055/10, 9,674/10, 10,728/10, 13,889/10, 14,773/10, 16,211/10 and 21,784/10.)
9.957 HEATHER. Control of induction motors of the slip-ring or equivalent type.
12.300 FIELD & FERRANTI. Electric motor-starters.
12.664 BROWN. Telegraphy.
12.843 HEISSE. Electric traction on elevated cable tracks. (27/10/09.)
12.926 BERRY. Alternating electric current distributing systems.
13,195 ADAMS MFG. CO. (Cutler Hammer Mfg. Co.). Switches for use in the control of electric motors.
13.525 PARSONS & BALL. Electromagnets and armatures.
15,988 RAILING & GARRARD. Electric cut-outs.
17,426 INCLEDON & INCLEDON. Connecting electrical conduits to their fittings.
19,095 A.E.G. UNION ELEK. GES. Tungsten filaments. 14/8/09.)
19,517 CONNER. Telephone receivers.
19,557 KRIZIK. Electromagnetic alternating-current apparatus. (Divided application on 651/10. 27/5.)
20.180 BEACH. Anodes for electrolytic purposes.
21,236 BATT. Electric ignition devices for internal-combustion engines. (Addition to 28,818/09.)
21.369 VOIGTLAENDER. Electric fire alarm.
22.293 SHELTON. Electric steam generators.
23.314 POOLE. Control of electric pressure and current regulators.
25.991 RUTTER. Portable electric battery lamps.
26.747 HARTMANN & BRAUN AKT.-GES. Mounting the electrodes of metal vapour apparatus. (1/12/09.)
27,798 SEFTON-JONES. (Oesterreichische Daimler Motorenges. Akt.-Ges.) Collectors for electric traction on the overhead conductor system. (Patent of addition not granted.)
28,884 BESANCON. Electric hour-meter. (Convention date not granted.)
29,309 ALLGEMEINE ELEKTRICITATS-GES. Coupling devices for electrically-driven looms. (16/12/09.)
29,733 ROCHE. Electric water-heaters. (21/12/09.)

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COMMERCIAL AND INDUSTRIAL SECTION.

MUNICIPAL, FOREIGN & GENERAL NOTES.

BRITISH NOTES.

Bacup-Rochdale Tramways.—The electric tramway from Bacup to Shawforth, constructed by Bacup Corporation at a cost of £24,000, was completed on Saturday, affording facilities for a through service from Bacup to Rochdale.

Birmingham.—In presenting the report of the Tramways Committee at the City Council meeting on Tuesday the Chairman (Mr. Harrison Barrow) moved:—

That the committee be authorised to enter into an agreement with the City of Birmingham Tramways Co. (Ltd.) for the purchase for £151,500, of the whole of the interests of the company and of the British Electric Traction Co. (Ltd.) in the tramways in Aston Manor, King's Norton and Northfield and Yardley, with the rolling stock (except 21 cars), lands, buildings, generating stations, appliances and apparatus in connection therewith, including the payments due from the Corporation in respect of rolling stock, &c., in connection with the Bristol-road tramway route and from the King's Norton and Northfield Urban District Council in respect of the rolling stock, &c., in connection with the Pershore-road tramway route.

Mr. Barrow said the Council now had the opportunity of getting control of and working the whole of the tramways in the district. The trams along the Handsworth route, the Bristol-road trams in Birmingham and the Pershore-road trams in King's Norton also came into the hands of Birmingham and King's Norton and were being worked by Birmingham, by arrangement with King's Norton and Handsworth. The company were, therefore, now left with the portion of the Bristol-road route in King's Norton running to Selly Oak, the Aston trams, and the trams in Yardley along the Stratford-road and Coventry-road. King's Norton had given notice to purchase their portion of the line from the present city boundary to the end of the Selly Oak line. The company would, therefore, shortly be left with only the Yardley trams to make a profit out of, so that it was obvious there were great advantages both to the Corportation and the company for the Corporation to purchase the interests of the company. A figure had been arrived at which the committee considered fair, and which they unanimously recommended the Council to accept. The acceptance would have to be confirmed by the Greater Birmingham Council. He recommended this purchase with every confidence, and felt cetrain it would be confirmed by the Greater Birmingham Council without hesitation.

Ald. Beale said sooner or later they would have had to purchase the whole of the Yardley system on arbitration terms, under the Tramway Acts, and the whole of the King's Norton system beyond Bournbrook to Selly Oak. Each would involve the purchase of valuable power stations which they would rather be without. Ultimately it had been agreed that the round sum of £150,000 would be fair to both. What they would earn from the Yardley tramways would not pay interest and sinking fund on the money they were spending, and they were in exactly the same position in regard to King's Norton and Handsworth. But they were fortunate in getting a good deal of what, at all events, was a going concern. They were getting the Bristol-road route which was equipped, and the Stratford-road route, which were the city end of routes that might be made remunerative. There was no reason to doubt that the extension along the Stratford and Warwick-roads would bring the Yardley system into a very remunerative concern. They had to face the fact that they had locked up some capital, but it would come back to them.

The motion was carried.

The Council then considered the Tramway Committee's proposal for the extension of existing tramway routes and the linking-up of routes in the centre of the city, and also a recommendation for the promotion of a bill in Parliament to enable the committee to undertake this work.

Mr. Barrow said he believed tramway development in Birmingham was still in its infancy, although they were now taking £400,000 per annum. Liverpool was taking £600,000, Manchester £800,000, Glasgow £1,000,000, and it seemed to him that they ought not to rest content until they had approached those figures.

Ald. Sir J. Smith moved that this part of the committee's report be deferred for further consideration. He pointed out that Hill-street (in which it was proposed to construct a tramway) was only 25 ft. 6 in. wide, and the margin between the body of a tram and the kerb of the gutter was only 5 ft. 6 in. Almost all vehicles were more than 5 ft. 6 in. wide. The new scheme would make the congestion in Navigation-street worse than at present. He had submitted another route which he thought might be at any rate partially accepted.

It was agreed to adjourn the proposal for the promotion of the bill for the construction of the extensions till Oct. 7.

On the motion of Mr. Harrison Barrow the committee were authorised to proceed with the erection of a new tramway depot at Hockley Brook, at an estimated cost of £33,000; it was also decided to instruct the Finance Committee to borrow £20,110, the estimated cost of converting the cable tramway in Handsworth to electric overhead construction.

The report of the Tramways Committee, with the exception of the portion adjourned, was then approved.

Brecon.—The Council have received formal notification from Mr. J. H. Edwards that he will apply for a provisional electric lighting order.

City and Guilds (Engineering) College.—On the report of the delegacy charged with the management of the City and Guilds (Engineering) College, the Council of the City and Guilds of London Institute have awarded the diploma of "Associate of the City and Guilds of London Institute" to certain matriculated third year students of the City and Guilds College who have completed a full course of instruction as prescribed by the Council. These diplomas include 56 which have been awarded for civil and mechanical engineering, the Brammell Medal being gained by Mr. G. O. C. Reilly. Thirty-one are awarded in electrical engineering as follows:—Messrs. A. H. Barrett (Siemens Memorial Medal), W. B. Bacon, W. E. Barker, A. S. M. Best, M. de Castro, S. N. Chopra, C. A. Claremont, H. J. Eley, E. P. Elworthy, C. F. Freeborn, C. L. Hall, N. P. Hinton, T. J. Hornblower, A. N. Kingsbury, W. H. Lovell, A. A. Maytham, B. McCormick, T. E. de Morsier, W. W. P. Page, E. Potter, S. M. Rawson, A. Riddle, H. W. D. Rock, P. G. Ryder, C. W. Saunders, G. F. R. Schmidt, G. J. Scott, R. W. Shackell, W. Still, C. Vandermin, while 10 are awarded in chemistry.

Clitheroe.—Mr. J. W. Speight has notified the Council of his intention to apply for a provisional electric lighting order for Clitheroe.

Douglas (Isle of Man).—A special committee has been appointed to consider and report upon the question of electricity supply for the district.

Dover.—The Corporation on Tuesday decided by 7 votes to 5 to refer back a recommendation of the Electricity Committee that the salaries of the chief engineer of the electricity department, Mr. Woodman, be increased from £425 to £475; that of Mr. Harpur, mains superintendent, from £200 to £225; and that of Mr. E. W. Smith, works superintendent, from £200 to £225. Mr. Chitty, who moved that the recommendation be not entertained, said he did not say the officials were not deserving of the increase but he thought the salaries were so adequate that they would be wrong in increasing them.

Edinburgh.—Edinburgh Tramways Committee have decided to recommend the Council to appoint Councillors Rusk, Rawson and Stewart and the burgh engineer, Mr. Campbell, to inspect the rail-less trolley traction system at Leeds and Bradford, with a view to amplifying a report prepared by Mr. Campbell, in which he points out the economy of the system compared with ordinary electric tramways and cable tramways. He thinks the system would be applicable for use in Fountainbridge and other narrow thoroughfares in the city, and also for extensions into the country.

Grimsby.—At a meeting of the Electric Lighting Committee last week Mr. Hobbs suggested a reduction of the charge for current to private consumers from 3¾d. to 3¼d., and the electrical engineer, Mr. W. A. Vignoles, is to report on the matter.

Guisborough.—At a recent meeting of the District Council an offer of the gas company to continue to light the public lamps for one year at 39s. 6d. per lamp, or for three years at 37s. 6d., was submitted.

A petition was also received from 400 residents in favour of the adoption of electric lighting, and suggesting that current in bulk be obtained. *Adjourned.*

Hammersmith (London).—The Finance Committee of London County Council have decided to grant the loan of £24,175 asked for by the Borough Council for additional plant.

Haslingden.—The Council have received sanction to a loan of £8,188 for mains, services, motors, meters and sub-station equipment.

Hastings.—The Council last week decided, on the recommendation of the Railways and Tramways Committee, not to accede to the proposal of the local tramway company to substitute the overhead system for the surface contact system of traction on the local tramways. The Council also declined to grant the request of the company that the wayleaves be continued at £50 per mile instead of being increased to £75 per mile.

Honiton.—Last week the Council adopted a recommendation to enter into an agreement with Dr. Purves, of Exeter, for supplying electrical energy for lighting the town.

Huddersfield.—The salary of Mr. J. W. Turner, chief electrical assistant in the Corporation electricity department, has been increased from £185 to £200.

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Inquest.—An inquest was held on Tuesday into the death of Arthur Street, chief assistant engineer, Corporation Electricity Works, Batley, who (as stated in another column) died on Monday from injuries received in a motor-bicycle collision at Alwoodley.

Mr. A. B. Chappell, electrical engineer, Batley, said that he and Mr. Street started together with the intention of cycling to Harrogate. At Harewood Bank witness pulled up at the back of a taxi-cab, thinking a vehicle was overtaking him. Street then ran into the back of his machine and both riders were thrown from their machines. When witness recovered he found Street lying unconscious. No one saw the accident.

Dr. Richardson, of Leeds Infirmary, said death was caused by an extensive fracture and laceration at the base of the skull.

The jury returned a verdict of accidental death.

Llandudno.—On Friday the Council decided, by the casting vote of the chairman, to reduce the flat rate for electricity supply from 5d. to 4½d. per unit.

London, Brighton & South Coast Railway Co.—Public announcement is made of this company's intention to extend the electrification of their line from Balham to Croydon, via South Norwood, within the next year.

London County Council.—At the meeting on Tuesday it was agreed, on the recommendation of the Finance Committee, to loan £5,260 to Stepney Council, repayable in 50 years, for the erection of an electricity sub-station.

Motor Vehicles for Fire Brigade.—The Fire Brigade Committee reported that they were anxious that the motor-driven fire engines and escape vans (including one electrically-driven turntable long ladder), for which the Council had invited tenders, should be ordered before the summer recess, and they asked the Council to authorise them to open and accept tenders, and the Council adopted this course.

New Tramways.—The Highways Committee submitted a report containing proposals for the construction of seven new tramways. The following are the proposed new lines: (1) Hampstead-road to King's Cross via Euston-road; (2) Charles-street to a point north of Ludgate-circus via Farringdon-road and Farringdon-street; (3) Norton Folgate to near Liverpool-street via Bishopsgate; (4) Tooley-street, from the existing terminus to near London Bridge; (5) Catford to Southend via Bromley-road; (6) Essex-road to Kingsland-road via Englefield-road and Stamford-road; and (7) Wood-lane to Harrow-road via a new road between Wood-lane and Latimer-road, thence via Walmer-road, Silchester-road, Clarendon-road, Cornwall-road, Westbourne Park-road, Porchester-road and Lord Hill's bridge. The total length of new lines proposed is 11 miles 6·4 chains, and the estimated cost of construction and equipment is £226,500. The first six new lines are to be on the conduit system and the last on the overhead.—Consideration of the report was postponed.

L.C.C. Annual Report.—The report of the London County Council for 1909-10 was issued last week.

Statistics of the various departments of the Council are given. They would be of more interest if they were issued more promptly. There were 134 miles of tramway in working order at March 31, 1910, and a good deal of reconstruction was done in the 12 months, and horse-traction lines were reduced from 42½ to 17¼ miles. The work of electrification has been continued. The number of passengers carried on the tramcars were 451,439,216 during the year, of which nearly 25 per cent. was represented by ½d. and about 47 per cent. by 1d. fares. The income of the tramways department was £2,023,003, and the working expenses were £1,233,967, leaving £789,036, but after providing for interest, repayment and income tax, the profit was £192,108, of which £132,230 was carried to renewals fund and £59,878 to reserve. The net debt outstanding on tramways account was £8,899,098.

Marylebone (London).—The rate per unit charged by the Council for current for contractors' showrooms is 2d. per unit, but in return for displaying current-consuming devices other than lamps the charge is to be reduced to 1d. per unit.

The Electricity Committee have approved suggestions by Mr. Seaton in regard to hire of wiring and inclusive charges per quarter for installation, maintenance and current. An agreement for three years is required, by which time the cost of wiring is repaid by the consumer and it becomes his property, and that this kind of wiring shall be done entirely to contractors; that with regard to the loan of apparatus to trade contractors be offered any apparatus which their customers desire to try on the same conditions as the Council's representatives loan such apparatus to consumers, and if the contractors' customer purchases the apparatus the department will sell it to him at trade price. The bonus payable to the general manager and chief officers of the department amounts to £787. 19s. 10d. for the year ended March 31 last. The conditions under which this bonus was granted were that the sales of electrical energy were to exceed those of the previous year by 500,000 units (the actual increase was 1,560,497 units), and the average price charged for both private and public supplies was to be diminished by not less than 5 per cent. on the previous year's average. The actual decrease was 0·387d. per unit, or 10·73 per cent.

Melrose (N.B.).—The Electric Supply Corpn. propose to erect an overhead electric lighting cable to Gattonside.

Millfield.—At the last meeting of the District Council Mr. Berry suggested that trackless trolley vehicles might be run in the district, the Council obtaining an Act and borrowing the necessary money. The discussion was adjourned.

Oldham.—At the meeting of the Electricity Committee last week a deputation from the Chambers of Trade attended, and complained that the Corporation electricity department were trading to private traders' detriment.

Mr. BUCKLEY (secretary of the Chamber of Trade) asked under what power the Electricity Committee were hiring out motors.

The TOWN CLERK said they only hired out motors through a contractor. The firm was not a local one, and was not on the list shown at the station.

Mr. BUCKLEY said he considered the Committee had sought to take business out of local firms' hands. Their grievance was that the Committee were supplying motors after an understanding that all orders should be referred to any members of the electrical section of the Chamber of Trade whose names were on the list. The members of the electrical section were willing to supply motors on the simple hire system as well as the purchase system.

The Committee promised the deputation that if the latter adopted the hire system and made it known the Committee would do nothing in the sale or hire of motors.

Poplar (London) Electric Showrooms.—On July 14 the Mayor of Poplar (Coun. F. Sedgwick) formally opened the Borough Council's new showrooms at 121, East India Dock-road.

Coun. H. R. BARGE, who introduced the Mayor, referred to the remarkable progress made by the electrical department under the management of the borough electrical engineer, Mr. J. Horace Bowden.

We have received a copy of a local paper which describes with unstinted praise the demonstrations (on the occasion referred to) of cheap, quick and excellent cooking, which were given by Mr. F. S. Grogan (of the Berry Construction Co.). These excellent results were the more praiseworthy because, as the local reporter remarks, "when it is remembered that he (Mr. Grogan) is entitled to place after his name the letters A.M.I.C.E. and A.M.I.E.E., one may gather that he has not had time to take cookery lessons."

Portsmouth.—The net profit on the municipal tramways department for the past year was £6,000, on the electricity supply department £4,500, and on the telephone department £500. Each undertaking has a large reserve fund, and the three together will contribute £9,500 in relief of rates. The electric light reserve fund has reached £29,000, this being equal to the limit of 10 per cent. allowed by Parliament.

Pwllheli.—It is stated that electricity works for lighting the town will be erected shortly.

Rawtenstall.—The Council have received sanction to a loan of £15,650 for their electricity department.

Rishton.—Mr. J. W. Speight has notified that he will apply for a provisional electric lighting order.

Sheffield.—A deputation asked the Tramways Committee on Tuesday to seek powers to run trackless trolley cars to Dronfield. The committee is considering the suggestion.

Stepney (London).—The Electricity Committee suggest that in future they should pay the equivalent of 0·23d. in stead of 0·4d. per unit for steam obtained from the destructor and the Works Committee have signified agreement to the reduction.

Stockton-on-Tees.—The Council decided on Friday to adopt the following scale of charges for electrical energy for power:—

Below 150 units per quarter 2d. per unit, 150 units and above 1½d., 500 and above 1¼d., 5,000 and above 1¼d. and 20,000 and above 1d., with the option of a special arrangement in the case of the larger consumers. The difference in revenue upon the present consumption would amount to £191.

Swansea.—An experiment with the restricted hour system of supply is being made by the Corporation electricity department and the electrical engineer (Mr. C. A. L. Prusmann), and the chairman and vice-chairman of the Tramways and Electric Lighting Committee will prepare a report.

The Council last week adopted a recommendation of the Tramways and Electric Lighting Committee that the profit of £8,062. 8s. 6d. on the past year's working of the undertaking be placed to reserve.

Telephone Charges.—The Association of Urban District Councils passed a resolution on Saturday to ask the Postmaster-General, in view of the favourable terms granted to agriculturists, to reduce the charge for telephones, especially in the case of subscribers resident in small urban districts, who only require a very limited number of calls annually.

Telephone Wayleaves.—In the course of correspondence on the subject, the Postmaster-General has informed the secretary of Dudley Chamber of Commerce that the rights of the Post Office as to erecting telegraph and telephone lines on or over private lands differ from those possessed by the National Telephone Co., that some of the privileges of the Post Office in this direction are conferred by special acts and some by common law, and that he con-

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siders it is well known that he does not possess or exercise any powers with regard to telegraphs and telephones which are oppressive or unfair to owners or tenants of property. The withdrawal of wayleaves granted to the National Co. can but inconvenience subscribers.

Truro.—The Council are in communication with Mr. Swarbrick as to an electricity supply scheme.

Watford.—The price of electric energy for cooking purposes is to be reduced to 1½d. per unit.

The Council have decided to engage Messrs. Robert Hammond & Son to prepare a report on a scheme of extensions of the electricity works.

West Ham.—Sanction to the borrowing of £2,925 for extension of cables in connection with the tramway system has been obtained.

West Hartlepool.—The L.G. Board inquiry into the application by the Corporation for sanction to borrow £38,000 for extension of the electricity undertaking was resumed last week.

The Corporation propose to utilise exhaust steam and waste heat at the Seaton Carew Iron Co.'s blast furnaces and to erect a power station adjoining the ironworks. The company, in return for their waste steam, are to have a supply of current free. The Cleveland & Durham Electric Power Co. who, it is stated, desire to obtain the use of the waste heat from the iron company, opposed the scheme.

Capt. D. R. Sankey, for the Corporation, admitted that it would be the first Corporation to generate electricity by means of waste heat, but denied that the scheme was an experiment.

Mr. J. F. C. Snell said if the Corporation were not in a position to maintain a proper and safe supply under the Durham & Cleveland Power Co.'s Act they could fall back on that company, who would be bound to supply them.

Mr. Clode (for the Corporation) produced a letter intimating that the North Eastern Railway Co. were offering no further opposition.

On behalf of the Cleveland & Durham County Electric Power Co., Mr. C. H. Merz said he was, so far as he knew, the first to design a waste heat station. Waste heat plant was not in itself sufficient for any public supply. It should be supplemented by coal fire plant with fires always burning. A waste heat station should always have a stand-by plant to counteract irregularities, and it would be better to put down a new modern coal station than the proposed complicated system of waste heat and coal fires. He had found in working waste heat stations that the variations were such that the system would be unreliable for public supply.

Mr. T. Terrell (for the Power Co.) said the Corporation had not in their scheme any effective supervision for dealing with deficient supply. On the other hand, the Power Co. had a large number of stations all linked up together.

Mr. Clode said, assuming that there were temporary interruptions in the supply of waste heat for short periods, the combination of gas firing and coal firing was already in use, and to-day any deficiency in exhaust steam was made up by coal firing.

The inquiry then closed.

Willesden.—The Electrical Engineer has been authorised to make arrangements to supply current at a substantial rebate to contractors in the district who make a good show of apparatus belonging to the Council or who advertise the Council's electricity undertaking.

Outing.—A number of the staff and employés of Gloucester Corporation tramways department, including the general manager, Mr. L. Johnson, had their annual outing to London on Tuesday last week.

COLONIAL AND FOREIGN NOTES.

Australasia.—The "Australian Mining Standard" says North Bulli Coal Co. (Clifton, N.S.W.) are installing new machinery, including electrical plant.

Coleraine (Victoria) Butter Factory Co. propose to instal electric lighting plant at their works, and to supply current for public and private lighting. Wannon Shire Council are willing to agree to a 10 years' concession.

Temora (N.S.W.) Council recently decided to engage Mr. J. E. Donoghue (Balmain) to prepare a report and estimate of the cost of electric lighting plant.

Daylesford (Victoria) Council have decided to borrow £4,000 for establishing electricity works.

A company is being formed at Ararat (Victoria) with a capital of £6,000 to carry out an electric light and power scheme for the town. Messrs. Lincolne & MacDougall have prepared a report, and they calculate that the capital expenditure will be £5,758, annual expenditure £1,170 and annual revenue £1,340. A majority of the Council have adopted the report.

About a year ago a conference of local Councils appointed a committee to consider the question of establishing hydro-electric works to utilise water power at Wairua Falls and supply current in Whangarei. The committee obtained a report from Mr. S. Irwin Crookes, which showed that for an outlay of £50,000 the falls could be harnessed and 1,500 H.P. generated. The Government are having the falls surveyed. Mr. Laurence Birks has charge of the work.

Austria-Hungary.—Reichenberg municipal authorities have decided to construct a tramway 3½ miles in length, from Tuchplatz to Hanichen and Ober Hanichen, at a cost of £27,000. A project for a rail-less trolley system to Heimstatel (Ober Hanichen), at a cost of £14,500, is to be considered.

Brazil.—The "Financial Times" states that on June 26 the Committee of Public Works appointed by the House of Representatives to investigate the petition of the Compagnie Bresilienne d'Energie Electrique for permission to lay down underground cables for supply of electric power for public and private purposes in Rio de Janeiro, have approved the company's scheme. It is also stated that the company have signed a contract with the municipality in regard to the matter. The committee of Public Works recommend the passing of a Parliamentary Bill stipulating that the period of the concession shall be 60 years, that the supply of current for private lighting shall only be available after Sept. 15, 1915, that the charge for lighting shall not exceed 100 reis (paper) per unit, and that the concession shall grant no monopoly, the Government reserving the right to grant concessions at all times for free competition.

China.—A report from Wuchow says there is a tendency for the Chinese to organise companies to exploit the province. Schemes recently started include electric lighting at Wuchow and a telephone system at Kueilin.

Reports state that the Chenghai-Swatow tramway scheme, which was to have been carried out with Chinese capital, has been abandoned.

Imports to Tientsin in 1910 included electrical material and fittings valued at £17,511 (compared with £19,515) and machinery £11,571 (against £49,404).

A company was formed to supply electricity in Hankow, but nothing further was done until the authorities arranged that half the capital should be supplied from official funds and that the company should be administered under official supervision. The scheme now seems likely to eventuate, and some machinery has been obtained through a foreign firm in Shanghai.

Exhibition.—An international agricultural and industrial exhibition is to be held at Rostov-on-Don (Russia), from Sept. 23 to Oct. 14. The British vice-consul at Rostov suggests that power plants, turbines and hardware of all kinds might be usefully shown. The prospectus (in Russian) may be seen at 73, Basinghall-street, London, E.C.

Japan.—The Japanese National Budget for 1911-12 provides for expenditure of £7,000 for the investigation of wireless telegraph, £42,000 on the Great Exhibition, £613,000 for telephone extension and £27,000 for the investigation of hydro-electricity.

The Supplementary Budget for Korea provides for expenditure of £31,000 on telegraph and telephone construction and £868,000 for railway construction and improvement.

Madagascar.—A consular report states that the city of Antananarivo has been provided with electricity supply during 1910.

New York.—On Friday last the Board of Estimate awarded the contracts for the construction of 88 miles new underground and elevated railways in New York to Brooklyn Rapid Transit Co. The capital expenditure by the City will be $206,800,000 and by the company $71,400,000. The work is expected to begin in 30 days.

Russia.—A consular report from Moscow says there was a very considerable increase in the use of electrical energy in Russia in 1910, and in the manufacture of machinery for generating electrical energy. The greatest increase was shown in the output of Diesel engines. Owing to the increasing needs of municipalities, factories turning out cables, tramway and telegraph fittings, &c., extended their business, the spirit of activity being particularly apparent in provincial towns such as Orel, Tamboff, Kaluga, Smolensk, Minsk, Tula and Moghileff, in each of which there are important municipal projects.

The British Vice-Consul at Moscow states that on a tour of inspection towns in the west and south of the Moscow district he found that British commercial enterprise was conspicuously lacking, whereas German commercial travellers were well known visitors in the provincial towns, and German price lists, drawn up in Russian, were widely distributed. It is suggested that several non-competing firms should combine to open depôts to introduce British goods.

The Vice-Consul at Krasnoyarsk says that trade in British goods has been small, although a considerable trade might be done in tools and hardware. German firms have travellers all over Siberia, and successfully compete with British firms by doing business on local terms, giving six months' credit. Electrical and agricultural machinery and machine tools should find a good market.

The Vice-Consul at Tammerfors (Finland) says British manufactured goods would command a greater sale in the district if travellers knowing the Swedish language were sent out. There have been for many years regular imports of British machinery for textile mills.

It was decided to considerably extend the generating plant of Viipuri with a view to the supply of electricity for a proposed municipal electric tramway.

Imports at Hangö (Finland) included electrical machinery valued at £1,100.

Reports from the Batoum district state that British capitalists might find in the Caucasus an enormous field of operation for commercial exploitation. The region is rich in metals and the laws governing gra-

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of concessions for prospecting and development are not irksome. Most towns require electric light, waterworks and drainage schemes, and the many existing traction and other projects give the capitalists further opportunities. The Government are considering the manufacture of ferro-manganese either by electric furnace (using water power for the generation of energy) or by the ordinary blast furnace.

Spain.—A scheme has been brought before the Cortes for the extraordinary expenditure of 60,000,000 pesetas on port works during the ensuing five years. Of this sum 800,000 pesetas (£31,667) is required for 16 electric cranes for Barcelona.

Wireless Telegraph Note.—It is announced that a project is under consideration to establish wireless telegraph communication between Paris and all French possessions in Africa.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Bootle (Lancs.).—The report of the borough electrical engineer (Mr. T. D. Clothier) states that as a result of the working of the electricity department for the year ended March 31 there was a record surplus.

After paying all expenses, including interest and sinking fund, providing £2,300 as a contribution towards depreciation, obsolescence and renewals, £150 for accumulator repairs' account, £1,500 was voted in relief of rates. There was every indication that the set back to the output due to the introduction of metal filament lamps had disappeared, and with the increased output this year there had been an increase in the maximum demand. There was a steady demand for current. There were 755 consumers, but in many cases they were only using a partial supply. Motors of 2,533 H.P. are connected, but users of over 9,000 H.P. are being served by steam and gas engines, and most or all of these users might wish to change as their present arrangements got older. That process would take place sooner if electricity were sold at a lower price. The percentage of gross profit was 8·83 per cent., but it was 13·6 per cent. on the outstanding capital, which was now £74,254. The entire revenue only amounted to 17·8 per cent. of the capital expenditure, so that careful management was required to leave any surplus.

Bristol.—At the City Council meeting on Tuesday the Electrical Committee submitted the accounts for the year to March last.

Revenue was £84,435 and working and general expenses £36,001, leaving gross profit £48,434. Adding £85 refunded on adjustment of income tax and £172 transferred from redemption and sinking fund account, there is a total of £48,891 available for dividends on stock, interest on loans, &c., repayment of capital, reserve for renewals (£3,042), stores written down (£752), expenses re Exchange premises. A deficiency of £768. 16s. 4d. is shown, which will be met from unappropriated balance in hand (£4,042), as will other sums properly chargeable to capital account but for which loans have not been sought, after which there will remain a balance of £2,628. 7s. 9d. to carry forward. The total amount borrowed for the undertaking is £831,365, of which £209,753 has been repaid or accumulated for repayment, and there is also in the reserve fund £23,490. 5s. 11d. There are 3,586 consumers (increase 198), and the connections to the mains are equivalent to 551,991 30-watt lamps (compared with 521,124 last year). Units sold were 9,034,709 (increase 892,333).

The report of the electrical engineer, Mr. H. Faraday Proctor, states that the use of metal filament lamps is still operating to the advantage of the consumer, as shown by the revenue derived from the lighting supply during the past four years, viz., 1908, £47,447, 1909 £43,416, 1910 £40,779, 1911 £41,543. Thus, although the light supplied for the past year is enormously greater than that supplied in 1908, the consumption in units to produce this increased light diminished to such an extent that consumers in the aggregate have paid £6,000 less.

Ald. PEARSON in presenting the accounts on Tuesday said: The gross profit had increased to a greater extent than the income, and that was explained by the fact that there had been a considerable reduction in the cost of generation. They had now paid out of revenue £209,752 to the sinking fund or repayment of mortgage, so they had either mortgage or money in their pockets to that extent. They had also put aside £23,000 for renewals.

The accounts were adopted.

Broughty Ferry.—The accounts of the electricity department show capital expenditure £19,719 (increase £517), of which £16,463 remains outstanding.

Revenue was £2,353 and working and general expenses £1,122, leaving gross profit £1,231. After meeting capital charges, £104 was placed to reserve, and £52 applied to writing off suspense account balance. The units generated were 151,305 (compared with 151,359 in previous year), supplied to public lamps 16,102 (18,627), by contract 998 (1,032) and to private consumers by meter 102,077 (97,479). Total maximum demand 92 kw. (90 kw.).

Cardiff.—At the meeting of the Electric Tramways and Lighting Committee last week Mr. John Allcock (city treasurer) explained the tramway and electricity supply accounts for the year ended March last.

In the tramways department the total capital expenditure was £780,920, and £176,777 had been repaid or set aside for redemption. Traffic receipts during the year were £116,806 (against £114,306 in previous year). Revenue from advertising in cars was £2,010 (£1,879), and energy supplied to the electric lighting department produced £16,351 (£14,188), making a total income of £136,394 (increase £4,829). Working and general costs were £76,441 (increase £2,063), gross profit £58,952 (£56,187). The net revenue surplus was £12,033 (increase £1,001), of which £6,946 has been placed to depreciation and £5,087 to reserve.

Capital expenditure on the electric lighting department was £272,250 (increase £3,820), and net liability on loan account now stands at £207,866.

Income during the year was £45,455 (increase £2,259), working costs were £27,638 (decrease £470), gross profit £17,817 (increase £2,730).

Hammersmith (London).—The accounts of the electricity department for the year ended March show capital expenditure £322,269 (increase £5,643), of which £77,847 has been repaid.

Revenue was £64,376 (against £53,433 in previous year), gross profit £33,940 (£25,155) and net profit £11,997 (£3,483). The maximum load was 5,520 kw. (4,653 kw.). Units generated 10,787,120 and purchased 584,898. Units sold by meter to private consumers were 8,455,695 and to public lamps 784,317. There are 191 arcs, 61 small arcs and 5,719 incandescents for public lighting. Average price obtained for public supply was 1·24d. (against 1·50d.) per unit, and for private supply 1·61d. (1·69d.). There are 2,800 (2,577) consumers, and the motors connected are 434 (=4,901 H.P.), against 386 (=4,587 H.P.).

Maidstone.—At the Corporation meeting last week the Electricity Committee submitted a report by Mr. A. W. King on the electricity supply undertaking.

The report stated that capital expenditure during the year ended March was £1,951. 9s. 11d., revenue £13,642, gross profit £5,817. 13s. 4d., but interest and instalments of loans required £5,976. 9s., leaving a deficiency of £158. 15s. 8d., which has been charged against the unappropriated surplus from previous year, reducing this to £598. 4s. 5d. The report was adopted.

Mr. King's report on the tramways stated that £1,675 was raised during the year for capital expenditure and £1,000 was expended in connection with cars.

Revenue was £9,340. 14s. 1d., and working expenses £7,091. 9s. 5d., leaving £2,249. 5s. 8d. gross profit. Interest and loan charges were £4,932. 6s. 8d., so that there is a deficiency of £2,623. 7s. to be charged to the borough fund.

Weymouth.—The accounts of the Weymouth and Melcome Regis electricity undertaking for the year to March last show capital expenditure £54,255 (increase £2,223), of which £8,160 has been repaid or provided for repayment.

Revenue was £7,011, gross profit £3,878, net profit £376. There are 540 consumers (against 420 at March, 1909), and the equivalent 33 watt lamps connected are 33,176 (28,778). Motors aggregate 187 H.P. The maximum load was 395 kw., and the combined load factor was 12·92 per cent. (against 12·68). Units sold to private consumers for lighting were 249,164 (202,674) and for power 32,476 (33,694), public lamps 165,493 (155,951). Coal cost 0·46d. (0·45d.) per unit sold, works costs were 0·92d. (0·95d.), total costs (including management, &c.) 1·42d. (1·44d.). Redemption of capital required 0·94d. (1·04d.) and interest 0·94d. (1·09d.), and the net profit was 0·20d. (0·06d.).

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Tenders are invited for the supply of telephone, telegraph and electric light material for the year 1911.12, and for the supply of a desiccating plant, to the Postmaster-General's department in NEW SOUTH WALES. Forms of tender, specifications, &c., may be obtained from the Commonwealth offices, 72, Victoria-street, London, S.W. See also advertisements.

The asylum of the Lancashire Asylums Board, WHALLEY, near Blackburn, is in course of erection, and the Committee of Visitors will shortly be prepared to let the contract for the electrical plant, &c. Contractors must send names and addresses by Aug. 7 to Mr. Harcourt E. Clare, clerk to the Committee of Visitors, County Offices, Preston. See also an advertisement.

Tenders are invited up to Sept. 5 for the supply of (*a*) 10,000 protectors and (*b*) sundries to the Postmaster-General's Department in VICTORIA. Tender forms and specifications at the Commonwealth Office, 72, Victoria-street, London, S.W. See an advertisement.

The Corporation of Dublin invite tenders for 12 months' supply of machinery oils for the electricity works, Pigeon House Fort, Dublin. Copies of specification, with conditions of contract (price 5s.), can be obtained from the town clerk, Mr. Henry Campbell, and tenders must reach his office by Aug. 2, 1911. See also an advertisement.

The Municipal Council of BUDAPEST, Hungary, require tenders for the manufacture and supply of plant for a steam-driven electrical generating station, including two groups of three-phase turbo-

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generators (5,000 kw. each), 10,000 volts 50 cycles boiler equipment for mechanical output of 5,000 kw. with reserve, pipeline, central switching and accessory equipments, travelling crane for engine room and coal-conveying plant. Specifications, &c., can be obtained at the Presidial Section of the Council, 9: IV., Városház-utca 16, II. 1, Budapest. The cable lines are not included in the contract. Tenders must be delivered personally or by a commissioned person to Dr. John Buzáth, Notary of the Council, or his substitute, at the above address, by 11 a.m. Sept. 30. For further particulars see an advertisement.

Tenders are invited by the FARNHAM GAS & ELECTRICITY CO. for the supply and erection of two high-speed Diesel oil engines coupled to two 90 kw. alternators with direct-coupled exciters, piping, tanks, overhead traveller and accessories, and main high-tension switchboard. Specifications, drawings and forms of tender may be seen at, but can be obtained from, the offices of the consulting engineers (Messrs. Handcock & Dykes), 11, Victoria-street, Westminster, S.W., and copies of the specifications, drawings and form of tender may be obtained from the Secretary, to whom tenders by noon, Aug. 16.

LONDON County Council require tenders by 11 a.m. Aug. 1 for installing about 250 lamps at Great College-street elementary school, Rochester-place, N.W. Specifications, &c., from the Chief Engineer, Spring Gardens, S.W.

BRUMBY and FRODINGHAM Council require tenders by Aug. 11 for supply and erection of poles, lamps, wires, &c., for lighting the streets electrically. Specifications, &c., from the Council Offices.

BLACKBURN Guardians want tenders by 9 a.m. Aug. 5 for a 28-point fire alarm for the workhouse.

PONTYPRIDD Council want tenders by noon Aug. 1 for 1,700 ampere-hour battery with motor-driven booster and switchgear. Specification, &c., from Mr. J. E. Tessdel, Treforest.

Tonyrefail and Gilfach Goch Electric Light Co., High-street, TONYREFAIL, require tenders by Aug. 1 for supply and erection of electric lighting mains, switchgear and street lighting fittings. Specifications from Secretary.

Tenders are invited for the supply of 530 a.c. meters, 495 d.c. meters and 133 maximum demand indicators to the City of MELBOURNE, Australia. Copies of specification, conditions of contract and form of tender from the agents for the City Council (Messrs. Mellwraith, McEacharn & Co. Propy, Ltd.), Billiter-square Buildings, London, E.C., to whom tenders are to be sent by noon Wednesday, Aug. 9.

Tenders are invited up to Aug. 23 for the supply of telegraph and telephone material to the Postmaster-General's Department in SOUTH AUSTRALIA. Specifications, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W.

Tenders are invited (up to Aug. 15) for the supply of (*a*) 80,000 insulators and (*b*) indiarubber covered wire to the Postmaster-General's Department in VICTORIA; up to Aug. 16 for cable, conduits, c.i. pipes, iron poles, insulators, wires, &c.; up to Aug. 23 for the supply of letter box fronts to the Postmaster-General's Department in QUEENSLAND; up to Aug. 23 for telegraph, telephone and electric lighting material to the Deputy Postmaster-General in NEW SOUTH WALES; and up to Aug. 30 for supply of porcelain insulators, copper wire, sleeves, &c., to the Postmaster-General's department in SOUTH AUSTRALIA. Specifications, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W.

The Metropolitan Water and Sewerage Board, Albert-street, BRISBANE, Queensland, want tenders by noon Jan. 30 next for supply and erection, of one, two or three complete units, each consisting of power generating plant and pump or pumps to lift not less than 6,000,000 gallons per day. Particulars from the Secretary.

MORTLAKE (Victoria) Butter & Cheese Factory Co. require tenders by noon Aug. 14 for supply of dynamo and booster, storage batteries and accessories, switchboard, cables, &c. Specifications from Messrs. F. A. McCarty & Co., 31, Queen-street, Melbourne.

WELLINGTON (N.Z.) Corporation require tenders by 4 p.m. Aug. 24 for supply of a motor power waggon and accessories for the electric tramways department. Gonville and Castlecliff Tramway Board, Ridgway-street, WANGANUI (N.Z.) require tenders by 4 p.m. Aug. 14 for supply of overhead tramway material, feeders, &c. Conditions, &c., can be seen at 73, Basinghall-street, London, E.C. Representation in New Zealand is necessary.

PENTICTON (British Columbia) Municipal Council require tenders by 8 p.m. Aug. 10 for supply and installation of two 100 k.v.a. three-phase 4,600-volt 900 revs. per min. a.c. generators, with pressure pipe line, switchboards, transformers, meters, distribution and street lighting system. Plans, &c., with Mr. F. H. Latimer, consulting engineer, Penticton.

The Generalpostsevrelsens Registratorskontor, Vasagatan, STOCKHOLM, will receive tenders until Aug. 1 for supply of 4,000 to 6,000 16-50 normal c.p. metal filament lamps for 110-250 volts.

Tenders will be received at the Town Hall, SYZRAN, Russia, on Oct. 14, for the construction of an electric tramway and the supply of electrical energy for lighting.

PHILIPPOLIS (Bulgaria) Municipality require tenders by Aug. 4 for a 50 years' concession for electric or gas lighting and for the provision of electric tramways. A deposit of £6,800 is required.

The time for the receipt of tenders by the Ministry of Public Works, Constantinople, for an electric power and tramway concession for JERUSALEM, is extended to Sept. 13. Specifications (in French) can be seen at 73, Basinghall-street, London, E.C.

Tenders will be received at the Prussian State Railway Offices, MAGDEBURG, on Aug. 10 for supply of 270,000 arc lamp carbons.

TENDERS RECEIVED AND ACCEPTED.

St. Pancras (London) Council received the following tenders for cables:—

Western Electric Co. (*accepted*)	£1,352 10 0
W. T. Henley's Telegraph Works Co.	1,383 17 6
Siemens Bros. & Co.	1,396 10 0
British Insulated & Helsby Cables	1,415 4 3
Callender's Co.	1,444 6 0

The tender of E. C. & J. Keay, for erecting boiler house roof and lengthening girders at King's-road generating station, at £261, has also been accepted by St. Pancras Council.

Stepney (London) Council have accepted the tender of the Aron Electricity Meter for supply of 10 special meters required in connection with the supply of current to the Port of London Authority at £164. 5s.

Hammersmith (London) Council have accepted the tenders of Nichols Bros. for feed pump, £190. 15s.; Lucy & Co. for lanterns for side street lighting, bracket and switch, 8s. 10d. each; and the General Electric Co. for hoods, 8s. 3d. each.

Fulham (London) Council have accepted the tender of the British Westinghouse Co. for a switchboard at £210.

Marylebone (London) Council have accepted the tender of the Electrical Co. for supply of lamps for street lighting.

Wm. Geipel & Co. have secured a contract for 68 Geipel steam traps for the new Copenhagen Hospital.

Huddersfield Corporation have accepted the tenders of the United Electric Car Co. for car bodies, and Dick, Kerr & Co. for electrical equipments, for 10 tramcars, the total cost being about £7,000.

Stoke-on-Trent Council have accepted the tenders of the Stirling Boiler Co. for three boilers and accessories, £5,044; and the Davenport Co. for a cooling tower, £1,035.

Swansea Council have accepted the tenders of the Electric and Ordnance Accessories Co. for two years' supply of motors, and H. Billings & Son, for extension of power station and new offices, £3,987. 10s.

Southend Council have accepted the tender of the Worcester Foundry Co. for 47 brackets for the electric lighting of the pier at 16s. 9d. each.

Derby Council have accepted the tenders of W. Rickard (Ltd.) for cables, £913. 13s. 6d.; British Electric Transformer Co., for transformers, £696. 10s.; and A. Reyrolle (Ltd.) for sub-station switchgear, £342.

Blackpool Corporation have accepted the tenders of Wm. Geipel & Co., for Henrion flame arc carbons, and of the Sloan Electrica Co. for Conradty open type carbons. (21 tenders were received.)

York Council are recommended to accept the tender of Callender's Co., at £2,640. 7s. 1d., for supply and laying of h.t. cable for supply to Messrs. Rowntree's works.

Wm. Geipel & Co. have for the third time secured a contract for the annual supply of Henrion open, enclosed and flame type arc lamp carbons (about 1,150,000) to the London & North Western Railway.

Ten electric tramcars made by the Brush Company for the Regina Municipal Tramways, Regina, Saskatchewan, Canada, have recently been shipped from Manchester. There are others to follow.

Sydney (N.S.W.) City Council have accepted the tenders of the Australian General Electric Co. for three transformers (3,200 kw.) £605; General Electric Co., circuit breakers, £601. 12s. 6d.; Union Electric Co., 40 8-ampere a.c. single carbon Excello type arc lamps, £256; Noyes Bros., 50 contact and suspension gears, £115.

Government Contracts.—The British Government Departments have placed orders with the following contractors during June:—

War Office.—Tudor Accumulator Co., storage batteries; Cox-Walkers, boosters, motor, &c.; Western Electric Co., chronograph cable; Mirr-

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lees. Bickerton & Day, oil engines, &c.; Spagnoletti Limited and British Insulated & Helsby Cables, telephone sets, &c.; H. J. Cash & Co., installation of electric light at Sandhurst Military College.

India Office.—Pritchetts & Gold, accumulators; General Electric Co., cells; Stewarts & Lloyds, pipes; T. Piggott & Co., piping; T. Summerson & Son, switches.

Crown Agents for the Colonies.—Telegraph Construction & Maintenance Co., submarine cable; Hooper's Telegraph & India Rubber Works, river cable, &c.; Tyer & Co., electric train tablet apparatus; National Gas Engine Co., gas engines and producer plant for electric lighting; F. Smith & Co., copper wire.

General Post Office.—Peel-Conner Telephone Works, telephone condensers; British Insulated & Helsby Cables, switchboards and flexible cords; British L.M. Ericsson Mfg. Co., switchboards; Western Electric Co., loop cable; W. T. Henley's Telegraph Works Co. and Siemens Bros. & Co., paper-core cable; Bullers (Ltd.), and Taylor, Tunnicliff & Co., insulators; Edison & Swan Co., Omega Electric Lamp Co., Rugby Lamp Co., and Siemens Bros. & Co., glow lamps; Western Electric Co., telephone exchange extension, Victoria; British Insulated & Helsby Cables, local telephone exchange equipment, Attercliffe; Peel-Conner Telephone Works, local telephone exchange equipment, Bury and Doncaster.

BUSINESS NOTICES.

Mr. A. G. M. Michell, M.C.E., of 413, Collins-street, Melbourne, Victoria, informs us that he has changed his business address, and that in future his practice as consulting and designing engineer will be carried on at third floor, 450, Collins-street, Melbourne, Australia.

The works of Pope's Electric Lamp Co. (Ltd.), Hythe-road, Willesden, will be closed for the summer holidays from Aug. 7 to 12, but a small staff will attend to see to urgent matters.

The partnership between Chas. Wm. Stanley and Joseph Wm. Simpson, electricians, &c., 9, Fort-road, and 5, King-street, Margate, has been dissolved. Debts by Mr. Simpson, who continues.

The offices and works of the British Prometheus Co., Highgate, Birmingham, will be closed on Aug. 2 for the annual holidays, and re-open on Aug. 14. A small staff will be in attendance.

The Dublin branch of the General Electric Co. has been removed to more commodious premises at 13, Trinity-street. (Telephone, "3,300 Dublin"; two lines.)

Frank Saunders (Ltd.) has been registered in New South Wales as a limited liability company. The company acquires the Sydney business of Saunders & Stuart, electrical engineers. The address of the company is 178, Clarence-street, Sydney.

The telephone number of the new offices and showrooms of the Benjamin Electric (Ltd.), at 117, Victoria-street, London, S.W., is 1297 Victoria.

Mr. H. B. Tilley, manager in the Manchester district for Bruce Peebles & Co., has left for a business tour in Canada on behalf of the firm. He expects to be away for fully a year.

Messrs. Newtons (Ltd.), Taunton, notify that the fire which occured in their main foundry on 19th inst. did no serious damage, and they are able to give their usual deliveries, the damage having been promptly repaired.

Patent Development.—The proprietor of patent No. 29,363/1904, for "Improvements in and relating to electrical measuring instruments" desires to enter into arrangements by way of licence and otherwise for ensuring the development and practical working of same in this country. Apply to Messrs. Haseltine, Lake & Co., Chartered Patent Agents and Consulting Engineers, 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

On the East Coast.—This is the title of an interesting book published by the Great Eastern Railway Co., of which we have to acknowledge the receipt of a copy of the edition de luxe. Prominence is given to some of the less known districts in East Anglia and to the country between the Cromer and Hunstanton coasts and the Norfolk broads. Illustrations are a feature of the book and show some interesting beauty spots on the G. E. system. A copy of the ordinary edition of this publication can be obtained free from the superintendent of the line, Liverpool-street Station, London, E.C.

BANKRUPTCIES, LIQUIDATIONS, &c.

The examination of Chas. Francis, electrical engineer, 66, Liverpool-road, Stoke-on-Trent, took place last week.

Debtor stated that at the date of the receiving order his liabilities were £512. 19s. 11d., and assets estimated at £11. In May, 1904, he commenced business as an electrical engineer in Liverpool-road, Stoke, his capital being £400, money borrowed from his wife. He had never been in a position to pay the money back, and she was scheduled as a creditor for £469. On Sept. 29, 1905, he entered into a partnership agreement with two others to carry on business in co-partnership. They carried on business at a loss until Feb., 1906, when, under a deed of assignment, the effects were realised and a dividend of 1s. was paid, the liabilities amounting to £1,243. From Sept., 1908, to Dec., 1910, he worked for employers. In Dec., 1910, with capital under £10, he again started to trade as an electrical engineer at Liverpool-road, and this business he had carried on up to the receiving order. Failure attributed to household and personal expenses in excess of income.

Examination adjourned to Aug. 15.

The public examination of Cuthbert Fenton Lindop, electrician, 62, Dale-street, Liverpool, was opened at Liverpool on Monday. The statement of affairs showed liabilities £902, assets nil. Debtor stated that he commenced business as an electrical engineer in Oct., 1909, at 62, Dale-street, Liverpool. He had £200 borrowed capital, which he mainly applied towards exploiting an electrical patent advertising sign of his own invention. It had so far proved a failure. He attributed his failure to this and to losses on contracts. Being in financial difficulties, he went, early in the present year, to a solicitor, but saw a clerk. The clerk advised him to form his business into a limited company, and promised to find him working capital. A company was registered on March 18, and on April 26 a debenture purported to have been issued by the company for £100, of which he received £73, the balance being applied in payment of costs of registering the company. He had to get the signatures of two gentlemen as directors, in connection with the issue of the debenture, which was in favour of a gentleman introduced by the clerk. It was a fact, he believed, that, although the articles of association of the company provided for not less than two or more than four directors, with a qualification of 100 shares, no directors, as far as he knew, had been appointed, nor had any shares been allotted. He was to receive 1,250 fully-paid £1 shares in the company. Shortly before June 29, the date of the receiving order, a debenture holder's action was commenced against the company, and the Chancery Court appointed a receiver on behalf of the debenture holders. His brother also signed the debenture referred to, as secretary to the company.

Examination adjourned to Sept. 18.

Emanuel Ristori, civil engineer, 54, Parliament-street, London, S.W., has been adjudicated bankrupt.

In the bankruptcy of Wm. Hy. Ridpath, electrical engineer, 20, Bath-street, Ilkeston, first meeting of creditors on July 31 at 5, Victoria-buildings, London-road, Derby, and public examination on Aug. 2 at 20, St. Peter's Churchyard, Derby.

A dividend is to be paid to creditors of Chas. Hellyer Pearson, electrical engineer, &c., 51A, Mosley-street, and Stockton-street, Manchester, and 4, Manchester-road, Hyde. Claims to Mr. A. Yearsley, 27, Brazennose-street, Manchester, by Aug. 4

The Batley Electric Carbonising Co. (Ltd.) is being wound up voluntarily. Mr. H. Appleyard, Prudential Buildings, Market-place, Dewsbury, is liquidator.

A dividend is to be paid to creditors of Wm. Hy. Illingworth, electrical engineer, &c., 30, Pellon-lane, Halifax. Claims to Mr. W. Durrance, 12, Duke-street, Bradford, by Aug. 2.

A first and final dividend of 8¼d. is payable at 68A, Castle-street, Canterbury, to creditors of Alphonse C. A. Wampach, electrical engineer, Formby Lodge, Seabrook-road, Hythe.

Claims against the Aluminium Corpn. (Ltd.) (which was incorporated in 1907 and went into voluntary liquidation Dec. 9, 1908), by Sept. 1 to Mr. R. Lawson, 60, London-wall, London, E.C. (This notice does not refer to the Aluminium Corpn. (Ltd.), which was incorporated Dec. 17, 1909.)

The discharge of Geo. Montague Sellick, electrical accessories manufacturer, 464, Romford-road, Forest Gate, London, E., is suspended for two years ending June 27, 1913.

COMPANIES' MEETINGS AND REPORTS.

City & South London Railway Co.

The fifty-fourth ordinary general meeting was held on Tuesday, the Right Hon. C. B. STUART-WORTLEY, K.C., M.P., in the chair.

The SECRETARY (Mr. W. F. Knight) having read the notice convening the meeting,

The CHAIRMAN said: We meet you after a record half-year, in which we have carried more passengers than ever and more passengers per train (126·6). Against the first half of 1910 we show increased receipts per train (17s. 11·4d. against 17s. 4·2d.), also increased receipts per train mile 2s. 5·41d., against 2s. 4·37d.), and decreased percentage of working expenses to receipts (45·52 against 47·52). The principal fact that emerges from the accounts is that we have for distribution in dividends a sum increased by £5,663 over last year. This would have enabled us to pay a dividend at the rate of not merely 1¾ per cent., but even at the rate of 2 per cent., and still to carry forward more by £113 than we did this time last year. At the end of the last week before the Coronation we had recorded an increased passenger traffic of £2,363. The two weeks which comprised the Coronation and all the sights and ceremonies that went before and after it brought us increases in traffics of £1,400. We made, moreover, about £600 by letting spaces for the erection of stands. You see, therefore, that these two non-recurring items of profit just about correspond in amount with the £1,850

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that it would have cost to give you a dividend for the half-year at the rate of 2 per cent. instead of 1¾. The Coronation period, and the exceptionally heavy traffic that it brought us, brought also special responsibilities to our staff, and demanded from them extraordinary exertion during critical periods. We repeated on this occasion the policy that we followed in 1902, of marking the Coronation day by the concession of a day's holiday, or in lieu therefor, a day's extra pay to all ranks and classes of our staff. Of the manner in which their duty was done I cannot use terms of higher praise than to repeat the simple statement made in our report that all ranks worked with such goodwill together that the whole of this extraordinary number of sightseers were brought in and carried back on each of the three days without a single mishap or delay of any kind whatsoever. The new high level subway at the Bank station has now been open for nearly three months, and affords safe and convenient access between our own Bank station and those of the Central London and the Waterloo & City railways. You will approve of our having placed the remainder of our 1903 preference stock. We may have to pay a fractionally higher rate of interest for the money thus realised, but we have got rid of a large debt to the bank, always demandable at short notice. Since our last meeting we have lost, in the late Mr. Ranking, a valued colleague and friend. We have been fortunate in securing for the vacant place on the Board the services of a former general manager and a present director of two great English railways. Mr. Gooday is present with us to-day, and has already given proof of his readiness to give to the service of this company its full share of the skill and energy that have gained him so much distinction in the railway world. When I last addressed you I referred to the speed of our trains. We are advised that without incurring such expense as would involve an application to Parliament, it may be possible so to improve our existing locomotives as to reduce by five or six minutes the time taken in each journey from one end of our system to the other. We have sanctioned the expenditure needful for a practical experiment in this direction. I now move the adoption of the report and accounts.

Mr. CHARLES SEYMOUR GRENFELL seconded the resolution, which was carried unanimously.

A resolution approving the dividends was also carried, and a hearty vote of thanks to the chairman and directors concluded the meeting.

National Telephone Co.

The forty-eighth ordinary general meeting was held yesterday, Mr. GEORGE FRANKLIN presiding.

The SECRETARY (Mr. Albert Anns) read the notice convening the meeting.

The CHAIRMAN said that during the past half-year there had been added to their system 15,675 stations, making the total number of stations on June 30, 549,928. The net result of the half-year's working was a profit balance of £576,277, an increase of £31,761, and out of the available balance of £436,886, the Board recommended the declaration of the usual dividends on the preference shares and of a dividend on the deferred stock at the rate of 6 per cent. per annum. They also proposed to transfer £200,000 to the reserve fund account. During the six months under review upwards of £200,000 was expended on construction of exchange and private stations. The Company's reserve fund totalled £4,059,123, and shareholders were constantly asking him where this sum was. To the extent of £1,839,800 it was represented by solid cash, and by freehold and leasehold properties. As to the balance he could say with some confidence that it would be found in the assets of the Company when these came to be distributed. In the absence of any agreement with the Postmaster-General as to the value of the Company's assets, such value had to be determined by arbitration, and it had appeared to the Board necessary to enter upon the preparation in detail of an inventory of the Company's plant and apparatus, upon which its claims for money compensation must be founded. This task of enumerating and checking the inventory commenced last October. It was occupying the constant time and attention of about 500 employés, and was, of course, a great expense alike to the Postmaster-General and to the Company. The Board anticipated that by the end of the current year this inventory would be completed, and it would be possible then, if necessary, to obtain the decision of the arbitrators as to the purchase price of the various assets to be transferred to the Postmaster-General. Under the provisions of the purchase agreement, they had received notices from the Postmaster-General of objections to purchase a quantity of its plant, land and buildings in what were known as competitive areas, as well as a general notice relating to plant not constructed in accordance with the specification comprised in the purchase agreement. The Board entirely dissented from the Postmaster-General's view, and proceedings were begun before the Railway and Canal Commission. Certain questions of law were decided, generally speaking, in the Company's favour, but that decision was unfortunately reversed by the Court of Appeal, from which Court there was no other appeal. Thereupon the proceedings were resumed before the Railway and Canal Commission, and an arrangement was effected between the Postmaster-General and the Company by which practically the whole of the plant objected to was to be taken over and purchased by the Postmaster-General, certain deductions from the ultimate purchase price of portions of the plant objected to having been agreed to be made by the Company. (Cheers.) He did not wish to say much about that settlement, but it was one which the Directors cordially approved. As to the notices of objection to the character of the plant, he said that the importance of these had been greatly diminished as the result of explanation given to the Court by the Law Officers of the Crown. On the introduction of the Telephone Transfer Bill, they found it necessary to raise objections to certain clauses, which in their view varied the purchase agreement. It was but right to say that, in response to representations made to the Postmaster-General by the Company, certain alterations had been approved which, while preserving to the Postmaster-General the necessary powers required, would at the same time remove the Company's objections to the Bill as at first presented. The difficulties were perhaps serious, and one felt that the Postmaster-General, on his attention having been immediately directed to the question, had met it in a fair, full and frank manner, and the Company had now no cause for complaint. (Cheers.) The Bill also made provision for the Company's staff, and it was due to the Postmaster-General to express satisfaction at the fair and reasonable provision which he offered to make in this regard. He hoped that an application of the same spirit to the case of the principal officers, and others, whose claims were now under consideration, might remove all difficulties, and secure for the Postmaster-General a continuance of the same loyal and devoted service which it had been the good fortune of this Company to enjoy. (Cheers.) He then moved the adoption of the report.

Mr. SAMUEL H. SANDS (the vice-president) seconded the resolution.

The CHAIRMAN, in reply to a question, said the purchase agreement provided for the transfer either on December 31 next or on some day or days to be fixed by the Postmaster-General during 1912. The main question was, of course, the purchase price, and this was still under consideration, and could not be discussed that day, but upon the solution of that question depended in a large measure the date when the actual transfer of the business should take place.

The resolution was passed unanimously.

The retiring Directors (Mr. C. S. Agnew, Lord Harris and Sir Albert Rollit) were then re-elected, and the proceedings terminated with a vote of thanks to the Chairman.

Electric & General Investment Co. (Ltd.)

The twenty-second ordinary general meeting was held yesterday, Mr. J. B. BRAITHWAITE presiding.

The SECRETARY (Mr. S. R. Shaw) read the notice convening the meeting.

The CHAIRMAN read the auditors' report and said: The past year has been an uneventful one. The net result is that we have earned £11,848, as compared with £13,086 in the previous year, or about £1,300 less. That enables us to pay the dividend on the preference shares, distribute the same dividend as last year on the ordinary shares—6 per cent.—and to add a further £2,975 to the contingencies fund, raising it to close upon £79,000. In the balance-sheet one or two changes have taken place of a favourable character. The item Loans against security £19,513 has disappeared, and investments have increased from £244,619 to £250,154. Sundry debtors have increased from £2,714 to £9,208; cash at bankers and in hand from £1,211 to £14,000. On the other side loans from bankers and others have decreased from £48,000 to £45,000. Sundry creditors and open accounts have increased from £22,899 to £28,269. The net result is to strengthen the balance-sheet materially. You may naturally wish to know how the depreciation on our investments is getting on. There, again, I am glad to say the progress made last year in the right direction is still being continued. Last year I said there was an improvement of about £7,000 in the depreciation, and this year, I am glad to say, the improvement is £13,652, so that in the two years there has been an improvement of over £20,000. As I pointed out last year, we have a large interest in the British Electric Traction Co., and you have, no doubt, been glad to notice the improved position of that concern as disclosed in the recent report and balance-sheet, and to see continual improvement in the traffic receipts of their various associated companies which has been steadily going on for a considerable period and recently has assumed very considerable dimensions. The other companies in which we are interested are the City of London Electric Lighting and the County of London Electric Supply, both of which are making very excellent progress. I now move the adoption of the report and accounts.

Mr. EMILE GARCKE seconded the resolution and said it afforded him pleasure to be able to confirm what the Chairman had made note of with regard to the British Electric Traction Co., of which he could speak with intimate knowledge.

In proposing the resolutions approving the dividends, the CHAIRMAN said: As I pointed out to the shareholders last year, the 6 per cent., together with the 6d. per share we are again proposing to distribute out of the reserve fund, gives the ordinary shareholders a return of 8½ per cent., which is not unsatisfactory I think, taking everything into consideration and in view of the sums we have had to put aside to the contingencies fund.

Mr. CECIL J. BULL seconded the resolution, which was approved, and the retiring director, Mr. J. B. Braithwaite, having been re-elected and the retiring auditors re-appointed,

The CHAIRMAN proceeded to set out the Directors' proposals as to the extinguishing of the founders' shares, and submitted a resolution for the adoption of the Board's scheme, which, after a brief discussion, was approved, and this concluded the ordinary meeting.

At an extraordinary meeting which followed of the preference, ordinary and founders' shareholders, resolutions were submitted and approved. Then followed an extraordinary meeting of all classes of shareholders, when the resolutions which had been previously approved were presented and agreed to, and the proceedings terminated with a vote of thanks to the Chairman and Directors.

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ANGLO-AMERICAN TELEGRAPH CO. (LTD.)—The report of the directors for the half year to June 30 states that the total receipts from Jan. 1 to June 30, including balance £2,609. 0s. 5d. brought forward, were £191,455. 0s. 11d. The traffic receipts show a decrease of £37,794, compared with the half-year ended June 30, 1910. Working expenses of the half-year were £76,980. 13s. 1d., an increase of £1,328. 2s. 3d. compared with the corresponding period of 1910. In addition there are the expenses of the negotiations with the Western Union Telegraph Co., for which £3,500 has been set aside. The agreement with the Western Union Telegraph Co. is settled in principle and in detail, but is not yet exchanged. It provides for a guarantee of £262,500 a year, payable quarterly (equal to 3½ per cent. on the ordinary, 6 per cent. on the preferred and 1½ per cent. on the deferred stock). In these circumstances the board has decided to place £5,000 only to the renewal fund for the half-year and to credit the interest on sundry securities to revenue account, thus leaving a balance of £105,974. 7s. 10d. Quarterly interim dividends of 15s. per cent. on the ordinarys and £1. 10s. per cent. on the preferred stock were paid on May 1 last, absorbing £52,500. and second quarterly interim dividends of 15s. per cent. on the ordinary and £1. 10s. per cent. on the preferred stock, amounting to £52,500, will be paid on Aug. 1. The balance, £974. 7s. 10d., will be carried forward.

BOMBAY ELECTRIC SUPPLY & TRAMWAYS CO. (LTD.)—At the meeting last week Sir Charles Ollivant, said that in spite of the continuous depression in the mill industry and its adverse effect on the company's traffic receipts further improved results from the working of the tramways had been achieved and was being maintained. The directors had further augmented the rolling-stock by adding 12 more cars. In the electric supply section of the business, for an increased expenditure of about £2,960 the company had obtained an increased revenue of over £9,300. 410 new consumers—increase 38 per cent.—had been secured. The fact that the increase in the revenue was only 16 per cent. was accounted for by the wider introduction into India of metal filament lamps. The new tariff of flat rates came into operation on Dec. 1. This method of charging was more popular than the maximum demand system. The average rate per unit sold to domestic consumers was 4·06d., a shade better than previously. Capital expenditure during the year was £129,882. 4s. 8d. Of this £115,817. 11s. 3d. was expenditure in the electric supply branch, chiefly for the construction of the new power-house at Kussara and new mains. He thought the report gave facts which encouraged the hope that their position by the time they next met might be such as to justify the payment of an ordinary dividend, if only on a modest scale.

CROMPTON & CO. (LTD.)—The report of the directors for the year ended March 31 states that the result of the year's trading, after the usual provision for depreciation, shows a loss of £14,195. 10s. 7d., compared with £20,493. 2s. 10d. for the previous year. After providing for debenture interest and other charges the balance to debit of net revenue account is increased to £48,271. 11s. 11d. The margin of profit obtainable during the financial year on the sale of goods of the company's manufacture has been small, but the demand is steadily improving, and an increase in the turnover is all that is required to enable the company to earn satisfactory profits. Pending the realisation of certain retention monies and other items which tended to lock up the working capital of the company, and which might otherwise have been used to develop the output at the company's works, the directors did not feel that they were warranted in permitting the works to hold so large a stock as in past years, and this reduction has adversely affected the output and the company's profits. The amount of capital so tied up is being gradually reduced, and it is anticipated that further sums will shortly be realised which will be employed for the benefit of the company's business, and this should materially improve the position. The structural alterations at the company's works, to accommodate the head quarters of the sales department, were completed in December last, and the past year's accounts, which had to bear the cost of removal, benefit but little by the saving in expense now being effected.

DUBLIN UNITED TRAMWAYS CO. (1896) (LTD.)—The directors' report for the half-year ended June 30 states that the amount available for division is £51,159. 4s. 8d., and it is recommended that dividends be paid for the half-year at the rate of 6 per cent., less tax, on both preference and ordinary shares; that £4,000 be set aside towards renewal of cars, and £2,000 towards accident insurance reserve, leaving £9,564. 4s. 8d. to be carried forward.

EAST LONDON RAILWAY CO.—At the meeting on Tuesday Lord CLAUD HAMILTON, M.P., said shareholders would have noticed in the report an expression of regret that no definite statement on the subject of the electrification of the line could be made. He was very glad he was now able to make a statement on the matter. The steps he had taken to get the six lessee companies into line in regard to the electrification had resulted the previous day in a special meeting of the Joint Committee when a resolution was passed practically ensuring the immediate electrification of the company's lines. The cost was estimated by the engineers, allowing for contingencies, not to exceed £65,000. Their solicitors advised that one of the lessee companies, if they thought fit to do so, should incorporate clauses in their next Bill taking steps to raise the money and ensuring the due payment of the interest of 4 per cent. by the other lessee companies or by the East London Company itself. It was believed that the extra working expenses incidental to the electrification of the line would be £3,000 a year, and that the lessee companies expressed their willingness to bear. He had always gone into this question of electrification with a very confident spirit that, having regard to the results of the electrification of the Metropolitan and District, and especially the Brighton line, the traffic receipts under a system of electrification would increase to an extent far in excess of their anticipations. He therefore did not think there was the slightest danger in agreeing to pay £2,600 a year interest on the necessary outlay for the electrification of the line. The District Co. were prepared to supply current from Lots-road, and the Metropolitan Co. felt that they could supply the necessary rolling stock.

FRENCH WESTINGHOUSE CO. (SOC. ANONYME WESTINGHOUSE).—The report for 1910 states that the result shown by the establishments at Freinville was a debit balance for the year of 131,534fr. (£5,261), due to the poor financial return made by the electrical departments. It is proposed to reduce the capital from 20,000,000 to 14,000,000fr.

LANARKSHIRE TRAMWAYS CO.—The directors' report for the half-year to June 30 shows that the result of the half-year's working is a revenue of £36,532. 9s. 5d., against expenses £19,359. 15s. 2d., leaving £17,172.14s.3d. Contributions payable to local authorities and interest amount to £2,166. 10s. 1d., leaving a balance of £15,006. 4s. 2d., or with £1,499.9s.10d. forward, £16,505. 14s. Dividend at the rate of 5½ per cent. for the half-year on the issued share capital requires £9,432. 10s., and £7,073. 4s. is transferred to revenue account. The traffic receipts show an increase of of £320 and the expenses a decrease of £1,240 compared with the corresponding half-year of 1910. The new Stevenston extension will be completed and opened for traffic early in August. Four additional cars have been ordered, and will be put into service shortly. The directors will, as usual, provide for depreciation when the final accounts are made up at the end of the year.

LIVERPOOL OVERHEAD RAILWAY CO.—The accounts for the past half-year show an available balance of £10,841. 6s. 1d., and the directors have resolved to recommend payment of dividends at the rate of 5 per cent. on the preference, and 1 per cent. on the ordinary shares, leaving £4,665 9s.1d. to be carried forward.

LONDON, BRIGHTON & SOUTH COAST RAILWAY CO.—The report of the directors for the half-year ended June 30 states that the gross revenue was £1,662,068, against £1,607,947 for the corresponding half of last year. Working expenses were £1,029,135, against £1,008,465. The increase of revenue arises almost entirely from passenger traffic, which has advanced both in numbers and money, and the electrical services have contributed materially towards this result.

MERSEY RAILWAY CO.—The report of the directors for the half-year ended June 30 states that the train mileage run during the six months was 326,063 miles, compared with 330,307 in the corresponding six months of 1910; passengers carried 6,027,753, against 5,948,152, exclusive of season ticket holders. Receipts from all sources were £55,796. 10s. 7d., compared with £54,652. 18s. 2d. Working expenses (exclusive of charges for pumping, ventilation, and lifts) were £26,426. 2s. 5d. (47·36 per cent.) against £28,916. 4s. (52·91 per cent.). Charges for pumping, ventilation and hydraulic lifts amounted to £2,798. 14s. 3d. (5·01 per cent.), compared with £3,279. 11s. 9d. (6·0 per cent.) £5,005. 11s. 2d. standing at the debit of the net revenue account at the close of the half-year ending Dec. 31, 1910, has been transferred and charged to the capital account. After providing for rent charges, renewal fund, and interest on new first perpetual debenture stock there is a balance at the credit of net revenue account of £8,061. 4s. 9d., which has been carried forward to Dec. 31 account.

METROPOLITAN RAILWAY CO.—The directors' report for the half-year to June 30 states that the total receipts were £400,735. 18s. 3d. (increase £9,247. 8s. 8d.), and expenses £195,666. 17s. 3d. (increase £1,646. 18s. 3d.), leaving £205,069. 1s. profit. After providing for interest and other fixed charges and placing £5,000 to electrical renewal and depreciation fund, there is a balance of £166,728. 6s. 6d., which will meet dividend payments on the preference stocks, and leave £61,424. 19s. 3d. available for dividend upon the ordinary stock. The Directors propose to declare a dividend on this stock for the half-year at the rate of £2 per cent., and to carry forward £4,104. 6s. 10d. This compares with £1. 5s. per cent. for the corresponding period of 1910, and a carry forward of £6,044. The dividend on the surplus lands stock, for the half year, will be at the rate of £3 per cent. During the half-year more "non-stop" trains have been introduced during the busy hours of the morning and evening, and the result has been a considerable increase in the issue of season tickets. Parcels and goods traffic continues to show satisfactory expansion. The installation of automatic signalling between Willesden Green and Neasden has been completed. The replacement of the existing electrical plant at Neasden by machines of larger capacity and improved economy is proceeding satisfactorily. Arrangements for the electrification of the East London Railway are engaging the special attention of the lessee companies, and the work is expected to be put in hand shortly. Its completion will permit of this company's train service over that railway to New Cross being resumed.

At the meeting on Wednesday the chairman (Lord Aberconway) said said they were charging £5,000 to electrical, renewal and depreciation fund, as against £10,000 a year ago. There had been an increase both in electrical and steam mileage. There was no doubt the maintenance of a frequent service within the Greater London area was the best advertisement the line could have. It had to borne in mind that competition was becoming keener and the number of motor omnibuses on the streets was increasing every week. The company had succeeded in getting a reduction of £26,852 on their rateable values assessment which meant a saving of about £10,000. This justified the view that railway property was unfairly treated by local authorities. The work under contract with the Westinghouse Co. for the replacement of the Metropolitan Co.'s generating plant at Neasden was proceeding satisfactorily. The work under the first of the Baker-street contracts was moving on rapidly, and within the last few days they had let the second principal

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contract—for the alteration of the station buildings and platforms with a view to getting the second through road between the northern extension and the City. The construction of the arcade at Liverpool-street Station, connecting up New Broad-street and Liverpool-street, was rapidly approaching completion, and the new station and bridge at King's Cross were also being pushed forward as rapidly as circumstances permitted. It was only three years ago that the balance available for dividend on the ordinary stock was not more than £18,000, but that figure had gradually advanced to £61,500, and he saw no reason why it should not continue to have an upward tendency.

The report was adopted unanimously.

SOUTH AMERICAN LIGHT & POWER CO.—The net profit for the year ended March 31, was, including £558 brought forward, £10,037. The directors recommend payment of a dividend of 5 per cent. on £150,000 capital and also payment of interest at the rate of 5 per cent. on the £71,380 capital expenditure incurred during the year by the railway company; leaving £1,080, of which £500 is to be placed to reserve, and £580 carried forward.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

ALDEBURGH ELECTRIC SUPPLY CO. (LTD.) (116,867)—*Reg.* July 18, capital £7,000 in £1 shares, to manufacture and supply electricity in Aldeburgh, Suffolk, and neighbourhood, and to adopt an agreement with Christy Brothers & Co. (Ltd.). *First* directors: W. H. Hall, G. O. Knowles, W. Hill, L. F. Christy and F. Christy. Reg. office: 177, High-street, Aldeburgh.

ALEXANDER HARVEY EXPLOITATIONS (LTD.) (116,852)—Reg. July 7, capital £6,000 in £1 shares, to carry on the business of electricians, mechanical engineers, suppliers of electricity, &c., and to adopt an agreement with H. A. Harvey, G. P. M. Lee and C. A. Owen. Private company. First directors: H. A. Harvey, G. P. M. Lee, Q. Marino and C. A. Owen. Reg. office: Norfolk House, Laurence Pountney-hill, London, E.C.

SAN LUIS (MEXICO) TRAMWAYS (LTD.) (116,808.)—Reg. July 13th, capital £150,000 in £1 shares, to construct, purchase, lease, or otherwise acquire, sell, grant leases of, use or work any tramways, railways, &c., to generate, purchase and supply electricity, &c.

C. S. WILSON & CO. (LTD.) (116,870)—Reg. July 18, capital £5,000 in £1 shares, to carry on the business of manufacturing, supplying and laying "Litosilo" and other compositions, engineers, electricians, &c., *to acquire* the business carried on by G. Harding at Liverpool as C. S. Wilson & Co. Private company. G. Harding is managing director.

STATUTORY RETURN.

BARNSLEY & DISTRICT ELECTRIC TRACTION CO. (LTD.)—Return to June 6 gives capital as £50,000 in £5 shares (5,000 preference). 4,400 preference and 4,007 ordinary shares taken up. £5 per share called up. £42,035 paid. Mortgages and charges: £21,000.

BIRKDALE DISTRICT ELECTRIC SUPPLY CO. (LTD.)—In return to May 29 capital is £30,000 in £5 shares. All shares taken up and paid for in full. Mortgages and charges: £3,000.

BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. (LTD.)—Return dated May 15. The capital is £1,875,000 in 500,000 £3 preference shares and 75,000 £5 ordinary shares. (Original capital: £1,500,000 in 200,000 £5 preference shares and 50,000 £10 ordinary shares.) All shares taken up. £3 per share called up on 500,000. £1,500,000 paid. £375,000 considered as paid on 75,000 shares. Mortgages and charges: £1,474,953.

MORTGAGES AND CHARGES.

LODGE-MUIRHEAD WIRELESS & GENERAL TELEGRAPHY SYND. (LTD.)—Issue on July 14 of £2,000 debentures, part of a series of which particulars have already been filed.

REASON MFG. CO. (LTD.)—Mortgage dated July 4, to secure £1,000 and certain costs, &c., charged on present and future indebtedness to the company of Motor Meters (Ltd.) and of the Municipal Corporation of Stepney. Holders: Barclay & Co. (Ltd.)

O. RUHL (LTD.)—Memorandum of satisfaction in full on July 4 of debentures dated Nov. 5, 1909, securing £800, has been filed.

"Z" ELECTRIC LAMP MFG. CO. (LTD.)—Floating charge on stock of manufactured lamps for time being at factory at Southfields, dated June 27, to secure moneys to extent of £9,500, which the mortgagees (as guarantors) may become liable. Holders: Kilburn, Brown & Co.

RECEIVERSHIPS.

BROCKIE-PELL ARC LAMP (LTD.)—R. Warner, of 10, Walbrook, E.C., ceased to act as receiver or manager on July 1.

CONSOLIDATED ELECTRIC WORKS AND APPLIANCES (LTD.)—Notice of the appointment of J. W. M. Harling, 73, Fairbridge-road, Upper Holloway, N., as receiver or manager, has been filed. (Notified July 10, 1911.)

C. PENTON LINDOP (LTD.)—Notice of the appointment of F. T. P. Deyes, 5, Cook-street, Liverpool, as receiver or manager, by order of court dated July 3, 1911, has been filed.

KIRLEW BROS. (LTD.)—Notice of the appointment of A. Whale, Bishopsgate House, London, E.C., as receiver and manager, by order of court dated July 14, has been filed.

NORFOLK ELECTRICAL CO. (LTD)—G. E. Ridsdale, Winchester House, Victoria-square, Birmingham, ceased to act as receiver or manager on July 8, 1911.

CITY NOTES.

MEMORANDA (July 27th.—**Bank rate 3 per cent. (March 9, 1911.) Price of silver, 24⅛d. per oz. Consols 78⅛—78⅜ for money and for account. Consols Pay Day, Aug. 2; Stock and Shares Continuation Days, Aug. 14 and 29; Ticket Days, Aug. 15 and 30; Pay Days, July 28 and Aug. 16; Mining Shares Carry Over Day, Aug. 11.**

PRICES OF METALS (London).—***Copper*, cash, 56⅜; three months, 56⅜.** ***Lead*, English, 14⅛—14⅜; Foreign, cash, 13⅞, three months, 14.** ***Spelter*, 25—25⅛.** ***Tin*, English, 192—194; Foreign, cash, 191½; three months, 186¾.** ***Iron*, Cleveland, cash, 46/10, three months, 47/6½.**

BAHIA TRAMWAY, LIGHT & POWER CO.—The earnings of this Company in June were £12,933 (increase £2,066). Aggregate from Jan. 1, £76,933 (increase £13,238).

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—The number of units delivered to consumers during the four weeks ended May 26 were 831,872, compared with 786,249 units in the corresponding four weeks of 1910.

CHELSEA ELECTRICITY SUPPLY CO. (LTD.)—The directors have declared an interim dividend at the rate of 4 per cent. per annum (2s. per share) on the ordinary shares for the half year to June 30.

CITY OF BUENOS AYRES TRAMWAYS CO.—A dividend of 1s. 3d. per share, less tax, for the three months ended June 30 is announced.

COMPANIES TO BE STRUCK OFF THE REGISTER.—The following will be struck off the register of Joint Stock Companies unless cause to the contrary is shown before Oct. 21.

Formby & Freshfield Electric Light Co., Macclesfield Electric Lighting & Power Co., Penarth Tramway Synd., Phœnix Electric Heating Co.

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD.)—The directors have declared interim dividends for the half-year ended June 30 at the rate of 6 per cent. per annum, less tax, on the preference and at the rate of 4 per cent. per annum, less tax, on the ordinary shares, payable Aug. 5. The transfer books and register of members are closed from July 25 to Aug. 4, inclusive.

LLANELLY & DISTRICT ELECTRIC LIGHTING & TRACTION CO. LTD.—This company is making an issue of £50,000 5 per cent. first mortgage debenture stock at par. The subscription list closes to-day (Friday).

MONTREAL LIGHT, HEAT, & POWER CO.—The directors have declared a dividend of 2 per cent. on the paid-up capital (being at rate of 8 per cent per annum) for quarter ending 31st inst.

The directors have decided to make an all-round reduction in their charges, the change to take effect as from the commencement of this month. In the case of domestic consumers the reduction amounts to 6¼ per cent., while for industrial enterprises the alteration is equivalent to a saving of 16⅔ per cent.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY CO. (LTD.)—An interim ordinary dividend of 2 per cent. is announced.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed Aug. 3 a special settling day in Speyer Bros.' scrip certificate (fully and partly paid) for £1,538,700 joint power house rent charge stock of the *Metropolitan District* and *London Electric Railways*, and fully and partly paid scrip for $3,500,000 first mortgage 5 per cent. 40-year gold bonds of the *Mississippi River Power Co.*, and have ordered both to be quoted. Quotations have also been granted to $4,899,000 5 per cent bonds (1925) of the *Bell Telephone Co. of Canada (Ltd.)*, a further issue of £200,000 deferred ordinary, £200,000 preferred ordinary and £200,000 5 per cent. cumulative perpetual preference stock of the *British Columbia Electric Railway Co. (Ltd.)*, and $5,664,200 additional common stock of the *Mexico Tramways Co.* The Committee have been asked to grant a quotation to a further issue of 22,000 £5 fully paid shares of the *Chili Telephone Co. (Ltd.)*.

TUBE AMALGAMATION.—An important amalgamation of Scottish producers of wrought iron and steel tubes has been effected after lengthy negotiations. The companies concerned are as follows:—Scottish Tube Co. (Ltd.), Wilson's & Union Tube Co. (Ltd.), David Richmond & Co. (Ltd.), Hendry Bros. (Ltd.), David Marshall & Sons, James Edie & Sons, Caledonian Co., Coats Tube Co., and the Tradeston Tube Co. Messrs. Stewarts & Lloyd (Ltd.), the leading firm in this country in this line, are not parties to the amalgamation, but are stated to be working in harmony with the new combine. The combination is wholly the outcome of the ruinous cutting of prices which has prevailed over the past three years in this branch of industry.

WEST INDIA & PANAMA TELEGRAPH CO.—A statement having appeared in one of the financial papers that the American Government in acquiring control of the West India and Panama Telegraph Co., Mr. R. P. Brown, manager and secretary of the company, has issued an emphatic denial of any truth in the statement so published.

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ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£	£	£	£
Aberdeen Corporation	July 19	1,706	— 6	7	11,367	+ 798
Airdrie	,, 14	259	+ 10	28	6,091	— 4
Anglo-Argentine	,, 22	46,054	+ 4,804	29	1,423,135	+ 142,257
Ashton-under-Lyne	,, 22	409	+ 6	17	7,124	+ 510
Ayr Corporation	,, 22	1,053	+ 140	10	3,962	— 52
Barnsley	,, 14	185	+ 23	28	5,028	+ 307
Barrow	,, 14	415	+ 65	28	7,638	+ 523
Bath Electric Trams, Ltd.	,, 19	1,027	+ 155	29	23,434	+ 886
Birmingham Corporation	,, 15	9,167	+ 2,422	15	115,179	+ 12,052
Birmingham & Midland	,, 14	904	— 36	28	24,997	+ 1,714
Blackpool & Fleetwood	,, 22	1,290	+ 117	..	..	..
Blackburn Corporation	,, 19	1,190	+ 81	†17	19,901	+ 1,739
Bolton Corporation	,, 23	2,602	+ 207	17	42,579	+ 3,348
Bombay	June 23	2,834	+ 304	..	71,437	+ 3,994
Bournemouth Corporation	July 19	1,975	— 1,269	16	28,266	— 2,107
Bradford Corporation	.. ..	..	.. ..	..	..	..
Brighton Corporation	,, 23	1,205	+ 166	¶16	17,150	+ 1,655
Bristol Trams & Carriage	,, 21	7,003	+ 1,026	16	117,314	+ 11,666
Burnley Corporation	,, 22	1,378	+ 119	16	14,881	+ 2,000
Burton Corporation	,, 23	308	+ 28	16	4,791	+ 437
Bury Corporation	,, 23	1,311	+ 117	¶16	21,186	+ 1,576
Calcutta Tramways Co.	,, 24	R58,302	+ R7,160	3	R175,998	+ R18,762
Camborne-Redruth	,, 22	122	+ 1	29	3,524	+ 29
Cardiff Corporation	.. ..	..	.. ..	..	..	..
Central London Railway	,, 22	4,656	— 986	3	14,624	— 2,717
Chatham & Dist. Lt. Rys.	,, 20	982	+ 55	29	23,844	+ 193
City & South London Rly.	,, 23	3,077	— 58	3	9,376	+ 98
City of Birmingham	,, 14	1,128	— 1,722	28	73,385	— 1,051
Cork Electric Trams Co.	,, 20	573	+ 20	29	14,187	+ 272
Devonport & Dist. Trams	,, 14	572	+ 151	28	13,035	+ 1,585
Dover Corporation	,, 22	299	+ 59	16	4,173	+ 744
Dublin & Lucan Railway	,, 21	509	— 14	3	861	— 10
Dublin United	,, 21	6,396	+ 508	3	26,170	+ 8,132
Dudley-Stourbridge	,, 14	942	+ 70	28	22,812	+ 1,873
Dundee Corporation	,, 19	1,238	+ 28	¶19	11,323	— 83
East Ham Council	,, 22	1,132	+ 106	16	18,077	+ 1,265
Exeter Corporation	,, 21	394	+ 44	16	5,691	+ 453
Gateshead & Dist. Trams	,, 14	1,101	+ 86	28	28,612	+ 1,555
Glasgow Corporation	,, 22	14,716	+ 1,179	§7	144,183	+ 9,997
Glossop Trams	,, 22	123	+ 4	29	3,510	+ 234
Gloucester Corpn.	,, 19	317	+ 22	3	955	+ 154
Gravesend-Northfleet	,, 14	215	+ 21	28	5,691	+ 147
Great Northern & City Rly.	,, 22	1,371	+ 40	3	4,222	+ 128
Greenock & Port Glasgow	,, 14	775	+ 101	28	19,417	+ 2,483
Halifax Corporation	,, 18	2,102	+ 201	†16	32,105	+ 3,409
Hartlepool Tramways	,, 14	361	+ 76	28	7,021	+ 588
Hastings Elec. Trams Co.	,, 20	1,232	+ 114	3	3,549	+ 82
Hong Kong	,, 22	$9,246	+ $663	3	$29,010	+ $1,732
Huddersfield Corpn.	,, 22	1,934	+ 174	16	31,983	+ 3,453
Hull Corporation	,, 22	2,879	+ 153	16	46,269	+ 2,434
Ilford District Council	,, 22	549	+ 27	17	9,278	+ 507
Ilkeston District Council	,, 19	131	+ 3	16	2,148	+ 104
Ipswich Corporation	,, 22	533	+ 54	16	7,375	+ 734
Isle of Thanet Co.	,, 22	1,483	+ 196	42	19,699	+ 1,011
Jarrow	,, 14	148	+ 21	28	3,567	+ 240
Keighley Corporation	,, 20	195	+ 14	16	3,186	+ 305
Kidderminster & District	,, 14	153	+ 5	28	3,001	+ 200
Kilmarnock Corporation	,, 22	237	+ 63	10	1,689	+ 156
Lancaster Corporation	.. ..	..	.. ..	..	..	..
Lancashire Trams Co.	,, 20	1,634	+ 76	29	40,410	+ 272
Lancashire United	,, 19	1,411	+ 72	29	38,266	+ 1,014
Leamington	,, 14	212	+ 8	28	4,450	+ 70
Leeds Corporation	,, 22	7,766	+ 612	16	124,038	+ 10,132
Leicester Corporation	,, 22	2,652	+ 153	16	42,124	+ 3,992
Leith Corporation	,, 22	955	+ 241	‡10	7,006	+ 530
Lincoln Corporation	,, 22	129	+ 5	16	2,178	+ 197
Liverpool Corporation	,, 15	12,557	+ 711	29	320,614	+ 12,227
Liverpool Overhead Rly.	,, 23	1,542	+ 110	3	4,844	+ 508
Llandudno & Colwyn Bay Ry.	,, 21	576	+ 68	§33	7,347	+ 390
London County Council	,, 12	46,465	+ 3,445	‡15	671,067	+ 58,111
London Elec. Ry. Co.	,, 22	12,530	+ 330	3	38,820	+ 1,370
London United	,, 22	7,985	+ 1,419	29	188,220	+ 8,347
Lowestoft Corporation	,, 22	310	+ 42	42	7,115	+ 625
Manchester Corporation	,, 22	16,213	+ 814	17	266,035	+ 15,495
Mersey Railway	,, 22	1,957	— 31	3	5,775	— 69
Mersey	,, 14	255	..	28	5,719	+ 84
Metropolitan Dist. Railway	,, 22	11,169	+ 503	3	34,910	+ 2,479
Metropolitan Elec. Trams	,, 14	10,057	+ 1,935	28	240,160	+ 37,317
Middleton	,, 14	411	+ 8	28	9,211	+ 611
Milton Corporation	,, 22	202	+ 39	§16	2,988	+ 618
Newcastle-on-Tyne Corp.	,, 22	4,250	— 50	16	70,270	+ 4,851
Newport (Mon.)	,, 22	729	+ 49	16	12,014	+ 903
Northampton Corporation	,, 21	566	+ 69	16	8,980	+ 980
Oldham, Ashton & Hyde	,, 14	616	+ 5	28	15,663	+ 441
Oldham Corporation	,, 23	2,098	+ 260	17	34,340	+ 2,023
Perth (W.A.) Elec. Trams	,, 19	212	+ 13	9	1,797	+ 150
Peterborough	,, 21	1,553	+ 1,558	29	46,959	+ 2,634
Portsmouth Corporation	,, 14	135	+ 11	23	3,455	+ 370
Preston	,, 22	2,645	+ 459	16	33,103	+ 4,792
Reading Corporation	,, 14	1,989	+ 256	28	53,750	+ 5,353
Rochdale Corporation	.. ..	..	.. ..	..	..	..
Rotherham Corporation	,, 20	672	+ 38	16	10,765	+ 943
Rugby	,, 14	577	+ 7	28	4,046	— 204
Salford Corporation	,, 24	5,014	+ 445	‡16	82,012	+ 4,850
Singapore	,, 19	$12,500	+ $1,675	3	$37,250	+ $3,950
Sheffield Corporation	,, 14	60	+ 7	28	1,340	+ 69
Southampton Trams.	,, 23	6,418	+ 503	17	110,583	+ 7,621
South Metropolitan	,, 22	$10,302	+ $774	3	$31,594	+ $1,672
South Staffs.	,, 14	1,092	+ 160	28	23,320	+ 1,038
Southampton	,, 14	906	+ 32	28	24,883	+ 1,992
Southend Corporation	,, 19	1,315	+ 205	16	19,727	+ 2,477
Southport Tramways	,, 19	835	+ 124	16	10,569	+ 1,606
Stockport, Timperley & Altrincham	,, 14	403	+ 6	28	8,091	+ 286
Sunderland Corporation	,, 22	835	+ 39	16	13,098	+ 1,217
Sunderland District	,, 23	1,517	+ 251	16	21,679	+ 2,784
Swansea Trams	,, 19	484	+ 22	38	17,139	+ 1,300
Sydney Corporation	,, 14	1,332	+ 158	28	31,015	+ 2,084
Taunton Corporation	,, 19	149	+ 17	16	2,519	+ 345
Tynemouth and District	,, 14	47	+ 4	28	1,149	+ 22
Tynemouth Trams Co.	,, 14	432	+ 56	28	6,246	+ 155
Walsall Corporation	,, 19	546	— 33	3	1,433	+ 21
Warrington Corporation	,, 22	1,189	+ 116	16	18,533	+ 3,079
Wellington Corporation	,, 22	544	+ 5	29	16,076	+ 680
West Ham Corporation	.. ..	..	.. ..	..	..	..
Weston-super-Mare	,, 20	2,820	+ 316	16	44,717	+ 4,927
Wolverhampton Co	,, 14	416	+ 6	28	3,025	+ 153
Wolverhampton Corpn.	,, 13	515	..	28	12,286	+ 623
Worcester	,, 19	1,052	+ 37	16	16,369	+ 1,177
Wrexham	,, 14	354	+ 20	28	7,869	+ 406
Yorkshire W.R. Trams	,, 14	115	+ 11	28	2,735	+ 87
Yorkshire Woollen District	,, 23	1,202	+ 109	30	38,073	+ 1,593
	,, 14	1,120	+ 71	28	28,897	+ 2,059

(a) These comparisons are with the corresponding period last year. † Minus 3 days. ‡ Minus 2 days. § Plus 3 days. ¶ Plus 2 days. • Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Shs	Last Dividend	Name.	Price Wed., July 26.	*Rate per cent. Yielded.	Dividend Due.	Business Week to July 26. Highest.	Lowest.
		Electricity Supply.		£ s. d.			
10	6/0	Bournemouth & Poole Elec. Sup. Ord.	8 —9	6 9 6	Mar, Sep	8⅝	8½
10	4/6	Do. 4½ per Cent. Cum. Pref.	9 —10	4 14 6	Feb, Aug	9⅛	..
10	6/0	Do. 6 per Cent. Cum. Second Pref.	10¼ —10½	5 6 0	Feb, Aug	10⅜	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101 —103	4 6 6	Jan, July	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	8 —8½	6 1 0	March	8¼	..
5	3/6	Do. 7 per Cent. Pref.	7½ —8	4 1 3	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Deb. Stock	98 —101	4 0 6	June, Dec	99	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	3⅞ —4⅛	5 2 6	Feb, Aug	4⅛	4
5	2/3	Do. 4½ per Cent. Pref.	4⅛ —5⅛	5 2 6	Feb., Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	94 —98	4 3 3	Jan, July	..	..
St.	4½%	†Do. 4½ per Cent. Deb. Stock (red.)	100 —102	4 8 3	..	..	..
5	2/3	Do. City Undertaking 4½% Cum. Pref.	3⅞ —4⅛	5 10 6	Jan, July	4⅛	..
5	3/0	Chelsea Electric Supply Ord.	4 —4⅛	5 11 0	March	4⅛	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	98 —100	4 11 0	June, Dec	..	..
10	8/0	City of London Electric Lighting Ord.	12 —12½	4 18 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	12 —13	4 12 3	Jan, July	12⅛	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	119 —123	4 1 0	June, Dec	..	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	100 —103	4 8 6	Jan, July	101⅛	..
St.	5%	County of Durham Elec. P. D. 5% 1st Mort. Deb. Stk.	89½ —91½	5 10 6	Jan, July	..	..
10	6/0	County of London Elec. Supply Ord.	7⅜ —8⅛	6 3 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11⅛ —11⅜	5 2 2	Mar, Sept	11⅛	11⅛
St.	4½%	Do. 4½ per Cent. Deb Stock (red.)	108 —110	4 2 6	Jan, July	110	..
St.	4½%	Do. Second Deb. Stock	100 —103	4 7 6	May, Nov	..	..
5	4/0	Folkestone Electricity Supply Co. Ord.	4⅛ —4⅜	5 19 0	April, Oct	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅞ —5⅛	4 15 3	Mar, Sept	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red)	97 —100	4 10 0	Feb, Aug	..	..
5	5/0	Hove Electric Lighting Ord.	6⅞ —7⅛	6 4 0	April, Oct	..	..
St.	4½%	Isle of Wight E. L. & P. Co. Deb. Stk.	88 —91	4 19 0	..	..	..
5	5/0	Kensington & Knightsbridge Ord.	7 —7⅛	5 16 0	Feb, Aug	..	..
5	6%	Do. 6 per Cent. 1st Pref.	5⅞ —6	5 0 0	Jan, July	..	..
St.	4%	†Do. 4 per Cent. Deb. Stock (red.)	91 —93	4 6 0	..	92⅛	..
St.	4%	Kensington & Knigtsbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	96 —99	4 1 0	April, Oct	..	..
St.	4½%	†Kent Elec. Power Co. Irred Deb. Stk.	78 —82	5 9 9	Jan, July	..	..
3	1/2⅔	London Electric Supply Ord.	1⅝ —2	3 11 3	Mar, Sept	..	..
5	3/0	Do. 6 per Cent. Pref.	4⅜ —5	6 3 0	Mar, Sept	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb	87 —92	4 8 0	Jan, July	..	..
5	3/0	Metropolitan Electric Sup. Ord.	3⅛ —4⅛	6 5 0	April, Oct	4⅛	3⅛
5	2/3	Do 4½ per Cent. Cum. Pref.	4⅛ —4⅜	4 17 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	100 —105	4 7 6	June, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	94⅛ —87⅛	4 1 6	Jan, July	..	..
..	4½%	Midland Elec. Corp. for Power Dist. 4½ 1st Mort. Debs.	96½ —98½	4 12 6	..	..	..
5	2/6	Newcastle Elec. Supply Ord.	3⅝ —4	4 14 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non Cum. Pref.	4 —4⅛	5 11 0	Feb, Aug	..	..
100	4½%	Do. 4½ per Cent. 1st Mort. Deb.	97 —99	4 12 0	Jan, July	..	..
100	5%	North Metro. Elec. Power Sup. 5 Morts.	101 —104	4 17 6	..	..	..
1	6%	Northampton Elec. Lt. & P. Ord.	1⅛ —1⅜	4 11 6	Feb, Aug	..	..
1	5%	Do. 5% Pref.	1⅛ —1⅜	4 6 0	Feb, Aug	..	..
St.	4%	Do. 4% Debs.	99 —101	3 19 0	June, Dec	..	..
10	6/0	Notting Hill Electric Ord.	..	5 17 6	March	..	..
5	4/3	Oxford Electric Ord.	6⅛ —6⅜	5 13 9	March	..	..
St.	4%	†Do. 4% Deb. Stk.	91 —94	4 5 1	..	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	9 —9½	5 8 0	Feb, Aug	9⅛	9
5	3/6	Do. 7 per Cent. Pref.	6⅞ —7⅛	4 16 6	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	84⅛ —86⅛	4 2 0	Jan, July	..	..
5	..	Smithfield Markets Electric Sup. Ord.	1⅛ —1⅜	..	Feb.	..	..
5	4/0	South London Electric Supply Ord.	2⅛ —3⅜	6 3 0	April	2⅜	..
St.	5%	Do. 5 % 1st Mort. Stock (red.)	96⅛ —101⅛	5 0 6	..	..	..
1	0 8⅓	South Metrop'n Elec. Lt & Power 7% 1st Pref	1⅛ —1⅜	5 18 0	Feb, Aug	..	..
1	0/7½	Do. 6 per Cent. 2nd Pref.	⅝ —¾	6 17 0	Feb, Aug	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	97 —100	4 11 6	April, Oct	..	..
5	1/3	Urban Electric Supply Ord.	⅞ —1	..	April, Oct	..	..
5	1/3	Do. 5 per Cent. Cum. Pref.	2⅛ —3	8⅓ 6 0	April, Oct	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	87 —89	5 2 3	April, Oct	89	..
5	5/0	Westminster Elec. Sup. Ord.	7⅛ —8⅛	6 1 8	Mar, Sept	..	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	5 —5⅛	4 3 6	Jan, July	5⅛	..
		Electric Railways and Tramways.					
1	..	Bath Elec. Trams Pref. Ord.	⅛ —¼	..	April	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	⅛ —¼	6 13 6	Jan, July	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	79 —83	5 8 6	April, Oct	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Deb. Stock.	89 —91	5 0 0	Jan, July	..	..
10	4%	Bristol Tramways & Carriage Ord.	6½ —6⅝	6 5 6	Feb, Aug	..	..
10	4%	Do. Cum. Pref.	7 —7⅛	5 10 0	..	..	..
St.	4%	Do. 4 per Cent. Debs.	100 —101	3 19 2	Feb, Aug	..	..
10	..	British Electric Traction Ord.	⅜ —½	..	June, Dec	1	..
10	..	Do. 6 per Cent. Cum. Pref.	3½ —4	..	Feb, Aug	3⅝	..
St.	5%	Do. 5 per Cent. Perpetual Debs.	94 —97	5 4 6	April, Oct	96½	9
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	77 —81	5 14 0	May, Nov	..	..
St.	3%	Central London Ordinary Stock	69 —71	4 5 3	Feb, Aug	77	7
St.	4%	Do. 4 per Cent. Pref. Stock	87 —89	4 10 0	Feb, Aug	88	..
..	6/4	Do. Pref. Scrip 50% pd	63 —64	..	..	55½	..
St.	2%	Do. Deferred Stock	55 —57	3 11 6	Feb.	..	..
100	4%	†Do. 4 per Cent. Debs.	102 —104	3 16 11	Jan, July	..	..
5	2/6	City of Birmingham Trams, 5 % Cum. Pref.	4⅛ —5⅛	4 19 6	April, Oct	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs	99 —102	3 18 9	April, Oct	..	..
St.	1¼%	City & South London Rly. Con. Ord.	32½ —33½	4 9 6	Feb, Aug	34	32
St.	5%	Do. 5 per cent. Perp. Pref. (1891)	110 —112	4 9 3	Feb, Aug	..	..
St.	5%	Do. (1896)	105 —103	4 13 0	Feb, Aug	..	..
St.	5%	Do. (1901)	104 —107	4 15 0	Feb, Aug	..	..
St.	5%	Do. (1903)	103 —105	4 15 6	Feb, Aug	105½	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	102 —104	3 17 9	May, Nov	..	..
10	6/0	Dublin United Trams. 6 per Cent. Pref.	12½ —13½	4 10 6	Feb, Aug	..	..
10	12/0	Gateshead and District Trams Ord.	8⅛ —8⅜	6 10 0	..	..	..
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	⅛ —1⅛	..	Feb, Aug	..	..
5	..	Hastings & District Elec. Trams, 6% C. P.	..	..	Mar. Sept	..	..
St.	4½%	Do. 4½ Deb. Stock	75 —80	5 10 0	April, Oct	..	..
10	..	Imperial Tramways Ord.	3 —3½	..	Mar, Sept	..	..
10	..	‡Do. 6 per Cent. Pref.	4 —4½	..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Debs.	72 —74	6 3 6	Jan, July	..	..
..	2/9	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	2½ —2⅝	5 0 0	Mar, Sept.	..	..
St.	4%	†Do. 4 per Cent. Deb. Stock	77 —82	5 1 0	Jan, July	..	..
10	6/0	Lanarkshire Tramways	10 —10½	5 12 3	Feb, Aug	..	..
St.	5%	Lancs Utd. Trams, 5% Prior Lien Deb. Stk.	79 —82	6 4 0	Jan, July	..	..
St.	4%	London Electric 4% Deb. St.	96 —98	4 2 6	..	97⅛	97
St.	4%	Do. 4% Pref.	84½ —85½	4 14 0	..	85½	84
10	..	London United Trams, 5% Cum. Pref.	3¼ —4	..	Jan, July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	74 —77	5 6 0	Jan, July	..	..
St.	..	Mersey Con. Ord. Stock	6 —8	..	Feb, Aug	..	..
1	1/1⅛	Metropolitan Elec. Tramways Ord.	⅞ —1⅛	6 0 0	..	1	..
1	..	Do. Deferred	⅛ —⅜	..	April	⅜	..
1	0/6	Do. 5 per Cent. Cum. Pref.	⅞ —1	5 0 0	Feb, Aug	..	..
St.	4½%	‡Do. 4½ per Cent. Deb. Stock	99 —101	4 10 0	Jan, July	100½	100
St.	5%	Do. 5 per Cent. Deb. Stk.	102½ —104½	4 16 6	..	..	..
St.	1½%	Metropolitan Railway Consolidated	47½ —48	2 17 6	Feb, Aug	49⅛	47
St.	2½%	Do. Surplus Lands Stocks	68 —70	3 19 9	Feb, Aug	70½	69
St.	3½%	Do. 3½ per Cent. Preference	90 —92	3 16 0	Feb, Aug	93⅛	..
St.	3½%	Do. 3½ per Cent. "A" Preference	89 —91	3 17 0	Feb, Aug	89⅛	89
St.	3½%	‡Do. 3½ per Cent. Convertible Pref.	89 —91	3 17 0	Feb, Aug	90⅛	89
St.	3½%	†Do. 3½ per Cent. Debenture Stock	92 —94	3 14 6	..	92½	92

* No allowance has been made for accrued interest or redemption.
‡ Ex Dividend. ‖ The London Stock Exchange Committee have declined to quote these.

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ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shrs	Last Dividend	Name	Price Wed., July 26.	*Rate per cent. Yielded.	Dividend Due.	Business Week to July 26. High- est.	Low- est.
		Electric Railways and Tramways— *Continued.*		£ s. d.			
St	3½%	†Met. Rly. 3½ per Cent. "A" Deb. Stock..	91 —93	3 16 0	Jan, July	..	..
St	..	Metropolitan District Railway Ord.....	27½—27¾	..	Feb, Aug	29	26½
St	3½%	Do. 4½% First Pref.	89 —91	4 18 11	Feb, Aug	90½	89
St	3½%	Do. Assented Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	76 —78	4 10 0	Feb, Aug	77	76½
St	3%	Do. 3 per Cent. Consoltd. Rent-charge	76 —78	3 18 0	Jan, July	..	..
St	4%	Do. 4 per Cent. Midland Rent-charge	102 —104	3 17 9	Jan, July	..	..
St	6%	Do. 6 per Cent. Perp. Deb. Stock.....	145 —147	4 2 0	Jan, July	145½	..
St	4%	Do. 4 per Cent. Ditto.....	96 —98	4 2 6	Jan, July	98	..
1	4d.	Potteries Electric Traction Ord.	⅛—¼	6 11 3	April, Oct	⅛	⅛
1	0/6	Do. 5 per Cent. Cum. Pref.....	⅛—¼	8 6 8	Feb, Aug	..	..
St	4½%	Do. 4½ per Cent, Deb. Stock.....	88 —91	5 0 0	May, Nov	..	..
1	1/2½	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	⅛—¼	10 2 0	..	..	..
St	4%	†Dc. 4 per Cent. Deb. Stock.....	73 —78	5 6 0	Jan, July	..	..
100	5%	Sunderland Dist. Elec. Trms. 5% 1stMtDb.	..	8 4 0	Jan, July	..	..
-	10/0	Undergd E. Rys. Lon. 6% 1n. bds with coup	64 —66	1 10 3	June, Dec	65½	65½
-	5%	Do. 5% Prior Lien Bonds.....	100½—101¼	4 19 0	..	101½	..
-	4½%	Do. 4½% Bonds with coup. 8	99 —101	4 10 0	..	100½	99
5	4%	Do. 4 per Cent. 1st Power Ho. Dbs. ..	101 —103	3 18 3	..	..	..
5	..	Yorkshire (W.R.) Elec. Trams. Ord.....	¼—¾	..	March ..	..	..
	..	Do. 6 per Cent. Cum. Pref.....	2½—2¾	..	..	..	..
	4½	Do. 4½ per Cent. 1st Debs.....	82 —85	5 8 0	Jan, July	..	..
		Electric Manufacturing, &c.					
	4½%	Anchor Cable Co. 4½ % Deb. Stock	98 —100	4 11 0	—	..	..
	(2½	Aron Electricity Meter Ord.....	⅜—½	..	..	..	..
	7½	Do. 6% Cum. Pf.	⅛—⅜	7 10 0	April, Oct	..	..
	2½	Babcock & Wilcox Ord.	5½—5⅝	4 15 0	April, Oct	5⅜	5½
	2½	Do. Pref.....	1⅛—1½	4 0 0	..	..	..
		British Insulated & Helsby Cables Ord...	6½—7⅛	6 15 6	July, Feb	7⅛	..
		Do. 6 per Cent. Pref.....	6 —6½	4 12 3	Jan, July	..	..
		Do. 4½ per Cent. 1st Mort. Deb. (red.)..	102 —104	4 7 0	Jan, July	..	..
		British Thoms'n-Houst'n 4½% 1st Mt.Db.	96 —99	4 11 0	Mar, Sept	..	..
		British Westinghouse 6 per Cent. Pref.....	⅛—⅜	..	Feb, Aug	..	..
		Do 6 per Cent. Prior Lien Dbs. (rd.)..	102 —104	5 17 0	..	..	..
		Do. 4 per Cent. Mort. Deb. Stock.....	59 —62	6 6 6	Jan, July	..	..
		BrushE. Eng. Co. 4½% Perp. 1st Deb. Stock	59 —64	7 0 6	Mar, Sept	..	..
		†Do. Perpetual 2nd Deb. Stock.....	39 —44	10 10 0	Jan, July	..	..
		Callender's Cable Con. Ord.	8½—9½	8 2 0	Jan, July	..	..
		Do. 5 per Cent. Cum. Pref.....	4¾—5⅛	4 17 6	Jan, July	..	..
		Do. 4½ per Cent. 1st Mort Debs. (red.)..	101 —103	4 8 0	Nov, May	..	..
		Castner-Kellner Alkali Co.....	3⅛—3⅜	5 7 3	May, Nov	3⅛	3⅛
		Do. 4½ per Cent. 1st Mort. Deb. (red.)..	104 —107	4 2 6	Feb. Aug	..	..
		Chadburn's (Ship) Telegraph Ord.	1⅛—1⅜	5 19 0	March ..	..	..
		Consolidated Electrical Co.....	⅛—⅛	7 8 9	August ..	⅛	..
		Consolidated Signal Co.....	⅛—⅛	6 13 6	April, Oct	—	..
		Do. 6 per cent. Cum. Pref.....	⅛—¼	7 6 6	April, Oct	..	..
		Crompton & Co (Nos. 1 to 85,000)	⅛—¼	..	Jan, July	..	..
		Do. 5 per Cent. 1st Mort. Debs. (red.)..	57½—67½	8 0 0	Jan, July	59	..
		Dick, Kerr & Co. Ord.....	⅛—⅜	5 14 0	Sept.	..	..
		Do. 6 per Cent. Cum. Pref.....	⅛—⅛	5 6 0	Sept	..	..
		Do. 4½ per Cent. Deb. Stock.....	95 —98	4 13 3	Jan, July	..	..
		Edison & Swan United ("A" Sh.) (£3 pd.)	⅛—⅜	..	Feb, Aug	⅛	..
		Do. (£5 paid)	1½—2⅛	9 3 0	Feb. Aug	..	..
		Do. 4 per Cent. Mort. Deb. Stock (red.)	67 —71	5 16 0	June, Dec	67½	..
		Do. 5 per Cent. 2nd Deb. Stock.....	78 —81	6 3 6	Mar, Sept	..	..
		Edmundson's Elec. Corp. Ord.....	⅛—⅜	..	Jan, July	..	..
		Do. 6 per Cent. Cum. Pref.....	2 —2⅛	..	May, Nov	2⅛	2⅛
		Do 4½ per cent. 1st Mort. Deb. (red.)..	84 —87	5 3 4	Jan, July	86	84
		Electric Construction Co.....	⅜—⅞	..	Jan, July	⅛	..
		Do. 7 per Cent. Cum. Pref.....	1⅛—2⅛	7 0 0	July	..	..
		Do 4 per Cent. Perp. 1st Mort. Debs...	73 —76	5 2 8	Jan, July	..	..
		General Electric (1900) 5% Cum. Pref. ..	8½—9	5 14 0	June, Dec	..	..
		Do. 4 per Cent. 1st Mort. Debs.....	88 —93	4 8 6	Mar, Sept	..	..
		Henley's Telegraph Works Ord.....	12½—12⅞	5 16 6	Feb, Aug	..	..
		Do. 4½ per Cent. Pref.	4½—5⅛	4 10 0	Feb, Aug	5⅛	4⅛
		Do. 4½ per Cent. 1st Mort. Deb. Stock	10b —108	4 4 6	Mar, Sept	..	..
		India Rubber, Gut. Per., &c., Works....	11½—13½	6 0 0	Feb, Aug	12½	..
		Do 5 per Cent. Cum. Pref.	10 —10⅜	4 18 0	..	10	..
		Do. 4 per Cent. Debs. (red.)	96 —96	4 1 6	April. Oct	..	..
		International Elec. Construction Co.....	⅛—⅜	..	April	..	..
		Richardsons, Westgarth & Co., Ltd. Ord.	⅜—½	..	Nov	..	..
		Do. 6 per Cent. Cum. Pref.	⅜—½	..	May, Nov	..	..
		Do. 4½ per Cent. Perp. Deb. Stock....	77 —80	5 14 6	Jan, July	..	..
		Simplex Conduits 6 per Cent. Cum. Pref.	4½—5	..	..	..	..
		Telegraph Construction & Maintenance..	35 —37	5 17 0	Mar, July	36½	35½
		Do. 4 per Cent. Deb. Bonds (1909)	99 —101	4 0 0	Jan, July	..	..
		Vickers, Sons & Maxim, Ltd., Ord.....	2⅛—2⅜	4 14 C	..	2⅛	2⅛
		Do. 5 per Cent. non-Cum. Preference..	1⅛—1⅜	4 3 0	..	1½	—
		Do. 5 per Cent. non-Cum. Preferred ..	109 —112	4 11 0	..	..	..
		Do. 4 per Cent. 1st Mort. Db. Sk. (red)	99 —101	3 19 2	June, Dec	100½	..
		Do. 4½ per Cent. 2nd Mort. Deb. (red.)	102½—104½	4 7 0	June, Dec	104½	104
		Do. 5 per Cent. 3rd Mort. Debs Scrip...	103 —105	4 16 0	..	..	103½
		W. G. White & Co. 6% Cum. Pref.	14½—15½	7 14 10	..	..	..
		Willans & Robinson Ord.....	⅛—¼	..	Apr, Oct	..	..
		Do. 6 per Cent. Cum. Pref.....	⅛—¼	..	Apr, Oct	..	..
		Do. 4 per Cent. 1st Mort. Debs.....	65 —65	6 3 0	May, Nov	..	—
		Telegraphs.					
		Amazon Telegraph	7⅛—7½	..	June, Dec	7⅛	7⅛
		Do. 5 per Cent. Debs. (red.)	98 —100	5 1 0	Jan, July	99½	..
		Anglo-American	68 —70	4 7 0	F,My,Ag,N	68½	68
		Do. Preferred	112½—113½	5 6 0	F,My,Ag,N	114½	113
		Do. Deferred	25⅜—25½	5 16 6	F,My,Ag,N	26⅛	25½
		Commercial Cable 4 per Cent. Deb. Stk...	87½—89½	4 10 6	Jn,Ap,Jy,O	88½	88½
		Cuba Submarine Ord.	10 —10⅛	4 17 6	Feb, Aug	..	..
		Do. Preference 10 per Cent.	17½—18⅛	5 13 0	Feb, Aug	..	..
		Direct Spanish Ord.....	3¾—4	5 0 0	April, Oct	..	..
		Do. 10 per Cent. Cum. Pref.....	8½—8⅞	5 16 0	April, Oct	..	..
		Do 4½ per Cent. Deb.	9⅞ —101	4 10 0	Jan, July	..	..
		Direct United States Cable xd and bonus	7⅞—8½	5 19 6	Ja,Ap,Jy,O	8½	7⅞
		Direct West India Cable 4½% Rg.Do.(rd.).	98 —100	4 11 0	June, Dec	..	..
		Eastern Ordinary xd and bonus	136 —139	5 12 4	Ja,My,Jy,O	138½	136
		Do. 3½ per Cent. Pref. Stock.....	84 —85	4 2 10	Ja,My,Jy,O	85¼	84½
		Do. 4 per Cent. Mort. Deb. Stk. (red.)..	101½—103½	3 18 0	May, Nov	103	102½
		Eastern Extension	13⅛—13½	5 4 0	Ja, Ap, Jy,O	13½	13⅜
		Do. 4 per Cent. Deb. Stock	101 —103	3 18 3	Feb, Aug	..	..
		Eastern and S.Af., 4% Mauritius Sub.Debs	99½—101½	3 19 0	May, Nov	..	..
		Great (of Copenhagen), with Coupon 83 ..	31 —32	5 14 3	Jan, July	..	..
		Indo-European	56½—58½	5 6 6	May, Nov	..	..
		Jackay Companies Common	92 —94	5 5 0	Ja,Ap,Jy,O	..	..
		Do. Preference	75 —77	5 2 0	Ja,Ap,Jy,O	..	..
		Marconi's Wireless Teleg. Co.....	2 —2⅛	..	April	2⅛	2
		Pacific & Europe'n Tel. 4% Guar. Dbs. (red.)	99 —101	4 0 0	June, Dec	..	..
		Pacific Coast of America	1⅛—1⅜	5 0 0	May	..	..
		Do. 4 per Cent. Debs.....	97½—99½	4 1 6	Jan, July	..	..
		Post India & Panama	2⅜—2⅝	4 18 9	May, Nov	2⅝	2⅛
		Do. 6 per Cent. 1st Pref.	10½—10⅝	5 16 6	May, Nov	10½	10⅛
		Do. 6% 2nd Pref.	9¼—10⅛	6 0 0	May, Nov	..	..
		Do. 5 per Cent. Debs.	101 —103	4 18 0	Jan, July	..	..
		Western Telegraph.....	13⅜—14⅛	5 1 1	Mr,Jn,O,D	14⅛	13⅜
		Do. 4 per Cent. Deb. Stock (red.).....	99 —101	4 0 0	June, Dec	—	—
		Western Union Telegraph, $1,000 4% Bds	105 —108	3 14 0	..	—	—
		Do. $1,000 4½% Fdg. & Rl. Est. Gd. Bnds	99½—102¼	4 9 3	..	—	—

Shrs	Last Dividend	Name	Price Wed., July 26.	*Rate per cent. Yielded.	Dividend Due.	Business Week to July 26. High- est.	Low- est.
		Telephones.		£ s. d.			
100	2$	Amer. Telephn. & Telegh. Cap. St.	142 —144	5 12 2	..	..	..
..	4%	Do. Coll. Trust $1,000 4 per Cent. Bds	94 —96	4 4 0	Jan. July	..	..
..	4%	Do. 4% Cons. Bonds 1936	114 —116	3 9 0	..	..	..
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101 —103	4 17 0	Mar, Sept	..	..
5	3/0	Chili Telephone	7 —7⅛	4 4 0	August ..	7⅛	7
1	0/7½	Monte Video Telephone Ord.....	⅛—1	6 0 0	Nov	⅛	⅛
1	0/6	Do. 5 per Cent. Pref.	⅛—⅞	5 11 0	May, Nov	⅛	⅛
St.	6%	National Co. Pref. Stock.....	105 —106½	5 12 8	Feb, Aug	106½	105
St.	6%	Do. Def. Stock	122 —125	4 16 0	Feb, Aug	123½	118
10	6/0	Do. 6 per Cent. Cum. 1st Pref.....	10 —10⅜	5 11 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.....	10 —10⅜	5 11 6	Feb, Aug	—	..
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.....	5⅛—5⅜	4 8 11	Feb, Aug	5⅛	..
St.	3½%	Do Deb. Stock 3½ per Cent. (red.).....	98 —100	4 1 0	June, Dec	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.).....	98 —100	4 1 0	Jan, July	..	..
..	4½%	New York Telephone Co. 30 yr. Bnds.....	102½—103½	4 7 0	..	..	..
1	1/0	Oriental	1⅛—1⅜	4 18 0	April, Oct	..	..
1	0/7½	Do 6 per Cent m. Pref.	1⅛—1½	4 16 0	April, Oct	..	..
St.	4%	Do. 4 per Cent. Red. Deb. Stock.....	87½—89½	4 10 6	Jan, July	..	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. (red.)	98½—100½	4 10 6	Jan, July	..	..
5	3/0	United River Plate Ord. (1—150,000) ex rts	7⅛—7⅜	5 2 6	July	7⅛	..
5	14½%	Do. (150,001—190,000) ex rights.....	7⅛—7⅜	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅛—5⅜	4 13 0	June, Dec	..	..
St	4½%	Do. 4½ Deb. St. Red.....	101 —103	4 8 0	Jan, July	..	..
		Financial, Investment, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref...	4 —4½	7 1 0	Jan, July	..	..
10	6/0	Globe Telegraph & Trust	10½—11½	5 6 8	Sp,DcMrJu	11⅜	10
10	3/0	Do. 6 per Cent. Pref.	13 —13½	4 10 9	Sp,DcMrJu	13⅜	13
10	6%	Submarine Cables Trust (Cert.).....	131 —134	4 9 6	April, Oct	132	..
		Colonial and Foreign Electric Railways, Tramways, &c.					
5	2/9	Anglo-Argentine 5% Cum. 1st Pref.	5⅛—5⅜	4 17 6	April, Oct	5⅜	..
5	2/9	Do. 5% Cum. 2nd Pref.....	4⅞—5⅛	5 : 6	Jan, July	4⅞	..
St.	4%	Do. 4% Deb. Stock	94 —96	4 3 4	June, Dec	95	..
St.	4½%	Do. 4½% Deb. Stock	99½—101½	4 9 6	..	101	..
St.	5%	Do. 5% Deb Stock	100 —102	4 19 0	..	101	..
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)....	102 —104	4 17 6	Jan, July	103½	103
5	4/0	Brisbane Electric Trams. Invest. Ord	6⅛—6½	6 1 0	May	6⅛	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5⅛	4 17 6	May, Nov	5	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Certs.....	102 —105	4 7 0	Jan, July	100½	..
St.	8%	British Columbia El. Rly. Df. Ord.	141 —145	5 12 0	Mar, Sept	142	14
St.	6%	Do. Pref. Ord. Stock	120 —124	4 16 10	May, Nov	122	12
St.	5%	†Do. 5% Cum. Perp. Pref. Stock.....	106 —109	4 13 0	Jan, July	107	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.....	100 —103	4 7 6	April, Oct	102½	..
100	4½%	†Do. Vancouver Power Debs.	101 —104	4 3 3	Jan, July	..	..
St.	4½%	Do. 4½% Perp. Con. Deb. St.	101½—103½	4 2 6	..	103½	10
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	100 —102	4 18 0	Mar, Sept	92	..
St.	6%	Buenos Ayres Port & City Tram, 1st Mt. Deb. Stock	95 —99	6 4 0	Feb, Aug	98½	..
		Calcutta Tramways (1 to 137,610).....	5½—6½	4 19 6	Mar, Sept	6⅛	..
100	2/6	Do. 5 per Cent. Cum. Pref.	5 —5½	4 17 6	Jan, July	5⅜	..
1	4½%	Do. 4½% 1st Deb. Stock (red).....	102 —105	4 5 9	Jan, July	103½	10
St.	5%	Cape Electric Tram Shares	⅛—¼	..	..	..	..
5	1/3	City of Buenos Ayres Trams Co. (1904) Sh.	5⅛—5⅜	4 5 0	F,My,A,N	5⅜	..
St.	4%	Do. 4 per Cent. Deb. Stock.....	94 —97	4 4 0	June, Dec	..	..
..	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.....	95 —100	5 2 6	May, Nov	..	..
1	5%	†Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	99 —102	4 18 0	Feb, Aug	..	..
100	5%	Hong Kong Tramways Co. 5 per Cent. 1st Mort. Debs.	77 —81	6 6 6	June, Dec	80	..
		Kalgoorlie Elec. Trams Sh.	⅛—⅜	..	..	..	..
100	5%	Do. 5 per Cent. "A" Deb. Stock.....	92½—95½	5 4 6	Jan, July	..	..
5	6%	Do. 6 per Cent. "B" Ditto	63 —67	8 15 0	Jan, July	..	..
5	0/6	Lisbon Elec. Trams. Ord.	1 —1⅛	4 16 0	July	..	..
100	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1⅛	4 16 0	Jan, July	..	..
St.	5%	Do. 5 per Cent. Reg. Mort. Debs.	97 —101	5 1 0	Jan, July	..	..
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	95 —98	5 3 6	Jan, July	91	..
100	5%	Manaos Trams and Lt. Co. 5% Debs	90 —93	5 9 6	..	83	..
100	5%	Manila Elec. Ry. $1,000 Gold Bonds.....	99½—101½	5 0 0	Feb, Aug	122½	1
100	$1½	†Mexico Trams Co. Com. St.	120 —122	5 14 6	..	95½	..
100	5%	Do. Gen. Con. 1st Mort. 5% Gold Bds.	98 —99	5 1 6	..	100	..
100	5%	Do. 6% 50 yr. Mort. Bds	99 —101	6 : 3	..	..	..
St.	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922) (Nos. 601 to 2,000))	102 —104	4 7 0	Feb, Aug	..	..
100	5%	Do. do. (Nos. 1 to 4,630)	102 —104	4 7 6	..	..	..
1	0/6	Perth Elec. Trams Ord.	⅛—¼	2 7 2	May	..	..
St.	5%	Do. 1st Mt. Db. Stock	101½—103½	4 17 6	Jan, July	..	..
5	3/0	Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	5⅛—5⅜	5 8 0	—	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. Stk.	97 —100	4 11 6	—	119	..
100	$1½	†Rio Janeiro Tram, Lt. & P. Co.....	116½—117½	4 5 3	—	102	..
100	5%	Do. 30 yr. Gold Bnds.	101 —102	4 18 0	—	98½	..
100	5%	Do. 50 yr. Mt. Bnds	97½—98½	5 2 0	—	..	..
100	$2½	Sao Paulo Tramway, Light & Power Co. $100 Stock	183 —186	5 7 3	..	184	..
100	5%	Do. 5 per Cent. 1st Mt. $500 Db.	103 —105	4 15 3	June, Dec	103½	1
100	4½%	Toronto Ry. Co 1st Mt. 4½% Ster. Bonds	93 —100	4 10 0	Feb, Aug	..	..
		Colonial and Foreign Electricity Supply, &c.					
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.....	5⅛—5⅜	5 8 0	Mar, Sept	..	..
10	5/0	Bombay E.S. & T. 6% Cm. Pf.	11 —11⅛	5 5 6	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stk. (red).....	96½—98½	4 12 6	Jan, July	97½	..
5	5/0	Do. 5 per Cent. 2nd Mort. Deb. Stock..	96½—98½	5 2 6	..	7	..
100	5%	Calcutta Elec. Supply Ord.	6⅛—7⅛	5 19 6	April, Oct	6⅛	..
100	$3½	Do. 5% Cum. Pref	4⅛—5⅛	4 13 0	..	97½	..
100	5%	Calgary Power Co. 5% 1st Mort. Bnds....	96 —98	5 2 0	—	111	..
100	7/2½	Canadian Gen. Elec. Co. Com. St.....	111 —116	6 3 6	—	124½	..
100	$3½	Do. 7% Cm. Pf. Stock	120 —123	5 15 0	—	..	..
100	5%	Castner Electrolytic Alkali Co. (of U.S.A.) 1st Mort. Stl. Debs.	94 —99	5 3 6	Jan, July	88½	..
500	5%	Elect. Development Co. of Ontario.....	86½—88½	5 11 6	..	..	..
St.	5%	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	84½—87½	5 4 0	Jan, July	..	..
10s	..	Indian Elec. Sup. & Trac. Co.	1 —1⅛	..	..	..	..
1	0/7½	Kalgoorlie Elec. Power & Ltg. Ord.	⅛—¼	..	..	..	..
100	5%	Do. 6 per Cent. Cum. Pref.....	⅜—½	8 6 6	April, Oct	102½	..
5	5%	Kaministiquia Power Co. 5% Gold Bnds...	101 —103	4 18 0	..	..	..
St.	$1	Madras E. S. Corp. Ord.....	2⅛—3⅛	..	..	..	..
500	$3½	Melbourne E. S. Co. Cons. Ord. St.....	36 —41	..	..	38	..
500	5%	Do. 5% 1st Mortg Deb. Stock	95 —97	5 4 0	—	96½	..
St.	$1	Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	88 —89	5 12 4	—	89½	..
500	$3½	†Mexican Lt. & Power Co. Com. St.	85 —88	4 12 0	—	88½	..
100	5%	Do. 7% Cum. Pref. St.	109 —111	6 7 0	—	99	..
100	5%	Do 5% 1st Mort. Gold Bnds.	93 —99	5 1 6	—	90½	..
100	8/2½	†Monterey Rly. L. & P. Co. 1st Mort. Db. Sk.	89½—91½	5 10 6	F,My,A,N	175	..
St.	5%	Montreal Lt. Ht. & Power Co. Cap. St.	173 —177	5 14 0	..	44	..
St.	£10	Northern Lt. Power & Coal 5% Gd. Bds ..	44 —46	5 9 0	April	..	..
St.	6%	River Plate Electricity Co. Ord. Stk.	218 —228	4 7 9	May	..	..
100	5%	Do. 6 per Cent. non-Cum. Pref. Stk. ..	107 —114	5 5 0	Jan, July	120½	..
100	5%	Do. 5 per Cent. Deb. Stock	101½—103½	4 17 6	..	..	..
100	$1½	†Shawinigan Water & Power Co. Ca.....	119½—121½	4 2 3	Jan, July	104½	..
..	4½%	Do. 5 per Cent. Bds.	107 —109	4 12 6	..	..	..
..	4½%	Do. 4½ Per Con. Mt. Db. St.	103 —105	4 6 0	..	..	..
..	4½%	Toronto Power Co. 4½% Db. St.	99 —101	4 8 0	..	..	..
..	4½%	Victoria Falls Power Co. Pref.	¾ —1	..	Jan, July	..	..

* No allowance has been made for accrued interest or redemption. † Ex Dividend. ‡ The London Stock xchange Committee have

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COMMERCIAL AND INDUSTRIAL SUPPLEMENT.

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NOTES.

Metallic Conductors without Resistance.

A most important experimental confirmation of the theory that at the absolute zero of temperature certain metals possess an infinite conductivity has just been announced by Prof. H. Kamerlingh Onnes, an abstract of whose Papers dealing with the subject appears elsewhere in this issue. The resistivity of metals is one of the physical properties which appeal very strongly to the electrical engineer, since it is of great practical importance in his work. The experimental results obtained by Prof. Onnes a few years ago, when he examined the behaviour of pure gold down to temperatures as low as −262°C., though affording proof that the resistivity continued to decrease as the temperature diminished, did not indicate at all clearly that zero resistance would be reached, seeing that at this very low temperature, only 11 deg. from the absolute zero, the resistance had merely fallen to one four hundredth of the resistance at 0°C., while in the case of mercury the resistance at −258·8 deg. C. was as much as $\frac{1}{1\,2\,9}$th of the resistance at 0°C. Since then, by the exercise of great care and improvement in experimental detail, together with the use of liquid helium, the lowest temperature reached has been pushed still further towards the absolute zero; and at 3°K., that is, 3 deg. on the Krypton thermometer, the resistance of a column of mercury has been found, by several different electrical methods, to be less than *one ten-millionth* of the resistance which it had at 0°C.

It can hardly as yet be realised what this result means to physical science, and to electrical science in particular. An almost limitless field of new experimental research is opened up, while many older problems can be re-attacked with greater probability of success. It is indeed a fascinating idea to think of working with an electrical conductor which has no such property as resistance. Prof. Onnes points out that films of metal of molecular thickness could be employed, and heavy currents could be carried by these without any heating occurring. Many other uses suggest themselves; for instance, solenoids of fine wire could be employed with enormous currents, and in this way magnetic fields greatly surpassing in intensity any which have been obtained hitherto will be realisable. On the other hand, there will be effects obtained, due to this practically infinite conductivity, which will be equally interesting to observe, though of less importance. One of these is the production of eddy currents in a mass of metal. Where the conductivity is so excessively high it is obvious that, even when any change in the current is made exceedingly slowly, there will be an enormously increased effect produced by the minute E.M.F.'s set up by the change. The number of examples could be extended indefinitely, but enough has been said to show that we are on the threshhold of a quite new, and we believe fruitful, field of research.

The Ways of Municipalities.

We fear that the impression will soon be current that municipalities have no conscience, whatever other virtues they may possess. Last week the West Hartlepool Corporation appealed against a judgment in regard to the West Hartlepool tramways. Some little time ago the Corporation exercised their option to purchase, and agreed to pay the sum of £12,963 which had been fixed by the arbitrator as the value of the undertaking. Subsequently it seems, however, the Corporation discovered some slight

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irregularity in the legal position of the Tramways Company and then saw that there might be some ground on which only part of the undertaking need be purchased; in other words, they saw a chance of getting the tramways at a very much reduced price owing to a possible legal technicality in regard to the title. The original action was given against the Corporation, but they thought fit to appeal. During the appeal Lord Justice BUCKLEY asked whether they wished to get out of their bargain, and the reply to this was that the Corporation wished the Company to get out of the streets because they were trespassers. To the lay mind this seems a little difficult, but counsel suggested that they could take their tramways away with them. Lord Justice VAUGHAN-WILLIAMS very pertinently remarked that it was the duty of a public body to act reasonably in the public interest, and Lord Justice FLETCHER MOULTON remarked that it really was scandalous that because the Company had made some irregularity in the formal transfer the Corporation should suggest that they had the power to take the undertaking and not to pay anything for it.

WE are glad to see that the appeal failed, for it appears to us that public bodies, such as municipalities, have a very distinct duty to the public at large. If such bodies have no sense of equity and are prepared to indulge in what is, to all intents and purposes, robbery when so permitted by legal technicalities, then the private individual who has not a sufficiently long purse to fight in such matters will very soon come off badly. Indeed, there is an increasing feeling at the present time that the interests of the private individual are by no means safeguarded when he is dealing with public bodies, and this is a feeling which is unfortunate from every point of view.

Electricity in Textile Mills.

THE problem of how best to apply the electric motor to the driving of textile machinery is one that still awaits a full and sufficient solution. This is to some extent, we think, due to the fact that many of the underlying peculiarities of this class of machinery are not fully grasped by those responsible for designing the motor. The mill is one of those places that require special treatment; it is not, for instance, sufficient just to put down a motor and connect it up to the looms by belt or direct. Further, we cannot help thinking that the report of the Bradford Engineering Society, published rather less than two years ago, had a detrimental effect on the progress of the electric drive. The report, it will be remembered, was not altogether favourable to the motor, and the feeling of uncertainty was further increased by the aspersions cast on the actions of the Committee by several of its members. At the time we said: "We think that the report is a move in the right direction, but we cannot help feeling that the Committee have not gone into the matter far enough, and we hope the question of individual drive will be considered in a later report."

SINCE that date very little has been done by any properly constituted body, though the introduction of the electric motor into textile mills has been making as satisfactory progress as could perhaps be expected. Now, however, as will be seen by reference to the next column, a further attempt is to be made to solve the question of the suitability of various forms of driving for mill work. A Joint Committee has been appointed, consisting of 14 members of the Textile Institute and 14 members of the Institution of Electrical Engineers, the latter being mainly drawn from the Lancashire and Yorkshire districts. Mr. THOMAS ROBERTS, of Darwen, a prominent cotton manufacturer, is the chairman, and Mr. S. L. PEARCE is the vice-chairman. We are pleased to note that experiments are to be made with the various forms of drive proposed, and it is to be hoped that, as a result, some conclusive data will be obtained. The deliberations should result further in an increase of mutual knowledge among the various members of the Committee, a state of things which is always greatly to be desired.

Rating of Telephone Property.—It is stated that Dundee Council have raised the question whether the Government should make provision, in the Telephone Transfer Bill or otherwise, to compensate local authorities for the loss of rates hitherto paid by the National Telephone Co., as such payments will cease automatically when the telephones become Crown property. In Dundee the valuation upon which such rates are payable is £5,682.

Applications for Extension of Patent.—A petition will be heard on or after November 27th for extension of the term of patents numbered 1,020 and 1,022 of 1898, granted to Chas. Hy. Stearn for "Improvements in the manufacture and production of a filamentary material and fabrics therefrom" and "Improvements in the manufacture and production of a material in film sheet or web form." The High Court has fixed November 20, 1911, as the day on or after which the petition of the Automatic Electric Co., of Chicago, for the extension of the term of Letters Patent No. 809/1898, will be heard.

Electricity in Textile Mills.—According to our Manchester contemporaries a meeting of representatives of the Textile Institute and of the Institution of Electrical Engineers was held at the Textile Institute, Manchester, on Friday last, to consider the question of conducting an investigation into the application of electricity in textile mills, both in the United Kingdom and abroad.

After discussion it was decided to form a joint committee to be known as the "Textile Mill-driving Committee," the committee to consist of 14 representatives of the Textile Institute and a similar number of representatives of the Institution of Electrical Engineers. Mr. Thomas Roberts, cotton manufacturer, Darwen, was unanimously elected chairman of the committee and Mr. S. L. Pearce, Manchester city electrical engineer, vice-chairman. The members of the committee elected were as follows:—*Textile Institute representatives:* Messrs. J. R. Denison (Messrs. Denison, Preusner & Co.), Bradford; B. Palin Dobson (Messrs. Dobson & Barlow), Bolton; E. P. Fry, of Shipley, Yorkshire; Oscar Hall (Messrs. Robert Hall & Sons), Bury; Frederick Leeves (Messrs. Platt Bros. & Co.), Oldham; Frederick Lye (Messrs. John Bright & Bros., Rochdale; F. Nasmith (Messrs. Nasmith & Barraclough), Manchester; W. J. Orr (Messrs. Orr & Sons), Castleton, Rochdale; Thomas Robert (Messrs. Whipp Bros. & Co.), Darwen; Fletcher Robinson, of Manchester; George B. Storie, of Rochdale; F. W. Whittaker (Messrs. Whittaker & Pendlebury), Bradford; and T. Rowland Wollaston, of Manchester. *Electrical Engineer representatives:* Messrs. H. Dickinson, R. K. Morcom, A. B. Mountain, S. L. Pearce, J. S. Peck, W. N. Rogerson, J. Schofield, J. F. C. Snell, C. D. Taite, S. J. Watson, H. Wilson, W. B. Woodhouse, Dr. R. Pohl and Prof. Schwartz.

There had been, it was pointed out, previous attempts to make investigations into the relative merits of electricity, steam, gas, &c., for motive power, but there had been no such representative committee appointed to examine into the question as that now brought together. The investigation which the joint committee proposes to conduct will be thoroughly exhaustive in character. It will not be a matter altogether of receiving evidence, but experiments will be carried out with the object of making the final report of real value to everybody concerned in the question of power supply.

Cable Interruptions.

	Date of Interruption
Assab—Perim	July 8, 1909
Latakia—Palura	May 26, 1910
Zanzibar—Mombasa	July 11, 1911
Guam—Manila	July 12, 1911
Cayenne—Salinas	July 29, 1911

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Diesel Locomotive for Prussian State Railways.—It is stated from Berlin that a 1,000 H.P. locomotive driven by a Diesel engine has just been set to work on the Prussian State Railways. The drive is direct to the axles and the outward appearance is similar to that on an electric locomotive. Nearly £12,000 has been spent in experimenting with this engine.

Employment of Electrically-worked Street Washers.—According to the "Commercial Motor," since the municipality of Schönberg, near Berlin, took over the duty of keeping the streets clean steady progress has been made in the direction of mechanical propulsion. Within the next few weeks the borough will possess a dozen electrically-driven street washers, and the year 1912 is to see all horse-drawn dust carts, street sweepers and water carts replaced by the mechanical type. A special depôt is being constructed for the housing of these automobiles.

The Manufacture of Nitrates in Italy.—According to "The Times" Engineering Supplement, for some time past experiments have been in progress at Legnano with the object of utilising the excess power generated during the night and certain hours of the day by a large hydro-electric station. The aim was to produce nitric acid and nitrates from the nitrogen of the air, and it is considered that the problem has now been satisfactorily solved. Some months ago the employment of 4,000 kw. for the production of nitric acid was initiated, and now preparations are being made for the use of 9,000 kw. more, energy being supplied by the Società Lombarda per Distribuzione dell' Energia Elettrica at a pressure of 50,000 volts.

The German Wire Industry.—"The Engineer" states that the convention between German manufacturers of wire and kindred goods, the formation of which was beset by many difficulties, has collapsed, and ceased its functions at the end of June, the members being now free to contract for sales for delivery. This result is regretted by many of its members, as the convention worked fairly satisfactorily. The stumbling block in the way of a renewal of the union was the absolute refusal of several works to submit to any limitation as to production. This, on the other hand, was insisted upon, as far as the large manufacturers were concerned, as a mere price agreement handicaps certain works. Of late there had also been certain price reductions which were at variance with the agreement. The cessation of the convention will probably have an unfavourable effect upon works which make wire rods.

35-ton Slow Speed Electric Locomotive.—According to the "Electric Railway Journal" the Woodward (Ala.) Iron Works have ordered a 35-ton low speed locomotive from the General Electric Co. It will be used for hauling coke. The locomotive will make about 50 trips a day, the approximate length of each trip being 2,000 ft., and it will handle 20 tons of coke per trip. There is a 3 per cent. gradient about 300 ft. long. The locomotive has an all-steel frame and cab, and an arch bar truck. It is equipped with single unit control. Current is supplied at 220 volts. The motor equipment consists of four motors furnished with gearing giving a ratio of 4·25 to 1. The motors can develop a tractive effort of 10,000 lb. at the rated one-hour load with a speed of six miles per hour. A bow trolley on the cab roof will make contact with a trolley wire having a variation in height from 15 ft. to 22 ft. above the rail heads. The fuse box and lightning arrester are also mounted on the cab roof.

Crystal Palace School of Engineering.—The terminal award of certificates and prizes at this school took place on Wednesday last, when Major Sir T. B. Robinson, Agent-General for Queensland, presided in the absence of Sir A. Fitzroy. Sir Thomas said there was plenty of room in Queensland for the engineer and he trusted that some day-students of that school would find it a profitable field for their energies. There were still questions awaiting solution by engineers. These included the discovery of improvements in the methods of propelling ships, while the development of the oil engine offered a wide field for men with brains. Another branch of work which deserved great attention was the improvement of workmen's tools. In conclusion, he gave some advice to students. It was really astonishing, he said, what duffers could do if they only stuck to it. It was his advice to duffers, among whom he reckoned himself, that all their difficulties would yield to persistent effort. It was the fellow who did everything a little more thoroughly and more quickly than other people who went ahead. The certificate of honour was awarded to Mr. J. M. S. Trelawney.

United States Government Control of Electricity in Mines.—An electrical section of the Bureau of Mines in the United States was organised in 1909 to investigate the conditions under which electricity is used underground, and to obtain data which would be of assistance to state officials who had charge of the regulation and inspection of mines, and also to those who used or manufactured electrical mining equipment. This section is part of the mining experimental station of the Bureau at Pittsburgh. Technical paper No. 4, issued by the Bureau of Mines, sets forth in detail the purposes and equipment of the section, and gives an account of some of its work. Preliminary investigations on incandescent lamps were made, which showed that certain sizes of lamps when broken ignite surrounding explosive mixtures of gas and air, and tests are now being made to determine the factor of safety of such lamps as have not caused ignition in previous experiments. An investigation is also being carried on relating to the action of acid mine water upon the insulation of electrical conductors. Tests have recently been finished of electric fuses with relation to their use in mines. Seven different types of enclosed fuses were tested by being mounted in standard clips or holders and placed inside a gas-tight, boiler-iron box, which was provided with means of admitting gas of any desired composition. The results of the tests were as follows:—(1) One or more sizes of all the brands of fuses tested ignited the gas, although in varying degrees. Two brands ignited the gas at once; three brands ignited it in more than 50 per cent. of the tests. (2) The principal sources of danger in fuses as they are now designed is the device for indicating whether or not a fuse has acted. (3) Danger from blowing at the relief ports will probably develop in some, and possibly in all, brands if tested with sufficient current.

Current Topics.

Subjects of current interest dealt with in this issue include the following:—

In an article on the "Hunting of Direct-current Interpole Motors" Dr. E. Rosenberg discusses in detail the effect of brush currents on the field of a motor, and their tendency to cause hunting.

In a Paper, of which we give an abstract, read before the Institution of Mechanical Engineers, Mr. E. Huber-Stockar gives an account of the present position of electric traction in Switzerland.

At the same meeting Mr. H. Zoelly read a Paper, of which we give an abstract, describing the development of that type of steam turbine which bears his name.

We conclude our description of the electrical equipment of ss. "Olympic" and "Titanic."

Prof. H. Kamerlingh Onnes has recently conducted some researches into the resistance of metals at the temperature of liquid helium. The results of these researches are given in this issue, and are notable for the fact that figures closely approaching zero resistivity were obtained.

Mr. F. Schubeler, in a Paper (of which we give an abstract) read at the recent meeting of the Institution of Mechanical Engineers, deals with the design of Diesel engines for various classes of work.

A single-phase locomotive which has been built by the A.E.G. for the Midi Railway of France is described.

Details are given of the electrical equipment at the Sneyd Colliery, Burslem.

A meeting of the Miners' International Association was held last week, when Mr. Albert Stanley, M.P., returned to his attack on the employment of electricity in mines. Mr. Stanley has a somewhat lurid vocabulary. He described electricity as "That new, weird and intangible, but very terrible factor," and in another part of his remarks as "that new and terrible agent." His hearers must have felt their very blood curdle.

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An abstract is given of the accounts of the L.C.C. tramways for the year ended March 31.

Legal.—On Monday Mr. Justice Swinfen Eady delivered judgment in the action brought by the Thermal Synd. (Ltd.) against Silicaware (Ltd.) for an injunction to restrain an infringement of letters patent relating to the working of silica. His lordship held that plaintiff's patent was valid, and he granted an injunction.

Companies' Meetings, Reports, &c.—At the meeting of the London, Brighton & South Coast Railway Co. on Wednesday Mr. C. Macrae stated that the results of the electrical working had been very satisfactory and that the number of passengers carried was increasingly steadily.

Particulars are given of the proposals for the re-arrangement of the capital of the British Electric Traction Co.

PERSONAL NOTE.

Prof. S. P. Thompson, F.R.S., has left London for Germany to represent the Royal Society at the centenary celebrations of the University of Breslau.

APPOINTMENTS VACANT AND FILLED.

The Borough of Aston Manor Education Committee require an assistant master qualified to teach electrical and mechanical engineering and mathematics (especially practical). Duties to begin Sept. 18. Commencing salary £160. Applications to Mr. H. Norwood, Director of Education, Education Offices, Aston Manor, near Birmingham, by Aug. 28. See also an advertisement.

Applications are invited for the post of assistant to the wireless telegraph expert on H.M.S. "Vernon," Portsmouth. The appointment will be for three years. Salary £300 per annum. Applications to the Secretary of the Admiralty, Whitehall, London, S.W. See also an advertisement.

An electrical fitter is required for Gold Coast Government Waterworks. Salary £300, rising to £350 by annual increments of £10. Applications to the consulting engineers, Messrs. Middleton, Hunter & Duff, 17, Victoria-street, London, S.W. See advertisement.

A demonstrator or assistant lecturer is required in the Physical Laboratory of University College, Reading. Commencing salary £125. Particulars from the Registrar. Applications by Aug. 28.

A chief assistant electrical engineer is wanted for Batley electricity works. Salary £130. Applications to the Town Clerk by Aug. 9.

The Rochester, Chatham and Gillingham Joint Higher Education Sub-Committee require a lecturer for engineering subjects. Commencing salary £150. Forms of application from Mr. R. L. Wills, M.A., 2, Military-road, Chatham, to whom applications by Aug. 9.

Dundalk Urban Council have appointed Mr. Percy A. Spalding, A.M.I.C.E., A.M.I.E.E., of Galway, out of 93 applicants, as resident engineer of their electricity undertaking, at a salary of £250 per annum. Mr. Spalding will act as clerk of works during the erection and equipment of the works, for which a loan of £20,000 has been obtained. Mr. Spalding was selected by the Council by 10 votes to 2.

Mr. Geo. Hy. Woollatt, principal of the Victoria Science and Technical Schools, Worcester, has been appointed (out of 75 applicants) head master of the new Workington Technical College, at a salary of £500 per annum.

Dr. Ing. M. Kloss, M.I.E.E., of Siemens Bros. Dynamo Works, Stafford, has been appointed professor of electrical engineering at the Technical University, Berlin-Charlottenburg.

Southampton Council have appointed Mr. A. Bennett, of the Westminster Electric Supply Corpn., as commercial engineer, or head of the business development department of the electricity undertaking at a salary of £225 per annum, rising at the end of 12 months to £250 per annum.

INSTITUTIONS AND SOCIETIES.

National Electric Light Association.—It is stated that the date for the next convention has been fixed for June 10 to 14, 1912. The meeting will be held at Seattle.

EDUCATIONAL NOTICES.

University of London.—In the faculty of engineering at University College an entrance scholarship, value 120 guineas, instituted by a fellow of the college, will be competed for in September. Candidates must have passed the University of London matriculation, or an examination accepted in lieu thereof.

The post-graduate courses for next session, which will commence on Monday, Oct. 2, will include: "The Photomicrographic Study of Metals," by Mr. F. Bacon; "The Design and Calculation of Aeroplanes," by Mr. A. R. Low; "Steam Turbines," by Mr. W. J. Goudie; and "Some Modern Methods in the Design of Structures," by Mr. H. P. Philpot.

University of Sheffield.—The faculty of applied science comprises the departments of engineering, metallurgy, coal mining and architecture. The courses in engineering or in metallurgy extend over three years and prepare respectively for the degree of B.Eng. or B.Met. of the university. The lecture courses commence on Oct. 4, and the technical laboratory courses on Sept. 18. Prospectuses and other particulars from the registrar, Mr. W. M. Gibbons.

University of Durham.—Armstrong College, Newcastle-upon-Tyne.—The 1911-12 session commences Sept. 25. There are departments of mechanical, marine, civil and electrical engineering, naval architecture, mining, metallurgy, agriculture, pure science, arts and letters. Particulars may be obtained from the secretary, Mr. F. H. Pruen, M.A.

University of Bristol.—The results of the examinations for the degrees and certificates in the faculty of engineering at this university are as follows:—

M.Sc., A. J. Margetson. B.Sc., C. E. Holloway and A. J. S. Pippard (first class honours in Civil Engineering); J. N. B. Bhaskar and T. H. P. Veal (second class honours in civil engineering); R. Woodward (2nd class honours in mechanical engineering); W. C. Batta, W. G. Came, N. L. Mehta, G. M. Sury and A. W. Thomas (pass degree in civil engineering) J. W. Burrough and L. G. Parkinson in mechancial engineering, and C. G. Bevan and E. J. Hamlin in electrical engineering. University certificates in civil engineering were granted to two students, in mechanical engineering to one, in electrical engineering to two, and in motor car engineering to one student.

City and Guilds (Engineering) College.—This college, which was formerly known as the Central Technical College of the City and Guilds of London Institute, forms the engineering section of the Imperial College of Science and Technology. The courses of instruction in civil and mechanical engineering are conducted by or under the supervision of Prof. W. E. Dalby and those in electrical engineering are under Prof. T. Mather.

The courses of instruction include (*a*) diploma courses for the Associateship of the City and Guilds of London Institute in civil and mechanical and electrical engineering; (*b*) special or partial courses for a limited number of students whose knowledge and experience enable them to engage in research work or to omit part of the regular diploma courses; and (*c*) advanced specialised courses for post-graduate and other duly qualified students. Prospectuses which contain full particulars of the entrance examination and courses of instruction, scholarships and fees may be obtained from the Secretary of the College, Exhibition-road, London, S.W.

City and Guilds Technical College.—This college provides a scientific training for students preparing to become electrical and mechanical engineers or chemists, and for engineering pupils who desire to supplement their practical training by a two years' course of instruction in the principles of engineering science. There are also arrangements for three-year courses in engineering. Particulars at the college, Leonard-street, City-road, London, E.C., or from the City and Guilds of London Institute, Gresham College, Basinghall-street, London, E.C.

Brighton Municipal Technical College.—Two students (W. W. Stainer and C. L. Weiss) of this college, who have this session been attending the third year engineering day course, have passed the Examination of the London University for the degree of B.Sc. in the faculty of Engineering.

Mr. Stainer, who is not yet 19 years of age, is the son of the head-master of the Municipal Secondary School (Mr. J. Stainer, B.A.) and received the whole of his education in Brighton, passing the matriculation and intermediate science examinations from the Secondary School, and the intermediate engineering last year at the Technical College. Mr. C. L. Weiss is 19 years of age, and was educated privately and attended evening classes at the Technical College for the intermediate engineering examination, which he passed in 1910, since when he has been a full time day student at the College.

ARRANGEMENTS FOR THE WEEK.

THE LONDON ELECTRICAL ENGINEERS.

Officer Commanding, Col. H. M. Leaf.

The following orders have been issued:—

Head-quarters will be closed for instruction, but will be open for office work as under until further orders:—

Monday to Friday, 10 a.m. to 4 p.m.

Saturday, 10 a.m. to 12 noon.

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ELECTRIC TRACTION IN SWITZERLAND.*

BY E. HUBER-STOCKAR
(Of Zurich).

Summary.—The author deals with the reasons why electric traction has not made so much progress in Switzerland as would have been expected, seeing that this was one of the earliest countries to adopt electric locomotion. He also gives full details of the various railways at present being electrically worked in Switzerland and finally of two schemes that have been prepared for the electrical operation of the St. Gothard Railway.

The reason for dealing more particularly with railway electrification in Switzerland is not because great progress has been made in that country, but because of the more general interest it presents in comparison with many other countries. First of all, it may be astonishing that progress has not been greater than it actually has been, when one considers that Switzerland has to buy all its coal from foreign countries and has a large amount of water-power still waiting for utilisation.

Secondly, Switzerland electrified certain railways at a comparatively early date, and might be expected to have gone onward on this basis, especially as applied electricity is highly developed in the country generally.

Thirdly, the very reason of the progress being less than may be expected adds greatly to the interest of the problem as presented in Switzerland. There are no such sections of railways as the terminal section of the New York Central and Hudson River and the New York, New Haven & Hartford Railways, where steam has played out its rôle on account of the frequency of the trains or the smoke nuisance, and no such sections as the London Bridge and Victoria line of the London, Brighton & South Coast Railway, where over a million passengers were recovered that had been better served by competing tube and street railways. Though railway electrification in Switzerland is inseparable from the use of water-power, and though this use is evidently beneficial to the financial situation of the country in the long run, still it must, for various reasons, be done in such a way as not to disturb the balance of traffic receipts on the one hand and the operating expenses and interests on loans on the other. The time is still far distant when even State railways are built, as the principal roads have been built all through the country and over the mountain passes, simply because they are necessary, no matter whether they are remunerative or not. Railways are still built and operated for the greater part, and most fortunately so, even by the State, on the basis of commercial enterprise. Therefore, more particularly in Switzerland, where railways are, on the whole, not making profits because of cost of construction, heavy gradients, rather irregular traffic, short average distance of travel, high wages, low fares and so on, the problem of railway electrification is in every case a problem mainly of general economics of railway operation, since the technical problem has admittedly been satisfactorily solved.

The electrifications of importance that have hitherto been or are being carried out are almost all either of an experimental or preparatory character, or were brought about by considerations not directly or purely economical. In Switzerland the economy of operation is having decisive weight and makes the problem difficult, while, as in other countries, the railways already electrified, or about to be electrified in the near future, are such that the smoke nuisance would render steam working almost prohibitive, as in the case of the Simplon tunnel, or where the capabilities of steam are nearly exhausted, as in the case of the St. Gothard railway.

The author then describes in detail several typical Swiss railways which are electrically worked. These include the Burgsdorf-Thun line which was the first railway of any importance to use three-phase current. The energy consumption on this line is 68 watts per ton-kilometre (109 watts per ton-mile). Another interesting line is the Freiburg-Murton-Ins Railway, which was the first normal gauge railway to undergo electrification and the only normal gauge line in Switzerland to be carried out on the continuous-current system with third rail. A pressure of 500 volts is used. The consumption is about 34 watts per ton-kilometre (57 watts per ton-mile), exclusive of losses in the converting machinery and batteries. The Simplon tunnel, Seebach-Wettingen, Seetal and the Martigny-Orsières lines, details of all of which have from time to time appeared in THE ELECTRICIAN, are next described in detail. Some figures with regard to these systems are given in the accompanying tables.

The author next describes the Bern-Lötschberg-Simplon (B.L.S.) Railway, which will give direct access to the Simplon tunnel from the north-west of Switzerland. It will be of prime importance to international traffic, as it considerably shortens the distance between certain important places and Milan.

The new railway is noted for its tunnel under the northern main range of the high Alps. It is still in course of construction, and will be opened probably within about two years from now. Its length is 60·4 km. (97 miles), and it will resemble the St. Gothard railway a good deal in general character. The smoke from steam locomotives would, as it does on the St. Gothard, interfere with the comfort of travellers, and inconvenience the operation. Electric traction has therefore been, from the very beginning, a *sine qua non* with the B.L.S. Co.

The access to the northern end of the new railway from the system of main lines is a railway from Spiez, on the Lake of Thun, to Frutigen, 13·4 km. (21 miles) long and operated by steam since 1901. This railway will be or has already been absorbed, and has been equipped electrically by the B.L.S. After careful consideration, single-phase traction with high voltage (15,000) and low frequency (15) was adopted, and towards the end of 1908 orders were placed for equipment. The electrification of this short line of access was undertaken as an experiment, and was completed at the end of 1910. The success of this electrification has been such that it will be extended to the whole line and on the same system. For this reason, the Spiez-Frutigen electrification deserves special consideration as the first section of a main-line railway which furnishes in certain respects exactly the problem of the St. Gothard electrification, namely, long heavy gradients of 2·7 per cent., and heavy trains requiring 2,000 H.P. and more to drive them.

The load on the power stations will be of a similar character to that of the St. Gothard railway, with reference to which some remarks will be made later.

The energy for the present service on the Spiez–Frutigen line is supplied from the Bernische Kraftwerke company's works near Spiez. Here there are, for the special purpose of the Spiez-Frutigen system, two hydro-electric sets of 3,200 H.P. each, generating single-phase alternating current at a voltage of 16,000 and a frequency of 15, that is to say, a current which requires no further transformation nor conversion to suit directly the motor cars and locomotive equipments.

The power supply from the Kanderwerk is but temporary. The Bernische Kraftwerke have started the operation of a new power station at Kandergrund, a place situate near the B.L.S. Railway, not far from its centre of maximum power demand on the northern slope. In the future, therefore, the supply of power to this part of the line will be from this station, and the southern slope will be supplied from another company's works on the rivers Rhône or Lonza.

The overhead line is of the most substantial design, all the supports being of steel. The devices for regulating the supply of current to the individual sections of the line or railway stations, the devices for protection from lightning and the instruments for measuring or electrical supervision purposes are very complete, in a style that may appear luxurious in comparison with most other electric railways, but is, in reality, only up to the general installation standard on main-line railways. The driving equipment consists of three motor cars and two locomotives, one of 2,000 H.P. and the other of 1,600 H.P. capacity. The contacts are of the pantograph pattern and are capble of self-adjustment between heights of 4·8 m. and 7·05 m (16 ft. to 23 ft.).

The large gears of the 2,000 H.P. locomotive are novel. They are of the **N** spiral type, the pitch circle diameters being 1,453 mm. and 447 mm. (5 ft. and 17·8 in.). They are automatically machine cut, and run without noise and vibration. They engage with each other on surfaces much in excess of those of any other type of gear wheels, and run at a circumferential speed of 22 m. (72 ft.) per second. The maximum surface-pressure on the teeth is 260 kg. per sq. cm. (3,800 lb. per sq. in.).

The Oerlikon locomotive nearly reaches that limit where the use of gearing affords a decided advantage over connecting rods direct from the motor. Such gearing does away with all reciprocating parts within the cabin of the locomotive and makes the balancing easy. For low-speed locomotives, especially goods engines, with a large pull on the draw-bar and comparatively little horse-power, the gearing is of decided advantage in many respects and is likely to be commonly adopted. The locomotive built by the A.E.G. for the B.L.S. is of a design novel in electric traction on Swiss railways. It has the motors placed high in the cabin, and cranks on the motor shafts, from which motion is transmitted to the horizontal connecting rods of the driving wheel axles, by means of a system of intermediate connecting rods that reciprocate up and down. The geared and the gearless type of locomotives will probably have each a more or less distinctly defined field of application of their own, though there is a field accessible to

* Abstract of a Paper read at the Meeting of the Institution of Mechanical Engineers at Zurich.

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Table I.—*Principal Electrically-operated Railways in Switzerland.*

Railway, name and short name (if any).	Year of opening railway.	Electric operation since	Gauge of track in metres.	Length in km. of railway operated electrically.	Electrical system, frequency, and line voltage.	Type of line.	Motor vehicles.
Orbe-Chavornay	1894	1894	1·435	3·9	d.c. 500	Overhead trolley	Motor cars (trailing).
Stansstad-Engelberg	1898	1898	1·000	22·5 1·5 rack	3-ph., 33 ∾, 750-800	Overhead bow	Motor cars (trailing), loco. on rack section.
Burgdorf-Thun., B.T.B.	1899	1899	1·435	40·2	3-ph., 40 ∾, 750-800	Overhead bow	Motor cars (trailing), and locomotives.
Freiburg-Murten-Ins., F.M.A.	1898	1902	1·435	32·3	d.c., 750-800	Third rail	Motor cars (trailing).
Gruyère, chemins de fer electriques	1901-04	1901-04	1·000	43·5	d.c., 750	Overhead bow	Motor cars (trailing).
Montreux-Berner-Oberland, M.O.B.	1901-05	1901-05	1·000	62·4	d.c. 750-1,000	Overhead bow	Motor cars (trailing).
Martigny-Châtelard	1906-08	1906-08	1·000	20·5, 2·5 rack	d.c., 750	Third rail (overhead bow on public road)	Motor cars (adhesion and rack mixed).
Simplon Tunnel	1906	1906	1·435	21·7	3-ph., 16 ∾, 3,000	Overhead bow	Locomotives.
Seebach-Wettingen	1881	1907	1·435	19·4	1-ph., 15 ∾, 15,000	Overhead bow and rod	Locomotives.
Locarno-Bignasco	1907	1907	1·000	27·1	1-ph., 20 ∾, 5,000	Overhead rod	Motor cars (trailing).
Bellinzona-Mesocco	1907	1907	1·000	31·3	c.c., 1,500	Overhead bow	Motor cars (trailing).
Seethalbahn	1883-1906	1910	1·435	54·2	1-ph., 25 ∾, 5,000	Overhead bow	Motor cars(trailing).
Martigny-Orsières	1910	1910	1·435	20	1-ph., 15 ∾, 8,000	Overhead bow	Motor cars (trailing).
Berninabahn	1908-11	1908-11	1·000	67	d.c., 1,200	Overhead bow	Motor cars (trailing).
Spiez-Frutigen, Lötschberg	1901	1910-11	1·435	13·4	1-ph., 15 ∾, 15,000	Overhead bow	Locomotives, motor cars (trailing).
Rhätische Bahn	1903-04 1912	1912 1912	1·000	12·6 49·1	1-ph., 15 ∾, 10,000	Overhead bow	Locomotives.

both types, where the one as well as the other represent more or less a compromise. Practical experience alone can determine which type will be the more advantageous to adopt in each individual case. The question of gears is more or less a question of electric traction motors proper and cannot be discussed except by going into the very details of their design, nor without considering certain particular features of the different systems of motors and their adaptability to high or low speeds. It need only be said here that, in general, with low speed, and more particularly with powerful low-speed locomotives, the adoption of gears permits of a more satisfactory design, construction and operation, while, with all high-speed locomotives, the elimination of gears is advantageous. The locomotives of the B.L.S. are neither high or low speed. Their maximum power is, however, developed on up gradients at decidedly low speeds, while higher speeds occur on the down slopes with no load, and on the gentle slopes or levels when the motors are not fully loaded. It will be highly interesting and important to compare the two radically different types of locomotives on the B.L.S., where there are reasons for the existence of each.

The transformers on the locomotives were arranged to permit of working at half contact line voltage, if, for one reason or another, 15,000 should have proved impracticable. In fact, at the time when all trains were steam-driven and the electric vehicles were being run for experimental purposes, some flashing over from smoky insulators in the Hondrich tunnel, just beyond Spiez, was observed, and a periodical cleaning of the insulators was carried out. Since steam traction has been discontinued, no such trouble has been experienced, and it is expected, as the smoke nuisance will not exist on the new line, that the voltage will not require reduction.

This Paper would be incomplete if it did not consider, in addition to the electric railways working or building, the work, more scientific than practical, done for years in Switzerland, with a view to elucidating the general railway electrification question under Swiss conditions, to determining by investigation the merits of the several systems and the cost of plant and of operation; and to making a fair comparison between steam and electricity for definite lines or groups of lines. Work of this kind has been and is still being done by a society with the title Schweizerische Studiencommission für electrischen Bahnbetrieb. It was founded on the initiative of Dr. E. Tissot, and under the auspices of the Society of the Electricians of Switzerland. It was constituted and commenced work in 1904, and railways, electricity works, manufacturing firms and scientific men are represented.

To-day it is easy to state the principal conclusions of the Studiencommission as to systems of electric traction, and more particularly as to the standardised frequency of the alternating current used for electric traction on the railways mentioned in this Paper. These conclusions are exhibited in their essence and in practice in the series of railways described, beginning with the Seebach-Wettingen experimental line and ending with the Engadine line of the Rhätische Bahn now in course of construction.

It is, of course, difficult to estimate the value and influence of the Studiencommission. It is, however, certain that the collaboration in the Commission of representatives of interests in competition with each other in business has acted beneficially so as to make the question of system less one of competition and more one of general scientific and common practical interest.

After having arrived at the conclusions set forth the Studiencommission made different comparative projects with special reference to the St. Gothard Railway as a railway, which, before all others in Switzerland, appeared to be ready for electrification. For more than a hundred kilometres it goes through country with tens of thousands of hydraulic horse-power doing nothing but embellishing the landscape, while the locomotives with their smoke detract from its beauty. The traffic on the St. Gothard line has developed to the limits of steam operation. There is a continuous and permanent demand for more powerful engines for dealing on the long and heavy gradients with a tonnage comparable with that of the busiest flat country main-line railways. The railway, with a length of 274 km. (170⅛ miles), presents the problem of electrification in a still more general way than does the Lötschberg, firstly because there the creation of the power stations forms part of the problem, and secondly because the more or less level sections north and south of the steep slopes require high speeds.

The Studiencommission has, in addition to certain alternative suggestions, prepared two complete projects with great care and attention, as if they were tendering for a contract. The first project, called "1904," has been prepared for the sole purpose of a fair and complete comparison of actual steam traction with hypothetical electric traction under known precise conditions of traffic. The second project, called "Future," pre-supposes a traffic considerably in excess of the traffic of 1907, which holds the record up to now, at the same time adopting speeds and accelerations more or less in excess of those accepted for the hypothetical electric traction of "1904."

The author thinks it sufficient to make a few indications, some of which have been published by the Schweizerische Studiencommission,* to give an idea of what would have been required in 1904 and what is expected in the "future" for electric traction on the St. Gothard Railway. Of the figures that follow, those in parentheses refer to the "future." The speeds of express trains are from 85 (90) km. per hour on the level to 40 (50) on 1 in 40 gradient. The speeds of passenger trains are 55 (75) to 26 (50), and those of freight trains 38 (45) to 18 (35) km. per hour.

* "Mitteilungen der Schw. Stud. Com. für Electr. Bahnbetrieb," published by Prof. Dr. W. Wyssling, Rascher & Co., Zürich, 1906-1908.

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Table II.—*Capacity and Cost of Construction of Railway, Rolling Stock, Traffic, Operation.*

Year 1909.	Orbe—Chavornay.	Stansstad—Engelberg.	Burgdorf—Thun.	Pich-burg—Martigny—Ins.	Gruyère chad. f. el.	Montreux—Oberland bernois.	Martigny—Châtelard.	Simplon Tunnel.	Seebach—Wettingen.	Locarno—Bignasco.	Bellinzona—Mesocco.	Seethal.	Martigny—Orsière, 1910.	Bernina.	Lötschberg. Spiez—Frutigen.	Lötschberg. Frutigen Brig.—(Building.)	Engadin (Rhätische Bahn). (Building.)	For comparison. St. Gothard, 1908.	For comparison. Federal‖ Railways, 1909.
Gauge, in metres	1·435	1·000	1·435	1·435	1·000	1·000	1·000	1·435	1·435	1·000	1·000	1·435	1·435	1·000	1·435	1·435	1·000	1·435	1·435
Length, in kilometres	4·0	22·5 (rack 1·5)	40·2	32·3	44·3	62·1	20·6 (rack 2·48)	21·7 (tunnel 19·803)	19·4	27·3	31·5	54·2	19·2	60·6	13·4	60·1	62·33	272·5 con'd 275·2 op'd	2,626 con'd 2,672 op'd
Minimum radius of curves, metres	200	50	250	200	100	40	80 (rack 70)	300	300	100	80	160	180	50	300	300	100	280	300‖
Level sections, % of total .	7·4	8·85	24·33	26·5	19·2	9·93	34·99	4·30	15	29·94	24·6	7·19	17·3	3·0	13·6	8·3	35·8	20·48	26·97
Gradient maximum, % ...	25	25	25	30	30	67	70 (rack 200)	10	12	33	60	37	35	70	15·5	27	25·0	25—27	26
Gradient, average of sections not level, %	10·9	(rack 250)	15·86	12·9	15·8	34·45	4·87	...	4	13·64	29·29	14·55	27·4	40·6	12·9	23·2	14·35	11·76	8·49
Kilometres above 1%	1·4	11·5	21·0	10·9	21·9	48·6	10·8	...	above 4% : 11·1	9·4	15·9	31·2	14·6	58·8	8·7	25% 12·4	...	98·6	539·5
Kilometres above 3%	...	... (exc. rck)	...	...	...	29·9	8·9	...	above 6% : 7·4	0·9	6·9	9·9	9·9	58·8(27·0 with70%)	...	20% 23·0	above 20% : 67·1	6·1	[elec. 1,178 st'm‡
Number of electric locos....	...	4 (rack)	2(1911:3)	...	...	...	...	4	3	...	...	14	...	...	(1911) 2		169	1,178 st'm‡	1 steam
Number of motor cars.....	4	10	6	4	13	24	12	...	...	3	6	10	...	15	(1911) 3		11	169	17,805
Average number of trains .	4	26	17	5·5	10·4	14·5	2·9	...	...	1·8	2·6	10·8	...	5·9	3·3		...	...	1 steam
	29·15	22·16	20·79	15·65	19·40	16·44	10·11	passgr.11 freight 5	16	13·74	12·86	24	...	...	24	30	...	2,100	17,805
Av. no. of axles p.r train...	4·16	5·32	9·67	8·71	8·91	10·55	4·78	*	‡84 in 1908	5·28	7·35	10·51	(1910)...	11·07				43·63	33·47‖
Trains, km. run, 1,000)	43	186	311	189	312	378	78	1464†	...	140	150	379		71				32·01	30·72‖
Passengers carried, 1,000...	105	200	656	277	365	443	231			188	229	786		211				1,449	31,547‖
Tons of all kinds of freight, 1,000	46	13	103	77	51	41	3			13	9	132		47				1,051	76,285‖
1,000 fr. per kilometre :—																			
Cost of purchase of land ...	11	18	24	12	20	28	27			6	6	14		28				57	48‖
Cost of elec. line equipment	9	12	21	14	13	16	23			10	11	...		...				...	(400 apprx. SimplonTL.)
Cost of buildings & station machinery	5	26	15	18	36	43	29			9	15	16		19				78	45‖
Cost of constructn. complete.	96	106	133	99	136	221	292			77	77	105		232				810	316‖
Cost of rolling stock, locomotive and other	24	23	20	15	130	34	65			9	15	23		26				95	66‖
Cost of railway complete...	125	133	162	122	179	272	418			94	99	136		273				1,083	426‖
Total amount.....	505	3,007	5,534	3,291	7,093	16,894	8,664			2,573	3,125	7,365		3,664				296,823	1,023,089
Total operating expenses...	48	223	420	243	333	519	207			96	103	644		150				5,124	99,757‖
Total receipts from traffic .	71	401	564	298	406	1,236	542			136	143	732	8·48688	254				8,510	158,745‖

Section of the Federal Railways. — No individual figures on hand. — Experiments in 1906 and 1907. Regular operation from 1 Dec., 1907, until May, 1909. — Figures not on hand. — Statistical figures not on hand. — In course of construction. — In course of construction. — In course of construction.

* Maximum weight of passenger trains 30t., of freight trains 400-600 tons without locomotive. ‡ 60-200 tons without locomotive. § Excluding Brunig but including St. Gothard.
† From June 1, 1908, until May 31, 1909; 22,933,000 ton-km. without and 32,458,000 with locomotive weight. ‖ Excluding St. Gothard and Brunig.

The starting horse-power is limited to 1·25 times the normal horse-power on 1 in 40 gradients; acceleration as such is, however, limited to 0·15 (0·20) m/s/s with expresses, to 0·15 (0·30) m/s/s with passenger and to 0·10 (0·10) m/s/s with goods trains. The weights of the trains will not increase much in future; they were, in 1904, with express trains on most sections 200-220 (280-350 maximum) tons, with passenger trains 120-180 (240-350 maximum), with goods trains on the main line 350-380 (500 maximum), and on other sections 270-350 (330-370 maximum) tons, all exclusive of locomotives. In fact, goods trains being moved by two eight-wheelers at the head and one at the rear are a usual sight on the slopes. There will be required about 19 (21) motor cars of 200-500 (400-1,100) H.P., about 9 (15) fast locomotives of 1,800 (2,200) H.P., and about 37 (38) goods locomotives of 800 (1,500) H.P.

Single-phase alternating current is adopted of a frequency of 15 and of a voltage of 15,000 for the supply to sections immediately adjacent, and of perhaps three times the pressure for transmission to transformer sub-stations supplying the sections remote from the power station. There will be two (three) power stations required, the most important one situated a little below Airolo, near the Ambri-Piotta station, having the Lake Ritom, into which other lakes drain, as an enormous water-power storage basin. The power required for traction is considerable and the load line has enormous peaks. The total power developed on the tread of the locomotive vehicles on the whole line will amount to about 14,000 (22,000) H.P. maximum and about 5,000 (10,000) H.P., on the average. On individual sections the proportion of maximum to average is, however, less favourable. There will be required from the hydraulic turbines 27,000 (46,000) H.P. maximum. There will be installed in two (three) power stations hydro-electric machinery of about 50,000 (95,000) H.P., including stand-bys. It is expected under "future" conditions to tap eventually about 26,000,000 m.³ of water from the Lake Ritom, temporarily of course, leaving but 6,000,000 m.³ in it, and thus lowering its surface more than 30 m. (100 ft.) a procedure which is of no material inconvenience in the case of a mountain lake with precipitous shores. In the case of the St. Gothard, the Studien-commission has considered the employment of accumulator batteries for storing power locally, independently of the site of the water power stations, and for providing for the local peak loads. These have, however, been found uneconomical, on account of the greatly increased expenditure for sub-station machinery, plant, maintenance and operation. Water storage was resorted to exclusively for providing for peak loads, because it was indispensable in allowing

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for the seasonal variations of fresh water supply in relation to the seasonal variations of traffic. While the storage for the latter purposes requires large reservoirs, storage for the former purposes requires reservoirs comparatively small. In the case of the St. Gothard the power station at Ambri-Piotta, with the Lake Ritom and its 36,000,000. m.³ on a level more than 800 metres above, as a storage basin will provide for the seasonal variations and other large variations not of a simple peak character, while small basins near the other (others) power station (power stations) will deal with the peak loads in their particular district of supply.

The total cost of the new plant, new rolling stock and accessories, alterations on telegraphs, telephones and signals, supervision, interest during construction, will amount to about 44 (67) million francs. These figures give an idea of the magnitude of this electrification which is expected to be started before long. The Federal Railways, a few years ago, acquired ample water powers in five places along the line.

In conclusion, railway electrification has made, and is making, noteworthy rather than rapid progress in Switzerland. As regards system, single-phase current of low frequency (15) and high-line voltage, varying from 5,000 to 15,000 according to circumstances, is being sanctioned by experience and by authority. An important electrification of a new line, the Lötschberg, is about to be carried out in the immediate future, and a still more important one, that of the St. Gothard Railway, is well prepared for by the investigations of the Schweizerische Studiencommission für electrischen Bahnbetrieb and by the Federal Railways' purchase of water powers along the line. Railway electrification and electric traction on a large scale is in a great measure a problem of power station economics. The heavy variations of load, and those due to rapid seasonal variations in the fresh-water supply, make, under Swiss conditions, water storage desirable and even imperative. All electrification in Switzerland is directly connected with the utilisation of water power.

STEAM TURBINES.*

BY H. ZOELLY
(of Zurich).

Summary.—The author gives an historical account of the progress in theory and practice made in the design of the type of steam turbine that bears his name. He also shows how certain details must be modified in accordance with the work the turbine is likely to be called upon to do.

Based chiefly upon his experience gained with water turbines, the author commenced about 15 years ago to experiment with steam turbines, considering that the steam turbine would resemble in most respects the water turbine, only using a much higher working pressure. For this reason he was guided in adopting the pure action or impulse type of steam turbine. As is almost invariably the case when experimenting with any new kind of machinery, it is very difficult to combine satisfactorily the ideas of the theoretical mind with those of the practical. In order to attain the most favourable efficiency, a very high circumferential speed of the rotor is necessary; but to obtain this result within economical limits is the chief difficulty of the constructor, whose contention was that a heavy and solid design was absolutely necessary for safe working as well as being a cheaper form to construct.

The first machine was designed on the radial-flow principle. In its design too much regard was paid to practical constructive considerations and too little to theory. The second machine was constructed on the same principle; the blades, however, were curved in preference to the previously flat ones, the steam in this case impinging against the rotor blades in a radial direction. This form of construction constituted quite a considerable improvement upon the earlier design. Already at this period it was found advisable to divide the drops in pressure into at least six and sometimes 10 to 12 separate pressure stages. The diameters of the rotor wheels were also increased towards the exhaust end in order to cope better with the increased volume of the steam.

As already observed, the principle of the action (impulse) type has been recognised and adopted from the commencement as being the best; the only alterations that took place for some time were in the manner of guiding the steam on to the wheels. The first wheels were constructed after the manner of the Pelton wheel, against which the steam impinged tangentially, after being directed through separate guide channels. It soon became apparent, however, that after impact, the steam became too dispersed. It was then decided to expand the steam axially instead of radially, at first only in the low-pressure stages, but subsequently, throughout the whole turbine. This method had formerly been adopted by English constructors as being the most practical.

What has always been, and is still, the most characteristic feature of the Zoelly turbine, is the designing of the runner wheels and guide channels in the diaphragms; the former of which, in spite of the high factor of safety that is necessary, are enabled to be given a relatively high circumferential velocity. Consequently greater latitude is permissible in regard to the number of pressure stages, and the speed of the steam in each. From the beginning two very characteristic diagrams were prepared (Figs. 1 and 2). These diagrams were obtained from theoretical calculations, which have since been proved by actual results. Fig. 1 contains as abscissæ the pressure relation per stage $p1/p2$ (where $p1$ = the initial steam pressure in atmospheres absolute, and $p2$ = the final steam pressure in atmospheres absolute in the same stage), and as ordinates the requisite number of stages for steam expanding from 10 atmospheres to 0·1 atmosphere (that is, 142 lb. per square inch to 1·42 lb. per square inch), assuming that the pressure ratio $p1/p2$ of the steam both before and after passing through the guide channels is constant. Fig. 2 shows the steam velocity resulting from pressure ratios given for various initial pressures. For a ratio pressure fall of $p1/p2 = 1{\cdot}732$, it follows from Fig. 1 that about nine stages are required. For relative pressure falls, where $p1/p2 = 1{\cdot}1, 1{\cdot}2, 1{\cdot}3, 2{\cdot}1, 3, 4{\cdot}6$, the requisite and corresponding

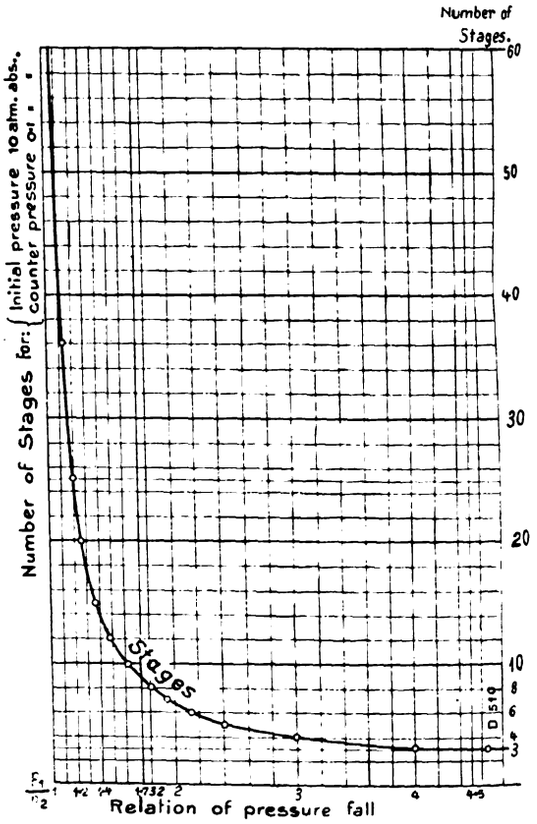

FIG. 1.—CURVE SHOWING NUMBER OF STAGES REQUIRED FOR EXPANDING FROM 10 ATM. TO VARIOUS FINAL PRESSURES.

number of stages for a total expansion of from 10 to 0·1 atmospheres absolute would be 42, 25, 18, 6, 4 and 3 respectively. Should we assume a greater ratio of pressure fall than 1·732 for the purpose of saving stages, then, in order to have only four stages, it is necessary to have a ratio pressure fall of $p1/p2 = 3$.

From Fig. 2, for a mean initial pressure of $p1 = 4$ atmospheres absolute, the steam velocity would be equal to 577 metres (1,893 ft.) per second. This steam velocity, on the other hand, would require a circumferential speed of about 250 metres (820 ft.) per second (for a simple velocity wheel) in order to obtain a reasonable efficiency. Again, if we take a smaller ratio of pressure fall than 1·732 1, for instance 1·30/1, the necessary number of stages would be increased from 9 to 18, that is, exactly double. Such a turbine would be far too complicated and expensive; besides it would not then work with perfect economy owing to the greater friction of the runner wheels and the greater length of steam passage.

After carefully weighing up all these considerations, the ratio pressure fall of $p1/p2 = 1{\cdot}73$ was chosen, as representing the best combination of efficiency and practical constructional economy. This pressure fall is called the "critical fall," and when this is exceeded then the resulting steam velocity approaches the velocity of sound.

* Abstract of a Paper read at the meeting of the Institution of Mechanical Engineers at Zürich.

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Directly one wishes to utilise a substantially higher pressure fall per stage, then it becomes necessary to depart from the simple construction of parallel guide nozzles which is peculiar to the Zoelly turbine, so that, instead of the simple parallel nozzle, one must adopt the expanding or "Laval" type of nozzle. The reason that Parsons employs such a small pressure fall per stage is entirely to keep as low as possible the losses through leakage which are unavoidable in reaction turbines.

The author does not intend to deal more fully with the various stages of improvement, which from that period have been solely of a constructional character, but will describe the Zoelly turbine as manufactured at the present time by Messrs. Escher, Wyss & Co. For turbines of 3,000 revs. per min. eight stages are usually employed; for 1,500 revs. per min., 12 stages; and for 1,000 revs. per min., 16 stages. The first diaphragm plate (guide wheel) of the high-speed turbines has nozzles which extend for a portion of the circumference only in the bottom half of the diaphragms; whilst in the other diaphragms, the nozzles usually extend completely round the circumference. In the case of large units, however, steam is admitted through channels extending completely round the circumference for all stages.

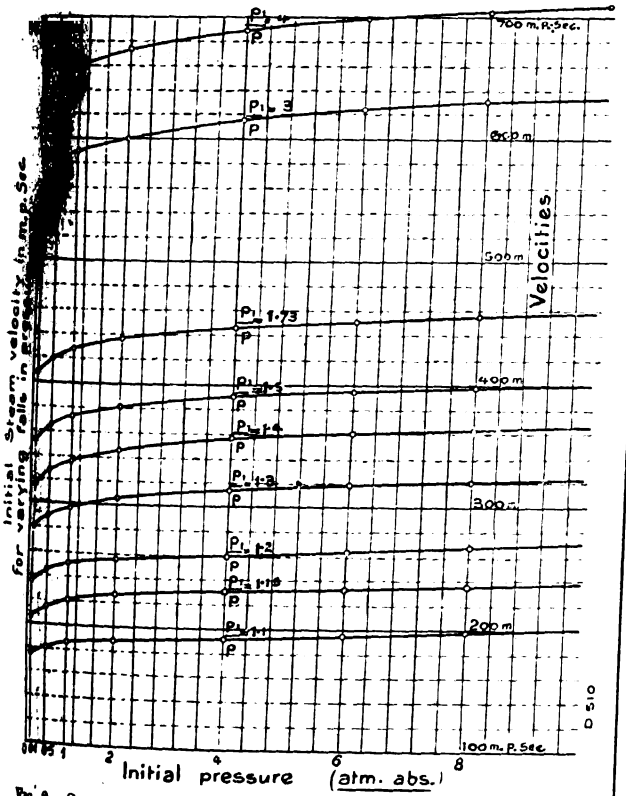

FIG. 2.—CURVE SHOWING STEAM VELOCITIES FOR VARYING INITIAL PRESSURES.

The governing is effected simply by throttling the live steam and not by varying the number of channels through which the steam is admitted. The throttle valve is actuated by oil under pressure in a small cylinder (servo motor) by hydraulic action, the oil being supplied by a small pump directly driven from the shaft. This is the same form of governing as that which has been found to work so successfully for water turbines, and is now being universally adopted by nearly all the different makers of steam turbines on the Continent. Its inherent advantages are that it is extremely simple and reliable, and, contrary to fears expressed by some engineers, this method of governing works particularly economically at partial loads, as is seen from the results shown later. This, however, is only possible when simple velocity wheels are used in connection with parallel guide nozzles throughout the whole turbine, and provided that the most favourable choice is made in regard to the subdivision of stages. The conclusion arrived at is that the compound velocity wheel design is only advisable in special cases, as, for instance, in shipbuilding, where a lower propeller speed is absolutely necessary.

The chief reasons against the adoption of the compound wheel design in the case of stationary turbines are the lower steam efficiency and the necessity of a complicated governing apparatus, in order to obtain a favourable consumption at partial loads. In this type of turbine the governing has to be carried out by controlling the number of nozzles through which the steam enters. Experience has shown that this method does not satisfactorily answer practical requirements—*i.e.*, continuous safe running. Besides, the governing is not so accurate and is less suitable for running in parallel with other machines.

The author would especially like to mention that for many years he has experimented with turbines designed with a high steam velocity and compound wheels. The many series of tests which he has carried out at different periods have all gone to show that under the most favourable conditions it is not possible to obtain a higher thermal efficiency with compound velocity wheels than 58 per cent., whereas with a turbine designed with entirely simple velocity stages it is possible to obtain an efficiency of 73 per cent. and more. If, therefore, in an impulse turbine it is found necessary to employ a combination design of compound and single velocity stages for such special cases as exceptionally large units for land purposes, or where it is necessary to work at low revolutions, the comparatively poor efficiency of the high-pressure compound velocity stage or stages must be compensated for as well as is possible by obtaining a relatively higher efficiency in the subsequent low-pressure single-velocity stages. For this purpose almost as many pressure stages must, on the whole, be provided for as in a design employing only single velocity stages.

It is often objected to in the Zoelly turbines that too high a pressure and temperature exist in the first pressure stage; against this it must be said that even with Zoelly turbines likewise large pressure falls can be utilised for the first stage even within comparatively economical limits, provided that the lower pressure or subsequent stages have a correspondingly lower pressure fall and thus consequently work with a higher efficiency. In this way it happens that by the application of live steam at about 170 lb. per square inch and 570°F. (300°C.) the pressure and temperature of steam after expansion in the first stage is 70 lb. per square inch and 465°F. (240°C.). Such conditions, as regards the solidity and durability of the casing and its stuffing boxes are nowadays easily mastered by steam turbine builders.

ELECTRICAL RESISTANCE OF PURE METALS—ESPECIALLY MERCURY—AT LIQUID HELIUM TEMPERATURES.*

BY H. KAMERLINGH ONNES.

In continuation of the author's work on liquid helium temperatures, he now indicates that liquid helium has been successfully transferred from the apparatus in which it was liquefied to a helium cryostat connected with the former. It has also been found that liquid helium is an excellent insulator—a fact which had not been definitely established previous to this. This behaviour of liquid helium is of considerable importance, since the resistance measurements were made with bare wires.

The experiments were concerned mainly with the resistance of gold and of mercury at helium temperatures. As regards the former metal, the resistance of pure gold is already inappreciable at the boiling point of liquid helium as was confirmed by determining the resistance of a gold wire in liquid helium and then estimating the resistance by extrapolation on the analogy of the platinum measurements. Within the limits of experimental error, which are, however, greater for this experiment than was the case for the others, the estimated resistance is supported by the direct measurement. The conclusion that the resistance of pure gold vanishes at helium temperatures is hereby greatly strengthened.

In the case of mercury, a formula has previously been deduced by the author for the resistance of solid mercury, this formula being based upon the idea of resistance vibrators. From this it was concluded: (1) That the resistance of pure mercury would be found to be much smaller at the boiling point of helium than at hydrogen temperatures, although its accurate quantitative determination would still be obtainable by experiment; (2) that the resistance at that stage would not yet be independent of the temperature; and (3) that at very low temperatures, such as could be obtained by helium evaporating under reduced pressure, the resistance would, within the limits of experimental accuracy, become zero.

The experiments have completely confirmed this forecast. While the resistance at 13·9°K. (13·9° on the Krypton thermometer) is still 0·034 times the resistance of solid mercury extrapolated to 0°C., at 4·3°K. it is only 0·0013, while at 3°K. it falls to less than 0·0001.

* From the "Proceedings" of the Koninklijke Akademie van Wetenschappen, Amsterdam. Slightly abbreviated.

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The results just given were founded on a single experiment and were, therefore, communicated with all reserve.

The author has now, in a later communication, made a more accurate experimental examination of the resistance of pure mercury at liquid helium temperatures. The measurements were made with the differential galvanometer by the method of overlapping shunts (Kohlrausch) and also by the method of the measurement of current strength and of potential difference. By this it is confirmed that at 3°K. the value of the resistance sinks to below 0·0001 times the value of the resistance of solid mercury at 0°C. extrapolated from the melting point. But from the present measurements it has also been ascertained that the actual value of the resistance is very much smaller than this upper limit which was ascribed to it from former measurements.

The value of the mercury resistance used was 172·7 ohms. in the liquid condition at 0°C.; extrapolation from the melting point to 0°C. by means of the temperature coefficient of solid mercury gives a resistance corresponding to this of 39·7 ohms. in the solid state. At 4·3°K. this had sunk to 0·084 ohm., that is, 0·0021 times the resistance which the solid mercury would have at 0°C. At 3°K. the resistance was found to have fallen below 3×10^{-6} ohm, that is to one-ten-millionth of the value which it would have at 0°C. As the temperature sank further to 1·5°K, this value remained the upper limit of the resistance.

The next step was to look for the point at which the resistance first becomes measurable as the temperature is raised. The temperature of this point was found to be slightly more than 4·2°K. at which the resistance was found to be 230 microhms or one-hundred-thousandth of the resistance (solid) at 0°C.

The more the upper limit which can be ascribed to the resistance remaining at helium temperatures decreases, the more important becomes the observed phenomenon that the resistance becomes practically zero. When the specific resistance of a circuit becomes a million times smaller than that of the best conductors at ordinary temperatures it will, in the majority of cases, be just as if electrical resistance no longer existed under those conditions. If conductors could be obtained which could be regarded as being devoid of resistance so long as their cross-section was not excessively small, or conductors of the smallest possible sections, either cylindrical with dimensions of the order of the wave length of light, or films of molecular dimensions, whose resistance would be small; if the Joulean development of heat had no longer to be reckoned with when increasing the current in a bobbin to exceedingly high values, because the development of heat in a constant-current circuit could be made extremely small compared with the latent heat of vaporisation of the liquid which can be used for cooling,—these further experiments in all possible directions would give the fullest promise, notwithstanding the great difficulties which are encountered when working with liquid helium. It is therefore all the more necessary to establish beyond all possibility of doubt the property of which advantage would be taken in such experiments. With this end in view modified measurements are being made.

THE ELECTRICAL EQUIPMENT OF THE S.S. "OLYMPIC" AND "TITANIC."

(*Concluded from page 619.*)

Summary.—In this article are described the various uses to which electricity is put on board the two latest White Star liners, the "Olympic" and "Titanic." These include, besides lighting, power for winches, cranes, fans, water-tight doors and stoking and helm indicators. The cooking and heating equipment are also electrically worked, while a complete telephone and wireless installation is to be found on board. The differences between marine and land practice are noted.

Winches and Cranes.

One of the little discomforts sometimes associated with modern ocean travelling is the noise caused by winches and other deck appliances, and although when on the high seas these are not much in evidence, yet when approaching port it is sometimes necessary to use them, as for instance when handling mails or passengers' luggage preparatory to disembarkation. With a view to avoiding this on the "Olympic" the aid of electricity has again been invoked, with the result that all the winches in the vicinity of the passenger accommodation, and the cargo cranes are electrically driven. The latter (*see* Fig. 12) have been made by Messrs. Stothert & Pitt, six having a capacity of 50 cwt. each, and two of 30 cwt. each. These cranes are fitted at the three after hatches and at the forward hatch near the passenger quarters.

The 50-cwt. cranes have radii from 26 ft. to 29 ft. and the 30-cwt. crane a radius of 26 ft. 6 in. The height of lift is about 100 ft. for the larger cranes and 80 ft. for the smaller. The lifting gear is fitted with the "free barrel" system with interlocks, which contributes so much to the smooth and e working necessary for cranes on a first-class passenger boa

The cranes are operated by separate motors for lifting slewing; the 50-cwt. cranes have 40 H.P. motors for the lift 5 H.P. for the slew, whilst the 30-cwt. cranes have 30 H.P. mo for the lift and 3 H.P. for the slew. The larger cranes lift 160 ft. per min, and the smaller at 200 ft. per min., the sle speed being about 500 ft. per min. in each case. The bra

Fig. 9.—Stoking Indicator.

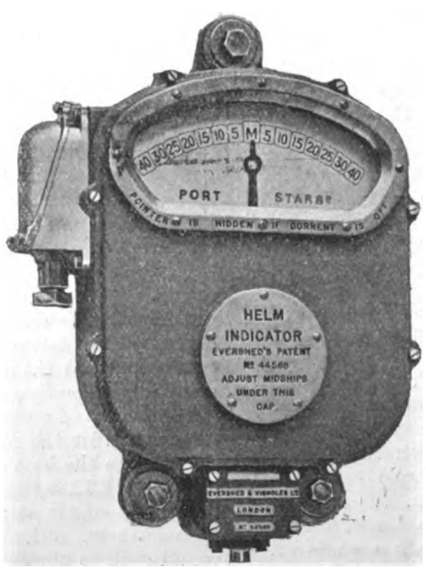

Fig. 10.—Helm Indicator.

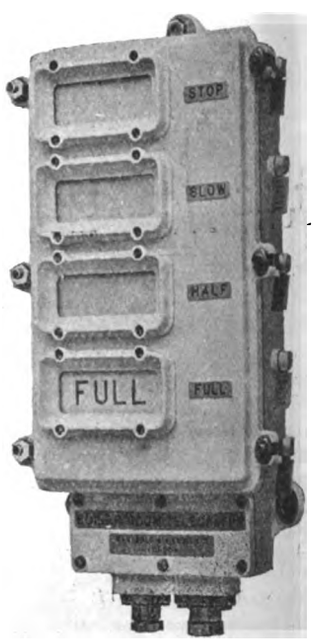

Fig. 11.—Boiler Room Orders Telegra

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both of the slewing and lifting gear are interlocked with the controller, so that current cannot be given to the motors when the brake is hard down.

In addition to the electric cranes, there are four 3-ton electric cargo winches at the hatches, as well as four 15-cwt. electric boat winches made by the Sunderland Forge and Engineering Co. (Ltd.) A 3-ton cargo winch is shown in Fig. 13.

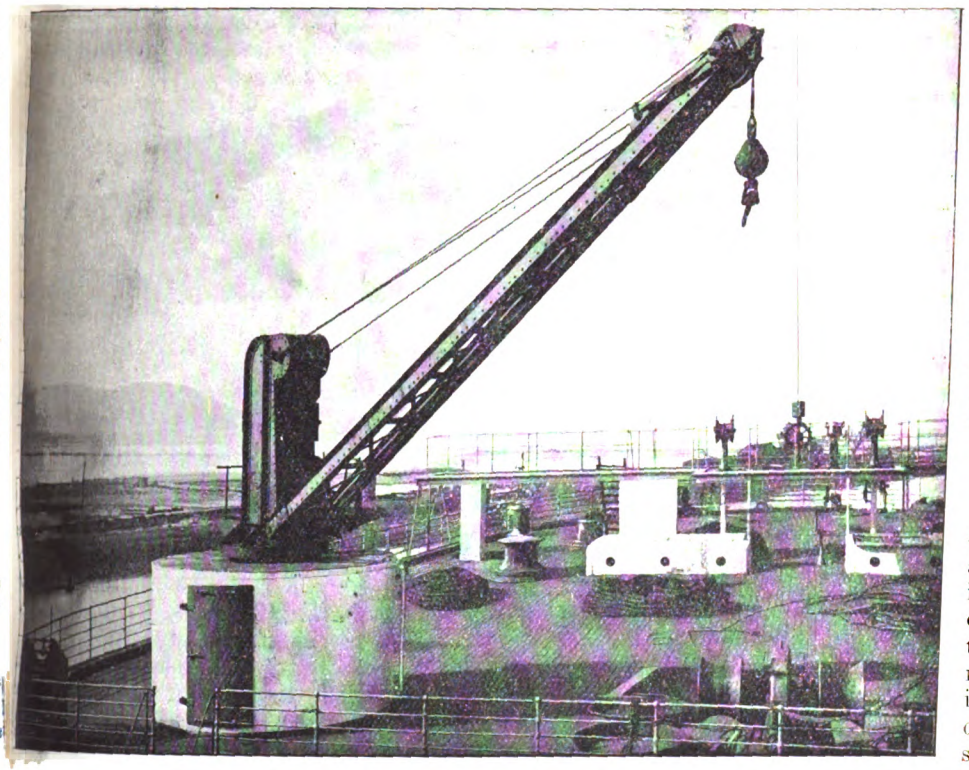

FIG. 12.—2½-TON ELECTRIC CRANE.

ACCESSORY POWER GEAR.

In all there are 150 motors on board varying from ½ to 40 H.P., to which it is impossible here to refer in detail. Special mention may, however, be made of several novelties; for instance, there are Kiiroy stoking indicators which automatically transmit orders from the engine room to each stokehold for the firing of each of the furnaces at correct and predetermined intervals of time, thus ensuring good combustion with resultant economy. There are also illuminated telegraphs in each boiler room which enable the engineer on watch in the engine room to communicate his orders to each stokehold; in addition to which he can speak to those in charge there by means of a loud-speaking telephone and thus be in communication even when all the water-tight doors are closed, and each compartment therefore isolated, as would obtain in thick weather. The convenience and additional security gained by this may be gauged when it is considered that there are no fewer than six boiler rooms and 11 stokeholds, the forward one being no less than 320 ft. from the engine room. Evershed helm indicators, for so many years used in the Navy, have been supplied and indicate on the bridge the position of the rudder. All these signalling devices have been manufactured by Messrs. Evershed & Vignoles in accordance with the builders' specified requirements. Some of these devices are shown in Figs. 9 to 11.

The steam whistles, previously referred to, are also electrically controlled, the officer on the bridge having merely to close a switch to give the blast, whilst there is also an electric time control arrangement whereby the whistle is automatically blowing for 8 to 10 seconds every minute without further attention during thick weather, the mechanism being Mr. W. J. Willett Bruce's patent.

The watertight doors are also electrically controlled from the captain's bridge, the arrangement being such that by merely closing a switch all the doors can be simultaneously shut, a bell having previously been rung to give warning below decks.

CLOCKS.

The clocks, of which there are 48 throughout the vessel, are all actuated electrically, and worked in complete synchronism, so that each registers exactly the same time; they are controlled by a master clock (*see* Fig. 14) placed in the chart room under the control of the officers, who can set them backwards and forwards according to the longitude.

The equipment, like that on many large liners of recent years, has been supplied by the Magneta Time Co. Ltd., and consists of the same type of Magneta apparatus that is installed in the chief postal buildings of London, with the modifications necessary for ship conditions, the balance escapement of the master clock being of a similar class to that used on marine chronometers. The master clock is capable of running 100 secondary clocks. Specially designed junction boxes have been fixed throughout the vessel, so that extra dials can be added

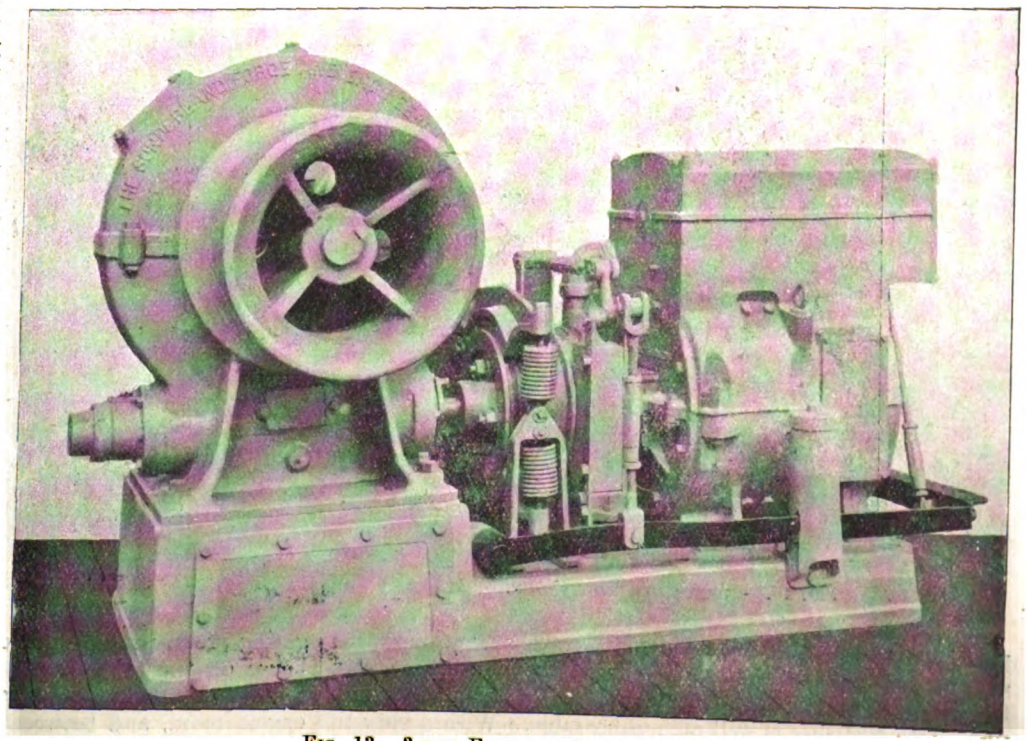

FIG. 13.—3-TON ELECTRIC CARGO WINCH.

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at any time without disturbing the existing wiring. As in all Magneta installations, batteries and contact points are abolished, and no outside source of current is resorted to; there is, therefore, nothing to maintain or renew.

Heating.

The heating of the ship is effected in several ways, partly in conjunction with the ventilation system, which latter is

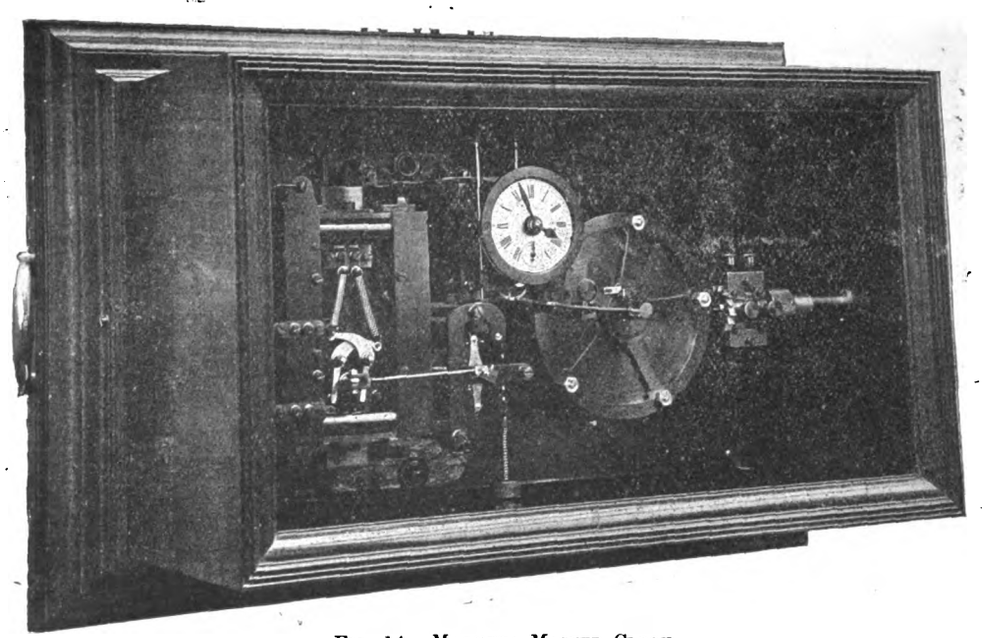

Fig. 14.—Magneta Master Clock.

installed in an elaborate and probably more perfect way than any yet attempted on board ship. Broadly speaking, the principle adopted is that in the large third-class compartments hot air is driven by means of the fans above referred to through insulated trunks in all directions, thus maintaining a pleasant temperature even in the coldest weather at the extremities of the vessel. The ventilation and heating of the first-class accommodation, on the other hand, involves some special

Fig. 15.—Forecastle Telephone.

problems, as the passengers' demands are so various; for instance, an American travelling from the Southern States frequently requires and is accustomed to an amount of heat which to a Britisher is well-nigh unbearable. With a view to meeting all requirements it was decided, after careful thought, to provide the first-class accommodation with ventilation both in the passages and individual state rooms—the latter under the control of the passengers—by means of air which is warmed to a moderate degree so as to maintain an even and pleasant temperature. This may be regarded as a warm-air system only, as distinct from a hot-air one, on the "Plenum" method. Each first-class room is in addition fitted with an electric heater of ample capacity, so that passengers requiring additional warmth can obtain it to the desired extent, whilst those who prefer the cooler atmosphere are equally catered for. In addition to the hot and warm air delivery fans referred to there are a large number of "suction" fans drawing the foul air from the lavatories, galleys, pantries, and other quarters, so that not merely is fresh air brought into the ship but all vitiated air is removed through that portion of the accommodation which, unless ventilated, might in itself prove objectionable. The mechanical system of ventilation adopted incidentally renders superfluous the imposing array of cowls so noticeable on the decks of many liners, ventilator cowls being on the "Olympic" and "Titanic," to use an Irishism, conspicuous by their absence. There are no fewer than 520 Prometheus electric heaters installed throughout the vessel, taking a collective current of over 5,000 amps.

Needless to say, the gymnastic appliances are also electrically driven, and include riding and rotating machines and other apparatus for physical drill. There are also electric Turkish baths.

Telephones.

The telephone installation is divided into two sections, viz., the navigating group and the internal system. The navi-

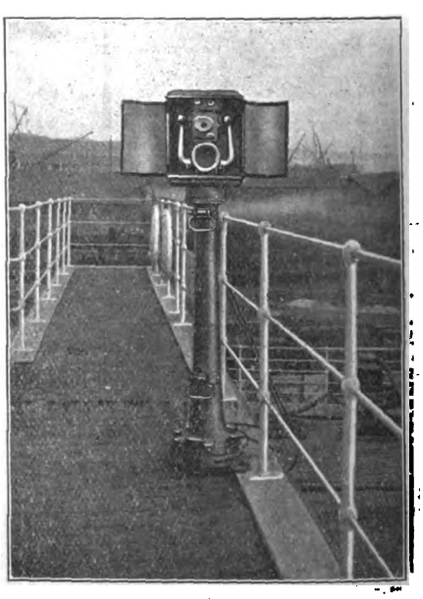

Fig 16.—Poop Instrument.

gating group provides for communication between the wheelhouse on the bridge and the forecastle, crow's nest, engine room, and poop; also between the chief engineer's cabin and engine room, and between the engine room and the various stokeholds.

The instruments employed are Messrs. Alfred Graham & Co.'s loud-speaking Navy telephones of the latest type. Exc

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in the chief engineer's room, where the cabin type is fitted, the telephones are of the "Universal" pattern, in which calls are given by means of an interrupter or bell as well as by voice. The apparatus is mounted in special forms to suit the various positions.

At the forecastle and poop (Figs. 15 and 16) the instruments are contained within a polished brass casing mounted on a pillar, and the whole fitting is arranged in portable form, so that the apparatus can be used at two alternative positions in the case of the forecastle set and a second position at the poop. For the crow's nest, the telephone is mounted within a metal hood, and this set also is portable.

In the wheel house on the bridge (Fig. 17) four instruments are fitted, and each telephone is provided with an indicating device, and in addition to a flag showing, as is usual, a signal lamp is caused to glow upon a call being received.

In the engine room (Fig. 18) three telephones are employed, and the instrument for communicating with the boiler rooms operates in conjunction with a combined switch and indicator giving both lamp and flag signals as previously referred to. In each boiler room, the telephone is mounted within a metal hood, and in addition a special calling receiver is provided at each station as well as a visual indicator.

The current for operating the system is obtained from the ship's lighting circuit, the pressure being reduced for telephonic working by means of resistances, and the noise of commutation, inherent in machine generated supply, is eliminated by the introduction of inductance coils. A standby battery is also provided, and is introduced in the circuit, should the main supply fail, by means of an automatic switch.

The internal system provides for inter-communication between a number of cabins through a central exchange, which has a capacity of 50 lines.

The switchboard is arranged to give a lamp signal upon a call being made, and in addition to the usual audible signal, a voice call can be given to the exchange from any station in connection, so that the rapidity of operation is assured.

The user in one of the cabins has simply to pick up the telephone and say straightaway the station he wishes to speak to and a loud receiver at the exchange gives the instruction, and the operator seeing a lamp glowing corresponding with the calling station then connects the calling station with the station required, thus obviating the usual delay in communicating with the calling station and ascertaining the position required.

The current supply is obtained from the lighting circuit, as in the case of the navigating telephone system, and the automatic switch and standby battery is contained within the exchange switchboard casing.

The telephone sets in each cabin are of Graham's intermediate loud-speaking type, and comprise a hand set with a circular metal push and terminal box. At the majority of

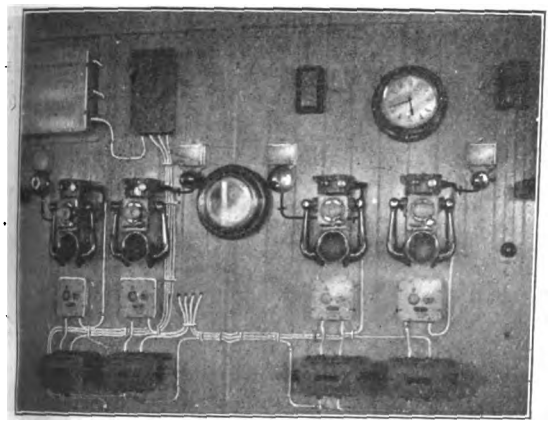

Fig. 17.—Wheel House Telephones.

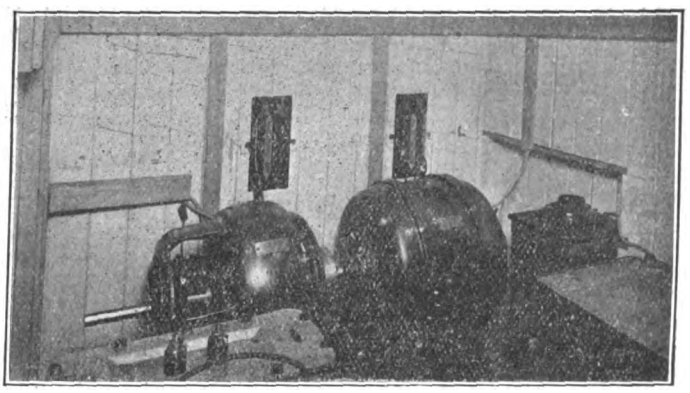

Fig. 19.—Part of Marconi Transmitting Apparatus in Silence Cabin.

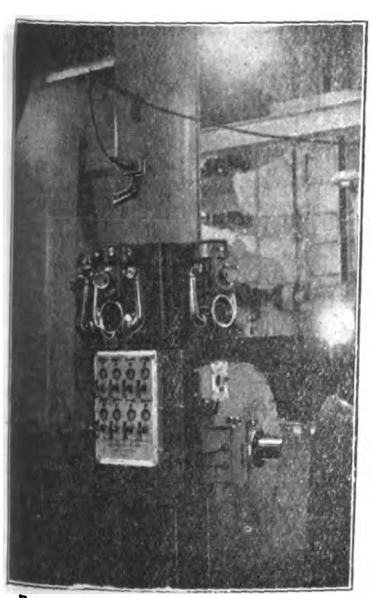

Fig 18.—Engine Room Telephones.

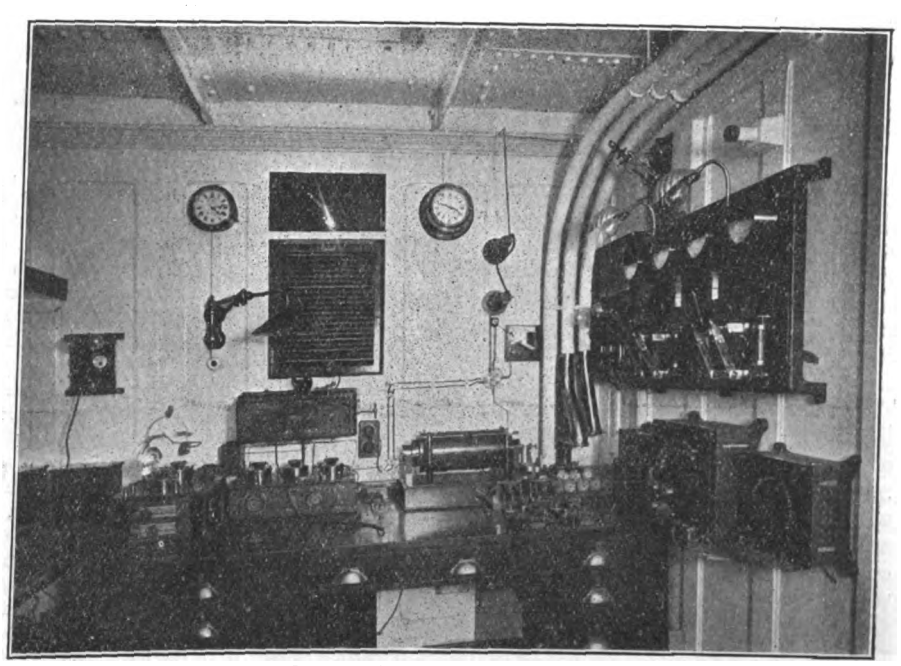

Fig. 20.—Marconi Apparatus in Operating Cabin.

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the positions the fittings are silver plated, and at others of polished and lacquered brass. Junction boxes have been introduced so as to facilitate testing and extension of the installation.

In addition to the exchange system, a separate group of circuits is provided for direct communication between the various pantries and the galley, baker's shop, butcher's shop, &c.

In foggy weather, when approaching land or in the vicinity of a lightship, submarine bells are sounded, attached thereto, under the sea, and the signals are heard by a telephone in the chart room, enabling those in charge of the vessel, to tell its precise position, whilst wireless telegraphy embodying Marconi's latest inventions for long-distance transmission gives additional security, and provides facilities for communication between ship and ship, and ship and shore, which are now too well recognised to need further description.

"Wireless" Equipment.

No modern liner is complete without a wireless telegraph installation. With such an equipment not only is communication with ship or shore possible in case of accidents, but the passenger is enabled during the voyage to keep himself in touch with the world's news. The "wireless" apparatus on the "Olympic" is of the Marconi type and consists of a 5 kw. motor-generator set combined with the latest type of valve receiver installed as a standby. The installation is designed to provide, when employed with a suitable aerial having a mean height of 170 ft., a working range of 250 nautical miles over water, and a maximum range considerably exceeding the above figure. It is arranged to tune when transmitting to waves of 300 and 600 metres, and to tune when receiving to all waves between 100 and 2,500 metres. Two masts, 200 ft. high, placed 600 ft. apart, are used for the support of the aerial, which is of the twin T type, one aerial only of appropriate type being employed for the double purpose of transmitting and receiving. The earth connection is made by insulated cable to convenient points on the hull of the vessel.

Continuous current at 110 volts is supplied to a continuous-current motor which is mounted on a common bed with and direct-coupled to an alternating-current generator. The latter has an output of 5 kw. at 300 volts. The manipulating gear consists of a Morse key which actuates electrically an electromagnetic relay key in the transformer primary circuit. The Morse key is provided with telephone short-circuiting contacts to prevent the operator's ear becoming insensitive owing to the noise in the telephone during transmission. The receiver is a standard magnetic detector and multiple tuner, by which all waves between 100 and 2,500 metres wave length can be received. The multiple tuner is calibrated to permit of the instrument being set to any pre-arranged wave length, and is further provided with a change-over switch permitting an instantaneous change of the circuit from a highly syntonised tuned condition to an untuned condition (for standing by). This arrangement has been especially devised for picking up incoming signals of widely different wave lengths. By reason of its robust nature the magnetic detector may be kept permanently connected to the transmitting aerial, thus dispensing with all mechanical change-over switching arrangements between the transmitting and receiving circuits. Further, in conjunction with the short-circuiting contacts on the manipulating key, it allows the operator to be interrupted during the transmission of a message in the event of there being erroneous reception at a corresponding station. A suitable testing buzzer is provided and is kept permanently installed for the purpose of instantaneously testing the receiving circuits, and a tuning lamp and adjustable choking coil are also permanently installed for the purpose of indicating the condition of syntony of the transmitting circuits, while a wave-meter, covering the full range of the transmitting circuit is supplied. The Marconi Apparatus is shown in Figs. 19 and 20.

The bell installation comprises no fewer than 1,500 pushes, which, in the staterooms, are for the most part grouped with the switches for controlling the lights on combination plates placed within convenient reach of each berth.

In conclusion, we would express our indebtedness to Messrs. Harland & Wolff for the information given above and to our contemporary "The Shipbuilder" for the loan of the blocks of Figs. 1, 3 and 12.

MODERN DIESEL OIL ENGINES.*

BY F. SCHUBELER.

Summary.—The author gives a short survey of the practical development of the Diesel engine up to the present time and its applications to various forms of driving.

As is already known, it was the intention of the inventor of the Diesel engine to burn coal direct in the working cylinder, which, however, proved to be impossible, as the unburned residues could not be removed from the latter. For dealing with liquid fuel the propositions made by different designers varied principally only in the arrangement of the air-pump and the construction of the fuel valve. For instance, Haselwander and Trinkler used the working cylinder, so to speak, as the first stage of the air-pump by extracting air during the compression stroke from the former as soon as a certain pressure (about 100 lb.) was reached, and only producing the differential pressure for the injection air (700 lb. to 900 lb.) in the actual air-pump. Haselwander had his air-pump combined direct with the working piston by a differential arrangement, whereas Trinkler provided a special air-pump in the cylinder cover. Other designers proposed an intermediate process between those of the ordinary gas engine and the Diesel engine. Thus Sabathé advocated compression up to about 300 lb. and artificial ignition of part of the fuel. The Brons motor, as still made by the Gasmotoren-Fabrik Deutz in the smaller units, has similar features. Generally, however, it can be stated that most of the above-mentioned propositions have disappeared and some have not even been carried out, all of them giving place to the well-known Diesel principle with its characteristics: compression in the working cylinder up to the ignition temperature of the fuel (about 500 lb. or about 1,000 F.), and creation of the pressure of the injection air (600 lb. to 850 lb. per square inch), by means of which the fuel is introduced atomised into the cylinder by an independent multiple-stage air-pump. It is only natural that the development of this principle should have caused some initial difficulties. In the hitherto-known steam engine the working process takes place partly in the boiler and only partially in the working cylinder. The boiler, which has no moving parts, deals with the heaviest part of the process and furnishes the working fluid in a refined state to the working cylinder, whereas with the Diesel engine the whole process has to be dealt with in the working cylinder. That it has been possible within a comparatively short period to develop the Diesel engine to such a degree as to enable it to compete successfully with the steam engine in large units certainly proves the present-day skill and thoroughness of engineering. It may be stated that as regards reliability the Diesel oil engine can now be considered as fully equal to the steam engine, it being only a question of economy in each individual case which of the two prime movers takes the preference. There was one principal difficulty which had to be overcome. The extremely high pressures and temperatures of the Diesel process put a limit to the dimensions of the cylinders, which hardly exceed a diameter of 30 in. This corresponds to an approximate cylinder output of 300 H.P. to 400 H.P., assuming 150 revs. per min. of the shaft and the ordinary Otto cycle. Theoretically there would be nothing to prevent any desired output being obtained by arranging any number of cylinders side by side. Practically, however, it is not advisable to provide for more than six cranks, as a larger number would produce an inadmissible twisting of the shaft. Furthermore, such units require a great amount of space and would become extremely costly. These reasons called forth the necessity of seeking other means by which to increase the specific cylinder output of the ordinary single-acting Otto cycle engine.

There are the following possibilities: (1) By carrying out the single-acting Otto-cycle machine as a double-acting one. (2) By adopting the single-acting two-stroke cycle working process. (3) By adopting the double-acting two-stroke cycle working process. The double-acting Otto-cycle cylinder under (1) corresponds approximately to a doubling of the cylinder output. Almost the same result can be obtained by the procedure under (2), which, however, necessitates the provision of special scavenging pumps. The solution under (3) would theoretically quadruplicate (practically about 3-4) the output of the ordinary Diesel engine cylinder and mean the adoption of the usual working process of steam engines for the oil engine.

* Abstract of a Paper read at the meeting of the Institution of Mechanical Engineers at Zürich.

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For smaller and medium size units the single-acting Otto cycle is the preferable, as it involves the smallest working strain on the cylinder. Although this type of engine necessitates a more or less frequent cleaning of the internal parts especially of the exhaust valves, the author is informed that such machines have worked for periods of six to eight weeks without interruption, even in cement factories and mills.

As the main advantage of the two-cycle engine it may be mentioned that the turning moment is much more favourable, and consequently the revolving masses for obtaining a certain degree of cyclic variation are much lighter. The two-cycle engine furthermore guarantees better starting and better conditions for regulation, which is specially important for direct coupling with alternators. The space required is considerably smaller and the engine is also lighter and, therefore, cheaper. The difference in price between an ordinary single-acting four-cycle and a single-acting two-cycle engine for a capacity of 1,000 H.P. amounts to about 25 to 30 per cent., which figure would have to be considerably increased if larger units were compared. Furthermore, the lubricating-oil consumption is somewhat smaller per horse-power, as the same cylinder and bearing dimensions are sufficient for producing about double the output.

It still remains for reference to be made to the chief advantage of the two-stroke engine—that is, the elimination of the exhaust-valve. Some difficulties cannot be avoided when the latter is used in large sizes. Generally speaking, the fewer working parts coming into contact with the hot gas the better. The scavenging valve (or valves) in the cylinder cover may be dispensed with. Only a part of the cylinder slots are then used as exhaust slots, the remainder on the opposite side being used for the introduction of the scavenging air. A special shape is given to the top of the piston to guide the current of scavenging air and to guarantee a thorough removal of the burnt gases. The scavenging valve is thus removed from the high temperatures, only the fuel valves and starting valves being so exposed.

It is self-evident that for the continually advancing engineer the problem of the double-acting Diesel engine is attractive, especially as he already has excellent models in the gas engine, for which the stuffing-box problem may be regarded as solved. On the other hand, it must be admitted at once that with the Diesel engine the conditions to be dealt with are much more unfavourable. It will, therefore, be preferable to avoid the difficulties with the stuffing-box in the first instance, and to develop the new type on the lines of the single-acting four-stroke cycle engine, with which the gain in output is practically the same. To pass at once to the double-acting two-cycle engine without first gaining experience with the single-acting engine seems to the author not to be the course of natural development and to be somewhat risky. As to the design of an engine of the latter type—namely, the double-acting two-stroke engine—the provision of a special cross-head and also the horizontal arrangement is recommended. This being so, it may be deduced from gas-engine and steam-engine practice that for the support of the pistons a rear stuffing-box with a bearing support for carrying the weight of the pistons has to be provided, which is certainly far from desirable. In addition, great inconvenience is caused by the piston-rod having to pass through the combustion chamber and necessitating an eccentric introduction of the fuel. The combustion process must, therefore, be far more unfavourable, and the construction of the valve gear more complicated. The proper setting of the two compression clearances on both sides of the piston is not as simple as with the single-acting engine, where by a shortening or lengthening of the connecting-rod the compression can be proportioned to any amount desired. With the double-acting machine a compromise has always to be made, and the length of the piston-rod has to be provided for an average compression on both sides.

The different working conditions of the Diesel oil engines naturally require different types. The piston speed is generally between 600 ft. and 1,000 ft. per minute, which cannot be reduced below a certain limit, as otherwise the slightest leakage could prevent the compression attaining the required amount. This is especially important for marine Diesel engines when they are being run dead slow. The piston speed can, however, be as low as 180 ft. to 200 ft. per min. for continual service.

For standard slow speed single-acting four-cycle engines the number of revolutions lies between 150 and 300, with outputs between 1,000 H.P. and 15 H.P. These engines have the best fuel consumption, but have also the disadvantage that they are heavy and expensive. For this reason a single-acting multiple cylinder high-speed four-stroke cycle engine was built which is especially suitable for direct coupling to dynamos. The speed varies between 220 and 350 revs. per min. for sizes varying between 1,000 H.P. and 100 H.P. These high-speed types, if suitably designed and carried out by first-class manufacturers, are just as reliable in service as the slow-speed types. They have, however, a slightly higher fuel consumption. On account of their smaller first cost they are especially suitable where the Diesel engine is intended as a stand-by. For very small auxiliary engines up to about 100 H.P. on board ship the speeds are still higher, and range from 400 to 600 revs. per min. and even higher.

Single-acting two-stroke engines with outputs ranging between 700 H.P. and 3,000 H.P. are built with speeds between 160 and 140 revs. per min.

For ship propulsion there is a tendency to use lower speeds in order also to obtain a good propeller efficiency. To give some figures, 100 to 350 revs. per min. may be taken as limits for sets of several 1,000 H.P. down to 100 H.P.

Following this course, the normal four-cycle Diesel engine was first adapted for marine purposes, and there are several boats running with such engines. This type, however, having, as already mentioned, a limited output and being moreover heavy, has the further disadvantage that the most essential feature of the marine engine—namely, the problem of direct reversibility—cannot easily be solved. For smaller crafts the propeller can be made reversible, or a special reversing gear can be fitted to the shaft, similar to those used in motor cars. Another possibility is to generate with a normal non-reversible Diesel engine electricity in a generator, and have the propeller coupled to an electric motor, which can easily be made reversible. This system, the so-called Delproposto system, which otherwise gives good results, is not very economical on account of the numerous transformations of energy. It is also rather complicated, expensive and heavy. The first boat of this type is the steamer "Vandal" on the Volga, carried out by Messrs. Nobel. A similar Diesel boat, the "Venoge," was built by Sulzer Brothers in 1904, for the Lake of Geneva. The engine has an output of 100 H.P. Another inconvenience of the four-stroke cycle type is the presence of exhaust valves, which necessitate a more or less frequent cleaning.

These difficulties, including also the last-mentioned one with the exhaust-valves, could be overcome by adopting the two-cycle engine. A number of boats fitted with such engines, with outputs up to about 1,000 H.P. are in service. The reversibility can easily be attained. It may be mentioned that Messrs. Sulzer Brothers have done the pioneer work in exhibiting the first engine of this type at the Exhibition of Milan in 1906. For outputs below 1,000 H.P. these engines may be of the ordinary trunk-piston type, whereas for larger units crossheads should be provided. The appearance of such an engine does not differ considerably from that of the well-known steam marine engine. Some firms have already gone further, claiming to be able to carry out a double-acting two-stroke machine. Unfortunately, the results obtained with such engines are unknown to the author, and a definite decision—whether single-acting or double-acting engines are most suitable for marine purposes—cannot be given for the time being. The author for his part feels somewhat doubtful whether success has already attended such efforts. Preferably a two-propeller arrangement is adopted, and with larger units the scavenging-pumps will be separated from the propulsion-engines and driven by independent non-reversible Diesel units.

The space required for marine Diesel engines is smaller than for steam plants, the difference amounting to about 30 to 50 per cent., and the saving in weight is also considerable, reaching as much as 50 per cent. With marine Diesel engines it is possible to attain a larger action radius for ships, which can be five to six times as large as that for ordinary steamboats.

Regarding other applications of the Diesel engine, attempts have been made to build also Diesel locomotives, but the author regrets not being in a position to furnish any information. The adoption of the Diesel engine for motor-cars and aeroplanes does not seem to be very promising on account of the high pressures and consequent heavy and expensive constructions, not only for the engine but also for the accessories. One word is required as to the thermal conditions of the engine. The calorific efficiency, respective mechanical output, may attain 30 to 40 per cent.; 25 to 30 per cent. are lost in the cooling water and the rest is contained in the exhaust gases. Of the latter heat about 20 per cent. can eventually be utilised for heating purposes, and in adding also the heated cooling water the total efficiency of a Diesel unit may go up to 80 per cent., which is certainly remarkable. With regard to the actual costs per brake-horse-power hour, in assuming a fuel price of 50s. per ton (which is certainly an outside figure) this will amount to about 0·11d. to 0·13d., or about 0·16d. to 0·2d. per kilowatt-hour. These figures are the actual figures maintained during actual service, assuming, of course, that the engines are kept in good condition. The author hopes that the discussion will raise other points of general interest, which are omitted in this Paper, or throw further light on others mentioned therein.

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SINGLE-PHASE ELECTRIC LOCOMOTIVE FOR THE COMPAGNIE DU MIDI, OF FRANCE.

Towards the end of the year 1908 the Compagnie du Midi, of France, decided to adopt electric traction on a large portion of its system, and with this object in view determined to open an experimental line on the track between Villefranche, Vernet-les-Bains and Marquixanes. At the beginning of the year 1909 the railway company, therefore, placed an order with the A.E.G. for the construction of an experimental electric locomotive to be built in accordance with its specification. The

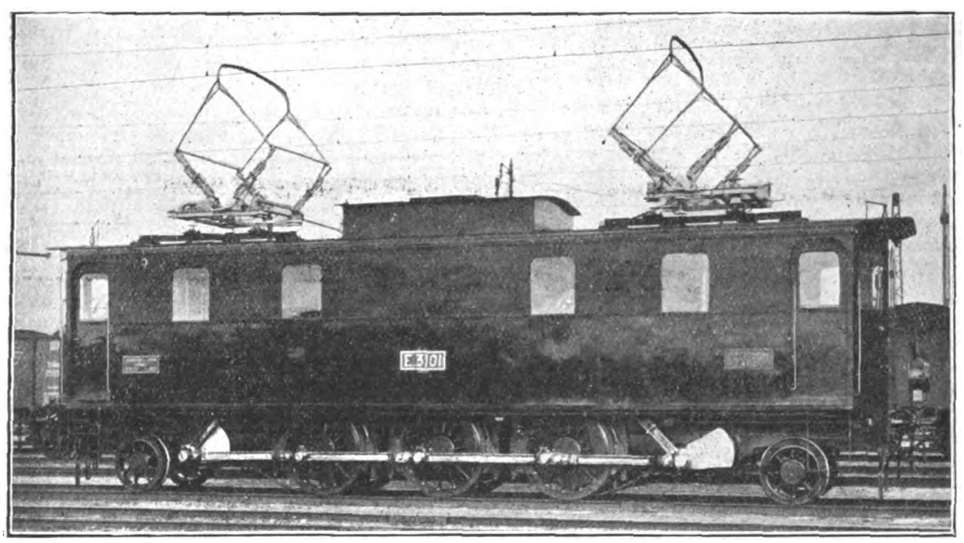

FIG. 1.—A.E.G. SINGLE-PHASE ELECTRIC LOCOMOTIVE FOR THE COMPAGNIE DU MIDI.

principal details with which it was necessary to comply were the following :—

Gauge	1,435 mm.	...	3 ft. 10 in.
Diameter of driving wheels	1,310 mm.	...	3 ft. 6 in.
Diameter of running wheels	850 mm.	...	2 ft. 9 in.
Diameter of crank circle	540 mm.	...	1 ft. 5 in.
Length of loco. over buffers	13,140 mm.	...	43 ft.
Greatest width	3,150 mm.	...	10 ft. 3 in.
Greatest height from the ground	4,250 mm.	...	14 ft.
Total wheel base of the loco.	9,600 mm.	...	31½ ft.
Side play of running axles	55 mm.	...	2·16 in.
Side play of centre axles	20 mm.	...	0·8 in.
Fixed wheel base	3,600 mm.	...	11·8 ft.
Pressure on driving axles	18 tons	...	—
Pressure on running axles	15·5 tons	...	—
Total weight	85 tons	...	—
Adhesive weight	54 tons	...	—
Minimum curve radius	160 m.	...	525 ft.
System of supply	Single-phase current	...	—
Overhead line tension	15,000 volts	...	—
Frequency	16⅔ cycles	...	—
Motor hourly rating	2×800 H.P.	...	—
Maximum speed	75 km. per hour	...	46 miles per hour
Max. tractive effort at drawbar	12,500 kg.	...	12·5 tons
Tractive effort at drawbar during one hour	8,000 kg.		8 tons

The locomotive was designed by the A.E.G. in conjunction with the locomotive builders, Henschel & Son, of Cassel. The two motors work with the driving rod set at an angle of 45 deg. to the horizontal on two intermediate crank shafts placed outside the driving axles. As no counter movement takes place between the inclined and horizontal coupling rods, both coupling rods could be arranged in a vertical plane. By this arrangement the crank pins for the intermediate crank shaft can be made shorter, and at the same time are not subjected to such heavy stresses.

By arranging the two motors and the main transformer in the centre of the locomotive the moment of inertia of the locomotive is kept comparatively small. This is of importance, as the fixed wheel base of the locomotive, which was specified by the railway company, is only 3·6 metres (11·8 ft.). In order to ensure flexibility of the locomotive on curves, running axles with radial adjustment towards the centre point of the curve were adopted, which allow the locomotive to travel over curves having a radius of 160 metres (525 ft.) without rocking.

For carrying the main frame and leading the running axles back to the central position a laminated spring is used, which, in the central position, has a tension of 2,400 kg. (2·4 tons), and for greater deviations about 4,800 kg. (4·8 tons). In order to obtain flexibility on curves, only the two outer coupling axles are rigidly fixed to the frame. The centre coupling axle has a side play of 20 mm. (0·8 in.) on each side, so that it can run on the outer rails on sharp curves, and is thus guided independently of the frame. The locomotive is guided by the two front axles on curves having a radius of not less than 250 metres (820 ft.). On curves of less than 250 metres (820 ft.) radius the leading coupling axles are drawn off the outer rail; the guiding of the locomotive is then effected by the front running axles only. The suspension springs are so arranged that the locomotive is supported at six different points. Each running axle is connected to the adjoining coupling axles by means of a bell crank. The centre coupling axle has separate springs, spiral springs being provided for the suspension of the frame instead of leaf springs. The ends of the coupling rods are provided with bushes which are not adjustable. This simple form of construction has already given good results on numerous railways. The motor bearings and intermediate crank-shaft bearings may be adjusted for wear.

The upper part of the locomotive is completely enclosed. The main transformer is mounted in the centre of the locomotive on double "T" iron girders arranged between the main frame covers, and strengthened by strong iron supports. The high-tension oil switch and a part of the controlling gear are mounted on a special frame immediately above the transformer. The central part of the locomotive roof may be opened, and for this purpose is provided with doors and hinges. By this arrangement the high-tension oil switch can be taken out, or the contactors inspected without entirely removing the roof. The main transformer may also be taken out after the removal of the contactor casing and the central part of the roof. On the right and left-hand sides of the main transformer the two motors are mounted on cross-girders fixed to the main framework; they may also be removed from above.

The two A.E.G. Winter-Eichberg motors employed, each having an hourly rating of 800 H.P., are constructed in the open form. They have 14 poles and are excited through the rotors. All brushes are conveniently accessible owing to the open form of construction adopted for the motors. The stators are wound with a single-phase lap winding. At high speeds the portion of this winding which lies in the reversing zone is connected to a part of the exciter transformer circuit by means of special contacts, in order to ensure good commutation at these speeds. The stators are rigidly bolted to strong cross-girders. The rotors run in amply dimensioned bearings having pad lubrication. The bearings are not directly connected to the stators, but are bolted to the longitudinal girders on the lower frame. In order to allow convenient access to the commutators, no bearing shields are used. The frames are stiffened at the bearings by steel castings which are riveted to the locomotive framework.

It should be specially mentioned that within speed limits of 30 km. to 55 km. (18·6 to 34 miles) per hour current can be returned to the line when travelling on down grades.

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The cranks for the motor shaft work in sheet-metal cases, which are only open below in order to allow the driving rod to pass through to the intermediate crank shaft. Between these cases, which may be easily opened for the inspection of the crank pins, and the outer wall of the locomotive ample space is allowed for the attendant to pass from one part to another. The drivers' cabins are situated at each end of the locomotive, and are fitted with all the necessary measuring instruments and driving gear. The remaining electrical apparatus is mounted in the machine compartment. A gangway on one side of the locomotive gives access from the driver's platform to all the apparatus. Two brakes are used, one being an automatic compressed air brake of the Westinghouse type, and the other a hand-operated brake. The coupled axles are braked on both sides in such a manner that 60 per cent. of the rail pressure of the driving wheels—*i.e.*, $0{\cdot}6 \times 54 = 32{\cdot}4$ tons—is braked. The locomotive is fitted with two speed indicators of the "Hausshalter" type, compressed-air sand strewers and whistles, petroleum signal lamps, and the other customary signalling devices and tools. Gangways at the ends allow the attendants to pass from the locomotive to the trains. Our illustrations show a general view of this locomotive and detailed drawings.

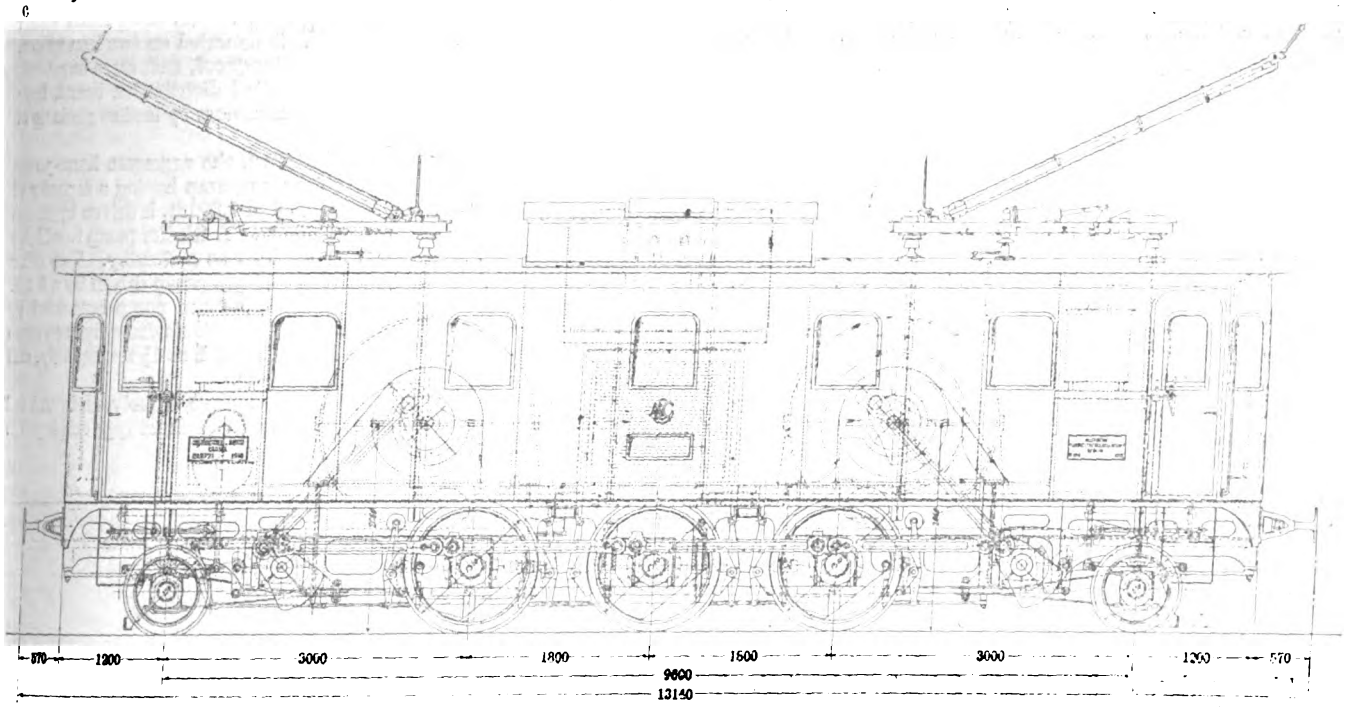

FIG. 2.—SIDE ELEVATION OF THE MIDI LOCOMOTIVE.

It should be mentioned that the locomotive is fitted with a pantograph collector, as shown in the photograph, and not with collectors of the ordinary bow type.

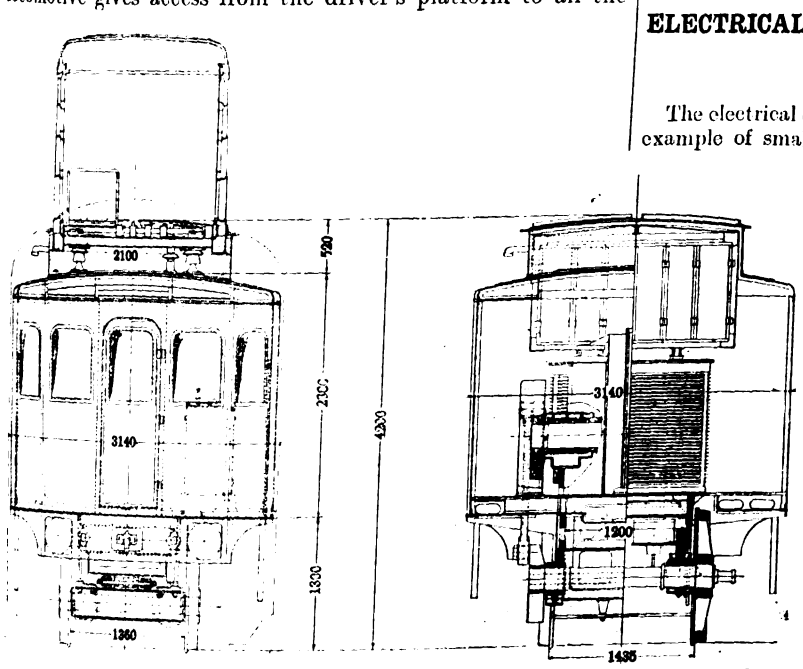

FIG. 3.—END VIEW AND SECTION OF LOCOMOTIVE, SHOWING COLLECTOR IN ITS UPPER AND LOWER POSITIONS.

ELECTRICAL EQUIPMENT OF THE SNEYD COLLIERY, BURSLEM.

The electrical equipment of the Sneyd Colliery, Burslem, is another example of small beginnings leading to satisfactorily large endings. The following details will doubtless be of interest at the present time when the whole position of electricity in mines is being attacked by interested persons.

Twenty years ago, this Company laid down a small lighting set to light their offices. Eight years later they put down a 50 kw. three-phase Westinghouse generator set for power purposes. This set operated two haulage systems (a 20 H.P. main and tail, and a 20 H.P. endless rope), and a 30 H.P. pump. It was something in the nature of an innovation, being one of the very earliest applications of the three-phase system to collieries in this country, but it proved so successful that the company decided to convert all the haulages in their mines, and for this purpose built their present power station.

The plant next installed consisted of two 250 kw. Howden high-speed engine sets, running at 375 revs. per min. direct coupled to three-phase 25 frequency 440 volt alternators, with exciters separately driven by small steam sets, plenty of space being left for extensions. In its two years of service this plant showed so many economies and advantages that it was further enlarged by the installation of a 500 kw. turbo-alternator. This turbine is of the Rateau type and runs on exhaust steam from the winding engines, with a thermo-accumulator interposed, and drives a British Westinghouse three-phase 25 frequency 440/500 volt turbo type alternator, with coupled exciter, the set operating at 1,500 revs. per min. Steam is supplied to the engine sets by three Babcock & Wilcox and six Lancashire boilers working at 120 lbs. and 90 lbs. pressure respec-

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tively, the Babcock & Wilcox grates being designed to burn the fine slack from the screening plant.

The switchboard is mounted on a platform at one end of the station and comprises three generator and four feeder panels, fitted with the usual meters, overload circuit breakers, &c., the rheostats for voltage regulation being placed at the back of the board, though they are operated from pillars in front. The supply is led to the various motors installed on the surface, and to the top of the pit shafts by underground cables, and thence down the pit to sub-stations.

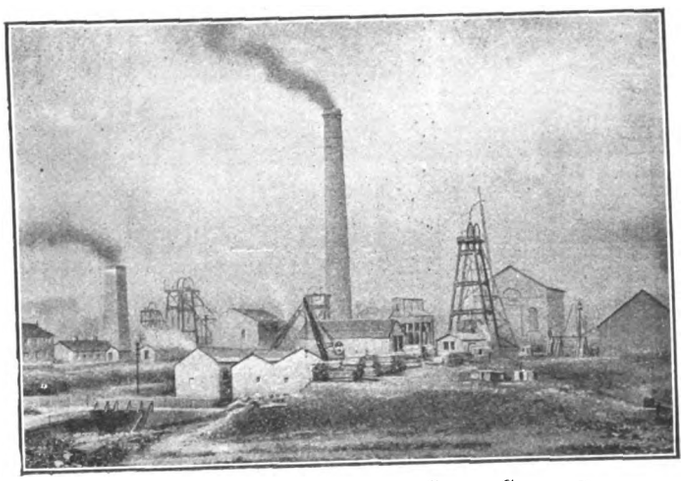

FIG. 1.—GENERAL VIEW OF SNEYD COLLIERY.

There are three pits known as No. 2, No. 3 and No. 4, the electrical machinery in No. 2 pit comprising 11 motors, totalling about 380 H.P., all engaged either in haulage or pumping work. The main haulage to the pit bottom is a single drum set, capable of dealing with six tubs per wind, each tub carrying approximately 12 cwt. of coal. These are hauled up a gradient of 1 in 3 for a distance of 160 yds., the motive power being furnished by 100 H.P., 440 volt, Westinghouse slip ring motor, running at 475 revs. per min., and driving by ropes to the haulage pulley, which transmits the power through a friction clutch and helical gearing to the drum, the haulage ropes being ¾ in. steel wire.

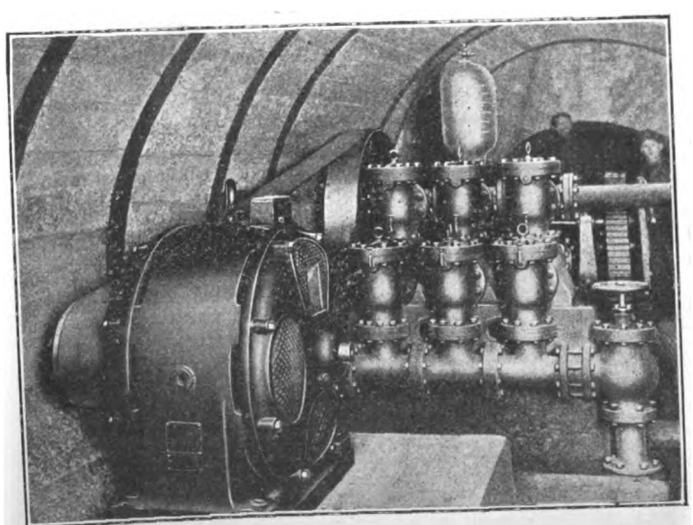

FIG. 2.—30 H.P. WESTINGHOUSE MOTOR DRIVING THREE-THROW SCOTT-MOUNTAIN PUMP AT SNEYD COLLIERY.

The control for this unit is effected by means of an oil immersed reversible controller. There are also the following haulage gears in this pit:—One 75 H.P. single-drum gear drawing nine waggons up an incline of 1 in 4½. One 75 H.P. endless rope plant, and three 20 H.P. single-drum haulage sets. The latter are semi-portable, the gears, motor, controller and resistance all being fixed in the same bed plate.

The sump at the pit bottom is furnished with two three-throw pumps, each having a lift of 750 ft. These are driven by a 30 H.P. squirrel-cage motor running at 710 revs. per min. through an 8 in. canvas belt, one being kept as a spare whilst the other is in use. Three small pumps each driven by a 3 H.P. motor act as an auxiliary plant.

The distribution switchgear supplying these motors is situated at the pit bottom, and current is led by three single-core cables to 'bus-bars at the back of the distribution board. The feeder switches are of the totally enclosed, automatic, oil immersed type, specially designed for mining work, the necessary meters being fitted within the casing of the switch. The gear is mounted on two iron pillars, and forms a complete dust proof, water-proof, and, more important still in colliery work, gas-tight, iron-clad distribution board, from which the current is led to the various motors by feeders made up of three-core armoured cables.

In No. 3 Pit six motors are installed, the aggregate horse-power amounting to 333. A three-throw ram pump having a capacity of 200 gallons per minute against a head of 1,200 ft. is driven by means of ropes from a 100 H.P. slip ring motor. A Riedler pump to which a motor of 75 H.P. is attached is provided as a standby. Two other pumps act as auxiliaries, viz., a centrifugal pump driven by a 5 H.P. motor, and a small portable three-throw ram pump connected by gearing to a 3 H.P. motor. There are two single drum haulage gears drawing waggons up incline of 1 in 3, and 1 in 4½ respectively, and both operated by 75 H.P. slip ring motors.

In No. 4 Pit there are two types of haulage, namely, main and tail and endless rope, which differ from the single drum type employed in No. 2 and No. 3 Pits.

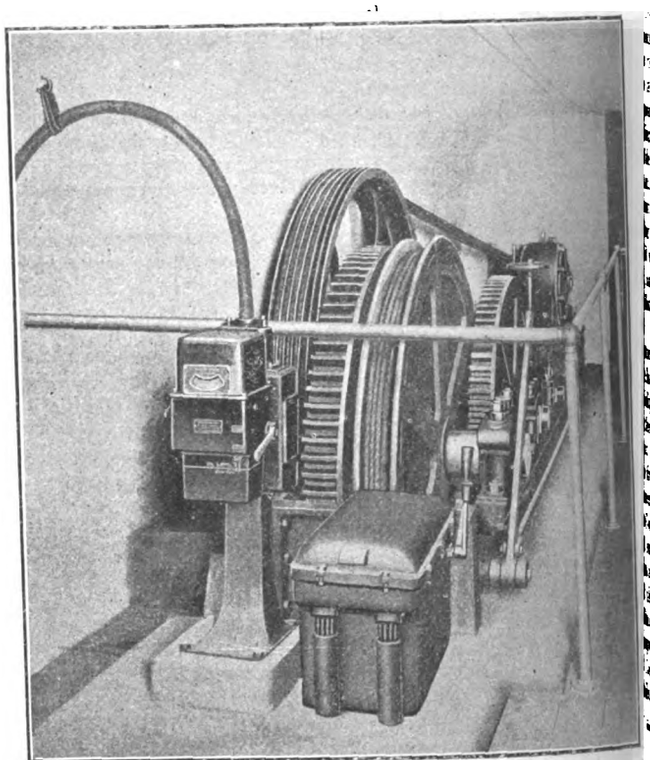

FIG. 3.—20 H.P. WESTINGHOUSE MOTOR DRIVING ENDLESS HAULAGE GEAR AT THE SNEYD COLLIERY, BURSLEM.

The single drum, as its name implies, consists of a single drum winding a single rope, and, therefore, the gradient must be steep enough to allow the tubs to draw the rope back by gravity; in the main and tail type, however, the main rope hauls the full tubes, and the tail rope takes back the empties. In No. 4 Pit there are two of these haulages, both driven by 75 H.P. motors, each capable of dealing with 30 trucks at an average speed of 5 miles per hour.

In the endless rope type of haulage the rope is passed two or three times round a "C" Pulley, and then round a guide wheel at each end of the road, the tubs being affixed to the rope by clips. It will be seen that to allow of the use of this type the road must be wide enough to allow two tubs to pass each other at any point on the route. In this particular case a 20 H.P. squirrel-cage Westinghouse motor drives the haulage pulley by ropes, thence by pinion and spur wheel to the "C" pulley. The switchgear operating the motor consists of a totally enclosed oil switch, similar to those used on the distributing board, and an oil immersed controller. All the haulages in the mine are fitted with strong brakes of the band type. There are also two single-drum haulages in this pit, driven by 20 H.P. slip ring Westinghouse motors, and controlled by tramway type controllers dealing with four tubs on a 1 in 4½ gradient.

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Two 5 H.P. squirrel-cage motors are used to operate creepers, one for raising loaded tubs and the other empty tubs, both working at the pit bottom. One motor of 50 H.P. drives a two-stage air compressor by means of a belt, the air being used for percussive drills, and two small haulage winches.

Hydraulic rams are used to push the full tubs into the cage, and at the same time push the empties off, a three-throw pump driven by a 10 H.P. motor supplying the water pressure. This is a most useful device, and saves a great amount of time and labour in getting the coal to the surface. The total horse-power of the 10 motors working in this pit is 300. The cages are of the four deck type, capable of carrying 8 tubs of coal per wind, and are operated by 2,000 H.P. steam winding engines working at 90 lbs. steam pressure.

On arriving at the surface electricity is again requisitioned to convey the coal to the screens, as well as in the actual operation of screening. At the pit brow there is a 20 H.P. motor driving a creeper by pinion and spur wheel, which is capable of pulling the loaded waggons up the incline to the screen, into which the coal is tipped by power-driven tipplers.

The principle of screening is so well known that it hardly needs description, and it will suffice to say that the screens are large rectangular sieves, placed on a slant, and shaken by eccentrics, the latter being driven by a 150 H.P. motor. As the coal drops through the screens, it is conveyed on belts to the shutes, the dirt being picked out by boys, and carried away by a small conveyor belt, known as the dirt belt. There are altogether five 5 H.P. Westinghouse motors operating these belts, and a 10 H.P. motor controlling the hoisting gear for raising the jib ends of the belt, and so minimising the breakage of coal falling from the belts. An interesting feature of the screens is the installation of Westinghouse Cooper-Hewitt mercury-vapour lamps, the light from which is admirably suited for coal picking. A fan driven by a 20 H.P. motor extracts most of the dust and delivers it in a "Maxanor" apparatus when it is mixed with water and allowed to settle, the sediment being afterwards dried and burnt in the boiler fires.

In the fitting shops a 3 H.P. squirrel-cage Westinghouse motor is doing splendid work, driving line shafting from which three lathes, a radial drill, and drilling machine, and a 6 ft. by 2 ft. planner are operated, whilst in the next shed a 20 H.P. motor drives a 4 ft. circular saw.

Electric motors are also used to operate the blacksmith's shop and the crane, the latter being worked by two motors, a 20 H.P. British Westinghouse slip ring motor for hoisting, and a 6 H.P. 110 volt direct-current motor for slewing the crane.

There are at present 53 motors installed, totalling 1,440 H.P., varying in size from a small 3 H.P. pump motor to a 150 H.P. motor driving the screens, all at work, saving time, labour, and, therefore, money for the Company.

The gradual extensions of this plant from a lighting set to an installation with a 1,000 kw. output, is, we think, proof more eloquent than words of the efficiency and economy with which electricity meets the conditions experienced in colliery work.

We have to express our indebtedness to Mr. Jno. Gregory, manager of the Sneyd Collieries, for permission to publish the foregoing interesting details.

ELECTRICITY SUPPLY IN THE CITY OF LONDON.

The annual report of the engineer to the City of London (Mr. Frank Sumner, M.Inst.C.E.) for the year 1910, which has just been issued, says:

The lighting of most of the main thoroughfares by arc lamps was continued throughout the year. The number of original type open electric lamps in lighting at the end of the year, at a cost of £26 each, was 334, a decrease of 32, which is accounted for by the substitution of the new and cheaper flame arcs in West Smithfield, and their removal from several thoroughfares in connection with the experimental lighting. The 18 Beason enclosed arcs were also removed. In addition, there were 80 Oliver flame arcs (partly experimental) and 36 metal filament lamps (experimental) in lighting during the year. The arc lamps in use at Dec. 31 included 334 of the original type open lamps and 59 Oliver flame arcs, at £17. 10s. per lamp per annum, supplied by the City of London Electric Lighting Co., and 10 Oliver centrally hung flame arcs in Cannon-street (experimental), at £17. 10s. per lamp per annum, supplied by the Charing Cross Co. In addition, there were 21 experimental arcs and 36 experimental metal filament lamps, making a total of 460 lamps. The metal filament lamps included 16 75 c.p., 10 100 c.p., 5 200 c.p., 3 600 c.p. and 2 600 c.p. The extra cost of electric lighting on dark and foggy days (27 days) was £182. 12s. 11d. The total number of defective lamps reported during the year was 89, including 9 of the experimental lamps in Cannon-street.

In the case of the gas lighting the defective lamps appear to be in a much larger proportion, the number of lamps in use being 2,659, the number of lights that failed 42 and the number of "feeble lights" 1,721.

The length of subways under the control of the Corporation is 1 mile 947 yds., and the mains and conduits therein include 1 mile 1,481 yds. owned by the City of London Co., 1 mile 1,721 yds. owned by the Charing Cross Co., 2 miles 1,230 yds. of mains and conduits for telegraph and telephone purposes, and 1 mile 1,353 yds. of pneumatic tubes owned by the G.P.O.

There are 52 police ambulance call posts and 50 fire-alarm call posts, besides one on private property and two just outside the City boundary.

Since March 26, 1903, it has been a condition that new clocks overhanging the public way shall be synchronised according to Greenwich time, and 13 such clocks have been licensed. Only 33 of the 102 private clocks observable from the public way are synchronised, and none of the 29 church clocks.

Since 1899 a total of about 25 miles of derelict overhead wires have been removed. During the past year 7 miles 508 yds. were removed as the result of 126 notifications by the Corporation. The system of identifying the owners by having the wires labelled has proved of great advantage. It has been found that large numbers of wires have been erected without notice. The number of private owners of lines is 141 and the number of companies owning lines is 26. The National Telephone Co. have about 735,136 spans across public thoroughfares, compared with 733,956 last year and 260,000 in 1899.

Although the exchange telephone systems of the National Telephone Co. and the Post Office have been greatly extended, there is a demand for private direct lines. The necessity of an immediate connection for business purposes is one cause of this increase, and there is nothing to prevent such lines being erected by wiring contractors for firms having premises in more than one part of the City, or between one or more different firms, subject, in the latter case, to license from the Postmaster-General.

Great inconvenience was caused, as in previous years, by the laying of services and the frequent and long-continued opening of the street boxes giving access to the conduits and cables in connection with the "Telephoning London" system, and no less than 2,154 notices were given during the year by the General Post Office authorities to open manholes for repairs, exclusive of inspection; 307 new services were laid and several new boxes constructed. This Department proceeded with the laying of several new conduits and ducts in various parts of the City, which necessitated the disturbance of about 2 miles of public ways, with the resultant inconvenience to the general public, although in every instance the regulations were abided by. The City of London Electric Lighting Co. gave notices for laying 225 services and the construction of 35 new boxes in connection with the supply of electrical energy to premises, and the Charing Cross Co. gave 144 notices for laying services. The London Hydraulic Power Co. gave 30 notices for laying on services from and extensions to existing mains.

THE PACIFIC CABLE.

A Bill (backed by the names of Mr. Hobhouse and Mr. J. A. Pease) has been introduced into the House of Commons whose object is to extend the Pacific Cable Act, 1901. The text of the new Bill is as follows:—

1.—(1) The Pacific Cable Board may, with the approval of the Treasury, apply out of their reserve fund such sums as may be required for the purpose of any works authorised under this Act: Provided that the sums standing to the credit of that reserve fund are not at any time thereby reduced below the sum of £100,000; and that the Pacific Cable Board shall pay to the reserve fund, as part of the annual expenses of the Pacific cable in each year, in accordance with regulations approved by the Treasury, such sums as may be sufficient to repay any moneys so applied in 35 years, with interest at the rate of 3½ per cent. per annum.

(2) Sections 3 to 7 of the Pacific Cable Act, 1901, shall be read as if references to the Pacific Cable included references to any works authorised under this Act, and as if references to the payment of annuities created under that Act included references to payments to the reserve fund required under this Act.

2.—(1) The works authorised under this Act are a submarine cable between Australia and New Zealand, as already sanctioned by the contributing Governments, and any other extensions, connections or re-arrangements in or near the Pacific Ocean which, in the opinion of all the contributing Governments, are necessary or expedient for the improvement of the Pacific Cable Board's undertaking.

(2) The reserve fund means in this Act the reserve fund established under the authority of the Treasury by the Pacific Cable Board.

(3) The contributing Governments mean in this Act the Governments represented on the Pacific Cable Board—namely, His Majesty's Government, the Government of Canada, the Government of the Commonwealth of Australia, and the Government of New Zealand.

3.—This Act may be cited as the Pacific Cable Act, 1911.

New Radium Institute.—The new Radium Institute in Riding House-street, which is the outcome of the munificence of Lord Iveagh and Sir Ernest Cassel, will, it is announced, be opened on August 14th, and will be equipped with £50,000 worth of radium. Only patients recommended by members of the medical profession will be admitted.

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With "THE ELECTRICIAN" for Sept. 14, 1906, was issued the first of a series of "Industrial Supplements," to be published from time to time with "THE ELECTRICIAN." The fifty-third issue of the Supplement published (Gratis) with the number of "THE ELECTRICIAN" for September 23, 1910, was the last of the monthly issues. "THE COMMERCIAL AND INDUSTRIAL SUPPLEMENT" to "THE ELECTRICIAN" is now issued weekly (Gratis). It will be found towards the end of the present issue.

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RAILWAY ELECTRIFICATION IN SWITZERLAND.

It is appropriate that the meeting of the Institution of Mechanical Engineers at Zürich last month should have been marked by the presentation of a lengthy Paper by Mr. E. HUBER-STOCKAR on "Electric Traction in Switzerland." Our readers will find an abstract of this Paper, necessarily very much abbreviated, elsewhere in this issue. It is only natural that electric traction should make very considerable progress in Switzerland for the reason that on the one hand there is abundant water-power, and on the other hand there is a total absence of native coal, all such fuel having to be imported. At the same time, although many of the Swiss railways are run by the State, it is nevertheless sought to work these (and still more those owned by companies) at a profit, and, consequently, schemes of electrification are viewed from a financial standpoint. At present but little profit is being made because the cost of construction is necessarily high; there are heavy gradients, rather irregular traffic, short distances, high wages and low fares. Consequently the problem is not altogether simple. Nevertheless, there are certain cases in which operation by steam is almost prohibitive, as in the case of the Simplon tunnel or where the capabilities of steam locomotives are scarcely equal to the task imposed upon them, as in the case of the St. Gothard railway.

The more recent projects appear to be of great importance. Among these may be mentioned the Bern-Alpenbahn connecting Bern with the Simplon via the Lötschberg. This

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is a new line, and it is important from the point of view of international traffic, as it will effect a considerable reduction in distance on certain routes to Italy. In many ways the conditions are similar to those of the St. Gothard railway, and for that reason the smoke from steam locomotives would be a disadvantage, and therefore electric traction has been favoured from the beginning. There are long gradients of 2·7 per cent. and the trains are heavy, requiring 2,000 H.P. or more. Single-phase traction has been adopted with a pressure of 15,000 volts and a frequency of 15. A short length of line from Spiez to Frutigen has been electrified, and this experiment has been so successful that the whole line is to be electrified on the same system. More than usual interest attaches to this line on account of the fact that two types of locomotive are being tried. In one of these, a 2,000 H.P. locomotive by the Oerlikon Company, power is transmitted by means of spiral gears which are automatically machine cut and run without noise or vibration, the surfaces in contact being much in excess of those of other types. The advantage, of course, is that reciprocating parts are avoided. The other type of locomotive is built by the A.E.G. It is of 1,600 H.P., with motors placed high in the cabin and with cranks on the motor shafts, from which motion is transmitted to the horizontal connecting rods of the driving wheels by means of intermediate connecting rods. It would seem that the geared locomotive will have a sphere of usefulness where speeds are low and a high draw-bar pull is required, whereas the reciprocating type can be used for higher speeds. Railway engineers will certainly watch the experiment with interest.

Another line which is to be electrified is that known as the Rhätische Bahn in the Engadin. Here again the single-phase system is to be used with a frequency of 15, but the pressure is only to be 10,000 volts, as it is a narrow-gauge line and the space in the tunnels is restricted. Finally, there is the projected electrification of the St. Gothard railway. This, of course, is a very important line, and is at present carrying as much traffic as can be handled by steam locomotives. There is any quantity of water-power along the route, and electric traction would no doubt be appreciated as giving more agreeable working in the tunnels and greater power in the locomotives, but the project is necessarily one that must be handled with the greatest care. The single-phase system at a pressure of 15,000 volts and a frequency of 15 is suggested.

A reference to the conditions in Switzerland would not be complete without some mention of the small commission initiated by Dr. E. TISSOT under the auspices of the Swiss Society of Electricians, and entitled Schweizerische Studienkommission für eletrischen Bahnbetrieb. This self-appointed commission, on which the railways, electricity works, manufacturing firms and technical science are all represented, appears to be doing extremely good work in facilitating the electrification of the railways. The object has been to investigate the merits of the several systems, the cost of plant and of operation, and to make a fair comparison between steam and electricity for definite railways. This has involved a great deal of work. The Commission has not stopped at such investigations, but has gone so far as to prepare complete schemes, such, for example, as that for the St. Gothard railway. Mr. HUBER-STOCKAR remarks that it is difficult to estimate the value of this work, but it is "certain that the collaboration in the Commission of representatives of interests in competition with each other in business has acted beneficially so as to make the question of system less one of competition and more one of general scientific and common practical interest." Certainly this seems to be an extremely good method of arriving at standardisation where such is possible, but perhaps it savours too much of combination to suit our insular minds.

REVIEWS.

(Copies of the undermentioned works can be had from THE ELECTRICIAN Office, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.)

Les Substances Isolantes et les Méthodes d'Isolement utilisées dans l'Industrie Electrique. By J. ESCARD. (Paris, 1911: Gauthier-Villars.) Pp. xx. + 314. 10fr.

A comprehensive work on insulating materials and methods of insulation, such as the book before us, ought to be welcome at the present time. No branch of electrical engineering needs or receives greater attention. Every installation is at every point dependent entirely upon the more or less satisfactory and permanent nature of the insulating materials employed. The qualities demanded of such materials, in addition to high specific resistance, are dielectric strength, surface insulation and mechanical properties such as strength, flexibility, ease of moulding or working; and it is necessary to know these qualities under all service conditions likely to arise and how they may vary with the lapse of time. These qualities are sufficiently various, and the materials to choose from may be more so. An experienced engineer will, therefore, be glad to have at hand a good work of reference on the subject.

Designers of electrical machinery in English-speaking countries are familiar with Turner and Hobart's useful work, and M. Escard should modify the statement in his preface that no work existed so far on the subject. The book before us, however, deals with all kinds of insulation, and only touches incidentally on the insulation problems of electrical machinery.

The opening chapters on electrical conduction and insulation in general are succeeded by sections in which are discussed the insulating properties, the dielectric strength and the surface and mechanical properties of all the materials of insulation: Air, natural minerals—such as mica, slate—porcelain, earthenware, rubber compounds, resins and varnishes and the numerous special insulating compositions; and finally oils and cotton and impregnated fibre materials. M. Escard succeeds in giving an attractive presentation of his subject from a scientific point of view and also from that of the engineer. Much of the book consists of a series of interesting essays with examples of observations illustrating the point under consideration, but frequently with no attempt to deduce technically useful figures on anything like a standard basis.

It would be very interesting, and we think it would greatly add to the usefulness of subsequent editions if the author would bring together in a table on a common basis, as far as it is possible, the essential qualities of every insulating material discussed—namely, specific resistance, dielectric strength, surface qualities and mechanical data, giving each at ordinary temperatures and also at, say, 50°C. higher. The book contains a great store of information from which such a table might be compiled.

Take, for example, the question of dielectric strength, whether of gaseous, liquid or solid insulators. Writers on this subject seem to have a tendency to forget that dielectric breakdown is caused by the maximum dielectric stress and not by average dielectric stress. In many places in the present work

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one is quite unable, even roughly, to gauge the real stress to which the breakdown figures correspond. The form of the electrodes, the nature of the voltage, whether direct or alternating, and, if the latter, the wave form, are essential conditions which are rarely even stated, while of the resulting maximum stress no attempt at an estimate is given.

The book contains many excellent illustrations and curves of experimental results. With regard to the plotting of curves in engineering publications, most writers agree that the *cause* or independent variable should be laid off from left to right, and the *effect* or dependent variable should be plotted upwards. But in some writings such as the present book, this convention is ignored, and the curves given are entirely without system from this point of view.

Special attention is directed throughout the book to the high-tension aspect of insulation problems. With regard to surface insulation, reference is made to the observations of Mr. Highfield on the formation of nitrates on the surface of H.T. windings, a subject on which further information is wanted. The insulating properties of the air and how they are modified by ionisation under certain circumstances is a subject to which M. Escard directs considerable attention, and the earlier work of Prof. H. J. Ryan and Mr. Mershon (who appears as Merthon) is referred to. We trust that in a later edition the author will find time to incorporate the recent work of these and other engineers on losses off H.T. power lines, and also that of Mr. E. A. Watson on corona formation and the use of compressed air.

We hope that the reader of p. 67 will not expect rubber gloves to protect him against 120,000 volts, and we trust that no one will be led from p. 51 to try and measure the insulation reistance of cable samples without precautions against surface leakage.

A concluding reference should be made to the excellent collection of information which the book contains as to the composition and qualities of the large number of special insulating materials both solid and liquid which are sold under various trade names. It is not always too easy to obtain such information or to gauge the probable usefulness of any such substance for a particular purpose. D. K. MORRIS.

Electric Motors: Their Action, Control and Application. By F. B. CROCKER and M. ARENDT. (*London*: Crosby Lockwood & Son; New York: D. VAN NOSTRAND Co.) Pp. vi. + 292. 10s. 6d. net.

Of the great number of technical books published at the present day, very few rise above a certain level. It always affords pleasure to find a book of a higher standard and we only regret the present book does not hold a place among these few. The method of treatment, however, is quite original on the whole, and the value of the book is enhanced by the references to other books, papers, patents, &c. In fact, these are rather appalling, for at the end of each chapter there is a list of a dozen or so works to which reference can be made for further information.

First of all, the theory of the direct-current motor is simply explained in a way which will appeal to the man who only wants a superficial working knowledge, though, at the same time, there are several weak points. For example, the only method given of finding the temperature rise is by measuring the increase of resistance. This, of course, is an excellent method, but it cannot always be used, and some explanation should be given of the relation between the rise found in this way and that found by a thermometer. Further, although promises are held out that the armature reaction will be explained later, the explanation does not appear. This is very unfortunate, since armature reaction plays a far more important part in the working of a motor than is generally realised.

The methods of control are treated in a concise manner and the diagrams for series-parallel connections are very clear. We think, however, that the chapter on the method of varying the speed by altering the magnetic reluctance might well be omitted in a practical book.

Passing now to the second part, on alternating-current motors, we find these treated in a much more theoretical way, perhaps too much so for a book of this kind. The synchronous motor is dealt with first, then the polyphase induction motor and lastly the single-phase induction motor. The treatment of this last-mentioned machine is exceedingly academical, and in the space at the author's disposal it would perhaps have been better not to have gone into the theory so deeply.

The chapter on the alternating-current commutator motor is certainly not so good as the preceding, for in the limited space of 25 pages, it attempts to deal with the series, repulsion and compensated repulsion motors. Moreover, the authors do not appear to be quite up to date, since they tell us that these are only used on single-phase circuits, whereas a chapter on the speed regulation of three-phase induction motors by means of a commutator would have been a very useful addition.

The numerical examples given throughout the book are very useful and the figures and curves are full and clear. It is a pity, however, that in one or two places the lettering on the figures does not agree with the text referring to them. This is a point on which great stress should have been laid in correcting the proofs.

Extracts from the Standardisation Rules of the American Institute are added at the end, which should prove useful for reference.

On the whole, sufficient information is given, especially in the first part of the book, to impart a working knowledge of the subject but beyond this we cannot go. R. G. J.

HUNTING OF DIRECT CURRENT INTERPOLE MOTORS.

BY DR. E. ROSENBERG.

Summary.—The author discusses in detail the effect of brush currents on the field of a motor and shows that these may cause hunting to occur in interpole motors under certain conditions. Incidentally, the effects of the brush currents on the voltage regulation of generators and on the speed regulation of motors are discussed.

It is a well-known fact that in interpole motors hunting troubles may occur if the motor is working with a weak field, for instance, in motors for a wide range of speed which is

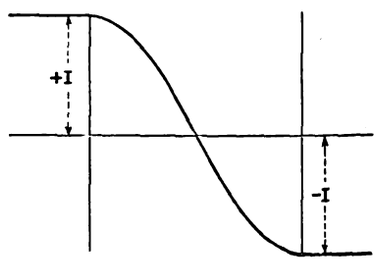

FIG. 1.

obtained by shunt regulation. This phenomenon has been discussed from time to time in the technical press, and in the "Elektrotechnische Zeitschrift," 1906, different explanations were offered by Messrs. Breslauer, Siebert, Pohl and others.

Dr. R. Pohl mentioned at the time that perhaps the hunting phenomenon may be explained by the short-circuit currents under the brushes. In this respect I fully agree with him, and I have tried in the following investigation to explain this influence fully.

In an interesting pamphlet, published some years ago, Pohl described the magnetic effects of the brush currents in d.c. armatures, mainly in machines without interpoles, and has pointed out the fact that in such machines the brush currents weaken the main field in generators, but strengthen the field in motors.

The fact can be easily explained. If the commutation was ideal, then the current of a coil passing a brush would gradually die down from its positive value +I to zero, for instance, according to a sine wave, and quite symmetrically grow again from zero value to the negative value −I (Fig. 1). The currents would then pass through zero in the geometrical centre

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of the brush; therefore, if the brushes remain in the no-load neutral, the passing through zero would actually take place in the no-load neutral. It is, however, self-evident that without a commutating field such an ideal reversal of the current cannot take place. Due to self-induction, the current will surely, for some time, keep up the direction it had in the previous half revolution, and, therefore, the reversal will be delayed. The currents under the brushes will, therefore, virtually shift the line of armature reaction forward in the direction of rotation, no matter whether the machine is generating or motoring.

In Fig. 2 is shown the magnetic field and the distribution of current in the armature wires of a direct-current machine working as a generator and running in clockwise direction. The delayed reversal of current will take place in the line CD instead of in the no-load neutral AB. If we draw a line, EF. symmetrical to CD, then we see that the armature reaction of the armature portion between C and F, and D and E, gives an armature reaction at right angles to the original field, but that the zone between EC on the one side and FD on the other side gives a field directly opposite to the primary field. The first one is the cross magnetising armature reaction, the second a demagnetising one, although no brush shifting has taken place.

With exactly the same distribution of currents in the two halves of the armature, and with the same polarity of the field, the machine run as a motor with external current will, of course, reverse its direction of rotation. The self-induction of the short-circuited armature coils will naturally tend to keep up the old direction of current after passing the geometrical

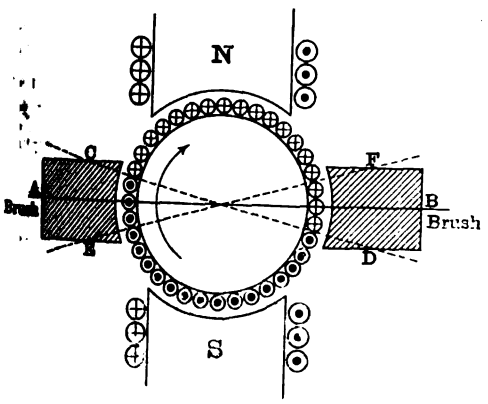

Fig. 2.—Distribution of Current in a Clockwise-running D.C. Generator.

neutral, and, therefore, the current in the zone A_1 to E_1 (Fig.) will be in the direction of the cross, the current from B_1 to in the direction of the point. The cross magnetising action f the armature is here just the same as in the generator, hereas the zone C_1 E_1 and D_1 F_1 has, as the figure shows, the fluence of strengthening the primary field of the motor.

So far we have considered only the effect of the armature self-duction on the delay of the current reversal. But a secondary fect of the armature reaction works in the same direction. ig. 4 shows in OI the direction of the lines of force of the ain field, and OII shows the direction of the field set up by amature reaction for the generator rotating clockwise. The me lines are shown for the motor rotating counter-clockwise Fig. 5. The field OII, working on the armature coils short rcuited under the brushes will produce an additional current hich has the same direction as the current had during the receding half revolution.

The magnetic influence of the short-circuit currents under ne brushes can be very considerable, and is, to a large degree, ependent upon speed, reactance of the short-circuited coils, idth of the brush and actual touching surface of the brush, nd, in consequence of the last-named item, also the mechanical ondition of the commutator is of great importance, and so it possible that high mica, a high bar, or a rough commutator urface influences the magnetic conditions of a machine to a onsiderable degree. It is not unusual that the ampere turns hich have to be added in a generator from no-load to full-load to compensate for armature reaction and demagnetising influences of the brush current are, in one machine, say, 10 per cent., and in another machine of exactly similar design, as high as 20 per cent.

In motors the magnetising action of the brush currents tends to reduce the speed with increasing load in the same way as the ohmic drop, whereas the field distortion caused by the cross magnetising ampere-turns counteracts this tendency. With a given brush position the armature reaction in two similar machines is exactly the same, and also the ohmic drop in armature windings and brushes varies very little in duplicate machines, but the influence of the brush currents varies to such an extent that it is not unusual to have in one motor a speed drop from no-load to full-load, say, of 6 per cent., and in a duplicate motor a speed drop of 10 per cent.

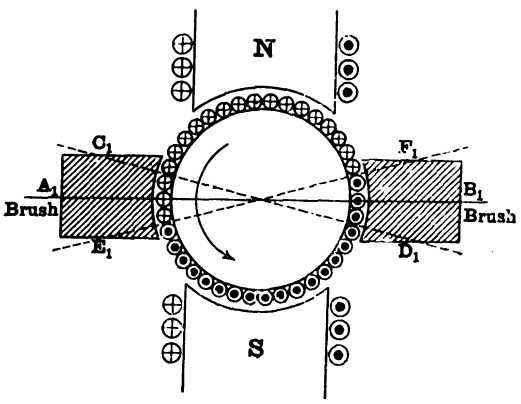

Fig. 3.—Distribution of Current in a Motor Running Counter Clockwise.

Being clear about the influence of brush currents in ordinary motors and generators without interpoles, we shall easily be able to understand the possible influence of commutating poles. A commutating pole of ideal proportions could produce an ideal commutation, as shown in Fig. 1, namely, a reversal of the current in the no-load neutral. If the commutating pole is too weak the reversal of the current will be delayed, therefore the action of the brush currents will be the same in quality, if not in quantity, as of a machine without commutating poles (Figs. 2 and 3). If the commutating pole, however, is too strong, the current reversal will take place before the no-load neutral is reached. In the case of a generator, therefore, the main field will be strengthened; in the case of a motor the main field will be weakened by the brush currents due to a strong commutating pole. The first thing explains the well-known fact that it is possible with proper brush position to obtain a level compound or over compound characteristic in a shunt machine with

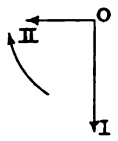

Fig. 4.—Magnetic Fields in a Clockwise-running Generator.

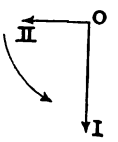

Fig. 5.—Magnetic Fields in a Motor Running Counter Clockwise.

commutating poles, even when fixing the brushes in the no-load neutral. Very often the compounding action is falsely attributed to the direct action of the commutating pole. This would offer an explanation, first of all, only for a brush position with a backward lead, for only then the commutating pole, having the polarity of the main pole following it in the direction of rotation, and being series excited, supports the main pole. Considering, however, that commutating poles are very often of such a small cross section that the total flux going through them is only a few per cent. of the main flux, and that a compound characteristic can be obtained even with brushes in the no-load neutral, it is clear that the direct action of the commutating pole is not a sufficient explanation, whereas the action of the

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brush current ampere-turns working on the big magnetic mass of the main field explains the phenomenon fully.

With regard to motors, we repeat that the brush currents due to a commutating field which is too strong will weaken the main field. If the commutating pole was always too strong, and the brushes were in the no-load neutral, then such a motor would behave like a compound-wound motor with reversed series winding. If the current grows to such a value that the ampere turns of the series winding form a big percentage of the main ampere-turns, then serious trouble will occur as the motor has the tendency of speeding up with increased load. An increase in current will weaken the field, and, therefore, in order to give the torque required with reduced field the armature current will be further increased, reducing in its turn again the field strength, which at last might lead to racing of the motor and blowing of the fuses.

Now it is easily possible that a commutating pole with a given number of turns is too strong for small currents and too weak for big currents: also that it is too strong for low speeds and too weak for high speeds. Every designer knows that to give satisfactory commutation, say, at 100 per cent. overload, the ratio of commutating ampere turns to armature ampere turns has to be made bigger than in cases where the machine has only to deal with normal full load, and also that for high speed machines a bigger ratio is necessary than for low speed machines. Of course, if a machine commutates satisfactorily at high currents and high speeds, the commutation will, as a rule, still be satisfactory at low currents and low speeds, although the commutating field is then really stronger than necessary.

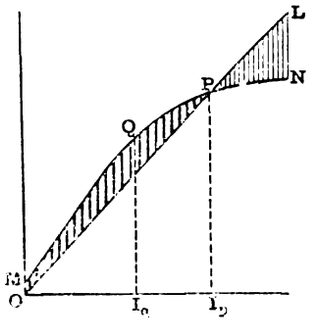

FIG. 6.

The change in the relative value of the commutating field will be particularly marked if the commutating pole has considerable leakage and has a small section. The magnetic characteristic of the commutating pole can be represented by the line MN in Fig. 6, the abscissæ representing the magnetising ampere turns, which are, of course, in direct proportion to the armature current I and the ordinates representing the field strength. The magnetisation curve will not start at the point O but at the point M, due to residual magnetism. The field set up in the direction of the commutating pole due to armature reaction and leakage can be represented as a curve OL, which is to all intents and purposes a straight line. This line cuts the curve MN, at a point P, corresponding to a certain armature current I_p, which, for well-designed machines, will lie sufficiently above the normal overloads with which the machine is expected to deal. In the above curve we have a positive commutating field for all currents below I_p, the corresponding vertical ordinates are represented by the thick shades in Fig. 6, whereas the thin shading in the part of the curve corresponding to armature currents above I_p shows negative values of the commutating field.

The critical point for the reversing of the magnetising action of the brush currents will, however, lie considerably below the armature current I_p, because we want a positive commutating field of sufficient strength to obtain the ideal reversal of the current in the centre of the brush. We may call the point corresponding to the ideal commutating field Q, in Fig. 6, the corresponding armature current I_q. For armature currents below the value I_q the commutating pole is too strong; for bigger armature currents the commutating pole is too weak. For lower currents, therefore, the main motor field is weakened, for higher currents strengthened.

Such an influence is well apt to set up hunting. In every motor, of course, slight oscillations of current occur all the time, due to the small oscillations of voltage in the impressed E.M.F., and due to small variations in the load torque, even if the motor is loaded with a practically constant load. In an ordinary motor, however, these oscillations work out their own salvation, because if the current is slightly smaller than that corresponding to the load torque this will cause a retardation, and the slight speed reduction will, in its turn, increase the current so as to be equal to that required by the load. In an interpole motor, however, as considered, if the current is for a moment smaller than it ought to be, the commutating field will be too strong and the brush currents will weaken the main field, thus causing the motor to speed up. With the reduced field the motor will take considerably more current, and the current might be so high that the commutating pole will then be too weak, which, in consequence of the brush currents, will strengthen the main field and will make the speed come down a very considerable amount, when the game starts fresh again.

The influence of the brush currents on the main field will, of course, be very marked if the field ampere turns are low, and that is the case at high speeds for a motor with field regulation. Suppose for a speed regulation of 1 to 4 the field ampere turns for the highest speed to be only 30 per cent. of the armature ampere turns, then it is quite clear that the brush ampere turns, even if only varying, say, between ±5 per cent., can make the motor unfit for use.

There are several remedies for hunting of interpole motors. One well known way is to increase the air-gap in the main field. It is clear that if, in the example given, the main field ampere turns at the highest speed are 50 per cent. of the armature ampere turns instead of 30 per cent., then brush currents of value of ±5 per cent. would have a smaller influence. In fact the brush currents would not even obtain this value, as the variation in brush current itself is reduced by reduced hunting and the cumulative effect is avoided. Therefore it often occurs that a small increase of the air-gap of the main field cures the trouble.

Another means is to rock the brushes forward in the direction of rotation. This has a double effect. First of all, the flux going through the commutating pole itself will now assist the main pole of the same polarity. Secondly, the brushes are no longer subjected to the full influence of the commutating pole. We know that by lessening the commutating field we lessen the demagnetising brush currents automatically. It is quite possible to bring, by this procedure, the brushes into such a weak field that the brush currents never weaken but always strengthen the main field. Anyhow, the actual shifting of the brushes by an angle α adds a number of magnetising ampere turns corresponding to the double angle 2α, and, therefore, demagnetising brush currents are set up they can be more than counteracted by these magnetising ampere turns, and by the assisting value of the commutating pole field.

This means, however, is only applicable in non-reversible motors, as, of course, the forward brush position for one direction would turn out a backward position for the other direction and aggravate the evil. For reversing motors the brushes have to be kept in the no-load neutral, and then it is important to keep the ratio between interpole ampere turns and armature ampere turns as low as ever compatible with good commutation. For this purpose the air-gap between interpole and armature should be made small, the pole tip should be shaped so as to give very small leakage, and the body of the interpole should have sufficient section so as to prevent saturation, and then it will be quite possible to commutate with a slight excess of interpole ampere turns. A well-designed machine is not so sensitive as to strike work if the commutating field is, say, 10 per cent. higher or lower than the best value, and here the negative margin should be used. Then only for very low currents the commutating field is slightly higher than the ideal value corresponding to these currents, but the demagnetising action is so small that it does not produce any appreciable

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effect, especially considering that for such small armature currents the field distortion due to cross magnetisation is also negligible. For higher currents the commutating field will be on the low side. The brush currents, therefore, will not tend to decrease but even slightly to increase the main field, which tendency may partly be neutralised by the field distortion due to armature reaction.

There might be the objection that the commutation must be impared by keeping the commutating field on the low side. This would be true to a certain degree if we would consider only the stable conditions, but hunting impairs the commutation far more than an intentionally low value of the commutating ampere turns. For, as we have seen, when hunting begins the current may rise to such a value till the point is reached, anyhow, where the commutating field is too weak, for only this checks the further speeding up. But as we know that oscillations always necessarily go beyond the point of static equilibrium, the current in a hunting motor will increase considerably beyond this value, and the commutation, therefore, will surely be worse than if the commutating field from the beginning is weaker and does not give rise to hunting.

In some cases it might be sufficient to reduce the width of the brushes.

CORRESPONDENCE.

THE EDUCATION AND TRAINING OF ENGINEERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to Dr. S. P. Smith's letter under the above heading in your current issue, and to your editorial notes on same, I beg to confirm what you say regarding the numbers of engineering students at the City and Guilds (Engineering) College, (late Central Technical College), South Kensington. As your figures show, the numbers taking the final year's courses must be reckoned by the hundred rather than by the dozen or half-dozen mentioned in Dr. Smith's communication. Dr. Smith also refers to the employment of technically trained men. Might I be allowed to say that the "enlightened employer" is not quite such a "rara avis" as Dr. Smith supposes. There has been a distinct move in the right direction during recent years, and several progressive firms now make a practice of applying some months before the end of our session for names of men we can recommend for employment. One such firm has taken seven of our men this month. This feature has become most marked in electrical engineering, and for the past two years my chief difficulty has been, not to find posts for our men, but to find men for the posts offered. In fact, the demand has exceeded the supply.

It is to be hoped that this satisfactory state of affairs will continue, for in addition to showing that the services of technically trained men are being more appreciated, it is also indicative of revival of business in electrical circles.

South Kensington, July 31. T. MATHER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I regret I did not make sufficiently clear in my letter of the 20th inst. what I meant by "departments of engineering." In most colleges, engineering is usually taught in several departments, such as civil, mechanical, electrical, mining, metallurgy, naval architecture, and it was these departments I had in mind when I mentioned that "in many of the departments scarcely a dozen students reach the course in the final year, and in many colleges this number would have to be halved."

This statement, strange though it may seem, you will find amply borne out from the examination lists published in the calendars of the provincial universities in this country; indeed, in several cases, the *total* number of engineering students, in the degree course, *successful* in their final year is below twelve.—I am, &c.,

Birmingham, July 31, STANLEY PARKER SMITH.

THE PRESENT STATUS OF OZONE WITH REFERENCE TO AIR PURIFICATION.*

BY R. D. SMALL.

The development of ozone for industrial uses, water purification and ventilation has progressed rapidly since 1903, a date which seems to be the median line between inaccuracy and accuracy, so far as determination, concentration, economical operation, properties and uses of ozone are concerned. In 1890, the French Academy of Sciences appointed a commission to report on the status of ozone in Europe. After a lengthy investigation, their report submitted proved absolutely inconclusive. The members were almost divided as to what they recognised had been scientifically proved. From 1895 to the present date the whole subject has been largely taken out of the laboratory and put on a commercial plane, and this has been chiefly dependent upon the progress and developments that have taken place in the electrical industry.

For air purification purposes, to a consideration of which this Paper is devoted, ozone is now being made with generators, which first change the direct current to an alternating current, preferably with a frequency of not less than 60, and then step-up the voltage to from 5,000 to 30,000, although it is now thought that to obtain the best economies, a voltage under 8,000 is poor practice. The discharge is made by electrodes on either side of a dielectric, such as glass, micanite, mica or some high insulating material, there being an air-gap between the dielectric and the electrodes. The electric glow, which has no sparks such as are exhibited in the voltaic arc, and which is comparatively heatless, is a brush discharge, purple in colour and fairly quiet in its action. Various types of condensers and electrodes have been used from 1859 down to date. The consensus of modern opinion is that point electrodes, such as employed by Andreoli and others, have disadvantages; first, because they quickly lose their pointed character and round off, or, second, because a minute particle of dust can do a great amount of destructive work on a small point in generating heat and interrupting the flow of electricity; third, because the necessary cleaning of an infinitely large number of points requires too much attention. Leon Gerard, one of the leading electrical engineers of Belgium, states: "The aigrette or point electrodes apparatus has only 55 per cent. efficiency of those where the glow discharge is used." Other types of electrodes are either plates or cylinders on either side of a dielectric material, and these appear in various forms—flat, serrated, gridded or perforated. Another type is the covered electrode, with no metal exposed, which is very commendable. A fourth in use is a rotating fan electrode, such as is shown in the Vohr type, which has the advantage of quickly forcing the air through the generating field and ozonising it at the same time, thus giving a high purity of product. It is generally regarded as axiomatic that the briefer the period of ozonisation, the purer the resultant gas, purity meaning practically an absence of oxides of nitrogen, which are principally produced by heat, sparking or the presence of dirt. The amount of nitrous oxide generated by any properly made type of air ozoniser, however, is so infinitely small that it can be totally disregarded. This statement, however, does not apply to all ozonisers, as will be later explained. It may be stated that the more modern machines consume in operation 40 to 250 watts per hour.

Of all known subjects which are intimately connected with our health and working efficiency, the least understood, the least attended to, with the most widely varying opinions in regard to it, is the subject of air purification and the chemistry of the air we breathe. What is the harmful part of bad air? The consensus of modern chemists, physicists and scientists on this subject is absolutely conclusive; it permits of no debate. Experiments have been tried, tests have been made, and the old bugaboo—carbon dioxide—has been effectually exposed. Many persons used to entertain an idea which is rapidly becoming obsolete, that is, that the carbon dioxide in the air is the particular thing that creates the harm. Carbon dioxide is harmful only in that it reduces the oxygen supply by displacing it. As long as you can get the proper percentage of oxygen in the air that you breathe, the amount of carbon dioxide produced in any chemical laboratory can be present, according to the best scientists of the last 10 years, to an amount of 20 times that which many engineers put as a figure destructive to life. Carbon dioxide is not poisonous, but when present in quantities in any air it is a danger sign that impurities exist in that air. It is a signboard, and not the danger itself. It is the organic impurities exhaled at the same time as the carbon dioxide that are poisonous, so merely getting rid of carbon dioxide is a good deal like burning up the danger sign to get rid of the danger.

* Abstract of a Paper read before the American Electrochemical Society.

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Organic impurities come from a variety of sources, as has been previously mentioned. In all confined spaces, however, the chief source of air pollution is the organic matter cast off through the pores of the skin and the nose, throat and mouths of the individuals occupying that space. The longer that matter which the body has cast off remains suspended in the air, the quicker it deteriorates. When it reaches a putrescent state, it is unfit to be re-breathed. This air is sewage, and is just as unfit to take into the system as diseased meat would be unfit for the stomach. What our body has cast off it is safe to assume is unfit for further use. This organic impurity has recently been called "crowd poison," according to Dr. Fischer, in "Ozone and Air Purification." He states: "What is known as 'crowd poison' is responsible for many of the bad air diseases. A large amount of decomposition is continually going on upon the surface of the body and in the nose, mouth and throat of every individual, so that large quantities of these 'decomposing products' are thrown out into the air. As these substances are formed more rapidly when there are a number of persons confined to the same space, they have been called 'crowd poisons.' Wherever there is decay, there is bound to be odour, and the unpleasant smell in confined spaces is due to this 'crowd poison.'

So that it would seem that, while ventilation is necessary to bring in out-of-door air to replace the oxygen which our breathing uses up, outdoor air alone is absolutely insufficient to purify the indoor air. It never did and never will destroy the impurities that constitute the danger element. Nature purifies her atmosphere with ozone. Man can purify it only with ozone. Nothing has been said about ozone as a deodoriser. Its properties are remarkable in this line, and with higher concentrations, almost any odour known—excepting the extraordinary perfumery from the pole-cat—can be successfully combatted. In an office, factory or home, the chief odours to be eliminated come from tobacco smoke, cooking, laundry, sick-rooms or any overcrowded spaces.

It now seems to be regarded as an accepted opinion that colds and kindred diseases come from bad air, chiefly because bad air disturbs that part of the nervous system which regulates the blood circulation, and local blood congestion ensues, bringing with it an interference with certain bodily functions which destroy the bacteria constantly taken into the system. Thus infection occurs, lowering resistance to disease, and we start with colds, which are frequently the forerunners of tonsilitis, bronchitis, pneumonia, and even tuberculosis. Undoubtedly ozonised air acts as a preventative of conditions which bring about many of our colds, and it is on the preventative rather than on the curative side that it has a serious claim to consideration. Pure air will help the body to cure itself, and that is all that ozonised air in a concentration proper for breathing will do; but interrupted administrations of ozone in high concentrations certainly cannot be seriously considered as beneficial as its continued use in more diluted and diffused form.

The use of ozone in the purification of air is undoubtedly one of the most valuable of the newer achievements of electrochemistry, first, as a preventative of conditions which undermine health; second, as a promoter of working efficiency, which involves the third—an increase of business output, so that commercial and physical welfare are materially aided by a little boxed-up lightning placed in one's office, factory or home.

LONDON COUNTY COUNCIL TRAMWAYS.

On Tuesday the Highways Committee of the London County Council submitted the accounts of the tramway undertakings for the year ended March 31.

The accounts have been approved by the Finance Committee. The tramways system on March 31, 1911, extended over a total length of 143⅔ street miles, 126¼ miles of electric and 17⅓ miles of horse lines. The whole of the system is worked by the Council with the exception of 2¾ miles (partly double and partly single line) of track in Harrow-road and ⅜ mile (double line) in Archway-road, Highgate, which are worked by the Metropolitan Electric Tramways. The capital expenditure on the undertaking up to March 31 was £11,618,836. 17s. 7d., of which £909,333. 1s. 9d. represents expenditure during 1910-11. The total sum provided for redemption of debt amounted to £1,710,162. 19s. out of revenue, and £328,716. 4s. 3d. from proceeds of sales of horses, old materials, &c. The net debt, after deducting £114,458 in respect of value of surplus land was, therefore, £9,465,499. 14s. 4d. The Council decided on June 23, 1908, subject to the approval of the Treasury, to repay the outstanding debt (estimated at £960,000) on the capital which will be obsolete on March 31, 1914, owing to the electrification of horse tramways, within 15 years from that date. The amount of obsolete capital on March 31, 1911, was £1,750,905. 1s. 6d. Deducting amount provided out of revenue and from sales of horses, &c. (£738,905. 4s. 4d.), the amount still to be provided for in respect of capital already obsolete is £1,011,999. 17s. 2d. The total income from the undertaking during the year and the working expenses were as follows:—

	Electric traction.	Horse traction.	Total.
Income	£2,150,239 12 9	£82,578 3 1	£2,232,817 15 10
Working expenses	1,235,821 13 11	101,947 19 2	1,337,769 13 1
Surplus on working	£914,417 18 10	£19,369 16 1*	£895,048 2 9

Interest amounted to £319,165. 12s. 11d. and redemption fund to £337,825. 8s. 2d., and after paying income tax and other charges there was a surplus of £232,727. The Council decided on June 23, 1908, that provision should be made for renewals at the rate of ¾d. for each car-mile on the total car-mileage run on the electric tramways each year, and that the question of the adequacy or otherwise of this provision should be again considered at the expiration of five years. Provision for 1910-11 at this rate, amounting to £127,281. 5s. 2d., has been made. £1,947. 9s. 11d. has also been provided in respect of the lines in Harrow-road leased to the Metropolitan Electric Tramways, making the total sum transferred from appropriation account to renewals fund £129,228. 15s. 1d. The renewals fund on March 31, 1911, amounted to £527,263. 17s. 6d. The Council also decided on June 23, 1908, on the recommendation of the Finance Committee, that a general reserve fund to provide for general contingencies, should be established, to which any balance remaining, after providing fully for renewals, should be carried, and in accordance with this decision £103,497. 19s. 4d. has been transferred from appropriation account to general reserve compared with £59,878. 8s. last year. The reserve fund amounted to £176,844. 18s. 5d. on March 31, 1911.

The total operating expenses for electric traction system were £1,235,821. 13s. 11d., including £22,993. 5s. 4d. for special charges, or 6·48d. a car-mile run, compared with 6·42d. in 1909-10. The total working expenses in connection with horse traction amounted to £101,947. 19s. 2d., or 10·38d. a car-mile run. Passenger traffic receipts in respect of electric traction amounted to £2,096,913. 16s. 7d., or 11·00d. a car-mile run, compared with 11·21d. From lines operated by horse traction the traffic receipts amounted to £80,580. 0s. 9d., or 8·20d. a car-mile run, compared with 8·14d. In considering the decrease of 0·21d. a car-mile as regards electric traction, the Committee remind the Council that, as stated on May 23, 1911, in their report with regard to tramways estimates for 1911-12, the receipts per car-mile are not necessarily an accurate index of the prosperity of the undertaking. It has been found in regard to a number of routes to be financially advantageous to increase the mileage run within certain limits; for instance 120 car-miles run with receipts at 10½d. a car-mile give a more satisfactory result than 100 car-miles with receipts at 11d. a car-mile. The surplus on working, assuming the working expenses per car-mile remain the same, would be greater while the debt charges would be increased to only a slight extent. In connection with the decrease a car-mile it must also be borne in mind that the most remunerative routes were the first to be reconstructed. During the past year less remunerative lines have been electrified; moreover, the weather during the summer and autumn of 1910 was wet and cold, while the increasing number of workmen carried each year contributes to the falling off in the receipts a car-mile run. Considerable loss was sustained during the reconstruction of horse lines for electric traction, as sections of some of the routes had to be closed, and this disorganised the traffic on several important routes. The lines opened during the year include the new tramways in Farringdon-road, Lea Bridge-road, from Woolwich to Eltham, in Mitcham-lane, Southcroft-road, Wimbledon-road, and from Brockley to Forest Hill, and the re-constructed tramways in Lea Bridge-road (from Cornthwaite-road to the county boundary at Lea Bridge) and from Tooley-street to Rotherhithe New-road. The total number of passengers carried and car-miles run during the year were as follows:—

	Electric traction.	Horse traction.	Total.
Number of passengers	482,296,935 ...	22,418,391 ...	504,715,326
Number of car-miles run ...	45,744,066 ...	2,357,504 ...	48,101,570

* Deficiency.

PARLIAMENTARY INTELLIGENCE.

ROTHERHAM CORPORATION BILL.

Before Lord Lamington's House of Lords Committee on Thursday last Mr. Honoratus Lloyd, K.C. (for the Great Central Railway Co.) said the company would be hit if the Corporation's tramway, trackless trolley and motor 'bus proposals were not a financial success. Bradford and Leeds were running trackless trolley cars inside their own borders, but power to run them in outside districts should not be granted.

On Friday Mr. STEPHEN SELLON gave evidence in opposition to the scheme. In his opinion it could not be a commercial success. The average of the proposed fares and the estimates of the number of passengers were too high.

Mr. TALBOT, K.C., for the Midland Railway Co., said the very Committee before which that Bill was brought in the House below and which, through some inadvertence, had allowed the Bill to go through without hearing the opposition, laid it down in the Newcastle case that unless they had the consent of the outside authorities they could not sanction the installation of rail-less traction outside borough boundaries.

Mr. RAM, K.C. (for the Corporation) said the tramways had been so successfully administered that the opposing companies, as ratepayers,

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had received substantial remissions of rates. The Midland Railway Co. had received £870 in five years and the Great Central £1,263.

After the Committee had deliberated in private, the Chairman said the decision of the Committee was that the Bill might proceed on condition that in respect to the trackless trolley undertaking it was necessary that the whole of the equipment authorised should be completed by Jan. 1, 1914, so far as outside borough limits were concerned; that the railways opposing the scheme should come under the district rates in respect of that system so far as it was outside the borough limits; and that the Corporation should put in a depreciation clause to satisfy the Board of Trade in respect to the undertakings authorised by the Bill. Those conditions also applied to the motor-omnibus routes.

ABERDARE URBAN DISTRICT COUNCIL'S BILL.

Consideration of this Bill was commenced by a Select Committee of the House of Commons, presided over by Sir Luke White, last week.

Mr. WEDDERBURN, K.C. (for the Council) said practically the only part of the Bill that was opposed was that relating to tramways. They had made three applications for powers for tramways but had failed on technical grounds. He had technical witnesses who would tell the Committee that trams could be run in Aberdare at a fair profit, so that the only argument that remained to the Taff Vale Railway Co., who opposed the Bill, was that of competition. The County Council said the rail-less cars would wear and tear the route, but the House of Lords had dealt with that and said the Urban Council were to contribute one-third of the cost.

Mr. STEPHEN NELLON and others gave evidence in support of the Bill.

Mr. BEASLEY (general manager of the Taff Vale Railway Co.) said 75 per cent. of their passengers might use the tramways instead of the railway.

The CHAIRMAN: From one aspect you say there will be a loss to you as ratepayers and from another you say that these tramways would be so convenient for the public that they would take 75 per cent. of your customers?—That is our point. We shall be contributing to a scheme that will be depriving us of custom.

The CHAIRMAN subsequently announced that he did not think it necessary that the Committee should hear Mr. Wedderburn, K.C., for the promoters as the Committee were unanimously of opinion that the preamble of the Bill should be passed.

Mr. TALBOT objected to a clause which provided that the limitation in the weight of parcels which the trams would carry should not apply to a number of small parcels together, but the Committee allowed the clause as it stood.

TELEGRAPH (CONSTRUCTION) BILL.

This Bill has been further considered by a Hybrid Committee of the House of Commons, of which the Postmaster-General was chairman, and on Tuesday they gave their decison as to the opposition of the Caledonian and the Glasgow and South-Western Railway Companies. The object of the Bill is to authorise the Postmaster-General to carry telegraph wires where they run along the public roads, "across" railways without having to seek the consent of the railway companies. 10s. per mile of wire is now paid by the Post Office in consideration of the companies waiving the right of maintenance under agreement. The prospect of the acquisition of the telephones by the Government raised the question of the continuance of a fee of £1 per mile at present paid by the company for the right of "cross." The Government would only pay 10s., which in the case of the Caledonian Co. meant a reduction of an income of £3,600 a year by one-half. But under the Bill even that payment will be altogether extinguished, as the Post Office will acquire the right of maintenance.

The POSTMASTER-GENERAL said the Committee had come to the conclusion that the case of the two railway companies had not been established, and that they would report the Bill without the recommendation of any amendment except those which had been agreed to. He was thankful to say, after consultation with the authorities of the House and consideration of the precedents, that there was no objection to the Postmaster-General being in the chair of a Hybrid Committee, even when his own department was concerned. The decision of the Committee would have been the same had he not been in the chair.

AUTOMATIC TELEPHONES.

In the House of Commons on Tuesday Mr. V. Kennedy asked the Postmaster-General if he intended to introduce into England the Strowger and Lorimer automatic telephone systems: what had been the cost to date in connection with the experiment: and what amount was it calculated it would cost to continue the same for, say, six months.

In reply, Mr. SAMUEL said that contracts were in course of arrangement for two experimental exchanges to be constructed at Epsom and Caterham Valley on the Strowger and Lorimer systems respectively. No special expense had at present been incurred for the purpose, nor could he say at what cost would be involved in working and maintaining those exchanges. The determination of the cost was one of the chief objects of the experiment.

Greater London Railway Bill.—A Committee of the House of Lords has during the week been considering this Bill, which has already passed the Commons. Yesterday (Thursday) the Committee found the preamble not proved.

Naval Wireless Telegraphists.—In the House of Commons on Monday Mr. McKenna said, in reply to Mr. Remnant, the discharge by purchase of telegraphist ratings is not prohibited altogether, but orders are in force that all applications for such discharge shall be carefully scrutinised and allowed only in really urgent cases. With the growing requirements of wireless telegraphy in the Fleet, it is desirable that the expansion of this new branch of the naval service shall not be checked more than is necessary.

Newcastle Corporation Bill.—On Wednesday a Select Committee of the House of Lords passed the tramway clauses of this Bill, but the carrying of goods and minerals is to be prohibited if the N.E. Rly. Co. desire. The clause inserted in the Rotherham Bill, which provides that in outside areas the railway company should be assessed on only one-fourth of the annual net value of any property which they hold for making good any loss made upon the tramways in question, was also inserted.

Brighton, Hove & District Rail-less Traction Bill.—On Wednesday this Bill, which had already passed the House of Lords, was considered by a House of Commons Committee. After hearing evidence, the Committee passed the Bill, and required the completion of the work of construction within two years.

LEGAL INTELLIGENCE.

Taxation of Municipal Undertakings.

On Saturday in the Court of Appeal the Master of the Rolls and Lords Justices Farwell and Kennedy heard an appeal by Leeds Corporation against a judgment of Mr. Justice Hamilton affirming an assessment on certain Corporation undertakings, including waterworks, gas, electric lighting, markets and tramways. The Income Tax Commissioners sought to make the Corporation liable to assessment on the profits of each separate undertaking, but the Corporation claimed that as, under their special Acts, they had pooled the profits for the purpose of meeting the interests on the loans applying to the undertakings, and as the tax had been deducted in respect of the interest, they were liable only for the balance which they had to raise by rates.

The MASTER of the ROLLS said that the question was whether the Corporation could apply the profits arising from one municipal undertaking to the payment of interest on loans for another. The Corporation by their Acts had raised large loans on the security of either the City Fund or the Consolidated Fund, and in no instance did the security extend to both funds. The interest on the loans was no longer payable out of the net receipts of one or other of the undertakings, but out of the common dividend fund which they had created under their Act of 1901, and in his opinion the decision of Mr. Justice Hamilton could not be supported, The appeal would therefore be allowed.

Lord Justice FARWELL said the Crown's contention amounted to payment of income tax twice over.

Lord Justice KENNEDY dissented, and thought the appeal should be dismissed.

By a majority of the Court the appeal was allowed and the order of the Court below was reversed, with costs.

Thermal Synd. (Ltd.) v. Silicaware (Ltd.)

On Monday Mr. Justice Swinfen Eady delivered judgment in this case. His lordship said the action was brought to restrain an alleged infringement of letters patent granted to J. F. Bottomley and Arthur Paget for improvements connected with the working of silica. The patent disclosed a process for working silica whereby it could be rendered plastic and could in that condition be removed from the furnace and then drawn or blown into any desired shape. Hitherto great difficulty had been experienced in the working of silica for commercial use, chiefly from the generation of gases in the furnace. His lordship reviewed the efforts prior to plaintiffs' invention, in which the oxy-hydrogen flame and the electric arc furnace were used. So far from being troubled by the gas generation, plaintiffs' invention actually took advantage of it. A graphite rod was fixed between two electrodes and covered with glass-makers' sand. A current of 15 kw. was then passed through for half an hour, and fusion took place at a temperature of 1,800°C. The great utility of such an invention was beyond question, but defendants disputed its validity and denied infringement. Defendants imported and sold in England articles made abroad from silica; the articles complained of by plaintiffs were said to be made on the Rhine. He had had great difficulty in ascertaining the actual process used in the manufacture of defendants' articles, but it appeared that they were made by semi-fused silica. Defendants denied that their process made use of the pressure of internal gas in the same way as plaintiffs'. It was clear from the evidence that plaintiffs' process, as described in their specification, was sufficient to achieve the purpose desired, whilst, on the other hand, the evidence of defendants in regard to their exhibits was extremely unsatisfactory and unreliable. He was of opinion that the articles complained of were made by a process the same, or substantially the same, as that of plaintiffs' invention, and the separation of fused silica at the core was obtained by gas pressure. In his judgment, plaintiffs' patent was a valid one, and defendants had infringed it. He would grant the injunction asked for, with costs, an enquiry as to damage, and a certificate of validity. He also made an order for immediate delivery up, on terms that plaintiffs undertook, in case of appeal, not to dispose of the articles so delivered up, or, in the alternative, an order for destruction.

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COMMERCIAL AND INDUSTRIAL SECTION.

MUNICIPAL, FOREIGN & GENERAL NOTES.

BRITISH NOTES.

Acton.—At the last meeting of the council, Coun. Page moved to rescind the resolution to use gas for lighting the Acton Park bandstand and to accept the offer of the Metropolitan Electric Supply Co. The motion was carried by 4 votes to 3.

Barking.—Messrs. Robt. Hammond & Son, who were recently engaged to report upon the proposed extension of the electricity undertaking at a fee of 50 guineas, have now presented their report.

Belfast.—The Corporation have applied to the L.G. Board for sanction to a loan of £40,000 for extensions of plant, cables, &c.

Bingley.—The Council have adjourned discussion of the request of the Electrical Distribution of Yorkshire (Ltd.) for assent to an application for a provisional electric lighting order for Bingley. Inquiries are being made as to the possibility of obtaining supply from Bradford, Shipley or Keighley.

Bolton.—The Council have applied for sanction to a loan of £20,000 for mains extensions, &c.

Braunton (Devon).—The arrangements for the formation of the Braunton Electric Light & Power Co. (Ltd.) are said to have been completed and that a supply of current will be available by the end of the year. Mr. Alan Jenkins, of Ilfracombe, drew up the scheme, and Messrs. Crompton & Co. will carry it out.

Chartered Institute of Patent Agents.—The qualifying examination of persons desirous of being registered as patent agents will be held in November next. A notice giving particulars appeared in the "Illustrated Official Journal (Patents)" of July 5, and a copy of the notice can be obtained from the Secretary, Chartered Institute of Patent Agents, Staple Inn-buildings, London, W.C.

Edinburgh Art College.—Edinburgh Council have approved the Electric Lighting Committee's recommendation that out of the surplus of £8,431 on the past year's working of the electric lighting undertaking such sum as may be necessary to meet one half the remaining sum required for the building of the Art College shall be devoted to that purpose, on condition that the other half is met by the Government.

Electric Cooking, &c.—Mr. F. S. Grogan (of the Berry Construction Co.) gave demonstrations of electric cooking at the showroom of the National Electric Supply Co., Preston, last week.

The "Tricity" cooker was used in the demonstrations and it is stated that a 10 lb. joint can be cooked for 2½d., and that the loss of 1¼ lb. of meat, which would take place by any other method, is avoided. A pint of hot water can be obtained in 3½ minutes. "Tricity" laundry irons were also shown to be quick and effective.

Electric Lifts in Infirmaries.—Croydon Guardians last week adopted a recommendation to proceed with the electrification of two of the lifts at the infirmary and Mr. A. C. Cramb, the borough electrical engineer, was asked to prepare a specification. Mr. Cramb had advised the adoption of electric power and the approximate cost would be £210 per lift, or £250 per lift including accessories and structural alterations.

Electricity in Mines.—At the Miners' International Congress in London last week, in proposing a resolution calling upon the Governments of the different nations represented at the Congress to proceed at once with such legislation as will tend to greater safety for the mine workers, Mr. Albert Stanley, M.P., returned to his attack on electrical working in mines and said:

There are three leading amendments upon which the representatives of the miners would insist. The first would be to secure better ingress to and egress from the mines, the second for a better system of ventilation; and the third with regard to "that new, weird and intangible, but very terrible, factor, the employment of electricity in mines." Electricity was (he proceeded to tell his awe-struck audience) a strange and mysterious thing in itself, but when supplemented by the other dangers of coal mines "it became a very terrible thing indeed." He said he was supported by the best technical opinion in Great Britain (which he entirely forgot to disclose) in the view that one, if not two, of the most appalling mining accidents in recent years were due to explosives caused by sparks given off by electrical apparatus. In the disaster in the West Stanley mine every possible factor except electricity had been eliminated, and he believed that Mr. Redmayne, the Chief Inspector of Mines, held the opinion that the explosion was due to electricity. [Mr. Redmayne has nowhere to our knowledge made such a statement.] One of the greatest electrical experts in England had located the centre of the explosion at a switch-box. When they saw electrical coal-cutting machines fusing not only the cables carrying the current but the rails on the ground, it was idle to talk of the danger from candles or defective lamps in comparison with the risk from "this new and terrible agent."

Electricity in Kent Collieries.—At the meeting of the South-Eastern Coalfield Extension (Ltd.) last week, the director-general (Mr. Arthur Burr) referred to the electrical plant which the company was having installed.

He said he was a little bit prejudiced at first, because of the failure of the electricity works under the Shakespeare cliff, but when he made inquiries he found that any colliery that was being constructed or opened up without the use of electricity was quite out of date; most of the modern collieries were not only pumped electrically but they used electricity for all motive power, and some—the most modern—actually used it for their winding engines. Electricity did not cost anything like so much as steam. Their engineer told him it would be of greater benefit than steam. Mr. Metzger was appointed their electrical consultant, and he received instructions to order their electrical plant. A schedule of what was ordered could be seen by any shareholder. The total cost of the contracts was about £30,000 of which he had paid £15,000 already. Mr. Hamilton, who had relieved him of the position of managing director of the East Kent Colliery Co., and Mr. Hallingsworth were asked to prepare a memorandum as to what they thought of the situation.

In his statement Mr. Hamilton said the progress made at Tilmanstone was entirely to his satisfaction and beyond their expectations. The installation would fully answer all requirements.

Mr. Metzger reported that the power station at Tilmanstone would enable them to use electric power at Snowdown. They would get the Royal assent in August to their Bill, which would give them control of the whole of the electric power stations in that part of England.

Electricity Meter Testing.—The Manchester Justices' Committee who are in charge of the Gas Meter Testing Department of Manchester, have prepared a special report for submission to the city justices.

The committee say that, following the suggestion made by the Lord Mayor on April 28 that the testing of electricity meters should be placed under them, it was considered desirable that information should be obtained regarding the present practice of testing in Manchester. To this end the chairman (Mr. Nathaniel Bradley) met the chairman of the Electricity Committee (Mr. Howarth) on June 29. The point urged by Mr. Bradley was that, although there was no Act of Parliament to regulate the testing and sealing of electricity meters, it was desirable that the meters should be tested and sealed by an authority other than the sellers of the electricity. The report of the deputation from the committee, who visited several gas-meter testing stations in July, 1906, contains a paragraph referring to the London County Council electricity meter testing offices, which reads: "Amongst consumers of electricity and water there is a growing feeling that, their case being analogous to that of gas consumers, there *ought* to be established some independent authority for testing the apparatus of measurement similar to that provided by the Justices' Committee under the Sale of Gas Act, 1859, for testing gas meters. Naturally the feeling is particularly strong amongst the users of electricity for lighting purposes, as they notice the absence in the meter for the new illuminant of that independent testimony to accuracy which is given by the seal of the testing station in the case of gas meters; and your committee are of opinion that it should be made compulsory for the sellers of electricity or water to supply meters which have been tested and sealed by an independent authority." The committee go on to say "Some towns being producers of electricity have instituted test stations under their own control. This is the case in Manchester. There is no doubt of the desirability of an independent testing authority for Manchester, but in the absence of statutory powers the work could only be transferred by the consent of the Manchester Corporation."

The Justices met on Monday, when Mr. Bradley moved the adoption of the Committee's report abstracted above.

Mr. GEO. HOWARTH (Chairman of the Electricity Committee) said the electricity authority had rather prided themselves on the way the work of electricity meter testing was being done. They had had no complaints as to the accuracy of the meters or other instruments. The justices had no power to enforce what they proposed.

Col. CROOK said the gas meters were tested by a separate authority. It paid the Corporation to have correct meters, for he understood that as a rule, the inaccuracy was generally against the Corporation.

The report was received and referred to a committee composed of representatives of the Justices and of the Electricity Committee.

Fatality.—Mr. Sidney Douglas, an assistant mains engineer of the Lancashire Electric Power Co., was accidentally killed on Saturday afternoon at the Swinton and Pendlebury sub-station. Deceased was investigating a fault, when by some means he came in contact with the machinery, and died a few minutes later.

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Glasgow.—A deputation of Glasgow Councillors and officials of the Tramway Department is visiting the works of various makers of turbo-generators in England and on the Continent with a view to advising the Tramways Committee with regard to the turbo-generators to be installed at Pinkston power station.

Goole.—Electrical Distribution of Yorkshire (Ltd.) propose to apply for a provisional electric lighting order for this district.

Hammersmith (London).—The Council decided last week to set aside £300 from the revenue of the electricity undertaking for advertising, including the salary of the present canvasser (£156).

Haslingden.—The Corporation have obtained sanction to borrow £8,188 for electricity supply purposes. Current in bulk will be taken from Accrington Corporation, with whom a seven years' agreement has been entered into.

Heston and Isleworth.—The Council have decided to reduce the price of current to free-wired premises from 5½d. to 5d. per unit.

Hospital Lighting.—At the meeting of the Salisbury and District Joint Isolation Hospital last week the architect, Mr. J. H. Goodman, dwelt upon respective merits of air gas and electricity as illuminants. In view of the disadvantages and failures experienced in connection with air gas he recommended the electric light as more economical in the end. It was resolved that electric lighting be adopted, and the architect was instructed to obtain tenders.

Hoyland (Yorks.).—The Council have decided to engage an expert to report on the advisability of carrying out an electric lighting scheme and to give an estimate of the cost.

Inquest.—An inquest was held at Rugby on Friday into the circumstances attending the death at the British Thomson-Houston Co.'s works on July 26 of Harold R. Fisher, who was employed in the testing department.

Mr. J. M. Ralph, chief of the department, said on Wednesday morning a test was being made of a motor generator, and deceased was connecting the terminals when the accident occurred. The test was of an ordinary kind, but the connections had never been used in exactly the same manner as on this occasion. It appeared that some copper strip had been connected up with the turbine as well as with the generator, and this fact was not known to deceased and others engaged on the work. The current in the circuit with which deceased came in contact had a pressure of 2,100 volts. A verdict of accidental death was returned.

Institute of Chemistry.—The pass list for the June-July examinations, 1911, at the examinations held in London and Glasgow, show that of the 31 candidates for the intermediate examination 17 were successful:—

Messrs. J. L. S. Allan, K. C. G. Arbuthnot, B.A., R. Clark, T. W. Dermott, E. C. Evans, B.Sc., H. Gilmour, R. E. Griffiths, B.Sc., C. L. Hayes, R. P. Keith, J. G. King, R. Linch, B. B. Murdoch, M.A., B.Sc., L. J. Robb, B.Sc., J. W. Tait, M.A., F. G. Tarn, T. A. Wilson, F. G. C. Yaker.

Of 34 candidates for the final examination for the Associateship, 23 passed. In the branch of Mineral Chemistry: G. Hamilton, S. R. Illingworth, A.R.C.S., E. A. Masters, B.Sc., C. B. Roos, B.Sc., J. Sorley, A. F. Wyatt. In the branch of Physical Chemistry: Arthur Bramley, B.Sc., A.R.C.S.; in the branch of Organic Chemistry: E. Anderson, O. L. Brady, A. D. S. Dawson, B.Sc., W. Jewell, J. A. McRae, M.A., W. G. Prescott, P. Schatz, D. B. Steinberg, B.Sc., J. C. White, L. Wilson, B.Sc.; and in the branch of the Chemistry of Food and Drugs, Fertilisers and Feeding stuffs, Soils and Water: H. J. Evans, Miss M. Gazdar, B.Sc., H. Lowe, B.Sc., W. R. Pratt, H. B. Stevens, J. A. L. Sutcliffe.

Of four candidates examined for the Fellowship, two passed in the chemistry of food and drugs, &c.: J. Hawthorne, B.A., Ph.D., and A. Miller, M.B., M.R.C.S., Major I.M.S.; and one in a special examination in metal chemistry: G. H. Stanley, A.R.S.M. One candidate for the intermediate examination presented himself at Singapore in June, and passed: A. M. Bailey. The board of examiners reported on 70 candidates altogether of these 44 passed.

Itchen (Hants.).—The Council have adopted a motion to apply for a provisional electric lighting order and to make inquiries of other authorities as to the cost of installing and running electric generating gear, &c.

King's Norton.—The Council have decided to commence at once the work of laying electric supply mains in certain streets which will be transferred to Birmingham Corporation on Nov. 9, but payment for laying the cables will not be made until after the date mentioned by Birmingham Corporation.

Lanarkshire Tramways.—On Tuesday the Board of Trade inspection of the extension of the Lanarkshire tramways from Motherwell to New Stevenston took place, and afterwards the new route was opened for traffic.

Leeds.—In moving the adoption of the minutes of the Tramways Committee at the Corporation meeting on Wednesday the chairman, Ald. C. F. Tetley, referred at length to the dispute with the tramway employés as to wages and hours.

In the course of the discussion the Lord Mayor announced that Mr. Askwith of the Board of Trade had offered his services in the dispute, and therefore the appointment of a special committee to deal with the matter was deferred until Mr. Askwith, K.C., had conferred with the men.

Llanelly.—On July 19 Llanelly & District Electric Lighting & Traction Co.'s tramways were formally opened. Messrs. Balfour, Beatty & Co., who constructed and equipped the line, were complimented by the local authority's representatives on the satisfactory work done and the straightforwardness of the whole of the negotiations.

London County Council.—On Tuesday sanction was given to the following loans for electricity supply:—St. Marylebone, £4,331, Woolwich £4,841, Hackney £4,364, Islington £5,500, and Poplar £34,995.

New Tramway Proposals.—The recommendations of the Highways Committee, authorising the Council to promote legislation in the next session of Parliament for the construction of seven new tramway lines (particulars of which were given in the last issue of THE ELECTRICIAN) was agreed to.

Loughborough.—The Council have received sanction to a loan of £2,200 for the electricity department.

Of this amount £1,930 is for turbines, &c., and is repayable in 19 years, and £270 for instruments and apparatus, in 15 years.

Luton.—The salary of the electrical engineer (Mr. W. H. Cooke) has been increased from £400 to £450, and that of the chief assistant (Mr. H. A. Kell) from £140 to £165 per annum.

Melrose (Scotland.).—The Town Council has granted the application of the Electric Supply Corpn. for consent to the erection of overhead wires from Melrose to Gattonside and Darnick. It has been practically decided to erect a power station to supply electricity to St. Boswells, Newtown, and Bowden.

Newcastle-Emlyn.—The Council last week accepted the offer of the local electric light company to light the whole of the urban area, including Aberarad, for one year from July 25.

Railway Electrification.—Mr. H. Cosmo O. Bonsor stated at the meeting of the S.E. & Chatham Railway Cos. on Friday that their auditor considered that the electrification of the Brighton Company's lines had had only a small effect as regarded competition with the South-Eastern Co.'s lines. The question of electrifying the North Kent lines had been before the board, but he did not think that, in itself, the electrification of the lines from Dartford to Charing Cross or Cannon-street would pay.

Reigate.—An unopposed inquiry was held last week into the Council's application for sanction to a loan of £8,400 for additional generating plant, &c.

Rosyth.—It is stated that schedules were issued on Saturday for the contracts for the erection of a power station in connection with the naval base at Rosyth. The cost of the power station is estimated at about £250,000 out of the total of £3,500,000 expected to be the total capital expenditure on the Rosyth naval base. The contractors for the work are Easton, Gibb & Co., who are sub-letting the contract for the power station.

Southampton.—The Northam main is to be doubled at a cost of £1,156, and mains are to be extended in the Bassett district at a cost of £155.

Sanction has been received to a loan of £5,700 for enlarging the trunk mains to Portswood and Shirley.

The borough electrical engineer (Mr. H. F. Street) has been instructed to obtain prices for a condenser and an air pump.

The Tramways Committee will put in hand the work of extending the loop at Highfield-road.

Southwark (London).—The Council last week adopted an estimate of £4,456 required for the electricity undertaking and decided to apply to L.C.C. for a loan.

Stoke-on-Trent.—The Federated Council have been notified by the L.G. Board, in reference to the Council's application to borrow £60,000 for electricity supply, that formal sanction has been given for £13,094 for laying cables, but deferring sanction for those portions of the loan required for buildings and plant.

Sunderland.—The Electricity and Lighting Committee have entered into a 10 years' contract for supply of electrical energy to the Sunderland Shipbuilding Co.

Swansea.—The Rural District Council is recommended to adopt electric lighting for Birchgrove on the terms arranged last year with Mr. Evan Lewis.

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Trackless Trolley Traction.—A deputation from Edinburgh Council is to go to Leeds and Bradford in inspect the rail-less trolley system of traction, with a view to considering its suitability for Edinburgh.

Keighley Corporation have asked Bingley Council's consent to the running of rail-less trolley cars through Bingley to Nab Wood, and Bingley Council have decided to ask Bradford Corporation if they are disposed to run tramways or rail-less trolley cars to Bingley.

Walthamstow.—On Thursday last Mr. T. C. Ekin held a L.G. Board inquiry into the application of the Council for permission to borrow, amongst other sums, £5,149 for an additional feeder cable, and £1,485 for a branch feeder and stoneware conduits.

Mr. Spurr, the Council's electrical engineer, said the demand in one area up to June last was 117 per cent. in excess of the demand last year.

Coun. Pollard said that the electrical undertaking had been the making of the town from the industrial point of view.

Mr. English supported both applications on behalf of the Property Owners' Association.

Wimbledon.—On Tuesday an inquiry was held into the Council's application for sanction to borrow £7,459 for giving a supply of electricity to Maldens and Coombe.

Wireless Telegraph Notes.—It was announced last week that a captain and lieutenant (Messrs. Brenot and Menard) of the French Army had ascended from the military school at St. Cyr on a Farman biplane fitted with a new type of apparatus for wireless telegraphy, 500 metres over Rambouillet (which is about 35 miles from the Eiffel Tower). Evolutions were carried out, and a message of 22 words sent to the Tower, whence it was retransmitted to the War Ministry. An interesting feature of this transmission was that the message was also transmitted to Fez and to Metsinez (Morocco). The apparatus employed is said to weigh only 21 kilogrammes.

The French military authorities announced last week that regular wireless connection had been established between Paris and Fez (Morocco.)

It is announced that the Australasian Wireless Co., Ltd., has been formed at Sydney to take over the undertaking of Australasian Wireless (1909), Ltd., including patent rights for Australasia and British possessions in the South Seas, factory, plant, stock and installations, for £15,000 in 6 per cent. preference shares, £20,000 in ordinary shares, and £10,000 cash. 30,000 shares of £1 have been publicly subscribed, making the issued capital £65,000. The company has contracted to supply 2 high-power stations in the Commonwealth, 2 high-power stations in New Zealand, and 5 low-power stations to the steamers of the Union s.s. of N.Z., A.U.S.N. Co., Huddart, Parker & Co., and Howard Smith. The company operates the Telefunken system.

Workhouse Lighting.—At a meeting of York Guardians last week it was reported that a communication from the York city electrical engineer had been received stating that an extension of the electric supply mains was proposed, and asking guardians to adopt electric power and lighting at the workhouse. Estimates are to be prepared.

Worthing.—A L.G. Board inquiry was held by Mr. H. R. Hooper on Friday into the application of the Council for permission to borrow £4,950 for extensions of buildings and plant at the electricity works. It is proposed to put down two new 125 kw. generators driven by Diesel oil engines.

Sports.—The annual sports of the Croydon municipal tramway employés took place last week, when some good sport was witnessed.

Mr. J. Hammond won the Club Mile Cycle Handicap and the Tantalum Cup presented by Siemens Bros. Dynamo Works; L.C.C. Tramways (Belvedere) beat the P. Division of Police in the final of the Bovril Challenge Shield tug of war and "walked over" for the Tramways Cup tug of war. The tramways military band was one of the attractions, and the Mayoress distributed the prizes.

COLONIAL AND FOREIGN NOTES.

American Telegraphic Matters.—We are informed that the Postal Telegraph Co., which is the American Landline System of the Commercial Cable Co., has written an open letter to the Attorney-General of Texas setting forth :—

That a monopoly and combination in violation of the Anti-Trust Acts of that State has been brought about by the Western Union Telegraph Co. and the American Telephone and Telegraph Co. and their subsidiary companies, with the effect that 83 cities and towns in Texas and surrounding States, each having more than 1,000 population, have been cut off from telegraph competition, besides a much larger number of smaller towns, that competitive telegraph offices have been closed in 23 cities and towns in those States, and that the Postal Company is building into that territory as fast as the lines can be constructed. The Postal Company have already reached Dallas and Fort Worth and is far on the way towards Galveston and Houston, but in the meantime Texas, Oklahoma, Arkansas and parts of three other States are practically without competition in telegraphy on account of this combine.

This open letter, we learn, is in response to an inquiry by the Attorney-General, who is investigating the subject in accordance with a resolution of the legislature of Texas. The open letter ends as follows: "We can maintain offices in all of your chief cities and towns, and intend to do so, and you may rely upon it that when we open offices in those cities and towns they will stay open and will not pass under the control of the Bell Company or the Western Union. We shall not enter into any combination, neither shall we sell out. The Mackay interests are entirely able to take care of themselves and are strongly intrenched in finances, organisation and fast service, and are not afraid of what seems to be the crushing out campaign of the combine."

Australasia.—Mr. G. T. Elder has entered into a contract to supply electrical energy for lighting Mudgee (N.S.W.).

Perth City Council have had a report prepared by Mr. H. Edmiston on routes which could be followed in providing an electric tramway service to supplement that owned by the Perth Electric Tramways (Ltd.). The report deals with 13¼ street miles (= 18 miles single track), and the estimate includes £40,000 for rolling stock and various sums for car-shed, workshops, feeders, overhead equipment, &c., the total expenditure being £179,394, exclusive of cost of land (if any) and preliminary and legal expenses and street widenings (if necessary).

The Courts have sanctioned the proposal of the Morthake (Victoria) Butter & Cheese Factory to instal electricity generating plant to supply current for their own use and also for public lighting. An Order in Council has been applied for.

The action brought by the Ore Concentration Co. (1905) and the Australasian Ore Concentration Synd. against the Sulphide Corpn. for alleged infringement of the Elmore process, has been dismissed with costs.

Messrs. Lincolne and McDougall are preparing plans, &c., for the electric lighting of Rutherglen (Victoria).

The Minister of Public Works has authorised the erection of electric cranes at Carrington Wharf, Newcastle (N.S.W.)

The Electrical Employés Union (N.S.W.) are applying to the Wages Board for the following amendments of the Boards' award of June, 1910: Men on shift work on private installations, if required to work on public holidays, to have two week's leave annually on full pay, and if they work on holidays in addition to ordinary working days that they shall be paid at time-and-a-half rates, and that men who attend to steam and electric plants combined shall be paid 11s. a day.

Conditions are being arranged for supply of electricity by the Tallangatta Butter Factory to Towang Shire Council for lighting Tallangatta.

Mr. W. G. T. Goodman, chief engineer and manager of the Municipal Tramways Trust of South Australia, has been appointed to report on the proposal to construct an electric railway from Hobart to Huon (Tasmania).

The acting Premier of Victoria, the Hon. W. A. Watt, has promised to submit to Parliament a scheme for the electrification of the Melbourne suburban railways.

Bolivia.—A hydro-electric plant is being equipped to supply the town of Oruro with light and to work the new electric tramways to the villages on the outskirts.

The first Diesel engine in this district was ordered by Mr. T. J. Hoope M.E., for the Berenguela mines; a second of 350 H.P. is being erected for Mr. S. Patiño's Uncia mines, and a third (150 H.P.) has been ordered by the Electric Light Co. of Cochabamba.

The question of obtaining water-power from the rivers beyond Uncia to supply electric power to all the mines in the district has been considered but was found to be too costly.

A French firm of contractors has asked the Bolivian Government to contribute £150,000 towards the cost of construction of a metre-gauge railway to connect Sucre with Potosi, a distance of about 136 miles. It is proposed to use electric or petrol driven cars both for passengers and goods.

Brazil.—The Sao Paulo Tramway, Light & Power Co. (a company incorporated in April, 1899, under the laws of the State of Maine U.S.A.) exploits certain concessions for running street railways and for supplying electricity for light and power in the city of Sao Paulo. A considerable proportion of the capital was subscribed in the United Kingdom.

The company utilises a waterfall of the Rio Tiété (23 miles from the city), which is capable of developing up to 60,000 H.P., and electric energy is transmitted to the city by overhead cables. The company owns 105 miles of tramway, and supplies current for lighting to over 5,000 customers, using some 72,000 8 c.p. lamps, and power to over 500 customers using nearly 15,000 H.P. The working of the company has been successful from its inception, and good dividends have been paid. For 1910 after having paid a dividend of 13 per cent., £200,000 was placed to reserve and £273,000 carried forward.

Abundance of hydraulic power is one of the most valuable natural assets of the state. The principal falls are the Rio Grande (600,000 H.P.), Rio Parana (447,000 H.P.), Rio Tiété (159,300 H.P.), Rio Jaguer (50,000 H.P.) and Rio Branco (15,000 H.P.); total 1,271,300 H.P. There are also a large number of lesser falls, giving a further aggregate of 1,000,000 H.P. The water power already utilised is about 80,000 H.P.

Canada.—A "Standard" correspondent states that supply from the Winnipeg municipal power plant will be available this month

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Negotiations are proceeding for the purchase by the Municipality of all the company's franchises—street railway, electricity, gas, &c.

It is expected that the Winnipeg hydro-electric generating station at Point du Bois will be working by Aug. 15, and that electrical energy will be transmitted to the receiving station in the city on that day. Mr. Chace, the engineer superintending the construction work, thinks the regular supply to customers will commence from two units of the power plant on Sept. 15. These first two units will generate about 4,000 H.P. each. According to present estimates three further units, making a total of about 20,000 H.P., will be ready and in commission by Dec. 1.

Copenhagen.—The Municipal Council took over the working of the town electric tramways on Tuesday.

Cuba.—According to the "Engineering News" a concession has been granted by the Cuban Government to the Cienfuegos, Palmera & Cruces Electric Power & Rly. Co., to construct approximately 450 km. (280 miles) of railway, to build dams, impound water and generate electricity.

The railway will have numerous branches to various sugar plantations on the south side of the island and will touch Rodas, La Isabella, Santa Clara, Caribarien, Salamanca, Placetas, Nazarene, Fomento and Zaza. Included in the concession is the right to use the public highways and to acquire private property where necessary. The concession further grants the use of all public waters on the Hanabanilla and Negros Rivers, where a hydro-electric plant will be erected to furnish motive power for the railway. No duties are to be levied on machinery or supplies imported in the operation or construction of the line.

France.—Frequent electric trains running in a tunnel 12 miles long, called the Galerie de la Mer, bring coal down from the mines of the Charbonnages des Bouches-du-Rhone at Gardanne to Cape Pinède into the port of Marseilles, and immediately over this tunnel at Les Aygalades a German firm (of Neuhausen) have established a factory for the extraction of alumine (carbonate of aluminium) from bauxite. The work can be carried on under best conditions, as coal is raised through a well from the tunnel, and water, electrical energy (from the power station at Janet) and caustic soda (from the Solvay works at Les Salins de Geràud) are all within easy reach.

The Provence shipyards established 11 years ago are thoroughly equipped with electric power. 34 ships were launched during 1910, one vessel being of 11,829 tons displacement and 538 ft. in length.

On July 21 a new law was published authorising Paris city authorities to borrow £9,600,000 for the completion of the Paris Metropolitan Railway.

Germany.—British Consul R. Bernal, at Stettin (Pomerania), reports as follows:—

Electric power stations are being erected in various parts of this province to supply towns, villages, estates and farms with electric light and power. Several of these stations are already working. They will be of great assistance to small farmers and artisans requiring power at a cheap rate, but there appears to be some doubt whether large landed proprietors will benefit to a similar extent. Up to the present steam engines have been used for agricultural purposes; it has, however, latterly been found that the cost of electric power is considerably higher. Current required for a threshing machine of average size is said to cost 2s. 1d. per hour; larger machines as now used would cost about £1. 5s. to £1. 10s. per 10 hours. Steam engines on the other hand consume about 7 cwt. of coal during 10 hours and 1 cwt. to 2 cwt. more when driving the larger threshing machines. For heavy agricultural machinery the steam engine would therefore be the more economical.

Mr. Bernal does not give his authority for these figures, nor other essential details.

Italy.—A new law was recently published allocating 3,210,000 lire (£128,400) for extensions to the State telephone system. Provision is included for the establishment of international lines as follow: Rome-Milan-Simplon, Turin-Milan, and Genoa-Milan, for communication with Germany; Milan-Swiss Frontier (Chiasso) and Milan-Swiss Frontier (Simplon), for direct communication with Bâle and Zurich.

The concession for the construction and working of an electric railway between Domodossola and the Swiss frontier has been formally awarded to Sig. J. Sutter.

The Societa anonima Elettrica della Sicilia Orientale has practically completed its plant for the supply of electric power in the Catania district of Sicily, and the Société Anon. Tramways et Eclairage Electriques à Catane is about to construct an electric tramway (in which the first-mentioned company is also interested) between Catania and Acireale.

South Africa.—The Postmaster-General of Southern Rhodesia recommends the erection of two additional copper telegraph wires along the railway from Salisbury to Bulawayo and Ramathlabama, at a cost of £20,000. He also proposes to introduce the double wire system in lieu of the existing single lines in the Bulawayo telephone system.

Spain.—Don Isidro G. Lastra has applied to the Public Works Department, Madrid, for a concession for the construction and working of an electric tramway from RENTERIA to the French frontier (province of Guipúzcoa).

Switzerland.—A consular report from Davos says that for some years activity has been shown in utilising the water power of mountain streams. About 17 years ago this source of power was used to supply the whole of Davos with electric light, small local installations having been at work for some years previously. The last few years have been marked by extraordinary development in this direction. In 1909 two mountain streams in the canton were employed to furnish electricity to Zürich—a distance of about 120 miles, at a cost of over £600,000, and during 1910 several new electricity works have been projected—two in the Engadine Valley, one at Sils, one at Bernina, and one in the Albula Valley. The Bernina scheme has been actually begun.

It is intended to run a branch line of the Rhaetian Railway, operated by electric traction, from Bevers to Schuls—the first step in the conversion of the cantonal railway network.

The "Berliner Tageblatt," says the work of the Swiss Commission for studying the electrification of the Swiss railways is progressing rapidly, and that a report will be published shortly dealing chiefly with the electrification of the St. Gothard Railway. The first route on which the electric service will be established is the Erstfeld-Biasca line. Capital expenditure is estimated at £800,000.

Trade with Brazil.—The Brazilian sub-section of the London Chamber of Commerce has presented to the Brazilian Minister in Great Britain a petition stating—

That at a meeting of Brazilian merchants held on Feb. 3, 1911, a resolution was unanimously passed expressing strong disapproval of the growing practice in connection with Brazilian trade of systematically undervaluing and misdescribing by means of fictitious invoices merchandise and machinery shipped to Brazilian ports; that this practice involves a considerable loss of revenue to the Brazilian Government, and is detrimental to the legitimate interests of those merchants who refuse to undervalue or misdescribe goods exported from the United Kingdom to Brazil; and that many of the other leading Chambers of Commerce in the United Kingdom, France and Germany, have confirmed the existence of the practice complained of, and have expressed in communications to the London Chamber of Commerce their strong condemnation thereof. The petition concludes by asking His Excellency to represent to the Brazilian Government the desirability of taking such steps as may be found possible to repress the practice complained of.

His Excellency has replied that a communication has been made to the proper department of the Federal Government.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Barnstaple.—The accounts of the electricity supply department for the year ended March last show capital expenditure £32,581 (increase £396), of which £6,536 has been repaid.

Revenue was £4,700, working and general expenses were £3,259, gross profit was £1,441, interest on debt required £857 and on overdraft £121, and instalment of principal repaid was £1,010, total £1,988, so that there was a deficiency for the year of £547, of which £209 has been transferred from general rate and the debit balance of £347 carried forward. Units generated were 347,581 (compared with 308,644 in previous year), 83,161 (79,240) were supplied to public lamps and 193,725 (157,142). There are 30 arcs and 183 osrams for public lighting. The total maximum demand was 255 kw. (248 kw.).

Barrow-in-Furness.—The accounts of the electricity department for the year to March last show capital expenditure £115,478 (increase £908), of which £30,167 has been repaid.

Income was £14,435 (against £13,266 in previous year) and gross profit £8,028 (against £7,384). After providing for interest and sinking fund there remained £706 (against £229), which has been placed to renewals fund. The combined maximum load was 951 kw. (925 kw.), and the combined load factor 14·99 (13·95) per cent., the traction load factor being 23·26 (22·08) on the 150 kw. generator employed. The units sold were 1,249,163 (1,130,092). There are 88,979 (83,419) equivalent 30 watt lamps connected, and the units sold per lamp (exclusive of traction) were 10·9 (10·4). The average price obtained for the total supply was 2·717d. (2·759d.) per unit. Fuel cost 0·404d. (0·420d.) per unit sold, works costs were 0·909d. (0·912d.) and total cost (exclusive of capital charges) was 1·231d. (1·249d.).

Birkenhead.—The income of the electricity department for the year ended March 31 was £25,826, including £20,542 from the sale of current by meter, and £40,26 from the tramways department, the balance being made up of motor and meter rental, &c.

The working expenses were £15,281, leaving a gross profit of £10,545. Interest and dividends on stock, &c., absorbed £5,082 and sinking fund £4,171 and after paying bank interest, income tax, &c., the balance (£952) was transferred to the district fund. The capital expenditure is £160,368, an increase of £2,889.

Bootle.—The accounts of the electricity supply department for the year to March last show capital expenditure £115,393 (increase £765), of which £38,380 has been repaid.

Revenue was £20,413, working and general expenses were £10,256, gross profit was £10,157, to which is added £394 income tax. £54 in-

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ELECTRICITY SUPPLY TABLES AND DATA.

This Valuable Set of Tables and Engineering Data relating to Electricity Supply and to Electric Traction on Railways and Tramways in the United Kingdom, the Colonies, and some important places abroad, is now ready, and can be obtained complete in handy book form, price 6s. 6d. post free, or on very hard paper for rough or constant use, price 8s. 6d. post free. A complete Index is included.

terest on money at deposit and 17s. 9d. interest on free wiring accounts. Interest required £2,507, repayment of principal £2,044 and sinking fund £2,255, reserve fund was increased by £2,300, to £11,078, and £1,500 has been applied to reduction of local rate. Units generated were 3,341,081, sold to public lamps 291,229, by contract 1,250,534, by meter to private consumers 1,498,950. There are 493 public lamps, including 174 arcs. The total maximum demand was 1,461 kw.

Carlisle.—The accounts of the electricity department for the year ended March last show capital expenditure £87,933 (increase £17,573), of which £25,746 has been redeemed.

Revenue was £14,833, and gross profit was £8,768 (increase £849) and net profit £3,346 (increase £296). The report of the city electrical engineer (Mr. S. T. Allen) says production costs, including management, rates and taxes, &c., but not capital charges, were £1,136 higher than those of the previous year (increase 24 per cent.), but the units sold increased 27 per cent., and the coal cost 10 per cent. more per ton. Interest and instalment of debt increased £486. Power units sold increased by 372,875, public lighting by 611 and miscellaneous 3,115, while private lighting decreased by 22,125 and tramway supply by 4,262, the total sold being 1,649,211 out of 2,076,793 generated. The decrease in lighting units is due to the use of metal filament lamps, although there is a steady increase in the number of lamps connected, and over 2,500 were connected during the year. Motors of 768 H.P. were connected during the year. Fuel per unit sold cost 0·26d. (against 0·24d.), and total works costs were 0·85d. (0·87d.).

Eccles.—The accounts of the electricity department for the year ended March show capital expenditure £55,508 (increase £4,266), of which £6,704 has been redeemed.

Revenue was £10,107 and gross profit £4,536, and after providing for capital charges, income tax, &c., and transferring £90 to capital account for excess expenditure, there was a surplus of £965, which has been placed to reserve. Units sold were 425,878 to private consumers, 764,285 for tramways and 97,225 for public lighting.

Heywood.—The accounts of the electricity department for the year ended March show capital expenditure £32,070 (increase £3,684), of which £14,945 has been repaid.

Revenue was £4,962 (against £5,037 in previous year), working expenses were £3,713 (£3,480), gross profit was £1,249 (£1,557). But interest and sinking fund contributions required £1,901 (against £1,433), so that the deficiency for the year was £652. In the report of the electrical engineer (Mr. Jas. Stott) it is stated that the interest and sinking fund on the last extension are included for the first time in the accounts. The units generated were 686,036 (against 674,228 in previous year), and 91,794 (95,705) were supplied for public lighting, 170,853 (69,766) to motors, and 418,889 (504,757) for traction. The decrease in consumption for private lighting is caused by the installation of metal filament lamps and the traction demand by reduced service and careful driving. Coal cost 0·53d. (against 0·57d.), and total working expenses were 1·22d. (1·23d.). The average price received was 1·71d. (1·78d.) per unit. The financial result of the year's working was due to the amount of capital the department has to repay in three years, and Mr. Stott considers it is scarcely equitable treatment for the L. G. Board to say that such a sum must be provided in so short a time, as the plant which has been cast out was not unworkable, but small and uneconomical.

The capital expenditure on the tramways is £66,624 (including £22,947, the amount of award to the Bury, Rochdale & Oldham Tramways Co.), and the loans extinguished and the mortgage sinking fund amount to £7,409. Revenue was £10,964 (£11,207), working expenses were £7,515 (£8,339), gross profit was £3,449 (£2,868), interest and sinking funds required £4,853, showing a deficiency of £1,404. Passengers were 2,084,396 (against 2,181,751), car-miles 275,064 (288,087), and units used 418,889 (504,757), or 1·52 (1·75) per car-mile.

Ilford.—In presenting the annual report of the electricity undertaking for the year ended March 31 Mr. Philpot stated last week that the mechanical stokers had acted so efficiently that while 147,000 more units had been generated the cost of coal had only increased by £5. £2,000 more had been received from their consumers than in previous years. The undertaking had been in existence just 10 years. Up to date they had borrowed £181,000, and had repaid £37,000 of capital.

King's Lynn.—The capital expended on the electricity undertaking at March 31 last was £50,766, an increase of £280.

Revenue was £6,983 (against £6,856) and working expenditure £2,569 (£2,508). Total expenses were £5,949 (£6,018) and the net profit was £1,034 (£838), of which £280 has been transferred towards expenditure on meters and £300 to district fund in relief of rates. Units generated were 525,520 (against 502,321), supplied to public lamps 129,311 (132,103), supplied for private lighting by meter 211,412 (191,669) and by contract 5,871 (5,670) and to motors and heating 132,163 (128,219). The total number of (equivalent) 8 c.p. lamps connected is 36,816 (increase 2,000). The maximum supply demanded was 345 kw. (330 kw.), and the combined load factor 15·84 (17·41). The total horse-power of motors connected is 411 (355). Fuel cost 0·44d. (0·45d.) per unit, works costs were 0·90d. (0·92d.), total costs were 1·29d. (1·31d.), or 2·99d. (3·15d.) including capital charges. Total average price obtained was 3d. (3·04d.) per unit.

Marylebone (London).—The accounts of the electricity department for the year ended March last show capital expenditure £2,051,160 (increase £23,884), of which £153,359 has been repaid or provided for repayment.

Revenue was £176,318 (against £166,572 in previous year) and gross profit was £125,878 (£121,669). Interest and special charges absorbed £75,052 (against £76,514), provision for repayment of loans £38,738 (£36,673) and the net profit was £12,089 (£8,482). Coal cost 0·268d. (0·288d.) per unit sold; generation costs were 0·432d. (0·498d.) and distribution 0·150d. (0·139d.), total working costs 0·901d. (0·961d.). Capital and special charges were 2·226d. (2·52d.) Total connections, in kilowatts, at March last were 20,643 (against 19,084 at March, 1910), including private lighting 14,992 (14,737), motors 2,486 (2,117), heating and other uses 2,771 (1,972), public lamps 393 (258) and street lighting by private lamps 1 (nil). Units generated were 15,881,452, supplied to public lamps 1,397,585 and to private consumers by meter 10,939,371, total sales being 12,336,956 (against 10,776,459). There are 87 arc and 3,516 incandescent lamps for public lighting. Maximum load was 8,333 kw. Expenditure on sales and publicity department for the year was £19,171 and the amount received for sale of apparatus, hire purchase, hire and maintenance, £16,959.

The report of the Electric Supply Committee is that electric cooking ranges can now be offered which are reliable and strongly competitive in running cost with other forms of cooking apparatus. The department bears the cost of negotiating agreements and contracts with consumers for all purposes, and there is frequently no income to set against the cost, when, as is often the case, the actual work goes to wiring contractors, but the main object is achieved, which is increased income from sale of current. Several agreements have been concluded which overcome the practice of farming out the supply of electricity by landlords of flats, which confined the tenants to the use of electricity for lighting only. This has thrown open a wide and lucrative field for the introduction of "other uses" of electricity. Consumers who have accepted the "telephone" system of charging are consuming electricity for heating and cooking in ever-increasing quantities. The figures relating to the sale of apparatus and work done for consumers show a substantial margin over prime cost, although they include apparatus sold and work done for contractors, builders and the Council, on which the margin is small. The results show that the statement that the department cuts prices and competes unfairly with contractors is, it is understood, without foundation in fact.

Stoke Newington (London).—Last week the Electric Lighting Committee reported that the accounts of the electricity undertaking showed that had Schedule II. of the agreement with the North Metropolitan Electric Power Supply Co. been in operation during the year ended March 31 last, a profit would have been secured to the Council of £223. 8s. 3d., after payment of all working and management expenses and loan charges; and that the total repayments of loans at March 31 were £3,610. 13s. 1d., and the Committee recommended that notice to terminate Schedule I. of the agreement at March 31, 1912, be given to the company. Consideration of this proposal, which, if acted upon, will place the entire management and control of the undertaking in the hands of the Borough Council, was deferred until the September meeting.

Wolverhampton.—The accounts of the electricity supply and tramway undertakings for the year ended March 31 were recently approved by the Council.

The total revenue of the electricity department was £49,935 (against £40,791 in 1910) and included £45,047 from the sale of current for private and public lighting and power. The expenses were £26,460, against £20,429, and after allowing £250 for bad debts, the gross profit was £20,225. Interest and sinking fund required £15,222 (£14,762) and after paying income tax (£140), &c., the net balance was £5,231 (£5,297). 12,981,989 units were generated and 10,818,089 units were sold: 196,918 units supplied to the public lamps, 8,165,344 to private consumers for power and light and 925,192 by contract and 1,530,635 to the tramways department. There are 62 arc and 231 incandescent lamps (against 62 and 207 respectively) for street lighting. The maximum load was 4912kw. (4,180 kw.) and the equivalent of 249,620 30-watt lamps (224,071) is connected. The decrease in the net profit is attributed to abnormal expenditure on repairs and maintenance, wages and material on capital account charged to revenue, renewals of plant and reduction in price of current for traction, and under the circumstances the result of the year's trading is considered very satisfactory, as the works costs were 0·557d. against 0·562d. There was an increase of 40 per cent. in the units sold for power, 17·6 per cent. for private lighting, 5 per cent. for traction, and 2·6 per cent. for public lighting. The increase in revenue from private

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lighting is extremely good and was the largest since 1903. The number of new consumers connected was the largest in the history of the undertaking. During the year £807 excess expenditure on capital account was charged to revenue, as were £687 for house services and £210 for "free" wiring. In future the Committee will allocate all future expenditure on "free" wiring to revenue or reserve fund. Motors of 769 H.P. were added during the year, and, apart from the important contract with Messrs. Bayliss, Jones & Bayliss, the demand for power is advancing very satisfactorily.

The receipts of the tramways undertaking were £49,710 (against £45,500), including £48,611 passenger receipts and £298 from parcels. The expenses were £28,892 (£27,585) and the gross profit was £20,818 (£17,915). Interest was £7,714, and after paying income tax and other items and crediting interest on investments, the balance was £13,113. The repayment of loans and sinking fund required £4,847, and £4,118 was placed to renewals and £2,023 to reserve fund, and the balance (£2,125) was devoted to relief of rates. 10,646,802 passengers were carried (against 9,670,657) and 1,126,607 (1,030,720) car-miles run. The gross capital expended is £277,410. The Committee are pleased with the reduction of 0·268d. per car-mile in the total working costs (6·155d. against 6·423d.) for the year.

TRADE NOTES AND NOTICES.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1911 Edition of the Big Blue Book is READY, price 15s., post free in the United Kingdom, 15s. 9d. The volume brings a great mass of very valuable statistical and technical data quite up to date, and the Directorial Division has been thoroughly revised and amplified up to February 24th.

All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters receive every attention in the new volume, which aggregates more than 2,000 pages. The Directory Division is complete and thoroughly accurate, and has been completely revised. The Big Blue Book contains more names of live electrical firms and persons than any other Directory published, and this notwithstanding that all mere lists of members of Societies and Institutions (so easily and cheaply available) are excluded, as unreliable and of little value for Manufacturers' and Dealers' purposes. The full set of valuable Statistical and Engineering Tables, &c., have been very carefully revised and extended, and are now issued in a handy form. These are included in the 1911 Big Blue Book, making it the most complete work of the kind ever published.

TENDERS INVITED.

The COMMISSIONERS OF H.M. WORKS AND PUBLIC BUILDINGS are required to receive tenders for the supply of electrical accessories for three years from Sept. 1 next. Forms of tender and particulars from the Storekeeper, H.M. Office of Works, 12, Lambeth Palace-road, S.E. Tenders by Friday Aug. 18 to the Secretary, H.M. Office of Works, Storey's Gate, London, S.W. See also an advertisement.

The Council of the County Borough of WEST HAM invite tenders for (a) water tube boilers, (b) coal handling and discharging plant, (c) 1,000 kw. turbo-alternator, with condensing plant, (d) river service pipework, (e) centrifugal pumps, (f) 750 kw. converter (two-phase to d.c.). Specification, form of tender, &c., from Mr. H. H. Couzens, engineer and manager, 84, Romford-road, Stratford. Tenders to the borough clerk, Mr. Fred E. Hilleary, Town Hall, Stratford, E., by 10 a.m. on Thursday, Aug. 31. See also an advertisement.

The asylum of the Lancashire Asylums Board, WHALLEY, near Clitheroe, is in course of erection, and the Committee of Visitors will shortly be prepared to let the contract for the electrical plant. Contractors must send names and addresses by Aug. 7 to Mr. Viscount E. Clere, clerk to the Committee of Visitors, County Offices, Preston. See also an advertisement.

Tenders are invited up to Sept. 26 for the supply of telephone material and 30 miles of telephone cable to the Postmaster-General's Department in VICTORIA. Specifications, forms of tender, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W. See also an advertisement.

Tenders are invited for the supply of a desiccating plant, to the Postmaster-General's department in NEW SOUTH WALES. Forms of tender, specifications, &c., may be obtained from the Commonwealth Offices, 72, Victoria street, London, S.W. See an advertisement.

Tenders are invited up to Sept. 5 for the supply of (*a*) 10,000 protectors and (*b*) sundries to the Postmaster-General's Department in VICTORIA. Tender forms and specifications at the Commonwealth Office, 72, Victoria-street, London, S.W. See an advertisement.

BIRMINGHAM Corporation require tenders by noon Aug. 18 for erection of a tramway depot in Whitmore-street, Hockley, Birmingham. Particulars from Mr. A. Rowse, King's Court, Colmore-row, Birmingham.

ABERDEEN City District Lunacy Board want tenders by 5 p.m. Aug. 14 for electrical and other works in connection with the erection of a new steading on Nether Kingseat Farm, Newmachar. Plans, &c., with Messrs. D. & J. R. M'Millan, 105, Crown-street, Aberdeen.

Tenders are invited by the FARNHAM GAS & ELECTRICITY CO. for the supply and erection of two high-speed Diesel oil engines coupled to two 90 kw. alternators with direct-coupled exciters, piping, tanks, overhead traveller and accessories, and main high-tension switchboard. Specifications, &c., may be seen at, but not obtained from, the offices of the consulting engineers (Messrs. Handcock & Dykes), 11, Victoria-street, Westminster, S.W., and obtained from the Secretary, to whom tenders by noon Aug. 16.

BRUMBY and FRODINGHAM Council require tenders by Aug. 11 for supply and erection of poles, lamps, wires, &c., for lighting the streets electrically. Specifications, &c., from the Council Offices.

WARRINGTON Electricity and Tramways Committee require tenders by noon, Aug. 9 for a motor-driven induced draught fan. Specification, &c., from the Borough Electrical Engineer.

The Metropolitan Water and Sewerage Board, BRISBANE (Queensland) require tenders by noon Jan. 30, 1912, for supply and erection of (alternatively) two or three units of pumping plant (including power generating plant), to deliver 6,000,000 gallons of water at an elevation of 400 ft. per day. Forms from the Agent-General for Queensland.

Tenders are invited for the supply of 530 a.c. meters, 495 d.c. meters and 133 maximum demand indicators to the City of MELBOURNE, Australia. Copies of specification, conditions of contract and form of tender from the agents for the City Council (Messrs. McIlwraith, McEacharn & Co. Propy. Ltd.), Billiter-square Buildings, London, E.C., to whom tenders are to be sent by noon Wednesday, Aug. 9.

Tenders are invited (up to Aug. 15) for the supply of (*a*) 80,000 insulators and (*b*) indiarubber covered wire to the Postmaster-General's Department in VICTORIA; up to Aug. 16 for cable, conduits, c.i. pipes, iron poles, insulators, wires, &c.; up to Aug. 23 for the supply of letter box fronts to the Postmaster-General's Department in QUEENSLAND; up to Aug. 23 for telegraph, telephone and electric lighting material to the Deputy Postmaster-General in NEW SOUTH WALES; and up to Aug. 30 for supply of porcelain insulators, copper wire, sleeves, &c., to the Postmaster-General's department in SOUTH AUSTRALIA. Specifications, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W.

Tenders are invited up to Aug. 23 for the supply of telegraph and telephone material to the Postmaster-General's Department in SOUTH AUSTRALIA. Specifications, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W.

The Metropolitan Water and Sewerage Board, Albert-street, BRISBANE, Queensland, want tenders by noon Jan. 30 next for supply and erection, of one, two or three complete units, each consisting of power generating plant and pump or pumps to lift not less than 6,000,000 gallons per day. Particulars from the Secretary.

WELLINGTON (N.Z.) Corporation require tenders by 4 p.m. Aug. 24 for supply of a motor power waggon and accessories for the electric tramways department. Gonville and Castlecliff Tramway Board, Ridgway-street, WANGANUI (N.Z.) require tenders by 4 p.m. Aug. 14 for supply of overhead tramway material, feeders, &c. Conditions, &c., can be seen at 73, Basinghall-street, London, E.C. Representation in New Zealand is necessary.

The Municipal Council of BUDAPEST, Hungary, require tenders for the manufacture and supply of plant for a steam-driven electrical generating station, including two groups of three-phase turbo-generators (5,000 kw. each), 10,000 volts 50 cycles, boiler equipment for mechanical output of 5,000 kw. with reserve, pipeline, central switching and accessory equipments, travelling crane for engine room and coal-conveying plant. Specifications, &c., can be obtained at the Presidial Section of the Council, 9: IV., Városház-utca 16, II. 1, Budapest. Tenders by 11 a.m. Sept. 30.

Tenders are wanted by Aug. 15 for the equipment of electric power works, and the provision of a system of telephones and an electric lift, at the Danviks Hospital, STOCKHOLM. Specifications from the Elek-

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triska Radfragningsbyran, Rosén och Waldenström, Regeringsgatan 20, Stockholm, on payment of deposit of 55/6.

Tenders will be received at the Town Hall, SYZRAN, Russia, on Oct. 14, for the construction of an electric tramway and the supply of electrical energy for lighting.

The time for the receipt of tenders by the Ministry of Public Works, Constantinople, for an electric power and tramway concession for JERUSALEM, is extended to Sept. 13. Specifications (in French) can be seen at 73, Basinghall-street, London, E.C.

The Public Works Department, Madrid, will receive tenders on Sept. 20 for the concession for the construction of the RENTERIA electric tramway.

Tenders will be received at the Electricity and Water Offices, BREMEN, on Aug. 14 for supply of transformers.

TENDERS RECEIVED AND ACCEPTED.

London County Council have received the following tenders for roadwork and platelaying, exclusive of supply of rails and special trackwork in connection with the construction, on the overhead trolley system, of tramways from Brixton-road to Herne-hill, via Effra-road and Dulwich-road. (The tenders also contain provision for certain paving works outside the tramway tracks in connection with street widenings along the route).

	Tramway works.	Paving works.
Kirk & Randall (*accepted*)	£18,104 9 0	£9,004 11 10
Dick, Kerr & Co.	18,950 4 6	8,653 16 2
Geo. Wimpey & Co.	18,407 6 10	9,250 2 2
A. N. Coles	19 010 7 10	9,681 0 3
John Mowlem & Co.	19,846 15 8	9,002 5 11
W. Underwood & Bro.	20,681 0 4	9,962 7 5
Chief engineer's estimate	19,616 0 0	9,500 7 1

London County Council have also received the following tenders for the execution of the roadwork and platelaying, exclusive of supply of rails and special trackwork, in connection with the adaptation and reconstruction, on the underground conduit system of electric traction, of the tramways in Seven Sisters-road, between Stroud Green-road and Green-lanes, in Green-lanes and Southgate-road, &c. (The tenders also contain provision for certain paving works outside the tramway tracks in connection with street widenings):—

	Tramway works.	Paving works.
John Mowlem & Co. (*accepted*)	£66,646 2 2	£5,347 0 8
Kirk & Randall	67,015 0 0	5,616 6 0
A. N. Coles, Plymouth	67,686 1 3	5,350 17 2
Dick, Kerr & Co.	67,750 15 0	5,788 10 6
William Underwood & Bro.	80,505 19 6	5,444 13 10
Chief engineer's estimate	68,727 9 5	5,418 5 7

London County Council have also authorised the expenditure of a sum not exceeding £400 for supply and laying of points, crossings, &c., for special trackwork in connection with the Hammersmith-Harlesden tramways, and the points, crossings, &c., are to be obtained from Hadfield's Steel Foundry Co. and laid by Geo. Wimpey & Co.

London County Council have sealed a contract with the British Westinghouse Electric & Mfg. Co. for supply of standard type controllers, electrical interlocking gear and additional cables for 100 double-deck electric cars at £6,390 (including an allowance to be made by the company of £195 in respect of 10) sets of existing controllers and switches).

London County Council have also accepted the tenders of Buck & Hickman (£1,565. 12s. 10d.) and Pollock & McNab, Ltd. (£524) for supply of plant and tools for the central car repair depot.

Southampton Council has received the following tenders:—

Surface condenser: Willans & Robinson (*accepted*) £730; Mirrlees Watson Co., £750; John Musgrave & Sons, £775; Cole, Marchent & Morley, £806; Richardsons, Westgarth & Co., £860. For a 200 kw. two-phase synchronous motor: Electric Construction Co. (*accepted*), £655; British Westinghouse Co., £670; British Thomson-Houston Co., £714; Maudsley's Ltd., £760; Lancashire Dynamo & Motor Co., £847; Dick, Kerr & Co., £988.

Swindon Council have accepted the following tenders:—

Tudor Accumulator Co., battery, £1,482 and £119 per annum for maintenance; Chloride Electrical Storage Co., automatic reversible traction booster and switchgear, £1,029; Electric Construction Co., three-wire hand-regulated booster, £275.

"Commercial Intelligence" announces that the following were the tenderers, through their local agents, for the supply of 21 miles of waterproof electric cable to Shanghai Municipal Council:—

Felten & Guilleaume Carlswerke (accepted); Arnhold, Karberg & Co.; General Electric Co.; United States Steel Products Co.; Bergmann Electrical Works; W. T. Henley's Telegraph Works Co.; Union Cable Co.; British Insulated & Helsby Cables; Callender's Cable & Construction Co.; Siemens Bros. & Co.; and Dr. Cassirer & Co.

At their last meeting, Holborn (London) Council formally accepted the joint tender of the Gas Light & Coke Co. and the Metropolitan Electric Supply Co. for street lighting at £7,654 per annum.

Luton Council have placed an order with the Hudson Economiser Co. for a cooling tower at £637. 10s., and that of Hayward, Tyler & Co. for a motor-driven feed pump at £120.

King's Norton Council have placed an order for the supply and laying of electric cables with Callender's Cable & Construction Co.

Eccles Council has accepted the tender of Korting Bros. for supply and delivery of a motor-driven centrifugal pump at £185.

The tender of Babcock & Wilcox has been accepted by Salford Council for the supply and erection of a water-tube boiler, superheater and mechanical stokers at £2,025.

Gloucester Electricity Committee have accepted the tender of Drysdale & Co. for a circulating pump at £135.

The tender of C. Suckling & Co. (at £65) has been accepted for wiring the Hendon hospital.

Peterborough Council have accepted the tender of G. Andrew & Co. for electric light fittings for Lincoln-road schools.

Bridlington Council have placed an order with A. C. Dickins for electrical fittings for the St. John-street schools.

York Council have accepted the tender of Callender's Co. for h.t. cables at £2,640.

The contract for the electric lighting at Victoria Hospital extension, Burnley, has been secured by Mr. R. B. Beattie.

Belfast Corporation have accepted the tender of the Ree Roturbo Mfg. Co. for a circulating pump, and that of the Worthington Pump Co. for a motor-driven air pump.

Wireless Telegraph Contract.—The "Marconigraph" states that a contract has been entered into by the Marconi Wireless Telegraph Co. and the Italian Government for the erection by the company of a 60 kw. station in the vicinity of Rome.

The building, masts and material are being supplied by Marconi's Wireless Telegraph Co., the erection of the masts being carried out through the intermediary of the Italian agency. Six towers in iron and wood of the Coltano type are being erected, two each being 75 metres high, and the remaining four each of 45 metres in height. These will support a multiple wire T aerial of a total length of 360 metres; the surface occupied by the aerial will be about 14,000 sq. metres. The Italian Government are erecting the building, which will contain engine power, battery and operating rooms, stores, waiting and staff rooms, and the necessary adjuncts. In the engine room, which will have a floor space of 32 ft. by 25 ft., there will be installed duplicate 50 B.H.P. Diesel oil engines, each driving, by means of a belt, a 30 kw. continuous current dynamo. Two 32 kw. low-frequency inductances will be provided for regulating the frequency of the discharge circuit to the value necessary for the number of sparks adopted, and, in addition two 32 kw. high tension transformers will be installed to transform the alternating current by the group of generators to the required voltage for the condensers. The receiving apparatus will consist of a valve receiver adapted to receive all words comprised between 2,650 and 6,500 metres. In addition to the valve receiver, a magnetic detector will also be furnished. The station is to test to Poldhu, and will have a normal power of 32 kw., and overload up to 100 kw. The exact arrangement of the plant for this overload has not yet been determined.

Commonwealth Contracts.—The Postmaster-General's Department in New South Wales have accepted the following tenders:—

Western Electric Co., telephone switchboard cable; Gibbs, Bright & Co., paper-insulated lead covered cable. The following are successful tenderers for the supply of telephone, telegraph and electric light material for 1911:—Western Electric Co., Jas. Paton & Co., British Insulated & Helsby Cables, General Electric Co., Noyes Bros., W. T. Henley Telegraph Works Co., R. J. Connolly, W. G. Watson & Co., Lawrence Hanson, British & Foreign Indent Co., Siemens Bros. Dynamo Works, India Rubber, Gutta Percha & Telegraph Works Co., Bullers (Ltd.), F. G. King, Haes & Eggers, Vacuum Oil Co., British Ever Ready Electric Co., Acme Bolt & Nut Co., Thornton & Watson, Williams & Co., Thesen Zwicker & Co., R. Johnson, Clapham & Morris, Geo. Cradock & Co., Brownlow, and H. A. Burnside.

The Victorian Railways Department have accepted the tender of Alfd. Adams & Co., for 50 electric bells, £179. 7s. 6d.

BUSINESS NOTICE.

Mr. Henning Proe, engineer and importer of electrical plant and other machinery, has opened offices and showrooms at 343, Re street, Sydney, N.S.W.

Summer Holidays.—The works and offices of the Electric Ordnance Accessories Co. (Ltd.), Aston, Birmingham, will be cl from the evening of Aug. 4 till Aug. 14.

The Dalston offices and stores of Siemens Brothers Dyna Works will be closed from Aug. 7 to 12.

The White Electrical Instrument Co. (formerly Electrical Dept Jas. Pitkin & Co.), Clerkenwell, London, give notice of closing fr Aug. 7 to 12.

The works and offices of the Crypto Electrical Co., Bermonds street, London, will be closed from noon Aug. 5 until Aug. 14.

In each case a small staff to deal with "urgent" matters will retained.

Sales by Tender.—Owing to their taking supply from the Dist Council, the directors of the Rugby School Electric Lighting

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invite tenders for 100 B.H.P. and 75 B.H.P. Crossley gas engines, two Tulli's belts, 50 kw. Mordey and 35 kw. Brush alternators (with exciters), 2,000 volts, 100 periods, Dowson gas plant, five cooling tanks, boiler, switchboard, instruments, gas meter and sundry transformers and meters. Tenders to Mr. A. E. Donkin, Iverley House, Rugby, by Aug. 19. The plant can be seen by appointment. See advertisement.

Pursuant to an order of the High Court, tenders are invited for the purchase of the undertaking carried on by F. A. Glover & Co. (Ltd.) (in liq.) at Vine-street, E.C., and Maclise-road, Kensington, London, and at Windsor (as Windsor & District Electrical Co.), Slough (as Slough & District Electric Lighting Co.), and at Caversham, together with the stock-in-trade, works, plant, &c., at the London businesses and branches. Tenders by noon of Aug. 31 to the receiver (Mr. A. F. Whinney, C.A.), 4B, Frederick's-place, Old Jewry, London, E.C. Particulars and conditions, with forms of tender, from the Receiver, and of Messrs. Mills & Morley, solicitors, 38, Lincoln's Inn Fields, London, W.C. See also an advertisement.

Patents Development.—The proprietor of patent No. 29,363/1904, for "Improvements in and relating to electrical measuring instruments" desires to enter into arrangements by way of licence and otherwise for ensuring the development and practical working of same in this country. Apply to Messrs. Haseltine, Lake & Co., Chartered Patent Agents and Consulting Engineers, 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

The proprietor of patent No. 18,842/1907, relating to "Means for receiving intelligence communicated by electric waves," wishes to dispose of the patent or to grant licences. Applications to Messrs. Cruikshank & Fairweather (Ltd.), 65 & 66, Chancery-lane, London, W.C.

"The Journal."—Part 203 of the "Journal" of the Institution of Electrical Engineers is now ready, price 5s. Particulars of contents are given in an advertisement.

BANKRUPTCIES, LIQUIDATIONS, &c.

A dividend is to be paid to creditors of John D. Carlmark, electrical engineer, 402, High-street, West Bromwich. Claims to Mr. A. S. Cully, 191, Corporation-street, Birmingham, by Aug. 12.

Alfd. Sitch, electrical engineer, &c., 77, Brecknock-road, London, has been adjudicated bankrupt.

A meeting will be held on Aug. 14 at 2, Coleman-street, London, E.C., to receive an account of the winding up of the Buchholtz Reversible Turbine Synd.

On Tuesday meetings of creditors and contributories were held in the liquidation of J. G. Childs & Co. (Ltd.), Hawthorn-road, Willesden Green, N.W.

Mr. H. E. BURGESS, senior assistant official receiver, reported that the statement of affairs showed unsecured liabilities £20,640, assets valued at £3,410. The receiver appointed on behalf of a debenture holder for £5,000 estimated the assets at £2,000 or £2,500, and it did not appear likely, therefore, that the unsecured creditors would receive any dividend. The company was formed in Dec., 1901, to take over the business of electrical engineers previously carried on by J. G. Childs. The purchase consideration was about £7,300, of which £5,300 was payable in shares. The trading of the company had resulted in a loss throughout, the total during the company's existence being £15,000. Certain patents taken out by Mr. Childs relating to wind turbines were considered to be valuable, and he did not think those patents were included in the estimate of assets. The liquidation was left with the O.R.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

*NOTE.—The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application, an asterisk is affixed.*

May 29 1911.

12,792 BALL & LINGARD. Electric telegraph insulators and the like.
12,828 SMITH, MAJOR & STEVENS, MAJOR & KENNARD. Electrical reversing apparatus for remote control.
12,860 BARTON & SONS & HARPER. Fittings for electrical conduits.
12,896 DUNTON. Signalling devices for telephone systems.*
12,907 PETSCHAUER. Telephonic relays.
12,918 B.T.-H. Co. & F. WHITAKER. System of electric distribution.
12,919 B.T.-H. Co. & J. WALLACE. Electric switches.
12,920 B.T.-H. Co. (G.E. Co., U.S.) Casting copper articles.
12,921 ALLGEMEINE ELEKTRICITATS-GES. Systems of electric motor control. (Convention date, 27/5/10, Germany.)*

May 30. 1911.

12,993 PERRY. Electrical heating apparatus.
13,041 RUSSELL & SAUNDERS. Electric solenoid railway carriage and safe lock.
13,064 WILKINSON. Electric resistances for electric heating and cooking apparatus.
13,065 BRUSH ELECTRICAL ENGINEERING Co., SALISBURY & MILLS. Electric conductors for vacuum apparatus and method and means of sealing same into quartz and the like.
12,976 AKTIESELSKABET HOVLANDS RADIOTELEGRAF. Electric condensers. (Convention date, 1/6/10, Norway.)*
12,978 SCHIEFERSTEIN. Means for varying the inductance of electric circuits. (Convention date, 30/5/10, Germany.)*
12,984 MOORE & SHARDLOW & Co. Terminals for ignition plugs, magnetos and other electrical connections.*
13,014 BURGESS & SHAND. Discharging excess of electrical pressure.
13,020 MARCONI & MARCONI'S WIRELESS TELEGRAPH Co. Installations for wireless telegraphy.
13,021 B.T.-H. Co. (G.E. Co., U.S.) Electric conductors.*
13,026 FRIEDREICH. Supporting devices for electric illuminating bodies. (Convention date, 30/5/10, Austria.)*

May 31. 1911.

13,037 HARRIS & DEE. Non-corrosive terminal for accumulators.
13,099 ROSENBERG. Generation of alternating electric current.
13,100 SCHNEIDER. Recording and reproduction of telephone communications.
13,102 AKON. Systems for electrically controlling the operation of time indicating devices.
13,103 VENNER & GRIESBACH. Automatic electric switches.*
13,124 B.T.-H. Co. (G.E. Co., U.S.) Arc lamp electrodes.

June 1, 1911.

13,142 LONGFORD & ASTON. Trimming magneto contacts.
13,177 STOBIE & DAVONPORT. Electric metallurgical furnaces.
13,213 MILNE. Electric wiring of buildings.

June 2. 1911.

13,246 ELECTRIC & ORDNANCE ACCESSORIES Co., GARNER & COLLINS. Pole shoes of magneto-electric machines for ignition purposes in connection with internal combustion engines.
13,266 BAYLEY, jun., & WOOD. Electrical accumulators.
13,272 EARNSHAW. Life guard for use on tramcars and such like.
13,282 MARKS. (Gans & Goldschmidt Elektrizitäts Ges.m.b.H. and Martin Kaul, Germany.) Apparatus for effecting the automatic forming of metal filaments for electric incandescent lamps.
13,285 HUMMEL. Electric lighting of staircases.*
13,299 LAKE. (U.S. Light & Heating Co., U.S.) Batteries.*
13,315 COMPAGNIE POUR LA FABRICATION DES COMPTEURS ET MATERIEL D'USINES A GAZ. Electric current limiting apparatus. (Convention date, 11/11/10, France.)*
13,335 ELEKTROCHEMISCHE WERKE G.M.B.H. & ROTHE. Producing disc-like flaming arcs for carrying out gas reactions. (Convention date, 8/7/10, Germany.)*
13,338 CREESE & ARON. Electrically operating time-indicating devices.
13,341 GRAEBE & LEHRBACH. Switch for electric illuminating devices.*

June 3, 1911

13,362 NISBET. Electrical machines.
13,403 BRADBURY. Electric resistance furnaces.

June 6, 1911.

13,430 PERRY. Wind power electric storage installation or apparatus.
13,450 TURNBULL, jun., & HOLMES. Regulating the voltage of electric generators.
13,469 TURNER & WILKINSON. Controlling apparatus for electric motors.
13,477 HIRST & ANGOLD. Automatic regulators for dynamo-electric machines.
13,483 VIGNEAULT & HEBERT. Magnetic compound.*
13,490 LUY. Magneto-electric lamp apparatus.*
13,492 KRYSHTOFOVICH. Transmission of electric power.
13,509 TWIGGER. Holders for shades or globes of electric and other lamps.
13,522 ALHORN. Transformers for continuous current.*
13,524 SCHMIDT. Spark plugs. (Convention date, 9/6/10, United States.)*
13,525 RICHARDSON. Manufacture of filaments for electric incandescent lamps.
13,561 TATE & MONKHOUSE. Arc lamps.
13,570 B.T.-H. Co. & POLLOCK. Regulators for dynamo-electric machines.
13,571 B.T.-H. Co. & WEDMORE. Electro-magnets.
13,573 BLEICHERT & BLEICHERT. Remote controlling means for electric trolleys.*
13,574 BLEICHERT & BLEICHERT. Remote controlling apparatus for electrically actuated travelling winches and the like.*

June 7, 1911.

13,601 ROOSE & FINLAY. Intercommunication telephone systems with secrecy.
13,604 FERRA. Thermo-electric generators.
13,605 FERRA. Generation of electric current.
13,615 RICHARDSON. Manufacture of filaments for electric incandescent lamps.*
13,623. SCHAEFFER. Air propeller driven by electric motor. (Convention date, 2/7/10, Germany.)*
13,641 STEINBERGER. Telephone mouthpieces. (Convention date, 13/6/10, U.S.)*
13,647 NETTENSTROM. Power transmission.*
13,648 STILLE. Electrical switch or operating devices. (Convention date, 20/7/10, Germany.)*
13,650 B.T.-H. Co. & YOUNG. Regulation of electric generators driven at varying speeds.

June 8, 1911.

13,662 HALL. Timing apparatus for magneto-electric ignition.
13,685 CODD. Electro-mechanical cut-outs.
13,705 BUSCH. Magneto-electric ignition machines. (Convention date, 27/8/10, Germany.)*
13,707 SIEMENS BROS. & Co. (Siemens & Halske Akt.-Ges., Germany.) Electrical measuring instruments of the dynamometer type.*
13,715 SUCHTING & OLOFF. Thermo-electric batteries.*

June 9, 1911.

13,750 HOWARD. Metallic armouring for insulated electric cables.
13,758 SMITH. Portable electric battery lamps.
13,782 PAPE. Manufacture of electric accumulator electrodes and means for use therein.
13,808 RODECK. Electro-deposition of metals. (Convention date, 10/6/10, Austria.)*
13,817 GEBRUDER SIEMENS & Co. Electric arc lamp electrodes. (Convention date, 29/6/10, Germany.)*
13,830 DUNNING. Electric circuit controlling devices. (Convention date, 10/6/10, U.S.)*

June 10, 1911.

13,877 SIEMENS SCHUCKERTWERKE GES. Speed regulation of polyphase series motors. (Convention date, 10/6/10, Germany.)*
13,884 ROSENBERG. Microphones.
13,885 ROSENBERG. Supporting a telephone receiver or similar instrument in contact with the ear.
13,886 THOMAS. Detachable coupling for electrical connections.
13,887 GRAHAM. Telephone exchange switchboards and arrangements.*
13,893 GRAFTON. Electric lighting of motor road vehicles and the like.

June 12, 1911.

13,905 SAYER. Maintaining constant the speed of a dynamo or other machine driven from a motor having variable speed.
13,948 BANN. Telephone receiver holders.*
13,968 SCHIESSLER. Electric inductive couplings. (Divided application on 24,696/10. 24/10.)*
13,970 NICHOLSON & NICHOLSON. Combined track and trolley switch operating mechanisms.*
13,984 ORLING & ORLING'S TELEGRAPH INSTRUMENTS SYND. Relay device.
14,987 B.T.-H. Co. (A.E.G., Germany.) Insulated electric conductors.*

June 13, 1911.

14,005 PRESTON. Regulating the power of an electro-magnet by either increasing or decreasing the number of turns in the windings.
14,008 GAMBRELL & GAMBRELL. Electrical condenser charge and discharge keys and the like.

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14,032 BARBOUR. Electric motor starters.
14,034 PHILLIPS & A. C. COSSOR. Pivot and moving system for electrical and magnetic measurement and detection.
14,050 HUIZER. Primary electric batteries.*

June 14, 1911.

14,092 FEHR. Automatically actuating the track points of electric railways and the like.
14,096 MILLS. Tramcar trolley-heads.
14,110 TUCKER. Electrical wall sockets and the like.*
14,123 ARON. Electrically operated time-indicating systems.
14,127 SIEMENS BROS. DYNAMO WORKS. (Siemens-Schuckertwerke G.m.b.H., Germany.) Arc Lamps.*
14,144 SIEMENS BROS. & Co. (Siemens & Halske Akt.-Ges., Germany.) Calling circuit arrangements for automatic and semi-automatic telephone exchanges.*
14,148 AUTOMATIC ELECTRIC BLOCK SIGNALLING CO. & BROUSSON. Electrically-operated signals for railways.

June 15, 1911.

14,175 ROTTENBURG. Electrical servo and telemotors, and their modes of application.
14,179 DAY. Electrical contact making devices.
14,183 HEATH & HARRISON. Globe or shade holders.
14,222 MIETH. Electrically-heated vessel.*
14,239 SOC. ANON. ELECTROMETALLURGIQUE (PROCEDES PAUL GIROD). Refining steel. (Addition to 26,598/09. Convention date, 15/6/10, France.)*

June 16, 1911.

14,274 ECCLES. Instruments for the measurement of electric currents and voltages.
14,276 LEACH. Miners' electric safety lamp.
14,303 BEY. Electric lamp holders for electrically-illuminated signs and devices.
14,360 VAUGHAN. Magneto-generating machines.

June 17, 1911.

14,380 LEVERMORE & MORRIS. Facilitating the connection of the trolleys attached to road cars, tramcars, and the like with the overhead wires.
14,410 ARON & DORMANN. Electrically-operated time-indicating devices.
14,432 SIEMENS SCHUCKERTWERKE G.M.B.H. Automatic regulators for electric circuits. (Convention date, 17/6/10, Germany.)*

SPECIFICATIONS PUBLISHED.

1910 SPECIFICATIONS.

1,893 SIMMS. Distributors for electric accumulator ignition gear. (25/7/10.)
10,717 HARRIS. Electric detonators for blasting. (Patent of addition not granted.)
11,336 HEATHER. Increasing the safety of the operations of hoisting and lowering with induction motors.
13,224 ADAMS MFG. CO. ((Cutler Hammer Mfg. Co.). Starting devices for electric motors.
13,325 ADAMS MFG. CO. (Cutler Hammer Mfg. Co.). Controllers for electric motors.
13,335 ADAMS MFG. CO. (Cutler Hammer Mfg. Co.) Starting devices for electric motors.
13,453 RANKIN. Electric controlling and regulating apparatus.
13,476 MCGEOCH & MCGEOCH & CO. Electric switches.
13,694 B.T.-H. CO. (G.E. CO.). Electrical transformers. (Addition to 13,278/04.)
14,380 PRICE. Prevention of sparking in the control of electric circuits.
14,391 AKT.-GES. BROWN, BOVERI ET CIE. Alternating current commutator machinery (17/6/09.)
14,429 HALLIWELL & JEREMIAH. Locking electric incandescent lamps to their holders.
15,137 HERING. Electric furnaces. (6/7/09.)
16,017 SHAW & GREEN. Detachable power handle for controllers on electric cars, cranes and the like.
16,485 LITTLER. Quick break switch on circuit breaker applicable to arc lamp and other electrical circuits.
17,873 UPTON. Means and appliances for removing and replacing electric light or like bulbs in their sockets.
18,359 DICKSON. Electric switches and signs.
19,359 B.T.-H. CO. (G.E. CO.). Alternating electric current motors.
19,532 ESSER & HODGKINSON. Electric lighting of motor cars, cycles, and other vehicles.
19,795 CITY OF LONDON ELECTRIC LIGHTING CO. & PEARD. Supporting and raising and lowering lamps.
21,041 B.T.-H. CO. (G.E. Co., U.S.) Electric voltage regulation.
21,157 GILBERT ARC LAMP CO. & DOWDELL. Electrodes for arc lamps.
21,522 SPEIGHT & WALMSLEY. Hangers or ears for overhead electric wires or conductors.
21,922 DUNNE. Secondary Batteries.
22,013 SIEMENS & HALSKE AKT.-GES. Telephone exchange circuits. (29/1/10.)
22,642 WILLIAMSON. Fire brigade and like electric alarms.
22,852 WESTINGHOUSE METALLFADEN GLUHLAMPENFABRIK GES. Metallic filament electric lamps. (6/10/09.)
22,959 NEUHOLD. Automatic telephone systems. (3/9/10.)
24,216 MAYES. Electric incandescent lamp cap.
24,808 THOMPSON. (Wirth, Bock & Knauss.) Apparatus for stopping and returning to the initial position electrically-operated mechanisms.
24,818 NEPLE. Inclinable electric lamp supports. (26/10/09.)
25,205 BAUER. Producing X-ray pictures and appliances there for.
25,502 AITKEN & BRITISH INSULATED & HELSBY CABLES. Telephone switchboards.
27,174 SOC. VEDOVELLI, PRIESTLEY & CIE. Suspension chain for high pressure electric transmission wires. (5/4/10.)
27,206 SIEMENS & HALSKE AKT.-GES. Automatic telephone circuits. (20/11/09.)
27,223 GARDNER & FERGUSON. Apparatus for causing electrical impulses for transmission to a distance.
27,860 SIEMENS & HALSKE AKT.-GES. Telephone exchanges with automatic call distributors. (9/12/09.)
28,657 Dr. PAUL MEYER AKT.-GES. & KUHNEL. Mercury contact electric switches.
28,834 RASMUSSEN. Composition for the use of electric insulating and other commercial purposes.
29,463 GRISSINGER. Automatic electric heat control. (22/12/09.)
29,506 SCHMIDT. Arc lamps. (20/12/09.)
29,700 SMITH & KAATZ. Incandescent lamp regulator.
29,726 CROMPTON & CO. & BURGE. Converting electric currents for supplying electric motors.

1911 SPECIFICATIONS.

132 LUDECKE & IMPERIAL LAMP WORKS (BRADDOWN) LTD. Manufacture of metal filaments for electric lamps
741 MOUL. (Kortine.) Arc lamps.
996 JULIUS PINTSCH AKT.-GES. Electric lighting plant for railway trains. (17/1/10.)
1,037 PENROSE. Electrical switches.
1,056 LANDIS & GYR. Electricity meters.
2,242 LANGE. Aerial conducting structures for wireless telegraphy and telephony. (2/2/10.)
2,259 MEHNE. Time switches for controlling electric circuits and for turning on and off gas lights. (Patent of addition to 14,052/09.)
2,520 TRAUS. Electric lamp switches. (4/2/10.)
2,594 SIEMENS BROS. DYNAMO WORKS & BOLTON. Electric switches.
3,251 PAULING. Electric furnace for treating gases.
3,705 SUN ELECTRICAL CO., RAWLINGS & SWEETSER. Electric switches.
3,747 SEFTON-JONES. (Oesterreichische Daimler-Motoren Ges.). Supports for electric conductors or rail-less track systems. (Divided application on 27,798/10. 29/11.)
3,947 GIRARDEAU. Radio-telegraphic plant. (1/12/10.)
4,077 GAMPER. Facilitating the packing of magnetic material.
5,248 Dr. ERICH F. HUTH GES. & HIRSCH. Apparatus for use in wireless telegraphy. (3/8/10.)
6,336 KORTING & MATHIESEN AKT.-GES. Alternating-current arc lamps. (29/3/10.)
6,783 KORTING & MATHIESON AKT.-GES. Alternating-current arc lamps. (29/3/10.)
9,815 SCHALLER. Electric incandescent lamp. (22/4/10.)
10,792 SCHOTT & GEN. Electrolytically measuring electricity. (23/5/10.)

COMPANIES' MEETINGS AND REPORTS.

Anglo-American Telegraph Co. (Ltd.)

The half-yearly meeting was held on Friday, Mr. F. A. BEVAN presiding.

The SECRETARY (Mr. T. H. Wells) read the notice convening the meeting and the auditors' report.

The CHAIRMAN then said this was the half-yearly meeting at which all the directors had to do was to put before the shareholders their report and statement of accounts for the past half-year. But there were matters of very great interest and importance alluded to in that report, and therefore he should go into those matters which had occupied for so long a time the attention of the board, and which had been the subject of a great deal of comment in the Press, and of talk among the shareholders. Before doing so he would remark upon the great falling-off that there had been in the receipts for the past half-year as compared with the corresponding half-year. The half-year's receipts, compared with those of the corresponding half-year, had declined to the extent of £37,000. Owing to the Western Union Co. having come to the conclusion that under the Sherman Trust Act the pooling agreement of 1882 was invalid, from March 1 last they had ceased to receive from the Western Union Co. the amount of traffic that they had hitherto been in the habit of receiving. They had therefore since that date ceased to hand over this traffic to the Anglo-American Co., and thus they had earned £37,000 less. That showed the immense importance of keeping on the best of terms with the Western Union. A great deal more than half the Company's traffic arose on the other side of the Atlantic, and it was in the power of the Western Union with their enormous ramifications throughout the Continent, to dispose of that traffic as they pleased. So long as there was a pooling agreement it did not matter whether the traffic came by the Anglo-American line or by the Western Union, but directly the pooling agreement ceased to take effect, the Western Union, having in the meantime laid a further cable which enabled them to carry the traffic they had not been able to do before, took a larger proportion for themselves. For some months before this occurred the Anglo-American Co. had been negotiating with the Western Union for a new agreement. He hoped that in a few days the arrangements would be complete, and then the shareholders would be specially called together to consider it. The principal terms were that the Western Union should take the lease of the Anglo-American Co.'s cables for 99 years. That involved the purchase by the Anglo-American Co. of the new cable laid down by the Western Union Co. That would absorb the greater part of their renewal fund—at least £700,000, or perhaps a little more. The Western Union were to give them a guarantee of 3¼ per cent. on their ordinary stock, amounting to £262,500, payable quarterly, and as the preferred stockholders took 6 per cent. that would leave 1¼ per cent. on the deferred stock. This meant that for 99 years the Western Union, which had an enormous capital, were bound to keep up their payment to the Anglo Co. of £262,500 a year. They were to maintain the Anglo-American Co.'s renewal fund in just the same way as they had themselves maintained it. They were to set aside £20,000 a year, and the interest upon the securities in which the fund was invested. The management would be in their hands, but a small board would be retained who would act really as trustees for the Anglo-American shareholders. The Western Union were to maintain the cables and all the Company's property so that in the very unlikely case of the agreement having to be broken through matters over which they had no control, their property would be restored to them in the same condition as far as possible as it was when they handed it over to the Western Union. The Board believed that in the interest of the shareholders it was very desirable that the agreement should be entered into. It must be remembered that the larger portion of the business of the Company originated in the United States, and not on this side of the Atlantic, and therefore if the Anglo-American Co. were to continue to have their fair proportion they must enter into some such arrangement as was now proposed. The security was as good as it could possibly be. Instead of having stock which was continually fluctuating according to the prospects of the half-year, the shareholders would have what he might call a gilt-edged security with an absolute fixed rate of interest guaranteed by one of the most powerful companies in the United States. When the Western Union first proposed this agreement they stated that they wished to make certain improvements with regard to the traffic arrangements. They wanted to have deferred messages at a cheaper rate. The board saw very soon that the company might suffer loss through this arrangement. Now the Western Union could make what arrangements they pleased. Whatever they did would be at their own risk. Whatever their tariff they were bound to give the Anglo-American Co. the £262,500 a year. Those were the principal reasons why the directors, after the most careful consideration, had thought it well to enter into this arrangement. It could not be carried through without the shareholders' consent. They would have the opportunity of considering, discussing, and voting upon it. He hoped the day was not far distant when the board would summon the shareholders to a special meeting for the consideration of this matter. He could not say that it was altogether what they liked, the surrendering of the management to the hands of the American Co. Perhaps it was only a sentimental question. If they could have gone on he did not think they would have moved in that connection, but the pressure came from the other side. They had to consider not sentiment but the interests of the shareholders. He then moved the adoption of the report and accounts.

Sir GERALD FITZGERALD seconded the motion, which, after a few brief complimentary observations from shareholders, was adopted, and the proceedings terminated.

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BULAWAYO WATERWORKS & ELECTRIC LIGHTING CO. (LTD.)—The directors' report for the year ended Dec. 31, 1910, states that gross profit from sale of electric current was £2,777, decrease £961, compared with the previous year. On the company's whole undertaking there is a total of £9,009 to the debit of profit and loss account. The sum now standing to reserve on depreciation and renewal account is £44,525. The decrease in revenue from the sale of electric current was entirely due to the general use of metallic filament lamps by private consumers, and their substitution for carbon lamps in the street lighting, but during the present year there has been a very great expansion of trade.

CROMPTON & CO. (LTD.)—At the meeting on Monday the Chairman Mr. J. Trotter, moved the adoption of the directors' report (abstracted in our last issue). He said the result of the year's working, after paying all charges, was a loss of £14,000, as compared with £20,000 last year. If prices remain as they are it only required a larger turnover to earn a satisfactory profit. There was a distinct improvement in the outlook of the electrical industry, and they were devoting themselves to improving the output. The report was adopted.

GREAT NORTHERN & CITY RAILWAY CO.—The directors' report for the half-year to June 30 states that the total revenue was £41,844. 13s. 7d. and cost of working £20,157. 13s. (48·17 per cent.). Traffic receipts were £39,864 (against £37,911 in the corresponding half of 1910). Net revenue was £21,687. 0s. 7d., which was insufficient to meet the company's fixed charges for the half-year, and £1,110. 12s. 10d., has been provided from outside sources. The number of passengers for the six months including season ticket holders, was 6,323,045 against 5,966,114 for the corresponding period last year. 2,524 local season tickets were issued, against 2,539. The number of three-route season ticket holders using the company's line during the past half-year was 3,166, against 2,728.

At the meeting on Wednesday the chairman (the Earl of Lauderdale) said that the cost of working had been at the rate of 48·18 per cent., against 50·12 for the same period of last year and 51·09 for the half-year ended Dec. 31 last. The net revenue increased by £1,903, and although that did not enable the Board to meet the entire fixed charges, yet it reduced the deficiency from £3,163 to £1,110 for the half-year just ended. The company seemed to be on the up grade. The recovery was naturally slow, but it was satisfactory to note that in the face of the keenest competition they were gradually, but he hoped surely, regaining the traffic they had lost. That they had had this half-year to rely upon outside assistance for but a comparatively small sum of money was a satisfactory feature in the position, and should they be able, as the directors believed would be the case, to maintain the steady increase in the company's takings, the day should not be far distant when it would again be quite independent.

LONDON, BRIGHTON & SOUTH COAST RAILWAY CO.—At the meeting on Wednesday Mr. C. C. Macrae, who presided, said that, comparing the June half-years, it was only in the years 1903 and 1904, when the present tramway competition was not fully developed, that the number of 27,000,000 passengers carried during that half-year was exceeded. From 1904 there was a gradual diminution in the numbers of their passengers until the opening of electrical services on the South London Railway at the end of 1909. Since then there had been a rapid increase, and they had not only regained the whole of the number lost on that section of railway, but during the last six months they had carried more passengers over it than they did prior to the establishment of the electric trams. He thought that showed very conclusively that electric traction on a railway could more than hold its own in competition with electric trams, and that the policy of the board with regard to electrification had been justified. The electrical services between Victoria and the Crystal Palace had only been running since May 12, but the result was equally satisfactory. At the end of this year, when they hoped similar services would be established between London Bridge and the Crystal Palace, they expected to attain even better results. It had not been practicable as yet to open these services because the contractors for the supply of energy had not been in a position to give the quantity required. They were, however, pushing on as quickly as possible with the works necessary for that supply, and they would make use of it as soon as they could get it. The electrical services were also quite satisfactory from the revenue point of view, and the additional receipts derived from them represented nearly 30 per cent. of the total increase of passenger receipts. Second-class tickets had been abolished on June 1, because of the introduction of electric traction on the line.

LONDON ELECTRIC RAILWAY CO.—Capital expenditure during the half-year ended June 30 amounted to £47,222. 10s. 7d. Gross receipts amounted to £392,817. 8s. 9d., an increase of £27,193. 2s. 3d. over the corresponding half of last year. Working expenses were £174,919. 11s. 1d., an increase of £7,699. 4s. 2d. After providing for interest and rents, and reserving £7,500 for contingencies and renewals, there remains £124,156. 3s. 7d. available for dividends, and the directors recommend that a dividend at the rate of 4 per cent. be declared on the preference stock, and at the rate of 1 per cent. on the ordinary shares, leaving £14,516. 9s. 7d. to be carried forward. The train mileage was 2,728,961, a decrease of 159,470, and the car-mileage was 9,284,870, an increase of 777,514. 52,548,384 passengers were carried, against 46,665,279 in the December and 50,045,140 in the June half-year of 1910. The company propose to proceed with the construction of the Charing Cross and Paddington extensions at an early date.

METROPOLITAN DISTRICT RAILWAY CO.—Capital expenditure during the half-year ended June 30 was £88,668. 14s. 5d. Gross receipts were £327,170, increase £27,124 over the corresponding half of last year. Working expenses were £152,741, increase £9,410. After providing for interest and other charges and setting aside £10,000 as reserve for renewals, the credit balance is £82,991. 18s. 7d., and the directors recommend that the full dividend be declared on the 4 per cent. guaranteed stock and on the 4½ per cent. first preference stock. The number of passengers carried (including workmen and season ticket holders) was 40,539,464, an increase of 4,359,156; the number of passengers carried at workmen's fares was 7,050,800, increase 404,268; average receipt per passenger 1·81d., against 1·86d.; train mileage 1,743,068, against 1,666,350; and car-mileage 7,107,134, against 6,646,998. 31 new carriages have been put in service during the half-year; 20 carriages remain to be delivered by the builders, and an order has been placed for 14 additional carriages.

MEXICAN LIGHT & POWER CO. (LTD.)—The report for 1910 states that during the past year the business has shown constant and satisfactory increases. Net revenue in gold for the year, after paying all expenses and fixed charges, was $1,456,612, and $149,385 from 1909 and $163,004 set aside from profits of 1909 to provide for the accrued dividend make $1,769,002. The directors have paid during the year $860,150 in dividends. The balance to profit and loss account is $745,848 and the reserve account remains at $377,883. The purchase of the business and undertaking of the Compania Electrica e Irrigadora en el Estado de Hidalgo, S.A., was completed during the year, and the results justify the action of the board in acquiring it. A transmission line has been constructed from the line of the Mexican Light & Power Co. to the lines of the Pachuca Light & Power Co. at Pachuca, and the Pachuca Company is taking 9,500 H.P., which it is selling in addition to the regular output from its own plants.

MEXICO TRAMWAYS CO.—The report for 1910 states that the net revenue in gold after paying all expenses and fixed charges, was $1,417,303, added to $416,344, balance from 1909, making $1,833,647. During the year dividends absorbed $931,581, leaving $894,066, out of which $250,000 have been added to reserve, and $644,066 have been carried forward. On Dec. 31, 1910, the system consisted of 179 miles of single track, of which 158 miles were operated by electricity and 21 by mules, the electric track mileage having been increased by 13 miles and the mule track reduced by five.

NEW GENERAL TRACTION CO. (LTD.)—The revenue for the year ended March 31 was £22,656, against £19,482 in 1910. The profit was £3,674, reducing the balance of loss to £21,631. Coventry Corporation have given notice of their intention to acquire the Coventry Electric Tramways.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

ANGLO-BRAZILIAN POWER AND SHIPPING CORPN. (LTD.) (116,742.)—Reg. July 11, capital £300,000 in £1 shares, to promote, purchase, apply for or otherwise acquire, contract for and hold, construct, equip, maintain, work, lease, or let any works in South America or elsewhere, and in particular factories, tramways, railways, ropeways, telegraphs and telephones (elsewhere than in the U.K.), cables, harbours, elevators, sidings, reservoirs, engineering, hydraulic and electric power and light works, &c., and to adopt an agreement with Horacio P. Vieira, relating to the sale of some land in the State of Parana, Brazil, with water rights. Purchase consideration, £270,000 in shares and £30,000 in cash. The British South American Financial Corpn. are to receive £100,000 shares and J. P. Nelson is to receive £5,000 shares from the vendor for services rendered in connection with the promotion of the company. First directors: Horacio P. Vieira, J. P. Nelson, and J. Wolstenholme. Reg. office, 4, London-wall Buildings, E.C.

ANGLO-FRENCH WIRELESS CO. (LTD.) (117,056)—Reg. July 29, capital £50,000 in £1 shares, to carry on the business of electrical and mechanical engineers and contractors, suppliers of electricity, manufacturers of and dealers in railway, tramways, electric and other apparatus, &c., to acquire certain inventions, patents, rights, privileges and other property relating to wireless telegraphy and telephony, and to adopt an agreement with Compagnie Generale Radiotelegraphique. Private company. First directors are M. Sins and M. Trouchon.

LONDON & MEXICO CONCESSIONS SYND. (LTD.) (116,939)—Reg. July 21, capital £20,000 in 18,000 £1 ordinary shares and 40,000 deferred shares of 1s. each, to acquire powers for construction and operation of railways, tramways, telegraphs, telephones, harbours, quays, docks, and irrigation, gas, electric light and power and other public works, &c., in relation to Mexico, Great Britain, Africa, Australia, Canada any British colony or dependency, North and South America, Japan, China and Europe. Private company. Reg. office: 3, Lombard-street, London, E.C.

PROVINCIAL ELECTRICAL CO. (LTD.) (116,972)—Reg. July 24, capital £250 in £1 shares, to carry on the business of electricians, electrical engineers, manufacturers of and dealers in apparatus and plant for electric lighting, telephones, telegraphs, or for producing power by means of gas, electricity, hydraulic, steam and other means, &c. Private company. First directors: W. H. Buxton, W. H. Bagley and F. E. Butler.

THOMAS THORP CO. (LTD.) (116,961).—Reg. July 22, capital £10,000 in £1 shares (3,000 preference), to take over the business carried on at Victoria Works, Besses-o'-th'-Barn, Whitefield, Lancs., as "Thomas Thorp & Co." and to carry on the business of manufacturers of and

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dealers in gas, electric and water meters and scientific instruments, electricians, electrical, mechanical and civil engineers, &c. Private company. First directors: T. Thorp, F. Thorp and H. T. Thorp.

WILSON APPARATUS CO. (LTD.) (116,761.)—Reg. July 11, capital £900 in £1 shares (300 "A" and 600 "B") to carry on the business of electricians, engineers, manufacturers of and dealers in instruments and apparatus used in connection with the generation, supply, accumulation and employment of electricity, &c., and to adopt an agreement with F. W. Wright, E. Wilson and W. H. Wilson. Private company.

STATUTORY RETURNS.

BOURNEMOUTH & POOLE ELECTRICITY SUPPLY CO. (LTD.)—Return to March 30, gives capital as £500,000 in 25,000 ordinary, 7,500 4½ per cent. preference and 17,500 6 per cent. second preference shares of £10 each. 15,000 ordinary, 7,500 4½ per cent. preference and 15,000 6 per cent. second preference shares taken up. £375,000 paid. Mortgages and charges: £187,500.

BRIDGWATER & DISTRICT ELECTRIC SUPPLY & TRACTION CO. (LTD.)—According to return to May 4, capital is £20,000 in £1 shares (5,000 preference). 12,899 ordinary and 525 preference shares taken up. £4,552 paid on 4,017 ordinary and 525 preference, including £10 on 100 forfeited shares. £8,882 considered as paid on 8,882 ordinary shares. Mortgages and charges £12,000.

BROMPTON & KENSINGTON ELECTRICITY SUPPLY CO. (LTD.)—Return dated March 30, filed April 28, 1911. Capital £300,000 in £5 shares (9,551 preference). 9,551 preference and 30,449 ordinary shares taken up. £5 per share called up on 9,551 preference and 29,449 ordinary. £195,000 paid. £5,000 considered as paid on 1,000 ordinary shares. Mortgages and charges: Nil.

CALCUTTA TRAMWAYS CO. (LTD.)—Return dated May 3 shows capital £1,400,000 in 140,000 ordinary and 140,000 preference shares of £5 each. 137,610 ordinary and 47,295 preference shares taken up. £2 per share called up on 4,400 ordinary, £2. 10s. per share on 8,000 ordinary, £3. 10s. per share on 22,000 ordinary, £5 per share on 79,430 ordinary and £5 per share on 47,295 preference. 23,780 ordinary considered as fully paid. £3 per share considered as paid on 4,400 ordinary, £2. 10s. per share on 8,000 ordinary and £1. 10s. per share on 22,000 ordinary. Mortgages and charges: £350,000.

CAMBORNE ELECTRICITY SUPPLY CO. (LTD.)—Return dated June 14, filed July 3, 1911. Capital £10,000 in £1 shares. 607 shares taken up. £1 per share called up. £605 paid, leaving £2 in arrears. Mortgages and charges: Nil.

CEDES ELECTRIC TRACTION (LTD.)—Return dated July 11, filed July 15, 1911. Capital £20,000 in £1 shares. 3,000 shares taken up. £3,000 paid. Mortgages and charges: Nil.

EASTERN TELEGRAPH CO. (LTD.)—Return dated May 31 shows capital £6,000,000 in £4,000,000 ordinary stock and £2,000,000 preferred stock. All stock taken up. £6,000,000 paid. Mortgages and charges: £1,896,705.

MORTGAGES AND CHARGES.

BURFORD ELECTRIC LIGHT & POWER CO. (LTD.)—Particulars of £1,500 debentures, created June 10 have been filed, the whole amount being issued. Property charged: Company's undertaking and property, present and future, including uncalled capital. No trustees.

CUTTING BROS (LTD.)—A Memorandum of satisfaction in full on Nov. 10, 1910, of debentures dated June 20th, 1904, securing £4,000, has been filed.

LAMPLOUGH & SON (LTD.)—An agreement, and a debenture issued pursuant thereto, both dated June 29, to secure £3,000, charged on Albany Works, Willesden; benefit of a licence, and the company's undertaking and property, present and future, including uncalled capital. Holders: London Steel Castings Co.

CITY NOTES.

MEMORANDA (Aug. 3).—Bank rate 3 per cent. (March 9, 1911.) Price of silver, 24 7/16d. per oz. Consols 77⅛—78⅛ for money; 78—78⅛ for account. Consols Pay Day, Sept. 1; Stock and Shares Continuation Days, Aug. 14 and 29; Ticket Days, Aug. 15 and 30; Pay Days, Aug. 16 and 31; Mining Shares Carry Over Day, Aug. 11.

PRICES OF METALS (London).—*Copper*, cash, 56⅜; three months, 56⅞. *Lead*, English, 14¼—14½; Foreign, 14—14¼. *Spelter*, 25¾—26. *Tin*, English, 193½—195½; Foreign, cash, 192½; three months, 188¾. *Iron*, Cleveland, cash, 46/9, three months, 47/7.

BRISTOL TRAMWAYS & CARRIAGE CO. (LTD.)—The directors have declared an interim dividend at the rate for 4 per cent. for the half-year ended June 30.

BRITISH ELECTRIC TRACTION CO. (LTD.)—The following circular letter has been addressed to the shareholders:—

As intimated in the last annual report, the directors have for some time past had the question of a re-organisation of capital in all its bearings under careful consideration, and I enclose a memorandum containing their proposals. [A lengthy memorandum accompanies the letter.]

The chief reasons for the proposals briefly are:—

(*a*) Depreciation of some of the assets has taken place, as has been explained by the directors and by the Company's auditors in their reports to the shareholders.

(*b*) The present profits are insufficient to pay the full cumulative dividend on the preference shares, and arrears are accumulating in front of the ordinary shareholders.

(*c*) A reduction of capital, which would fall on both the preference and ordinary shareholders, has been suggested as a way of meeting the depreciation of assets, and of adjusting the rights of the two classes of shares.

(*d*) For the reasons stated in the memorandum, however, the directors do not consider that a reduction of capital is in the best interests of the shareholders.

The directors therefore recommend a re-arrangement, not a reduction, of capital, and they propose to continue to deal with depreciation of assets in the manner described in the memorandum and in their previous reports. By the proposed re-arrangement of capital, the preference shareholders obtain an advantage in regard to priority of capital, and waive part of their rights to future distribution of profits. The holders of the ordinary shares have their prospect of dividend improved, and waive part of their rights as to capital. The re-arrangement necessarily contains some elements of a compromise, and has presented many difficulties in the equitable adjustment of its details. The directors, however, are satisfied that the proposals are just and fair to both classes of shareholders, and they unanimously recommend them for adoption. The memorandum requires careful perusal in its entirety, and in order to allow the shareholders time to consider the matter, the directors propose to defer holding the necessary extraordinary general meetings until October. Meanwhile any shareholder who so desires may obtain further explanation or information by letter or by personal application at the offices of the Company. CHAS. H. DADE, Secretary.

Electrical Federation Offices, Kingsway,
London, W.C., July 31.

BROMPTON & KENSINGTON ELECTRICITY SUPPLY CO. (LTD.)—The directors have declared an interim dividend of 9 per cent. (4s. 6d. per share), less tax, on the ordinary shares for the half-year to June 30.

CANADA.—Amongst the companies recently incorporated by Acts of the Quebec Provincial Legislature are the Montreal Tramways Co. (capital £4,110,000), to acquire existing electric railway undertakings and to construct tramways in Montreal city: and the Montreal & South-Western Railway & Power Co. (capital £411,000).

The "Financial News" says it is understood that with the transfer of the Toronto Electric Light Co. to the Mackenzie and Mann interests, on Aug. 1, there was to be a change in the management of the company. Mr. H. H. Macrae is, it is said, to retire, and it is likely Mr. R. J. Fleming (manager of the Toronto Railway Co. and the Electrical Development Co.) will be asked to direct the affairs of the Toronto Electric Light Co. This would place Mr. Fleming in control of all the Mackenzie and Mann electrical enterprises that furnish light and power to Toronto.

CHARING CROSS, WEST END & CITY ELECTRICITY SUPPLY CO. (LTD.)—The directors have decided to pay an interim dividend at the rate of 5 per cent. on the ordinary shares of the West End undertaking.

KENSINGTON & KNIGHTSBRIDGE ELECTRIC LIGHTING CO. (LTD.)—The directors announce an interim dividend of 4s. per share (at the rate of 8 per cent.), less tax on the ordinary shares for the past half-year.

MADRAS ELECTRIC TRAMWAYS, 1904 (LTD.)—This company's traffic receipts for the fortnight ended July 31 were R.23,607 (increase R.2,858). The aggregate from Jan. 1 was R.307,946 (increase R.25,749).

METROPOLITAN ELECTRIC SUPPLY CO. (LTD.)—An interim dividend at the rate of 4 per cent. for the half-year ended June 30 is payable on 10th inst.

RIO DE JANEIRO TRAMWAY, LIGHT & POWER CO. (LTD.)—The gross earnings of this company during June were £220,267 (increase £25,936). The aggregate from Jan. 1 is £1,036,179 (increase £218,844).

SCANDINAVIAN POWER SCHEME.—It is stated that negotiations are proceeding between German, English and Scandinavian financial interests for the amalgamation of a number of Norwegian and Swedish power companies in a new undertaking to be called the Hydraulic Power & Smelting Corpn., which will carry on zinc smelting and refining at Thallhätta and Sarpsborg, and the hydraulic power station at the mouth of the Tysse on the Hardanger Fjord, now generating 57,000 H.P., and to be ultimately increased to 126,000 H.P. In Germany the Siemens-Schuckert Werke, the A.E.G. and the Gesellschaft für Elektrische Unternehmungen are said to be financially interested in the scheme. The proposed capital is £1,000,000, with borrowing powers of the same amount.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have been asked to appoint a special settling day in and grant a quotation to a further issue of 37,900 £1 fully-paid ordinary shares of *Marconi's Wireless Telegraph Co. (Ltd.)*, to appoint a special settling day in a further issue of 74,362 7 per cent. £1 cumulative participating preference shares of the same company, and to allow 227,011 7 per cent. £1 cumulative participating preference shares of the same company to be quoted. The committee have also been asked to grant quotations to a further issue of £20,000 4½ per cent. 1st mortgage prior lien gold bonds of the *Montreal Water & Power Co.*, and partly paid scrip for £60,000 5 per cent. prior lien debentures of the *Torquay Tramways Co. (Ltd.)*

VICKERS (LTD.)—For the half-year ended June 30 interim dividends have been declared of 2½ per cent. (less tax) on the preferred stock and 1s. per share (tax free) on the ordinary shares.

WESTMINSTER ELECTRIC SUPPLY CORPN. (LTD.)—An interim dividend is announced for the half-year ended June 30 at the rate of 10 per cent. per annum (less tax), payable on Sept. 1 next.

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ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	July 26	1,618	+ 156	8	12,986	+ 954
Airdrie	" 21	207	+ 24	29	6,298	+ 20
Anglo-Argentine	" 29	44,548	+ 1,671	30	1,467,583	+ 143,928
Ashton-under-Lyne	" 29	435	+ 35	18	7,559	+ 545
Ayr Corporation	" 29	583	+ 78	11	4,546	+ 25
Barnsley	" 21	180	+ 14	29	5,208	+ 320
Barrow	" 21	347	+ 14	29	7,985	+ 537
Bath Electric Trams, Ltd.	" 26	1,016	+ 127	30	24,450	+ 1,012
Birmingham Corporation	" 22	9,017	+ 2,345	16	124,196	+ 14,397
Birmingham & Midland	" 21	900	+ 40	29	25,987	+ 1,754
Blackpool & Fleetwood	" 29	1,380	+ 88	..	..	..
Blackburn Corporation	" 26	1,214	+ 138	†18	21,115	+ 1,191
...lton Corporation	" 30	2,692	+ 166	18	45,272	+ 3,514
...mbay	June 30	2,739	+ 328	26	74,176	+ 4,322
...urnemouth Corporation	July 26	2,019	+ 144	17	30,285	− 1,963
...adford Corporation	" 29	5,720	+ 539	17	97,818	+ 8,334
...ighton Corporation	" 30	1,223	− 169	¶17	18,373	+ 1,487
...istol Trams & Carriage	" 28	7,531	+ 1,322	17	124,845	+ 12,988
...rnley Corporation	" 29	1,461	+ 174	17	16,342	+ 2,174
...rton Corporation	" 30	301	+ 1	17	5,082	+ 438
...ry Corporation	" 30	1,297	+ 63	¶17	22,483	+ 1,639
...lcutta Tramways Co.	" 29	R57,302	+ R6,534	4	R233,300	+ R25,296
...mborne-Redruth	" 29	121	..	30	3,645	+ 29
...rdiff Corporation	" 29	2,627	+ 287	17	44,064	+ 4,786
...ntral London Railway	" 29	4,492	− 801	4	19,116	− 3,518
...atham & Dist. Lt. Rys.	..	..	..	..	..	..
...y & South London Rly.	" 30	3,108	− 28	4	12,484	+ 70
...y of Birmingham	" 21	1,288	+ 1,570	29	74,513	− 2,621
...Electric Trams Co.	" 27	571	+ 38	30	14,757	+ 310
...venport & Dist. Trams	" 21	579	+ 179	29	13,615	+ 1,765
...r Corporation	" 29	314	+ 37	17	4,488	+ 782
...lin & Lucan Railway	" 28	164	+ 8	4	676	− 3
...lin United	" 28	6,332	+ 692	4	32,502	+ 8,887
...ley-Stourbridge	" 21	880	+ 52	29	23,692	+ 1,925
...ke Corporation	" 26	1,266	− 41	¶10	12,590	− 125
...Ham Council	" 29	1,091	+ 55	17	19,167	+ 1,330
...ter Corporation	" 28	422	+ 77	17	6,113	+ 530
...head & Dist. Trams	" 21	1,105	+ 51	29	29,718	+ 1,606
...gow Corporation	" 29	16,933	+ 2,225	§8	161,116	+ 12,811
...op Trams	" 29	135	+ 12	30	3,645	+ 246
...ester Corpn.	" 26	375	+ 83	4	1,330	+ 237
...send-Northfleet	" 21	251	+ 26	29	5,942	+ 173
...t Northern & City Rly.	" 29	1,368	+ 52	4	5,590	+ 180
...ock & Port Glasgow	" 21	783	+ 65	29	20,200	+ 2,548
...ax Corporation	" 25	2,190	+ 381	†17	34,296	+ 3,790
...epool Tramways	" 21	343	+ 33	29	7,364	+ 621
...ngs Elec. Trams Co.	" 27	1,300	+ 91	4	4,849	+ 173
...Kong	" 29	$9,098	+ $182	4	$38,108	+ $1,914
...erfield Corpn.	" 29	2,024	+ 242	17	34,007	+ 3,695
...Corporation	" 29	2,835	+ 88	17	49,105	+ 2,522
...District Council	" 29	532	+ 14	18	9,810	+ 520
...n District Council	" 26	141	+ 14	17	2,290	+ 118
...h Corporation	..	..	..	..	..	..
...Thanet Co.	" 29	1,511	+ 78	43	21,210	+ 1,089
...	" 21	147	+ 3	29	3,714	+ 243
...ey Corporation	" 27	209	+ 21	17	3,395	+ 326
...minster & District	" 21	163	+ 31	29	3,164	+ 231
...nock Corporation	" 29	329	+ 85	11	2,018	+ 241
...dy Corporation	..	..	..	..	..	..
...shire Trams Co.	" 27	1,205	+ 74	30	41,616	+ 346
...shire United	" 26	1,435	+ 121	30	39,721	+ 1,168
...gton	" 21	252	+ 42	29	4,682	+ 112
...rporation	" 29	8,016	− 312	17	132,055	+ 9,833
...Corporation	" 29	2,749	+ 269	17	44,873	+ 4,261
...rporation	" 29	731	+ 98	‡11	7,738	+ 679
...Corporation	" 29	131	+ 10	17	2,309	+ 206
...l Corporation	" 22	12,205	+ 580	29	332,819	+ 12,807
...l Overhead Rly.	" 30	1,637	+ 120	4	6,481	+ 628
...o&Colwyn Bay Ry.	" 28	575	+ 2	§34	7,922	+ 392
...County Council	" 19	45,401	+ 3,625	‡16	716,468	+ 51,739
...Elec. Ry. Co.	" 29	12,255	+ 235	4	51,075	+ 1,605
...United	" 29	7,391	+ 940	30	195,611	+ 9,237
...t Corporation	" 29	357	+ 44	43	7,473	+ 298
...er Corporation	" 29	16,567	+ 1,516	18	282,602	+ 17,057
...ailway	" 29	1,898	− 183	4	7,673	− 257
...	" 21	218	+ 7	29	5,937	+ 90
...tan Dist. Railway	" 29	10,921	+ 246	4	45,831	+ 2,725
...tan Elec. Trams	" 21	9,739	+ 2,051	29	249,899	+ 39,378
...	" 21	383	+ 15	29	9,594	+ 626
...rporation	" 29	201	+ 44	§17	3,189	+ 663
...on-Tyne Corp.	" 29	4,594	+ 577	17	74,864	+ 5,419
...(Mon.)	" 29	727	+ 31	17	12,742	+ 935
...ton Corporation	" 28	563	+ 66	17	9,543	+ 1,046
...Ashton & Hyde	" 21	588	− 7	29	16,251	+ 434
...rporation	" 30	2,052	+ 188	18	36,393	+ 2,211
...) Corporation	" 26	232	+ 21	10	2,029	+ 171
...) Elec. Trams	" 28	1,568	+ 1,568	30	48,527	+ 4,202
...gh	" 21	129	+ 11	29	3,585	+ 380
...& Corporation	" 29	2,706	+ 432	17	40,814	+ 5,224
...	" 21	1,895	+ 158	29	55,645	+ 5,511
...rporation	" 26	789	+ 54	17	13,513	+ 1,030
...Corporation	" 27	756	+ 137	17	11,522	+ 1,081
...	" 21	886	− 47	29	4,932	− 251
...poration	" 31	5,007	− 23	§17	87,019	+ 5,190
...	" 26	$12,250	+ $1,264	4	$49,500	+ $5,214
...rporation	" 21	64	+ 9	29	1,404	+ 78
...Trams	" 30	6,542	+ 648	18	117,125	+ 8,284
...opolitan	" 29	$9,583	− $165	4	$41,177	+ $1,507
...s	" 21	1,016	+ 182	29	24,336	+ 1,219
...n	" 21	831	+ 36	29	25,764	+ 2,029
...orporation	" 26	1,397	+ 265	17	21,124	+ 2,742
...Tramways	" 26	910	+ 154	17	11,480	+ 1,761
...Hyde, &c., Jt. Bd.	" 21	375	+ 24	29	8,466	+ 310
...Corporation	" 29	871	+ 82	17	13,969	+ 1,300
...District	" 30	1,601	+ 303	17	23,280	+ 3,087
...ams	" 26	548	+ 44	39	17,687	+ 1,343
...rporation	" 21	1,218	+ 72	29	32,233	+ 2,156
...	" 26	147	+ 11	17	2,666	+ 356
...and District	" 21	50	+ 1	29	1,199	+ 23
...ams Co.	" 21	480	+ 4	29	6,726	+ 151
...rporation	" 26	701	+ 173	4	2,134	+ 194
...poration	" 29	1,290	+ 211	17	19,824	+ 3,290
...Corporation	" 29	568	+ 35	30	16,644	+ 714
...Corporation	" 27	396	+ 7	17	6,806	+ 171
...r-Mare	" 27	2,830	+ 348	17	47,346	+ 5,275
...oon Co.	" 21	439	+ 132	29	3,463	+ 284
...on Corpn.	" 21	434	+ 18	29	12,720	+ 640
...	" 26	1,021	+ 113	17	17,390	+ 1,290
...	" 21	334	+ 10	29	8,203	+ 416
...R. Trams	" 21	101	+ 5	29	2,836	+ 91
...oollen District	" 30	1,332	+ 50	31	39,405	+ 1,643
...	" 21	1,103	+ 79	29	30,006	+ 2,138

(a) Comparisons are with the corresponding period last year. * Partly electrical.
† Minus 3 days. ‡ Minus 2 days. § Plus 3 days. ¶ Plus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Share	Last Dividend	NAME.	Price Wed., Aug. 2.	*Rate per cent. Yielded. £ s. d.	Dividend Due.	Business Week to Aug. 2. Highest.	Business Week to Aug. 2. Lowest.
		Electricity Supply.					
10	6/0	Bournemouth & Poole Elec. Sup. Ord.	8 —9	6 9 6	Mar, Sep	8 1/16	—
10	4/6	Do. 4½ per Cent. Cum. Pref.	9 —10	4 14 6	Feb, Aug	..	—
10	6/0	Do. 6 per Cent. Cum. Second Pref.	10½—10¾	5 6 0	Feb, Aug	10 11/32	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101 —103	4 6 6	Jan, July	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	8 —8½	6 1 0	March....	..	..
5	3/6	Do. 7 per Cent. Pref.	7½—8	4 1 3	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Deb. Stock	98 —101	4 0 6	June, Dec	..	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	3¾—4¼	5 2 6	Feb, Aug	4 7/32	..
5	2/3	Do. 4½ per Cent. Pref.	4¾—5¼	5 2 6	Feb., Aug	..	—
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	94 —98	4 3 3	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	100 —102	4 8 3	..	..	..
5	2/3	Do. City Undertaking 4½% Cum. Pref.	3¾—4¼	5 10 5	Jan, July	..	..
5	3/0	Chelsea Electric Supply Ord.	4 —4½	5 11 0	March ..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	98 —100	4 11 0	June, Dec	..	..
10	8/0	City of London Electric Lighting Ord.	12 —12½	4 18 0	Feb, Aug	12⅛	12 1/16
10	6/0	Do. 6 per Cent. Cum. Pref.	12 —13	4 12 3	Jan, July	..	—
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	119 —123	4 1 0	June, Dec	121	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	100 —103	4 8 6	Jan, July	..	..
St.	5%	County of Durham Elec. P. D. 5% 1st Mort. Deb. Stk.	89½—91½	5 10 6	Jan, July	..	—
10	6/0	†County of London Elec. Supply Ord.	7½—7¾	6 8 0	Feb, Aug	7 7/16	—
10	6/0	†Do. 6 per Cent. Cum. Pref.	11 —11½	5 6 6	Mar, Sept	11¼	11⅛
St.	4½%	Do. 4½ per Cent. Deb Stock (red.)	108 —110	4 2 6	Jan, July	109¼	108¼
St.	4½%	Do. Second Deb. Stock	100 —103	4 7 6	May, Nov	—	..
5	4/0	Folkestone Electricity Supply Co. Ord.	4¼—4¾	6 13 3	April, Oct	..	—
5	2/6	Do. 5 per Cent. Cum. Pref.	4½—5½	4 15 3	Mar, Sept	..	—
St.	4½%	†Do. 4½ 1st Deb. Stock (red)	95 —98	4 13 3	Feb, Aug	..	..
5	5/0	Hove Electric Lighting Ord.	6¾—7½	6 6 3	April, Oct	..	—
St.	4½%	Isle of Wight E. L. & P. Co. Deb. Stk.	88 —91	4 19 0	..	..	—
5	4/0	Kensington & Knightsbridge Ord.	6¾—7½	6 6 3	Feb, Aug	—	—
5	6%	Do. 6 per Cent. 1st Pref.	5½—6	5 0 0	Jan, July	..	—
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	91 —93	4 6 0	..	..	—
St.	4%	†Kensington & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	96 —99	4 1 0	April, Oct	..	—
St.	4½%	Kent Elec. Power Co. Irred Deb. Stk.	78 —82	5 9 9	Jan, July	81	—
3	1/2⅗	London Electric Supply Ord.	1¾—2	3 11 3	Mar, Sept	..	—
5	3/0	Do. 6 per Cent. Pref.	4¾—5	6 3 0	Mar, Sept	..	—
St.	4%	Do. 4 per Cent. 1st Mort. Deb	89 —92	4 8 0	Jan, July	..	..
5	3/0	Metropolitan Electric Sup. Ord.	3¾—4¼	6 1 6	April, Oct	4¼	3 15/16
5	2/3	Do. 4½ per Cent. Cum. Pref.	4¼—4¾	4 17 0	Jan, July	—	—
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	100 —105	4 7 6	June, Dec	..	—
St.	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	84½—87½	4 1 6	Jan, July	..	..
..	4½%	Midland Elec. Corp. for P.D. 4½ 1st Mort. Debs.	96½—98½	4 12 6	..	—	..
5	2/0	†Newcastle Elec. Supply Ord. (1-50,000 & 57,010-137,500)	3¾—3⅞	6 4 0	Feb, Aug	..	—
5	2/6	†Do. 5 per Cent. non Cum. Pref.	3¾—4¼	6 5 0	Feb, Aug	—	..
100	4½%	Do. 4½ per Cent. 1st Mort. Deb.	97 —99	4 12 0	Jan, July	..	..
100	5%	North Metro. Elec. Power Sup. 5 Morts.	101 —101	4 17 6	..	..	..
1	6%	Northampton Elec. Lt. & P. Ord.	1¼—1 5/16	4 11 6	Feb, Aug	..	—
1	5%	Do. 5% Pref.	1 3/32—1 5/32	4 6 0	Feb, Aug	..	—
St.	4%	Do. 4% Debs.	99 —101	3 19 0	June, Dec	..	—
10	6/0	Notting Hill Electric Ord.	..	5 17 6	March	..	..
5	4/3	Oxford Electric Ord.	6⅛—6⅝	5 13 9	March	..	..
St.	4%	Do. 4% Deb. Stk.	91 —94	4 5 1	..	..	..
5	5/0	†St. James' & Pall Mall Elec. Ord.	8½—9½	5 11 0	Feb, Aug	—	..
5	3/6	†Do. 7 per Cent. Pref.	6¾—7¼	5 2 6	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	84½—86½	4 2 0	Jan, July	86	—
5	..	Smithfield Markets Electric Sup. Ord.	1¼—1¾	..	Feb.	1 7/16	—
5	4/0	South London Electric Supply Ord.	2¾—3	6 5 6	April	..	—
St.	5%	Do. 5% 1st Mort. Stock (red.)	98½—101½	5 0 6	..	..	—
1	0 8¾	South Metrop'n Elec. Lt & Power 7% 1st Pref	1⅛—1¼	5 18 0	Feb, Aug	—	—
1	0/7½	Do. 6 per Cent. 2nd Pref.	⅞—1	6 17 0	Feb, Aug	..	—
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	97 —100	4 11 6	April, Oct	..	—
5	1/3	Urban Electric Supply Ord.	¼—1	..	April, Oct	..	—
5	1/3	Do. 5 per Cent. Cum. Pref.	2½—3	8 6 0	April, Oct	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	87 —89	5 2 3	April, Oct	89	..
5	5/0	Westminster Elec. Sup. Ord.	7½—8½	6 1 8	Mar, Sept	..	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	5 —5½	4 3 6	Jan, July	5 1/16	..
		Electric Railways and Tramways.					
1	..	Bath Elec. Trams Pref. Ord.	⅛—3/16	..	April	..	—
1	0/6	Do. 5 per Cent. Cum. Pref.	⅝—⅞	6 13 6	Jan, July	..	—
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	79 —83	5 8 6	April, Oct	—	—
St.	4½%	B'ham & Midland Trams 4½ 1st Deb. Stock.	89 —92	‡4 19 6	Jan, July	..	..
10	4%	Bristol Tramways & Carriage Ord.	6 —6½	6 8 0	Feb, Aug	—	—
10	4%	Do. Cum. Pref.	7 —7½	5 10 0	..	..	—
St.	4%	Do. 4 per Cent. Debs.	100 —101	3 19 2	Feb, Aug	..	—
10	..	British Electric Traction Ord.	1⅛—1¼	..	June, Dec	1⅛	1 3/16
10	..	Do. 6 per Cent. Cum. Pref.	3¾—4¼	..	Feb, Aug	4	3⅞
St.	5%	Do. 5 per Cent. Perpetual Debs.	94 —97	5 4 6	April, Oct	96	94½
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	76 —80	5 14 6	May, Nov	..	..
St.	3%	Central London Ordinary Stock	68 —70	4 7 0	Feb, Aug	69	68
St.	4%	Do. 4 per Cent. Pref. Stock	87 —89	4 10 0	Feb, Aug	88½	87½
..	6/4	Do. Pref. Scrip 50% pd	63 —65	..	..	63½	..
St.	2%	‡Do. Deferred Stock	50 —52	3 18 6	Feb.	53½	50
100	4%	‡Do. 4 per Cent. Debs.	102 —104	3 16 11	Jan, July	..	..
5	2/6	City of Birmingham Trams, 5% Cum. Pref.	4 13/16—5 1/16	4 19 6	April, Oct	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 18 9	April, Oct	..	—
St.	1¾%	City & South London Rly. Con. Ord.	31½—32½	5 9 6	Feb, Aug	33	32½
St.	5%	†Do. 5 per cent. Perp. Pref. (1891)	108 —110	4 11 9	Feb, Aug	..	—
St.	5%	†Do. (1896)	104 —106	4 16 0	Feb, Aug	..	—
St.	5%	†Do. (1901)	103 —105	4 17 0	Feb, Aug	103½	102
St.	5%	†Do. (1903)	102 —104	4 16 0	Feb, Aug	103½	101
St.	4%	Do. 4 per Cent. Perpetual Debs.	102 —104	3 17 9	May, Nov	..	..
10	6/0	Dublin United Trams. 6 per Cent. Pref.	12½—13½	4 10 6	Feb, Aug	..	—
10	12/0	Gateshead and District Trams Ord.	8½—8¾	6 19 0	..	..	..
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	¾—1¼	..	Feb, Aug	..	..
5	..	Hastings & District Elec. Trams, 6% C. P.	..	..	Mar. Sept	..	..
St.	4½%	Do. 4½ Deb. Stock	75 —80	5 10 0	April, Oct	..	..
10	..	Imperial Tramways Ord.	3 —3½	..	Mar, Sept	..	..
10	..	‡Do. 6 per Cent. Pref.	4 —4½	..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Debs.	72 —74	6 3 6	Jan, July	..	—
..	2/6	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	2¼—2¾	5 0 0	Mar, Sept.	..	—
St.	4%	Do. 4 per Cent. Deb. Stock	77 —82	5 1 0	Jan, July	..	—
10	6/0	Lanarkshire Tramways	10 —10½	5 12 3	Feb, Aug	..	—
St.	5%	Lancs Utd. Trams, 5% Prior Lien Deb. Stk.	79 —82	6 4 0	Jan, July	—	—
St.	4%	London Electric 4% Deb. St.	96 —98	4 2 6	..	97½	97½
St.	4%	Do. 4% Pref.	84½—85½	4 14 0	—	85½	84½
10	..	London United Trams, 5% Cum. Pref.	3½—4	..	Jan, July	3¾	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	74 —77	5 6 0	Jan, July	74	..
St.	..	Mersey Con. Ord. Stock	6 —8	..	Feb, Aug	—	..
1	1/1½	Metropolitan Elec. Tramways Ord.	[illegible]	6 0 0	..	[illegible]	..
1	..	Do. Deferred	⅛—3/16	..	April	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	[illegible]	5 0 0	Feb, Aug	[illegible]	..
St.	4½%	‡Do. 4½ per Cent. Deb. Stock	99 —101	4 10 0	Jan, July	99	..
St.	5%	Do. 5 per Cent. Db. Stk	102½—104½	4 16 6	—	103	..
St.	2%	†Metropolitan Railway Consolidated	46½—46¾	3 15 0	Feb, Aug	48½	46¾
St.	3%	†Do. Surplus Lands Stocks	66 —68	3 15 6	Feb, Aug	66	..
St.	3½%	†Do. 3½ per Cent. Preference	88 —90	3 18 6	Feb, Aug	89½	87½
St.	3½%	†Do. 3½ per Cent. "A" Preference	87 —89	3 19 6	Feb, Aug	87½	[illegible]
St.	3½%	†Do. 3½ per Cent. Convertible Pref.	87 —89	3 19 6	[illegible]	[illegible]	[illegible]
St.	3½%	Do. 3½ per Cent. Debenture Stock	92 —94	3 [illegible]	[illegible]	[illegible]	[illegible]

* No allowance has been made for accrued [illegible]
† Ex Dividend. ‡ The London Stock Exch[illegible]

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ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Share	Last Dividend	Name	Price Wed., Aug. 2.	*Rate per cent. Yielded. £ s. d.	Dividend Due.	Business Week to Aug. 2. High-est.	Low-est.
		Electric Railways and Tramways— *Continued.*					
St.	3½%	Met. Rly. 3½ per Cent. "A" Deb. Stock..	91 —93	3 16 0	Jan, July	91⅜	..
St.	..	Metropolitan District Railway Ord.....	27 —27½	.. ..	Feb, Aug	27⅜	26⅝
St.	3½%	Do. 4½% First Pref.....	90 —92	4 19 0	Feb, Aug	91⅜	91
		†Do. Assented Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	74 —76	4 13 6	Feb, Aug	75⅛	75⅛
St.	3%	Do. 3 per Cent. Consoltd. Rent-charge	76 —78	3 18 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Midland Rent-charge	102 —104	3 17 9	Jan, July	..	..
St.	6%	Do. 6 per Cent. Perp. Deb. Stock.....	145 —147	4 2 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Ditto.....	96 —98	4 2 6	Jan, July	..	..
	4½d.	Potteries Electric Traction Ord.	⅜ —⅝	6 11 3	April, Oct	..	..
St.	0/6	Do. 5 per Cent. Cum. Pref.....	1/16 —⅛	8 0 0	Feb, Aug	..	..
	4½%	Do. 4½ per Cent, Deb. Stock.....	88 —91	5 0 0	May, Nov	..	..
St.	1/2⅔	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	⅛ —⅜	10 2 0	.. ..	..	..
	4%	Do. 4 per Cent. Deb. Stock.....	73 —78	5 6 0	Jan, July	..	..
100	5%	Sunderland Dist. Elec. Trms. 5% 1st Mt Db.	..	8 4 0	Jan, July	..	..
	10/0	Undergd E. Rys. Lon. 6% In. bds with coup 7	64 —66	1 10 3	June, Dec	65½	64
	5%	Do. 5% Prior Lien Bonds.....	100⅛ —101¼	4 19 0	.. ..	..	..
	4½%	Do. 4½% Bonds with coup. 8	99 —101	4 10 0	.. ..	99⅛	..
5	4%	Do. 4 per Cent. 1st Power Ho. Dbs. ..	101 —103	3 18 3	.. ..	..	..
5	..	Yorkshire (W.R.) Elec. Trams. Ord.....	⅛ —⅜	.. ..	March ..	..	..
	..	Do. 6 per Cent. Cum. Pref.....	2 —2½	.. ..	.. ..	..	..
St.	4½	Do. 4½ per Cent. 1st Debs.....	80 —85	5 9 6	Jan, July	..	..
		Electric Manufacturing, &c.					
St.	4½%	Anchor Cable Co. 4½ % Deb. Stock	98 —100	4 11 0	—		
	1/2⅔	Aron Electricity Meter Ord.....	⅜ —½	.. ..	.. ..	..	..
	0/7½	Do. 6% Cum. Pf.	1/16 —⅛	7 10 0	April, Oct	..	..
	3/2⅔	Babcock & Wilcox Ord.	5⅛ —5⅜	4 15 0	April, Oct	5⅛	5⅛
	0/7½	Do. Pref.....	1⅜ —1½	4 0 0	.. ..	..	..
	6/0	British Insulated & Helsby Cables Ord...	6½ —7⅜	6 15 6	July, Feb	7⅛	6⅛
	3/0	Do. 6 per Cent. Pref.....	5¼ —6½	5 0 0	Jan, July	6½	6⅛
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)..	102 —104	4 7 0	Jan, July	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	96 —99	4 11 0	Mar, Sept	..	..
	..	British Westinghouse 6 per Cent. Pref....	⅛ —⅜	.. ..	Feb, Aug	..	..
100	6%	Do. 6 per Cent. Prior Lien Dbs. (rd.)..	102 —104	5 17 0	.. ..	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock.....	59 —62	6 6 6	Jan, July	..	..
St.	4½%	Brush E. Eng. Co. 4½% Perp. 1st Deb. Stock	58 —63	7 8 6	Mar, Sept	..	..
St.	4½%	†Do. Perpetual 2nd Deb. Stock.....	39 —44	10 10 0	Jan, July	..	..
	5	Callender's Cable Con. Ord.	9 —9⅛	8 2 0	Jan, July	9⅜	..
	10/0	Do. 5 per Cent. Cum. Pref.....	4⅞ —5⅛	4 17 6	Jan, July	..	..
	2/6	Do. 4½ per Cent. 1st Mort Debs. (red.)..	101 —103	4 8 0	Nov, May	101	..
St.	4½%	Castner-Kellner Alkali Co.....	3⅛ —3⅜	5 7 3	May, Nov	3⅛	3⅛
	1/6	†Do. 4½ per Cent. 1st Mort. Deb. (red.)..	102 —105	4 7 0	Feb. Aug	103	..
St.	4½%	Chadburn's (Ship) Telegraph Ord.	1⅛ —1⅜	5 19 0	March ..	..	..
	1/0	†Consolidated Electrical Co.....	1/16 —⅛	7 8 9	August ..	..	..
	0/8½	Consolidated Signal Co.....	⅛ —¼	7 5 6	April, Oct	⅛	⅛
	0/6	Do. 6 per cent. Cum. Pref.	¼ —⅜	7 6 6	April, Oct	..	..
	0/7½	Crompton & Co (Nos. 1 to 85,000)	1/16 —⅛	.. ..	Jan, July	..	..
	..	Do. 5 per Cent. 1st Mort. Debs. (red.)..	57½ —67½	8 0 0	Jan, July	..	..
100	5%	Dick, Kerr & Co. Ord.....	⅛ —⅜	5 14 0	Sept.	..	..
5	1/0	Do. 6 per Cent. Cum. Pref.....	1 —1⅛	5 6 0	Sept	..	..
5	0/7½	Do. 4½ per Cent. Deb. Stock.....	95 —98	4 13 3	Jan, July	..	..
St.	4½%	Edison & Swan United ("A" Sh.) (£3 pd.)	⅜ —½	.. ..	Feb, Aug	..	..
5	..	Do. (£5 paid)	1⅝ —2⅛	9 3 0	Feb, Aug	..	..
	..	Do. 4 per Cent. Mort. Deb. Stock (red.)	67 —71	5 16 0	June, Dec	..	..
St.	4%	Do. 5 per Cent. 2nd Deb. Stock.....	78 —81	6 3 6	Mar, Sept	..	..
St.	5%	Edmundson's Elec. Corp. Ord.....	1/16 —⅛	.. ..	Jan, July	..	..
	..	Do. 6 per Cent. Cum. Pref.....	2⅛ —2½	.. ..	May, Nov	..	..
	..	Do 4½ per cent. 1st Mort. Deb. (red.)..	84 —87	5 3 4	Jan, July	..	..
St.	4½%	†Electric Construction Co.....	1/16 —⅛	6 3 0	Jan, July	..	..
	2½%	†Do. 7 per Cent. Cum. Pref.....	1⅛ —1⅜	7 4 6	July	..	..
2	2/9½	Do 4 per Cent. Perp. 1st Mort. Debs...	73 —76	5 6 0	Jan, July	..	..
St.	4%	General Electric (1900) 5% Cum. Pref. ..	8½ —9	5 14 0	June, Dec	..	..
10	5/0	Do. 4 per Cent. 1st Mort. Debs.....	88 —93	4 8 6	Mar, Sept	..	..
St.	4%	Henley's Telegraph Works Ord.....	12⅛ —12⅞	5 16 6	Feb, Aug	12⅜	..
5	10/0	Do. 4½ per Cent. Pref.	4⅛ —5⅛	4 10 0	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. 1st Mort. Deb. Stock	105 —108	4 4 6	Feb, Aug	..	..
St.	4½%	India Rubber, Gut. Per., &c., Works....	11⅛ —13⅛	6 0 0	Mar, Sept	..	..
10	15/0	Do 5 per Cent. Cum. Pref.	10 —10⅝	4 18 0	Feb, Aug	10⅜	..
10	5/0	Do. 4 per Cent. Debs. (red.)	96 —98	4 1 6	.. ..	..	..
100	4%	National Elec. Construction Co.	⅛ —¼	.. ..	April. Oct	..	..
1	..	Richardsons, Westgarth & Co., Ltd. Ord.	1/32 —1/16	.. ..	April	..	..
1	..	Do. 6 per Cent. Cum. Pref.	3/32 —⅛	.. ..	Nov	..	..
St.	4½%	Do. 4½ per Cent. Perp. Deb. Stock....	77 —80	5 14 6	May, Nov	..	..
5	..	Simplex Conduits 6 per Cent. Cum. Pref.	4⅛ —5	.. ..	Jan, July	..	..
12	12/0	Telegraph Construction & Maintenance..	35 —37	5 17 0	.. ..	..	..
100	4%	Do. 4 per Cent. Deb. Bonds (1909)	99 —101	4 0 0	Mar, July	36⅛	..
1	1/0	Vickers, Sons & Maxim, Ltd., Ord.....	2 1/32 —2 3/32	4 14 0	Jan, July	..	2⅛
1	0/6	Do. 5 per Cent. non-Cum. Preference..	1⅛ —1⅜	4 3 0	.. ..	1⅛	..
St.	5%	Do. 5 per Cent. non-Cum. Preferred ..	108 —112	4 11 0	.. ..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Db. Sk. (red)	99⅛ —101⅜	3 19 6	.. ..	111⅛	109⅛
100	4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.)	103 —105	4 6 6	June, Dec	101	100⅛
100	5%	Do. 5 per Cent. 3rd Mort. Debs Scrip..	103 —105	4 16 0	June, Dec	..	..
10	12%	J. G. White & Co. 6% Cum. Pref.	14⅛ —15⅛	7 14 10	.. ..	104	103⅜
1	..	Willans & Robinson Ord.....	⅛ —⅜	.. ..	.. ..	15⅜	15 3/32
5	..	Do. 6 per Cent. Cum. Pref.....	½ —1	.. ..	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.....	55 —65	6 3 0	Apr, Oct	..	..
		Telegraphs.			May, Nov	..	..
10	..	Amazon Telegraph	7⅛ —7⅞	.. ..	June, Dec	..	..
100	5%	Do. 5 per Cent. Debs. (red.)	98 —100	5 1 0	Jan, July	..	..
St.	15/0	†Anglo-American	67 —69	4 8 0	F,My,Ag,N	..	..
St.	30/0	†Do Preferred	111⅛ —112⅛	5 6 6	F,My,Ag,N	112⅜	111⅛
St.	30/0	Do. Deferred	25⅛ —26⅛	5 15 0	F,My,Ag,N	26⅛	25⅛
St.	4%	Commercial Cable 4 per Cent. Deb. Stk...	87⅛ —89⅛	4 10 6	Jn,Ap,Jy,O	89	88
10	6/0	Cuba Submarine Ord.	10⅛ —11	5 13 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	17⅛ —18⅛	5 13 0	Feb, Aug	..	..
5	2/0	Direct Spanish Ord.	3⅛ —4	5 0 0	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.....	8⅛ —8⅞	5 16 0	April, Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	99 —101	4 10 0	Jan, July	..	..
10	3/0	Direct United States Cable xd and bonus	7⅞ —8⅛	5 19 6	Ja,Ap,Jy,O	8⅛	8
100	4½%	Direct West India Cable 4½% Rg. Do. (rd.).	98 —100	4 11 0	June, Dec	..	..
St.	25/0	Eastern Ordinary xd and bonus	136 —139	5 12 4	Ja,My,Jy,O	137⅛	136
St.	17/6	Do. 3½ per Cent. Pref. Stock.....	8½ —86	4 2 10	Ja,My,Jy,O	85⅜	85¼
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (red.)..	101⅛ —103⅛	3 18 0	May, Nov	..	..
St	2/6	†Eastern Extension	13⅛ —13⅜	5 4 0	Ja, Ap, Jy, O	13⅛	13⅛
10	4%	†Do. 4 per Cent. Deb. Stock	100 —102	3 19 3	Feb, Aug	..	..
25	4%	Eastern and S.Af., 4% Mauritius Sub. Debs	99⅛ —101⅛	3 19 0	May, Nov	..	..
10	5/0	G.N (of Copenhagen), with Coupon 83 ..	31 —32	5 14 3	Jan, July	..	..
25	52/6	Indo-European	56⅛ —58⅛	5 5 6	May, Nov	..	..
100	5%	Mackay Companies Common	88 —90	5 12 3	Ja,Ap,Jy,O	..	..
100	4%	Do. Preference	75 —77	5 2 0	Ja,Ap,Jy,O	..	..
1	1/0	†Marconi's Wireless Teleg. Co.	2⅛ —2⅜	.. ..	April	2⅛	2
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (red.)	99¼ —101	4 0 0	June, Dec	..	..
2½	1/3	West Coast of America	1⅛ —1⅜	5 0 0	May	..	..
100	4%	Do. 4 per Cent. Debs.	97⅛ —97½	4 1 6	Jan, July	..	..
10	1/6	West India & Panama	2⅜ —2⅝	4 11 6	May, Nov	..	..
10	6/0	Do. 6 per Cent. 1st Pref.	10⅛ —10⅝	5 16 6	May, Nov	10½	10⅛
10	6/0	Do. 6% 2nd Pref.	9⅛ —10⅛	6 0 0	May, Nov	10	..
100	5%	Do. 5 per Cent. Debs.	101 —103	4 18 0	Jan, July	..	..
10	3/0	Western Telegraph	13⅜ —14⅛	5 1 1	Mr,Jn,O,D	14⅛	13⅜
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	99 —101	4 0 0	June, Dec	..	..
—	4%	Western Union Telegraph, $1,000 4% Bds	106 —109	3 14 3	.. ..	..	..
—	4½%	Do. $1,000 4½% Fdg. & Rl. Est. Gd. Bnds	100 —103	4 8 6	—	—	—

Share	Last Dividend	Name	Price Wed., Aug. 2.	*Rate per cent. Yielded. £ s. d.	Dividend Due.	Business Week to Aug. 2. High-est.	Low-est.
		Telephones.					
	2$	Amer. Telephn. & Telegh. Cap. St.	139 —141	5 14 3	.. ..	..	..
	4%	Do. Coll. Trust $1,000 4 per Cent. Bds.	94 —96	4 4 0	Jan, July	..	..
St.	4%	Do. 4% Cons. Bonds 1936	111 —113	3 11 3	.. ..	..	..
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101 —103	4 17 0	Mar, Sept	..	..
	4/0	†Chili Telephone	6⅞ —7⅛	4 5 9	August ..	..	..
	0/7½	Monte Video Telephone Ord.....	½ —1	6 0 0	Nov	..	..
	0/6	Do. 5 per Cent. Pref.	½ —¾	5 11 0	May, Nov	..	..
St.	6%	†National Co. Pref. Stock.....	102⅛ —104½	5 16 0	Feb, Aug	102	..
St.	6%	†Do. Def. Stock	119 —122	4 19 6	Feb, Aug	128	..
	6/0	†Do. 6 per Cent. Cum. 1st Pref.....	10 —10⅜	5 11 6	Feb, Aug	..	..
	6/0	†Do. 6 per Cent. Cum. 2nd Pref.....	10 —10⅜	5 11 6	Feb, Aug	..	..
	2/6	†Do. 5 per Cent. non-Cum. 3rd Pref.....	5⅜ —5⅝	4 8 11	Feb, Aug	..	..
St.	3½%	Do. Deb. Stock 3½ per Cent. (red.)....	98 —100	4 1 0	June, Dec	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.).....	98 —100	4 1 0	Jan, July	..	..
	4½%	New York Telephone Co. 30 yr. Bnds.....	102⅛ —103⅜	4 7 0	.. ..	..	..
	1/0	Oriental	1⅛ —1⅜	4 18 0	April, Oct	..	..
	0/7⅛	Do 6 per Cent. Cum. Pref.	1⅛ —1¼	4 16 0	April, Oct	..	..
St.	4%	Do. 4 per Cent. Red. Deb. Stock.....	87⅛ —89⅛	4 10 6	Jan, July	..	..
	4½%	Telephone Co. of Egypt 4½% Db. Stk. (red.)	98⅛ —100⅛	4 10 6	Jan, July	..	..
	5/0	United River Plate Ord.....	7⅛ —7⅜	5 0 0	July	..	..
	2/6	Do. 5 per Cent. Cum. Pref.	5⅛ —5⅜	4 13 0	June, Dec	..	..
St.	4½%	Do. 4½ Deb. St. Red.....	101 —103	4 8 0	Jan, July	..	..
		Financial, Investment, &c.					
	3/0	Elec. & Gen. Investment 6% Cum. Pref...	4 —4½	7 1 0	Jan, July	..	..
	6/0	Globe Telegraph & Trust	10⅛ —11½	5 6 8	Sp,DcMrJu	..	..
	3/0	Do. 6 per Cent. Pref.	13 —13½	4 10 9	Sp,DcMrJu	..	..
	6%	Submarine Cables Trust (Cert.)	131 —134	4 9 6	April, Oct	..	..
		Colonial and Foreign Electric Railways, Tramways, &c.					
	2/9	Anglo-Argentine 5% Cum. 1st Pref.	5⅛ —5⅜	4 17 6	April, Oct	..	..
	2/9	Do. 5% Cum. 2nd Pref.....	4⅛ —5⅜	5 1 6	Jan, July	..	..
St.	4%	Do. 4% Deb. Stock	94 —96	4 3 4	June, Dec	..	..
St.	4½%	Do. 4½% Deb. Stock	100 —102	4 9 0	.. ..	..	..
St.	5%	Do. 5% Deb. Stock	100 —102	4 19 0	.. ..	..	..
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)....	102 —104	4 17 6	Jan, July	..	..
	4/0	Brisbane Electric Trams. Invest. Ord	6½ —7	5 14 0	May	..	..
	2/6	Do. 5 per Cent. Cum. Pref.	5 —5⅛	4 17 6	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.....	102 —105	4 7 0	Jan, July	..	..
St.	8%	British Columbia El. Rly. Df. Ord.	141 —145	5 12 0	Mar, Sept	..	..
St.	6%	†Do. Pref. Ord. Stock	118 —122	5 0 0	May, Nov	..	..
St.	5%	Do. 5% Cum. Perp. Pref. Stock.....	106 —109	4 13 0	Jan, July	..	..
	4½%	Do. 4½ per Cent. 1st Mort. Debs.....	100 —103	4 7 6	April, Oct	..	..
	4½%	Do. Vancouver Power Debs.	101 —104	4 3 3	Jan, July	..	..
St.	4½%	Do. 4½% Perp. Con. Deb. St.	102⅛ —104⅛	4 2 0	.. ..	..	..
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	100 —102	4 18 0	Mar, Sept	..	..
St.	6%	†Buenos Ayres Port & City Tram, 1st Mt. Deb. Stock	92 —96	6 8 0	Feb, Aug	..	..
	3/6	Calcutta Tramways (1 to 137,610).....	5⅜ —6⅛	4 19 6	Mar, Sept	..	..
	2/6	Do. 5 per Cent. Cum. Pref.	5 —5⅛	4 17 6	Jan, July	..	..
	4½%	Do. 4½% 1st Deb. Stock (red).....	102 —105	4 5 9	Jan, July	..	..
St.	..	Cape Electric Tram Shares	⅛ —¼	.. ..	.. ..	..	..
	1/3	City of Buenos Ayres Trams Co. (1904) Sh.	5⅜ —5⅝	4 5 0	F,My,A,N	..	..
St.	4%	Do. 4 per Cent. Deb. Stock.....	94 —97	4 4 0	June, Dec	..	..
	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.....	95 —100	5 2 6	May, Nov	..	..
	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	99 —102	4 18 0	Feb, Aug	..	..
	5%	Hong Kong Tramways Co. 5 per Cent. 1st Mort. Debs.	77 —81	6 6 6	June, Dec	..	..
	..	Kalgoorlie Elec. Trams Sh.	⅛ —¼	.. ..	.. ..	..	..
	5%	½ Do. 5 per Cent. "A" Deb. Stock.....	92½ —95½	5 4 6	Jan, July	..	..
	6%	Do. 6 per Cent. "B" Ditto	63 —67	8 15 0	Jan, July	..	..
	0/6	Lisbon Elec. Trams. Ord.	1 —1⅛	4 16 0	July	..	..
	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1⅛	4 16 0	Jan, July	..	..
St.	5%	Do. 5 per Cent. Reg. Mort. Debs.....	97 —101	5 1 0	Jan, July	..	..
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	95 —98	5 3 6	Jan, July	..	..
	5%	Manaos Trams and Lt. Co. 5% Debs	90 —93	5 9 6	.. ..	..	..
	5%	Manila Elec. Ry. $1,000 Gold Bonds.....	100 —104	4 19 0	Feb, Aug	..	..
	$1⅛	Mexico Trams Co. Com. St.	122⅛ —121⅛	5 13 6	.. ..	..	..
	5%	Do. Gen. Con. 1st Mort. 5% Gold Bds.	99 —100	5 0 6	.. ..	..	..
St.	6%	Do. 6% 50 yr. Mort. Bds.	99 —101	6 1 3	—	..	..
St.	4½%	†Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922) (Nos. 601 to 2,000)	100 —102	4 9 0	Feb, Aug	..	..
		Do. do. (Nos. 1 to 4,600)	102 —104	4 7 6	.. ..	..	..
	0/6	Perth Elec. Trams Ord.	⅜ —⅝	2 7 2	May	..	..
St.	5%	Do. 1st Mt. Db. Stock	101⅛ —103⅛	4 17 6	Jan, July	..	..
	5/0	Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	5⅜ —5⅝	5 8 0	—	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. Stk.	97 —100	4 11 6	—	..	..
	5%	Rio Janeiro Tram, Lt. & P. Co.....	117 —118	4 5 0	—	..	..
	5%	Do. 30 yr. Gold Bnds.	101 —102	4 18 0	—	..	..
	5%	Do. 50 yr. Mt. Bnds	97⅛ —98⅛	5 2 0	—	..	..
	$2⅛	Sao Paulo Tramway, Light & Power Co. $100 Stock	181 —184	5 10 0	..	..	..
	5%	Do. 5 per Cent. 1st Mt. $500 Db.	103 —105	4 15 3	June, Dec	..	..
	4½%	Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	98 —100	4 10 0	Feb, Aug	..	..
		Colonial and Foreign Electricity Supply, &c.					
	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.....	5¼ —5⅝	5 8 0	Mar, Sept	..	..
	6/0	†Bombay E.S. & T. 6% Cm. Pf.....	10⅛ —11⅛	5 9 0	.. ..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stk. (red).....	96½ —98⅛	4 12 6	Jan, July	..	..
	5%	Do. 5 per Cent. 2nd Mort. Deb. Stock..	96½ —98⅛	5 2 6	.. ..	..	..
	5/0	Calcutta Elec. Supply Ord.	6⅞ —7⅛	5 19 6	April, Oct	..	..
	2/6	Do. 5% Cum. Pref	4⅛ —5⅜	4 13 0	.. ..	..	..
100	5%	Calgary Power Co. 5% 1st Mort. Bnds....	96 —98	5 2 0	—	..	..
100	7/2½	Canadian Gen. Elec. Co. Com. St.	111 —116	6 3 6	—	..	..
100	$3½	Do. 7% Cm. Pf. Stock	120 —124	5 15 0	—	..	..
100	5%	Castner Electrolytic Alkali Co. (of U.S.A.) 1st Mort. Stl. Debs.	94 —99	5 3 6	Jan, July	..	..
500	5%	Elect. Development Co. of Ontario.....	85 —88	5 11 6	.. ..	..	..
St.	5%	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	84½ —87½	5 4 0	Jan, July	..	..
10s	..	Indian Elec. Sup. & Trac. Co.	1 —1⅛	.. ..	.. ..	..	..
1	..	Kalgoorlie Elec. Power & Ltg. Ord.	⅛ —⅜	.. ..	.. ..	..	..
	0/7½	Do. 6 per Cent. Cum. Pref.	1/32 —⅛	8 6 6	April, Oct	..	..
5	5%	Kaministiquia Power Co. 5% Gold Bnds..	101 —103	4 18 0	.. ..	..	..
St.	..	Madras E. S. Corp. Ord.....	2⅜ —3⅛	.. ..	.. ..	..	..
St.	..	Melbourne E. S. Co. Cons. Ord. St.	34 —39	.. ..	.. ..	..	..
500	5%	Do. 5% 1st Mortg Deb. Stock	95 —97	5 4 0	—	..	..
St.	$1	Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	90 —91	5 10 6	—	..	..
500	$3½	‡Mexican Lt. & Power Co. Com. St.	91 —93	4 7 0	—	..	..
St	5%	Do. 7% Cum. Pref. St.	109 —112	6 6 6	—	..	..
100	5%	†Do 5% 1st Mort. Gold Bnds.	97 —99	5 2 0	—	..	..
100	8/2½	Monterey Rly. L. & P. Co. 1st Mort. Db. Sk.	87½ —91½	5 10 6	—	..	..
100	£10	†Montreal Lt. Ht. & Power Co. Cap. St.	171 —175	4 12 6	F,My,A,N	..	..
St.	5%	Northern Lt. Power & Coal 5% Gd. Bds ..	45 —47	5 7 6	—	..	..
St.	£10	River Plate Electricity Co. Ord. Stk.	218 —228	4 7 9	April	..	..
St.	6%	Do. 6 per Cent. non-Cum. Pref. Stk. ..	107 —114	5 5 0	May	..	..
100	5%	Do. 5 per Cent. Deb. Stock	101¼ —103½	4 17 6	Jan, July	..	..
St.	$1¾	†Shawinigan Water & Power Co. Ca.....	119⅛ —121⅛	4 2 3	.. ..	..	..
St.	5%	Do. 5 per Cent. Bds.	107 —109	4 12 6	Jan, July	..	..
St.	4½%	Do. 4½ Per Con. Mt. Db. St.	103 —105	4 6 0	—	..	..
	14½%	Toronto Power Co. 4½% Db. St.	* 99 —101	4 8 0	—	..	..
	11/85	Victoria Falls Power Co. Pref.	⅛ —1	..	Jan, July	..	..

* No allowance has been made for accrued interest or redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

The Joint Textile Committee.

THE publication of the names of members suggested for the Joint Committee to consider the uses of electricity for textile mill driving has already given rise to much comment, particularly among electrical manufacturers, who, singularly enough, have only two representatives on the Committee. Among the general and special duties of the Committee will be the examination of witnesses drawn from the manufacturing element, who will presumably give evidence on the work done by them, such evidence including data and technical information gained in the course of each particular firm's experience. From what we are able to gather in the textile districts, the manufacturers are competitively rather than co-operatively inclined. Consequently, it is conceivable that any one electrical manufacturer with a good textile connection will be disinclined to give away the details of his experience to his rivals. This diffidence will apply as much to a manufacturer sitting on the Committee as to one not doing so, and it is an attitude which can be readily understood. By the present constitution of the Committee electrical manufacturers need not be given seats, and certainly so small a number as two is totally inadequate to represent so large a body of interested electrical engineers. The situation will not be improved by the increase of this number, but rather by its decrease by the actual removal of the two representatives in question. The Committee will then have a clear road to collect its evidence in a manner which will give satisfaction to all the manufacturers alike. If some such step as the above is not taken, we fear that the work of the Joint Committee will suffer enormously in consequence.

Tramway Revenue.

ALTHOUGH tramway committees may sometimes be impressed by an increase in the traffic revenue per car-mile, it does not necessarily follow that such increase i always in the best interests of the undertaking, or most satisfactory to the passengers. This point is evidently appreciated by the Highways Committee of the London County Council, for in presenting the accounts of their electric tramways last week the Committee emphasised the fact that the decline in traffic revenue from 11·21d. to 11·0d. per car-mile during the past year did not necessarily indicate a decline in the prosperity of the undertaking; indeed, they mentioned that it had been found financially advantageous to increase the mileage run in certain instances, with a corresponding diminution in the revenue per car-mile. As to what is the most satisfactory figure for the revenue per car-mile must be left to each tramway manager to determine, since it depends, among other factors, upon the working expenses, the capital charges and the prospect of increased revenue with additional mileage in each case; 11d. per car-mile however, appears to be about the average figure reached, or favoured, on large undertakings in this country. It is worth noting, moreover, that at Blackburn, although a traffic revenue of 12·6d. per car-mile was recorded, a financial deficit was shown for the year ended March 31st last. Our detailed analysis elsewhere in this issue of the

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past year's operation of the Manchester Corporation Tramways shows that the traffic revenue last year was 11·04d. as against 10·87d. in 1909–10. This is one of the most successful undertakings in this country, as may be judged from the fact that the ratepayers have benefited to the extent of over half a million pounds during the last 10 years; moreover, there was put aside out of last year's profits a sum of £86,250 for depreciation and reserve after contributing £75,000 to the rates. The financial success of a few of the largest tramway undertakings only emphasises the disparity between different undertakings. Thus, the Gloucester tramways, of which the annual accounts have recently come to hand, have required assistance from the rates to the extent of £2,925. As the total traffic revenue was only £14,966, and no allowance was made for depreciation, the ratepayers in this case have to pay heavily for the convenience of the cars.

Protecting High Tension Circuits.

When Mr. J. S. Peck read his paper some three years ago before the Institution of Electrical Engineers on apparatus for protecting high-tension lines against lightning and similar discharges, little had been done in this country in that direction, and at the present time we are dependent to a considerable extent on American experience. Valuable information on this subject has now been collected by the National Electric Light Association, and particulars of the report of a Committee of the Association and of the discussion thereon are given in our present issue. It appears that electrolytic arresters are coming into increasing favour and would be more largely employed if it were not for their high first cost and the trouble of charging. Their installation, however, is recommended except where other arresters are giving satisfaction. It is interesting to observe that Mr. P. M. Lincoln believes that better results can be obtained without arresters on overhead lines if suspension insulators and an earth wire are used. It may be noted that the Committee strongly advise the use of an overhead earth wire, and that this should be earthed at every support; a lightning rod placed above the earth wire is also recommended. It is extremely important that such lines should be rendered safe, and we think that those engineers who have studied the matter realise that a substantial continuous earth wire is the proper solution of the difficulty. Such a wire should be earthed at frequent intervals, though preferably not at every pole. It is useless to employ a wire that is not capable of carrying a reasonably heavy current, and the earth connections must not be of that haphazard variety which, we regret to say, is sometimes found.

International Telephone Lines.—The "Times" correspondent at Berne states that the Swiss Government has just announced that the Bill concerning the establishment of telephonic communication between Milan, Zurich, Basel, Frankfurt and Berlin has been passed by the Italian Parliament. The proposals for the new telephonic lines have still to be ratified by the authorities in Germany, Italy and Switzerland, but this is a mere matter of form. Tenders are to be invited for the construction of these new lines, and it is expected that the work will very soon begin; but as the shortest line between the different places must always be chosen, a new plan of the telephonic route has to be made. The railway lines are not to be followed, nor are the high roads, for it is intended that the new line shall be reserved exclusively for the telephone. The lines from Milan to Basel and from Milan to Basel and Frankfurt will probably pass through the Simplon and go via Lausanne, whence the shortest route will be taken to Basel. It is said that the establishment of these new telephonic communications will be one of the largest undertakings of the kind to be carried out in Europe next year.

Extension of the Anglo-French Telephone Service.—A short time ago the Post Office laid a new and improved telephone cable in the Straits of Dover (*see* The Electrician, Vol. LXVI., p. 375), and this has recently been connected to land lines from London and Paris, thereby providing increased and improved telephone facilities between the two capitals. By the extension of these circuits to provincial towns speech is rendered possible between places in England and France which could not previously so communicate with each other. In order to determine the extent of the increased range, experiments have recently been carried out by English and French officials from a number of provincial towns on this side of the Channel. Before the new cable was provided no town north of a line connecting the Humber and Mersey could communicate with Paris, but in the recent trials it was found possible to converse with the French capital from Newcastle-on-Tyne, Glasgow and Edinburgh, and finally trials were made from Aberdeen involving a circuit length of over 900 miles. With the best conditions of line and apparatus, commercial speech could be conducted from that place with Paris. These tests will enable the Post Office engineers to determine what other English towns can communicate with France, and it is hoped that a list of such towns will be published shortly. The increase in the range of telephonic speech has been brought about by means of the new telephone cable recently laid between England and France. This cable, it will be remembered, is fitted with loading coils which neutralise the disturbing effects on speech transmission introduced by the insulating material which must necessarily be employed when conductors are laid in water.

"Results of Experiments with Francis Turbines and Tangential (Pelton) Turbines."—In a Paper on this subject read at the recent meeting of the Institution of Mechanical Engineers at Zurich, Dr. F. Prásil stated that within the last 10 years the Francis turbine and the Pelton wheel in the most various forms of construction had quite taken the place of the old types, such as the Jonval and Girard turbines. Capacities as high as 16,000 H.P. in single units had now been reached. The Francis turbine was applied with success to falls of from 1 to 150 metres (3·3 ft. to 492 ft.); the Pelton wheel to falls from 40 to 950 metres (131 ft. to 3,116 ft.). In this progress was to be noted not only a steady improvement in the details of construction of the turbine, but also in the efficiency of the automatic governing and the safety-mechanism. Particularly in modern plants with long supply-pipes and conduits, with the severe specifications for high-standard reliability in the safety apparatus, these requirements made large claims upon the skill and ability of the engineers. The result had been, however, a large measure of success in the production of successful designs. In regard to efficiency, much further advance in the future was not to be expected; the problem of governing could still be considered as not yet completely solved, since there still appeared in view a series of applications which would influence the further development of this problem. The electrification of railways might be mentioned as one example. But the hope might well be expressed, considering the results already obtained, that with the help of the material and intellectual instruments now available, technical science would be able to find a satisfactory solution of these future, and perhaps of much more difficult, problems.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair
Assab—Perim	July 8, 1909 ...	—
Latakia—Palura	May 26, 1910 ...	—
Zanzibar—Mombasa	July 11, 1911 ...	—
Guam—Manila	July 12, 1911 ...	Aug. 4, 19
Cayenne—Salinas	July 29, 1911 ...	Aug. 5, 19

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Arc Headlights for Electric Cars.—According to the "Electric Railway Journal" the new arc headlights developed by the General Electric Co. (U.S.A.) for electric cars embody a magnetite arc. The brilliant light given from these lamps when operated normally, insures units of high efficiency, while the low luminosity resulting with reversed polarity affords a most convenient means for dimming the glare of the lights. All the lamps are adjusted to operate in series on a 550-volt direct-current circuit, the voltage across the arc being 80 volts and the current 4 amperes. The headlights for cars operating on suburban tracks with many curves and intersecting roadways are equipped with parabolic reflectors of highly polished metal. They furnish a broad fan beam which illuminates the track directly from the head of the car and 50 ft. on each side to a distance of 1,200 ft. or 1,500 ft. On cars which operate only between towns the headlight illuminates the track to a distance of 2,000 ft., the beam being practically the width of the track alone. In these lamps the electrodes automatically maintain the arc at the focus of the reflector, thus eliminating from the duties of the motorman the trouble of frequent adjustment. The positive electrode consists of a stationary copper forging sheathed in suitable metal to prevent it from oxidising. It has a life of about 2,000 to 3,000 hours, and may be considered as "non-consuming." The negative electrode is a steel tube containing a mixture of iron oxide and other substances. It has a life of from 60 to 80 hours.

"Some New Types of Dynamometers."—In a Paper with this title, which was read at the meeting of the Institution of Mechanical Engineers at Zurich by Dr. A. Amsler, the author described two types of dynamometers, one of which is suitable for high speed and the other for low-speed machines. The former of these is of the torsion type, and consists of three discs, one at one end of the shaft whose torque is required, and the other two at the other end. The first disc is provided with a transparent circumferential celluloid scale, which can be observed from the third disc through a fine slit in the second. This fine slit acts, in fact, as a pointer, and the amount of torsion can thus easily be read off when the scale is illuminated by a 50 c.p. lamp. Provided the shaft be perfectly elastic, the angle through which the extreme ends are turned will be proportional to the twisting moment—that is, proportional to the power transmitted. If the shaft is made of a special spring steel of very high yield point—that is, above 6,000 kg. per square centimetre (90,000 lb. per square inch)—it can be twisted to a considerable degree without breakage or permanent distortion. In the example given the twist of the rod 40 cm. (15¾ in.) long is for a twisting moment of 20 m.-kg. (1,736 in.-lb.) about 20 deg. The shaft has a cross-section of 12 mm. by 12 mm. (0·4725 in. by 0·4725 in.), and is, therefore, subjected to a stress of 5,200 kg. per square centimetre (78,000 lb. per square inch), which is below the yield point. In the second type of instrument a pulley is provided with two projections, which when in rotation press a small piston into a cylinder filled with oil. This causes a registration proportional to the torque to be given on a gauge through a mechanism similar to that of an ordinary steam indicator. A strip of paper passes under the pencil of a registering gear at a velocity proportional to the speed of the shaft of the instrument. The area of any portion of the diagram thus obtained represents the energy absorbed by the machine and the mean height the average power transmitted.

Current Topics.

Subjects of current interest dealt with in this issue include the following:—

Mr. J. H. Dellinger contributes an article on "The Expression of Resistivity of Electrical Conductors."

Mr. J. Härdén contributes an article on "The Effect of Power Factor and Load Factor in Electric Furnace Work."

We give an abstract of a Paper by Mr. L. Zodel on "High Pressure Water-Power Works," read at the recent meeting of the Institution of Mechanical Engineers at Zurich.

At this meeting Messrs. T. Weber and S. Abt contributed a Paper on "Rack-Railway Locomotives of the Swiss Mountain Railways."

At the meeting of the International Photometric Commission at Zurich last month Messrs. W. J. A. Butterfield, J. S. Haldane, F.R.S., and A. P. Trotter read a Paper on "Corrections for the Effects of Atmospheric Conditions on Photometric Flame Standards."

The Edison-Beach storage battery car was described by Mr. R. H. Beach in a Paper read before the Street Railway Association of the State of New York.

A new type of single platform prepayment tramcar is being introduced in Buffalo. This is discussed in our Leading Article.

We describe the large turbine-driven power station which supplies electric light and power in Marseilles.

Bispham Council are borrowing £10,800 for their electricity supply project.

Burnley Council have secured sanction to borrow £8,552 for extensions of generating plant.

Hornsey (London) Council have received sanction for a loan of £9,000 for extensions to the electricity undertaking.

Municipal Loans.—Dublin Corporation have received sanction to a loan of £100,000 for their electricity supply department, loans or similar purposes have been granted to Burnley Corporation (£8,552), Wrexham Corporation (about £3,600), Aldershot Council (£2,500) and Bispham Council (£10,800). Sheffield Corporation have applied for permission to borrow £61,000, Hereford for £2,350 and Briton Ferry for £1,200 for electricity supply extensions.

Companies' Meetings and Reports.—The reports of the meeting of the Central London Railway Co. and the Tyneside Tramways and Tramroads Co and the directors' reports of the Yorkshire Electric Power Co., the Liverpool Overhead Railway Co. and the Hankow Light and Power Co. are given on another page.

OBITUARY.

E. Mercadier.—The death took place on the 27th ult. of M. Ernest Mercadier, formerly director of studies at the Ecole Polytechnique, Paris. M. Mercadier entered the French telegraph service in 1859, and held the post of Director of Telegraphs during the siege of Paris, when he also organised the military telegraph service. After the war he became professor of Physics at the Ecole Supérieure de Télégraphie, and in 1881 he became director of studies at the Ecole Polytechnique, where he remained until 1903. The deceased wrote on electric telegraphy, and was the inventor of a number of technical appliances. M. Mercadier was a foreign member of the Institution of Electrical Engineers and a member of the Société Internationale des Electriciens.

W. I. Last.—We regret to record the death of Mr. William Isaac Last, science director of the Victoria and Albert Museum, South Kensington. Mr. Last was born at Dorchester in 1857, and, serving his time as a mechanical engineer, became senior Whitworth scholar in 1878. He was then engaged in engineering work both in England and South Africa till 1890, when he was appointed keeper of the machinery and inventions section at the South Kensington Museum. He was appointed senior keeper in 1900 and director in 1904.

John A. Surtees.—The death took place on Aug. 1 at the age of 33 years of Mr. John A. Surtees, who had just been appointed manager of the Cromer Electricity Works. He had been assistant engineer with the Urban Electricity Supply Co. at Grantham for eight years.

Charles William Pearson.—We also regret to record the death of Mr. C. W. Pearson, a member of Pearson Bros., electrical engineers of Nottingham. Deceased, who had been suffering from a breakdown due to overwork, was 46 years of age.

PERSONAL NOTE.

The French Government has conferred upon Mr. H. V. Browne the distinction of Officier de l'Instruction Publique, in recognition of his long and friendly relations with and services to the French colony at Barcelona, and as President of the British Chamber of Commerce for Spain and founder of the Chamber. We recently announced Mr. Browne's departure for Marseilles, where he becomes manager of the station of the Direct Spanish Telegraph Co. in that city.

APPOINTMENTS VACANT AND FILLED.

The Governing Body of the Northampton Polytechnic Institute, St. John-street, London, E.C., invite applications for the following appointments:—

1. Junior drawing office assistant in the mechanical engineering department (commencing salary £100 per annum).

2. Assistant junior demonstrator in the electrical engineering and applied physics department (commencing salary £80 per annum).

Particulars of conditions of appointment, &c., with forms of application, can be obtained from the principal, Dr. R. Mullineux Walmsley, to whom applications must be sent by 10 a.m. of Sept. 1. See an advertisement.

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Applications are invited for the post of assistant to the wireless telegraph expert on H.M.S. "Vernon," Portsmouth. The appointment will be for three years. Salary £300 per annum. Applications to the Secretary of the Admiralty, Whitehall, London, S.W. See also an advertisement.

The Committee of East Ham Technical College invite applications for the post of instructor of the evening classes in telegraphy and telephony. Salary 10s. 6d. per evening. Applications to Mr. W. H. Barker, B.Sc., Technical College, East Ham. See advertisement.

Instructors in general mechanical engineering and motor car engineering are required for Guildford Technical Institute. Fee not less than 10s. per evening, plus fares. Applications to Mr. F. S. Tosswill, Technical Institute, Guildford, by Aug. 16.

The Crown Agents for the Colonies give notice that they require from time to time (for service in East and West Africa) mechanics (£300) and assistant mechanics (£250) in the Telegraph Department, civil and mechanical engineers (£300 to £400) and draughtsmen (£250 to £300) in the Public Works Department. Application forms from the Crown Agents for the Colonies, Whitehall Gardens, London, S.W.

A draughtsman, used to a.c. and d.c. machines, is wanted by the Lancashire Dynamo & Motor Co. (Ltd.), Trafford Park, Manchester.

The Borough of Aston Manor Education Committee require an assistant master qualified to teach electrical and mechanical engineering and mathematics (especially practical). Commencing salary £160. Applications to Mr. H. Norwood, Education Offices, Aston Manor, near Birmingham, by Aug. 28.

A demonstrator or assistant lecturer is required in the Physical Laboratory of University College, Reading. Commencing salary £125. Particulars from the Registrar. Applications by Aug. 28.

The Council of the University College of Nottingham have appointed Mr. W. H. McMillan, B.Sc., of Glasgow University, to be the first occupant of the newly-founded Chair of Mining at the college.

Mr. I. Bulfin, electrical engineer at Bournemouth, has been also appointed general manager of the Corporation tramways in succession to Mr. C. W. Hill.

Mr. A. G. Balfour (Dartford) has been appointed general manager of the Carlisle Tramways.

Mr. S. T. Biddell, shift engineer at Watford, having resigned, Mr. L. B. Dent has been appointed to the vacancy, and Mr. F. Craven, improver, has been appointed junior shift engineer.

Sir Alexander King, K.C.B., has been appointed secretary to the Post Office, in place of Sir Matthew Nathan, G.C.M.G., now chairman of the Board of Inland Revenue.

Mr. Ayton has been appointed by Winchester Corporation city electrical engineer and manager of the electricity undertaking.

INSTITUTIONS AND SOCIETIES.

Institute of Metals.—The annual autumn meeting of the Institute of Metals will be held at Newcastle-on-Tyne on September 20th, 21st and 22nd. The Hon. Sir Chas. A. Parsons, K.C.B., F.R.S., is acting as chairman of the local committee, and Dr. J. T. Dunn as honorary secretary. The meeting will open at 10 a.m. on Wednesday, September 20th, when the members will be welcomed at Armstrong College by the Rt. Hon. the Lord Mayor of Newcastle, Sir W. H. Stephenson, and the local committee, after which a series of Papers will be read and discussed, Sir Gerard A. Muntz, Bart., president, being in the chair. In the afternoon members will have the opportunity of visiting shipbuilding, engineering, metallurgical and electrical works in the neighbourhood. In the evening there will be a reception of the members and their ladies, followed by a conversazione in the Laing Art Gallery, by invitation of the Rt. Hon. the Lord Mayor. On Thursday, September 21st, Papers will be read and discussed at a morning session of the Institute, and in the afternoon there will be further visits to works. For September 22nd the Tyne Improvement Commissioners have kindly placed a steamer at the disposal of the local committee for a voyage to the mouth of the river Tyne and back.

EDUCATIONAL NOTICES.

University of London, University College.—The next session begins on Monday, Oct. 2, and students desirous of entering the faculty of engineering with a view to taking a degree or diploma course must have passed matriculation or some other examination accepted in lieu thereof. The fee for the full three year diploma course, including the course for graduation (B.Sc.) in the faculty of engineering, is 120 guineas, payable in three instalments. There are special courses for students who have already undergone a partial training elsewhere, and these may obtain a general certificate in engineering after not less than two consecutive sessions. Graduates in science or engineering, or students who have done work equivalent to a degree, may be admitted to special courses of study to prosecute original research. An interim scholarship of the value of 120 guineas will be competed for in September. Intending students should communicate with the Provost as soon as possible, and in any case not later than Sept. 16. Further particulars may be obtained from the secretary, Mr. Walter W. Seton, M.A., Gower-street, W.C.

University of Sheffield.—The faculty of applied science comprises the departments of engineering, metallurgy, coal mining and architecture. The courses in engineering or in metallurgy extend over three years and prepare respectively for the degree of B.Eng. or B.Met. of the university. The lecture courses commence on Oct. 4 and the technical laboratory courses on Sept. 18. Prospectuses and other particulars from the registrar, Mr. W. M. Gibbons.

University of Durham.—Armstrong College, Newcastle-upon-Tyne—The 1911-12 session commences Sept. 25. There are departments of mechanical, marine, civil and electrical engineering, naval architecture, mining, metallurgy, agriculture, pure science, arts and letters. Particulars may be obtained from the secretary, Mr. F. H. Pruen, M.A.

University of Birmingham.—The session commences Oct. 2. The full courses extend over four years, and students who enter after matriculations and who pass successfully the examinations at the end of each year will be entitled to the degree of Bachelor of Science in the branch of engineering to which they devote themselves. The technical engineering classes are detailed, and a list of the professors lecturers, &c., is given in an announcement on another page.

City and Guilds Technical College.—This college provides a scientific training for students preparing to become electrical and mechanical engineers or chemists, and for engineering pupils who desire to supplement their practical training by a two years' course of instruction in the principles of engineering science. There are also arrangements for three-year courses in engineering. Particulars at the college, Leonard-street, City-road, London, E.C., or from the City and Guilds of London Institute, Gresham College, Basinghall street, London, E.C.

Northampton Polytechnic Institute, Clerkenwell, London.—Full day courses in the theory and practice of mechanical and electrical engineering, and in electro-chemistry will commence on Oct. 2. The entrance examinations will take place on Sept. 27 and 28, at which five entrance scholarships will be offered. The courses for mechanical and electrical engineering include periods spent in commercial works shops, and extend over four years, and they also prepare for the degree of B.Sc. in engineering at the University of London. There are also full and partial day courses in technical optics. Particulars from the Principal, Dr. R. Mullineux Walmsley.

Glasgow and West of Scotland Technical College.—The diploma of the college is granted in the departments of civil, electrical and mechanical engineering, mining, naval architecture, chemistry, metallurgy, mathematics and physics, building and textile manufactures. The courses of study usually extend over three sessions and holders of the diploma are eligible for the degree of B.Sc. in engineering of the University of Glasgow, after attendance for at least one session at prescribed university classes. The laboratories are well equipped, and facilities for research are afforded in the departments of physics, electrical engineering, chemistry, metallurgy, mechanics, &c. The preliminary examination begins on Sept. 25, and names of candidates must be sent in by Sept. 1. The day classes begin Sept. 26 and the evening classes Sept. 21. Calendar (by post 1s. 4d.) and prospectuses (gratis) will be sent on application to the Director.

City of Bradford Technical College.—At this college there are day courses qualifying for the college diploma in civil, mechanical and electrical engineering. The next session commences Sept. 25. The new power house, especially arranged for experimental and educational work, will be opened during the session, and the equipment of the electrical engineering laboratories and machine shops has also been considerably extended and brought up to date. Calendar, containing particulars of all courses, on application to the director of education, Mr. A. C. Coffin.

ARRANGEMENTS FOR THE WEEK.

THE LONDON ELECTRICAL ENGINEERS.

Officer Commanding, Col. H. M. Leaf.

The following orders have been issued:—

Head-quarters will be closed for instruction, but will be open for work as under until further orders:—

Monday to Friday, 10 a.m. to 4 p.m.

Saturday, 10 a.m. to 12 noon.

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MANCHESTER CORPORATION TRAMWAYS.

In their electric tramway undertaking the Manchester Corporation possess a most valuable asset, and one which must prove very popular with the ratepayers, since the annual contribution in relief of the rates has shown a tendency to increase from year to year. The amount paid over for this purpose for the year ended March 31, 1911, was £75,000, bringing the total contributions during the last 10 years to £527,000.

During the 12 months in question the aggregate length of single track open for traffic has been increased by 1 mile, bringing the total (including the lines over which the Corporation are exercising running powers) to 183 miles, whilst 18 new cars were put in service. The number of cars in stock on March 31st last was 600, 321 of these being of the single truck type, 234 double truck and 45 combination.

A very satisfactory feature of the year's report is that the number of passengers carried shows a greater increase than for several years past; the total of 165,800,077 represents 184 journeys per annum per head of population served (approximately 900,000). The number of car-miles was 17,367,200, as against 17,161,774 a year ago, the number of passengers per car-mile having risen from 9·26 to 9·55. The total number of units used was 29,063,006, or 1·673 per car-mile, compared with 1·709 in the previous year.

As regards the financial results, the average traffic revenue per car-mile was 11·043d., as against 10·869d. last year, the respective totals being £799,079 and £777,219. The working expenses were 64·08 per cent. of the receipts, and amounted to 7·174d. per car-mile. The average fare paid per passenger was 1·16d., as against 1·17d. a year ago, and the percentage of passengers carried at the various fares also shows little change. Halfpenny fare passengers only amount to 8·29 per cent. of the total number, as against 8·40 per cent. last year. It should be noted in this connection that ½d. fares have only been adopted on the circular and cross routes, and not on the main routes. Passengers paying 1d. fares are 67·11 per cent. of the total, whilst 1½d. and 2d. fares account for 14·75 and 6·05 per cent. respectively.

The parcels department of the tramways continues to make progress, as will be seen by the following figures :—

	1911.	1910.
Number of parcels carried	948,074	835,734
Total receipts	£10,018	£8,678
Total profits	£2,484	£2,264

We give below an analysis of the various items in the tramway revenue account, together with the cost per car-mile of each item, the corresponding figures for the previous year being also given :—

		Cost per car-mile. 1911.	1910.
Traffic Expenses.			
Superintendence	£2,408	0·03d.	0·03d.
Wages of drivers and conductors	143,764	1·99d.	1·99d.
Wages of other traffic employés	23,891	0·33d.	0·32d.
Cleaning and oiling cars	24,283	0·34d.	0·34d.
Cleaning track	2,681	0·04d.	0·04d.
Depôt expenses	12,550	0·17d.	0·16d.
Ticket check	10,565	0·15d.	0·16d.
Uniforms	6,087	0·08d.	0·09d.
Miscellaneous	1,612	0·02d.	0·03d.
Total Traffic Expenses	£227,841	3·15d.	3·16d.
Repairs and Maintenance.			
Permanent way	£17,499	0·24d.	0·23d.
Electrical equipment of line	8,022	0·11d.	0·14d.
Buildings, &c.	4,109	0·06d.	0·05d.
Machinery	679	0·01d.	0·01d.
Cars	57,631	0·79d.	0·78d.
Other rolling stock	1,215	0·02d.	0·01d.
Total Repairs and Maintenance	£89,155	1·23d.	1·22d.
General Expenses.			
Salaries	£11,851	0·16d.	0·15d.
Store expenses	1,180	0·02d.	0·02d.
Rents	4,004	0·06d.	0·06d.
Rates	41,313	0·57d.	0·54d.
Printing and stationery	1,303	0·02d.	0·02d.
Compensation	8,704	0·12d.	0·14d.
Miscellaneous	12,136	0·16d.	0·11d.
Total General Expenses	£80,491	1·11d.	1·04d.
Power Expenses			
Current purchased at average price of 1·004d. per unit	£121,655	1·68d.	1·73d.
TOTAL WORKING EXPENSES (ex. capital charges)	£519,142	7·17d.	7·15d.
Capital Charges, &c.			
Interest	£55,227	0·76d.	0·75d.
Sinking fund	48,709	0·67d.	0·66d.
Income tax	7,083	0·10d.	0·08d.
Rent of leased lines	24,597	0·34d.	0·36d.
Promotion of bills and miscellaneous	1,638	0·02d.	0·02d.
Total Capital Charges, &c.	£137,254	1·89d.	1·87d.
TOTAL EXPENSES (inc. capital charges, &c.)	£656,396	9·06d.	9·02d.
Revenue			
Traffic revenue	£799,079	11·04d.	10·87d.
Miscellaneous revenue	8,531	0·12d.	0·12d.
Parcels department	2,484	0·03d.	0·03d.
Bank and other interest	11,616	0·16d.	0·08d.
TOTAL REVENUE from all sources	£821,710	11·35d.	11·10d.
Balance	£165,314	2·29d.	2·08d.

This balance is allocated as follows :—

Reserve, renewals and depreciation fund	£86,250	1·19d.	0·98d.
Street improvements	4,064	0·06d.	0·05d.
Contribution in aid of rates	75,000	1·04d.	1·05d.
	£165,314	2·29d.	2·08d.

The contribution in aid of rates is, as mentioned above, a similar amount to that provided a year ago, whilst the provision for renewals and depreciation is greater—viz., £86,250, as against £70,021. The present very satisfactory contribution brings the total amount of this fund at March 31, 1911, to £431,182. The outlay on renewals during the 12 months was as follows : Permanent way £59,590, overhead equipment £3,350, cars £8,469.

The outlay on capital expenditure during the year was £23,567, bringing the total to £1,981,161. This is distributed between the various items as follows :—

		Per cent. of total.
Permanent way	£654,872	33·0
Overhead equipment	182,784	9·2
Depôts and car sheds	386,344	19·5
Tramway shelters	1,874	0·1
Cash offices	3,940	0·2
Rolling stock	395,030	19·9
Machinery and plant	12,813	0·7
Office furniture	6,445	0·3
Cost of Carriage Co.'s undertaking	291,553	14·8
Preliminary expenses	25,751	1·3
Promotion expenses	19,755	1·0
Total outlay	£1,981,161	100·0

HIGH-PRESSURE WATER-POWER WORKS.*

BY L. ZODEL
(of Zürich).

Summary.—The author first indicates the method employed in classifying water-power plants into high, medium and low pressure, and the conditions which make the choice of any of these desirable, and when storage reservoirs should be included. A number of recent high-pressure hydro-electric stations and the more interesting points in the design of their pipe lines are then described.

It is necessary to divide water-powers into three classes, namely, low, medium and high head. Certainly there is no well-defined limit, but for general convenience we may call low-pressure plants those with a head of from 1 m. to 10 m. (32·8 ft.) or to perhaps 15 m. (49 ft.); medium-pressure those from 10 m. to 100 m. (328 ft.); and high-pressure those over 100 m. or 200 m. (656 ft.). The water-turbine builder has a much sharper and more precise distinction. He calls low-pressure plants those in which the turbines are placed in open flumes; medium-pressure those in which the turbine is placed in closed casings (such as pipes, drums, spirals, &c.); and high-pressure those in which impulse wheels are employed.

It is also possible to classify such plants according to the volume of water utilised. Thus, with the same head, a station might be

* Abstract of a Paper read at the meeting of the Institution of Mechanical Engineers at Zürich.

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termed medium-pressure or high-pressure, according as the discharge utilised was large or small. A plant with, for example, 100 m. head and a very large volume of water, say 20 cub. m. (716 cub. ft.) per second, would be considered one of medium head, because a closed reaction turbine having a draught tube would be employed; yet the same head with only 1 cub. m. (35 cub. ft.) per second would certainly constitute a high-pressure plant, for impulse turbines would be installed.

High-pressure plants usually work out considerably cheaper than low-pressure for the same power, but a long transmission line may so increase the capital outlay on the former that a low-pressure station nearer the consumer is preferable. All such questions must be carefully worked out for the particular case in hand. A very great advantage possessed by high-pressure plants over low-pressure, and shared to a large extent by medium-pressure also, is the readiness with which the irregular flow of rivers may be regulated to supply a constant-power demand by means of storage reservoirs and weirs. With these it becomes possible to utilise the whole of the rainfall of a district and to store the water till required by the power consumer. Thus we may say that such storage plants are by far the more rational proposition. Storage, however, increases the cost of a station very considerably, and the amount of such storage must be limited to such capital charges as will be borne by the plant as a paying concern. The greater the head of water the more rational will a storage reservoir be, since the same quantity of accumulated water will represent a proportionately larger store of energy.

Questions of national economy, and of political or even strategic importance, are often solved by water-power stations, besides the immediate interests of the promoters of the scheme. This is especially the case in countries such as Switzerland, which have no coal or other natural fuel, and have to depend on foreign States for their supply; hydro-electric stations represent the foundation of their industrial security and independence.

Many large high-pressure stations, with both natural and artificial storage reservoirs, have been built within the last few years all over the world. Some of these are described in the Paper, reference being more particularly made to the pipe lines and conduits carrying the water from the lake or river to the turbines. For it is exactly to these pipe lines that too little attention is usually devoted. Many people, and not a few engineers, consider that the pipe line is a secondary part of a hydraulic power plant, so long as the thickness of the pipe allows a good factor of safety against the pressure, and a continuous line has been laid over the ground from the intake to the turbine. Hence it is that pipe lines are often built by engineers who are experts in the choice of material and in the manufacture of a pipe, but who do not understand the essentially important functions which a complete pipe line, and especially a high-pressure pipe line, has to fulfil. The general arrangement, the relative dimensions of different parts of the pipe line, the methods of anchoring and placing of fixed points, are all such important factors that they can only be properly determined by the turbine builder, because on them depends to a very great extent the proper working of his turbine, and hence the success of the whole plant.

As a first step towards the enlargement of their power house at Necaxa, the Mexican Light & Power Co. decided to increase the capacity of the existing six 8,200 H.P. turbines to 11,000 H.P. each, by fitting new runners and new nozzles. This was successfully carried out, and is an interesting case, since the velocity of the water in each of the six pipe lines supplying the six turbines was thereby increased to 5·5 m. (18 ft.) per second. This is an exceptionally high figure, but was not found to be injurious in any way. The capacity of the station thus became 66,000 H.P.

The next step was the erection of two new units of 16,000 H.P. each. These are supplied with water through a new pipe-line system which has been just recently erected. A new low-pressure feeder pipe starts from the intake tower in the Necaxa reservoir and joins with another feeder which is arranged to draw water directly from the conduit, connecting the Tenango and Necaxa basins. Interconnecting valves are arranged between these feeders. The new feeder is laid in cuts and tunnels parallel to the first to a receiver, from which the two new pressure pipe lines descend in a separate tunnel to the power house. The two high-pressure pipes are arranged in four sections of 1,160, 1,100, 1,075 and 1,040 mm. (46, 43, 42 and 41 in.) diameter respectively, having a total length of about 680 m. (2,230 ft.). The maximum velocity in these pipes is 4·7 m. (15·4 ft.) per second. The new pipe-line system is thus almost a completely parallel construction with that first built, and is in every way similar, though on a considerably larger scale. The capacity of the power station is now 98,000 H.P.

The pipe line at the power house of the Rio de Janeiro Tramway, Light & Power Co. on the Lages River, where a very large reservoir has also been constructed, has a great similarity to that of Necaxa, and is made in two sections, consisting of two upper low-pressure pipes and of six main high-pressure pipes for the lower portion leading to the power house.

This upper system of pipes consists of two independent riveted steel feeder pipes 2,435 mm. (8 ft.) in diameter, with a total length of 1,684 m. (5,530 ft.). These are an interesting feature, as at Necaxa, in that they replace the open flume or conduit which up to the present has been the more usual construction, but would have caused considerable difficulty here. The steel feeder pipes have the great advantage that, being under pressure, they utilise the full head obtained at all times in the reservoir. They are built of plate varying in thickness from 6·4 mm. to 16 mm. ($\frac{1}{4}$ in. to $\frac{5}{8}$ in.), and are under a maximum pressure head of 56·78 m. (186 ft.). The average fall of the pipes varies from 0·15 per cent. to 9 per cent.; they pass through three tunnels with lengths of 187, 88 and 436 m., and a valley is crossed by means of an inverted siphon 131 m. long and 29 m. deep. At about half-way between the intake and the receiver, at the exit of the third tunnel, each pipe is provided with an 8 ft. stand pipe, 16 m. (52 ft.) high, open to the atmosphere, carried above the spillway level, for the purpose of equalising any pressure oscillations due to water hammer. The two feeders each connect to a receiver pipe under a pressure head of 57 m. at an elevation of 347 m., and a second pair of stand pipes 8 ft. in diameter are taken up the side of the hill to the same height as the other two, in order to equalise pressure oscillations at this point. A valve house is provided, enclosing the two receiver pipes and containing a 2,435 mm. (8 ft.) sluice valve on each feeder, a 1,525 mm. (5 ft.) valve between the two feeders, and 915 mm. (3 ft.) valves at the top of each pressure pipe leading from the receivers to the power house. The latter valves can be closed by little Pelton-wheel turbines, supplied with water from the receiver and started by solenoids actuated from the power house, so that water can be quickly shut off from the 915 mm. (3 ft.) pipes in cases of emergency.

Three lines of high-pressure 915 mm. (3 ft.) pipes start from each receiver, and each of the six lines connects to a 9,000 H.P. turbine. A seventh pipe line of 305 mm. (1 ft.) diameter passes from both receivers to drive the exciter turbine sets. The main high-pressure pipe lines have a thickness of from 10 mm. to 26 mm. (0·4 in. to 1·02 in.), and are 670 m. long; the pipes are lap-welded steel of 10 m. length with flanged ends, held together by loose rings. A 150 mm. (6 in.) stand pipe, carried above the spillway level, is provided on each high-pressure pipe line just behind the sluice valves next the receiver, so that the whole arrangement with the pressure receivers approaches the conditions of an open penstock chamber and has been eminently satisfactory. The whole pressure system is divided into two completely separate and self-contained units, and this provides great safety in operation. The velocity of flow in the pipes is 4·4 m. per second. The power house is constructed entirely of steel and concrete, 72 m. long, 29 m. wide and 24 m. high. 2,500 tons of steel were used.

The six turbines are impulse-wheel machines, built by Escher Wyss & Co., with vertical shaft and four needle nozzles symmetrically arranged round the cast-steel wheel disc, which has an effective diameter of 2,120 mm. (84 in.), and is provided with 18 cast-steel buckets. They are designed for a head of 273 m. to 290 m., and generate 9,000 H.P. at 300 revs. per min. An oil-pressure thrust bearing supports the turbine and generator rotors, which amount to 40 tons dead weight. These bearings are supplied with pressure oil by three-throw pumps, which also feed the turbine governors. A pressure-relief valve is arranged to limit rise of pressure in the pipes to 10 per cent. on throwing full load off the turbine. Two exciter units of 400 H.P. each are provided.

The generators supply three-phase current at 6,000 volts and 50 frequency, which is stepped up through transformers to a line voltage of 88,000 for transmission to Rio de Janeiro, the distance being 88·5 km. (55 miles). Up to the present time turbines developing a total of 54,000 H.P. have been installed, and sanction has just been given for a further increase of units of 19,000 H.P. each. The author next describes the Tyssedalen station in Norway (*see* THE ELECTRICIAN, Vol. LXVII., p. 250), and the Brusio stations in Italy which contains no special features.

At the Siagne station, in the Alpes Maritimes province of south eastern France, two parallel pipes were provided, each 900 mm. (35·4 in.) diameter, built of single pipes about 6 m. long of rivete plate of from 4 mm. to 25 mm. thickness, the individual pipes being riveted together *in situ*. The pipes rested on masonry pedestals and closely followed the surface of the ground, so that the pipe line consisted of a large number of inclines and angles in every direction. About 40 m. vertically above the station they formed a kind of distributing pipe from which the connecting pipes branched off to the turbines. Above this distributing pipe, the pipe lines rose at a very steep angle, in places almost vertically, to a point 90 m. below the

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intake. From this point they turned to the left and led for a considerable distance at a very slight gradient to the penstock chamber.

The principal faults in the arrangement of this line were as follows: (1) Too great a length of the upper portion, under low pressure, with pipes of small thickness, whereby a continual working or respirating phenomenon became apparent in this part of the pipe line. (2) Insufficient fixing or anchoring of the pipes in the lower portion of the line, and a most curious position of the distributing pipe, in which very harmful vibration combined with displacement of the pipes could take place on sudden variations of water velocity or shocks in the pipe line; this might easily lead to a burst, especially in the case of riveted pipes. (3) Unsuitable dimensions of the connecting pipes between distributor and the turbines, with their length too great and their diameter too small, resulting in considerable accentuation of the pressure variations.

Each pipe line formed one single rigid piece from top to bottom, and no provision was made to allow for expansion and contraction, such as the insertion of expansion joints. Expansion due to temperature changes in an exposed pipe line is, however, unavoidable, and if no arrangements are made to allow of longitudinal motion, then additional stresses will be set up in the pipe walls that will be difficult to foresee, and will cause resultant stresses which may under certain conditions have a fatal effect. It must be mentioned here that French engineers in general build pipe lines on this principle—that is, without expansion joints—and that a large number of such high-pressure pipe lines are now in continuous operation in France. This design must, nevertheless, be characterised as irrational, especially in view of the demands made, at the present day, on the pipe line of a central station with continually and rapidly changing water velocities.

Shortly after starting up the works a burst occurred about the middle of one of the pipe lines, probably owing to some such sudden variation in the pipe velocity. A longitudinal riveted joint was torn open for a length of 2 m., and the water suddenly streamed with such velocity from the gap that a large part of the upper section of the pipe was completely flattened by the vacuum which was produced in spite of large air pipes at the penstock chamber. Exhaustive investigation led to the final decision to replace the entire existing pipe lines by others over a quite different route.

The new line has been in continuous operation since the spring of 1908. It consists of two parallel pipe lines of almost the same dimensions as the old, but differs therefrom in that it passes straight down the side of the mountain from the penstock chamber to a point about 30 m. to 40 m. above the power house, when it turns round and passes towards the latter through a tunnel.

The upper part of the pipe line was made as short and as steep as possible, and the lower arranged longer in proportion. The whole line is divided into six straight sections; the angle points between them are formed into main anchorages (fixed points) of solid concrete masonry, into which the pipe bends are rigidly bedded. An expansion joint is placed below each fixed point. The intermediate concrete pedestals supporting the pipe line are laid at a uniform distance of 7·90 m. apart.

These pipe lines were also riveted together *in situ*, the upper portion, up to 13 mm. (½ in.) thickness, being of riveted pipe, and the remainder of pipes lap-welded by the water-gas process. The total length of the pipe line is 876 m. (2,870 ft.), composed of three sizes of pipes of 950, 900, 850 mm. (37½, 35½ and 33½ in.) diameter respectively. The thickness varies between 7 mm. and 22 mm. Each pipe is fitted at the penstock chamber with an automatic hydraulic stop valve, also arranged to be operated electrically from the power house by means of a solenoid. This automatic hydraulic valve can be set to close at any desired maximum discharge of water; if for any reason the discharge exceeds the limit, the intake opening closes at once. The whole erection of the new pipe line was finished in six months. The result, as compared with the old pipe line, was as expected. The extraordinary surges and resonance effects of the pressure shocks, especially the visible movement and trembling of the pipes, completely disappeared. No disturbance or irregularity could be observed in the pipe line even with severe and sudden load variations during running.

The Siagne power station is used as one of the hydro-electric plants which feed the high-tension system supplying power to Nice and Cannes.

Conclusion.—The water-carrying system of a high-pressure hydraulic power scheme consists of two parts: the low-pressure part to cover most of the horizontal distance between the lake or river intake and the power house, and the high-pressure part to give the operating head for the station. The high-pressure pipe line represents one of the most costly items of the plant, and is, therefore, made as short as possible by taking the low-pressure conduit to the nearest advantageous point above the power house. There are two main types of this conduit: that in which water flows under pressure, and that with water flowing freely in an open flume. The former may be further subdivided into (1) the pressure tunnel arrangement leading to a deep penstock chamber, as in the case of the Tyssedalen and Brusio installations; and (2) the low-pressure feeder-pipe arrangement connecting to a receiver with a stand pipe, as at Necaxa and Rio de Janeiro. Both of these systems allow of the total head available at any time in the reservoir to be utilised even with large variations in water level.

The type of conduit with open flume cannot, however, utilise any head in the reservoir, and this must be lost. In the case of a long conduit, a balancing reservoir must also be constructed to provide for any sudden increase in the load, since the open flume will not draw a greater volume of water to supply a greater demand, as happens automatically with the pressure conduit. This case is illustrated in the Siagne power station. Another example is the well-known Kinloch'even plant of the British Aluminium Co. in Scotland. The choice of the arrangement of conduit most suitable for a power scheme depends entirely on the particular conditions of the works, and no rule can be laid down.

RACK-RAILWAY LOCOMOTIVES OF THE SWISS MOUNTAIN RAILWAYS.*

BY T. WEBER AND S. ABT
(of Winterthur).

Summary.—The authors describe the various railways in Switzerland which are operated either wholly or partially on a rack system. Details of both the steam and electrically worked lines are given.

The authors, after a short historical introduction and a description of the racks used on the various railways, go on to give details of the steam-operated rack railways in Switzerland. These include the Vitznau-Rigi Railway (opened in 1871, and the first rack railway used for passenger traffic in Europe), the Arth-Rigi Railway (opened in 1875) and the Pilatus Railway (opened in 1889), as well as the Generoso, Brienz-Rothorn, Glion-Rochers de Naye, Schynige Platte and Wegneralp Railways. All the above are wholly rack railways, but in 1888 the Brunig Railway, operated by locomotives adapted for both rack and adhesion working, was opened. The Visp-Zermatt, St. Gallen-Gais-Appenzell and Martigny-Chatelard Railways are also worked on this dual system.

The very great improvements made in electrical traction were naturally utilised for the working of rack railways. The Gornergrat line, which starts from the terminus of the Visp-Zermatt Railway, was the first rack railway to use electricity, and afterwards a whole series of other railways followed its example.

The Gornergrat line was opened in 1898; the gauge is 1 metre, the rack is on the Abt system; it has a length of 5·8 miles, and ascends a height of 7,740 ft. The maximum gradient is 20 per cent., and the smallest curves are 262½ ft. The locomotives are provided with two polyphase motors, each having a maximum output of 90 H.P. at 800 revs. per min., the pressure being 500 volts. The motion is conveyed to two independent rack driving wheels by means of an intermediate shaft and double spur-wheel gearing. The locomotives rest on two carrying axles having springs with a definitely controlled range. The passenger coach is suspended on the locomotive frame in accordance with Mr. Rowan's design. By this construction a part of the coach's load increases the weight of the locomotive and so prevents the rack wheels from riding. The engine is fitted with two hand brakes, each of which acts on both driving rack wheels, and an automatic brake working on the rotor axles. This brake can also be manipulated by hand, either by the engine driver or by the conductor in charge of the train. When the train is going down hill the motors act as generators.

One month after the Gornergrat Railway was opened the first part of the Jungfrau Railway was also started. The part between "Kleine Scheidegg" and "Eismeer" has a difference in level of 3,580 ft., and it was opened in 1905. The length is 3·6 miles, and the gradient is generally 25 per cent. The gauge of the line is 1 metre. Where the line is in the open cutting the curves have a radius of 328 ft., the curves in the tunnel being 656 ft. Strub's rack was first applied here and three-phase current used. The locomotive is of the same construction as the Gornergrat locomotive, its capacity being somewhat higher. The speed of the train is 4·65 miles an hour. When running down hill the braking is controlled by means of an electric resistance which is cooled by a fan. The motors then

* Abstract of a Paper read at the meeting of the Institution of Mechanical Engineers at Zürich.

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work as ordinary generators owing to a special change in their connections, and the current thus generated is transformed into heat.

In the years 1900 and 1901 the Aigle–Leysin and Bex–Gryon–Villars Railways were opened as the first rack railways with continuous current. The gauge is 1 metre, the gradients are from 9 to 23 per cent., and the minimum curves 60 m. The rack is on the Abt system. The locomotives are fitted with two driving and a brake rack wheel. On these engines the Winterthur Locomotive Works pattern friction-disc coupling was first employed. It serves to reduce the shocks resulting from short-circuiting and those arising from irregularities of the rack pitch.

The Brunnen–Morschach Railway on the Vierwaldstätter See was opened in the year 1905. The line is 1¼ miles long, the mean gradient being 12·6 per cent., and the maximum gradient 17 per cent. The line rises 842 ft. and the curves are 262 ft. radius. Strub's rack gear was used in this case. The locomotives are connected to the coaches on Rowan's system. These engines have only one single driving wheel, driven by two polyphase motors, each of 80 H.P., by means of double transmitting gear. The trailing carrying axle is provided with a brake rack wheel, and it and the driving rack wheel are both braked. On both the up and down journeys a safety grip is used, in addition to which the brake wheels are fitted with guide flanges in order to provide for greater security against the wheels mounting the rails.

The Wengernalp Railway commenced to use electric driving in June, 1909, and now has 10 locomotives of 300 H.P. each. These engines are generally of the same construction as those of Gornergrat and Jungfrau. They are the only ones built for 2 ft. 7½ in. gauge, which presents great difficulties in arranging for the transmission of power and the arrangement of the brakes. The pressure on the rack wheels is equalised by means of balancing levers. This arrangement has been adopted by the Swiss Locomotive Works, as well as a system of automatic interlocking which prevents the automatic brakes from being put in action when the train is going uphill. Each locomotive is provided with two series continuous-current motors, each of 150 H.P., this full power being capable of continuous use. The motors make 750 revs. per min., and they are worked in series by bow contacts at pressures from 1,500 to 1,800 volts. Short-circuiting braking is used when running down hill.

The Stansstad–Engelberg line was opened in the year 1898, and has a length of 14 miles. It is driven by three-phase current at 750 volts. The gauge is 1 metre, and for a length of 4,920 ft. the ladder form of rack rail is used. The total ascent is 1,850 ft., and it is worked by adhesion up to 5 per cent. gradients, the steepest rack line gradient being 25 per cent. The two motors of the engine develop 150 H.P. each, and work by means of "V" gearing and an intermediate shaft to the one-rack driving wheel. A special construction of friction switch (made by the Winterthur Locomotive Works) permits the two carrying axles engaging as driving axles on the adhesion lines by means of coupling rods.

The Martigny–Chatelard Railway was opened in the year 1904. It is 11·9 miles long, is provided with a Strub rack arrangement for a length of 1½ miles, of which 1·2 miles have a gradient of 20 per cent. The adhesion part of the line has gradients up to 7 per cent., and the smallest curves have a radius of 82 ft. The locomotives on this line are worked by continuous current. Their general construction is the same as those on the Jungfrau Railway, but they are independent of the carriage. As these engines have also to work on adhesion lines with 7 per cent. gradients, they are provided with a rigid coupling by means of connecting rods between the rack driving axles and carrying axles. The locomotive is equipped with the differential Westinghouse brake. In addition to these locomotives there also are on the Martigny–Chatelard line nine motor carriages, each of which rests on two four-wheel bogies. Each bogie has two motors of 80 H.P. to 100 H.P., which, by means of spur-wheel gearing on an intermediate shaft, transmit the power to the rack as well as to the adhesion axles. This rigid connection between adhesion and rack wheels is not to be recommended, but up to date the system has worked without any interruption.

The line between Monthey and Champery was opened in 1906, and has a length of 7 miles with three heavy banks of 13 per cent. up to 13·6 per cent. It rises a total height of 398 ft. The gauge of the line is 1 metre, it is fitted with Strub rack gear, has curves of 49·7 ft. radius, and is worked by means of a mixed system of motor coaches. The portions that are worked by adhesion have maximum gradients of 5 per cent. and curves of 37·3 ft. The bogies, each of which has one adhesion and one rack-wheel driving motor, each independent of the other, allow varying gradients to be worked in the most efficient manner by the rolling stock. The adhesion axles are driven by the adhesion motor and are connected by coupling rods. The rack-wheel motor works by means of double spur gear on a rack-driving wheel mounted loose on one of the adhesion axles.

In order to make the direct communication with the steam rack railway at Glion–Rochers de Naye, which starts from the upper end of the Territet–Glion rope railway above Montreux, the Montreux–Glion line was built in the year 1909; it has a gauge of 2 ft. 7½ in., and the Abt double-flitch rack was used in order that this line might form a direct communication between Montreux and Rochers de Naye. The line has a total length of 1¾ miles, and rises 984 ft., the maximum gradient being 13 per cent. The radii of the curves are 262 ft. in the open part of the line, 197 ft. in the railway station and 164 ft. at the points.

The locomotives are arranged so that they can run either by adhesion or by the rack gear only. The two-rack driving axles are each connected to the neighbouring adhesion axles and carry a loose rack-brake wheel. The rack wheels are always in motion as they are coupled up through double spur wheel gearing to the motors. The arrangement for running on the adhesion part of the line is as follows: A friction-clutch coupling is keyed on to the intermediate shaft and transmits the power from this by spur-wheel gearing and connecting rods to the adhesion axles. In principle the general construction is that of the Engelberg locomotive.

In conclusion, it may be mentioned that the Blonay-les-Pleiades and the Altstätten–Gais Railway lines are intended to be put in service during the present summer. Both these lines have metre gauge and Strub's rack gear. The first line works with mixed locomotives similar to those on the Montreux–Glion line, the second line has six-wheeled motor carriages having bogies similar to the Monthey–Champery type.

THE EDISON-BEACH STORAGE BATTERY CAR.*

BY R. H. BEACH.

Summary.—The author describes a number of tests which have been made on cars fitted with an improved type of Edison iron-nickel accumulators. Operating costs are among the details given.

Experience with batteries composed of lead compounds immersed in acid electrolyte has been such as to lead many to think that all secondary batteries are delicate and have a short life, and therefore are to be avoided for use on vehicles. The Edison secondary battery, which is the source of energy in the Edison-Beach storage battery car, is neither delicate nor short lived. From experience extending over several years it is known that the battery will not fall off in capacity during the first six years of its life. It is guaranteed for three years, and it is believed that it will last for a much longer time especially if distilled water be used.

With the older types of storage batteries it has been necessary to allow almost as long for charging the battery as for discharging it under service conditions. The older types of batteries require about 11 hours for a complete charge, and in car operation this would mean that the car would be out of service at least half the time. Because of the fact that the Edison battery is not injured by high rates of charging, a car equipped with this type of battery need be out of service practically none of the time. In Washington, D.C., a car is operated over a line 4 miles long. The running time is 16 minutes and the layover time at the terminus is three minutes. The battery is charged at five times its normal rate during the three-minute layover, and the car then runs to the other terminal, where the operation of charging is repeated. The battery is not charged at any other time, and the car runs 204 miles each day. The three-minute layover at each terminal is required for changing the fender and giving the conductor an opportunity to re-set the fare register. Advantage is merely taken of this time to charge the battery. Another car operated in Concord, N.C., runs 99 miles a day, and is charged five times for 10 minutes at each terminal. The total charging time during the day is 3 hours and 20 minutes.

In designing the cars on which these batteries are used the writer has aimed to reduce the dead weight and to eliminate, as far as possible, friction losses. The average Pullman car weighs 3,000 lb. per seated passenger. The ordinary wooden day coach used by steam railroads weighs about 1,500 lb. per seated passenger. A steel suburban coach weighs 1,100 lb. per seated passenger. An ordinary single-truck trolley car weighs about 800 lb. per seated passenger and an ordinary double-truck car about 1,000 lb. per seated passenger. The average current consumption of a trolley car is approximately 125 watt-hours per ton-mile. The Edison-Beach double-truck storage battery car weighs only 600 lb. per seated passenger while the small single-truck car weighs 380 lb. per passenger. The latest type of long wheel base single-truck car weighs 360 lb. p

* Abstract of a Paper read at the annual meeting of the Street Railway Association of the State of New York. From the "Electric Railway Journal."

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seated passenger. The weight of the battery required on each of these cars is about 60 lb. per seat.

This reduction in weight has been accomplished by making a number of departures from the usual practice in body and truck construction. All of the joints in the truck frame are welded instead of being riveted or bolted. No difficulty has been experienced from broken welds. In longitudinal seat cars an electrically welded latticed steel girder forms a rest for the seat, and extends the length of the car body. It is bolted to the side, cross sills and side posts. In an 18 ft. car these girders weigh about 300 lb., and they so stiffen the body that a reduction of nearly 3,000 lb. can be made in the weight of the other parts. A very light roof is used, because it is not necessary to support a trolley base. The body of an 18 ft. car with 5 ft. platforms and folding doors, but no bulkheads or interior doors, weighs about 3,700 lb. A standard monitor-deck car body of the same length weighs about 6,700 lb., and the light bodies with the steel girders are much stronger than the heavy bodies.

After extensive experiments had been made it was found that there was a considerable saving in friction losses if the wheels were permitted to rotate on the axles instead of having the axles fixed in the wheels and rotating in the journal bearings. Exactly how much saving in current consumption has been effected by this change is not known. A silent chain drive is used between the motors and the wheels. There is some gain in efficiency with this type of drive over the gear drive, but it is difficult to say exactly the amount. When new the gear drive is probably very nearly as efficient as the chain, but as it wears it loses its efficiency, whereas the chain does not. The chain drive possesses a great advantage over the gear drive while the car is coasting. On a test run between Athena and North Newark on the Erie Railroad, a distance of about 7 miles, a chain-driven car accelerated from 0 to 35 miles per hour, and maintained that speed on a practically constant gradient of from ½ to 1 per cent. without the use of any current. An ordinary journal-bearing car will scarcely move down this slope without the application of power. The average current consumption of the Edison-Beach storage battery car is very low, in no case exceeding 60 watt-hours per ton-mile. In a test made at Atlantic City at the time of the American Electric Railway Association Convention in October, 1910, one of these cars made 36 trips, aggregating 14·4 miles, with an average of six stops per mile and an average speed of 9 miles per hour. The average number of passengers carried was 18, and the average consumption of current per ton-mile was 54·2 watt-hours.

A double-truck car which was tested on the Greenwood Lake Division of the Erie Railroad between Forest Hill and Sterling Forest ran a total distance of 70·2 miles. The weight of the car, including passengers, was 16·53 tons, and the maximum speed was 25 miles per hour, the schedule speed being 18 miles per hour. This line has a number of heavy gradients, but the current consumption per ton-mile averaged only 49·63 watt-hours. Another test made on the Erie Railroad between West Orange and Forest Hill at the same rate of speed showed a current consumption of 46·1 watt-hours per ton-mile.

The Washington, Spa Springs & Gretta Railroad has had an Edison-Beach car in service for a number of months on a line which has gradients as steep as 8 per cent. The battery car has averaged about 355 watt-hours per car-mile, and it has been found that one of these cars consumes only about one-fourth the current required by an ordinary trolley car.

It is of interest to note the long-distance runs which may be made by these cars on a single charge of the battery. The double-truck car previously mentioned has been run on a single charge from West Orange, N.J., via Jersey City, to Middletown, N.Y., over the Erie Railroad, as the second section of an express train. The same car has run on a single charge from Jersey City to Atlantic City, N.J., over the main line of the New Jersey and the Reading Railroad, a total distance of 135 miles. Sufficient energy was left in the battery upon arrival at Atlantic City to run about 40 miles more. This car can attain a speed of 25 miles per hour on a level with full load and a speed of 16 miles per hour on a 6 per cent. gradient. It is equipped with four motors rated at 15 amps. and 200 volts and an Edison battery weighing 4,800 lb. On the single-truck cars carrying 26 passengers two motors rated at 30 amps. and 110 volts are used, and the battery weighs 1,800 lb. The lower voltage used on the single-truck cars lessens motor and controller troubles.

As showing what can be done with one of these cars on a small road, the results of operation on the Salisbury & Spencer Railway, Concord, N.C., are of interest. The total cost of this line, which is 1½ miles long, was £4,000, and the net earnings of a single car are at the rate of £1,534, which is equivalent to more than 33 per cent. on the investment. The current for charging the battery of this car is purchased from the Southern Power Co. at a price of 0·875d. per kilowatt-hour, measured on the alternating-current 'bus bar. The car is operated by one man, passengers entering and departing by the front door. The following is a record of 30 days' operation :—

Total car-miles	2,687·5
Total kilowatts	5,268·0
Kilowatts per mile	1·95
Total receipts	£197·33
Operating expenses :—	
Power at £0·35 per kilowatt	£18·44
Conductors and motormen	£46·59
Miscellaneous	22·39
Total expenses	£69·50
Net profit	£127·83

THE BUFFALO NEAR-SIDE SINGLE-PLATFORM CAR.*

Some time during next month the International Railway, Buffalo, N.Y., is to place in service 35 single-platform prepayment cars, to be known as "near-side" cars. To prepare the public for this radical change in car design and operation, the railway authorities have issued an elaborately illustrated bulletin from which the following information is taken. The first part of the bulletin sets forth the conditions which should be met by a car to give the maximum convenience and comfort to passengers and employés and to ensure the minimum liability to accidents. It is pointed out that the usual form of prepayment car, having no entrance at the front, is at a disadvantage during bad weather in such cities as Chicago, Philadelphia and Buffalo, where ordinances require the cars to be stopped at the near crossing. Furthermore, the conductor cannot see all approaching passengers from his position on the rear platform, while alighting passengers who get off at the rear and turn toward the far side of the street are in danger of being run down. Although the rear-entrance prepayment car has greatly reduced platform accidents, it still leaves the conductor's control imperfect, because he must divide his attention between collecting fares at the entrance and watching the step. The near-side prepayment car is intended not only to remove these disabilities, but also to incorporate certain other advantages, such as effective automatic ventilation and improved destination signs.

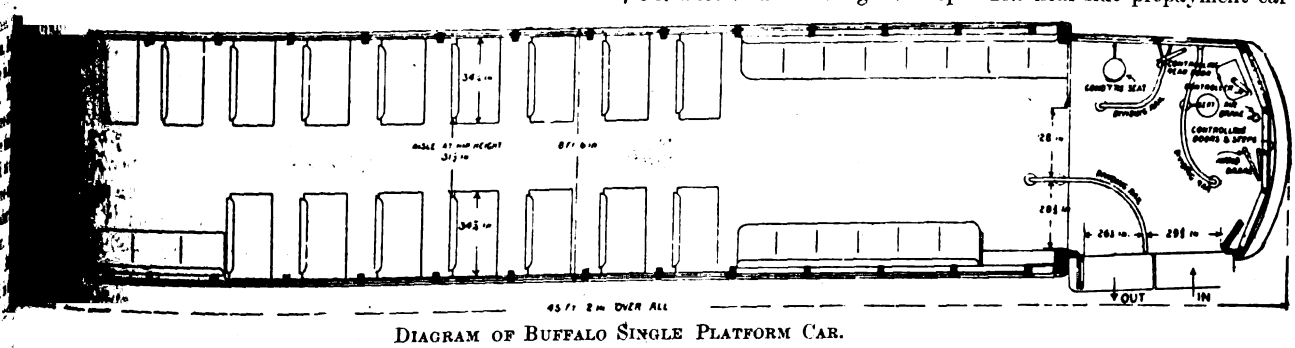

DIAGRAM OF BUFFALO SINGLE PLATFORM CAR.

As shown in the accompanying illustration, the entrance and normal exit are by way of the front platform. The plan shows a step entrance of 29¾ in. and a step exit of 26¼ in. The corresponding divisions at the front end of the car body proper are 28 in. and 28¾ in. The motorman is provided with a seat, and in the operation of his apparatus is protected from interference by a dividing rail. His vision is guarded against reflected light by installing an adjustable curtain. By means of a lever the motorman controls the entrance and exit folding doors and steps either separately or together. While the car is at a standstill the motorman can plainly see the passenger enter and leave, and is thus able to act promptly in operating the doors and steps and in getting the car under way

* From the "Electric Railway Journal." Slightly abbreviated.

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without waiting for the bell signal. Passengers are not permitted to remain upon the platform when the car is in motion. This rule prevents the motorman's attention from being diverted, and consequently enables him to give all his attention to watching for passengers and avoiding collisions.

The conductor is provided with a seat within the rail space directly opposite the entrance to the front platform. In this position he is able to control the entrance passage in the body of the car. As the conductor is amply protected from the weather, he can be clothed always in the way most convenient for his work. When the car is taking on passengers the conductor collects fares and issues transfers. He is able to do this work more rapidly and accurately than heretofore because the motorman relieves him of the necessity of watching the step and of giving the starting signal. The entrance portion of the front platform will accommodate 10 to 15 oncoming passengers. When the car is in motion the conductor, whether seated or standing, directly faces the passengers, thus placing him where he can most readily observe the signals of those passengers who cannot conveniently reach the signal push-buttons. Having no other duty to perform while the car is moving, the conductor is able to call the streets as required, and as he faces the passengers the street names are much more easily heard and understood.

Passengers alighting from the car by way of the front platform and passing across in front of it have a direct view of cars or automobiles approaching from the opposite direction. Should they desire to pass behind the car from which they alight, they must necessarily await its forward movement. These conditions serve to forestall the accidents which occur when passengers alight from the rear end of the car and pass directly behind it.

It will be noted from the plan that, strictly speaking, there is no rear platform. However, a door and step are installed for emergency exit or for use at points where the car is entirely unloaded, as at parks, baseball grounds, &c. This rear exit may be operated either from the rear end of the car or by the conductor from his position on the front platform. The space heretofore required for a rear platform is utilised for a circular seat, thereby giving a largely increased seating capacity. In fact, the total seating capacity of the car is 53, as compared with 40 for a prepayment car of the same length. Of these 53 passengers 35 face forward; there is also room for 30 standing passengers, on the basis of each standing passenger occupying an oval 12 in. by 18 in.

This car, as described, operates ordinarily from one end only, necessitating loops or wyes at the ends of the line. It can, however, be run in the reverse direction in case of emergency. This single-end design permits the use of a non-reversible cross seat, which, with the semi-convertible window construction, gives a considerable increase in the width of the aisle and the width of the cross seats without increasing the overall width of the car. The adoption of maximum traction centre bearing trucks allows the use of two-motor instead of four-motor equipments, greatly reducing the weight per passenger and also reducing the height of the car floor to such a degree that the lower step is carried 2 in. nearer the ground.

Another interesting feature of the construction of this car is the use of a flat-arch roof in connection with the automatic ventilating system. Fresh air is brought in over the electric heaters, which are controlled by a thermostat, and the foul air is discharged through nine registers placed in the ceiling directly over the seat. These registers are connected with ventilators placed at intervals on the roof of the car. The vacuum created by the motion of the car draws out the foul air so rapidly that the air in the car is renewed every 3½ minutes. To provide against the inadequacy of the usual destination signs, there is used to designate the route a large illuminated white letter on a black background located in the upper half of the right-hand front vestibule window. This letter is large enough to be visible by day or night for a distance of several blocks. Supplementary thereto, a side destination sign occupies the full length of the opening immediately over the entrance and exit doors. An application of European practice is found in the "Car Full" sign, which is dropped into place below the initial destination sign whenever a maximum car load of passengers has been taken on.

The seating capacity, dimensions, weights, &c., of the near-side car, as compared with the standard pay-as-you-enter cars used in Buffalo and Chicago, are as follows:—

	Near-side car.		Pay-as-you-enter car.
Seating capacity	53	.....	40
Length of cross-seat cushion	34⅜ in.	.....	34 in.
Width of aisle at hip height	31½ in.	.....	27 in.
Width of car	8 ft. 6 in.	.....	8 ft. 6 in.
Length of car overall	45 ft. 2 in.	.....	45 ft.
Height of car	12 ft.	.....	12 ft. 5 in.
Height of lower step from ground	14 in.	.....	16 in.
Weight of car fully equipped	39,000 lb.	.....	52,000 lb.
Weight per seated passenger	736 lb.	.....	1,300 lb.

The inherent accident prevention features of this car are supplemented by the use of the H.-B. lifeguard and by a safety grab handle round the front vestibule. The handle is so designed and placed that it can be easily seized by a person about to be struck by the car who might otherwise be thrown under the platform.

ELECTRICITY SUPPLY AT MARSEILLES.

Summary.—A description is given of the station at Marseilles where direct current and alternate current at two different frequencies and voltages are generated to meet the requirements of the varying needs of the district.

A good example of a modern steam-turbine generating station is to be found at Marseilles. Marseilles is a very active centre of electrical interests, and possesses what is probably the most extensive system of tramways on the Continent. The present station was erected in order to keep pace with the increasing demands for current both for lighting and power. It is owned by the Société du Gaz et de l'Electricité de Marseille, and this company are now supplying lighting in the central and the outlying quarters of the city. Current from the steam-turbine plant is supplied to the city system at 5,500 volts and a frequency of 25. This is transmitted to a large sub-station from which the central district is supplied. From this sub-station continuous current at 220 volts is delivered to a three-wire network. The station also supplies current at 5,500 volts and a frequency of 50 to the outlying districts. Low-tension mains on the alternating system are fed from small transformer posts placed at various points, the secondary voltage being 190 volts in this case. For the power supply, especially for large motors, the company is operating a special system of high-tension mains, using a pressure of 13,500 volts delivered directly from the machines at the central station, a frequency of 25 being used. The high-tension lines owned by the company have been laid out so that in case of need they can be supplied with current from the network of power lines which covers the Maritime Alps region and runs as far as the large sub-station of Allauch, in the neighbourhood of Marseilles. This power system is the most extensive in France, and is fed from a number of hydraulic plants lying in the mountain region. It can be drawn upon if required, and inversely the Marseilles station can feed into the Allauch sub-station, so as to afford a reserve supply for the latter. Such an arrangement is therefore of mutual benefit to the two sets of power supplies. The general arrangement and elevation of the station are shown in Figs. 1 and 2.

In order to satisfy the above-mentioned conditions, the Marseilles plant has been arranged to furnish three different kinds of current at various voltages and frequencies. Current is produced by three 1,000 kw. (Fig. 3) turbines at 5,500 volts three-phase and a frequency of 25 for the supply of the central sub-station of Marseilles. For the transformer posts in the outer districts of the town current is obtained from one 1,000 kw turbine. While the voltage in these districts is the same as that in the centre of the town the frequency is 50 instead of 25. For interchange purposes a frequency-converter consisting of 50-frequency and a 25-frequency alternator coupled on the same shaft is used. Either one of these machines can act as synchronous motor so as to operate the other as an alternator and thus produce current at either of these two frequencies required.

For the supply of the high-tension lines a turbine which delivers three-phase current at 13,500 volts and a frequency of 25 is installed. In the station also there is a set of transformers having a ratio of 13,500/5,500, so that the high-tension current can be fed to the 5,500-volt bars, or *vice versa*. Care has thus been taken in laying out the station to make the above three systems interchangeable, and any one of the five turbine groups can be used to supply any of the circuits of the station in spite of the different voltages and frequencies.

The boiler room for the 1,000 kw. units contains eight multitubular boilers which are designed to work normally at a pressure of 190 lb. per sq. in. Each of these boilers has 225 sq.

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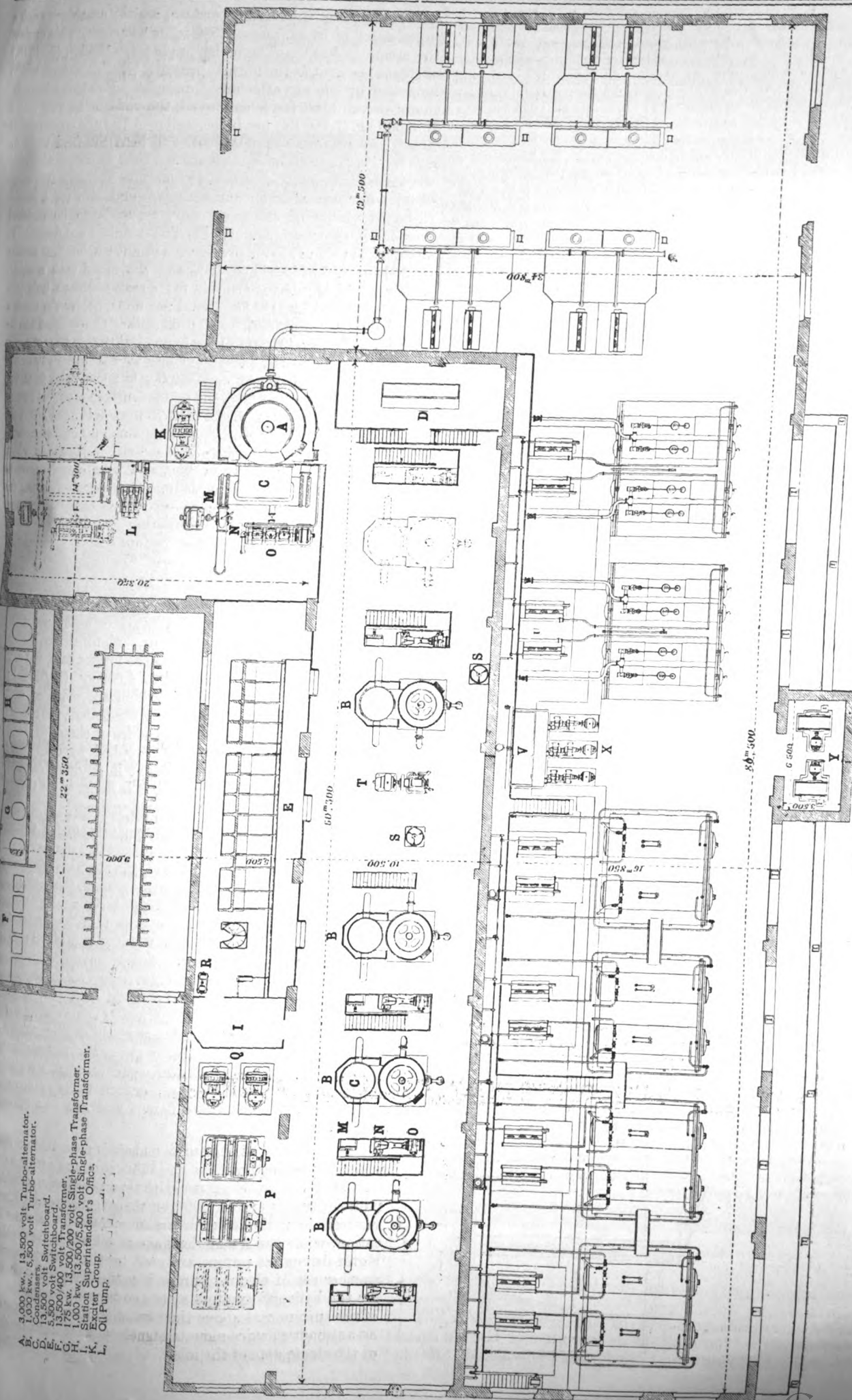

FIG. 1.—GENERAL ARRANGEMENT OF STATION.

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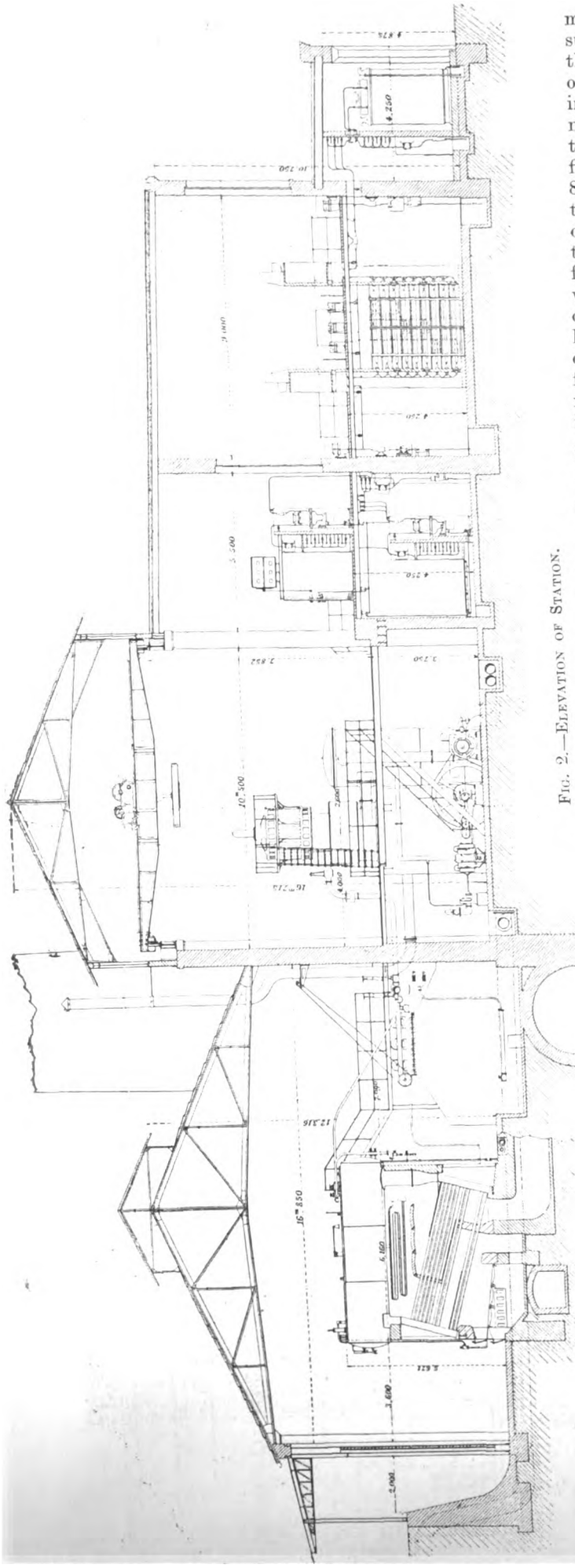

Fig. 2.—Elevation of Station.

metres (2,430 sq. ft.) heating surface, and is combined with a superheater of 54 sq. metres (580 sq. ft.) surface, which raises the steam to 300°C. The boiler produces 3,125 kg. (6,875 lb.) of steam per hour at the normal pressure, but this output can be increased by the use of a forced draught. For this purpose a motor-driven blast fan is employed, the yield being thus raised to 3,500 kg. (7,700 lb.) per boiler unit. A 72-tube economiser is fitted to each of the boilers, so as to heat the feed water to 80°C. This battery of eight boilers is used in connection with the three turbo-alternator units which operate at a frequency of 25. For the 50-frequency machines and also for a second turbo-alternator of the same type which is to be installed four other boilers are employed. These boilers are designed to work at the same steam pressure, but have a heating surface of 265 sq. metres (2,860 sq. ft.), and are fitted with a superheater of 65 sq. metres (700 sq. ft.) surface. Each unit produces 3,600 kg. (7,920 lb.) of steam per hour, or, by the use of a forced draught provided by the same fan, the output can be raised to 4,200 kg. (9,240 lb.) per hour. With this type of boiler is used a 96-tube economiser. Owing to the proximity of the gas works, the company can employ the gas coke from this latter plant in order to heat the boilers with economical results. The gas works lies at a height of 3·75 metres (12 ft.) above the floor of the electricity works, and thus the mouth of the coal bunkers which lie on one side of the boiler-room are on a level with the outside ground, so that the coal can be dumped directly into the bunkers without any further handling by means of the cart which circulates between the gas works and the electricity station.

The second boiler-room of the station is laid out on quite a different plan from the other, and automatic stoking is employed, together with a well-designed system of conveyors for bringing in the coke supply. The eight multitubular boilers which are here installed have a rated capacity per unit of 4,000 kg. (8,800 lb.) of steam per hour. Motor-driven blast fans are used to give a forced draught in the former case, and in this way the output can be increased to 4,800 kg. (10,500 lb.) per hour. From the coal bunkers, which are mounted on the second floor of the station and above the boilers, the coke is fed down to each of the furnaces by a series of chutes in the usual way. The bunkers are supplied by coke from the gas works. This is brought in on dump carts. The present set of eight boilers is designed for the supply of the large 3,000 kw. steam turbine.

The Curtis turbine groups (Fig. 6) for the 25-frequency current are operated at the standard speed of 1,500 revs. per min., and the steam is admitted at a mean pressure of 11·5 atmospheres, this being superheated to 275°C. These turbine alternators are designed to carry an overload of 30 per cent. for two hours' continuous running and of 50 per cent. for a 15-minute run. Steam governing is effected by the use of a ball governor, which acts through a hydraulic motor upon the main gate valves of the steam piping. A second method of regulating is by means of valves operated by a small electric motor, and this makes it possible to secure slight variations of speed. The attendant at the switchboard can control the working of the electric motor, and in this way can obtain synchronism between the different machines in a convenient manner.

The lower end of the turbine shaft is mounted in a bearing which is provided with water lubrication at a pressure of 30 lb. per sq. in., the water for this purpose being supplied by motor-driven pumps. Of the three guide bearings for the vertical shaft, the lower one is also provided with water lubrication, while the remainder have an oil feed in the usual way. Motor-driven oil pumps are used for this latter purpose, and another set of electric pumps is used for supplying the water for the hydraulic motors of the governors. Should the speed of the turbine rise above the normal by more than 15 per cent. an automatic device mounted for the purpose causes the closing of the steam gate of the inlet.

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In the basement under the dynamo room are located the condensers for each of the steam-turbine units together with the necessary water and air-pumps belonging to these.

A transformer post is erected in the station so as to allow common working between the 5,500 volts and the 13,500 volts

the board is designed for the supply of the station premises. It allows for the parallel connecting of different groups among themselves and also with the storage battery which the station contains. In order to avoid having a drop in voltage due to the starting-up of one of the groups, which would lower the

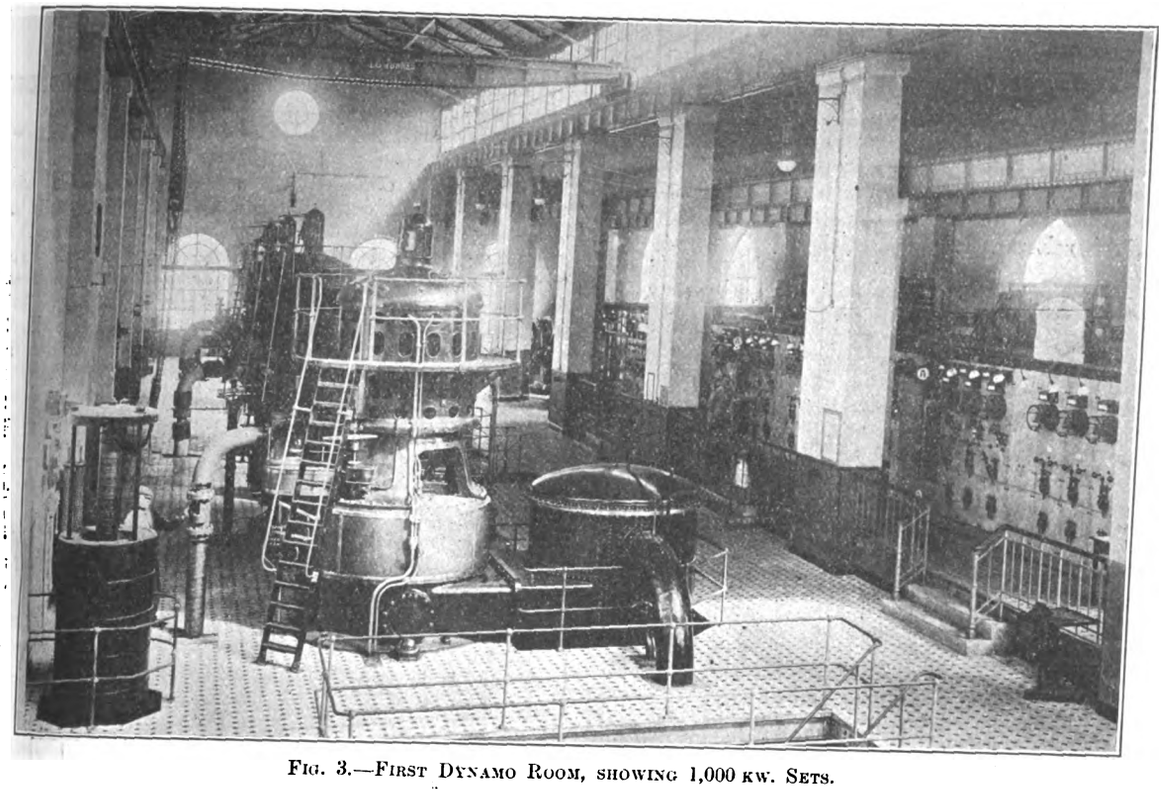

FIG. 3.—FIRST DYNAMO ROOM, SHOWING 1,000 KW. SETS.

circuits. For this purpose three transformers of the 1,000 kw. single-phase type are employed and are coupled on the three-phase system.

As regards the switchboards these are divided into two distinct portions. One part is used for all the low-tension

voltage of the exciter circuits of the alternators, the switchboard has two independent sets of 'bus bars which are usually kept separated. One set of bars is used especially for the exciter circuits and the second set serves for the station services,

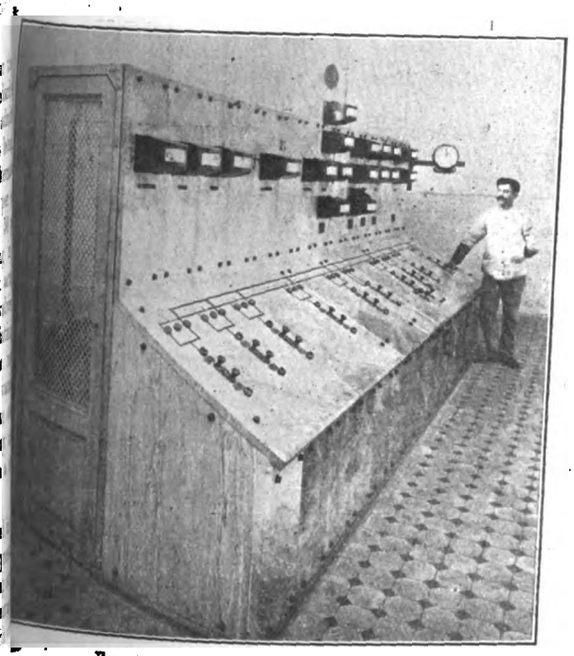

FIG. 4.—13,000-VOLT SWITCHBOARD.

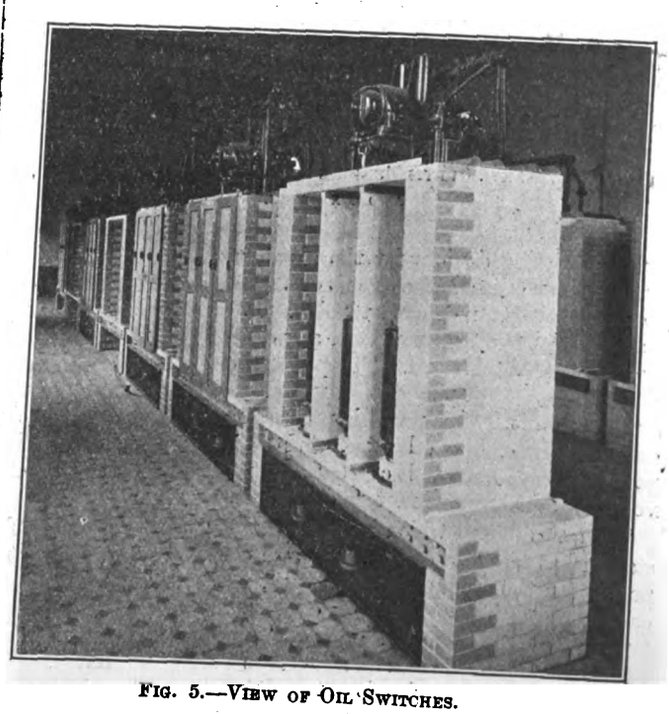

FIG. 5.—VIEW OF OIL SWITCHES.

chines at 5,500 volts and the second part serves for the 500-volt machines. The 5,500-volt switchboard is divided o three main portions, one of these being used for the direct rent, the second for alternating current at 25 frequency, d the third for 50 frequency. The direct current portion of

such as lighting, boiler-room motors, frequency-converter motors, oil-pumps, &c.

The second part of the 25 frequency alternating-current board is fitted with two sets of 'bus bars, and has the following panels: Four feeder panels which by the use of extra bars and

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section couplers allows any one of the outgoing cables of the station to be fed, or two or three of such cables to be supplied in parallel. This can be done by any one of the panels or by all the four panels at the same time. On these panels are mounted meters for registering the amount of energy furnished or received by the station as a whole. There are next five alternator panels—*viz.*, two panels for the alternators (or synchronous motors) of the frequency-converters working at a frequency of 25. At the lower part of each panel is placed a circular contact switch for raising or lowering the resistance which is put in series with the field winding of the starting motors of these groups, so as to be able to adjust the speed of direct-current motors and obtain synchronism of the three-phase motors of the frequency-converter, without it being necessary to leave the switchboard. There are also three panels corresponding each to a 25 frequency turbine-alternator. Each of these panels carries the

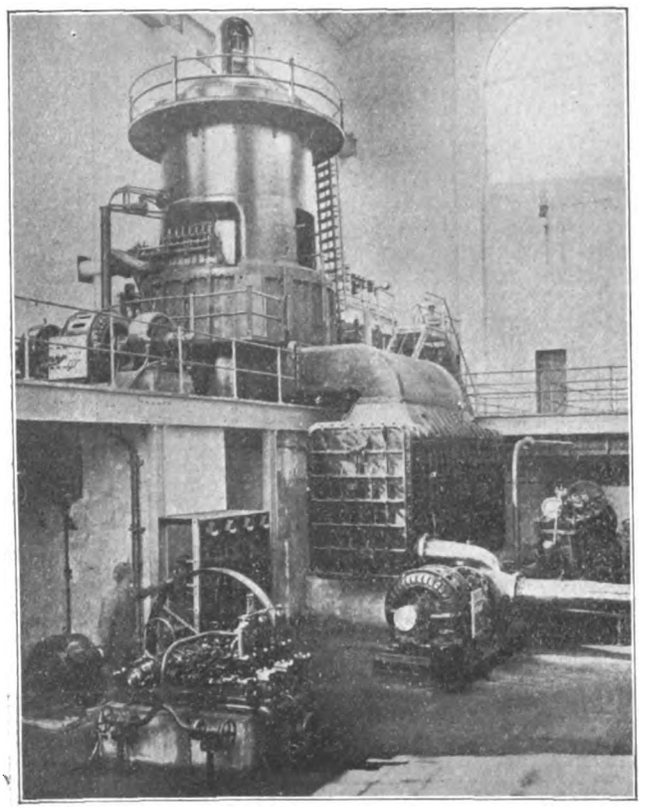

FIG. 6.—3,000 KW. CURTIS TURBINE SET WITH CONDENSER, PUMPS, AND EXCITERS.

usual switching devices for the alternator. At the base is a switch which controls the circuit of a small synchronising motor mounted at the top of each turbine. It is possible to synchronise one of the alternators with any one of the others without leaving the switchboard. There is also one panel for the high-voltage circuits of the station transformers for supplying the station circuit. This panel is provided with an automatic circuit-breaker of the oil type, and here is also one machine panel for the 13,500-volt current, and two panels for the 5,500-volt non-synchronous motors of the exciter sets.

The switchboard which is used for the current supplying the station has two sets of 'bus bars and comprises two alternator panels for the frequency-converters, three feeder panels each corresponding to an outgoing cable and one alternator panel for the fourth 1,000 kw. group. The board contains blank panels for future use and an automatic voltage regulator, which acts upon the exciter circuit of the alternators. The 13,500 kw. switchboard is mounted on an elevated platform at one end of the main dynamo room, and is laid out for two 3,000 kw. alternators, one of which is now erected. It is fitted with two machine panels and six feeder panels for 13,500 volts and 25 cycles, as well as blank panels ultimately giving four alternator and seven feeder panels. The oil switches which are operated from this switchboard are of the Thomson-Houston distant-control type. On the board is engraved a simplified plan of the circuits of the station with a number of pilot lamps, which indicate the opening or closing of the main switches, and these aid the attendant in carrying out the various operations. A view of the 13,500-volt board is shown in Fig. 4 and of the oil switches in Fig. 5.

ALTERNATE-CURRENT RESISTANCE AND INDUCTANCE OF COILS.*

BY A. ESAU.

1. *Single-layer Coils.*—When a straight cylindrical wire is traversed by a direct current, the stream-lines distribute themselves uniformly over the whole section of the wire. When the current is alternating, however, the stream-lines crowd towards the outer surface of the wire, a phenomenon known as the "skin effect." This increases the resistance and reduces the inductance. An accurate knowledge of the effect of the frequency is necessary wherever rapid oscillations are used, since the natural rate of oscillation and the damping depend upon it. Rayleigh † calculated the effect for a straight wire. Of practically greater importance are solenoids and coils, and in these the skin effect produces a concentration towards the interior of the coil, thus increasing the resistance still further. The effect has been investigated by Dolezalek, M. Wien, Sommerfeld, Batelli, Magri, Black, Cohen, Coffin, Nicholson, Lindemann and Meissner.‡

If the resistance for a certain inductance is to be a minimum, the most favourable arrangement is a coil with a single layer of wire.

Theoretical Formulæ.—Wien's general formula is

$$\frac{W}{W_0} = 1 + \frac{C}{A} n^2 \pm \ldots,$$

where W is the alternate current resistance, W_0 is the direct-current resistance, n is $2\pi \times$ frequency, and C and A are complicated

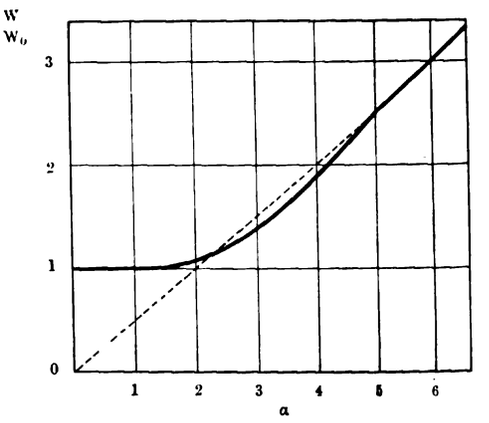

FIG. 1.

expressions involving the shape of the sectional area of the wi If the latter is an ellipse with a major axis $2b$ in the axial direct of the solenoid and 2ρ in the radial direction, the ratio becomes

$$\frac{W}{W_0} = 1 + \left[\frac{2\pi^2\rho^3\left(\frac{b}{\rho}\right)m\sigma n}{c}\right]^2 \times 0{\cdot}272,$$

where c is the length of the solenoid, m the number of turns and σ conductivity. This formula shows that if the wire is made a flatter band of elliptical section the alternate-current resistance is increas For a circular section the formula reduces to

$$\frac{W}{W_0} = 1 + \left[\frac{2\pi^2\rho^3 m\sigma n}{c}\right]^2 \times 0{\cdot}272.$$

If the section of the wire is rectangular, with the sides $2b$ (a and 2ρ (radial), the formula becomes for thin wires

$$\frac{W}{W_0} = 1 + \left(\frac{8b\rho^2\pi\sigma n}{g}\right)^2 \times 0{\cdot}356,$$

where $g = c/m$ = the pitch of the solenoid.

* Abstract of an article in the "Annalen der Physik," 34, pp. 5 and pp. 547-564, 1911.

† "Phil. Mag.," 21, p. 381, 1886.

‡ *See* "Annalen der Physik," 1903, 1904, 1906; "Bulletin" o Bureau of Standards, 4, No. 1; "Proc." of the Am. Acad. of Arts Sciences, 41, No. 34, 1906; Verh. der Deutsch. Physik Ges., 1 and "Jahrbuch der Drahtl. Telegr.," 3, 1909.

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If the wires are infinitely close together, $g=2b$, and

$$\frac{W}{W_0}=1+(4\rho^2\pi\sigma n)^2\times 0{\cdot}356.$$

Sommerfeld's formula for high frequencies is $W/W_0=a/2$, where $a=4\rho\sqrt{2\pi n\sigma}$.

The complete formula, applicable to any frequency, is

$$\frac{W}{W_0}=\frac{1+\frac{a^4}{5}+\frac{a^5}{19}+\ldots.}{1+2\frac{a^4}{\underline{|6}}+2\frac{a^5}{\underline{|10}}+\ldots.}$$

From this formula the following table of theoretical values has been calculated :—

a	W/W_0	a	W/W_0
0	1·0000	3·5	1·6183
0·5	1·00035	4·0	1·8978
1·0	1·00553	4·5	2·1903
1·5	1·0278	5·0	2·4769
2·0	1·0856	5·5	2·7493
2·5	1·1987	6·0	3·0000
3·0	1·3781	...	...

These figures are plotted in the accompanying diagram (Fig. 1).

The formula only applies so long as the section of the wire is small in comparison with the diameter of the solenoid. When the solenoid becomes narrow, the ratio W/W_0 decreases.

When the solenoid itself has a rectangular section with sides $2r_1$ and $2r_2$, the value of a becomes

$$4\rho\sqrt{\frac{2b}{g}}\sqrt{2\pi n\sigma}\sqrt[4]{\frac{4r_1r_2}{(r_1+r_2)^2}}.$$

Measurements.—These were carried out by Wien's method with Wheatstone bridge and low-resistance telephone (7 ohms). The plate of the latter was tuned to resonance for the frequency, so as to increase the sharpness of the minimum.

The general results are as follows :—

The formula of Wien and that of Sommerfeld (which are identical for the present purpose) represent correctly the increase of resistance for frequencies up to 6,000 ~ per sec.

There is a small decrease of W/W_0 with decreasing solenoid radius.

For pitches above 6ρ the ratio W/W_0 increases with increasing pitch, instead of decreasing as expected. This applies both to circular and rectangular wire sections. For high frequencies the change is satisfactorily represented by a (corrected) formula due to Piccati.*

$$\frac{W}{W_0}=1{\cdot}234\rho\sqrt{\frac{2\rho}{g}}\sqrt{2\pi n\sigma}.$$

One of the actual series of measurements is quoted below :—

Square section of wire. $2\rho=0{\cdot}3$ cm., $g=0{\cdot}8$ cm., $W_0=0{\cdot}02$ ohm.

Frequency.	a	W/W_0 calc.	W/W_0 obs.	W.
510	1·27	1·02	1·02	0·0201
1,060	1·80	1·05	1·05	0·0210
2,100	2·57	1·21	1·22	2·0244
3,060	3·10	1·43	1·43	0·0286
4,120	3·60	1·67	1·67	0·0334
5,270	4·07	1·94	1·92	0·0384
5,530	4·17	2·0	2·02	0·0404

On comparing the increase of resistance with the increase calculated by Lord Rayleigh for a straight wire, it is found that the A.C. resistance of a wire may be increased $2\frac{1}{2}$ times by winding it into a single-layer coil.

Decrease of Inductance.—This amounts to something between 1·5 and 2·5 per cent. within the range of frequencies studied. It is due to the crowding of the stream-lines towards the axis of the solenoid, which reduces the core area. The decrease is least in high-pitched wires, and is less in round wires than in wires with square section, and is well-represented by Coffin's (corrected) formula

$$\frac{L_n-L_{inf}}{L_{inf}}=\frac{1}{\sqrt{\frac{2b}{g}}\sqrt{2\pi n\sigma}}\times\frac{1}{r-\rho},$$

the higher frequencies, L_n being the inductance for frequency n, the inductance for infinitely rapid alternations and r the radius the solenoid.

* "Nuovo Cimento," 11, December, 1906.

2. *Multiple-Layer Coils.*—According to Wien, the increase of resistance in a coil on substituting alternating for direct currents is given by

$$\frac{W-W_0}{W_0}=\frac{64}{3}\frac{b^2\rho^4\pi^2m^2\sigma^2}{c^2}\left(1-\frac{(r_1+r_2)^2}{c^2}\right)n^2,$$

where W is the A.C. resistance, W_0 the D.C. resistance, b the width and ρ the thickness of the wire (of rectangular cross-section) and r_1, r_2 the inner and outer radii of the coil.

For infinitely long coils with wire of square section this may be written

$$\frac{W-W_0}{W_0}=\frac{16}{3}\rho^4\pi^2m_1^2\sigma^2n^2,$$

where m_1 is the number of layers.

Sommerfeld's formula is identical with this, except that the numerical factor is $\frac{64}{9}$ instead of $\frac{16}{3}$.

The experiments undertaken were incapable of deciding between the two formulæ. Both appear to be fairly correct for small frequencies and for a large number of layers. For the higher frequencies (4,000 to 6,000) the resistances fall below the calculated values, especially when there are only a few layers (two or three).

As regards the inductance, it is found to change least when the coil is long and the number of layers is large. The changes ranged from 1 to 8 per cent.

3. *Influence of Damping upon Resistance and Inductance.*—Barton* has studied the resistance and inductance of a straight wire for damped oscillations, such as occur in condenser discharges. He found an increase in both as compared with Rayleigh's values for undamped oscillations.

The author calculates these effects for coils by Sommerfeld's method, introducing, however, the damping factor δ. He finds for square wires and slow oscillations

$$\frac{W}{W_0}=1+\frac{16}{45}s^4\pi^2n^2\sigma^2(1+\delta^2),$$

where s is the thickness of the wire.

For rapid oscillations and small damping factors

$$\frac{W}{W_0}=s\sqrt{2\pi n\sigma}\,(1-\tfrac{1}{8}\delta^2).$$

The first formula shows an increase of resistance, and the last a decrease. In either case it is very small, being $\frac{1}{2}$ per cent. for a decrement of 0·2.

Rusch has shown that this is the actual behaviour of coils with wires of circular section.

The inductance also shows an effect of damping. For rapid oscillations the calculated relation is

$$\frac{L}{L_0}=\frac{3}{2s\sqrt{2\pi n\sigma}}(0{\cdot}1+\delta-\tfrac{1}{8}\delta^2),$$

but when the damping is considerable the formula is more complicated, and the increase may be converted into a decrease. In the case of slow oscillations the increase in the inductance is positive, zero, or negative, according as to whether the expression

$$1-\frac{21}{2s^2\pi n\sigma}\delta-\frac{15}{2}\delta^2+\frac{21}{2s^2\pi n\sigma}\delta^3+9\delta^4$$

is less than, equal to, or greater than zero.

In conclusion, the author refers to the work of Lindemann on stranded wire, which shows that an equal distribution of the stream-lines is attainable, and Meissner's work on the effect of the capacity of a coil upon its resistance, which amounts to an increase. This influence of capacity is strongest in the case of coils of many layers of thin wire. For slight damping the diameter of the strand element should not exceed 0·07 mm., and a flat coil is the best. For any given diameter of wire and wave-length it is possible to calculate the number of wires giving the smallest damping for a given inductance and dimensions.

* "Phil. Mag.," 47, p. 433, 1899.

Hydro-Electric Station in the Caucasus.—According to "The Times Engineering Supplement," the Council of Ministers has sanctioned the leasing to a British group for a term of 75 years 275 acres near the River Terek and 407 acres near Lake Soktcha for the purpose of hydro-electric stations. The Government reserve the right to acquire the works there erected within 30 years or on default of the promoters to satisfy certain regulations. The promoters have agreed to pay £2,500 annually for Government inspection. It is stated that the price of power will not exceed 1d. per kilowatt-hour.

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ELECTROLYTIC CORROSION IN REINFORCED CONCRETE.*

BY C. E. MAGNUSSON and G. H. SMITH.

Summary.—After confirming the results of other investigators, that an electric current produces failure of reinforced concrete, the authors discuss the various theories of this action, reaching the conclusion that the increase in volume due to chemical action is the direct cause of the failure. Methods for protecting the concrete are finally considered.

While reinforced concrete was coming into general use as a structural material much space was given in the technical press to discussions and reports on the durability of the encased iron. The results from a large number of experiments gave fairly conclusive evidence that under ordinary conditions the iron is protected, and that even if it was rusty when placed in the concrete, it will be free from the oxide after remaining in the concrete for some time. It was quite natural therefore to infer that when failures did occur, the crack in the concrete preceded the corrosion of the iron, and that the presence of the iron in no way entered as a factor in causing the failure of the concrete. The complex chemical changes taking place for a considerable time in the hardening process of cement make it difficult to secure any chemical basis on which this inference might be refuted. Besides the complexity of the chemical changes, many variables of poorly defined range enter into the making of concrete, both in quality of material and manner of construction, so it becomes very difficult to prove that any portion of a structure where failure develops was constructed in a proper manner and from good material. Under these conditions it has become quite customary to assume that a crack in the concrete is in itself evidence of poor cement, careless construction, faulty design or some other similar factor.

Outside causes like vibrations from periodic impulses have been investigated in special cases, and for the past four years or more some attention has been given to the possible effects of electric currents. In the discussion of Knudsen's Paper a marked difference of opinion was manifest and it appeared that more experimental data would be necessary to determine the true nature of the phenomena. Accordingly, a series of experiments was begun in September, 1907, in the Electrical Engineering Laboratory of the University of Washington, for the purpose of studying the electrolytic effects on iron in reinforced concrete. The work is discussed below under three heads.

The cement used was of the "Washington" brand made at Concrete, Washington. The iron was cut into 8 in. lengths from commercial stock of ¾ in. Johnson steel bar. A copper wire was soldered to one end for making electrical contact. The ratio of cement to sand was one to three for the concrete. Cylindrical blocks 9 in. high and 6 in. in diameter were formed in moulds. The iron bar was placed along the axis and extended to within 2½ in. of the lower end, thus leaving a layer of about 2½ in. of concrete between the water in the tank and the iron bar. Each block was kept in a moist condition for at least 30 days before the E.M.F. was applied. Three blocks were made at a time, two were used in the circuit and the third kept as a check.

Will the Electric Current cause Failure in Reinforced Concrete?—The experiments supported the affirmative conclusion reached by other investigators. Modifications in applied voltage, current density and kinds of aqueous solutions did not alter the general result, viz., that an electric current passing from the iron through the concrete will cause corrosion where it leaves the iron, and, if the process be continued for a sufficient length of time, the surrounding concrete will crack.

Analysis of the Processes Involved.—The following suggestions are discussed: (*a*) Temperature rise due to RC^2 losses. (*b*) Hydrostatic pressure at the anode due to the current and to changes in solution density. (*c*) Pressure caused by the generated gases. (*d*) Chemical change in the cement, due to the current directly, destroying the cohesive strength of the concrete. (*e*) During corrosion, the iron changes to an oxide or a salt; this involves an increase in volume.

(*a*) In cases where the current is comparatively large and more heat is generated than can be dissipated without a great rise in temperature, this factor may be the cause of the failure. With sufficient heat generated to cause the water to change into steam, failure of the concrete will quickly follow. Such cases, however, are rare and readily noticed, and the flow of the current stopped. The large majority of cases deal with small currents, a few hundredths of an ampere, and the rise in temperature is slight.

(*b*) While the hydrostatic pressure at the anode is sufficient to force a few drops of discoloured water up around the edges of the iron on top of the block, the porous nature of the blocks makes it improbable that any considerable stress should come from this source.

(*c*) From the porous nature of the surrounding material it seems quite impossible that any large force should come from this source. Moreover, when two blocks are connected in series the hydrogen gas will be twice the volume of the oxygen. No action, however, was observed where the hydrogen was liberated, while the block receiving the oxygen cracked in 19 hours.

(*d*) In order to determine what action, if any, was produced directly on the concrete by the electric current the resistance of cement and concrete was first measured under various conditions; special cubical blocks being made and afterwards tested for their compressive strength.

The results of the tests recorded in the Paper may be summarised as follows:—(1) Concrete and cement, when dry, are good insulators. Their specific resistances being of the order of 1,000 megohms per cubic centimetre. (2) The conductivity of concrete and cement depends upon the porosity of the material and the nature of the solution in the pores. When the pores are full with an aqueous sodium chloride solution, both cement and concrete are fairly good conductors of electricity. (3) The current flowing through the concrete probably follows the ordinary laws of electrolysis, with the liquid in the porous spaces of the concrete mass as the conductor. (4) An electric current of low density passing through cement or concrete does not affect the compressive strength of the cement or concrete.

(*e*) When the current leaves the iron through an aqueous solution, oxygen and, under some conditions, chlorine will be liberated at the iron surface. An iron oxide or a salt will be formed and these chemical changes are accompanied by an increase in volume. When iron is changed to ferric oxide (Fe_2O_3), the volume is increased in the ratio 1 to 2·2, and a similar increase occurs when the other compounds are formed. Without doubt the forces produced by chemical action are ample to break the concrete, and all the observed facts can readily be explained on this basis. The observed data give evidence that the corrosion of the iron, caused by the electric current, precedes the crack in the concrete; and that the increase in volume when the iron changes into an oxide or a salt is the direct cause of the failure of the concrete.

Methods for Protecting the Concrete.—Five methods are discussed, viz., (*a*) Keeping the iron negative to the surrounding concrete so that the current will flow to the iron in all cases. (*b*) Using alternating currents. (*c*) Filling the pores of the surrounding concrete with some non-conducting material. (*d*) Coating the iron with a metal so that the conduction will be metallic instead of electrolytic when the current reaches the iron. (*e*) Coating the iron with some insulating material before it is placed in the concrete.

As regards (*a*), this is usually impracticable. Experiments showed that unless the currents are large enough to produce excessive heating no deteriorating effect will come to the reinforced concrete from alternating currents of equal positive and negative wave forms. The conclusion is also reached that it is not likely that any combination can be found which will so fill the pores that the moisture will be excluded and the concrete become a non-conductor of electricity.

In regard to (*d*), coating the iron with zinc proved useless. Bearing in mind the eletcrolytic properties of aluminium, the bars were covered with two or three coats of aluminium paint, using banana oil (amyl acetate) as a binder. There was observed the characteristic drop in current—that is, the rapid rise in resistance due to the formation of aluminium oxide—and when the circuit was broken recovery occurred. The paint, however, did not protect the iron from corrosion. The time element, before failure of the concrete occurred, was considerably increased, but the blocks cracked as in the case of bare iron. Two explanations are suggested. First, the salt water solution, the chlorine given off at the cathode attacks the aluminium and thus destroys the protective qualities of the oxide film, and when the aluminium has all been changed to a salt, the current can attack the iron. Second, the oxygen ions pass between the layers of aluminium flakes and thus reach the iron. The latter process seems to be the most probable. With the iron coated by a continuous layer of aluminium so as to eliminate the passage-way for the oxygen ions to the iron, the desired results might be achieved. Iron bars plated with aluminium were not available but it seems likely that the automatic increase in resistance would follow in a manner similar to the experiments on aluminium wire. With a practical method of coating the iron with aluminium, the problem of protecting the reinforcing bars in concrete from electrolytic action may be solved.

If the iron bar be coated with an insulating compound before being placed in the concrete, thus preventing the flow of electricity, it is evident that there will be no corrosion of the iron. To find a material with which such an insulating coating can readily be placed on the iron so as to produce commercially practical results is no easy task

* Abstract of a Paper read at the Annual Convention of the American Institute of Electrical Engineers.

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Work has been done on this problem by Dr. Maximilian Toch who has prepared a special paint for which he claims protective properties. This and a number of other commercial paints were tested and a summary of the observations is given in the Paper. The results indicate that the time element is an important factor in determining the protective qualities of a paint. The deterioration of the insulating power of the paint is probably due to a slow absorption of moisture. In one case no indication of corrosion was seen during the first four months, while complete failure followed by continuing the process two months longer. Three sets of blocks gave no evidence of corrosion; but whether the concrete will be protected indefinitely or failure will follow by continuing the process for a few more months remains to be seen.

It was found also that the presence of the paint greatly reduced the maximum shearing force.

PROTECTION FROM LIGHTNING.

A report on this subject was presented at the recent meeting at New York of the National Electric Light Association. Twenty power supply companies who had investigated the matter very thoroughly were circularised, and the report (of which an abstract was given in the "Electrical World") is based on the replies received. It states that with improvements in insulation and lightning arresters failure of apparatus from lightning is becoming very much less frequent.

The results obtained from the use of the electrolytic type of arrester have been very satisfactory. Arresters of the horn type are in common use, but in a great many cases are being rapidly replaced by those of the electrolytic type. On the other hand, an objection to the electrolytic arrester is its high first cost and the necessity of frequent charging and attention; indeed, in a station of minor importance it has been considered cheaper to replace an occasional damaged transformer. Transmission lines having overhead earth wires appear to have suffered the least damage. The use of an earthed metal ring for each insulator is reported as being effective for the elimination of line disturbances, but is no protection against a direct stroke and is expensive. In some cases an earthed spark-gap has been provided for each insulator, and still another form is that of installing an earthed wire on each pole, carrying it well above the top. A special device, known as an arc suppressor, is now being experimented with for the relief of transmission line troubles due to an arc around the insulator, the device being used at the 'bus bars of the principal station to take care of the entire system.

In its recommendations the Committee states that where all lines leading into a station are operated separately, each of them should be provided with an arrester installed on the line side of all apparatus. In other cases experience justifies installing one arrester on the common 'bus bar. The installation is recommended of choke coils on every circuit leading to the generating station, advantage also being taken of the newer and improved types of insulation for transformers and other classes of apparatus connected with a high-tension system that are especially susceptible to damage from lightning or surges. In the case of stations where no arresters are being used the electrolytic type is recommended; if, however, arresters of the multi-gap or horn type are in use and giving satisfactory service there is no need for a change. The Committee unqualifiedly recommend the use of the overhead earth wire, which should be earthed at every supporting structure, either pole or tower. A lightning rod carried down the earth wire is also recommended.

The results of investigations have shown that a lightning arrester will not protect any apparatus on a distributing system more than 300 or 500 ft. away. A calculation is given showing that it would pay to increase the number of arresters beyond one for each $1,000 worth of transformers. The Committee repeats its recommendation as to the inspection of arresters, as well as to the importance of detailed records.

DISCUSSION.

Dr. C. P. Steinmetz said that the problem of lightning protection had become essentially an economic one, as to how far the cost of protective means was balanced by probable damage to apparatus. A protective device should be close to the apparatus to be protected, and it was a question whether we should not abandon altogether the attempt to protect distribution circuits, and confine attention to the apparatus connected to these circuits, installing the devices near them. In other words, it was becoming more economical from year to year to connect arresters to the device to be protected, and not distribute them along the line. Dr. Steinmetz described the manner in which the various data relating to lightning disturbances and abnormal voltages might be scientifically determined.

Prof. E. E. F. Creighton recommended, as a means for determining the condition of an aluminium lightning arrester, connecting an ammeter in series with it when it was being charged. The details of the method, however, were not elaborated. The valuable quality of an aluminium arrester was its capability of discharging heavy currents at abnormal voltages, but it could not economically be built to discharge the main generator current.

Mr. R. P. Jackson emphasised the importance of good insulation of apparatus. He did not believe in the indiscriminate use of lightning arresters that discharged freely, when they should be set to a higher voltage and the additional stress taken by the insulation of the apparatus. Some of the money that had been spent in protective apparatus might well be spent in better insulation and on improving the transmission lines.

Mr. Farley Osgood said there was a possibility in some cases of decreasing the number of lightning arresters now in use; but the lightning protection problem was one for individual study, as local conditions might influence the number of arresters to be used. Earthing the secondary would enable a reduction to be made in the number of arresters.

Mr. Percy H. Thomas agreed with Mr. Jackson as to setting lightning arresters at low voltage, as it was a menace every time an arrester discharged, the system being strained each time. A trouble to be expected with the electrolytic lightning arrester was that when the discharge passed over the horn-gap the potential of the line was momentarily reduced, and the apparatus subjected to a severe shock. The electrolytic arrester had the disadvantage over the multi-gap series arrester of discharging frequently. Numerous advantages of the multi-gap type of arrester were pointed out. Mr. Thomas said that the new schemes for shunting out an arcing earth on a transmission line seemed to have made progress. The idea of the type of device referred to was to close a circuit automatically in shunt at the power house as soon as the arc was established. This took the potential off that portion of the line, which then was automatically restored.

Mr. P. M. Lincoln said there were several means besides lightning arresters for taking care of lightning disturbances. One was the use of the suspension insulator, which had an earthed portion above the line to be protected; the second was the use of an earth wire above the transmission line, and the third was the earthing of the secondary distribution and primary transmission circuit. These three methods of construction would, he believed, secure a greater reduction in damage from lightning disturbances than the use of arresters.

Prof. Creighton considered some of the comparisons made between the aluminium and multi-gap arrester. The former, he said, was designed specifically to take care of continuous surges for a considerable length of time, which the latter could not possibly do, because of the heavy current that flowed and the high voltage expended in the resistance rods. When the neutral was earthed the difficulty was transferred from potential to current troubles. In many cases, however, it was advisable to earth the neutral, especially in the operation of a railway system.

Mr. E. J. Richards said that very good results had been obtained during the past two years from the use of aluminium-cell arresters on high-tension lines and feeders. He directed attention to the inspection and care required in the operation of aluminium-cell arresters. There had been only one interruption due to insulator failure on the lines referred to during the past two years, and this was caused by a direct stroke of lightning.

Mr. F. Osgood could not agree with the statement that multi-gap arresters required no attention, because dirt collected on them and would cause trouble if not removed.

Mr. H. L. Wills said that in the case of a 6,600-volt system good results had been obtained by connecting one side of the lightning arresters to the line and the other side to the earth wire; the next line was connected to a lightning arrester, but not connected to the same earth wire, &c. By connecting one lightning arrester to one line at one pole, and the next lightning arrester to the other line at another pole, there was a much easier discharge.

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from *The Electrician* office, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published under 2s., and 5 per cent. for books published nett. Add 10 per cent. for abroad or for foreign books.]

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"Illumination: Its Distribution and Measurement." By A. P. Trotter. (London, 1911: Macmillan & Co.) 8s. 6d. net.

"Quaternions as the Result of Algebraic Operations." By A. L. Baker. (London, 1911: Constable & Co.) 6s. net.

"The Design of Static Transformers." By H. M. Hobart. (London, 1911: Constable & Co.) 6s. net.

"The Principles of Scientific Management." By F. W. Taylor. (London, 1911: Harper & Bros.) 5s. net.

"Proceedings of the Royal Society." Series A. Vol. LXXXV., No. A. 579. 3s. 6d.

"Guide to the Income Tax." By F. B. Leeming. (London: Effingham Wilson.) 2s. 6d. net.

"Wiring Houses for the Electric Light." By N. H. Schneider (London, 1911: E. & F. N. Spon). 1s. 6d. net.

"Low-Voltage Electric Lighting with the Storage Battery." By N. H. Schneider (London, 1911: E. & F. N. Spon). 1s. 6d. net.

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With "THE ELECTRICIAN" for Sept. 14, 1906, was issued the first of a series of "Industrial Supplements," to be published from time to time with "THE ELECTRICIAN." The fifty-third issue of the Supplement published (Gratis) with the number of "THE ELECTRICIAN" for September 23, 1910, was the last of the monthly issues. "THE COMMERCIAL AND INDUSTRIAL SUPPLEMENT" to "THE ELECTRICIAN" is now issued weekly (Gratis). It will be found towards the end of the present issue.

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INNOVATIONS IN TRAMCAR CONSTRUCTION.

It is a common trouble on tramcars that the driver can not see easily what is taking place on the step of the car and consequently accidents occur over which he can have but little control. An attempt to overcome this difficulty is being made by the International Railway of Buffalo, U.S.A., and although the conditions there are not quite the same as in this country it may be worth while to call attention to the type of car which is there being introduced. As will be seen by the account given in another column the car is intended for use on what are called "street railways" in the United States. These railways work under conditions that apply in this country to tramways on the one hand and to light railways on the other.

The car is of the single-deck type and the entrance is at the front end only, there being two gates side by side, one for exit and the other for entrance. The driver is screened off from the car proper, but has full view of both these gates, which are on the same side of the car; he can therefore close them and start the car when he is certain that it is safe to do so. Although a conductor is provided the car is worked on the "pay-as-you-enter" principle, consequently the conductor has time to observe any signals that may be made to him and to call out the names of the streets. We doubt whether this mode of working would be acceptable in this country, but the main point of the construction is that the streams of incoming and outgoing passengers do not interfere with one another, and since the movements of the passengers entering or leaving the

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car can be easily seen, accidents are avoided and there is greater ease of working. Passengers alighting can pass in front of a car of this kind instead of behind, and thus obtain a clear view of cars or other traffic approaching in the opposite direction, whereas such traffic is hidden from passengers passing behind in the usual fashion, and is thus a source of danger. The car in question has seats for 53 passengers and standing room for 30, the overall length being 45 ft. 2 in. The chief drawback seems to be that a car of this kind must always run in the same direction, and this involves a loop at the end of the line. A turntable might, of course, be used, but this would generally present serious objections. A loop, on the other hand, is extremely convenient for the handling of cars at the end of a line, particularly if the traffic is heavy, but it is not always easy to provide a terminus of this kind There should, however, be no great difficulty in making double-ended cars on the same principle by sacrificing a few seats.

Another type of car described in the present issue, and of interest owing to the special conditions involved, is that on which Edison accumulators are being used as a source of power. In an accumulator car the weight, and also any inefficiency due to friction, become of extreme importance, owing to the fact that a greater weight of battery must be carried to compensate for such defects. In order to give the Edison accumulator as good a chance as possible, the cars on which it is mounted have been constructed on somewhat different lines from those usually adopted. Thus, instead of having each pair of wheels fixed to a common axle, free running wheels are used, the axles themselves being fixed. No figure is given as to the precise saving in friction effected by this construction, but it is obvious that under certain circumstances the saving should be very considerable, and Mr. R. H. BEACH seems to have found it so in this particular case. Further, the usual gear drive has been replaced by a chain drive, as it is found that the efficiency of the latter is maintained longer at a high value than that of the gear drive, of which the efficiency suffers considerably by wear. The weight of the cars has also been reduced to a minimum. Whereas an ordinary single truck car weighs about 800 lb. per seated passenger and a double-truck car about 1,000 lb., the Edison-Beach double-truck accumulator car weighs per seated passenger only 600 lb., while a small single-truck car weighs 360 lb., the weight of the battery being 60 lb. per seat. The result of these alterations is that the energy consumption has been brought to a very low figure. Thus, in the case of a double-truck car, the consumption was 49·63 watt-hours per ton mile (presumably from the battery), whereas the consumption in the case of a double-truck trolley car would be something like 125 watt-hours per ton mile.

We do not suggest that all tramcars can be made correspondingly light; for the results obtained in such cases must be judged by the useful life obtained, and of that we have so far no information on which to go. We do think, however, that there is always a danger of working in a groove, and at the present time, when tramways generally do not pay as well as those who have control of them would wish, it might be worth while for the tramway engineer to look round and inquire whether present practice is necessarily all that is to be desired.

REVIEWS.

(Copies of the undermentioned works can be had from THE ELECTRICIAN Office, post free, on receipt of published price, adding 2d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.)

Three-Phase Transmission. By W. BREW. (London, 1911: Crosby Lockwood & Son.) Pp. viii. + 292. 7s. 6d.

In the preface the author tells us that he has omitted mathematics as far as possible, and that the few algebraical expressions he uses are of the most elementary character. Now there are two ways of avoiding mathematics. The one is by replacing the purely technical methods of the professional mathematician by the common-sense arguments of the engineer, and the other consists in simply skipping all mathematical investigation and introducing the result by some such phrase as: "It can be shown that the following formula holds good." Of the two, most readers would prefer the first method, but it becomes impossible with a subject of such complexity as the author treats in this book; he is perforce obliged to fall back on the second method. The result is not altogether satisfactory, since the reader has to take too much on trust. Take as an instance the expression given on page 20 for the capacity of a three-phase cable:—

$$K = 1{\cdot}5K_1 - 0{\cdot}166K_2,$$

where K_1 denotes the capacity of one core against the other two bunched together with the sheath, and K_2 the capacity between the three cores bunched and the sheath. Surely the reader may expect to be told in what way this formula is obtained. It is, of course, undesirable to burden the text of a practical treatise with mathematical arguments, but since a complex subject cannot be quantitatively treated without their help they might at least be given in footnotes.

Apart from the omission of such footnotes, the book is an admirable treatise on the technical and financial aspect of power transmission by three-phase current. The author never loses sight of the condition that engineering enterprise is only justified if it yields a financial profit, and he very justly insists that it is good policy to scrap old plant whilst still serviceable if by the substitution of new plant the profit on the total capital invested can be increased. This point, especially as regards transformers, cannot be too strongly insisted on. Manufacturers, consulting engineers and station engineers know quite well that it pays to scrap inefficient transformers and replace them with modern types; but, unfortunately, they cannot always convince the owners of the undertaking that it is good policy to buy new transformers. Mr. Brew shows that even a small improvement in hysteretic loss is, at present prices, sufficient to turn the scale in favour of a scrapping policy.

In Chapter I. we find a general survey of the whole subject, including tables of transmission plant now working in this country and abroad, life of plant, depreciation, repayment, covering interest and sinking fund, working pressure, drop and other characteristic features. According to the author, for transmission by cable, 20,000 volts over a maximum distance of 30 miles may be taken as reasonable limits; with overhead lines the corresponding figures are 110,000 volts and 300 miles.

In the second chapter the author discusses copper, dielectric, sheath and iron losses, and cites some experiments which showed a greater sheath loss with an unarmoured cable laid in cast-iron troughing than with the same cable armoured. In the first case the loss at $\nu = 50$ was 1·7 kw. per mile, and in the second only 1·3 kw., whilst with the unarmoured cable in air it was only 0·6 kw. As regards the most economical voltage, the author gives on p. 34 a table showing the cost per mile of a cable to transmit 1,000 kw. over distances of from 5 to 50 miles with a line loss of 2 per cent. It is remarkable that from 10 miles upwards minimum cost is obtained at a working pressure of 20,000 volts, and only for 5 miles is the lower working pressure of 15,000 more economical.

This subject of working pressure is further elaborated in the following chapter, especially in relation to annual cost, regulation, dielectric strength and corona effect.

After a descriptive chapter on control apparatus, the author

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discusses impedance, pressure rise, higher harmonics, resonance, reflected waves, power surges and other complex phenomena; and, considering that he is doing so under the self-imposed handicap of higher mathematics being excluded, discusses it fairly clearly. Earthing and the effect of an accidental earth are treated in Chapter VI., whilst the constructive parts of an overhead line, both from a mechanical and electrical point of view, are treated in Chapter VII. In appendices are given the Board of Trade regulations for overhead wires, formulæ for self-induction and capacity, examples of line calculation and a comparison of transmission systems.

GISBERT KAPP.

Engineering Mathematics. By C. P. STEINMETZ. (New York, 1911: McGraw Hill Book Co.) Pp. xvii.+292. 4s. 6d. net.

This book gives a *résumé* of a series of lectures delivered by Prof. Steinmetz at Union College. The lectures were intended as an introduction to the study of the author's engineering works, and so special stress is laid on the methods which he employs. The book, therefore, is not a complete treatise on the subject and is not intended to displace the standard text books. As an introduction to the study of Prof. Steinmetz's Papers and books it can be recommended.

Recent developments in telephony and radio-telegraphy make a more thorough knowledge of mathematics essential to the engineer who desires to keep his knowledge up to date. This knowledge has opened up many fields of research. It gives to the engineer that perfect confidence in theory which is essential to the successful working out of many kinds of apparatus. Lack of this knowledge also, especially when combined with unlimited commercial push, is often a danger to the community as well as to the individual. In the reviewer's opinion, it is more than ever necessary that those engineering students who have the necessary talent be encouraged to widen the foundations of their mathematical knowledge so that this country may keep in the forefront of scientific development.

Many of the expressions in this book will seem quaint to the English reader. In explaining addition, for instance, we are told to add a "bunch of horses" numbering five to a "bunch" numbering three, and so obtain a "bunch" of eight. "Logarithmation" serves as an introduction to the quadrature number j. The old-fashioned phrase "equilateral" hyperbola is used instead of rectangular or equi-axial hyberbola. The method of "indeterminate coefficients" is an example of another old-fashioned phrase. If the coefficients are really indeterminate, surely the method is of no use, and if they can be determined then they are not indeterminate. It would be much better to call it the method of undetermined coefficients, or simply the method of coefficients. It is never advisable to use untruthful phrases.

In an appendix a useful introduction is given to the Theory of Functions. It is a pleasure to find the distinction between elliptic integrals and elliptic functions clearly stated and to have the doubly periodic nature of the latter pointed out. The gamma functions are described. On p. 274 we find the following line:—

"$0=1$; $\lfloor n=1\times2\times3\times\ \ldots\ \times n$."

Our sympathies are entirely with the junior student who has the sense to put $n=0$ in the second formula and then wonders why it does not agree with the first. As the author gives no help, he will naturally conclude that $0=0$, and that the 1 is a misprint. He will the more readily come to this conclusion as the number of misprints in this book is unexpectedly large. Hence he will be laying up for himself trouble in the future.

We think that the work would be very considerably improved and its value to the student greatly increased if the author gave references to Papers and books where the reader would find more detailed information on some of the functions described. For example, on p. 275 we were glad to find an elementary introduction given to the very important sine, cosine and logarithmic functions which are very rarely met with even in professedly pure mathematical books. Surely a statement that their numerical values have been tabulated by J. W. L. Glaisher in the "Phil. Trans.," London, 160, pp. 367-387 (1870) might save some budding radio-telegraphist days of dreary numerical calculation.

We are sorry that Bessel's functions have not been included. To the physicist in this country they are much better known than the θ functions. A description of Kelvin's ber and bei functions also would have been welcome, as they are required in two very fundamental electrical problems.

Tables of the values of ε^x, $\cosh x$, $\sinh x$, &c., are given to five decimal places, but in some cases we have found that the last figures are doubtful. It is easy to compute, for instance, the values of $\varepsilon^{\frac{1}{2}}$, $\cosh(\frac{1}{2})$ and $\sinh(\frac{1}{2})$. The reviewer makes them 1·64872, 1·12763 and 0·52110 respectively. The values given in the table are 1·64970, 1·12761 and 0·52108. To the engineer this may sound hyper-criticism, but the reviewer has spent so many hours in checking formulæ which he thought were inaccurate, as they gave results slightly differing from the tables, that he regards it as imperative that the last figure given in tables should be correct.

A. RUSSELL.

THE EXPRESSION OF RESISTIVITY OF ELECTRICAL CONDUCTORS.

BY J. H. DELLINGER.

Summary.—The author discusses the desirability of expressing resistivity as "mass resistivity" rather than volume resistivity, the chief reasons being that mass is more easily measured than cross-section and conductors are sold by weight rather than volume.

In THE ELECTRICIAN for March 17, 1911, there appeared an abstract of an article on the conductivity of copper,* by F. A. Wolff and the present author. In a summary preceding the abstract the editor states that in the article "several suggestions, including the expression of resistivity in ohms per metre-gramme, are made." The fact is that the article discussed and emphasised the advantages of using ohms per metre-gramme, but it was not the purpose of the authors to suggest a new unit, inasmuch as this unit is already in extensive use. Its advantages were appreciated a half-century ago, for Lord Kelvin, in "Phil. Mag.," Vol. XXIV., p. 156, 1862, says: "It is much to be desired that the weight-measure, rather than the diameter or the volume-measure, should be generally adopted for accurately specifying the gauge of wires used as electric conductors." Furthermore, Matthiessen, in 1865, gave his results of resistivity measurements of the metals in ohms per metre-gramme. The American Institute of Electrical Engineers in 1893 defined the standard resistivity from which their copper wire table was calculated in ohms per metre-gramme. The British Engineering Standards Committee define the standard resistivity of copper in terms of the resistance in ohms of "a wire 1 metre long, weighing 1 gramme." In this case the unit in question is used, although it is not given the specific name, "ohms per metre-gramme." Thus, we see that it is a well-established practice to express standard values of resistivity in ohms per metre-gramme. This unit is, moreover, established in commercial practice, at least for copper, as a number of the large electrical companies and copper wire manufacturers in the United States express the resistivities of wires in terms of it. Those who employ English units exclusively use "ohms per mile-pound" (sometimes called "pounds per mile-ohm"). This is exactly the equivalent of "ohms per metre-gramme," either unit being the product of resistance per unit length and mass per unit length, which is the definition of "mass resistivity." However, there are some persons who are not familiar with this unit, and some who do not think it is as desirable a one as the "volume resistivity"—*i.e.*, the resistance of a unit cube. A discussion of the subject, therefore, appears in order.

From the standpoint of the engineer and the user of conductors, especially line wires, the quantities directly concerned are the ohms, mass and length, rather than the ohms, cross-section and length; and the former are the quantities actually measured in the usual commercial and engineering tests of

* "Bulletin" of Bureau of Standards, Vol. VII., No. 1, p. 103.

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copper. The measurement of cross-section or density is comparatively rare, and should be so, since the mass can be more easily and accurately measured. Accordingly, if the standard resistivity is defined in terms of cross-section, the result of the ordinary resistivity measurement expressed in terms of the standard will have different values depending on the density assumed. Thus, great confusion can arise in practice. From the practical standpoint, the "mass resistivity" combines two variables in one—viz., the "volume resistivity" and the density. To the purchaser of copper for conducting purposes it is equally desirable to have either the conductance 1 per cent. greater or the mass 1 per cent. less, and it is evident that either variation would affect the "mass resistivity" equally.

Since conductors are usually sold by weight, the relative commercial value to users of conductors of the same or even of different metals is given simply by multiplying the cost per unit mass by the mass resistivity. This statement of relative commercial value neglects differences in insulation, differences of stranding of cables, economy of space, &c. The reasons why the "mass resistivity" is preferable to the "volume resistivity" may be summarised, as in the Paper referred to above, as follows :—

1. The measurement of either cross-section or density in many cases is difficult and inaccurate.

2. The direct measurement of cross-section is practically impossible for irregular shapes of cross-section.

3. Conductors are sold by weight rather than by volume, and, therefore, the information of value to most users is given directly by the "mass resistivity."

Possibly one reason why the volume resistivity is still exclusively used by some people is the ease of defining it in terms of a unit cube. Such persons believe that their preference for volume resistivity over mass resistivity is due to the former's being more "scientific," whereas the real reason that they prefer it is because the mental picture of a unit cube is easy to retain. The opinion is here expressed that the worst thing about the unit, "volume resistivity," is the mental picture of a unit cube which accompanies it. Experience with students' examination papers has convinced the author that this conception too frequently leads to the gross error of thinking of resistance as proportional to volume. Indeed, practical men are often not careful to state "ohms per centimetre cube," so that we frequently read of "ohms per cubic centimetre." The resistance of a unit cube is not a practical case; wires are the usual articles whose resistance is desired to be known, and a form of expression of "volume resistivity" which fits the case better has been devised and is in extensive use. This form of expression is the "ohms per metre-millimetre" or "ohms per mil-foot," in which the greater dimension is the length of the wire and the smaller is the diameter. In these definitions we have the mental picture of a wire of a certain length and a certain diameter. When we speak of "ohms per metre-gramme" we have the conception of a conductor of a certain length and a certain mass per unit length. There should be no greater difficulty about the second conception than about the first, especially since the mass per unit length can be actually determined with greater ease and accuracy than the mean diameter.

It is to be noticed that the term "specific resistance" has not been used at all in this discussion. "Specific resistance" has been very extensively used in the past for the resistance of a unit cube. The term was, however, not well chosen, and seems to be tending to go out of use and give way to "resistivity." "Specific resistance" is considered to be an unfortunately chosen name for the resistance of a unit quantity because similar names—*e.g.*, specific heat, specific gravity, specific inductive capacity—refer primarily not to the property of a unit quantity of the substance, but to the ratio of the property of the particular substance to the same property of a standard substance. Another pedagogical stumbling block is found herein; for students are sometimes found defining "specific resistance" as the ratio of the resistance of some quantity of a metal to the resistance of the same quantity of copper. "Specific resistance" has probably not been much used for the resistance of a unit mass.

The term "resistivity" is a better name for the resistance of a unit quantity, just as "conductivity" is a better term than "specific conductance" would be. There is no *a priori* reason why "resistivity" could not refer to the unit mass, as some people profess to believe; and this term has not been limited to the idea of the unit cube historically. For example, as mentioned above, in the A.I.E.E. copper wire table the standard "resistivity" was given in ohms per metre-gramme. "Resistivity" is simply the property of unit quantity of a substance, and in defining it we are at liberty to choose any of the units of length, mass and time and the international electrical units. Since there are two modes of defining resistivity in common use, the unit mass and the unit cube, it is always desirable to indicate which is meant by using the precise expressions "mass resistivity" and "volume resistivity." These expressions are used in Alexander Russell's "Theory of Electric Cables and Networks," 1908. It may be worth remarking that no definition of resistivity is admissible which involves something not a property of the material itself. For example, we cannot speak of a "cost resistivity," since a unit whose value depends on business conditions cannot be considered a physical expression of the properties of unit quantity of a substance.

In the expression of "per cent. conductivity" there is a similar necessity for distinguishing between the definitions in terms of the unit mass and the unit cube. The term "per cent. conductivity" is extensively used in the copper industry, and on account of its convenience will probably continue in use. Of course, the per cent. conductivity can be calculated from either the mass resistivity or the volume resistivity, and if the density of the sample is different from the standard density these two per cent. conductivities will not agree. Accordingly, the use of "per cent. conductivity" should be limited to copper unless it is very carefully indicated whether it was calculated from the mass resistivity or the volume resistivity by the use of the terms "mass per cent. conductivity" or "volume per cent. conductivity." A striking example of the difference between the two per cent. conductivities in the case of a metal of different density from that of copper is furnished by aluminium. Thus, the "mass per cent. conductivity" of average commercial hard-drawn aluminium is 200 per cent., while the "volume per cent. conductivity" is 61 per cent. The general conclusion may be drawn from the foregoing that it is always desirable to state conductivity or resistivity directly in terms of the mass resistivity at a standard temperature rather than in terms of per cent. conductivity.

To sum up, this discussion has tried to show: (1) That "ohms per metre-gramme" is well established as a unit of resistivity, (2) that from a practical standpoint the "mass resistivity" is preferable to the "volume resistivity," (3) that the advantage of a mental picture to aid in defining volume resistivity is no less available in defining mass resistivity, (4) that "specific resistance" is an undesirable term, (5) that the term "resistivity" is susceptible of a certain breadth of definition, (6) that there are limitations to the proper use of "per cent. conductivity."

THE COMPARATIVE SENSITIVENESS OF SOME COMMON DETECTORS OF ELECTRIC OSCILLATIONS.*

BY LOUIS W. AUSTIN.

Summary.—The author describes some experimental comparisons of the sensitiveness of various wireless detectors including electrolytic, magnetic and vacuum valve detectors, a perikon detector being taken as the standard.

Although probably many comparisons of the sensitiveness of detectors have been made in the laboratories of the wireless companies, very little quantitative information on this subject has been made public. The difficulties usually encountered in laboratory tests are due mainly to the direct effect of the source of the oscillations on the receiving circuits and detector; but by using properly designed exciting circuits in connection with a buzzer as a source of oscillations these difficulties have been removed.

* Abstract of an article in the "Bulletin" of the Bureau of Standards.

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Method of Experiment.—The exciting circuit in all the experiments is shown in Fig. 1. Here B is a buzzer run by two storage cells with considerable resistance in series. The oscillatory circuit consists of a variable air condenser, C_1, having a maximum capacity of 0·005 mfd., and for moderate wave lengths an inductance, L_1, of 0·062 millihenries. These are connected directly across the contact of the buzzer.

The action of the circuit is as follows : When the buzzer contact is broken, the condenser C_1 is charged and this charge is retained until the contact is again closed, when the condenser discharges through the contact, producing oscillations in the circuit L_1C_1. As these oscillations take place in a closed metallic circuit, they are very feebly damped unless extra resistance is introduced at R.

All buzzers are not equally suited to producing oscillations by this method. In some, considerable adjustment of the contact is required before sharp tuning is obtained. The buzzer used in these experiments was of the 1905 United States Signal Corps type, and gave very satisfactory results with wave lengths varying between 350 and 2,000 metres. With some care in adjustment the wave length could be pushed up beyond 3,000. For telephonic reception of signals it was usually found necessary to cut down the intensity of oscillations from the buzzer, and this was done by placing an incandescent lamp across the buzzer contact. The chalcopyrite-zincite rectifier known as the perikon detector was used as a standard for the comparison of the various detectors. As its sensitiveness varies somewhat from time to time, it was standardised before each experiment in the following manner, the circuits being shown in Fig. 2. Here I is the buzzer circuit, II a circuit containing a thermoelement of known sensitiveness, and III the circuit consisting of the perikon D, its coupling inductance L_4, and a suitable stopping condenser K of about 0·04 mfd. With a given loose coupling between L_3 and L_4 the relation was noted between the reading of the galvanometer attached to the thermoelement and that attached to the perikon, the condition of wave-length and damping being kept constant. This relation gives at once the relative sensitiveness of the perikon.

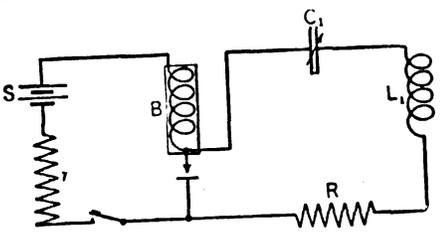

Fig. 1.

Two general methods have been used for measuring the sensitiveness for telephonic reception of radiotelegraphic receivers : First, the shunted telephone method in which the relative loudness of response to the same signal in two different receivers can be compared ; and, second, the variable coupling method by means of which the least audible signals for the different receivers can be compared.

Electrolytic Detector.—Comparison was made of the sensitiveness of the electrolytic detector and the perikon, using a wave length of approximately 900 metres and a decrement of the waves given out by the exciter circuit, amounting to 0·16. The values of the inductances and capacities of the circuits were so chosen that they simulated the conditions of commercial work. The perikon was used without external E.M.F. and also with about 0·2 volt applied in the direction of the rectification. Comparison was made by the shunted telephone method. Without external E.M.F. the perikon was found to be less than half (average 1/2·5) as sensitive as the electrolytic, but when 0·2 volt is applied the difference is very small, from 10 to 30 per cent in favour of the electrolytic. The electrolytic used was of the free-wire type and two positive Wollaston wires were used during the test, one 0·003 and one 0·0012 mm. in diameter. This was done because it has been frequently stated that the finer wire was more sensitive to weak signals. No marked difference between the two, however, could be detected.

A comparison of the galvanometer deflections with the thermoelement in circuit II and the intensity of signals in the electrolytic in circuit III, as measured by the shunted telephone method, showed that the responses of the electrolytic are proportional to the square of the oscillatory current.

Magnetic Detector.—The circuits for the comparison of the magnetic and perikon detectors are shown in Fig. 2. The magnetic detector was connected directly in circuit II, since it is usually used in the antenna. The magnetic detector employed was of the ordinary commercial type, the direct-current resistance of the oscillatory coil being 9·7 ohms and the telephone coil 120 ohms. For the comparison of sensitiveness the variable coupling method was used, the coupling L_1 and L_2 being changed until the signals became inaudible. When the readings on the magnetic were being taken the circuit containing the perikon was removed, then for the perikon readings the magnetic was cut out and the coupling L_3 L_4 regulated for maximum strength of signals. The relative strength of signals for the different degrees of coupling between L_1 and L_2 was determined by means of the deflection of a galvanometer attached to the perikon.

With waves from the buzzer circuit having a damping of 0·16 and a wave length of about 900 metres, it was found that the magnetic detector required 2·1 times as much energy to produce an audible sound as the perikon used without external E.M.F.

Further experiments showed that by putting a 0·05 mfd. condenser in series with the telephone of the magnetic, thus tuning it roughly to the rate of the buzzer, the loudness of signals could be increased so that there was very little difference between it and the perikon.

At a wave length of 3,000 metres the magnetic detector with tuned telephone was 1·5 times as sensitive as the perikon ; at 2,000 metres there was very little difference, whilst with waves of 350 metres the perikon was nearly five times as sensitive as the magnetic.

In order to explain these differences in relative sensitiveness, the logarithmic decrement of the circuit containing the magnetic detector was determined for various frequencies. The results indicated that the amount of iron and the number of turns of the oscillatory circuit of the magnetic detector should be varied according to the frequency for which it is to be used. The loudness of the signal in the telephone attached to the magnetic detector was found to be not proportional to the square of the oscillatory current, but more nearly to the 1·4 power.

Fleming Vacuum Valve Detector.—The detector tested was constructed with fixed coupling coils enclosed in its case, so that it was found impossible to test it fairly at any except very short wave-lengths without taking it completely to pieces. The circuits were arranged as shown in Fig. 2, the vacuum valve being coupled by its own coils to circuit II. At a wave length of 350 metres and with a decrement of the incoming signals of 0·16, the ratio of senstiveness of the perikon to that of the vacuum detector, as determined by the

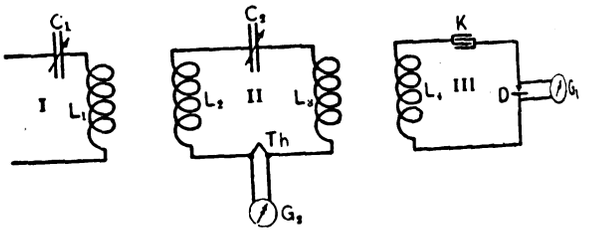

Fig. 2.

variable coupling method, was almost exactly two to one. For wave length of 900 metres the perikon appeared to be at least 1 times as sensitive as the vacuum valve. As there is no reason t believe that the vacuum detector would change its sensitiven with frequency, this difference is almost certainly due to insuffici coupling. The oscillatory energy in the main circuit was found to proportional to the audibility of signals in the telephone of vacuum detector.

The Audion.—The sensitiveness of the De Forest form of vacu detector, called by him the audion, was compared with that of t electrolytic already described by the varying coupling method. (Fig. 2.) The detectors were introduced alternately in circuit II and their most favourable conditions of coupling were determin separately. The audion, having a higher resistance, requires stronger coupling. The same telephones (1,200 ohms) were used both detectors, previous tests having shown that they were suited each. The energy sensitiveness of the audion was 1·5 times that the electrolytic. Some of the bulbs were slightly more sensit than this when first tried, but the sensibility decreased with use.

The law governing the relations between the intensity of the os lations and the loudness of response in the telephone, as determi by the shunted telephone method, seems to depend on the impres direct E.M.F. from the battery and also on the temperature of filament. For most adjustments the response of the telephon apparently nearly proportional to the square of the oscillatory curr

In addition to the above detectors, a very large number of ot types have been tested in the laboratory, including the tellur silicon and many crystal detectors. These are all of the rectify type and are remarkable in that when properly adjusted and with telephones of proper resistance, and in some cases with E.M.F. in the direction of the rectification, they all give practic the same sensibility as the perikon. The usefulness of severa these is, however, limited by the difficulty of adjustment and l of constancy. In most of these detectors the loudness of the sig increases nearly in proportion to the square of the oscillating curr although in some of them the increase in loudness is less rapid.

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CORRECTIONS FOR THE EFFECTS OF ATMOSPHERIC CONDITIONS ON PHOTOMETRIC FLAME STANDARDS.*

BY W. J. A. BUTTERFIELD, F.I.C., J. S. HALDANE, M.D., F.R.S., AND A. P. TROTTER, B.A.

Summary.—The authors describe apparatus which they have used for determining the effects of variation of pressure, degree of humidity and atmospheric vitiation on the candle-power of the Harcourt pentane and the Hefner amyl-acetate lamps. As a result of these experiments, curves are given which go to show in the case of the Hefner lamp that Liebenthal's formula for corrections for barometric height does not rest on acceptable data. In conclusion, general correction formulæ for both lamps are given.

The effects of variation of the pressure, degree of humidity and vitiation of the atmosphere on the luminous intensity of flames cannot be determined from the variations naturally occurring in an ordinary photometric testing room, except perhaps by deduction from the data obtained in a very prolonged series of observations made with exceptional care concurrently with extremely accurate determinations of the composition of the air. The investigation may, however, be carried out in a much shorter space of time and with greater trustworthiness if the observations are made in a room or chamber provided with means by which one set of conditions may be varied at will to any desired degree almost or wholly independently of the other two sets of conditions.

The effects of variations in the atmospheric pressure on the light afforded by the Harcourt 10-candle pentane lamp, and by the Hefner amyl-acetate lamp, were first studied. For this portion of the work, and for some of the later investigations also, use was made of a steel compression chamber, designed primarily for physiological research on "caisson" disease or diver's palsy and mountain sickness. This chamber, which had been presented to the Lister Institute of Preventive Medicine by Dr. Ludwig Mond, F.R.S., was kindly placed at the disposal of the authors by Dr. Martin, the director of that institute. It is a short boiler of $\frac{5}{8}$ in. (16 mm.) plate resting on its side; the ends are slightly dished steel plates $\frac{1}{2}$ in. (13 mm.) thick. Inside it measures $7\frac{1}{2}$ ft. (2·29 m.) in length by 7 ft. in diameter (2·13 m.) and has a capacity of 336 cubic ft. (9,500 l.). In one end is an elliptical manhole 24 in. by 15 in. (609 mm. by 381 mm.), the cover of which is secured by large bolts and can be readily fixed or removed from outside the chamber. In addition to four spring valves, the chamber is provided with three simple valves by means of which the pressure can be completely controlled either from inside or outside. The pressure is raised or reduced by a simple compressor driven by a gas engine, and it can be raised when required at the rate of about 2 lb. per sq. in. (about 0·133 kg. per sq. cm.) per min. The circulation of air maintained by the pump was sufficiently rapid to prevent serious vitiation of the air of the chamber when two observers were present in it. The Harcourt lamp, when used, was placed below a hood directly connected with the outlet air-way from the chamber, so that the greater part of the products of combustion of the pentane did not mix with the air in the chamber before they were extracted from it. The efficiency of the ventilation of the chamber was checked by a determination of the proportion of carbon dioxide in a sample of the air taken while each set of photometric observations was in progress. These determinations were made by means of the portable apparatus for the determination of carbon dioxide in air devised by J. S. Haldane (*vide* "Journal of Hygiene," 1901, I., 109). In the subsequent investigation of the effects of atmospheric vitiation on the light afforded by the Harcourt and Hefner lamps, the proportion of oxygen in the air was also determined by means of the portable form of gas analysis apparatus devised by J. S. Haldane ("Journal of Hygiene," 1906, VI., 74). When necessary an electric fan was used in the chamber to keep the air well mixed. The chamber was provided with electric light and electric heaters, and telephone communicating with the outside. There were small stout glass windows in the ends. Two benches were arranged in the chamber. On one of them the photometer, with an electric standard lamp and the flame standard, was set up, while the other was used for the air-analysis apparatus and accessories. The degree of humidity of the air was ascertained by means of an Assmann hygrometer (*vide* "Zeits. für Instrumentenkunde," 1892, XII., 1) which consists broadly of wet and dry bulb thermometers, over which a regulated current of air is drawn by means of a clockwork fan. A simple U mercury manometer, one limb of which communicated with outside, was used for measuring pressures above normal, and the pressures below normal were read on a standard mercury barometer inside the chamber.

A small electric lamp was used as a standard. It was mounted on a carriage guided by V notches. A rod attached to the carriage, as in the Gas Referees' photometer, was used to adjust the position of the lamp. A scale was carried on the rod, and an index was fixed to the photoped. The filament of the lamp was carefully set and this setting was inspected from time to time, but after about 20 sets of observations had been made it was found that the filament had warped, and that the warping was introducing an uncertainty of about 2 per cent. in the later sets of observations of the first series. An Osram lamp intended to give 10 c.p. at 10 volts was tried, and was supplied by six accumulators controlled by an adjustable resistance. But a comparison with the pentane lamp showed that the colours of the lights differed too widely to make accurate photometry possible until the light of the electric lamp had been reduced

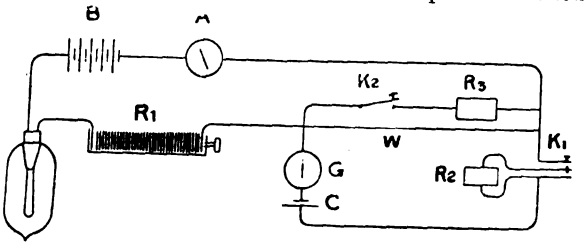

FIG. 1.—DIAGRAM OF ELECTRICAL ARRANGEMENTS.

to about 1 c.p. It was hoped that a metallic filament lamp thus used would have an enhanced "life," or, in other words, would vary less by ageing than if worked at 10 c.p. But the result was disappointing. It might have been better if the lamp had been worked at a constant pressure; but with the view of eliminating the effects of imperfect contacts, adjustment was made for working at a constant current. Another defect in the arrangement was the use of the electric lamp with the filament erect instead of hanging downwards. Notwithstanding the low candle-power at which it was worked, the filament warped as has been mentioned.

The arrangement used is shown in Fig. 1. The lamp L was supplied with current from the five-cell battery B, the circuit was completed through an adjustable rheostat of carbon plates, R, a manganin wire, W, of about 1·54 ohms resistance, and an ammeter, A. In parallel with the wire W, a circuit contained a reflecting galvanometer G, a Weston cadmium cell C, and a double key, K_1. A light pressure of this key completed the circuit through the high resistance R_2, which saved the cell from injury in case the lamp circuit was not completed. When an approximate adjustment of the current to 0·66 amp. had been made, the key was pressed hard down and kept closed. Another circuit contained a resistance of 1,000 ohms, R_3, and a key, K_2. When the current was adjusted and the galvano-

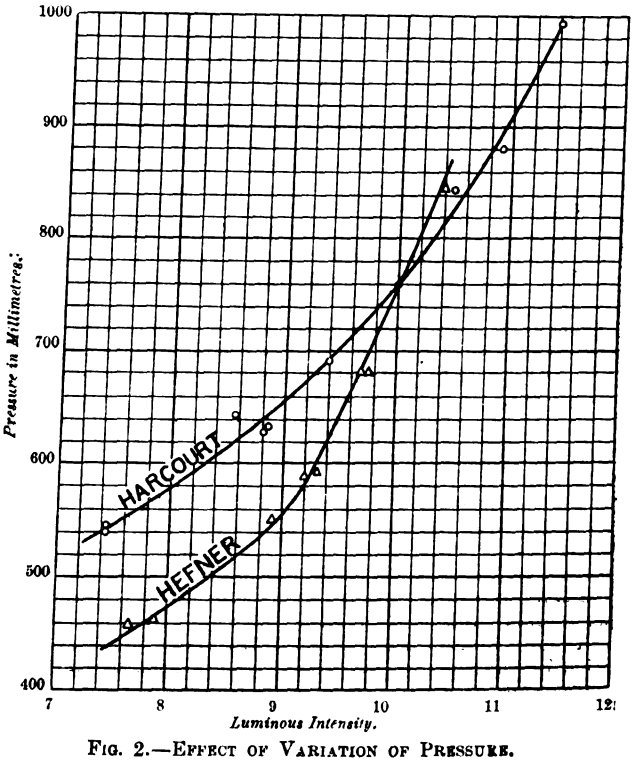

FIG. 2.—EFFECT OF VARIATION OF PRESSURE.

* Abstract of a Paper read at the meeting of the International Photometric Commission at Zürich, July, 1911.

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meter G indicated zero, closing K_2 gave a deflection corresponding to 0·35 per cent. difference of current. The current, as a rule, was kept steady within about one-tenth of this amount. In the second series of experiments, a large battery being available, a Fleming-Ediswan photometric lamp standard was used, giving 10 c.p. at 60·05 volts with 0·7577 amp. This gave no difficulty. The lamp holder was double-wired, and the volts were measured with a potentiometer.

The experiments made to determine the corrections for variations of atmospheric pressure were all carried out in the steel compression chamber described above. The range of variation of pressure for the observations was from about 450 mm. to 1,000 mm. (or from about 17¾ in. to 39½ in.). The results of the observations were ultimately corrected for the variations in the proportions of aqueous vapour and of carbon dioxide in the air (according to formula referred to later) and the corrected figures thus obtained were plotted and give the curves shown in Fig. 2. The curves show that the relation between atmospheric pressure and the yield of light is not constant or expressed by a straight line. The falling-off in the light with reduction of pressure is much greater at the lower than at the higher pressures.

The curve for the Harcourt lamp is, however, nearly a straight line for the range of 700 mm. to 850 mm., and shows that within these limits the light increases or decreases by 1 per cent. with an increase or decrease respectively in pressure of 12·5 mm. or that a variation of 10 mm. in pressure is attended by a variation in the same sense of 0·8 per cent. in the light afforded by the lamp. These figures agree exactly with the correction deduced by C. C. Paterson ("Journal" Inst. of Electrical Engineers, 1907, XXXVIII., p. 280), which may, therefore, be accepted as correct for variations of pressure at about the neighbourhood of normal. In regard, however, to the effect of variations of pressure elsewhere, the authors

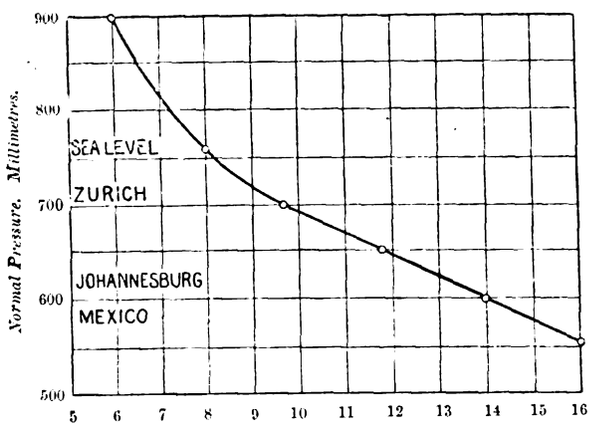

FIG. 3.—CURVE OF CORRECTION FACTOR.

have failed to find a rational equation to the pressure curve for the Harcourt lamp, and prefer to give the curve of the differential coefficient (shown in Fig. 3) rather than an empirical formula. By the use of this curve, the correction which should be applied to the Harcourt lamp for barometric variations at any place at which the mean barometric height is considerably below 760 mm. may be deduced.

The curve for the Hefner lamp is likewise nearly a straight line for the range of 700 mm. to 850 mm., and shows that within these limits the light increases or decreases by 1 per cent. with an increase or decrease respectively in pressure of 25 mm., or that a variation of 10 mm. in pressure is attended by a variation in the same sense of 0·4 per cent. in the light afforded by the lamp. These figures differ from the correction deduced by Liebenthal from observations of the variation of the light of the Hefner lamp caused by the natural fluctuations of the barometer between 735 mm. and 775 mm. Liebenthal has adopted a formula according to which a variation of 10 mm. in pressure is attended by a variation of only 0·1 per cent. in the light. ("Zeits. für Instrumentenkunde," 1895, XV., 157, and "Praktische Photometrie," p. 121.) Paterson mentions that he found for 10 mm. variation in pressure 0·2 per cent. variation in the light. The authors have therefore found that, about the neighbourhood of normal, variation of pressure has only half the effect on the light of the Hefner lamp which it has on that of the Harcourt; but, on the other hand, that it has on the Hefner lamp four times the effect shown by Liebenthal's formula, which has been very generally accepted. The facts that the effect of small barometric changes, such as Liebenthal had available, is small compared with the effect of the unavoidable changes in the proportions of aqueous vapour and carbon dioxide in the air, and that the proportion of the latter was not ascertained by Liebenthal, indicate that his formula for the corrections to be applied to the Hefner lamp for variations of barometric height does not rest on acceptable data. The authors ascertained the proportions both of aqueous vapour and carbon dioxide in the air during the observations, and applied corrections to eliminate their effects, while the greater range of barometric change which they had at their disposal reduced the effect of unavoidable errors of observation on the final result. For these reasons, they believe that their figure of 0·4 per cent. should now be accepted in preference to Liebenthal's 0·1 per cent. for the effect on the light of the Hefner lamp of a change of 10 mm. in barometric pressure in the neighbourhood of 760 mm. In regard to the effect of variations of pressure in other regions of the barometric scale, the curve found by the authors coincides fairly well with the results of observations made by Liebenthal in a pneumatic chamber, in which results, however, he appears to have placed but little reliance because of the presence of a number of disturbing factors.

The experiments made to determine the effect of variations in the humidity of the air on the light afforded by flames were carried out partly in the steel chamber already described and partly in a small room at the Electrical Standards Laboratory of the Board of Trade at No. 8, Richmond-terrace, Whitehall, London. This room was 4·03 m. (13 ft. 2¾ in.) long, 1·975 m. (6 ft. 5¾ in.) wide, and 2·45 m. (8 ft. ½ in.) high. There was no pump for renewing the air of this room, but a hood attached to a flue-pipe passing through the wall of the room was placed over the lamp, the heated products from which created a strong draught through the flue-pipe. The proportion of aqueous vapour in the air was increased as required by passing steam into the chamber or room from a small boiler placed outside it. A large range in the proportion of aqueous vapour in the air was secured by choosing dry, cold days, on which observations of the light of the lamps when the humidity was low could be made. The chamber or room having been heated by electric heaters, the air was then nearly saturated with steam at the high temperature. The range of humidity thus secured was from about 1 per cent. to over 4 per cent. by volume of aqueous vapour in the air. Sets of observations on the Harcourt lamp showed that a change in the temperature *per se* of the air from 8°C. to over 20°C. had no definite effect on the light afforded. The steam introduced was well disseminated in the air of the chamber or room by means of an electric fan. In one set of observations, greater initial dryness of the air was secured by exposing trays of granulated calcium chloride in the room for 12 hours, while circulation of the air over the trays was maintained by the fan. The results of observations were in all cases corrected for variations in the barometric height and in the proportion of carbon dioxide in the air. The results showed that the light of both the Harcourt and Hefner lamps decreases by 1 per cent. for an increase of 0·16 per cent. in the aqueous vapour in the air or that an increase of 1 per cent. in the aqueous vapour in the air is attended by a decrease of 6·25 per cent. in the light of the lamps. Liebenthal found 5·5 per cent. for both lamps ("Zeits. für Instrumentenkunde," 1895, XV., p. 157, and "Praktische Photometrie," pp. 118 and 128), while Paterson has found 6·6 per cent. for the Harcourt and 6·0 per cent. for the Hefner lamp ("Journal" Inst. Electrical Engineers, 1907, XXXVIII., pp. 276, 277) as the decrease in the light caused by 1 per cent. increase in the aqueous vapour in the air.

Experiments made to determine the effect of different degrees of vitiation of the atmosphere on the light afforded by flames were made on air vitiated, partially by breathing and partially by the combustion of pentane or illuminating gas. The ratio of carbon dioxide produced to oxygen consumed differs according to the composition of the fuel consumed, and the composition of vitiated air will therefore differ according as the vitiation arises wholly or mainly from breathing, from the combustion of a hydrocarbon body such as pentane, or of the mixture of a number of combustible gases, in which hydrogen predominates, which constitutes ordinary town illuminating gas. In the experiments made by the authors, the proportions of both carbon dioxide and oxygen in the vitiated air were determined by analysis, and the somewhat complex results obtained will be dealt with more fully in a subsequent communication. But taking the proportion of carbon dioxide in the air as the sole measure of vitiation caused partially by breathing, but mainly by combustion of paraffin hydrocarbons or town gas, it was found that 1 per cent. decrease in the light of the Harcourt lamp was caused when approximately 0·035 per cent. of carbon dioxide was present in the air, and in the light of the Hefner lamp with 0·04 per cent. Or the presence of 0·01 per cent. of carbon dioxide in the air was attended by a reduction of 0·29 per cent. in the light of the Harcourt, or of 0·22 per cent. in the light of the Hefner lamp. In the experiments on which these figures for the Harcourt lamp are

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based, the proportion of carbon dioxide in the air ranged from 0·09 per cent. to 2·54 per cent., and of oxygen from 20·80 per cent. to 17·40 per cent. With 2·54 per cent. of carbon dioxide and 17·40 per cent. of oxygen, the flame of the Harcourt lamp was blue and practically non-illuminating. The diminution in light is fairly uniformly proportional to the increase in the amount of carbon dioxide up to about 2 per cent. of the latter—*i.e.*, the curve given by the figures is nearly a straight line to that point. The experiments on the Hefner lamp were not made over so wide a range as those on the Harcourt lamp.

The corrections found for the Harcourt and Hefner lamps may be applied thus:—Let A be the accepted normal percentage of aqueous vapour in the air, C the accepted normal percentage of carbon dioxide in the air, P the accepted normal pressure of the air in millimetres, *a* the prevailing percentage of aqueous vapour in the air when the lamp is in use, *c* the prevailing percentage of carbon dioxide in the air when the lamp is in use, *p* the prevailing pressure of the air when the lamp is in use, then the actual light (I′) of the lamp at the time, expressed in terms of its light (I) in normal conditions will be found with sufficient accuracy for all practical purposes from the equations. For the Harcourt lamp:—

$$I' = \frac{100 - \left(\frac{a-A}{0{\cdot}16} + \frac{c-C}{0{\cdot}035} - \frac{p-P}{12{\cdot}5}\right)}{100} I.$$

For the Hefner lamp—

$$I' = \frac{100 - \left(\frac{a-A}{0{\cdot}16} + \frac{c-C}{0{\cdot}045} - \frac{p-P}{25{\cdot}0}\right)}{100} I.$$

The results obtained in the observations made on the flames of the No. 2 "Metropolitan" argand, and the Bray $\frac{\text{"C"}}{L}$ 5 ft. $\frac{15}{10}$" slit flat-flame gas burners, when consuming the gas supplied in Chelsea and Westminster by the Gas Light & Coke Co., and on the flame of the English Parliamentary standard spermaceti candle, must not be accepted as so trustworthy as those given for the Harcourt and Hefner lamps because they are based on fewer observations. These results are therefore given with reservation in the following tabular statement:—

	1 per cent. decrease of light is caused approximately by the following changes from normal:		Vitiation expressed by $\%CO_2$.
	Pressure.	Aqueous vapour.	
No. 2 Metropolitan argand gas	−2·5 mm.	+0·20 per cent.	+0·03 per cent.
Flat-flame gas	−5 mm.	+0·11 ,,	+0·035 ,,
Spermaceti Candle	−20 mm.	+0·50 ,,	+0·04 ,,

These results indicate that small variations in the atmospheric conditions of a gas-testing room will not appreciably affect the results of photometric comparisons in which the Harcourt or Hefner lamp is used as the standard of light, and that these standards will give as accurate results as are anyhow practically obtainable in determinations of the illuminating power of gas if they are used in all ordinary circumstances without correction for any divergence from normal atmospheric conditions. In other circumstances, however, as in the testing of electric lamps by a flame standard, corrections are called for.

THE EFFECT OF POWER FACTOR AND LOAD FACTOR IN ELECTRIC FURNACE WORK.

BY J. HÄRDÉN.

In addition to being affected by frequency the power factor of an induction furnace is also affected by the design, and may be improved by shortening the diameter of the secondary winding—*i.e.*, the melting chamber—as the space for the leakage field is thereby reduced. But apart from the danger of thinning the lining too much, this has not such a great effect as one might expect, as the resistance is thereby lowered, because of the shorter circumference of the ring. For this reason some inventors have patented hearths of strange shapes, forming an oblong loop, &c., but the practical man is generally content with the simplest shape—*i.e.*, the ring—in spite of all power factors. Shields for checking the leakage field are also being tried, but are generally found to be too complicated.

The simplest solution seems to be the combined or Roechling-Rodenhauser type of furnace, where the auxiliary secondary winding is in close proximity to the primary, thus effectively checking the stray field. This has enabled the furnace builder to design such furnaces in sizes up to 16 tons, while the plain induction furnace works best in capacities of 1 to 3 tons.

The metallurgist is more familiar with the term load factor than with power factor. The fluctuations of the load are particularly noticeable in the case of arc furnaces where the whole power is converted into heat by means of one or two arcs in series, playing between the steel and the electrode. Owing to the larger amount of power which has to pass over a distance of, say, 1 in. to 2 in., and confined to an area of 200 sq. in only, the gases in this space are highly superheated, and will therefore expand violently, acting, in fact, as a strong blowpipe. The result is that the slag is driven out from beneath the ends of the electrodes, leaving the metal bare. In consequence of the high temperature on these spots, a strong boiling action of the steel can be observed; the steel is strongly agitated and touches the electrode frequently, causing a momentary short-circuit, especially when charging cold material. The current will, therefore, fluctuate between 0 and 35 to 45 per cent. overload.

It will be of some interest to compare the effect of power factor and load factor upon the first cost of an installation of arc and induction furnaces and also upon the operating costs. Dealing first with the induction furnace and the lower power factor, *or else lower frequency*, for a furnace of, say, 5 tons capacity under extremely bad conditions, we find $\cos\phi = 0{\cdot}55$ at 10 cycles, and $\cos\phi = 0{\cdot}13$ at 50 cycles; and we shall assume that the practical rule is correct, which says that the weight of a generator for a given kilovolt-ampere output is in about inverse proportion to the speed and the square root of the frequency. In such a case, as O. Zander has suggested, it would be economical to compensate the power factor by operating synchronous motors for other purposes in parallel with the furnace generator. Under these conditions the weights (and thereby the costs) for the aggregates would be as follows:—

Assuming that "A" is the actual weight of a generator, built at 50 periods, and a power factor of $\cos\phi = 1$, then the weight X of other generators will be:—

1. For a generator for 10 periods and $\cos\phi = 0{\cdot}55$,

$$X = \sqrt{5} \cdot \frac{1}{0{\cdot}55} A = 4{\cdot}048 A.$$

2. For a generator at 10 cycles and $\cos\phi = 1$, together with one synchronous motor for 10 cycles and double the speed of the generator, the weight

$$X = \sqrt{5} \cdot A \cdot \frac{\sqrt{5} A 1{\cdot}52}{2} = 3{\cdot}94\ A.$$

3. For a generator at 50 cycles and $\cos\phi = 1$, together with one synchronous motor for 50 cycles and 10 times the speed, the weight

$$X = A \cdot \frac{17{\cdot}6\ A}{10} = 1{\cdot}76\ A.$$

The reduction of the weight may be even greater, because one can, as is well known, run a 50-cycle generator at a greater speed than one for 10 cycles. If the energy is supplied from a distributing system of 50 cycles only one high-speed synchronous motor is required instead of a heavier low-speed motor-generator, as is commonly used at the present time. As a rule, however, such extreme conditions need rarely be reverted to, as the Roechling-Rodenhauser furnace shows a much higher power factor.

To compare the actual prices of generators to suit normal conditions, the following quotations were obtained from one of the leading European electrical firms, viz.: The conditions were to operate either a Roechling-Rodenhauser furnace for 10 tons at 10 and at 25 cycles or an arc furnace of the same capacity. The prices were as follows:—

For Induction Furnaces.			
(*a*) One generator for 3,000 volts 25 cycles 1,000 kw. power factor 0·6	£1,900	0	0
(*b*) One generator for 3,000 volts 10 cycles, 1,000 kw. power factor 0·85	£2,280	0	0
For Arc Furnaces.			
(*c*) One generator, 3,000 volts 25 cycles 1,000 kw. power factor 0·85 to 0·09, provided with such arrangements as to suit arc furnace conditions (transformer not included)	£1,800	0	0

The difference in price for the arc furnace generator and that for the induction furnace generator is, as will be seen, only slight. If we consider that the induction furnace can be operated direct with high pressure up to 5,000 volts, while the arc furnace requires only about 100 volts, so that a transformer will be generally necessary, the difference in price will be even more insignificant, although it is true that the transformer is already built in, forming part of the induction furnace. Against this it must be remembered that the prime mover in the case of an arc furnace plain and simple must be far more substantially built, and therefore more expensive than for an induction furnace, in order to stand the sudden current fluctuations.

As to the cost of operation of both systems, it should be remembered that in the case of the induction furnace only the actual kilowatt-hours have to be paid for. It is true that a supply company will incur a somewhat higher charge for the current if the power factor is lower than 0·90, but as a "peaky" load will be charged for

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at a considerably higher rate than a steady load, the difference in running costs should not show much difference.

Conclusions.—Taking all the above statements into consideration, it is quite clear that from the electrical engineer's point of view, apart from the requirements of metallurgists, neither the induction furnace, as such, nor the plain arc furnace work under ideal conditions, the former because of its lower power factor and the latter for the reason of its unsteady load. Therefore, a furnace so designed as to combine the good features of both—*i.e.*, the higher power factor of the arc furnace and the high and steady load-factor of the induction furnace—would undoubtedly be very desirable, and it stands to reason that such a solution of the problem would be welcomed by the metallurgist as well, provided the design be simple and reliable. Then to convey all the energy of a large furnace, say, for 15 or 30 tons capacity, to the bath by means of electrodes only appears to be rather difficult if we consider that a 15-ton furnace for three-phase current requires electrodes about 26 in. square. Such electrodes are very difficult to obtain, and the maintenance of the roof is no easy task under such conditions.

Again, a combined furnace for 16 tons can be and, in fact, has been designed, but there are many metallurgists who maintain that a higher temperature should and must be applied from above the bath. Hence, a furnace showing the above-mentioned features certainly appears to be desirable. It may perhaps be of interest to mention that a furnace of this kind is now under design, but owing to pending patent applications the description of the same must be deferred to a later date. [Since writing the above these patents have been granted, and are embodied in the "Paragon" furnace referred to previously in this Paper, which furnace has been designed on the above principles by the author.]

THE CAUSES OF ZERO DISPLACEMENT AND DEFLECTION HYSTERESIS IN MOVING COIL GALVANOMETERS.*

BY ANTHONY ZELENY.

Summary.—In a moving coil galvanometer the displacement in the zero reading which takes place after a first deflection has generally been ascribed to a true set in the suspension fibre. The investigations here described prove this view to be erroneous and that practically the whole effect is due to the action of magnetic impurities within the coil.

Zero Displacement after a Deflection.—A galvanometer coil, G, was suspended within a wooden frame between the poles of a large electromagnet as shown in Fig. 1. If the zero displacement is due

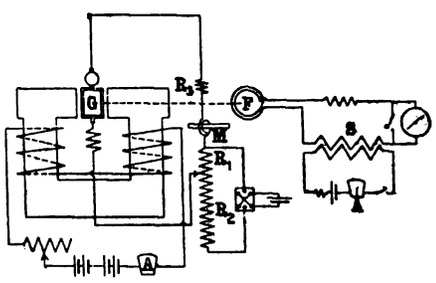

FIG. 1.

to a true set in the fibre its magnitude after reversed deflections of equal size would be independent of the intensity of the magnetic field, but if the effect is due to magnetic impurities within the coil the magnitude of the displacement would increase with the intensity of the field. The deflecting current was varied so as to produce the same deflection with each altered intensity of the field. In all cases the coil was made to move aperiodically to its deflected position as well as to its zero or null reading, in stronger fields by placing the proper resistance in R_3 of the galvanometer circuit and in weaker ones by induced currents from an accessory coil and magnet M. The intensity of the field was measured by jerking the test coil F through the field by means of a spring and comparing the ballistic galvanometer throws with those obtained from a standard inductance coil S. The test coil had the same area as the pole pieces and measured the intensity of the field in the immediate neighbourhood of the poles. The galvanometer coil G was at some distance from the poles, and the intensity of that part of the field containing it was obtained by multiplying the values given by the test coil by the approximate, experimentally determined factor 0·768.

The galvanometer coil was taken from a Leeds and Northrup galvanometer, and was the one of several tested that contained the smallest amount of magnetic impurities. The coil is a hollow rectangle, 2·05 by 5·1 cm., and has a mass of 6·66 gms. and a moment of inertia of 3·49 C.G.S. units. The upper suspensions employed were of phosphor-bronze strip and the lower suspension was an ordinary 1·5 mil phosphor-bronze strip spiral of 7·5 turns.

The observations for the zero displacement of the coil for any particular field intensity were taken at equal intervals of one minute, after several successive deflections alternating in direction. The zero displacement after the first reversal was always considerably larger than that observed after the following ones which gave nearly equal though consistently diminishing values. The displacement of the null reading in fields of different intensity, when using the 3 mil upper suspension and reversing the current from a deflection of 20 cm., is given in Curve A, Fig. 2, the displacement after the first reversal being discarded and the average of the following three taken. It is observed that in fields whose intensity is less than 100 the displacement curve is nearly horizontal, and the point where it cuts the axis of ordinates represents the amount of displacement due to a true set in the suspension fibre. This, however, is so small that under ordinary conditions of use it would rarely be observable. Under the conditions given, the true set in the fibre is represented by a displacement of 0·015 cm., while the zero displacement in a field whose intensity is 400, such as is common in ordinary galvanometers, is 0·26 cm. With this coil and suspension, less than 6 per cent. of the observed zero displacement in a galvanometer is due to a true set in the suspension fibre and more than 94 per cent. to the magnetic hysteresis within the coil.

With a 1·5 mil phosphor-bronze strip suspension the zero displacement, under the same conditions as above, gave in the weakest

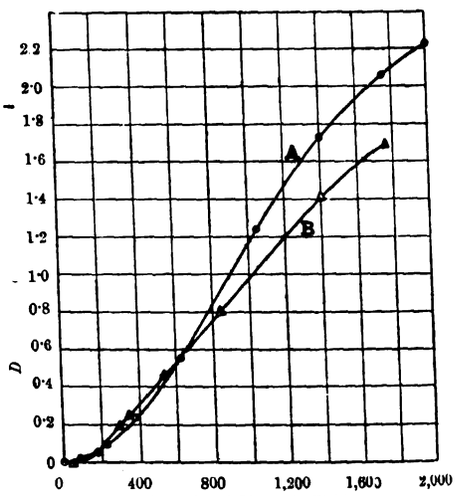

FIG. 2.

field a displacement not exceeding 0·005 cm., or one-third that obtained with the 3-mil strip. It is seen, therefore, that the larger zero displacement observed in galvanometers with the thinner suspensions is due entirely to the magnetic properties of the coil and not at all to a greater set in the fibre. The magnitude of the torsional moment of the suspension practically alone determines the amount of the zero displacement for the same alteration in the magnetic moment produced by the reversal.

The results of a set of observations taken with a 1·5 mil phosphor-bronze strip suspension are plotted in curve B of Fig. 2. In this case the reversals were taken from a deflection of 15 cm. in place of 20; and the distance of the scale was 125 cm. in place of 54·5 cm. for Curve A. The zero displacement in the weakest field was too small to be observable, and, therefore, no appreciable set existed in the suspension fibre in any of the displacements observed.

The magnetic moment due to the magnetism in the galvanometer coils was found to differ considerably, even in instruments of the same type and manufacture, varying from 0·129 to 0·217 C.G.S. units.

Deflection Hysteresis.—In a former Paper* on "Precision Measurements with the Moving Coil Galvanometer," the writer observed that deflections of different magnitude were obtained with the same current, depending on whether they reached their value from a larger or a smaller one. This was explained as due to a change in the intensity or direction of magnetisation of the impurities within the coil. In order to account for the observed changes, it was necessary to assume that the coercive power of the magnetic impurities was very large. To prove, experimentally, that this is so, the

* Abstract of an article in the "Physical Review."

* Physical Review," Vol. XXIII., p. 401, 1906.

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values of M/T (M=magnetic moment due to action of field on impurities, less diamagnetic effect on copper; and T=torsional moment) were now obtained in various fields with the intensity increasing to a maximum and then decreasing. The hysteresis curve obtained, when using a 3 mil suspension fibre, is plotted in Fig. 3. The coercive power is found to be sufficient to account for the observed deflection hysteresis. It will be seen, also, that the upper bends in the curve begin, as should be the case, in a field of the same intensity as the upper bends of the zero displacement curves in Fig. 2. These bends occur in a field whose intensity is more than 200 times that which produces the same effect in the case of iron. The stray magnetism was found to have no appreciable effect upon the torsional moment of the suspension fibre.

An investigation of the change in the damping factor with the intensity of the field showed that in field intensities of 400, common to galvanometers, when the coil is on open circuit, the damping due to the induced currents is less than 50 per cent. of that due to the resistance of the air and the internal friction of the fibre, or only about one-third of the total.

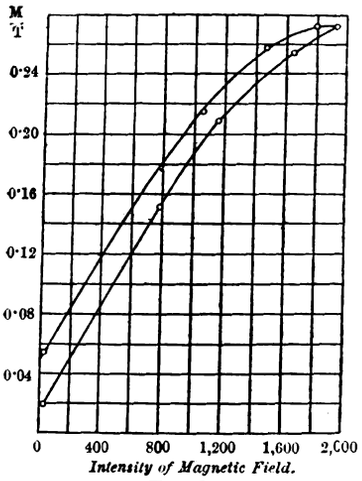

FIG. 3.

The sensibility of the galvanometer formed by the electromagnet and the coil was found, as expected, to increase at a smaller rate than the intensity of the field. The current for 1 mm. deflection being $1{\cdot}53\times10^{-8}$, $0{\cdot}84\times10^{-8}$ and $0{\cdot}7\times10^{-8}$ for fields of intensity 445, 932 and 1,315 respectively.

AN IMPROVED TRAMCAR LIFEGUARD.

The proper design of devices for protecting people who may fall in front of trams from serious injury is a question highly deserving of attention by tramway managers. However careful a foot passenger

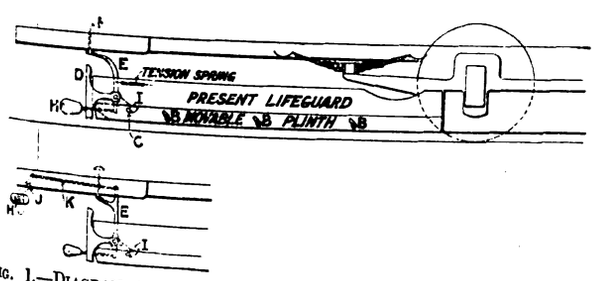

FIG. 1.—DIAGRAM SHOWING THE IMPROVED LIFEGUARD FITTED TO A TRAMCAR.

may be in crossing the streets of a crowded town (and he does not generally err unduly in this respect), or however attentive the driver may be, collisions are sometimes inevitable. This being the case, it is necessary that some guard should be provided to prevent the unfortunate person who is knocked down from being enmeshed in the wheels, not only for his own sake, but because such a catastrophe must necessarily lead to traffic delays.

Many excellent arrangements have been designed with this end in view, and by the Board of Trade regulations some such device must be carried on every car. The plough lifeguard has been associated with the Liverpool tramways for some years, and it has been found satisfactory. With the idea of making it more perfect Mr. C. W. Mallins, general manager of the Liverpool Corporation Tramways, has designed an attachment which he hopes will have the effect of still further reducing the number of fatal accidents. Its object is to close the space that at present exists between the plough and the ground.

This device, which is illustrated in Fig. 1, consists essentially of two movable plinths which are attached by screws and studs, B, to each side of the plough lifeguard. These studs are free to move in slots cut in the plinth. The plinths are held in their normal out-of-action position—that is, with the studs at the bottom of the slots—by means of the lever E. This lever turns round a pivot which carries the nose, D, that holds up the plinths. It has three arms. The first is hooked at its extremity so as to form a catch which engages with the cross stay, C, connecting the plinths. The second lever, E, mentioned above, releases this catch when necessary, being operated by a foot-punch, F, on the driver's platform. On depressing this punch the catch, I, is raised and the plinths and nose fall to the ground, the studs, B, rising to the top of the slot. When the pressure is released the lever is returned to its normal position by a spring. The third lever abuts against the stem of the radial buffer, H, on the front of the car, so that when any obstruction strikes the latter the catch is released and the plinths are allowed to fall, thus closing the aperture between the plough and the ground. The plinths can alternatively be released by means of a Bowden wire leading down from the controller top. By threading the shank of the arm, I, and making it adjustable, the distance between the lower edge of the plinths when in upper position and the ground can be kept constant as the wheels wear away. The lower edges of the plinths are provided with rubber belting or piping which takes up the shock. We understand that experiments made with a dummy on this arrangement have given the highest satisfaction.

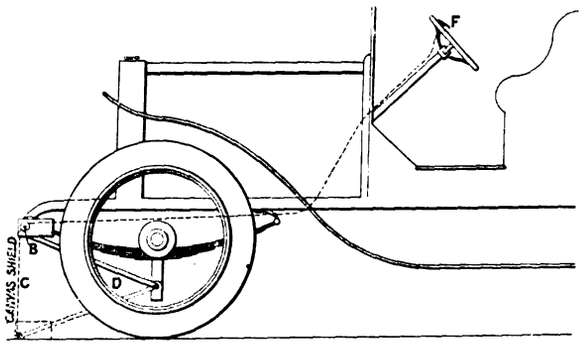

FIG. 2.—THE LIFEGUARD FITTED TO A MOTOR 'BUS.

The same idea has also been applied to motor omnibuses (*see* Fig. 2). A light angle iron frame slightly curved at the extremities, is mounted on the dummy iron. Attached by spring eye-bolts fixed to the underside of this frame by short brackets is a steel spring roller, B, carrying a strong canvas shade (or shield), C, the lower edge of which is fastened to an angle-iron frame similar to the first. The arms D are attached at one end to the lower frame and at the other to the axle-tree, and take the thrust when the guard is in operation; a locking catch holds the lower frame up in position, and is released by means of a Bowden control operated from the steering wheel. In operation the driver depresses the thumb lever, F, which draws back a catch, and allows the lower frame to fall to the ground, and in so doing unwinds the shade, or shield, from the roller, thus preventing any injury to the person in front of the car. This device has been applied to the motor omnibuses running to Woolton, which hitherto have carried no such safeguard. A similar arrangement would not be out of place in London.

COLLIERY POWER PLANT: A COMPARISON OF GAS AND EXHAUST STEAM.*

BY JOHN BURNS.

All collieries require a convenient, economical, and reliable supply of power. The following classification will be found useful in dividing up the subject into groups:—(1) Collieries with uneconomical steam-plant, (2) Collieries with steam-plant running fairly economically. (3) Collieries equipped with coke-oven plant, where a large supply of waste-gas is available, and (4) new collieries.

It is only possible here to consider groups (1), (2) and (3), but there

* Abstract of a Paper read before the South Staffordshire and Warwickshire Institute of Mining Engineers. Abstracted by permission of the Council of the Institution of Mining Engineers from the "Transactions," Vol. XLI., p. 24.

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is one point in connection with new collieries which must not be passed over. A clear line of demarcation should be drawn between new collieries to be run in conjunction with existing pits and those which are independent. In the first case, it will probably be found that a combined plant offers the best solution, the existing steam-plant being modernised at the existing pits, and the excess power transmitted electrically to the new pit.

When collieries are working with uneconomical steam-plant, there are two questions to be considered, the first involving the scrapping of the whole plant. This is seldom possible, and circumstances, financial or otherwise, will in general prevent a wholesale scrapping policy, although there are certain cases where this would doubtless be the most far-sighted plan. The second alternative is to make the best possible use of existing plant. It is assumed that no modification of the plant is possible, and that it is too valuable to be scrapped. All the steam used will be available for driving a low-pressure turbine, and, the amount of steam being considerable, a large amount of power will be obtained. This plan has the obvious objection that the main engines become practically exhaust steam producers, and the "superior person" condemns the arrangement outright by comparing these engines to steam-pipes, which only incidentally produce a small amount of power! This is an extreme view, for there are many cases where a large saving results at a comparatively small capital cost. On the other hand, there are very few winding-engines which cannot be converted into economical machines by the addition of expansion gear. This seems a most obvious improvement, and it is only necessary to refer to an entropy diagram to see the difference in actual work produced under the two conditions. It is a noteworthy fact that there are thousands of engines in this country running without this comparatively inexpensive addition, and in most cases these engines use 100 per cent. more steam than is necessary.

There are many types of gear which can be added to existing engines, and one of the simplest is the Melling automatic cut-off gear, as fitted to the winding-engines at Littleton Colliery. With this gear there is no interference with the full steam-supply at the beginning and end of the wind. The centrifugal governor acts directly on the expansion-valves, and the action is dependent on a continuous increase of speed, which gradually alters the point of cut-off so as to reduce the steam admission. When the steam is shut off towards the end of the wind, the governor closes and the expansion-valve is practically put out of action, leaving full steam available for decking, &c., through the main steam-valves only.

Another method which has been tried for improving the economy of winders is the addition of condensing plant. This method is at best unsatisfactory, and colliery engineers are practically unanimous in opposing the use of condensing plant for this purpose. A winding-engine must be absolutely under control, and every additional item of plant introduces a further element of risk. The reduction in steam-consumption also will not exceed 10 per cent. in actual practice, although theoretically it ought to be from 15 to 20 per cent. This is due chiefly to the very irregular rate at which the steam is delivered to the condenser. The most obvious improvement on this method is to interpose an accumulator and a low-pressure turbine between the engines and the condensing plant. The condenser will be very much smaller, as the steam will now be passed through the turbine continuously, and it will work at its highest efficiency. The winding-engines, having been altered to give a fair economy, are practically in the same condition as the second group, and these can be considered together. The steam is being exhausted to the atmosphere, and is still capable of performing work in a low-pressure turbine. This amount of work is worth obtaining, although probably it will be only one-half of the amount obtainable in the first group of collieries.

Littleton may be taken as an example where a moderate estimate shows that an output of 300 kw. can be obtained from the steam exhausted by the two winders and the fan engine. This would cause no alteration in the conditions under which these engines are now running. As this figure is based on a very safe estimate, the actual output would very probably be 350 kw., or even more, and this output would assist very materially the power-supply which is normally required. Additional boilers would not be required, for the existing boilers would give considerably more than 300 kw. when the steam was supplied direct to the turbine when the winders were not running. Had the winders been running without expansion-gear, the power obtainable from the exhaust-steam would have been from 600 to 750 kw.; but this means that the winding-engines would not have been working under the best possible conditions.

If the high-pressure steam is required for long periods, it may be advisable to instal a mixed-pressure turbine which will utilise equally economically either high-pressure or low-pressure steam. The following is a typical case which is now under consideration: The colliery is of average size, with two winders and a large fan-engine. For haulages, screens, &c., which are all steam driven, about 15,000 lb. of steam per hour are required. The winders and fan take 30,000 lb., which will give 750 kw. in a low-pressure turbine. Electric driving for all the auxiliary plant will not take more than 500 kw., so that there is a clear gain of 250 kw. for coal-cutting and other work, in addition to a reduction of at least 15,000 lb. of steam per hour. This last item alone gives a saving of £300 per annum for 300 days of only 8 hours each, taking the cost of coal at 2s. 6d. per ton. Owing to special causes which cannot be discussed here, many collieries are unable to apply electric power, and it is necessary to fall back upon compressed air as the transmitting medium. Now in these cases a large proportion of the supply can be obtained by means of a turbo-compressor, driven by exhaust-steam collected from existing engines. If this steam is neglected, these engines continue to run as at present, while additional boiler-plant must be installed to supply steam for new high-pressure steam-driven compressors.

As regards collieries equipped with coke-oven plant, a different problem has to be solved. In general, it will be found that all the power required can be obtained from the steam exhausted by the existing engines, supplemented by steam from boilers fired with the coke-oven gas. Where a large supply of waste gas is available, and only a limited amount of power can be utilised, it is obviously better to instal steam plant of comparatively low efficiency. The gas-engines will have a much higher thermal efficiency, but the capital cost and upkeep will also be high, and will go far to counterbalance the efficiency. Attendance and other charges will all be in favour of the steam plant. On the other hand, where a large demand for power exists either for outside consumers or for other pits, a large gas plant driven by coke-oven gas presents many advantages; and it is only necessary to refer to the large plant of this type now running in South Wales. The total power of this plant is about 6,000 kw., but the problem is very different, owing to the continuous running and the good load-factor, both of which conditions are absent in the average colliery plant.

It will be appropriate here to consider the relation of the different parts of the plant. In the case of steam plant, the winder, the fan, and the power turbine are all in direct connection with the steam-producer, the turbine being also designed to take steam from the winder when this engine is working. In the case of gas plant, while the auxiliary plant is in the same relation to the gas-producer, the winder and the fan have also been moved down to the same position, and, if a balancer-motor is required for the winder, it is moved down one stage farther. Instead, therefore, of being in direct connection with the producer, the winder has two, and possibly three, additional links with the power-producer, both of which introduce additional risks.

The chief argument against a gas plant for collieries is that it makes electrical winding practically compulsory. It has not yet been suggested that winders should be driven direct by gas-engines, and if a steam-driven winder, with gas for the supplementary plant, be adopted, the complication of two systems is introduced, of neither of which is taken complete advantage. Electric winding is now on its trial, and it is only necessary to refer members to the recent discussion at Newcastle-upon-Tyne.* Mr. Mountain has demonstrated the excessive expenditure both in capital and on running charges of the complete electrical plant as against steam winding, the exhaust being utilised in turbines. These remarks are not intended to imply a general objection to electrical winding. The writer has in mind at least two cases—one in South Wales and the other in Yorkshire—where new pits are being entirely driven by electricity. The power is being transmitted from older pits, in which the surface plant and winders are steam driven. In addition to the supply of a large amount of electric power on the spot, there is a large surplus which will be used at the new pits. At one of these there will not be a single boiler. This appears to the writer a most convincing argument in favour of using exhaust steam wherever it is available.

It is obvious also that very few collieries are prepared to scrap existing plant, and, if they decide to do so, it is necessary to compare modern steam winders with modern gas plant and electric winders and the simplicity of operation of the steam winder will in most cases be the deciding factor. Old steam winders are notoriously uneconomical, but many of these could have their useful life extended, and their steam consumption reduced to a reasonable figure, by the addition of an inexpensive automatic cut-off and expansion gear.

In conclusion, the writer thinks it necessary to add a word of warning. He has discussed the subject with many colliery men, and their unanimous opinion demands simplicity—not only simple plant requiring comparatively little in the way of repairs, but,

* *See* "Trans." Inst.M.E., 1910, Vol. XL., p. 307.

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above all, simplicity of operation. The writer contends, therefore, that the maximum of simplicity with economy is obtained in the average colliery by improving the steam conditions of the winders, and utilising their exhaust to drive a low-pressure turbine. These plants are absolutely independent of each other. The winders are under the absolute control of the drivers, and are run under exactly the same conditions whether the turbine is running or not. The power supplied by the turbo-plant, whether the transmission medium be electricity or compressed air, will drive all the underground plant in addition to the outlying plant on the surface; and, finally, the turbines use all the low-pressure steam available to its utmost advantage, and automatically use only sufficient extra high-pressure steam required to make up the exact output.

DISCUSSION.

Mr. A. McKINSTRY (Trafford Park, Manchester) said he was disappointed that Mr. Burns had not gone into the question of the cost of power as produced by the plant which he had described. After all, assuming that the different plants were equally reliable and equally simple, the average colliery owner and colliery engineer would want to know what the power would cost. He agreed with Mr. Burns that each case must be treated on its merits in deciding which plant would be most suitable, and he would not take up the attitude that gas-plants were the most suitable in every case for colliery work; but he was prepared to offer some justification for the installation of the gas plant at Littleton, because, so far as he had been able to obtain figures, the plant was producing power as economically as it was guaranteed to do, and under such conditions certainly justified its introduction from the point of view of power-production cost. With regard to simplicity, in the gas-producer itself there was no moving part, except a steam blower. Coming to the engines themselves, members could form their own conclusions as to their simplicity. The auxiliary gear—namely, the small battery and charging outfit for the ignition and the motor-driven compressor with air-tanks for providing compressed air for starting—was much simpler than the auxiliary apparatus connected with an exhaust steam installation. Mr. Burns had suggested that it might have been possible at Littleton to put down exhaust-steam turbines, and so utilise the powers of the exhaust steam from the various steam-engines. He (Mr. McKinstry) was personally not in a position to speak with regard to the amount of steam-plant in detail that was at Littleton, but no doubt the amount of exhaust steam available, the facility for collecting this at one central point, the question of condensing water, the cost of proper steam accumulators, and the capital cost were all taken into consideration by the Littleton authorities before issuing the specifications calling for a gas plant.

Mr. J. BRINDLEY (Wolverhampton) said that the gas plant at Littleton impressed him as being an uneconomical plant. He was sorry that none of the gentlemen who had spoken that day had given them any figures. They had no definite facts, for instance, with regard to fuel consumption, which, of course, was the main point. He did not doubt for one moment the reliability of the plant, but he did not think that it was an economical plant, and the only remark in its favour which he had heard that day was that it had been put in where there was no great amount of water available for condensing purposes.

Mr. JOHN BURNS (Rugby) replied that he was afraid it was almost impossible at short notice to give the figures that had been asked for. It was almost impossible to obtain figures with regard to working costs. The matter of capital cost was another question. At present the average market value for plant of all kinds was remarkably low. Therefore, he thought that figures based on present data would also be rather misleading. That was a point worthy of remembrance in considering the capital cost of installations.

PARLIAMENTARY INTELLIGENCE.

GLASGOW CORPORATION TELEPHONE STAFF.

In the House of Commons on Thursday last week Mr. SCOTT asked the Postmaster-General whether he would consider the desirability of extending to ex-members of the Glasgow Corporation local telephone staff now in his employ concessions with regard to the reckoning of service with the Corporation for purposes of annual leave, sick pay, pension, gratuity and superannuation similar to the concessions proposed to be granted to ex-employés of the National Telephone Co. in connection with the Telephone Transfer Bill.

Mr. SAMUEL said the telephone staff of Glasgow Corporation had been in a better position than the staff of the National Company, seeing that after a comparatively short period of employment under the Corporation on telephone duties they were taken into the service of the State more than five years before the transfer of the company's staff. He did not consider they had any claim to participate in the special arrangements made for the company's staff.

Mr. WATT also asked the Postmaster-General whether on the transfer of the Glasgow Corporation telephones to the Post Office, an assurance was given to the staff that their conditions of employment would not be less favourable than those employed under the Corporation.

Mr. H. SAMUEL said that the assurance was given, and there was no intention of departing from it. The great majority of the officers in question had received established appointments, and the increments of their class were being paid as they accrued. Two of the three officers whose cases were then under consideration had since been classed as unestablished with a scale of pay and conditions of employment which, taken altogether, were not less favourable than those they enjoyed under the Corporation. The case of the third who refused an established appointment was still engaging his attention.

TRAMCAR SPEED INDICATORS.

In the House of Commons last week Mr. WATT asked the President of the Board of Trade whether the regulation which required a speed indicator to be fitted on every car had ever been put in force by his Department; and, if not, would he say how he could ensure that the maximum speed of 16 miles per hour allowed the tramcars in Glasgow was not often exceeded, especially as the Corporation encouraged motor cars in their streets at 20 miles an hour.

Mr. BUXTON said the regulation required that a speed-indicating apparatus should be fitted to the cars if and when required by the Board of Trade. The Glasgow Corporation had not been required to fit such an appliance owing to the difficulty of procuring a reliable apparatus and the cost thereof, but he understood that improvements in speed indicators have been made, and the Board had recently suggested to tramway authorities that indicators should be fitted to a certain number of their cars for educating motormen in estimating speeds. The responsibility for seeing that the speed limits in Glasgow were observed by the motormen rested with the Corporation, and no complaints had been received by the Board that those limits were exceeded.

TEMPORARY BORROWING BY MUNICIPALITIES.

The Municipal Corporations (Temporary Borrowing) Bill, which has been introduced into the House of Commons by Mr. Harmood-Banner, is promoted by the Association of Municipal Corporations, and seeks to enable corporations to make temporary borrowings from their bankers or other persons pending the receipt of rates and other income.

Electricity in Mines.—In the House of Commons on Wednesday, Mr. SUTTON asked the Home Secretary whether, in view of the statement of the Committee on the use of electricity in mines that almost every electrical accident was preventible, and in view of the badly constructed or badly maintained apparatus in the mines, he would consider the appointment of an adequate number of competent electrical inspectors.

In reply, Mr. Churchill said he was aware of the statement by the Home Office Committee referred to in the question. The responsibility for the provision of electrical apparatus of proper type and its maintenance in a safe condition rested primarily with the management of the mine, and the new rules which the Committee had recommended, and which he was taking steps to bring into force, proposed further and more stringent requirements to ensure safety of construction and maintenance in the case of the electrical plant used in mines. It would be the duty of the inspectors to see that those requirements were carried out, and adequate provision had already been made for the purpose. An electrical inspector of mines was appointed in 1908, whose whole time was given to that work. Many of the other inspectors had the necessary electrical knowledge, and the possession of such knowledge had for some years been a condition of the appointment of all new inspectors, and, as he had already informed the House, a large increase of the inspectorate had recently been sanctioned.

Telephone Rating.—In the House of Commons last week Sir C. Kinloch-Cooke asked the Postmaster-General whether, since the Telephone Transfer Bill contained no provisions as to rating of the telephone undertaking after it has been transferred to the Government, it was the intention of the Government to make a contribution in lieu of rates to the local authorities upon the part of the undertaking other than buildings occupied by the Crown; and whether provision would be made in the bill to obviate, in the case of telephones, the effect of sec. 22 of the Telegraph Act, 1868, which had prevented the telegraph undertaking being re-assessed since the passing of that Act.

In reply, Mr. Samuel said the question was under consideration. No legislative powers were necessary in any case. The section of the Telegraph Act, 1868, quoted had no application in the present instance.

Coal Mines Bill.—The Committee stage of this bill was concluded on Wednesday.

LEGAL INTELLIGENCE.

Damage Caused by Animals on Tramcars.

At Westminster County Court on Friday last Judge Woodfall delivered judgment in an action by a Mrs. Wright against the London United Tramways (Ltd.) for £3. 19s. 6d., the value of a dress said to have been ruined through a dog tearing it when she was travelling on one of defendant company's cars, and said the question was whether a tramway company was entitled to carry dogs on their cars without taking the risk of such injuries as might be caused to passengers through the behaviour of the dogs. The duty of carriers of passengers was to use all reasonable care, skill and diligence in and about their conveyance. This duty was not limited to providing a vehicle safe and proper for the journey, but involved an obligation to use reasonable care to prevent the intrusion on the vehicle of persons, animals and things who or which might be a cause of danger or damage to passengers. In that case the tramway company, through their conductor, knowingly permitted a dog to be at large on the car. The animal caused damage to plaintiff, and he was of opinion that the company was liable for the breach of their duty to her as their passenger, and that the company's bye-laws supported that conclusion. There must be judgment for plaintiff for the amount claimed, with cost.

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COMMERCIAL AND INDUSTRIAL SECTION.

MUNICIPAL, FOREIGN & GENERAL NOTES.

BRITISH NOTES.

Aberdeen.—At the Corporation meeting on Monday Mr. Young, convener of the Tramways Committee, submitted the tramway accounts for the past year.

The total revenue was £73,470, an increase over the previous year of £2,348, and a record. The outstanding feature of the year's work was that the income per car-mile had increased from 10·77d. to 10·89d., notwithstanding that they had run 34,000 car-miles extra, and that the working expenses had been reduced from 6·13d. to 5·88d. per car-mile. The accounts were adopted.

Aldershot.—The Council have obtained sanction to a loan of £2,500 for additional generating plant.

Barking.—In a recent report on the electricity undertaking the consulting engineers (Messrs. Robt. Hammond & Son) stated that they were satisfied that an extension of the generating works was essential.

Messrs. Hammond & Son also stated that they had carefully considered Mr. H. Howard's scheme for the extension of the works, and agreed with his proposal to instal a 400 kw. Diesel engine and generator. They were of opinion that the purchase of the auxiliary plant proposed by Mr. Howard was an integral part of the scheme, and that its omission would prejudicially affect the financial results of the extensions. The cost of buildings could be reduced by a modification of the design. They had also come to the conclusion that the installation of Diesel plant would have a favourable effect upon the financial results of the undertaking.

Further consideration of the matter is postponed to enable the clerk to communicate with the firms mentioned in the report.

Barrow-in-Furness.—The tramway extension to Biggar Bank, Walney Island, was opened for traffic on Friday.

Bispham.—The Council have been authorised to borrow £10,800 for carrying out their electricity supply scheme.

Briton Ferry.—The Council have applied for sanction to a loan of £1,200 for extensions of the electricity works.

Burnley.—The Council have received sanction to a loan of £8,552 for extensions of the generating plant, but £471 was deducted for superseded plant.

The Board of Trade recently recommended the trial of speed indicators on the tramcars. The tramways manager (Mr. H. Mozley) has reported on the matter, and the Tramways Committee have informed the Board that when a speed indicator is made satisfactory for bogie cars the Corporation will consider the advisability of adopting it.

Calorific Tests of Fuel.—We have received a letter from Mr. John B. C. Kershaw, in which he calls attention to the unsatisfactory nature of Berthier's test (referred to at the recent Convention of the Incorporated Municipal Electrical Association). In regard to this test, Poole in his book on "The Calorific Power of Fuels," states that The formula is faulty, as was shown by some of Berthier's own determinations in which contradictory results were obtained. Dr. Ure showed that no uniform results could be obtained using the same materials. Scheurer-Kestner in 1892 showed that the formula not only gave erroneous results, but actually reversed the relation of the combustibles. In one case cited the heats actually obtained by a calorimeter were 8,813 and 8,750, while by the litharge test they were 7,547 and 7,977. The results were not only low, but reversed the ratio.

Customs Duties.—According to recent decisions, the import duty on illumination devices (gas or electric) imported into British South Africa is 3 per cent., and on Stolz electrophones 15 per cent. ad val., the rebate on British goods being 3 per cent. in both cases.

Dublin.—The L.G. Board have now sanctioned the borrowing of £100,000 (including £50,000 already sanctioned) for the electricity supply department, but the Board are of opinion that it is desirable before sanction to borrowing beyond that amount is given, a clear statement of expenditure and definite proposals, supported by plans, specifications and estimates, for any further works should be submitted. The Corporation had applied for authority to borrow £158,817.

Egham.—The Board of Trade have granted the application of the Egham & District Electric Light Co. for the erection of a generating station at Egham Causeway.

Electric Pumping.—At the meeting of J. Grayson Lowood & Co. last week the chairman (Mr. C. B. Stuart-Wortley, M.P.) said they had made considerable headway towards a better state of working conditions in the Deepcar mine, a change having been made in the pumping plant from steam to electricity. The new electric pumping plant was got to work a few days before Christmas, and had rendered excellent service since. Therefore, they confidently believed that the difficulty caused by inrushes of water into the mine had been surmounted at least for many years to come, without any further likelihood of heavy expenditure, except that they purposed duplicating the motive power at an opportune time. The working conditions in the mine would be improved by the change, and the directors anticipated a considerable saving in the cost of pumping.

Epsom.—Last week the Council considered a report by the resident electrical engineer (Mr. A. E. Gilling) on the advantages of installing a Diesel engine at the electricity works.

Mr. GILLING stated that with the Diesel engine there were no stand-by losses, whilst it was considerably more efficient at light loads. The engine consumed the cheapest class of liquid fuel—viz., petroleum residue—the average cost of which was about 2d. per gallon. By installing a Diesel engine they would have extra plant to cope with increased demands in future. The Diesel set, being a self-contained producer of power, would be entirely independent of the present plant, and would give further valuable safeguards against interruptions of supply, and the total cost of production would be reduced. The present steam costs for generating 250,000 units were £888. 19s. 2d.; similar cost by Diesel engine would be £245. 4s. 2d., showing a saving of £643. 15s. The attendance required for a Diesel engine was considerably less than that required for a steam plant, and although perhaps they might make some saving under that heading, it was not advisable seriously to diminish the present small staff. The capital costs were estimated at £3,500, including £3,100 for the Diesel engine and generator. The result would be reduction in works costs £639. 15s., less extra capital charges (interest and repayment of capital) £350, net saving £289. 15s.

The Electricity Committee recommended that an electrical expert be appointed to advise on Mr. Gilling's scheme at a fee not to exceed £5. The Committee also complimented Mr. Gilling on the financial and technical success of the undertaking since his appointment as resident engineer, and recommended that the annual increment of £10 (fixed on July 1, 1909) be increased to £20 as from Aug. 15, 1911, until the maximum of £250 was reached.

Consideration of the Extension Scheme was adjourned till after the holidays.

Finchley (Middlesex).—The Council have retained counsel to represent them in their appeal against the increase in the assessment of their electricity works from £400 to £1,800.

Grimsby.—The borough electrical engineer (Mr. W. A. Vignoles) is preparing a specification for the electric lighting of the new lending library, and he is also preparing to report upon a proposal to reduce the charge for electricity to private consumers from 3½d. to 3d. per unit.

Hastings.—The Council have decided not to entertain the petition, signed by 4,225 residents, in favour of the substitution of overhead for surface contact system of traction on the front.

Hereford.—Application has been made for sanction to a loan of £2,350 for the electricity department, including £500 for mains, £1,000 for services and £850 for mechanical stokers.

Hornsey.—Sanction has been received by the Council to a loan of £9,000 for electricity supply extensions.

Ilkley.—The Council have refused to entertain the scheme of the Wharfedale Electric Lighting Co. for supplying electricity to the Council in bulk.

Islington (London).—At the meeting of the Council on Friday the Lighting Committee reported that they had had under consideration the price paid by the Council for electricity supplied for public lighting, and they recommended that the same should be reduced from £12,100 to £11,000, and also that £1,000 out of the surplus funds of the undertaking should be applied to relief of rates.

Leeds.—On Wednesday evening last week the tramway employés resolved to go out on strike, but on Friday morning they resumed work in accordance with their acceptance of the Tramway Committee's terms.

The strike was thus confined to a single day. The men's hours have been reduced from 60 to 54 a week, whilst there has been a compromise over the "spread-over" terms, and a revised set of conditions with regard to waiting for cars has been agreed upon.

Light Railways.—The Board of Trade has modified and confirmed the light railway order for the construction of a light railway at Weston-super-Mare, connecting the Weston, Clevedon and Portishead light railway with the tramways of the Weston-super-Mare & District Electric Supply Co.

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Llandudno.—The charge for electric current for private lighting has been reduced ½d. a unit.

L.C.C. Tramways.—Islington Council have agreed to contribute £20,000 towards the cost of widening Balls Pond-road to enable a double line of electric tramways to be constructed.

Mill Driving.—The directors of the Victoria Mill, Rishton, have decided to adopt electric driving. It is stated that this is the first mill in the district to be operated electrically. There will be a separate motor for each loom.

Nelson.—The Board of Trade have authorised the supply of electricity in bulk to Brierfield, but not in connection with tramways worked by Burnley Corporation.

Newport (Mon.)—A long discussion took place at Tuesday's Council meeting on the position of the tramways and electricity supply undertakings.

Councillor Moxon said they had gone to the expense of employing an expert (Mr. C. P. Sparks) to report on the undertaking, and they had practically discarded his recommendations. They were charging the tramways department 1·35d. per unit, while they charged private concerns only 1·18d. for power. Mr. Sparks had warned them that they were on dangerous ground, and that though the concern had been running 16 years they had made no provision for depreciation. The rolling stock of the tramways department was not in good condition, and an enquiry was necessary.

Ultimately it was unanimously resolved to ask the Electricity Committee to consider at an early date and report to the Council upon the whole position of the electrical undertaking.

North Berwick.—The Council have agreed to lease a piece of ground to Messrs. Crompton & Co. for electricity supply works.

Oulton Broad.—The Council have applied for sanction to the use of overhead wires for electricity supply.

Patent Notices.—Application has been made for the restoration of patents No. 13,746/1903, granted to S. M. Young for "Improved method for operating signals on electric railways," and No. 7,320/1907, granted to the Saltpetersäure Industrie Gesellschaft G.m.b.H.) for "Improvements in arc furnaces for the electrical treatment of gases." Notices of opposition must be given at the Patent Office, London, W.C. by Aug. 28.

Presentations.—Chelmsford staff of Messrs. Crompton & Co. have presented a canteen of cutlery to Mr. M. E. Sizer on his marriage.

The staff of the electrical department at Portsmouth Dockyard have presented a gold watch and travelling case to Mr. K. N. Saye, sub-station supervisor, on his departure for the Straits Settlements.

St. Helens.—The Council will give a supply of electrical energy to the Earlestown works of the L. & N.W. Railway Co.

The L. & N.W. Co. guarantee a minimum consumption equal to 500 kw. for 21 years, with the option for the company to discontinue supply at the end of 7 or 14 years on paying the Corporation compensation in respect of the mains laid on the company's property. Two new high-tension cables are to be laid from the power station to St. Helens Junction and thence along the permanent way of the railway company to Earlestown. The new feeders will be available for a supply to the Parr side of the borough and also to the works of Messrs. Bolton & Sons.

Sheffield.—On Wednesday the Electric Light Committee reported they desired to increase their expenditure on capital account during the current year by £11,503, the balance of the loan of £78,207, sanctioned in March, 1910, and also that they were asking for sanction to a further loan of £61,099 in connection with the extension of the Neepsend generating station.

The Tramways Committee recommended that powers be sought in the next Parliamentary Bill for railless cars to be worked from the present Malin Green terminus to Fulwood Church, and also for the subsequent construction of ordinary tramways if and when considered advisable by the Committee.

Tottenham.—Last week the Council adopted certain recommendations of the Tramways Committee which will permit of the early construction of the connecting link between the Tottenham and Walthamstow tramways, giving access to Epping Forest by tramcar from Finsbury Park. The Metropolitan Electric Tramways (Ltd.) will have the line (about two miles) completed within 12 months.

Wimbledon.—The Borough Electrical Engineer has been instructed to supply mains in seven roads in Merton, and he has also been authorised to proceed with laying mains and other works necessary for giving a supply of electricity in the Maldens and Coombe as soon as possible after the Wimbledon Electric Lighting (Extension) Order has been confirmed by Act of Parliament. A loan to cover the cost of the work has been sanctioned.

Wireless Telegraph Notes.—22,108 messages were transmitted by the Marconi station at San Cataldo during 1910, an average of 60 messages per day. Two new masts have been constructed.

According to the "Marconigraph," in the course of the 12 months ending March last, 3,955 wireless weather reports were sent from Western liners. Only 3.4 per cent. of these messages reached the Meteorological Office in time to be included in the same day's map of the Daily Weather Report. 39 per cent. were received in time to be included in the "yesterday" map published with the daily report.

The cadet ship "Mersey," belonging to the White Star Line, recently arrived in the Thames after a voyage around the world. This is said to be the first sailing ship to be equipped with wireless apparatus, which worked for 11 months without a single breakdown, and this notwithstanding that there were no operators with practical experience on board. The tribute of efficiency is due to the Marconi system and the apparatus connected therewith.

The latest adaptation of wireless is described in the Paris "Figaro," which famous journal states that Hertzian waves are being used at Epernay "for shaking up the sediment in champagne after it has been bottled." To what base uses are we come.

Following the example of Norway, Russia is establishing wireless telegraph stations in the Extreme North. It has been decided to erect four stations, one at Petschora, another at Vaigatz, one on the Murman coast and one on White Island, the estimated cost of this work being between £30,000 and £40,000.

A consular report states that the Uruguayan Government are installing a service of wireless telegraphy in the country on the Telefunken system.

Three land stations are to be erected, one at Cerrito, a point near Montevideo (range 500 miles); the second at Paso de los Toros, about the centre of the Republic, 156 miles north of the capital (range 312 miles); and the third at Rivera, on the Brazilian frontier, 175 miles northwards from Paso de los Toros (range 312 miles). Of these the first only will be for public use, the others being reserved for military purposes. The Uruguay army is to be furnished with portable instruments, five of 125 miles range and four of 25 miles. Five vessels of the fleet will be provided with apparatus ranging from 250 miles to 62 miles. Installations are to be placed on Lobos Island and on the lightship on the "English Bank," the latter with a range of 50 miles. The Lobos Island installation will be employed for the transmission of signals made by sailing ships and others that pass outside the island and so are unable to signal by means of flags to the Government telegraphic station at the extremity of Punta del Este, and the installation on the "English Bank" will be of value in case of shipwreck at that point. The apparatus is, it is said, on order from Berlin.

Wolverhampton.—Last week the Council adopted a recommendation to purchase, at a cost of £1,500, a 400 kw. rotary converter and switchgear for giving a supply of energy to the Knowles Oxygen Co.

Wrexham.—The L.G. Board, who held an inquiry on June 2 into the Council's application for sanction to a loan for electricity supply, have now granted sanctions for the following works:—

Excess expenditure on previous loans, £437 (for 20 years); traction battery, £450 (7 years); meters, £140 (4 years); extensions to feed pumps, forced draught furnace, automatic expansion gear to one engine, £450 (10 years); street lighting, £500 (10 years). A period of 15 years has been allowed in the following cases: Extension to condensers, £80; electrical instruments and sundries, £50; machinery tools, £220; erecting and fitting out stores and offices, £350; coal elevator, £300; switchboard, £260; reversible booster, £150; switchboard, £100; cabling, £50, and concrete flooring, £50.

At the inquiry strong opposition was made by the local gas company, but this has had no influence with the L.G. Board, since the Council have secured practically everything they asked for. Included in the original application was £600 for a switchboard, but as £340 remained to be paid off on the old switchboard, this was deducted from the £600. An item of £114 for excess expenditure up to March 31, 1908, which was not submitted to the Board at the last inquiry, the Board has declined to sanction and this will have to be made good out of revenue. In addition to the over-expenditure on previous loans, certain work has already been carried out, as follows: Extension of feed pumps, forced draught apparatus, fitting out stores and offices, extension to condensers, electrical instruments and sundries and meters.

COLONIAL AND FOREIGN NOTES.

Argentina.—The "Review of the River Plate" states that at Carmen de Areco there is a proposal to form a local company for erecting electricity works.

Cordoba Government recently invited tenders for the purchase of their electricity station in Cordoba City, which has never been in operation. The upset price was $150,000 (paper).

Patagones Municipality received only one tender (from D. A. Sorondo) for the equipment of electricity works, and a concession for 15 years is to be granted to him.

Mr. J. J. Costa has applied to Congress for a concession for an electric tramway from Ingeniero White to Puerto Galvan and the city of Bahia Blanca.

The Argentine Post Office Department have laid a new submarine cable 34 miles in length between Buenos Ayres (Argentina) and Martin Garcia (Uruguay).

The Government has authorised the United River Plate Telephone Co. to renew its lines to La Plata. The company intend to lay underground lines in La Plata, and to substitute the C.B. for the magneto system.

Australasia.—The "Australian Mining Standard" states that Port Melbourne Council recently appointed a committee to

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ELECTRICITY SUPPLY TABLES AND DATA.

This Valuable Set of Tables and Engineering Data relating to Electricity Supply and to Electric Traction on Railways and Tramways in the United Kingdom, the Colonies, and some important places abroad, is now ready, and can be obtained complete in handy book form, price 6s. 6d. post free, or on very hard paper for rough or constant use, price 8s. 6d. post free. A complete Index is included

consider the best means of supplying electrical energy in the district.

Messrs. F. A. McCarty & Co. have presented their report to Shepparton (Victoria) Council on alternative schemes for electric lighting and improved water supply. The system of supply proposed in each case is three-wire d.c., with a pressure of 460 volts for power and 230 for lighting. The first scheme includes suction gas engines, the second locomobile pattern steam engines, and the third Diesel oil engines, the total capital cost being £7.974, £8.444 and £7.894 respectively. It is estimated that the total maximum demand in the first year would be 210 H.P. and the average 120 H.P.

Kilmore (Victoria) Council recently put in an auxiliary engine, and invited tenders for the supply of a battery of accumulators.

Daylesford (Victoria) Council have decided to borrow £4.000 for erection and equipment of electricity works.

The Railways Standing Committee of the Victorian Government have reported on the proposal to duplicate and regrade certain suburban railway lines. The report favours the adoption of electric traction, and recommends that the level crossings on the Caulfield and Camberwell lines be abolished, at a cost of £157.000 and £153.000, part of which should be contributed by the local authorities. The amount which would have to be spent on duplicating the Caulfield and Camberwell lines if steam traction were continued would go a long way towards paying for their electrification. Electricity (says the report) would give a cleaner, faster, more frequent and safer service, and would remove the risk of narrow platforms becoming congested.

In giving evidence (at Sydney) before the Victorian Traffic Commission recently the Lord Mayor of Sydney (Ald. Taylor) said the profits of tramways ought to be used for the development of a certain prescribed radius. He would abolish all overhead wires.—The town clerk (Mr. Nesbitt) favoured the establishment of a central authority similar to London County Council, to control tramways, lighting, &c.—Mr. T. R. Johnson, Commissioner of N.S.W. Railways and Tramways, thought Victoria might defer action with regard to electrification.—Mr. W. Fitzpatrick, chairman of the Railway Commissioners, said the Commissioners did not consider the circumstances justified them in recommending the electrification of the suburban lines at present. The more extended experience of other countries in which electric traction was receiving attention would be valuable to them.

On June 7 the Premier of South Australia (Mr. J. G. Verran) formally opened the new power station of the Adelaide Municipal Tramway Trust. The Trust has 75 miles of single track and 163 cars. Work is now in hand in connection with the outer circle, comprising lines to Prospect, Nailsworth, Enfield, Glen Osmond, Mitcham, Paradise, Magill and Goodwood. The substitution of electric for horse traction had (said the Premier) proved satisfactory.

The Railway Commissioner has informed Newcastle (N.S.W.) Council that he could not supply current for the Newcastle tramways in the event of their electrification.

A company has been formed at Murchison (Victoria) to run a co-operative butter factory and electric light and power plant for public and private supply. The local waterworks trust will take energy from the new company for pumping.

Tungamah (Victoria) Shire Council are considering a proposal to light the town electrically.

It is stated that Mr. F. W. Paul has been appointed as a Royal Commissioner to report as to the suitability of Australian ores for the manufacture of iron and steel, the cost of plant capable of producing the iron and steel likely to be required in future by the State Governments and the Commonwealth, including rails, bridges, &c., plates for shipbuilding, &c.

Alexandria (N.S.W.) Council have entered into a 10-years' agreement to take a supply of current from Sydney Council, and notice has been given for the gas lighting to be stopped on Jan. 1 next. In addition to the public lighting demand, there are over 100 factories in Alexandria, most of which require electric power.

Brazil.—The Government has approved the plans for urgent harbour works at Manaos (including electric hoists) at a cost of £59.000.

Canada.—It is stated that the Government of Alberta are constructing 800 miles of new telephone line this year. There are 4.000 miles of trunk and 3.000 miles of rural lines, and over 11.000 subscribers.

Chili.—The plans submitted by Messrs. C. C. Larrain and J. Gross for electricity supply works and electric tramways in the communal district of Barrancas, and by Senor D. R. S. Ruiz for an electric tramway in Viña del Mar, have been approved by the Minister of the Interior.

China.—A consular report states that net imports at Shanghai in 1910 included electrical materials value £62.287 compared with £66.656 and £63.482 in 1909 and 1908 respectively, and machinery £163.297 (compared with £49.350 and £169.674), railway materials £97.239 (compared with £70.474 and £152.458).

In a Consular report on the trade of China during 1910 it is stated that the Chinese telegraphs (under a purely native administration) are one of the most costly and at the same time one of the worst managed telegraph systems in the world.

The value of the imports of electrical materials and fittings in 1910 was £186.775, against £177.676 in 1909 and £23,257 in 1908, and the values of telegraph materials were £63.666, £45.199 and £47.611 respectively.

It is stated that railways are being constructed and projected in every province; coal and other mines are being opened, and factories are springing up in all directions. British manufacturers are urged to take steps to maintain their dominant position in the Chinese machinery market.

India.—"Indian Engineering" says the Public Works Minister of the Jammu and Kashmir State announces that 400 kw. of electric power is for disposal at the Mohora generating station or along the transmission line to Baramulla and Srinagar, at £8 per horse-power per annum for 24 hours' daily service.

Italy.—Rome municipality have granted to M. Berthelot (manager of the Cie du Chemin de Fer Metropolitan of Paris) and M. G. Boucher (Provincial Councillor of the Seine Department) a concession for the construction of an electric railway (partly underground) from the centre of Rome to Ostia, on the coast, a distance of about 18 miles.

A consular report states that the railway and tramcar construction works at Naples delivered 522 cars to the State Railway and 60 cars to the tramway company during 1910, besides repairing 922 railway cars.

A report from Bari (in the Naples consular district) states that the local electrical company, which in 1909 started the Bari-Carbonara tramway, extended the service to the town last year and it is expected that further lines to Canneto and perhaps from Cassano to Murge will be added shortly. Electric tramways from Trani to Andria and to Corato are also to be laid.

The British Consul at Rome says the report of the Banca Commerciale Italiana states that the metal factories have yielded very satisfactory results. The report expresses satisfaction at the general economic conditions, and the increased industrial prosperity is largely attributed to the extensive use which is being made of the power supplied by the abundant waterfalls from the Alps and the Apennines.

Rome municipality are now establishing electricity supply works. The Anglo-Roman Gas Co., which was established in 1852, has hitherto had no competitors. The tramway service in Rome has until lately been conducted by a company, but recently the city authorities have constructed and started working some new lines.

At Civita Vecchia harbour improvement works are progressing, though somewhat slowly. All the quays along the breakwaters will be equipped with electric cranes.

Melbourne (Victoria).—The annual report of the Electric Supply Committee for the year ended Feb. 28 states that gross revenue was £120.363 (against £113.579 in previous year), working expenses £56.429, gross profit £63.034.

After meeting capital charges and placing £20,766 to depreciation there was a balance of £19.532. The committee recommended a further special appropriation of £5.000 to depreciation. Revenue from sales of current for private lighting was £64.944 (against £62.758) and for power and heating £23,570 (£19.846). Units sold for private lighting were 3,803.091 (increase 149,028), and for power and heating 3,098.960 (increase 537.969). Total units sold, including public lighting, were 8,920.489 (increase 760,526), total generated 10.75 (increase 969,478).

Pemba.—Fifty miles of telephone line (14 miles constructed during 1910) now connect the principal towns in Pemba, an island near Zanzibar.

Russia.—Reval municipal authorities have applied for authority to borrow 1,500,000 roubles (about £158.000) for public works including electricity supply works.

Spain.—Spain has some natural advantages, and the past year has witnessed her slow awakening to the possibilities of one of her most important sources of wealth—her mountain streams. Madrid has taken the lead in this development. A large electric generating station, utilising the power of a waterfall some 125 miles distant, has been established, and the owning company state that they are in a position to supply for industrial purposes electrical energy at a cheaper rate per unit than in any other European centre. The establishment of other power stations, taking water power from the streams of the Guadarrama mountains, is contemplated.

The Belgian Consul at Almeira states that the Southern Railway have recently erected a power station near Santa Fé, on the left bank of the Andarax river, for supplying electrical energy for traction on a section of line (14 miles) between Gergal and Santa Fé. The plant was supplied in France. This is stated to be the first example of electric traction on a standard Spanish railway.

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ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Barnsley.—The capital expended at March 31 was £78.192, an increase of £751 during past year.

The revenue was £13.529, including £13,363 from sale of current by meter, and the total expenditure £6.090, leaving a gross profit of £7.439. Interest required £2.486 and sinking fund £744 and sinking fund and instalments of principal £2.890, leaving a net profit of £2.054: 1.802,164 units were generated and 1.544.192 were sold (991.573 to private consumers, 271.185 for traction and 281,434 for public lighting); there are 290 public lamps and the total maximum supply demanded was 905 kw

Birkenhead.—The total revenue of the tramways department for the year ended March 31 was £57.662, the traffic receipts being £56,717.

The total expenditure was £36.969, and after providing legal and other expenses the balance was £21.255. Interest on capital absorbed £9.556, sinking fund £9.503, and, after paying bank interest, income tax, &c., there was a deficit of £115 (against a profit of £1,833), which was increased to £1.115 by the contribution of £1.000 to renewals fund. The capital expended is £366.128, an increase of £9. 12.640.261 passengers were carried (against 12.283.344) and 1.207.761 car-miles run (against 1,201,476). The year's results were adversely affected by an increase of £1,551 in working expenses, of £286 in capital charges and £760 in legal expenses.

Doncaster.—The revenue of the electricity department for the year ended March 31 was £11.799, including £6.780 from sale of current by meter and £4.263 from the tramways department.

The total expenses came to £6.018, leaving a gross profit of £5.781. Interest required £1.496 and sinking fund instalments £1,973, and after adding £315 to sinking fund to make good deficiency in interest, the net balance (£2,022) was carried to renewal fund. The total capital expended is £67,849, an increase of £3.349.

The total receipts of the tramways were £16.513 and the expenses £12.207, leaving a gross profit. Interest required £2,729 and sinking fund instalments, &c., £1.589, leaving a deficit of £81. The capital expenditure is £94,757, an increase of £3.362. The passengers carried numbered 4.131.412 and the car-miles run 503.185. 682,083 units (1·35 per car-mile) of current were consumed. The average traffic revenue was 7·73d., and the total expenses 7·91d. per car-mile.

Gloucester.—The accounts of the light railways department for the year ended March 31 show total income of £15,968, including £14.965 traffic revenue.

The operating expenses came to £12.165, leaving a gross profit of £3,8?64. After providing £4.271 for interest and £792 paid to County Council for rent of county portion of lines, there was an adverse balance, after taking credit for £2.925 from the city fund account, of £1.726. The sinking fund came to £1.980. The capital expended is £131.316, an increase of £15. 3.853.492 passengers were carried and 586.290 car-miles run. The operating expenses were 75 per cent. of the receipts.

Greenock.—At the meeting of the Electricity Committee on Monday the Convener (Councillor J. W. Bailey) intimated that, although the accounts had not yet been fully prepared, he was able to indicate that the output for the year showed a great increase, rising from ...000 to 7.000,000 units.

It was estimated that there would be a profit balance of £2.000, but this had been greatly exceeded. The net profit, after meeting all charges, including interest and sinking fund, amounted to fully £5.000. The allocation of the surplus would be considered next week at the meeting of the Corporation, when the annual report of the department would also be considered.

...h.—The accounts of the electricity supply and tramways departments for the year ended May 15 have been issued:—

The income from sale of current was £23.467, and the working expenses £13.306, leaving a gross profit of £10,161. During the year £1,000 was transferred from the surplus of the electricity undertaking for relief of rates, and a reduction of charges has also been made.

The tramway undertaking began the year with a debit balance of ... The receipts amounted to £31.517, the working expenses were ..., leaving a gross profit of £13.728. Capital charges were £14,769 and other expenses £862, leaving a debit balance of £1.903.

...efield.—The accounts of the electricity supply department were approved by the Council last week.

The total capital expended was £86.959, an increase of £1.519. The revenue from sale of current was £9,512, the income from public lighting, meter rental and sewage pumping making a total of £11,301. The total expenses were £6.680, leaving a gross profit of £4.620. 10s. Interest required £1.801 and redemption fund £3.115, leaving a deficit of ..., against £802. 1.190.160 units were sold (against 1.185.521), including 386.203 (386.220) for private lighting, 141.184 (147.191) for public lighting, and 662.773 (652.120) for power. There are 729 consumers, an increase of 42, and the maximum supply demanded 889 kw., against 1,205. The total works cost was 1·34d. (1·37d.), and the total cost ...33d. (2·33d.) per unit sold.

The chairman of the Electricity Committee (Councillor ENGLAND), moving the adoption of the accounts, said their prospects were improving. The changes made in the scale of charges for power consumers enabled them to offer reasonable terms to large and long-hour consumers. In consequence, they were obtaining customers it was impossible previously to persuade to take current.

Watford.—1.148 consumers, with an equivalent of 67.371 32-watt lamps, are now connected to the mains.

During the past year the profit was £790, and during the first quarter of the present year there has been an increase, compared with the corresponding quarter last year, of 43 per cent. in the units sold, and of 36 per cent. in revenue, the increase in working expenses being only 3 per cent. Mr. Goodrich, chairman of the Electricity Committee, is confident that the net profit for the current year will run into four figures.

Wimbledon.—In presenting the accounts of the electricity department for the past year Councillor Stuart stated at the last meeting of the Council that the figures would compare favourably with any public company.

Councillor STUART said the cost per unit was lower than that of the preceding year, although they generated 250,000 more units. The cost of maintenance and repairs was slightly higher. The total cost was 2·7d. per unit, as against 2·922d. in the previous year, and the surplus was £2.100, against £1.986. They had increased the number of consumers at the rate of over 8 per cent., but he thought they would do a great deal better this year in view of the extensions in hand. The reserve fund amounted to over £13.000, which was not quite up to what they required, 10 per cent. of the capital, but it was very satisfactory. He thought the Committee should consider whether or not it was time to sell their Consols and invest the money in Corporation loans at 3½ per cent. He had spent considerable time on the street lighting question, and so far as he could see the charge was a very reasonable one. Some of the arc lamps were expensive, and if they substituted others for them and got a good light he thought they could save something like £500 a year. He had charged 2½ per cent. for depreciation and reserve on the capital outstanding. The profit was 7¾ per cent. on the capital, but some Councillors did not appreciate the fact that they had to pay 9 per cent. in repayment of loans and interest. He hoped they would not have any serious additions to the capital unless it was for purposes of new business. They hoped to add many consumers in Merton during the coming year, which would help them considerably, and then there was the Maldens and Coombe, where they would no doubt have a very remunerative business.

The accounts were adopted.

TRADE NOTES AND NOTICES.

TENDERS INVITED

CLEETHORPES-WITH-THRUNSCOE Urban District Council invite tenders for the supply, delivery and laying down of a system of vulcanised bitumen distribution and feeder cables on the low-pressure three-wire d.c. system. Specification, conditions of contract and form of tender from the clerk of the Council, Mr. B. Greaves, Council offices, Cleethorpes, to whom tenders must be sent by noon of Saturday, Sept. 2. Specifications and general conditions of contract may be seen at the offices of the consulting engineers, Messrs. Vesey Brown & Hall, Milburn House, Newcastle-on-Tyne. See also an advertisement.

The Municipal Commissioners of PENANG invite tenders for the supply and delivery, f.o.b. British port, of one 500 kw. steam dynamo engine or turbine with ejector condensing plant and switchgear. Specifications, general conditions and form of tender may be obtained from the consulting engineers, Messrs. Preece, Cardew & Snell, 8, Queen Anne's-gate, Westminster, S.W., to whom tenders (in duplicate) are to be sent by noon of Tuesday Sept. 5. See also an advertisement.

Tenders are invited up to Sept. 26 for the supply of telephone material and 30 miles of telephone cable to the Postmaster-General's Department in VICTORIA. Specifications, forms of tender, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W., See also an advertisement.

Tenders are invited for the supply of a desiccating plant, to the Postmaster-General's department in NEW SOUTH WALES. Forms o tender, specifications, &c., may be obtained from the Commonwealth offices, 72, Victoria-street, London, S.W. See an advertisement.

Tenders will be received until noon Monday Sept. 18 for the supply of Swedish, Norwegian, Finland or Russian red fir telegraph poles, for the GENERAL POST OFFICE. Forms of tender, containing all particulars, may be obtained from the Controller of Stores, Mr. G. Morgan, Stores Department, G.P.O., 17 and 19, Bedford-street, London, W.C., See also an advertisement.

The COMMISSIONERS OF H.M. WORKS AND PUBLIC BUILDINGS are prepared to receive tenders for the supply of electrical accessories for three years from Sept. 1 next. Forms of tender and particulars from the Storekeeper, H.M. Office of Works, 12, Lambeth Palace-road, S.E. Tenders by Friday, Aug. 18, to the Secretary, H.M. Office of Works, Storey's Gate, London, S.W.

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"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1911 Edition of the Big Blue Book is READY, price 15s., post free in the United Kingdom, 15s. 9d. The volume brings a great mass of very valuable statistical and technical data quite up to date, and the Directorial Division has been thoroughly revised and amplified up to February 24th.

All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters receive every attention in the new volume, which aggregates more than 2,000 pages. The Directory Division is complete and thoroughly accurate, and has been completely revised. The Big Blue Book contains more names of live electrical firms and persons than any other Directory published, and this notwithstanding that all mere lists of members of Societies and Institutions (so easily and cheaply available) are excluded, as unreliable and of little value for Manufacturers' and Dealers' purposes. The full set of valuable Statistical and Engineering Tables, &c., have been very carefully revised and extended, and are now issued in a handy form. These are included in the 1911 Big Blue Book, making it the most complete work of the kind ever published

The Council of the County Borough of WEST HAM invite tenders for (*a*) water tube boilers, (*b*) coal handling and discharging plant, (*c*) 5,000 kw. turbo-alternator, with condensing plant, (*d*) river service pipe-work, (*e*) centrifugal pumps, (*f*) 750 kw. converter (two-phase to d.c.). Specification, form of tender, &c., from Mr. H. H. Couzens, engineer and manager, 84, Romford-road, Stratford. Tenders to the town clerk, Mr. Fred E. Hilleary, Town Hall, Stratford, E., by 10 a.m. Aug. 31.

BIRMINGHAM Corporation require tenders by noon Aug. 18 for erection of a tramway depot in Whitmore-street, Hockley, Birmingham. Particulars from Mr. A. Rowse, King's Court, Colmore-row, Birmingham.

Tenders are invited by the FARNHAM GAS & ELECTRICITY Co. for the supply and erection of two high-speed Diesel oil engines coupled to two 90 kw. alternators with direct-coupled exciters, piping, tanks, overhead traveller and accessories, and main high-tension switchboard. Tenders to the Secretary by noon Aug. 16.

LONDON COUNTY COUNCIL invite tenders for four sets of crushing rolls, screens and elevators, and two sets of sand drying plant, for the tramways department. Tenders by 11 a.m. Aug. 22.

IPSWICH Corporation want tenders by Aug. 24 for one year's supply of paper-insulated underground cables. Specification from Mr. F. Ayton, Electricity Works, Constantine-road, Ipswich.

SWINTON AND PENDLEBURY Council require tenders by 9 a.m. Aug. 22 for the electric lighting of a new school off Cromwell-road, Pendlebury. Plans, &c., from Mr. T. J. Bushell, John Dalton-street, Manchester.

Tenders are invited up to Aug. 23 for supply of letter-box fronts to the Postmaster-General's Department in QUEENSLAND and for telegraph, telephone, and electric lighting material to the Deputy Postmaster-General in NEW SOUTH WALES; and for telegraph and telephone material to the Postmaster-General's Department in SOUTH AUSTRALIA; up to Aug. 30 for supply of porcelain insulators, copper wire, sleeves, &c., to the Postmaster-General's department in SOUTH AUSTRALIA; and up to Sept. 5 for the supply of (*a*) 10,000 protectors and (*b*) sundries to the Postmaster-General's Department in VICTORIA. Tender forms and specifications at the Commonwealth Office, 72, Victoria-street, London, S.W.

The Metropolitan Water and Sewerage Board, Albert-street, BRISBANE, Queensland, want tenders by noon Jan. 30 next for supply and erection, of one, two or three complete units, each consisting of power generating plant and pump or pumps to lift not less than 6,000,000 gallons per day. Particulars from the Secretary, and forms from the Agent-General for Queensland.

The Municipal Council of BUDAPEST, Hungary, require tenders for the manufacture and supply of plant for a steam-driven electrical generating station, including two groups of three-phase turbo-generators (5,000 kw. each), 10,000 volts 50 cycles, boiler equipment for mechanical output of 5,000 kw. with reserve, pipeline, central switching and accessory equipments, travelling crane for engine room and coal-conveying plant. Specifications, &c., can be obtained at the Presidial Section of the Council, 9: IV., Városház-utca 16, II. 1, Budapest. Tenders by 11 a.m. Sept. 30.

Tenders will be received at the Town Hall, SYZRAN, Russia, on Oct. 14, for the construction of an electric tramway and the supply of electrical energy for lighting.

The time for the receipt of tenders by the Ministry of Public Works, Constantinople, for an electric power and tramway concession for JERUSALEM, is extended to Sept. 13. Specifications (in French) can be seen at 73, Basinghall-street, London, E.C.

The Public Works Department, Madrid, will receive tenders on Sept. 20 for the concession for the construction of the RENTERIA electric tramway.

The BOMBAY, BARODA & CENTRAL INDIA RAILWAY Co. want tenders by *noon* Aug. 22 for supply of steam engines and d.c. dynamos, air compressors and centrifugal pumps. Forms of tender, &c., from the Secretary, 110, Bishopsgate, London, E.C.

TENDERS RECEIVED AND ACCEPTED.

Northallerton Council have renewed the contract with the Northallerton Electric Light & Power Co. for street lighting for five years at the following rates:—

13s. per arc lamp burning 100 hours, 3s. per 32 c.p. lamp in main street, and 3s. 9d. per 32 c.p. lamp in side streets, and 2s. 6d. per 100 hours for each 16 c.p. lamp, less 5 per cent. in each case.

Hastings Council have accepted the following tenders:—

Oliver Arc Lamp, for arc lamp carbons at 30s. per 10,000: A. H. Wood wiring Clive Vale schools, £63; Bruce & Co., wiring Tower-road technical schools, £100.

Stockport Council have accepted the following tenders:—

Walter Scott (Ltd.), tram rails, £6. 15s.. and fish plates, £9. 15s. per ton; Walker's Road & Destination Indicators (Ltd.), 36 destination indicators, £18; Morgan Crucible Co., carbon brushes; British Insulated & Helsby Cables, overhead line material.

Crook Council have accepted the tender of Pease & Partners for installing 20 25 c.p. lamps at Sunniside at £213, and supplying current at 35s. per lamp per annum.

Dundalk Council have placed an order with Sandycroft Foundry Co. for a storage battery for their electricity works.

Heston and Isleworth Council have placed an order with Kraft & Jacoby for metal filament lamps for street lighting.

Watford Council have accepted the tender of Ferranti Limited for switchgear at £175.

Shrewsbury Council have placed an order with Edwin Danks & Co. (Oldbury) for a boiler at £422. 10s.

Tunbridge Wells Council have placed an order with the West Electric Co. for a year's supply of cables.

Blackburn Council have placed an order with Joseph Wright & Co. for water softening plant.

Coventry Guardians have accepted the tender of H. J. Tew for wiring the nurses' home at £61.

Blackburn Council have placed an order with McPhail & Son for a superheater.

W. T. Henley's Telegraph Works Co. have secured the contract for all the cables required in connection with the supply of electricity to the Central India Spinning, Weaving & Mfg. Co., Nagpur.

Balmer, Lawrie & Co. have contracts for the electric lighting of camps of the Government of India, the Governor of Bombay, the Governor of the United Provinces, the Resident of Baroda and the Governor-General of Rajputana, at the Delhi Durbar.

The Madras & Southern Mahratta Railway Co. recently placed an order for two Worthington electric pumps in connection with the water supply scheme for Bangalore city station.

The Prahran-Malvern (Victoria) Tramway Trust have accepted the tender of Edgar Allen & Co. for special track work, at £1,[illegible].

Sydney (N.S.W.) Council have ordered 50 additional arc lamps, £275, and eight feeder panels (at £2. 12s. each) for sub-stations, from the Australian General Electric Co.

Mortlake (Victoria) Butter Factory have accepted the tender of Fiddes & Morgan for erection of power house, &c. (£330), and Bennie, Teare & Co. for a 60 H.P. suction gas engine (£756).

The British General Electric Co. (Sydney) recently received an order from Gisborne (N.Z.) Council for a switchboard.

Prahran-Malvern Tramways Trust have accepted the tender of British Insulated & Helsby Cables for supply and erection of overhead equipment and supply and laying of underground feeders, £4,555. 7s. 9d.

The Municipal Commissioners of Shanghai have placed an order with the General Electric Co. for Osram lamps, which include 100 c.p., 500 200 c.p. and 200 400 c.p. lamps.

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Cardiff Corporation have accepted the following tenders :—

British Insulated & Helsby Cables for l.t. cable, £1,617. (Eight tenders received, from £1,680 to £1,590.)

British Insulated & Helsby Cables (lowest tender) for h.t. cable, £454. 13s. 4d. (Eight tenders received, highest £540.)

Musgrave & Co., for induced draught plant, £495. (Seven tenders received, from £710 to £460.)

E. Green & Son, for fuel economisers, £1,061. (Ten tenders received, from £1,600 to £989.)

F. & C. Osler (Calcutta) have obtained contracts for the electric lighting of 40 camps at the Delhi Durbar, including the King's and many of the Indian chiefs' camps, the Delhi Circuit House, the Agra Circuit House and the two shooting camps in Nepal.

Commonwealth Contracts.—The Postmaster-General's Department in New South Wales is purchasing from the Western Electric Co. telephone apparatus for the Sydney exchange, at £745.

The Public Works Department of Western Australia has ordered electric pumping machinery from C. C. Humby & Co., at £5,518. 13s.

The Railways Department of Victoria have placed an order with W. T. Henley's Telegraph Works Co. for lead-covered paper-insulated telephone cable, at £162 per mile.

The British General Electric Co. (Sydney) recently received orders from the Australian Postmaster-General's Department for two motor-boosters for Sydney G.P.O. electric lighting plant.

The tenders of Lawrence & Hanson (£494) for wiring and supply of lamps and that of Noyes Bros. (£728) for electric light cables for the Small Arms Factory, Lithgow (N.S.W.), have been accepted.

BUSINESS NOTICES.

The registered offices of Richard Pape (Ltd.) have been removed to Belvedere Works, Belvedere, Kent, where all future communications should be sent.

Mr. H. N. Warburton, engineer, manager and secretary for the past 14 years of the Winchester Electric Light & Power Co., whose undertaking has been acquired by the Corporation, has decided to start in practice as a consulting engineer, with offices at 4, Upper High-street, Winchester, and 31, Great James-street, London, W.C.

Sale by Auction.—Messrs. Horne & Co., 35, Old Queen-street, Westminster, S.W., will sell by public auction at the Royal Arsenal, Woolwich, on Thursday, Oct. 24, some unserviceable and obsolete stores, including quantities of cast and wrought iron, steel scrap, brass, copper, cupro-nickel, lead, &c., some electric cable, a number of hydraulic and screw jacks, lathes, tools, metal filament lamps, &c. Lots may be viewed at the Royal Arsenal, Woolwich, on the Monday, Tuesday and Wednesday previous to and on morning of sale. Catalogues from the War Office, Whitehall, S.W., the Ordnance Office, Tower, E.C., and the Ordnance Office, Royal Arsenal, Woolwich. See also an advertisement.

Patents Development.—The proprietor of patent No. 18,842/1907, relating to "Means for receiving intelligence communicated by electric waves," wishes to dispose of the patent or to grant licences. Applications to Messrs. Cruikshank & Fairweather (Ltd.), 65 & 66, Chancery-lane, London, W.C.

Patents Guide.—We have received a copy of a pamphlet of 32 pages by Mr. Clarence W. Crossley on patent law and procedure. It contains some useful hints to inventors and manufacturers in regard to patent procedure and the development of patents. The pamphlet is published at 9d. nett by the author at 18, Pollard's Hill North, Streatham, London, S.W.

Imports.—The following are official values of electrical machinery material and apparatus imported into this country (*a*) during July, 1911, and (*b*) during the current year from Jan. 1 to July 31, and the increases or decreases compared with the corresponding periods of 1910 :—

Electrical machinery (*a*) £82,059 (increase £38,347), (*b*) £627,361 (increase £304,217); telegraph and telephone cables (*a*) £38,488 (increase £31,238), (*b*) £227,154 (increase £127,457); telegraph and telephone apparatus (*a*) £17,611 (increase £7,107) (*b*) £97,438 (decrease £68); other electrical wires and cables, rubber insulated (*a*) £8,198 (decrease £12,882), (*b*) £51,601 (decrease £68,794; with other insulations, £2,763 (decrease £22), (*b*) £21,193 (increase £3,833); carbons (*a*) £38 (decrease £1,545), (*b*) £72,579 (decrease £5,637); glow lamps (*a*) £833 (decrease £36,329), (*b*) £168,588 (decrease £152,139); arc lamps and electric searchlights (*a*) £119 (decrease £105), (*b*) £872 (decrease £53); parts of arc lamps and searchlights (other than carbons), (*a*) £514 (increase £1,965), (*b*) £62,127 (increase £21,935); primary and secondary batteries (*a*) £2,823 (decrease £545), (*b*) £25,276 (increase £1,337) total of electrical goods and apparatus, other than machinery and telegraph and telephone wire (*a*) £106,545 (decrease £13,719), (*b*) £795,065 (decrease £46,026).

Exports.—The exports of electrical machinery, material, &c. (*a*) during July, 1911, and (*b*) during the current year from Jan. 1 to July 31, and the increases and decreases compared with the corresponding periods of 1910, are as follows :—

Electrical machinery (*a*) £170,438 (decrease £1,814), (*b*) £1,002,053 (increase £110,378); telegraph and telephone cables (*a*) £44,769 (decrease £85,230), (*b*) £412,649 (decrease £617,444); telegraph and telephone apparatus (*a*) £18,999 (increase £832), (*b*) £151,396 (increase £51,262); other electrical wires and cables, rubber insulated (*a*) £29,404 (increase £444), (*b*) £233,409 (increase £5,086; with other insulations (*a*) £26,760 (increase £1,310), (*b*) £220,160 (increase £50,214); carbons, (*a*) £656 (decrease £543), (*b*) £10,078 (increase £217); glow lamps (*a*) £12,661 (increase £3,113), (*b*) £90,417 (increase £18,052); arc lamps and searchlights (*a*) £786 (decrease £816), (*b*) £10,917 (decrease £105); parts of arc lamps and searchlights (other than carbons) (*a*) £1,523 (increase £230), (*b*) £9,579 (increase £1,547); primary and secondary batteries (*a*) £10,839 (decrease £6,031), (*b*) £80,328 (increase £10,292). Total of electrical goods and apparatus, other than machinery and telegraph and telephone wire (*a*) £187,700 (decrease £82,195), (*b*) £1,542,133 (decrease £420,556).

BANKRUPTCIES, LIQUIDATIONS, &c.

The Helptophone Co. (Ltd.) is being wound up voluntarily. Mr. R. Evans Smith, 53, New Broad-street, London, E.C., is liquidator.

COMPANIES' MEETINGS AND REPORTS.

BULAWAYO WATERWORKS CO. (LTD.)—The chairman (Colonel Lockwood, M.P.) stated at the meeting last week that for the first five months of this year there was an increase in working profit of £1,800 for electric current compared with 1910. The number of consumers in May was 699, compared with 615 in May, 1910. The board consider that the outlook is distinctly encouraging. Considerable economies have been effected in working costs, and those, combined with increased demand should enable the company to arrive at a commercial success.

CENTRAL LONDON RAILWAY CO.—The chairman (Mr. H. F. Parshall) stated at the meeting last week that during the past half-year £51,464 had been expended on capital account, £40,282 in connection with the Liverpool-street extension, £2,617 on the high level subway connection with the City & South London Railway at the Bank station, and £779 the extra cost of replacing wooden platforms with stone. Work on the Liverpool-street extension was proceeding satisfactorily, and arrangements had been made that the work should be completed six months ahead of the original contract time, and will be ready next year. The high level subway at the Bank station was opened in May. Further capital expenditure, amounting to £310,485, was estimated to be required for the coming and subsequent half-years. During the past half-year they had carried over 20,000,000 passengers, a decrease of 658,609 compared with the corresponding period of 1910, which was undoubtedly due to increased motor 'bus competition along the company's line of route. Under the new organisation, without diminishing the efficiency, there had been a decrease in working expenses of £3,420, brought about by economies effected in all departments. After providing for debenture interest and other payments, and including the amount brought forward, the available balance was £75,655. A dividend on the ordinary stock at the same rate as last year (3 per cent.) would absorb £27,351, and the preferred would take £11,765, leaving £36,538. From this balance the directors propose to carry forward to the dividend suspense account £5,882 on account of the deferred stock at rate of 2 per cent. per annum, which would leave £30,655. During the three days of Coronation festivities they carried 730,000 passengers without a hitch of any kind. The staff worked admirably throughout that trying period, and the Board of Trade had intimated that H.M. the King had decided to grant Coronation medals to two members of the staff in appreciation of the splendid way in which the crowds were handled. The men all received an extra day's pay. On July 1 season tickets were inaugurated, and had been highly appreciated by the public, with satisfactory results to the company. Improvements were being effected at the stations, and a system of ventilation was being installed throughout the line.

Mr. MATHER asked whether the company's engineers had considered the question as to whether the time had now come to instal fresh plant in their generating station. He thought considerable economies could be effected by substituting for the generating engines a turbine plant.

The CHAIRMAN said the directors had given the subject their serious consideration, and had come to the conclusion that there was no justification whatever for scrapping their plant at Shepherd's Bush and installing turbines. They were using Allis Corliss engines of the very best type, and to-day they were running at less than 3 lb. of coal per kilowatt-hour, which was a very fine record for a power house. There was no station in the kingdom, and certainly there was none in the London area, which showed such good results as their Shepherd's Bush station.

CIA ARGENTINA DE ELECTRICIDAD.—The first report, from Oct. 1, 1909, to Dec. 31, 1910, states that $10,168 (gold) have been written off concessions account and a dividend of 5 per cent. declared on the preference shares. Sales of current produced $181,391 m/n. The authorised capital is $400,000, of which $11,400 is not yet issued.

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HANKOW LIGHT & POWER CO. (LTD.)—The directors' report states that in March last tenders were accepted for a 300 kw. plant, which is now practically finished, and will, it is expected, be installed at the power station in time for the winter service. The lighting franchises from the English, French and Russian concessions have been formally assigned to the company. A new system of public lighting has been installed which is giving every satisfaction. There has been a steady increase in the private lighting and power department, and the receipts for the year ended March were £8,981. 5s. 10d., against £4,662. 19s. 7d. Working expenses for the year were 50·89 per cent. of total receipts, against 56·64 per cent. for the half-year to March 31, 1910. The credit balance of the trading account for the year was £4,228. 17s. 2d. After paying various amounts, there was a balance of £1,432. 18s., which reduces the debit balance to £2,513. 15s. 8d.

LANARKSHIRE TRAMWAYS CO.—At the meeting last week Mr. A. R. Monks said the result of the half-year's working of the system had been satisfactory. It had been decided to proceed with the extension to New Stevenston, as that would be completed before their powers lapsed, but the extensions to Bellshill and Mossend could not be proceeded with.

LIVERPOOL OVERHEAD RAILWAY CO. The directors' report states that gross revenue receipts for the half-year to June 30 amounted to £38,153. 17s. 2d. and working expenses to £27,229. 10s. 8d. The total number of passengers carried was 5,393,597, an increase of 303,517, producing an increase in receipts of £1,968. 3s. 1d. The bill for the consolidation of borrowing powers and for authorising the Mersey Docks and Harbour Board to guarantee payment of interest on debenture stock has passed both Houses of Parliament and awaits the Royal Assent. After paying debenture interest, &c., and adding balance brought forward (£4,246. 7s. 9d.) a balance of £10,841. 6s. 1d. is available for dividend. Out of this balance the directors recommend declaration of dividends at the rate of 5 per cent. on the preference and 1 per cent. on the ordinary shares, leaving £4,665. 9s. 1d. to be carried forward.

LONDON, TILBURY & SOUTHEND RAILWAY CO.—Mr. A. L. Stride, who presided at the meeting last week, stated that electric traction was working, as it did last half-year and the half-year before, at still lower and still better results, and earning more money for the expenditure on the other side of the account. The company had fought successfully the Greater London Bill. They did not know whether the Midland Railway Co. would be allowed to take over their line.

TYNESIDE TRAMWAYS CO.—At the meeting on Tuesday the Chairman (Dr. J. T. Merz) stated that there was a decrease in the car-mileage of 582, but the receipts per car-mile were 8·87d., against 8·273d. for the corresponding period of last year. They had carried 276,615 more passengers. The expenses had gone up somewhat. The balance brought forward was £456, and they carried forward a balance of £619, and they had increased the dividend from 1 to 1½ per cent. The loans had been reduced by £1,980, and they expected that in the course of the current half-year the remaining loans would be wiped out.

YORKSHIRE ELECTRIC POWER CO.—The gross profit for the half-year ended June 30 was £6,633. 8s. 2d., against £4,950. 3s. 6d. and £2,598. 12s. 11d. in the June half-years 1910 and 1909 respectively. The net profit for the same periods, after deduction of mortgage interest, was £4,137. 6s. 9d., £2,621. 17s. 8d. and £1,069. 17s. 11d. There has been a general increase in the sale of energy to all classes of consumers, including supply to local authorities and others holding electric lighting orders. Extensions of mains and plant have been made during the past half-year to meet new demands and the capital expended upon these has not yet become wholly productive. Further agreements have been made for the supply of energy to power users. The balance available (including amount brought forward) at June 30 was £13,612. 18s. 5d. and the directors recommend payment of the preference dividend to June 30 (£1,136. 7s. 4d.). The carry forward is £12,476. 11s. 1d.

NEW COMPANIES, MORTGAGES AND CHARGES, STATUTORY RETURNS, &c.

NEW COMPANIES.

COMPANIA DE ELECTRICIDAD DE VA PROVINCIA DE BUFNOS AIRES (LTD.) (117,118.)—Reg. Aug. 3, capital £1,000,000 in £1 shares, to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity and gas, manufacturers of and dealers in cables, wires, lines, lamps, dynamos, generators; railway, tramway, carriage and motor car proprietors; transmitters of telephonic and telegraphic communications outside the United Kingdom, &c., and to adopt an agreement with Alex. L. Secretan & Co.

FLYNN MANUFACTURING CO. (LTD.) (117,137.)—Reg. Aug. 4, capital £1,000 in £1 shares, to carry on the business of machinery and plant manufacturers, insulators of wire, wire coil and other metals, &c. Private company. First directors, C. Terry, A. E. Brambles, A. V. Terry, and T. J. Flynn.

MAGIC APPLIANCES (LTD.) (117,110.)—Reg. Aug. 2, capital £5,100 in 5,000 ordinary shares of £1 each and 2,000 deferred shares of 1s. each, to carry on the business of electrical and general engineers and contractors, manufacturers of and dealers in electrical and mechanical appliances, &c. Private company. First directors, W. Schmahl (man.), S. J. Atkinson, A. Stolberg and O. Ruoff. Reg. office, 6, Farringdon-avenue, London, E.C.

OHIO POWER SYND. (LTD.) (117,111.)—Reg. Aug. 2, capital £2,000 in £1 shares, to carry on the business of electricians, suppliers of electricity, &c. Private company. Reg. office, 123, Cannon-street, London, E.C.

STATUTORY RETURNS.

SHANGHAI ELECTRIC CONSTRUCTION CO. (LTD.)—In return to May 18 capital is £320,000 in £10 shares. All shares taken up. £317,000 paid. £3,000 considered as paid. Mortgages and charges, nil.

MORTGAGES AND CHARGES.

CORONA LAMP WORKS (LTD.)—Particulars of £2,000 debentures, created July 10 have been filed, amount of present issue being £200. Property charged: Company's undertaking and property, present and future, including uncalled capital. No trustees.

CUTTING BROS. (LTD.)—Particulars of £4,000 debentures, created July 12, have been filed, the whole amount being now issued. Property charged: Company's undertaking and property, present and future, including uncalled capital. No trustees.

VENNER TIME SWITCHES (LTD.)—Particulars of £5,000 debentures, created July 4, and secured by trust deed dated July 10, have been filed, the whole amount being now issued. Property charged: Company's undertaking and property, present and future, including uncalled capital. Trustee, R. B. Young.

RECEIVERSHIP.

G. W. CLARKE & CO. (LIVERPOOL) (LTD.)—W. L. Jackson, 51, North John-street, Liverpool, ceased to act as receiver or manager on July 28.

CITY NOTES.

MEMORANDA (Aug. 10).—Bank rate 3 per cent. (March 9, 1911.) Price of silver, 24 7/16d. per oz. Consols 78—78¼ for money and for account. Consols Pay Day, Sept. 1; Stock and Shares Continuation Days, Aug. 14 and 29; Ticket Days, Aug. 15 and 30; Pay Days, Aug. 16 and 31; Mining Shares Carry Over Day, Aug. 28.

PRICES OF METALS (London).—*Copper*, cash, 56 7/16; three months, 57 4/16. *Lead*, English, 14⅛—14⅜; Foreign, cash, 13 15/16—13 15/16; three months, £14. *Spelter*, 25 3/16—25 5/16. *Tin*, English, 194—196; Foreign, cash, 195½; three months, 188¾. *Iron*, Cleveland, cash, 46/9, three months, 47/7.

DUBLIN & LUCAN ELECTRIC RAILWAY CO. (LTD.)—The gross receipts for the half-year to June 30 were £3,455, and the directors propose payment of the preference dividend, carrying forward £444.

ELECTRIC SUPPLY CO. OF VICTORIA (LTD.)—This company's tramway and lighting receipts for April were £7,269.

MATHER & PLATT (LTD.)—The directors have declared an interim dividend on the ordinary shares of 5 per cent. (tax free) for the half-year to June 30, being at rate of 10 per cent. per annum.

OLDHAM, ASHTON & HYDE ELECTRIC TRAMWAYS (LTD.)—The directors have declared an interim dividend at the rate of 5 per cent. (5s. per share), less tax, on the ordinary shares for the past half-year.

PARA ELECTRIC RAILWAYS & LIGHTING CO. (LTD.)—The directors announce an interim dividend at the rate of 10 per cent. per annum (less tax) on the ordinary shares for the past half-year.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed Aug. 16 a special settling day in and have granted quotations to £100,000 5 per cent. debenture stock of the *Adelaide Electric Supply Co. (Ltd.)*, and fully and partly paid scrip for $4,500,000 5 per cent. first mortgage 30-year gold bonds of the *Mexican Northern Power Co. (Ltd.)* Quotations have also been granted to a further issue of £30,000 5 per cent. second mortgage debentures of the *Bombay Electric Supply & Tramways Co. (Ltd.)*, a further issue of 22,000 £5 fully paid shares of the *Chili Telephone Co. (Ltd.)*, and a further issue of £20,000 4½ per cent. first mortgage prior lien gold bonds of the *Montreal Water & Power Co.* The Committee have been asked to grant quotations to 20,000 £5 fully paid 7 per cent. first cumulative preference shares of the *Melbourne Electric Supply Co.*, 2,998 £10 fully paid 6 per cent. cumulative and 11,402 £10 fully-paid 6 per cent. non-cumulative preference shares and 27,050 1s. fully paid ordinary shares (in lieu partly of the 10,852 ordinary shares now quoted) of the *Notting Hill Electric Lighting Co.*, and a further issue of 5 per cent. 50-year mortgage bonds of the *Rio de Janeiro Tramway, Light & Power Co.*

VICTORIA FALLS & TRANSVAAL POWER CO. (LTD.)—We learn on good authority that the operations of this company are affording much gratification to the directors and officials, the prospects being exceptionally good. We believe we are correct in stating that the net profits on last month's working approximated £30,000. The called-up capital of the company, according to the last return, was £4,538,000—£1,000,000 in £1 ordinary shares, £1,838,000 in 6 per cent. cumulative preference shares, and £1,700,000 in 5 per cent. debentures.

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ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
een Corporation	Aug. 2	1,866	+ 186	9	14,852	+ 1,140
s	July 28	188	+ 16	30	6,486	+ 35
-Argentine	Aug. 5	43,015	— 526	31	1,510,598	+ 143,402
n-under-Lyne	„ 5	410	— 21	19	7,968	+ 523
rporation	„ 5	493	— 10	12	5,039	+ 14
ley	July 28	187	+ 18	30	5,395	+ 338
	„ 28	364	+ 31	30	8,349	+ 568
w	„ 28	978	— 310	31	25,428	+ 703
Electric Trams, Ltd.	Aug. 2			31	133,271	+ 16,810
ngham Corporation	July 29	9,074	+ 2,413	17		
ngham & Midland	„ 28	901	+ 18	30	26,798	+ 1,772
	..	..	..	..	..	..
pool & Fleetwood	Aug. 2	1,203	+ 132	†19	22,313	+ 2,018
burn Corporation	„ 6	2,428	— 86	19	47,700	+ 3,428
n Corporation	July 7	2,925	+ 295	27	77,101	+ 4,617
ay	Aug. 2	2,054	— 563	18	32,339	— 2,526
mouth Corporation	..	..	..	..	..	..
ford Corporation	„ 6	1,856	— 392	¶18	22,229	+ 1,095
ton Corporation	„ 4	7,218	— 1,036	18	132,066	+ 11,952
ol Trams & Carriage	„ 5	1,377	+ 74	18	17,719	+ 2,248
ley Corporation	„ 6	320	+ 3	18	5,403	+ 441
on Corporation	„ 6	1,597	+ 389	¶18	24,082	+ 2,029
Corporation	„ 5	R59,106	+ R4,636	5	R291,406	+ R29,932
tta Tramways Co.	„ 5	123	+ 4	21	3,768	+ 34
orne-Redruth	..	..	..	..	..	..
ff Corporation	..	..	..	..	..	..
ral London Railway	„ 5	4,076	— 1,016	5	23,192	— 4,534
ham & Dist. Lt. Rys.	..	..	..	..	..	..
& South London Rly.	„ 6	3,092	— 64	5	15,576	+ 6
of Birmingham	July 28	1,174	— 1,689	30	80,755	— 4,310
Electric Trams Co.	Aug. 3	576	+ 40	31	15,333	+ 350
ton	July 28	1,905	+ 260	17	32,337	+ 3,016
nsport & Dist. Trams	„ 28	627	+ 199	30	14,242	+ 1,964
er Corporation	..	..	..	..	..	..
ds & Lucan Railway	Aug. 4	168	— 43	5	844	— 46
ds United	„ 4	6,172	— 358	5	38,675	+ 8,504
ley-Stourbridge	July 28	918	+ 64	30	21,610	+ 1,989
ster Corporation	Aug. 2	1,180	— 1	¶11	13,770	— 126
n Corporation	„ 5	1,062	+ 173	18	20,229	+ 1,137
Han Council	„ 5	454	+ 20	18	6,567	+ 551
ter Corporation	„ 4	1,122	+ 90	30	30,840	+ 1,696
nshead & Dist. Trams	July 28	19,160	+ 2,159	§9	180,275	+ 15,487
gow Corporation	Aug. 5	130	+ 7	31	3,775	+ 253
ton Trams	„ 5	351	— 71	5	1,691	+ 166
caster Corpn.	„ 2	251	— 1	30	6,194	+ 173
esend-Northfleet	July 28	1,338	+ 61	5	6,923	+ 241
t Northern & City Rly.	Aug. 5	809	+ 115	30	21,009	+ 2,603
nock & Port Glasgow	July 28	2.230	+ 86	†18	56,526	+ 3,876
fax Corporation	Aug. 1	368	+ 57	30	7,733	+ 678
erpool Tramways	July 28	1,352	— 569	5	6,201	— 396
tings Elec. Trams Co.	Aug. 3	$8,190	— $573	5	$288,721	+ $2,548
g Kong	„ 5	1,957	— 12	18	35,964	+ 3,582
dersfield Corpn.	„ 5	2.927	..	18	52,033	+ 2,522
Corporation	..	..	..	..	..	..
District Council	„ 2	141	— 23	18	2,431	+ 95
on District Council	July 29	527	— 63	17	7,905	+ 715
ch Corporation	Aug. 5	1,795	— 443	44	23,005	+ 646
Thanet Co.	July 28	146	+ 8	30	3,860	+ 251
	Aug. 3	219	+ 31	18	3,615	+ 358
ley Corporation	July 28	148	+ 24	30	3,312	+ 255
erminster & District	Aug. 3	1,386	+ 69	31	43,002	+ 415
amock Corporation	..	..	..	..	..	..
shire Trams Co.	„ 2	1,421	— 151	31	41,145	+ 1,009
shire United	July 28	257	+ 61	30	4,940	+ 173
ington	Aug. 5	6,693	— 1,176	18	138,748	+ 8,371
Corporation	„ 5	2.555	— 126	18	47,428	+ 4,135
ster Corporation	„ 5	760	+ 84	‡12	8,498	+ 763
ton Corporation	..	..	..	..	..	..
rpool Corporation	July 29	12,270	+ 768	30	345,089	+ 13,575
rpool Overhead Rly.	Aug. 6	1,558	— 149	5	8,039	+ 479
dudno&Colwyn Bay Rly.	..	..	..	..	..	..
don County Council	July 26	44,854	+ 3,409	‡17	761,321	+ 57,147
don Elec. Ry. Co.	Aug. 5	11,200	— 300	5	62,275	+ 1,305
don United	„ 5	7,383	— 2,211	31	222,994	+ 7,776
nsett Corporation	„ 5	453	— 38	44	7,926	+ 259
hester Corporation	„ 5	15,728	— 610	19	298,330	+ 16,223
y Railway	„ 5	1,827	— 210	5	9,500	— 467
ay	July 28	227	+ 21	30	6,164	+ 112
politan Dist. Railway	Aug. 5	10,186	+ 242	5	56,017	+ 2,967
politan Elec. Trams	July 28	10,053	+ 2,417	30	259,952	+ 41,796
ton	„ 28	397	+ 63	30	9,990	+ 689
n Corporation	Aug. 5	183	+ 13	§18	3,372	+ 674
castle-on-Tyne Corp.	„ 5	4,272	— 287	18	79,135	+ 5,131
ort (Mon.)	„ 5	725	— 161	18	13,467	+ 773
mpton Corporation	„ 4	567	— 192	18	10,110	+ 855
m, Ashton & Hyde	July 28	623	+ 53	30	16,874	+ 488
n Corporation	Aug. 6	1,961	+ 105	19	38,354	+ 2,315
(N.B.) Corporation	..	..	..	..	..	..
(W.A.) Elec. Trams	„ 4	1,554	+ 1,554	31	50,081	+ 5,756
rough	July 28	141	+ 11	30	3,725	+ 391
south Corporation	..	..	..	..	..	..
les	„ 28	1,937	+ 144	30	57,582	+ 5,655
n Corporation	..	..	..	..	..	..
rham Corporation	Aug. 3	876	+ 156	18	12,398	+ 1,236
ay	July 28	614	+ 59	30	5,546	— 192
Corporation	Aug. 7	4,967	+ 140	§18	91,986	+ 4,978
ial	„ 2	$11,500	+ $682	5	$61,000	+ $5,896
ess	July 28	69	..	30	1,473	+ 77
ld Corporation	Aug. 6	6,197	+ 35	18	123,322	+ 8,295
ore Trams	„ 5	$10,279	+ $181	5	$323,976	+ $18,528
Metropolitan	July 28	1,020	+ 202	30	25,357	+ 1,422
Staffs	„ 28	898	+ 28	30	26,662	+ 2,057
mpton	Aug. 2	1,439	+ 24	18	22,554	+ 2,750
nd Corporation	„ 2	980	— 273	18	12,461	+ 1,489
port Tramways	July 28	402	+ 59	30	8,867	+ 368
dge, Hyde, &c., Jt. Bd.	..	..	..	..	..	..
land Corporation	Aug. 6	1,594	+ 41	18	24,875	+ 3,128
land District	„ 2	581	— 89	40	18,268	+ 1,254
ds Trams	July 23	1,243	+ 85	30	33,476	+ 2,241
on Corporation	Aug. 2	168	— 29	18	2,834	+ 327
on	July 28	47	+ 2	30	1,245	+ 24
outh and District	„ 28	470	+ 90	30	7,196	+ 241
de Trams Co.	Aug. 2	571	— 79	5	2,705	+ 116
ey Corporation	„ 5	1,248	— 88	18	21,072	+ 3,202
ll Corporation	..	..	..	..	..	..
gton Corporation	..	..	..	..	..	..
ham Corporation	..	..	..	..	..	..
n-super-Mare	„ 3	2,707	— 270	18	50,254	+ 5,005
nampton Co.	July 28	423	+ 158	30	3,886	+ 443
nampton Corpn.	„ 28	444	+ 18	30	13,164	+ 658
nster	Aug. 2	1,014	— 133	18	18,404	+ 1,157
ham	July 28	359	+ 37	30	8,562	+ 454
dare W.R. Trams	„ 28	109	+ 10	30	2,946	+ 102
dare Woollen District	Aug. 6	1,361	— 336	32	40,767	+ 1,307
	July 28	1,293	+ 107	30	31,299	+ 2,244

These comparisons are with the corresponding period last year. * Partly electrical.
† Minus 3 days. ‡ Minus 2 days. § Plus 3 days. ¶ Plus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Shrs	Last Dividend	Name	Price Wed., Aug. 9.	*Rate per cent. Yielded. £ s. d.	Dividend Due.	Business Week to Aug. 9. Highest.	Lowest.
		Electricity Supply.					
10	6/0	Bournemouth & Poole Elec. Sup. Ord.	8 —9	6 9 6	Mar, Sep	..	—
10	4/6	Do. 4½ per Cent. Cum. Second Pref.	9 —10	4 14 6	Feb, Aug	..	—
10	6/0	Do. 6 per Cent. Cum. Second Pref.	10½—10¾	5 6 0	Feb, Aug	10¾	—
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101 —103	4 6 6	Jan, July	..	—
5	5/6	Brompton & Kensington Elec. Sup. Ord.	8 —8½	6 1 0	March	..	—
5	3/6	Do. 7 per Cent. Pref.	7½—8	4 1 3	Mar, Sept	..	—
St.	4%	Central Elec. Sup. Co. 4% Guar. Deb. Stock	98 —101	4 0 6	June, Dec	..	—
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	3¾—4⅛	5 2 6	Feb, Aug	4⅛	—
5	2/3	Do. 4½ per Cent. Pref.	4⅛—5⅛	5 2 6	Feb., Aug	4⅛	—
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	94 —98	4 3 3	Jan, July	95½	—
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	100 —102	4 8 3	..	100½	—
5	2/3	Do. City Undertaking 4½% Cum. Pref.	3¾—4⅛	5 10 6	Jan, July	..	—
5	3/0	Chelsea Electric Supply Ord.	4 —4½	5 11 0	March	..	—
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	98 —100	4 11 0	June, Dec	99½	—
10	8/0	City of London Electric Lighting Ord.	12¼—12⅝	4 17 0	Feb, Aug	12⅝	12⅝
10	6/0	Do. 6 per Cent. Cum. Pref.	12 —13	4 12 3	Jan, July	..	—
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	119 —123	4 1 0	June, Dec	..	—
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	100 —103	4 8 6	Jan, July	..	—
St.	5%	County of Durham Elec. P. D. 5% 1st Mort. Deb. Stk.	89½—91½	5 10 6	Jan, July	..	—
10	4/0	†County of London Elec. Supply Ord.	7⅛—7½	3 5 9	Feb, Aug	..	—
10	6/0	†Do. 6 per Cent. Cum. Pref.	11 —11½	5 6 6	Mar, Sept	..	—
St.	4½%	Do. 4½ per Cent. Deb Stock (red.)	108 —110	4 2 6	Jan, July	109½	—
St.	4½%	Do. Second Deb. Stock	100 —103	4 7 6	May, Nov	..	—
5	4/0	Folkestone Electricity Supply Co Ord.	4¼—4⅜	6 13 3	April, Oct	..	—
5	2/6	Do. 5 per Cent. Cum. Pref.	95 —98	4 13 3	Mar, Sept	..	—
St.	4½%	†Do. 4½ 1st Deb. Stock (red)	5¼—5⅛	4 15 3	Feb, Aug	..	—
5	5/0	Hove Electric Lighting Ord.	6¾—7⅛	6 6 3	April, Oct	..	—
St.	4½%	Isle of Wight E. L. & P. Co. Deb. Stk.	88 —91	4 19 0	..	..	—
5	4/0	Kensington & Knightsbridge Ord.	6¼—7⅛	6 6 3	Feb, Aug	..	—
5	6%	Do. 6 per Cent. 1st Pref.	5¼—6	5 0 0	Jan, July	..	—
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	91 —93	4 6 0	..	..	—
St.	4%	†Kensington & Knigtsg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	96 —99	4 1 0	April, Oct	..	—
St.	4½%	Kent Elec. Power Co. Irred Deb. Stk.	78 —82	5 9 9	Jan, July	..	—
3	1/2½	London Electric Supply Ord.	1⅝—2	3 11 3	Mar, Sept	..	—
5	3/0	Do. 6 per Cent. Pref.	4⅜—5	6 3 0	Mar, Sept	4⅞	—
St.	4%	Do. 4 per Cent. 1st Mort. Deb	89 —92	4 8 0	Jan, July	89½	—
5	3/0	Metropolitan Electric Sup. Ord.	3⅞—4⅛	6 1 6	April, Oct	4⅛	—
5	2/3	Do 4½ per Cent. Cum Pref.	4⅛—4½	4 17 0	Jan, July	..	—
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	100 —105	4 7 6	June, Dec	..	—
St.	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	94½—87½	4 1 6	Jan, July	..	—
..	4½%	Midland Elec. Corp. for P.D. 4½ 1st Mort. Debs.	96½—98½	4 12 6	..	..	—
5	2/0	†Newcastle Elec. Supply Ord. (1-50,000 & 57,010-137,500)	3¼—3⅝	6 4 0	Feb, Aug	..	—
5	2/6	†Do. 5 per Cent. non Cum. Pref.	3¼—4⅛	6 5 0	Feb, Aug	..	—
100	4½%	Do. 4½ per Cent. 1st Mort. Deb.	97 —99	4 12 0	Jan, July	..	—
100	5%	North Metro. Elec. Power Sup. 5 Morts.	101 —104	4 17 6	..	102½	—
1	6%	Northampton Elec. Lt. & P. Ord.	1⅛—1⅜	4 11 6	Feb, Aug	..	—
1	5%	Do. 5% Pref.	1⅞—1⅝	4 6 0	Feb, Aug	..	—
..	4%	Do. 4% Debs.	99 —101	3 19 0	June, Dec	..	—
St.	4%	Notting Hill Electric Ord.	..	5 17 6	March	..	—
10	6/0	Oxford Electric Ord.	6¼—6⅝	5 13 9	March	..	—
5	4/3	Do. 4% Deb. Stk.	91 —94	4 5 1	..	..	—
St.	4%	†St. James' & Pall Mall Elec. Ord.	9 —9⅛	5 8 0	Feb, Aug	..	—
5	5/0	†Do. 7 per Cent. Pref.	6¼—7⅛	5 0 0	Feb, Aug	7⅛	—
5	3/6	Do 3½ per Cent. Deb. Stock (red.)	84⅛—86½	4 2 0	Jan, July	..	—
St.	3½%	Smithfield Markets Electric Sup. Ord.	1⅜—1⅝	..	Feb.	..	—
..	..	South London Electric Supply Ord.	2⅝—3	6 5 6	April	..	—
5	4/0	Do. 5% 1st Mort. Stock (red.)	98½—101½	5 0 6	..	..	—
St.	5%	South Metrop'n Elec. Lt & Power 7% 1st Pref	1¼—1⅝	5 18 0	Feb, Aug	..	—
1	0 8⅓	Do. 6 per Cent. 2nd Pref.	⅝—¾	6 17 0	Feb, Aug	..	—
1	0/7½	Do. 4½ 1st Deb. Stock (red.)	97 —100	4 11 6	April, Oct	..	—
St.	4½%	Urban Electric Supply Ord.	½—1	..	April, Oct	..	—
5	1/3	Do. 5 per Cent. Cum. Pref.	2½—3	8 6 0	April, Oct	..	—
5	1/3	Do. 4½ per Cent. 1st Mort. Deb.	87 —89	5 2 3	April, Oct	89	—
St.	4½%	Westminster Elec. Sup. Ord.	7½—8½	6 1 8	Mar, Sept	8	7½
5	5/0	Do. 4½ per Cent. Cum. Pref.	5 —5⅛	4 3 6	Jan, July	..	—
5	2/3	**Electric Railways and Tramways.**					
1	..	Bath Elec. Trams Pref. Ord.	⅛—¼	..	April	..	—
1	0/6	Do. 5 per Cent. Cum. Pref.	⅛—¼	6 13 6	Jan, July	..	—
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	79 —83	5 8 6	April, Oct	..	—
St.	4½%	B'ham & Midland Trams 4½ 1st Deb. Stock	90 —92	4 19 0	Jan, July	..	—
10	4%	Bristol Tramways & Carriage Ord.	6 —6½	6 8 0	Feb, Aug	..	—
10	4%	Do Cum. Pref.	7 —7⅛	5 10 0	..	..	—
St.	4%	Do. 4 per Cent. Debs.	100 —101	3 19 2	Feb, Aug	..	—
10	..	British Electric Traction Ord.	1⅛—1⅜	..	June, Dec	1⅛	1⅛
10	..	Do. 6 per Cent. Cum. Pref.	3¾—4¼	..	Feb, Aug	4¼	3⅞
St.	5%	Do. 5 per Cent. Perpetual Debs.	94 —97	5 4 6	April, Oct	95½	94½
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	76 —80	5 14 6	May, Nov	..	..
St.	3%	Central London Ordinary Stock	68 —70	4 7 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Pref. Stock	87 —89	4 10 0	Feb, Aug	..	..
..	6/4	Do. Pref. Scrip 50% pd	63 —65	..	..	..	..
St.	2%	Do. Deferred Stock	49 —51	4 0 0	Feb.	..	..
100	4%	Do. 4 per Cent. Debs.	102 —104	3 16 11	Jan, July	104½	103
5	2/6	City of Birmingham Trams, 5% Cum. Pref.	4⅛—5⅛	4 19 6	April, Oct	..	—
100	4%	Do 4 per Cent. 1st Mort. Debs	99 —102	3 18 9	April, Oct	..	..
St.	1½%	†City & South London Rly. Con. Ord.	31 —32	5 9 0	Feb, Aug	32⅛	31
St.	5%	†Do. 5 per cent. Perp. Pref. (1891)	108 —110	4 11 9	Feb, Aug	..	..
St.	5%	†Do. (1896)	104 —106	4 16 0	Feb, Aug	..	..
St.	5%	†Do. (1901)	103 —105	4 17 0	Feb, Aug	..	..
St.	5%	†Do. (1903)	102 —104	4 16 0	Feb, Aug	104	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	102 —104	3 17 9	May, Nov	104	103½
10	6/0	Dublin United Trams. 6 per Cent. Pref.	12½—13½	4 10 6	Feb, Aug	..	—
10	12/0	Gateshead and District Trams Ord.	8¾—8⅞	6 19 0	..	..	—
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	⅛—1⅛	..	Feb, Aug	..	—
5	..	Hastings & District Elec. Trams, 6% C. P.	..	..	Mar. Sept	..	—
St.	4½%	Do. 4½ Deb. Stock	75 —80	5 10 0	April, Oct	..	—
10	..	Imperial Tramways Ord.	3 —3½	..	Mar, Sept	..	—
10	..	‡Do. 6 per Cent. Pref.	4 —4½	..	Mar, Sept	..	—
St.	4½%	Do. 4½ per Cent. Debs.	72 —74	6 3 6	Jan, July	..	—
..	2/0	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	2½—2¾	5 0 0	Mar, Sept.	..	—
St.	4%	Do. 4 per Cent. Deb. Stock	77 —82	5 1 0	Jan, July	..	—
10	6/0	Lanarkshire Tramways	10 —10½	5 12 3	Feb, Aug	..	—
St.	5%	Lancs Utd. Trams, 5% Prior Lien Deb. Stk.	79 —82	6 4 0	Jan, July	..	—
St.	4%	London Electric 4% Deb. St.	96 —98	4 2 6	..	97½	97
St.	4%	Do. 4% Pref.	84½—85½	4 14 0	..	85½	—
10	..	London United Trams, 5% Cum. Pref.	3½—4	..	Jan, July	..	—
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	73 —76	5 7 6	Jan, July	..	—
St.	..	Mersey Con. Ord. Stock	6 —8	..	Feb, Aug	..	—
1	1/1⅛	Metropolitan Elec. Tramways Ord.	¾—1⅛	6 0 0	..	..	—
1	..	Do. Deferred	⅛—¼	..	April	⅛	—
1	0/6	Do. 5 per Cent. Cum. Pref.	⅝—1⅛	5 0 0	Feb, Aug	⅛	—
St.	4½%	‡Do. 4½ per Cent. Deb. Stock	99 —101	4 10 0	Jan, July	99	—
St.	5%	Do. 5 per Cent Db. Stk	102½—104½	4 16 6	..	..	—
St.	2%	†Metropolitan Railway Consolidated	45½—46	3 16 6	Feb, Aug	46⅛	45½
St.	3%	†Do. Surplus Lands Stocks	65 —68	3 15 6	Feb, Aug	66½	..
St.	3½%	†Do. 3½ per Cent. Preference	88 —90	3 18 6	Feb, Aug	89	88½
St.	3½%	†Do. 3½ per Cent. "A" Preference	87 —89	3 19 6	Feb, Aug	88½	..
St.	3½%	†Do. 3½ per Cent. Convertible Pref.	87 —89	3 19 6	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Debenture Stock	92 —94	3 14 6	J	92½	87½

* No allowance has been made for accrued interest or redemption.
† Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shares	Last Dividend	Name	Price Wed., Aug. 9.	*Rate per cent. Yielded.	Dividend Due.	Business Week to Aug. 9. Highest.	Lowest.
		Electric Railways and Tramways—*Continued.*		£ s. d.			
St.	2½%	Met. Rly. 3½ per Cent. "A" Deb. Stock..	91 —93	3 16 0	Jan, July	..	..
St.	..	Metropolitan District Railway Ord.....	26½—27	..	Feb, Aug	27†	26½
St.	..	Do. 4½% First Pref.	90 —92	4 19 0	Feb, Aug	91½	90½
St.	3½%	†Do. Assented Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	74 —76	4 13 6	Feb, Aug	..	..
St.	3%	Do. 3 per Cent. Consolid. Rent-charge	76 —78	3 18 0	Jan, July	76	..
St.	4%	Do. 4 per Cent. Midland Rent-charge	102 —104	3 17 9	Jan, July	..	..
St.	6%	Do. 6 per Cent. Perp. Deb. Stock.....	145 —147	4 2 0	Jan, July	105½	..
St.	4%	Do. 4 per Cent. Ditto.....	96 —98	4 2 6	Jan, July	..	..
1	4½d.	Potteries Electric Traction Ord.	⅞—1	6 11 3	April, Oct	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.....	⅞—1	8 0 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent, Deb. Stock.....	88 —91	5 0 0	May, Nov	..	..
1	1/2½	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	⅛—⅜	10 2 0	..	..	..
St.	4%	Dc. 4 per Cent. Deb. Stock.....	73 —78	5 6 0	Jan, July	..	..
100	5%	Sunderland Dist. Elec. Trms. 5% 1stMtDb.	..	8 4 0	Jan, July	..	..
—	10/0	UndergdE.Rys.Lon.6% In. bds with coup?	63 —65	1 10 3	June, Dec	64½	63
—	5%	Do. 5% Prior Lien Bonds.....	100½—101¼	4 19 0	..	..	..
—	4½%	Do. 4½% Bonds with coup. 8	99 —101	4 10 0	..	..	..
—	4%	Do. 4 per Cent 1st Power Ho. Dbs. ..	101 —103	3 18 3	..	..	..
5	..	Yorkshire (W.R.) Elec. Trams. Ord.....	½—¾	..	March ..	..	..
5	..	Do. 6 per Cent. Cum. Pref.....	2½—2¾	..	..	..	..
St.	4½	Do. 4½ per Cent. 1st Debs.....	80 —85	5 9 6	Jan, July	82½	82
		Electric Manufacturing, &c.					
St.	4½%	Anchor Cable Co. 4½ % Deb. Stock	98 —100	4 11 0	—	..	..
1	1/2½	Aron Electricity Meter Ord.....	⅜—½	..	..	..	..
1	0/7½	Do. 6% Cum. Pf.	⅞—1⅛	7 10 0	April, Oct	5⅜	5⅛
1	3/2½	Babcock & Wilcox Ord.	5¼—5⅝	4 15 0	April, Oct	..	..
1	0/7½	Do. Pref.....	1⅜—1⅝	4 0 0	..	..	..
5	6/0	British Insulated & Helsby Cables Ord...	6½—7⅛	6 15 6	July, Feb	..	..
5	3/0	†Do. 6 per Cent. Pref.....	5⅜—6½	5 0 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)..	102 —104	4 7 0	Jan, July	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt.Db.	96 —99	4 11 0	Mar, Sept	..	..
5	..	British Westinghouse 6 per Cent. Pref....	⅛—¼	..	Feb, Aug	..	..
100	6%	Do. 6 per Cent Prior Lien Dbs. (rd.)..	102 —104	5 17 0	..	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock.....	59 —62	6 6 6	Jan, July	61	..
St.	4½%	BrushE.Eng. Co. 4½% Perp. 1st Deb.Stock	58 —63	7 8 6	Mar, Sept	..	..
St.	4½%	†Do. Perpetual 2nd Deb. Stock.....	39 —44	10 10 0	Jan, July	..	..
5	10/0	Callender's Cable Con. Ord.	9 —9½	8 2 0	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.....	4½—5½	4 17 6	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort Debs. (red.)..	101 —103	4 8 0	Nov, May	..	..
1	1/6	Castner-Kellner Alkali Co.....	3½—3⅝	5 4 3	May, Nov	3½	3½
St.	4½%	†Do. 4½ per Cent. 1st Mort. Deb. (red.)..	102 —105	4 7 0	Feb. Aug	..	..
1	1/0	Chadburn's (Ship) Telegraph Ord.	1⅛—1⅜	5 19 0	March ..	..	..
1	0/8½	†Consolidated Electrical Co.....	⅛—¼	7 8 9	August ..	..	..
1	0/6	Consolidated Signal Co.....	⅞—1	8 0 0	April, Oct	..	..
1	0/7½	Do. 6 per cent. Cum. Pref.	½—⅝	7 6 6	April, Oct	..	..
3	..	Crompton & Co (Nos. 1 to 85,000)	⅜—½	..	Jan, July	..	..
100	5%	Do. 5 per Cent. 1st Mort. Debs. (red.)..	57½—67½	8 0 0	Jan, July	..	..
5	1/0	Dick, Kerr & Co. Ord.....	⅛—⅜	5 14 0	Sept.	..	..
5	0/7½	Do. 6 per Cent. Cum. Pref.....	1⅛—1⅜	5 6 0	Sept	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock.....	95 —98	4 13 3	Jan, July	..	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	⅜—⅝	..	Feb, Aug	..	..
	..	Do. (£5 paid)	1⅝—2⅛	9 3 0	Feb. Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (red.)	67 —71	5 16 0	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock.....	78 —81	6 3 6	Mar, Sept	..	..
—	..	Edmundson's Elec. Corp. Ord.....	⅛—¼	..	Jan, July	..	..
5	..	Do. 6 per Cent. Cum. Pref.	2⅛—2⅜	..	May, Nov	2⅛	2⅛
St.	4½%	Do 4½ per cent. 1st Mort. Deb. (red.)..	84 —87	5 3 4	July	..	..
2	2½	†Electric Construction Co.....	⅜—⅝	6 3 0	Jan, July	..	..
2	2/9⅛	†Do. 7 per Cent. Cum. Pref.....	1⅛—1⅜	7 4 6	July	..	..
St.	4%	Do 4 per Cent. Perp. 1st Mort. Debs..	73 —75	5 6 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref. ..	8½—9	5 14 0	June, Dec	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.....	88 —93	4 8 6	Mar, Sept	..	..
5	10/0	Henley's Telegraph Works Ord.....	12½—12¾	5 16 6	Feb, Aug	12½	12¼
5	2/3	Do. 4½ per Cent. Pref.	4½—5⅛	4 10 0	Feb, Aug	5⅛	5⅛
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	106 —108	4 4 6	Mar, Sept	..	..
10	15/0	India Rubber, Gut. Per., &c., Works....	11½—13½	6 0 0	Feb, Aug	..	..
10	5/0	Do 5 per Cent. Cum. Pref.	9½—10⅛	4 19 0	..	..	..
100	4%	Do. 4 per Cent. Debs. (red.)	96 —98	4 1 6	April. Oct	..	..
1	..	National Elec. Construction Co.	⅛	..	April	..	..
1	..	Richardsons, Westgarth & Co., Ltd. Ord.	⅜—½	..	Nov	..	..
1	..	Do. 6 per Cent. Cum. Pref.	⅝—¾	..	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. Perp. Deb. Stock....	77 —80	5 14 6	Jan, July	..	..
5	..	Simplex Conduits 6 per Cent. Cum. Pref.	4½—5	..	..	..	..
12	12/0	Telegraph Construction & Maintenance..	35 —37	5 17 0	Mar, July	35½	35
100	4%	Do. 4 per Cent. Deb. Bonds (1909)	99 —101	4 0 0	Jan, July	..	..
1	1/0	Vickers, Sons & Maxim, Ltd., Ord.....	2⅛—2⅜	4 13 0	..	2⅛	2⅛
1	0/6	Do. 5 per Cent. non-Cum. Preference..	1⅛—1⅜	4 3 0	..	..	..
St.	5%	Do. 5 per Cent. non-Cum. Preferred ..	105 —112	4 11 0	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Db. Sk. (red)	99½—101⅛	3 19 6	June, Dec	..	..
100	4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.)	103 —105	4 6 6	June, Dec	..	..
100	5%	Do. 5 per Cent. 3rd Mort. Debs Scrip...	103 —105	4 16 0	..	..	..
10	12%	J. G. White & Co. 6% Cum. Pref.	14½—15½	7 14 10	..	..	..
1	..	Willans & Robinson Ord.....	⅜—⅝	..	Apr, Oct	⅜	..
5	..	Do. 6 per Cent. Cum. Pref.....	½—1	..	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.....	55 —65	6 3 0	May, Nov	..	..
		Telegraphs.					
10	..	Amazon Telegraph	7⅛—7½	..	June, Dec	..	..
100	5%	Do. 5 per Cent. Debs. (red.)	98 —100	5 1 0	Jan, July	..	..
St.	15/0	†Anglo-American	67 —69	4 8 0	F,My,Ag,N	67½	67½
St.	30/0	†Do Preferred	111¾—112½	5 7 0	F,My,Ag,N	112½	111¾
St.	30/0	Do. Deferred	25⅛—26	5 15 0	F,My,Ag,N	25⅛	25⅛
St.	4%	Commercial Cable 4 per Cent. Deb. Stk...	87½—89½	4 10 6	Jn,Ap,Jy,O	..	..
10	6/0	Cuba Submarine Ord.	10½—11	5 13 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	17½—18½	5 13 0	Feb, Aug	..	..
5	2/0	Direct Spanish Ord.....	3¾—4	5 0 0	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.....	8¼—8½	5 16 0	April, Oct	..	..
50	4½%	Do 4½ per Cent. Deb.	99 —101	4 10 0	Jan, July	..	..
10	3/0	Direct United States Cable	8 —8½	5 18 0	Ja,Ap,Jy,O	8⅛	8⅛
100	4½%	Direct West India Cable 4½% Reg.Db.(rd.).	98 —100	4 11 0	June, Dec	..	..
St.	25/0	Eastern Ordinary xd and bonus	136 —139	5 12 4	Ja,My,Jy,O	138½	136
St.	17/6	Do. 3½ per Cent. Pref. Stock.....	84 —86	4 2 10	Ja,My,Jy,O	85½	84½
St.	4%	Dc. 4 per Cent. Mort. Deb. Stk. (red.)..	101½—103½	3 18 0	May, Nov	103½	102
St.	2/6	Eastern Extension	13½—13¾	5 4 0	Ja, Ap, Jy,O	13¾	13⅛
10	4%	†Dc. 4 per Cent. Deb. Stock	100 —102	3 19 3	Feb, Aug	..	..
25	4%	Eastern and S.Af., 4% Mauritius Sub.Debs	99½—101⅛	3 19 0	May, Nov	..	..
10	5/0	G.N. (of Copenhagen), with Coupon 83 ..	31 —32	5 14 3	Jan, July	..	..
25	52/6	Indo-European	56½—58½	5 6 6	May, Nov	56½	56
100	5%	Mackay Companies Common	87 —89	5 14 0	Ja,Ap,Jy,O	..	..
100	4%	Do. Preference	74 —75	5 7 6	Ja,Ap,Jy,O	..	..
1	1/0	†Marconi's Wireless Teleg. Co.	2⅛—2⅛	..	April	2⅛	4⅛
100	4%	Pacific & Europe'n Tel.4% Guar.Dbs.(red.)	99 —101	4 0 0	June, Dec	..	..
2½	1/3	West Coast of America	1¼—1⅜	5 0 0	May	..	..
100	4%	Do. 4 per Cent. Debs.	97½—99½	4 1 6	Jan, July	..	..
100	1/6	West India & Panama	2⅛—2⅜	4 11 0	May, Nov	2⅛	2⅛
10	6/0	Do. 6 per Cent. 1st Pref.	10½—10¾	5 16 6	May, Nov	..	..
10	6/0	Do. 6% 2nd Pref.	9⅝—10¼	6 0 0	May, Nov	..	..
10	6/0	Do. 5 per Cent. Debs.	101 —103	4 18 0	Jan, July	..	..
100	5%	Western Telegraph	13¾—14½	5 1 1	Mr, Jn,O,D	14½	13¾
10	3/0	Do. 4 per Cent. Deb. Stock (red.)	99 —101	4 0 0	June, Dec	100½	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	106 —109	3 14 3	..	..	..
—	4½%	Western Union Telegraph, $1,000 4% Bds	101 —104	4 8 0	..	..	..
		Do. $1,000 4½% Reg. & Rl. Est. Gd. Bnds					

Shares	Last Dividend	Name	Price Wed., Aug. 9.	*Rate per cent. Yielded.	Dividend Due.
		Telephones.		£ s. d.	
100	2%	Amer. Telephn. & Tslegh. Cap. St.	139 —141	5 14 3	—
..	4%	Do. Coll. Trust $1,000 4 per Cent. Bds.	94 —96	4 4 0	Jan, July
..	4%	Do. 4% Cons. Bonds 1936	111 —113	3 11 3	..
..	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101 —103	4 17 0	Mar, Sept
5	4/0	†Chili Telephone	6⅛—7⅛	4 5 9	August ..
1	0/7½	Monte Video Telephone Ord.....	⅛—¼	6 0 0	Nov ....
1	0/6	Do. 5 per Cent. Pref.	⅛—¼	5 11 0	May, Nov
St.	6%	†National Co. Pref. Stock.....	103 —105	5 14 6	Feb, Aug
St.	6%	†Do. Def. Stock	119 —122	4 19 6	Feb, Aug
10	6/0	†Do. 6 per Cent. Cum. 1st Pref.....	10 —10½	5 11 6	Feb, Aug
10	6/0	†Do. 6 per Cent. Cum. 2nd Pref.....	10 —10½	5 11 6	Feb, Aug
St.	4%	†Do. 5 per Cent. non-Cum. 3rd Pref.....	5⅞—5¾	4 11 3	Feb, Aug
St.	3½%	Do Deb. Stock 3½ per Cent. (red.)....	98 —100	4 1 0	June, Dec
St.	4%	Do. 4 per Cent. Red. Deb. Stock.....	98 —100	4 1 0	Jan, July
St.	4½%	Telephone Co. of Egypt 4½% Db.Stk.(red.)	102½—103½	4 7 6	..
5	5/0	†United River Plate Ord.....	7⅛—7½	5 5 0	July ....
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼—5⅜	4 13 0	June, Dec
St.	4½%	Do. 4½ Deb. St. Red.....	102 —104	4 7 6	Jan, July
		Financial, Investment, &c.			
5	3/0	Elec. & Gen. Investme ..% Cum. Pref...	4 —4½	7 1 0	Jan, July
10	6/0	Globe Telegraph & Trust	10½—11½	5 6 8	Sp,Dcb'r,Ju
10	3/0	Do. 6 per Cent. Pref.	13 —13½	4 10 9	Sp,Dcb'r,Ju
10	6%	Submarine Cables Trust (Cert.)	131 —134	4 9 6	April, Oct
		Colonial and Foreign Electric Railways, Tramways, &c.			
5	2/9	Anglo-Argentine 5% Cum. 1st Pref.	5⅛—5⅜	4 17 6	April, Oct
5	2/9	Do. 5% Cum. 2nd Pref.....	4¾—5⅜	5 1 6	Jan, July
St.	4%	Do. 4% Deb. Stock	94 —96	4 3 4	June, Dec
St.	4½%	Do. 4½% Deb. Stock	103 —102	4 9 0	..
St.	5%	Do. 5% Deb' Stock	100 —102	4 19 0	..
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)....	102 —105	4 16 6	Jan, July
5	4/0	Brisbane Electric Trams. Invest. Ord....	6½—7	5 14 0	May ....
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5⅛	4 17 6	May, Nov
5	4½%	Do. 4½ per Cent. Db. Prov. Certs.....	102 —105	4 7 0	Jan, July
St.	8%	British Columbia El..Rly. Df.Ord.	141 —145	5 12 0	Mar, Sept
St.	6%	†Do. Pref. Ord. Stock	119 —123	4 19 9	May, Nov
St.	5%	Do. 5% Cum. Perp. Pref. Stock.....	106 —109	4 13 0	Jan, July
St.	5%	Do. 4½ per Cent. 1st Mort. Debs.....	100 —103	4 7 6	April, Oct
40	4½%	Do. Vancouver Power Debs.	101 —104	4 3 3	Jan, July
100	4½%	Do. 4½% Perp. Con. Deb. St.	102½—104½	4 2 0	..
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	100 —102	4 18 0	Mar, Sept
St.	6%	†Buenos Ayres Port & City Tram, 1st Mt. Deb. Stock	92 —96	6 8 0	Feb, Aug
5	3/6	Calcutta Tramways (1 to 137,610).....	5½—6½	4 19 6	Mar, Sept
100	2/6	Do. 5 per Cent. Cum. Pref.	5 —5½	4 17 6	Jan, July
1	4½%	Do. 4½% 1st Deb. Stock (red).....	102 —105	4 5 9	Jan, July
St.	..	Cape Electric Tram Shares	⅞—1	..	Feb,Aug
5	1/3	City of Buenos Ayres Trams Co. (1904) Sh.	5⅜—5¾	4 5 0	Mar, Sept
St.	4%	Do. 4 per Cent. Deb. Stock.....	94 —97	4 4 0	Jan, Dec
St.	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.....	95 —100	5 2 6	May, Nov
1	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	99 —102	4 18 0	Feb, Aug
100	5%	Hong Kong Tramways Co. 5 per Cent. 1st Mort. Debs.	77 —81	6 6 6	June, Dec
1	..	Kalgoorlie Elec. Trams Sh.	⅝—¾	..	..
100	5%	Do. 5 per Cent. "A" Deb. Stock.....	92½—95½	5 4 6	Jan, July
5	6%	Do. 6 per Cent. "B" Ditto	63 —67	8 15 0	Jan, July
5	0/6	Lisbon Elec. Trams. Ord.	1 —1½	4 16 0	July ....
100	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1½	4 16 0	Jan, July
St.	5%	Do. 5 per Cent. Reg. Mort. Debs.	97 —101	5 1 0	Jan, July
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	95 —98	5 3 6	Jan, July
St.	5%	Manaos Trams and Lt. Co. 5% Debs.	90 —93	5 9 6	..
100	5%	Manila Elec. Ry. $1,000 Gold Bonds.....	100 —104	4 19 0	Feb, Aug
100	$1½	Mexico Trams Co. Com. St.	120½—122½	5 15 6	..
100	5%	Do. Gen. Con. 1st Mort. 5% Gold Bds.	99½—102½	4 19 0	..
St.	6%	Do. 6% 50 yr. Mort. Bds.	99 —101	6 1 3	..
St.	4½%	†Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922) (Nos. 601 to 2,000)	100 —102	4 9 0	Feb, Aug
1	0/6	Do. do. (Nos. 1 to 4,600)	102 —104	4 7 6	May ....
1	0/6	Perth Elec. Trams Ord.	⅝—¾	2 7 2	..
5	5%	Do 1st Mt. Db. Stock	101½—103½	4 17 6	Jan, July
5	3/0	Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	5⅜—5⅝	5 8 0	..
St.	4½%	Do. 4½% 1st Mort. Deb. Stk.	98 —101	4 10 6	..
100	$1½	Rio Janeiro Tram, Lt. & P. Co.....	116 —117	4 5 9	..
100	5%	Do. 30 yr. Gold Bnds.	101 —102	4 18 0	..
100	5%	Do. 50 yr. Mt. Bnds	97½—98⅛	5 2 0	..
..	$2½	Sao Paulo Tramway, Light & Power Co. $100 Stock	180 —183	5 10 0	..
5	5%	Do. 5 per Cent. 1st Mt. $500 Db.	103 —105	4 15 3	June, Dec
100	4½%	Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	99 —101	4 10 0	Feb, Aug
		Colonial and Foreign Electricity Supply, &c.			
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.....	5⅛—5⅜	5 8 0	Mar, Sept
10	6/0	†Bombay E.S. & T. 6% Cm. Pf.....	10⅜—11⅛	5 9 0	..
St.	4½%	Do. 4½ per Cent. Deb. Stk. (red).....	96½—98⅛	4 12 6	Jan, July
..	5%	Do 5 per Cent. 2nd Mort. Deb. Stock..	96½—98⅛	5 2 6	..
100	5%	Calcutta Elec. Supply Ord.	6⅜—7⅛	5 19 6	April, Oct
100	5%	Do. 5% Cum. Pref	⅛—5⅛	4 13 0	..
100	5%	Calgary Power Co. 5% 1st Mort. Bnds...	96 —98	5 2 0	..
100	7/2½	Canadian Gen. Elec. Co. Com. St.....	110 —115	6 4 3	..
100	$3½	Do. 7% Cm. Pf. Stock	121 —125	5 14 0	..
100	5%	Castner Electrolytic Alkali Co.(of U.S.A.) 1st Mort. Stl. Debs.	94 —99	5 3 6	Jan, July
500	5%	Elect. Development Co. of Ontario.....	86½—88½	5 14 0	..
500	5%	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	84½—87½	5 4 0	Jan, July
10s	..	Indian Elec. Sup. & Trac. Co.	1 —1⅛	..	..
..	..	Kalgoorlie Elec. Powsr & Ltg. Ord.	⅛—⅜	..	..
..	0/7½	Do. 6 per Cent. Cum. Pref.	½—¾	8 6 6	April, Oct
100	5%	Kaministiquia Power Co. 5% Gold Bnds..	101 —103	4 18 0	..
St.	..	Madras E. S. Corp. Ord.	2⅜—3¼	..	..
St.	..	Melbourne E. S. Co. Cons. Ord. St.	35 —40	..	..
500	5%	Do. 5% 1st Mortg Deb. Stock	95 —97	5 4 0	..
500	$1¼	Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	89½—90½	5 11 0	..
St.	$1	‡Mexican Lt. & Power Co. Com. St.	89 —91	4 9 0	..
500	$3½	Do. 7% Cum. Pref. St.	110 —112	6 6 0	..
500	5%	†Do 5% 1st Mort. Gold Bnds.	97½—98⅛	5 2 6	..
100	5%	Monterey Rly. L. & P. Co. 1st Mort. Db. Sk.	87½—91⅛	5 10 6	F,My,Aug
100	8/2½	†Montreal Lt. Ht. & Power Co. Cap. St.	168 —173	4 14 0	..
St.	5%	Northern Lt. Power & Coal 5% Gd. Bds ..	45 —47	5 7 6	April ....
St.	£10	River Plate Electricity Co. Ord. Stk.	218 —228	4 7 9	May ....
St.	6%	Do. 6 per Cent. non-Cum. Pref. Stk. ..	107 —114	5 5 0	Jan, July
100	5%	Do. 5 per Cent. Deb. Stock	101½—103½	4 17 6	..
St.	$1½	†Shawinigan Water & Power Co. Ca.....	117 —119	4 4 9	Jan, July
St.	5%	Do. 5 per Cent. Bds.	107 —109	4 12 6	..
St.	4½%	Do. 4½ Per Cen. Mt. Db. St.	103 —105	4 6 0	..
St.	4½%	Toronto Power Co. 4½% Db. St.	99 —101	4 8 0	Jan, July
—	4%	Victoria Falls Power Co. Pref.	⅛ —1	—	—

* No allowance has been made for accrued interest or redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

Labour Unrest.

ALTHOUGH there is a tendency, in certain quarters, to exaggerate the gravity of the situation, it cannot be denied that the strike epidemic gives cause for serious anxiety. No sooner is one dispute settled than another arises, and there is, apparently, no certainty that any given section will resume work, even on its own terms, unless other sections also receive satisfaction. So far as the electrical industry is concerned it will naturally be affected indirectly as is the case with other industries, but at present it does not appear to be threatened with upheaval. On the other hand, the railway situation is, at the moment of going to press, very difficult, although by no means hopeless. It might, perhaps, be opportune for the railways to consider how far it is possible to supersede hand signalling by automatic electric signalling, thus tending to reduce the inconvenience attendant on a great strike.

Progress in St. Marylebone.

OWING to the ease with which consumers can make alterations to their installations, such changes are apt to pass unrecorded by the supply authorities, and whilst considerable difficulty has always been experienced by the latter in keeping records of connections, &c., the introduction of improved forms of lamps during recent years has brought about such extensive changes in consumers' installations that several engineers have given up the attempt to keep even an approximate record of the apparatus installed. The Annual Report of the St. Marylebone Electric Supply Committee which accompanies the Statement of Accounts for the year ended 31st March last is, however, noteworthy for the careful and detailed particulars as to connections to the mains. It will be seen from the statistics on another page of this issue, where we analyse the past year's Accounts, that in March last 17 electric ovens, of an average capacity of 5 kw., and 150 other cooking utensils were connected to the St. Marylebone mains. At no distant date, therefore, Mr. A. H. SEABROOK will be in possession of valuable figures as to the cost, &c., of electric cooking.

WITH regard to heating, it is very gratifying to notice that the number of electric radiators on circuit increased during the past year by no less than 45 per cent., whilst electric irons seem to be jumping into popularity, since more than three times as many were in use in March last as compared with the number in use in the previous year. It is also surprising to notice the amount of electro-medical apparatus employed, 458 devices, requiring 313 kw., being connected to the mains. Much of the credit for recent progress is undoubtedly due to the Sales and Publicity Department of the undertaking, and whatever criticism may be brought forward as to the methods of this department, it must be admitted that the publicity side of electricity supply has need of development. In the case of an undertaking such as that of St. Marylebone, which is handicapped by abnormal capital expenditure and has not the opportunities for obtaining a large power load, much may be done by the encouragement of the domestic uses of electricity in reducing the capital charges per unit sold.

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Mr. SEABROOK has made a good start in this direction, and the progress of his publicity department will prove interesting to other engineers.

Electrical Research.

As a rule, Mr. C. P. STEINMETZ is both original and entertaining, and his address to a joint meeting of two American societies, an abstract of which appears on another page, will therefore repay careful perusal. He spoke of many things, here a little and there a little, and in the main few people will be found to dispute his conclusions. Nevertheless, there may be some who will raise a protest concerning his complaint that "too often investigators have taken a pair of carbon terminals—since carbon terminals are mostly used in arc lamps—have put various things on them, and then written a treatise on the arc, without ever realising that whatever applies to the carbon arc does not necessarily apply to any other arc." This is unquestionably the truth, but it is not the whole truth. As a matter of fact, a very considerable amount of work has been done with metal electrodes of different kinds under widely varying conditions. It is perfectly correct that only a small corner of the field has yet been explored, but the work goes on, and it goes on in the right direction. Mr. STEINMETZ devoted considerable attention to the causes of lightning phenomena, mainly dwelling upon the accepted idea that the potential of a cloud, or a portion of a cloud, is raised by the coalescence of charged drops. Since the volume of a sphere varies as the cube of the radius and the surface as the square of the radius, it follows that if two equal drops of equal potential join together to form one, the potential of the new drop must be higher than that of either of the old drops.

IT is, perhaps, to be regretted that he did not indicate rather more clearly some possible methods by which his "unexplored fields" might be investigated. It is conceivable, of course, that he desired to draw the attention of engineers, as distinct from physicists, to these problems, in the hope that his audience might be disposed to undertake the work from the standpoint of the so-called practical man. Generally, however, the engineer has neither the time nor the equipment necessary for the investigation of these things, and it is often more convenient to leave it to the physicist to do the inquiry part of the business and then for the engineer to apply the results to practice.

Direct-current Traction at 1,500 volts. — According to "The Times Engineering Supplement" a contract for the electrification of two sections of the Piedmont Traction Co.'s system in North and South Carolina has recently been placed. This contract is especially interesting, as this is the first American railroad electrification project requiring apparatus wound for 1,500 volts direct current. One section, 35 miles long, extends from King's Mountain to Charlotte, N.C., and the other, 95 miles, extends from Greenwood to Spartanburg, S.C., with a 10-mile branch from Belton to Anderson. The power for both the electrified lines will be purchased from a local company and fed to the line through motor-generator sets in substations.

Electricity in Textile Mills.—In the list of members of the committee appointed to consider this question which we published in our issue of August 4th, the name of Mr. S. D. Schofield, electrical engineer of the Shipley Urban District Council, appeared as Mr. J. Schofield.

High Tension Power Transmission in California.—According to the "Electrical World," plans have been prepared by the Pacific Gas & Electric Co. for an additional hydro-electric plant of 71,000 H.P. This will cost about £2,000,000. The plans provide for the erection of two plants in the canyon of the South Yuba river, the first having a head of 1,647 ft.; this will develop 50,000 H.P. The second will use the same water, and will have a fall of 750 ft. developing 21,000 H.P. The overflow of water will be used for irrigation purposes. The Company now serves about 33,000 sq. miles in central California, and has about 1,100 miles of high-tension transmission line.

Results of High-Tension Continuous Current Railway Working.—The Washington, Baltimore & Annapolis Electric Railway was, when first opened, operated by single-phase current. Some years ago, however, the Company thought that better results might be obtained if continuous current at 1,200 volts were used. The change was completed in 1910. According to the "Electric Railway Journal," this high-tension system is reported to give every satisfaction and to be very economical. The maintenance of the single-phase cars cost 0·42d. per car-mile, but the new system only costs 0·09d., whilst the maintenance of the electrical equipment on the cars has fallen by 33 per cent. The total operating expenses for single-phase current were 11·9d. per car-mile, and have been reduced by the new system to 9·5d. Electrical delays have been reduced from 33 per cent. of the total to 19 per cent., although the total delays, including "power off," have been much reduced.

Telephonic Communication between London and Berlin.—It is stated that considerable interest has again been aroused in commercial circles at the prospect of a telephone service between London and Berlin, and the hope is expressed that the project will soon be realised. The new service to Berlin from London appears, from the reports, to be dependent upon a new land line which the French authorities have under construction to the German frontier, and when this is completed and linked up with the German line there will be direct communication between Berlin and London *via* the new cable which has been laid across the Channel by the British Government. There is also said to be a project on foot to establish a telephone line between Berlin and St. Petersburg, a project which has originated with a group of capitalists in the latter city. A Russian electric company has offered to construct the line for 10,000,000 roubles (£1,000,000). The route proposed is *via* Vilna, Warsaw, Lodz, Kalisch, &c.

The Best Position for Rail Bonds.—According to the "Engineer," the ideal place for placing rail bonds is underneath the angle plates. In this position the bond can be made very short, usually not over 10 in. Unless double bonding is required for conductivity, the practice is not recommended. It is better to use a single bond of sufficient capacity. For contact surface about 100 amps. per sq. in. is good practice. Angle plates should have a sufficiently large space between the plates and web of the rail, so that the bonds will not be pinched. In drilling holes in the rail oil must not be used. Sal ammoniac in water is a good lubricant. Immediately after drilling, the hole must be wiped out and the bond put in place without delay. When using a screw compressor a very small amount of flake graphite mixed with oil placed in the punch hole in the bond head will prevent the compressor plunger from cutting the bond, and enable the compressor screw to be turned up much more readily.

Cable Interruptions.	Date of Interruption.
Assab—Perim	July 8, 1909
Latakia—Palura	May 26, 1910
Zanzibar—Mombasa	July 11, 1911

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Rubber Substitute.—The "Electrical Review and Western Electrician" states that the soya, or Manchurian bean, is claimed to make a capital substitute for rubber. The plant is an annual, and grows extensively in Japan and the East Indies. It somewhat resembles the kidney bean. When treated with nitric acid and alkalis, and subjected to great heat, it develops into a rubbery substance that can be vulcanised.

"Mazda" Wire Lamps.—Through the courtesy of the British Thomson-Houston Co., a party of press representatives visited Rugby on Wednesday last and were given an opportunity of inspecting the Company's lamp factory. The occasion provided an opportunity of announcing that the B.T.H. Co. has succeeded in producing a satisfactory drawn tungsten wire lamp. The visitors were shown how readily this material can be handled, especially when it was being wound on suitable supports on the lamp stem. They were also provided with samples of the drawn tungsten wire, and thus were able to test its toughness. The visit to the factory and the announcement made will be referred to more fully in our next issue.

Large Gas Engines for Steel Works.—The "Electrical World" states that the six gas engines being installed in the new power house of the Indiana Steel Co. at Gary, Ind., are the largest units ever constructed. They have a rating of 3,200 kw. each. The new engines are of the twin tandem double-acting Allis-Chalmers type, with cylinders 44 in. by 60 in. The engines will operate on blast-furnace gas, and are to drive alternators delivering three-phase current at 6,600 volts and a frequency of 25 to the power network of the Gary mills. Energy from the Gary power house will also be transmitted to the new plants of the American Bridge Co. and the American Sheet & Steel Co., west of Gary, and to the Indiana Harbour and South Chicago steel mills of the steel corporation. Three gas-engine sets similar to the new Gary units have been ordered for the Central Furnaces at Cleveland, Ohio, and two other units for the Joliet plant of the Illinois Steel Co.

Accidents in Mines.—The annual report for the year 1910 of Mr. R. A. S. Redmayne, Chief Inspector of Mines, which has just been issued shows that the total number of fatal accidents in the coal mines of the United Kingdom was 1,242, involving the death of 1,775 persons. Compared with 1909 there is an increase of 60 in the number of accidents and of 322 in the number of deaths. This total of 1,775 is the largest yet recorded. Of the 1,775 persons killed, 114 were under 16 years of age, as against 95 in the preceding year. Twenty accidents involving the death of the same number of persons were attributable to electrical causes. This is an increase of nine in the number of accidents and seven in the number of persons. Four of these accidents, involving the death of the same number of people, occurred on the pit bank. In metalliferous mines there were 38 fatal accidents which caused 43 deaths. Compared with 1909 the number of fatal accidents is the same, whilst there is an increase of three in the number of deaths. At quarries there were 80 fatal accidents, which resulted in 84 deaths. Compared with 1909 there is a decrease of three in the number of accidents, while the number of deaths remains the same. As regards non-fatal accidents which disabled the injured for more than seven days, the number in coal mines was 58,565, in metalliferous mines 1,578 and in quarries 5,156. Compared with 1909 these figures show increases of 5,736, 62 and 319 respectively. Of these 44, 1, and none respectively were due to electricity.

Electrically-driven Conveyors for Unloading Bananas.—According to the "Electrical World," at New Orleans and Mobile the United Fruit Co. makes use of motor-driven machines of the marine-leg type for unloading bunches of bananas from the holds of its vessels, saving much of the time, labour and damage to the fruit that was formerly occasioned by hand unloading. From an extension boom projecting over the water's edge a 35 ft. vertical marine leg is dropped into the hatch of the vessel drawn up to the wharf. Sprocket wheels on the marine leg and stationary portions of the unloader carry a pair of chains 4 ft. apart, between which, on cross-bars, is stretched a canvas strip so arranged with slack as to form pockets at 3 ft. intervals. The four machines at New Orleans have 92-pocket belts, and each is driven by its own 15 H.P. induction motor. These machines are individually capable of unloading 2,500 bunches of bananas per hour, the bunches weighing from 60 lb. to 120 lb. each. In the hold of the vessel the conveyors are filled from three levels, each level loading into every third pocket of the conveyor, the speed of the latter being too high to permit filling successive pockets from a single position. After reaching the back or dock end of the conveyor the pocket chain passes over a flat roller, which gently discharges the bananas on to a moving belt running along to the cars where the fruit is loaded for shipment by rail. At New Orleans the level of the Mississippi varies periodically by about 14 ft., and the unloaders must be designed for this variation as well as to reach the hatches of any ordinary vessel. The suspended marine leg is supported from an auxiliary boom hinged to the main boom, so that by making a jack-knife bend practically any hatch level or distance from the wharf can be negotiated. The manipulation of the booms and hoists and the side travel of the huge machine along the dock front are all operated from friction clutches on the main conveyor-motor shaft. Within three to five minutes after the vessel's hatches are made ready the machines can be placed in position and the unloading begun. Ships are unloaded in from 90 minutes to seven hours, depending, of course, on the size of their cargo. The four machines at New Orleans working together can unload 10,000 bunches of bananas per hour. Besides expediting the work of unloading and saving labour, the machines effect their most important economy in preventing damage to the fruit. Current is supplied from plug connections placed on the side of the quay.

Current Topics.

Subjects of current interest dealt with in this issue include the following:—

Mr. L. H. Walter contributes an article on the "Accuracy of the Bellini-Tosi Wireless Compass for Navigational Purposes."

We describe an interesting wireless telegraph station erected by Mr. W. Dubilier on Puget Sound, near Seattle, U.S.A.

At a joint meeting of the Franklin Institute and the American Institute of Electrical Engineers, Dr. C. P. Steinmetz contributed a Paper on "Some Unexplored Fields in Electrical Engineering."

We give an abstract of a Paper read by Messrs. A. J. Makower, W. Makower, W. M. Gregory and H. Robinson before the Royal Meteorological Society on "Investigation of the Electrical State of the Upper Atmosphere."

Prof. E. Wilson and Mr. L. C. Budd read a Paper before the Physical Society on "Previous Magnetic History as Affected by Temperature."

Mr. R. B. Williamson recently read a Paper before the National Electric Light Association on the "Ventilation of Turbo-Generators."

We analyse the accounts for the year ended March 31, 1911, of the St. Marylebone electricity department.

Abstracts of the accounts of several municipal electricity and tramway undertakings are given in another column.

Parliamentary.—The Telephone Transfer and Pacific Cable Bills have passed through the Committee stage in the House of Commons.

Legal.—The Osram Lamp Works (Ltd.) have been successful in an action for infringement of patent against the British Tungsten Lamp Co., and an order has been made (by consent) restraining defendants from further infringement.

Companies' Meetings, Reports, &c.—At meetings of the London Electric and Metropolitan District Railway Companies last week Lord Geo. Hamilton gave interesting particulars of the development of the traffic on these lines. Other meetings which are reported include those of the Lancashire & Yorkshire Railway, the Liverpool Overhead Railway and New General Traction Companies.

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PERSONAL NOTE.

The following notice appeared in "The Times" of Tuesday last: Parshall-Johnson.—On August 5th, at Folkestone, Horace Field Parshall, D.Sc., M.Inst.C.E., of 59, Netherhall-gardens, N.W., to Bertha Johnson, of Scruton, Yorkshire.

APPOINTMENTS VACANT AND FILLED.

A lecturer and instructor in telephony (for one evening) and a teacher of manipulative telegraphy (for two evenings per week) are required at the Wimbledon Technical Institute. Applications to the Principal, Gladstone-road, Wimbledon. See an advertisement.

Marconi's Wireless Telegraph Co., Watergate House, Adelphi, London, W.C., have vacancies for two electrical engineers in Spain. See advertisement.

The Committee of East Ham Technical College invite applications for the post of instructor of the evening classes in telegraphy and telephony. Salary 10s. 6d. per evening. Applications to Mr. W. H. Barker, B.Sc., Technical College, East Ham.

The Borough of Aston Manor Education Committee require an assistant master qualified to teach electrical and mechanical engineering and mathematics (especially practical). Commencing salary £160. Applications to Mr. H. Norwood, Education Offices, Aston Manor, near Birmingham, by Aug. 28.

It is announced that Mr. Edward Crabb, C.B., has been appointed second secretary to the Post Office in succession to Sir A. F. King, K.C.B., promoted to be secretary. In view of the approaching transfer of the National Telephone Co.'s business to the Post Office, and in order to secure a proper co-ordination of the work of the Telegraph and Telephone Departments, the Postmaster-General has established a post of third secretary with supervision over those departments. Mr. A. M. Ogilvie, hitherto assistant secretary in charge of the Telephone Department, has been appointed third secretary. Mr. A. B. Walkley and Mr. L. T. Horne have been promoted from principal clerks to be assistant secretaries to the Post Office.

Mr. G. Allbut has been appointed electrical engineer to the Newcastle (N.S.W.) City Council.

Mr. C. H. Lydall has been appointed Argentine representative of Messrs. Merz & McLellan.

Mr. R. E. Armstrong has been appointed charge engineer at the Greenwich power station of the London County Council.

INSTITUTIONS AND SOCIETIES.

American Institute of Electrical Engineers.—It is announced that Mr. R. W. Pope, who has held the post of secretary of this Institute for the past 26 years, resigned his position on the first day of this month. Mr. Pope became connected with electrical work at the early age of 14, and until 1882 was in the employ of various telegraph companies in the United States. In the latter year he was appointed manager of the Union Electric Mfg. Co. of New York, and in 1884 took over the associate editorship of the "Electrician and Electrical Engineer." In 1885 he was appointed to the position he has just resigned, the American Institute of Electrical Engineers having been formed the year before. The Board of Directors have appointed Mr. Pope honorary secretary of the Institute.

Institution of Civil Engineers.—The Council of this institution have made the following awards in respect of students' Papers read during the session 1910-1911: The "James Forrest" medal and a Miller prize to Mr. D. Hay, B.S.., and Miller prizes to Messrs. D. A. Howell, R. Bonner, G. F. Walton, R. G. Parrott, E. E. Farrant, A. C. Dean, B.Sc., H. W. Coales, A. H. Meade, A. C. Swales and H. J. F. Gourley, B.Eng.

EDUCATIONAL NOTICES.

University of Manchester.—A complete theoretical and practical training is given at this University to students preparing for the higher positions in the electrical engineering profession. The subject may be taken as part of the course preparing for the B.Sc. degree in both the Honours Schools of Engineering and of Physics, and a special course has also been arranged extending over three years, and preparing for the certificate in electrical engineering. The John Hopkinson laboratories (which are being extended) and dynamo house are fitted with modern electrical machinery, and good facilities are offered for educational and research work. The 1911-1912 session commences on Oct. 3. Prospectuses may be obtained from the Registrar.

University of Sheffield.—The faculty of applied science comprises the departments of engineering, metallurgy, coal mining and architecture. The courses in engineering or in metallurgy extend over three years and prepare respectively for the degree of B.Eng. or B.Met. of the university. The lecture courses commence on Oct. 4, and the technical laboratory courses on Sept. 18. Prospectuses and other particulars from the registrar, Mr. W. M. Gibbons.

University of Durham.—Armstrong College, Newcastle-upon-Tyne.—The 1911-12 session commences Sept. 25. There are departments of mechanical, marine, civil and electrical engineering, naval architecture, mining, metallurgy, agriculture, pure science, arts and letters. Particulars may be obtained from the secretary, Mr. F. H. Pruen, M.A.

Imperial College of Science and Technology.—During the 1911-12 session an advanced course of instruction on the systematic design and manufacture of dynamo-electric machinery will be given at the City and Guilds (Engineering) College, Exhibition-road, London, S.W., under the general supervision of Prof. T. Mather, F.R.S.

The course is intended for post graduates and other fully qualified students, the number of whom will be limited. The lectures (about 45 in number) will be delivered during the first half of the session by Mr. W. E. Robson, M.I.E.E., and the practical work will commence in October and continue throughout the session. Ratings, frame sizes, windings, &c., for complete lines of machines will be considered in detail, as well as works organisation for systematic manufacture. In addition to lectures, practice in designing, estimating and drawing office work will be given, and advanced laboratory work relating to the limiting conditions existing in modern machines. It is intended that the course should deal with present-day problems in design, construction and testing in a thoroughly practical manner, and an experienced designer and draughtsman, who has been specially engaged for the purpose, will devote his whole time to the drawing office work in connection with the course. Applications for admission to the Dean of the College, Exhibition-road, London, S.W.

City and Guilds Technical College.—This college provides a scientific training for students preparing to become electrical and mechanical engineers or chemists, and for engineering pupils who desire to supplement their practical training by a two years' course of instruction in the principles of engineering science. There are also arrangements for three-year courses in engineering. Particulars at the college, Leonard-street, City-road, London, E.C., or from the City and Guilds of London Institute, Gresham College, Basinghall-street, London, E.C.

Glasgow and West of Scotland Technical College.—The diploma of the college is granted in the departments of civil, electrical and mechanical engineering, mining, naval architecture, chemistry, metallurgy, mathematics and physics, building and textile manufactures. The courses of study usually extend over three sessions and holders of the diploma are eligible for the degree of B.Sc. in engineering of the University of Glasgow, after attendance for at least one session at prescribed university classes. The laboratories are well equipped, and facilities for research are afforded in the departments of physics, electrical engineering, chemistry, metallurgy, mechanics, &c. The preliminary examination begins on Sept. 11, and names of candidates must be sent in by Sept. 1. The day classes begin Sept. 26 and the evening classes Sept. 21. Calendar (by post 1s. 4d.) and prospectuses (gratis) will be sent on application to the Director.

City of Bradford Technical College.—At this college there are full-day courses qualifying for the college diploma in civil, mechanical and electrical engineering. The next session commences Sept. 1. The new power house, especially arranged for experimental and educational work, will be opened during the session, and the equipment of the electrical engineering laboratories and machine room has also been considerably extended and brought up to date. Calendar, containing particulars of all courses, on application to the director of education, Mr. A. C. Coffin.

ARRANGEMENTS FOR THE WEEK.

THE LONDON ELECTRICAL ENGINEERS.

Officer Commanding, Col. H. M. Leaf.

The following orders have been issued:—

Head-quarters will be closed for instruction, but will be open for all work as under until further orders:—

Monday to Friday, 10 a.m. to 4 p.m.

Saturday, 10 a.m. to 12 noon.

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ST. MARYLEBONE ELECTRICITY SUPPLY ACCOUNTS.

In view of the fact that the total sales of electrical energy during the year ended March 31 last showed an increase of 14½ per cent., compared with the figures for the previous year, it will be seen that the St. Marylebone electricity undertaking is making considerable progress. Both private and public lighting and power and heating have contributed to the above increase, the respective figures for the two years being as follows :—

	1911.	1910.
Private lighting	9,151,553	8,447,124
Public lighting	1,397,585	743,002
Power and heat	1,787,818	1,586,333

The large increase in the output for public lighting is due to the Electricity Department having taken over the lighting of the remainder of the street lamps of the Borough; whilst the fact that the number of consumers has increased from 7,479 to 8,098—a larger growth than for many years past—also testifies to the activity of the Department.

The average price received was: for private lighting 3·826d. per unit, and for power 1·477d., the average for the whole of the private supply being 3·44d.

It is very gratifying to notice the steady improvement of the load-factor. For the past year this was 16·9 per cent., as against 15·7 per cent. in 1909-10, 14·5 per cent. in 1908-9, and only 11·8 per cent. in 1906-7. Under these conditions it is not surprising that the cost per unit sold has shown a very satisfactory decrease, and from our analysis below of the past year's accounts, it will be seen that the total cost, excluding capital charges, is now down to 1d. per unit sold, this figure including the cost of the Sales and Publicity Department.

It is, however, as regards capital charges that the undertaking is most severely handicapped. Indeed, it will be noticed that these charges are more than double the total of all the other items, and bring the actual cost of supply to 3·23d. per unit. It may be noted that the present figure for the capital charges, viz. 2·23d. per unit, compares with 2·52d. in the previous year, and 3·01d. in 1908-9, so that progress is being made. These figures emphasise the importance of improving the load-factor of the undertaking, and the present policy of Mr. A. H. Seabrook, of popularising the use of electricity for all purposes, is evidently making a satisfactory impression on these abnormal capital charges.

The statistical tables and diagrams which accompany the Report of the Electric Supply Committee and the Statement of Accounts for the past year are of particular interest in this connection, and are noteworthy for the amount of detail which they contain, very full information being given as to the nature of the connections to the supply mains. The amount of heating apparatus on circuit on March 31, 1911, was as follows, the increase during the previous twelve months being also given :—

Heating and other apparatus on circuit.	March, 1911. No.	Kw.	Increase. No.
(a) Radiators	1,323	1,456	413
(b) Cooking apparatus { Ovens	17	84	52
(b) Cooking apparatus { Sundries	150	121	52
(c) Irons	516	172	356
(d) Medical apparatus	458	313	31
(e) Sundry apparatus unclassified	644	596	73

The number of motors connected to the mains at the same date was 870, an increase of 138 during the year, the total horse-power connected being 3,254. Of the above motors 3 are on hire. An interesting feature also is that the number of repayment supplies has increased by 222, and is now 719.

In connection with the Sales and Publicity Department, the total expenditure for the year was £19,171, this including £4,208 for salaries, £1,679 for establishment expenses, stationery, etc., and £11,228 for goods and works carried out for consumers. The receipts by this Department totalled £16,959, £5,484 of this being for sale of apparatus, &c., to consumers. The net cost of the Department for the year was therefore £2,212; which represents less than 1½ per cent. of the revenue obtained from the sale of current.

It should be noted that this cost also includes that of keeping business already obtained. A special feature has been made of this section, the "satisfied consumer" being the aim in view. An idea of the importance of this part of the Department's work can be gathered from the fact that for quite a month at the end of each quarter practically the whole of the staff is employed in settling account queries and complaints. In every case, in addition to providing a satisfactory explanation, an improved scheme of lighting is drawn up for the consumer.

The Report states that much has been done by the Department in preparing the ground for the application of electric cooking and heating, which offers great possibilities. Finally, the Committee claim that the results show conclusively that the statement made and reiterated that the Department cuts prices and unfairly competes with contractors is without foundation in fact.

We give below an analysis of the various items of expenditure and revenue in the Accounts for the year ended March 31, 1911, together with the cost per unit sold for each item :—

		Cost per unit sold.
Generating Costs.		
Fuel	£13,748	0·27d.
Oil, waste, water, &c.	541	0·01d.
Wages at station	5,228	0·10d.
Repairs and maintenance	2,558	0·05d.
Miscellaneous	148	0·00d.
Total Generating Expenses	£22,223	0·43d.
Distribution Costs.		
Wages	£1,331	0·02d.
Repairs to mains	1,915	0·04d.
Repairs to meters, &c.	1,409	0·03d.
Repairs at sub-stations	1,175	0·02d.
Salaries and establishment expenses	1,897	0·04d.
Total Distribution Costs	£7,727	0·15d.
Management Costs.		
Salaries	£4,994	0·10d.
Meter reading	679	0·01d.
Stationery and printing	601	0·01d.
General establishment charges	1,474	0·03d.
Central establishment charges	350	0·01d.
Law and parliamentary charges	784	0·01d.
Insurance	502	0·01d.
Special expenses	273	0·01d.
Total Management Costs	£9,657	0·19d.
Rents, Rates and taxes	£4,552	0·09d.
Public lighting maintenance	5,210	0·10d.
Sales, publicity, &c. (£19,171 less £16,959 revenue).	£2,212	0·04d.
TOTAL COSTS (*ex.* capital charges)	**£51,581**	**1·00d.**
Capital Charges.		
Interest	£75,617	1·47d.
Sinking fund	37,938	0·74d.
Miscellaneous	169	0·00d.
Part cost of installing street lamps	800*	0·02d.
Total Capital Charges	£114,524	2·23d.
TOTAL COSTS (*inc.* capital charges)	**£166,105**	**3·23d.**
Revenue.		
Sale of current	£156,539	3·04d.
Public lighting (*inc.* maintenance)	13,769	0·27d.
Meter rents	6,179	0·12d.
Rent of property (*less* repairs)	616	0·01d.
Bank Interest	553	0·01d.
Miscellaneous	538	0·01d.
TOTAL REVENUE	**£178,194**	**3·46d.**
Balance	£12,089	0·23d.

This balance is disposed of as follows :—£2,166 is allocated to expenditure in the nature of capital; £1,192 to motors, &c., supplied to consumers; £1,183 to sundry improvements and special works; £48 to capital expenditure written off; £788 to bonuses to staff; and the remaining £6,712 is unappropriated.

The capital expenditure on the undertaking during the past year was £23,884, due almost entirely to the extension of

* Balance (£6,525) charged to General Rate.

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mains in connection with the street lighting, and to service lines and meters for new consumers. The total capital expenditure to March 31 last was £2,061,160, made up as follows:

Purchase of undertaking	£1,399,935
Lands	41,011
Buildings	72,563
Machinery	193,415
Accumulators	15,680
Mains and services	136,609
Meters	19,108
Electrical Instruments	423
Change of pressure and system	149,928
Tools	2,873
Furniture	940
Engineers' commission	23,460
Cost of order and Acts	5,215
TOTAL	£2,061,160

SOME UNEXPLORED FIELDS IN ELECTRICAL ENGINEERING.*

BY C. P. STEINMETZ.

Summary.—The author suggests a number of electrical phenomen[a] which require further investigation. Among these are: the curren[t] distribution in a conductor conveying alternating current, lightning discharges, the conduction of gases and vapours, the loss of energy by a cyclic change of magnetism, magnetic alloys. Two vast fields in which increased knowledge is of immediate industrial importance are: the properties of materials beyond the elastic limit and transient phenomena resulting from the readjustment of the stored energy of systems.

A lot of work has been done along many lines since the early days of electrical engineering and a lot of different fields have been uncovered; but there are larger fields still unexplored and there are regions that are still unknown. For example, there is no simpler and

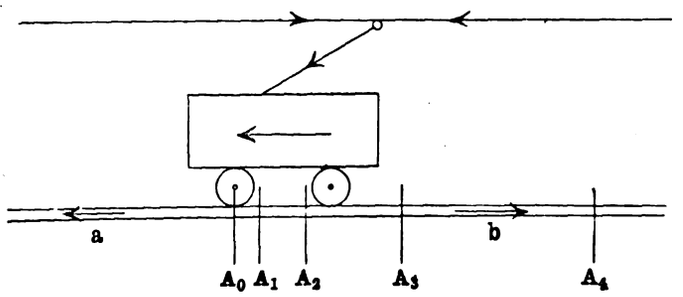

FIG 1.

apparently better known phenomenon than the resistance of a conductor. A conductor has a definite resistance which varies with the temperature, &c. With alternating current the resistance apparently increases in large conductors, because the current flowing in the conductor is not uniform throughout the entire section. We can calculate the phenomena of the lack of uniformity of the current density in the conductor for the case where the current density is not yet very un-uniform (the current density at the centre being only 5 to 10 per cent. lower than at the periphery) and get an approximation which is satisfactory for all purposes of electrical engineering. There is also the other extreme, where the current density in the middle of the conductor is practically zero, and the current is limited to a thin shell on the outer surface as in the rail return of the single-phase railway, or in ordinary conductors at very high frequencies, as with lightning discharges. This case we can also calculate, determine the current distribution in the conductor, the apparent penetration and the effective resistance of the conductor, with an approximation as close as our knowledge of the constants of the material, the conductivity and permeability permits. But when you come to the intermediate and probably most interesting case, where there is current even in the centre of the conductor, but a material difference in the current density between the outside and the centre of the conductor, we find as solution an infinite series, which in this case converges so slowly as to be practically useless, and this case thus is still practically unexplored.

* Abstract of a Paper presented at a joint meeting of the electrical section of the Franklin Institute and the Philadelphia Section of the American Institute of Electrical Engineers.

Another unexplored phenomenon of every-day occurrence: there are many thousands of trolley cars running all over the country with a direct-current supply of about 500 volts, and rail return. While the car passes along the track, the current flows from the wheels down into the rails, and then in the rails to the station, as sketched diagrammatically in Fig. 1. At the point A_0 the current enters the rail from the wheel. To the left of this point, it flows towards the left, as indicated by the arrow *a*. To the right of A_0, it is supposed to flow towards the right, as indicated by *b*, and at the point A_0 the current in the rail thus is supposed to reverse. However, the current cannot instantly reverse in the entire rail section, but the same screening effect of the magnetic field in the conductor, which causes unequal current distribution with an alternating current, makes it impossible for the current inside of the conductor to reverse instantly, and in the first moment, the reverse current *b* thus flows only on the very top surface of the conductor and only gradually penetrates deeper into the conductor, and before the current flows uniformly throughout the entire rail section in the new direction *b* the car has moved hundreds or even thousands of feet. Thus, the current distribution in the rail behind the moving car, in the successive sections A_1, A_2, ... is as indicated approximately in Fig. 2, where the black or shaded portion of the rail shows the section in which the current has already reversed, the unshaded portion the unreversed part, that is, that part in which the current still flows in opposition to the resultant current flow, is running forwards instead of backwards. The obvious result is an increase of the effective resistance of the rail return, which immediately behind a high-speed car may be very considerable. Still this phenomenon, which occurs daily all over the country, has never been investigated, not even been recognised in its existence.

In some fields of electrical engineering or of electrical science we might almost say that we know less now than we knew, or rather believed we knew, a quarter of a century ago. There are things which had been investigated a quarter of a century ago and which were explained in a satisfactory manner to our limited knowledge in the early days, but this explanation does not seem satisfactory now, with our greater knowledge. A curious example we might cite from the text-books on natural history. There are supposed to be some fishes which are capable of giving electric shocks, fishes which have

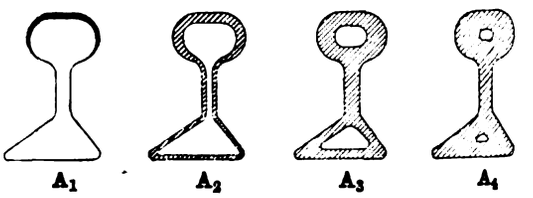

FIG. 2.

an organ which generates electricity; it has been described as being constituted like a Volta-pile. That theory was quite acceptable 25 years ago, but is not satisfactory now. To give a severe shock would require about 500 to 1,000 volts, and it is not intelligible how such voltage could be generated in the conducting animal tissue, without being short-circuited. Furthermore, the fish is immersed in water, which is a fair conductor, especially sea water, and 500 volts or more would produce hundreds of amperes in the surrounding water, representing hundreds of kilowatts, and it is not intelligible how such a large power could be generated even momentarily. Just why that phenomenon has not been investigated by electrical engineers we do not know; especially when considering that one of the electric fishes, *raja torpedo*, lives in the Mediterranean and is frequently caught on the Italian shores, that is, within easy reach of engineers.

But we do not need to go so far from home; right at hand we have some of the most important uninvestigated phenomena of electricity. The thunder-storm, the lightning, and so forth. Speculations were made in the early days as to how the clouds became charged, and as then the only method of producing electricity was by friction, it was said it might be the friction of the vapour through the air, or the rain drops through the air, or some other form of friction. That explanation used to appear satisfactory, but with our present knowledge of dielectric phenomena, it is not satisfactory any more. It was thought that lightning was the discharge from the cloud to the ground. That means that the electric field between the cloud and the ground must be beyond the breakdown strength of air. In a uniform field, the breakdown strength of air is about 75 000 volts per inch, or nearly a million volts per foot. Even if the cloud is only 1,000 ft. above ground, this would require a thousand million volts. If there were

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an electrostatic field between the cloud and the ground of a thousand million volts extending over the whole area of the thunder cloud, this would represent such an immense amount of electric energy that it is inconceivable how any reasonable source of energy can produce it; how it can exist without having a destructive effect far beyond anything known of lightning. Furthermore, a uniform field cannot well exist between clouds and ground, on account of the unevenness of the ground surface.

Let us look into another conception, not a uniform electrostatic field, but an un-uniform field, like that of the discharge between points. With long striking distances between points, the average gradient is about 170,000 volts per foot. This would require only 170 million volts between a cloud 1,000 ft. high, and the ground. This would be more reasonable. It would not require such an unreasonably vast amount of stored electric energy. But we know that in such an un-uniform field the spark is preceded by a brush discharge covering more than half the distance. Thus, lightning should be preceded by a brush reaching down from the cloud and up from the ground, for several hundred feet. Now such an enormous brush has never been observed, and is inconceivable; the brush discharges occasionally observed at points during storms are only a few inches long. Furthermore, a 300 ft. brush is inconceivable, because the resistance of the ground is not low enough to conduct the energy necessary to maintain such a brush discharge. Furthermore, most of the lightning discharges are not between the cloud and the ground, but are internally in the clouds, frequently reaching the length of several miles.

With our present knowledge we must consider as the most probable explanation—although not certain by any means—that the lightning discharge is the phenomenon of the equalisation of internal electric stresses in the cloud, and is analogous to the splintering or breaking of an unevenly stressed brittle material, like glass. But how do those uneven electrostatic stresses originate in the cloud, and how do they reach such values as to cause internal equalisation by rupture?

It is not so difficult to make a preliminary estimate of the building up to very high and uneven voltage distribution in the cloud as soon as you have assumed some initial voltage. We do not know where the initial voltage comes from, but we must accept the fact that there is normally a voltage gradient in the air, a potential difference between different altitudes which may amount to a hundred volts or more per foot. In the air 100 ft. above the ground there may be a potential difference against ground amounting to thousands of volts. Possibly, this potential gradient in the atmosphere may even be of cosmic origin: the earth having a high negative potential against our solar system, against the universe, which would mean that there must be a positive voltage gradient from the surface of the ground into space.

If condensation takes place in the higher regions of the atmosphere, rain drops form, minute drops at first, which necessarily must be at the potential of the air in which they form. That means they have a potential difference against the ground, and therefore an electrostatic charge against the ground corresponding to this potential difference. Assuming now that many of these minute rain drops conglomerate to larger drops, it means that many small condensers conglomerate to one condenser, which is somewhat larger in capacity than each component, but very much smaller in capacity than the sum of the capacities of its components. But it contains all the electrostatic charges of the rain drops, and at the much smaller capacity the same charge gives a higher potential difference. Conglomeration of minute drops into larger ones thus must give a great increase of potential difference against ground. We know the clouds are not uniform in density, and where the density is greatest conglomeration of condensed drops takes place to a much greater extent, building up to a much higher voltage, and thereby between the parts of the cloud of different density, the light and the dark portions, potential differences must appear and increase with increasing condensation, until somewhere the disruptive gradient is passed, equilisation occurs by a lightning discharge, and then the same play repeats again and again. Lightning discharges, then, are the result of the voltage inequalities produced in the clouds by the unequal rate of conglomeration of rain particles due to the unequal cloud density. In agreement with this is that heavy lightning strokes are usually followed by a heavy downpour of rain; in reality they are preceded and caused by it, but it takes time for the rain drops to come down.

Let us assume now that the process is reversed, and after conglomerating to high voltages the rain drops evaporate again. Since gases apparently do not carry electrostatic charges, the rapidly dwindling rain drop retains its entire charge, hence must rise in potential, and finally must discharge, and this progressive evaporation of the rain drops must also result in the building up of potential differences and therefore the formation of lightning, and this may explain the two forms of lightning—that accompanying rain-storms and thunder-storms, and the so-called "heat" lightning. The former is the result of condensation and conglomeration, the latter the result of evaporation of rain drops.

Again, we must abandon the conception of the theory of electrostatics of the early days—which still largely is used in theoretical text-books—as incorrect and useless. Capacity is not the capability of the conductor to store electric quantity, but is the ratio of the number of lines of dielectric force to the E.M.F. which produces them; "charging current" is no more a current charging the conductor with electricity than the "inductance voltage" is a voltage charging the conductor with magnetism; the former, as "capacity current," supplies the energy stored in the dielectric field, just as the inductance voltage supplies the energy stored in the magnetic field, and dielectric and magnetic phenomena are very largely analogous and treated in the same manner and with the same simplicity.

Next, as to the conduction of gases and vapours, it is a field in which an enormous amount of investigation has been carried on in late years by the physicists, so that it may almost be called the best explored branch of modern physics. Unfortunately, there has been very little, if any, benefit from all this work to the electrical engineer. If you ask some simple engineering question, as, for instance, you have a Geissler tube, 4 cm. diameter and 10 m. long, filled with nitrogen gas under 0·1 mm. pressure. What will be the voltage required to pass a current through the tube; what will be the amount of light given by it; and how will the voltage vary with the current and with the gas pressure? The answer is unknown.

We now have some data on the electrical constants of gas conduction, and our knowledge is rapidly increasing by the work of engineers, who finally, as in other fields of research, despairing of ever getting the scientific investigators to drop metaphysical speculations long enough to determine physical facts, have started to investigate the engineering facts themselves.

The same applies to arc conduction, though arc conduction has been investigated by the engineers for a much longer time, and more is known about it. Much of the work done on arc conduction is worse than useless, by unjustified generalisation. Too often investigators have taken a pair of carbon terminals—since carbon terminals are mostly used in arc lamps—have put various things on them, and then written a treatise on "the arc," without ever realising that whatever applies to the carbon arc does not necessarily apply to any other arc.

The conductor in the Geissler tube is the gas which fills the space between the electrodes, and the material of the latter is therefore of secondary importance; but the phenomena, as the voltage, the colour and the spectrum of the light, &c., essentially depend on the nature of the gas in the space between the electrodes, and on its pressure. In the arc, however, the conductor is a stream of electrode vapour; the material of the electrode therefore is of fundamental importance on the voltage, luminosity, colour and spectrum of the arc stream, while the surrounding gas is of secondary importance only. The conducting vapour stream, or "arc stream," usually is at the boiling point of the electrode material. The carbon arc thus is the hottest arc. The dielectric strength of gases decreases with increase of temperature, and at the temperature of the carbon arc stream has fallen below the voltage drop in the arc stream, so that in the carbon arc all the phenomena resulting from the dielectric strength of the vapour stream are absent, since the surrounding air has a disruptive strength less than the supply voltage of the arc. Nearly the same is the case with a few other very hot arcs. The carbon arc thus is not a typical arc, but is one of the extremes in a series of arc conductors, of which the other extreme probably is the mercury arc, as the coldest arc. The latter thus gives the phenomena of the dielectric strength of the arc stream most pronounced.

As the phenomena of arc conduction essentially depend on the temperature of the arc stream, that is, the boiling point of the electrode material, typical conditions we can expect only from electrode materials having boiling points intermediate between the extremes, carbon and mercury. Such are many metals, as iron, copper, &c. The iron arc thus is a typical arc, but not so the carbon arc. In the study of a typical arc we find that the vapour stream, which conducts the current, issues from the negative terminal, as shown by its spectrum, and by the character of the arc; the latter depends on the material of the negative terminal, but is unaffected by any change of the positive terminal. The vapour conductor of the arc is moving rapidly from the negative terminal towards the positive, and is a conductor in the direction from the negative terminal to any point reached by the arc stream, which is positive towards the negative arc terminal, but is non-conducting with regard to any body negative towards the negative arc terminal. The arc stream is a unidirectional conductor, and is extensively used for rectification.

The voltage range, within which an arc stream is non-conducting towards a negative body, or, as usually called, the "rectifying vol-

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tage range of the arc stream," is determined by the disruptive strength, and thus is a function of the temperature. It is many thousand volts with the low temperature mercury arc, is still several hundred volts with the iron or copper arc, but vanishes below the temperature of the carbon arc, and the latter thus does not show any more the unidirectional conductivity of the arc stream to any marked extent. It is therefore an exception, and is not a typical arc.

As in arc conduction the conductor is the unidirectionally moving electrode vapour stream, this stream has first to be produced, by the expenditure of energy, before arc conduction can begin. In an alternating current arc at every half wave a new arc stream has to be started, in opposite direction from that of the preceding half wave of current, and the supply voltage thus must be high enough to jump a static spark across the arc terminals through the residual hot vapour of the preceding half wave. This voltage is low with the carbon arc, but becomes very high with a lower temperature arc.

Entirely different from arc conduction apparently is the conduction of the Geissler tube and of the electrostatic spark. Geissler tube conduction and the electrostatic spark, however, apparently are the same phenomena, differing only by the difference of gas pressure. Thus we can pass gradually from the noisy and brilliant short-circuiting spark to the streamer, brush discharge, corona and to the silent discharge or steady glow. But while a gradual transition from Geissler tube conduction to spark conduction exists, I have never been able to get any gradual transition from Geissler tube conduction to arc conduction. Under conditions where both can occur, the one always changes abruptly into the other, and these two classes of conduction thus seem to be different in their nature: the one conduction by the gas in the space between the electrodes, the other conduction by a stream of electrode vapour. Thus, if we have a Geissler discharge through mercury vapour, of limited current and high voltage, and gradually cut the resistance or reactance out of the circuit, or increase the supply voltage, the Geissler discharge suddenly, with a "flash" changes to arc conduction; the current rises and the voltage drops. Cutting resistance in again, just as suddenly the arc drops, and is superseded by the Geissler discharge. Here, then, we have an very interesting and very important field, in the conduction of gases and vapours, in which still very much is unknown.

"Permanent magnetism" is still an unexplained and mysterious phenomenon. The question is, What is permanent in the permanent magnet? The magnetic flux, or the magnetomotive force, or the flux density or flux distribution, or the magnetic energy?

Another interesting and important phenomenon of magnetism is the loss of energy by a cyclic change of magnetism, as occurs in an alternating magnetic field. Twenty years ago I found this loss to be expressed empirically by the 1·6th power of the magnetic flux density, with sufficient approximation over a wide range of magnetic densities. Since that time, some observers have found that for very high magnetic densities the loss is less than that given by this law of the 1·6th, and other observers find that it is more. Considering the great difficulty of getting exact results at high densities, it appears probable herefrom that even at high densities the law of the 1·6th power still applies at least approximately. For very low densities I have shown that it finally cannot continue to hold, but the coefficient must increase to 2·0. However, with all the work done on magnetism, we still are entirely in the dark regarding the cause of this strange coefficient 1·6. The only other instance of such a fractional exponent is the exponent of the adiabatic expansion curve of gases, 1·4.

Only recently another instance has been found, where the coefficient 1·6 appears. The resistance of pure metals, as the tungsten filament, is proportional to the absolute temperature: $r=aT$. The black-body radiation, however, is proportional to the fourth power of the absolute temperature, and if no other loss of power occurs, as when the radiator is enclosed in a high vacuum, as in the tungsten filament incandescent lamp, the power input equals the radiation power, and thus also is proportional to the fourth power of the absolute temperature, $p=bT^4$. Substituting $r=e/i$ and $p=ei$, and eliminating T, gives $e=ci^{1·6}$.

That is, in a perfect metal, which gives black-body radiation, in a high vacuum at high temperatures the impressed voltage varies with the 1·6th power of the current. This is the only other instance of a 1·6th power law which I found. It may be a mere coincidence, but it is interesting to reflect that here as well as in the hysteresis law, a conversion of electric energy into heat takes place.

Even in fields where very much is known, there are numerous trails leading into unexplored regions. Magnetism, for instance, is one of the most explored branches of electrical science. It was known many years ago that manganese has some curious magnetic properties: a few per cent. added to iron makes it practically non-magnetic. However, it is non-magnetic only in its virgin state, and by heat treatment it is brought into a magnetic state, where it has about the same characteristics as other steels. Here, then, you find a material which may be magnetic or unmagnetic. This trail was never followed up until a few years ago, when a strongly magnetic alloy of manganese, copper and aluminium was discovered. It seemed to overthrow all our conceptions on the nature of magnetism as an elementary property. Even then, however, most investigators followed the same trail, making various alloys of these three metals, and speculating on the cause of the magnetic property of the alloy of three unmagnetic metals, without following the trail further, to the study of other alloys of these metals. Such study shows that copper and aluminium are immaterial for the magnetic property, but that manganese is essential, and is indeed a magnetic metal. Pure manganese has never been produced in the magnetic state, but numerous alloys of manganese, as those with antimony, tin, zinc, &c., are magnetic or may be brought to a magnetic state. Most interesting is the manganese-antimony alloy, as it can be produced much easier than the Heussler alloy of manganese, copper and aluminium. Mixing coarsely powdered manganese and antimony, in the proportion, for instance, of 1 : 3, by moderate heating—in a test-tube over the bunsen burner—the mass becomes strongly magnetic and can be used to show the lines of force of a magnet, just like iron filings. When I tried the magnetic properties of a collection of various alloys, which I had for a considerable number of years, I found quite a number of manganese alloys which showed magnetic properties. Thus after all we do not have to change our conception of magnetisibility as a property of the element, but it merely means that manganese—and possibly chromium—have to be added to the list of magnetic metals.

Oxygen also is magnetic, and now should be easily available, but I do not know that its magnetic characteristics have ever been investigated, except very roughly and qualitatively. While it may not be of industrial importance, it certainly is of great scientific interest, as the only magnetic non-metal and non-conductor. We do not know its magnetisation curve, whether magnetic saturation occurs, and what the saturation value is, whether there is a hysteresis loss, &c., whether and how far ozone shows the magnetic properties, &c.

A curious oxide of chromium has been mentioned for years which has strongly magnetic properties. It is formed by the reduction of chromylchlorid, within narrow temperature limits.

With manganese, a lower oxide of the metal seems to exist, which has much greater magnetic properties than any of the manganese alloys investigated, and even on the old and well-known magnetic oxide of iron, the only data which we have are investigations made 20 years ago, but which apparently have never been continued further.

You see, there is really no lack of unexplored phenomena in the realm of electrical science and engineering. But the two vast fields in which an increased knowledge is of immediate industrial importance, and in which indeed energetic investigating work is going on, are the study of the properties of materials beyond the elastic limit and the study of transient phenomena resulting from the readjustment of the stored energy of systems.

Most investigations of physicists have dealt with the properties of materials below the elastic limit, where the processes are reversible. But of almost greater interest is the range beyond the elastic limit, where the action of forces is not reversible, where mechanically the materials are deformed, such as where steel is rolled into rails, or wire is drawn. So with the electrical forces, in the electrostatic field, irreversible phenomena occur at high voltage, in the corona; energy is stored into the dielectric field, but is not returned, but dissipated as heat, if the dielectric flux density reaches beyond the disruptive strength of the material, and in our modern high voltage transmission lines we have closely approached this limit. In the field of magnetism, the phenomena of hysteresis represent such an irreversible process. So also the ageing of many kinds of magnetic materials, &c.

The second important field of investigation is the study of the transients. Transients are the phenomena by which stored energy adjusts itself to changed conditions of the system. Most of our electrical engineering theory deals with the steady flow of electric power, by direct or by alternating current. But accompanying the flow of electric power is a storage of electric energy in the magnetic and in the dielectric field of the conductor, and any change of the circuit conditions, any change of current and of voltage, thus usually involves a change of the stored magnetic and dielectric energy. Since a change of stored energy cannot occur instantly—as this would represent infinite power—a transition period thus must intervene after every change of circuit condition, that is, an electrical transient occurs. When the electric systems were small, these transients usually were of negliglible energy; but with our modern huge systems, the stored energy is such that the transients frequently may reach destructive powers, and therefore their study has become of great industrial importance.

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SOME ALLOYS FOR PERMANENT MAGNETS.*

BY C. F. BURGESS AND J. ASTON.

In the investigation of electrolytic iron and its alloys, carried out at the University of Wisconsin, under agrant from the Carnegie Institution at Washington, tests were made of the magnetic qualities of all samples. Among these, many showed low permeabilities and high coercive forces suggesting their utility for permanent magnets, rather than as electromagnetic material. Upwards of 100 samples were tested for this feature; all the bars contained chromium, manganese, molybdenum, nickel and tungsten as binary alloys, or in various combinations together or with other elements. Much information regarding the best steels and the best treatment for permanent magnets has undoubtedly been accumulated by the manufacturers and users of such material, but is held as a trade secret; and published data along these lines is very meagre. Again, such publications deal largely with the study of the critical points of the steels, with the view to determining the proper heat treatment to give them for the best service.

The tests here recorded are for the most part on carbon free alloys. The results are mainly of value, therefore, as indicating the influence of the various elements in inducing the conditions necessary for a good permanent magnet. They were made upon an Esterline permeameter, an apparatus giving directly the flux density in the bar under test for any impressed magnetising force. It consists of a small dynamo, driven at predetermined constant speed. The test bar forms part of the magnetic circuit of the generator, and can be subjected to magnetising forces of varying degrees. The flux density in the bar, being directly proportional to the voltage set up, can be read off on a properly calibrated millivoltmeter.

It is not necessary to make a complete magnetisation curve in testing material for permanent magnets. The desirable feature is to have as high a residual magnetism as possible, or, better, to have a high retentivity after some disturbing factor has tended to destroy the residual magnetism, together with a high coercive force to resist the tendency towards this loss of the magnetic flux. The method of procedure was as follows: The bar was inserted in the permeameter, the magnetising force H was raised to the maximum of 200 and the density $B_{max.}$ was recorded, H was decreased to zero, and the retentivity $B_{ret.}$ noted; next the coercive force H_c, necessary to reduce the retentivity to zero, was determined. Similar readings were taken for the reverse magnetising forces, and the average of these positive and negative readings of $B_{max.}$, $B_{ret.}$ and H_c for each bar was recorded for comparison. In fact, the whole operation is identical with the taking of a hysteresis loop, in which only the few readings noted above were recorded.

The bars were tested as forged, and after water quenching at 1,000°C. To prevent oxidation of the samples while heating them for quenching, a barium chloride bath was used. The quenching at 1,000°C. may not have brought out the best qualities of some of the bars; but it was deemed the best general treatment, since with so many bars under test it was impossible in this research to subject each sample to tests for its critical points and special conditions of heating.

In addition to the general test noted above, all bars which showed fair retentivity and a coercive force above $H_c=30$ were subjected to a test for their stability or their ability to hold residual magnetism after shock. For this test the bar was subjected to the maximum magnetising force of $H_c=200$, and the retentivity noted when this magnetising force was reduced to zero. The bar was then removed from the machine, subjected to the disturbing factor, and the retentivity again recorded after reinserting the sample in the permeameter. The two means commonly employed in practice for seasoning permanent magnets were used—namely, jarring or rapping the bar, and boiling. For the latter treatment, each bar was inserted in a piece of wrought-iron pipe, which served as a shield to prevent the mutual influences of the magnetic fields, and boiled in water for three hours.

A large number of comparative trials of the rapping and boiling treatments showed them to be practically equal in their effect, and because of the simplicity of the former, it has been resorted to in the later tests. However, should the material be very brittle, it would be safer in practice to use the boiling method.

The alloys tested are divided into five groups, according to their content of chromium, manganese, molybdenum, nickel and tungsten, either alone with iron, or together with iron and any other elements except the above five; in addition, a sixth miscellaneous group includes materials of various compositions in which more than one of the above five metals are present. The results as a whole showed a wide variation in the physical and magnetic hardness of the various bars, not only before quenching, but afterwards as well. Also, it appeared that the effect of quenching was varied in its results, with either increase or decrease of coercive force, or with no material alteration. However, it appeared that where marked changes were the result, it was generally with an increase of magnetic hardness.

Chromium.—In the chromium group, it appears that this element alone, even in percentages as high as 16·65, does not result in bars of high coercive force suitable for permanent magnets, even after quenching at 900°C. And the coercive force was no higher with large than with small chromium additions. A large number of chrome-silicon alloys were tested, and in practically all cases the bars were relatively soft and of low coercive force in the forged condition. The coercive forces in all but two instances were well below 30, and the alloys were thus unsuited in this state for permanent magnets. In these two instances but little change resulted on quenching; but for the other bars, quenching resulted in a marked increase of coercive force; and with the accompanying relatively high retentivities, these materials were well adapted for permanent magnets. The best alloys seemed to have about a medium chromium content (5 or 6 per cent.), since then the retentivity was high and the coercive force great enough to ensure stability.

The addition of vanadium also seemed to be very beneficial, although in this case the raw forged bars were especially hard, and the coercive forces were high initially, and suffered but little change in quenching. Here, again, the best results seem to be gained with medium chromium content, because of the higher retentivities. In a few instances, carbon was present, together with vanadium and silicon. The materials showed hardening upon quenching, but the magnetic results were no better than where there was no carbon.

Summarising, it may be said that the addition of chromium alone to carbonless iron will not result in a material suitable for permanent magnets; but that the further addition of 0·75 to 1 per cent. of silicon or 0·3 to 0·5 per cent. of carbon to 5 or 6 per cent. of chromium is highly beneficial, and gives an alloy very suitable for this class of service.

Manganese.—According to the classification adopted, the only manganese alloys falling in this group were of a series in which manganese alone in varying amounts had been added to the iron. In the raw forged condition, the coercive force increased, with a corresponding decrease of retentivity, for each increase of manganese content, until at 10·41 per cent. Mn the alloy was non-magnetic. A bar with 10 per cent. of manganese had the high coercive force of 90·1, but the retentivity was too low for permanent magnets. The most satisfactory bars were two with 4·51 and 6·0 Mn, where the retentivities were fairly high and the coercive forces great enough to ensure stability. But three bars were tested after quenching, and the result was a decrease of coercive force, a peculiarity corroborated by other tests upon this series.

Molybdenum.—Of the entire set of this series of alloys, only one was magnetically hard in the forged condition; this was a bar of composition 8Mo, 0·3V, 0·6C, which had the high retentivity of 9,200 and the fair coercive force of 39·0. In the quenched condition, there was practically no change in any of the carbon free alloys. But in four cases where carbon was present the quenching resulted in physical hardening of the bars, and they became very fine materials for permanent magnets, with exceptionally high retentivities and very good coercive forces. In one case, a bar with 4Mo and 0·6V attained a good coercive force; whether this was due to absorbed carbon is problematical. If the magnetic hardening took place without the aid of carbon, it would indicate that the proper conditions of temperature, &c., might have the same effect on the other molybdenum alloys. This is merely conjecture, however, and the tabulated results showed no hardening effect of vanadium, such as was noted for the chromium alloys.

Nickel.—In the binary alloys of nickel and iron, increase of nickel caused a decrease of retentivity and increase of coercive force, until at about 26 per cent. of nickel the material was non-magnetic. Beyond this percentage, the magnetic properties were restored, the alloys being of rather high permeability and low coercive force. Quenching at 900°C. invariably greatly decreased the coercive forces, so that none of the binary nickel alloys can be considered suitable for permanent magnets in the quenched condition, either because of low coercive force or because of low retentivity where the coercive force is ample. The addition of vanadium resulted in increased magnetic hardness, which was again increased by quenching. The most satisfactory bar was one with 10Ni and 0·6V, which in the forged condition had a retentivity of 9,900 and a coercive force of 32·6; both values were slightly lowered by quenching. One bar with 10Ni, 2Si, 1C had a fair retentivity of 6,800 with a high coercive force of 62·0 in the forged condition; but after quenching it became almost non-magnetic. The nickel alloys as a whole, therefore, cannot be regarded as satisfactory materials for permanent magnets. In this case, as noted for chromium, the vanadium seems to act as a hardening agent.

Tungsten.—Seven binary alloys of tungsten and iron were recorded, with a tungsten content varying from 0·93 to 23·87 per cent. In no

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instance was the coercive force high enough to make them suitable for permanent magnets; and quenching had but little effect, usually resulting in a decrease of coercive force. For the two alloys, where there was an addition of vanadium, one bar, with 4W and 0·4V, became, after quenching, an exceptionally good permanent magnet, with a retentivity of 11,300 and coercive force of 43·8; on the other hand, another sample, with 7W and 0·3V, experienced but slight increase of hardness. A bar with 5W and 0·5C became noticeably harder after quenching, with increase of retentivity and coercive force to the high values of 11,700 and 59·0. Four other bars were good for permanent magnets as forged, and there was a marked hardening due to quenching. Summarising, the binary alloys of tungsten and iron are not satisfactory for permanent magnets. The addition of vanadium may be beneficial, and the addition of carbon certainly is. There were in this series some highly satisfactory alloys; of those worthy of particular mention, however, all but one contained carbon.

Miscellaneous.—This miscellaneous group included such a large number of combinations of these several self-hardening alloys that a systematic discussion of the results is difficult. Of the 51 bars here grouped, almost two-thirds were good materials for permanent magnets. The effect of quenching was somewhat varied; in 13 instances there was a considerable increase of coercive force, in 30 cases but little change, and in six instances a marked decrease. In four cases bars which were originally poor became of fair quality after quenching; and in numerous instances the quality of fair materials was greatly improved; in no case, however, has quenching resulted in a bar of fair quality becoming poor material for permanent magnets although at times the quality was better before quenching than after. One of the most striking features noted was the detrimental effect of the additions of nickel, with its tendency towards non-magnetic alloys. In all cases where the material was classed as non-magnetic, or where it was worthless for permanent magnets because of very low retentivity, there was a considerable amount of nickel present. Of the 17 bars of poor quality for permanent magnets, 12 had nickel; and of the five bars without nickel, the quality was poor not because of a tendency towards being non-magnetic, but because the coercive force was too low. Several bars of nickel with chromium, with molybdenum or with tungsten, had fair retentivities together with high coercive forces. The various combinations of chromium with molybdenum or tungsten, either alone or with additions of silicon, vanadium and carbon, gave generally satisfactory results. In fact, it is difficult to point out any preferable combinations of these various self-hardening elements beyond the caution to keep nickel out of the alloy. Of particular quality may be mentioned the following:—

Bar.	Composition.	$B_{ret.}$	H_c	
136M	5Cr 3Mn 4Mo 1St	11,350	55·8	As forged
136V	10Ni 5Mo	10,150	36·7	,,
150C	2Cr 10Mo 0·5C 0·3V	10,500	78·0	Quenched
155Y	10Ni 5W	10,300	35·2	,,
156A	1Mn 2Mo	10,500	39·6	,,
155P	1Mn 10Mo 0·5C.	10,750	58·4	,,

Strange to say, two of these alloys have a high nickel content, but they may be put down as exceptions to the general rule. The values given above indicate a very high standard of material for permanent magnets.

Summarising, it may be deduced from the above tests that chromium, manganese, molybdenum and tungsten are the important additions in the manufacture of steels for permanent magnets; but the presence of some third element is necessary. While carbon is beneficial, it is possible to obtain highly satisfactory materials either by various combinations of the above four elements or by suitable additions of silicon or vanadium, the latter, in particular, being very desirable. Also, suitable materials may be made which will require quenching, although in this case carbon is most beneficial; or, if desired, equally satisfactory results may be obtained without.

Stability.—As mentioned previously in the general discussion of the tests for permanent magnets, a better indication of the value of material for this service is obtained by a stability test which gives the residual magnetism after shock. In our tests the rapping method was used, the details being given above. Those bars were tested which showed a coercive force above 30, either before or after quenching, this being considered the minimum value at which permanence might be expected. The figures of interest are those for the retentivity $B_{ret.}$ after rapping; they show the marked decrease of the residual magnetism due to shock, a decrease averaging about 50 per cent., but varying according to the coercive force of the material under test. As a result of these tests, it appears that for the investigation of materials for permanent magnets, this stability test gives a very satisfactory indication of the quality. In addition, of course, it would be necessary to test the ageing qualities, or the ability to retain this residual magnetism for long periods of time, and under working conditions.

VARIATION OF THE RESISTANCE OF SELENIUM WITH THE E.M.F.*

BY J. LUTERBACHER.

W. G. Adams found during his experiments on crystalline selenium that the resistance of a selenium "cell" varies with the E.M.F. to which it is exposed, and that, in general, the resistance decreases as the E.M.F. increases. This effect is examined in detail in the present Paper, with a special consideration of the alternate-current resistance.

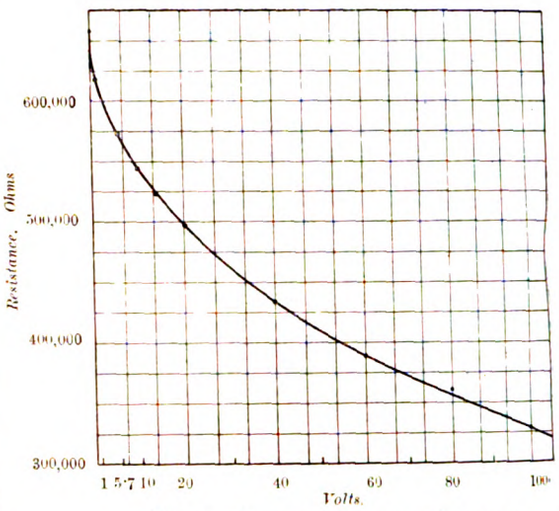

FIG. 1.—VOLTAGE EFFECT IN SELENIUM.

In all the tests the variations due to illuminations and heating were eliminated by keeping the cells for several days together at a temperature of melting ice and in absolute darkness.

Most of the cells examined were of the Shelford–Bidwell pattern. To these was added a Ruhmer cell of the glow-lamp type.

The cooling was carried out by enclosing the cells in a water-tight brass box containing a piece of calcium chloride for absorbing traces of moisture. The box was then surrounded by 10 kg. of ice in small pieces, which was renewed as found necessary.

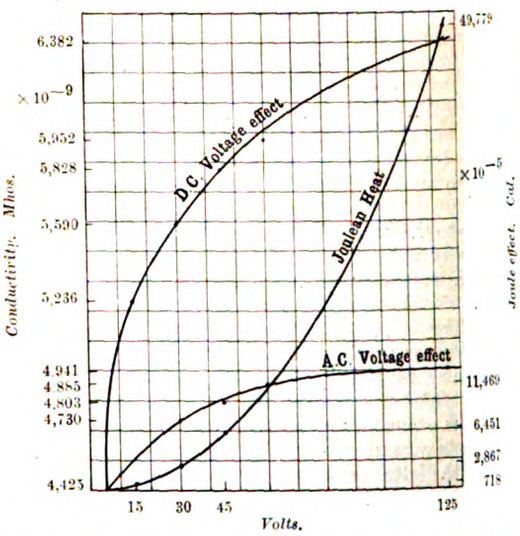

FIG. 2.—VOLTAGE EFFECT COMPARED WITH JOULEAN HEAT.

The following questions were investigated:

1. Is the resistance as measured with a small E.M.F. permanently affected by a high E.M.F., or only temporarily?
2. Has the effect the same direction in all cells, and is it proportional to the E.M.F.?
3. Is the effect the same for direct currents as for alternating currents?
4. Is the photoelectric sensitiveness of the cells affected by treatment with high E.M.F.s?
5. Is the decrease of resistance due to the heating of the cell?

* Abstract of an article in the "Annalen der Physik."

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The author calls the effect studied the "voltage effect" or "tension effect" (*Spannungseffekt*). It had the same sense—that of an increase of conductivity with rising E.M.F.—in all cells except one, which showed an inversion.

The voltage effect is greater with direct currents than with alternating currents. There is in general no proportionality between the applied voltage and the voltage effect, a given difference in voltage being less effective at high voltages. The voltage effect is not instantaneous, nor does it disappear at once after taking off the high E.M.F. The time of recovery increases in general with the voltage and the time during which it was applied. The photoelectric sensitiveness is not affected in any way by the voltage effect. The latter may be connected with a polarisation in the direction of the current. It is not at all explained by the heating effect due to the current.

The above are the main conclusions arrived at by the author. A number of interesting details are given.

The Ruhmer cell was studied with direct currents from a battery of accumulators, the voltage ranging from 0·1 volt to 100 volts.

The following table and the curve in Fig. 1 give the results :—

E.M.F. volts.	Resistance, ohms.	Period of recovery, minutes.
0·1	658,200	
1	617,400	20
5·7	573,500	20
10	544,200	25
20	498,200	20
40	435,400	60
60	389,200	35
80	361,700	30
100	329,800	35

The curve is approximately a parabola. It differs from the photoelectric curve in not commencing as steeply as the latter.

The light effect was studied both before and after these experiments, and showed no difference attributable to the voltage effect.

All the Gilthay cells showed a gradual rise of resistance in the dark. In one of them this gradual rise continued for a month, during which the resistance rose from 135,400 to 228,000 ohms. This cell showed a sudden recovery after direct voltages up to 30, but not for stronger direct currents, nor for alternating currents.

Another Shelford-Bidwell cell showed a curious anomaly in the voltage effect in the shape of a minimum resistance under 5 volts, with a gentle rise towards 100 volts.

That the Joulean heating is not the cause of the voltage effect is shown by the aspect of the curves (*see* Fig. 2) which show that the Joule effect increases very slowly at low voltages, whereas the voltage effect rises abruptly, even for alternating currents. Besides, if the Joule effect were the cause, there is no explanation for the difference between the direct current and alternating curves.

On cutting off the voltage abruptly and leaving the selenium cells discharge through a galvanometer, polarisations of 7 to 22 millivolts were observed for a few seconds. The author suggests that this polarisation stays in the same direction as the original current) may be much stronger when the current is on, and may thus explain the voltage effect.

Electricity in a Lumber Mill.—The "Electrical Review and Western Electrician" gives an account of an electric-driven lumber mill at Brooklyn, U.S.A. A special feature is the use of band saws for nearly every cutting operation, and each machine throughout the entire mill is driven by an individual motor. These motors are of the squirrel-cage type and aggregate 950 H.P. During the past month the company has also started in operation a sash and door factory equipped with 45 machines, each one driven by its own individual motor. These motors are the same as in the mill, and aggregate 300 H.P.

DUBILIER WIRELESS TELEGRAPH STATION AT SEATTLE.

A wireless telegraph station has recently been erected by Mr. W. Dubilier on Puget Sound, near Seattle, U.S.A., and as the equipment is very complete the following details, which

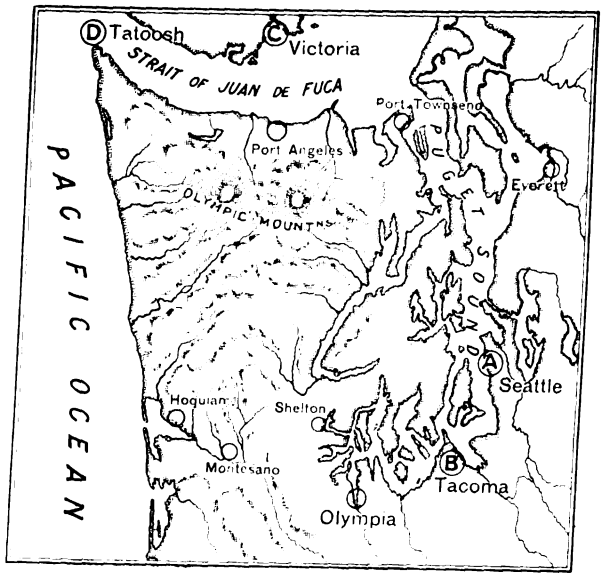

FIG. 1.

have been placed at our disposal, will no doubt prove interesting to our readers. As the station was to have a world-wide range, many points had to be considered in its construction, such as high mast, large surface area, high altitude, and a position near a satisfactory body of water. Many locations on Puget Sound were investigated before an ideal spot was

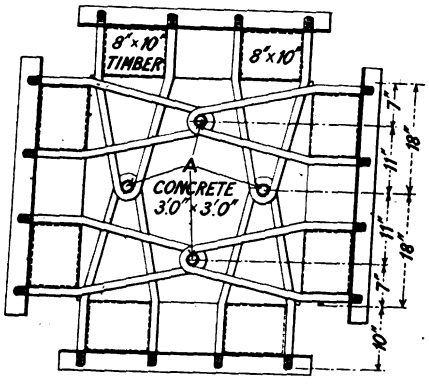

FIG. 2.

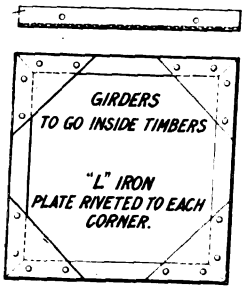

FIG. 3.

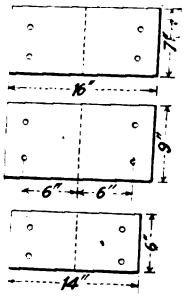

FIG. 4.

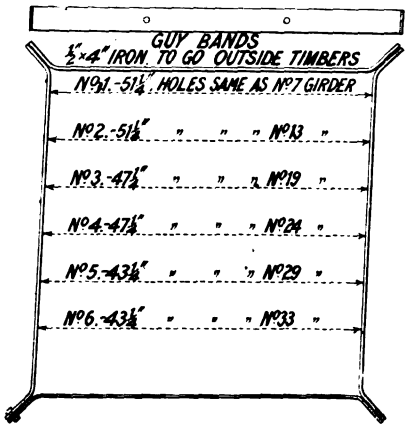

FIG. 5.

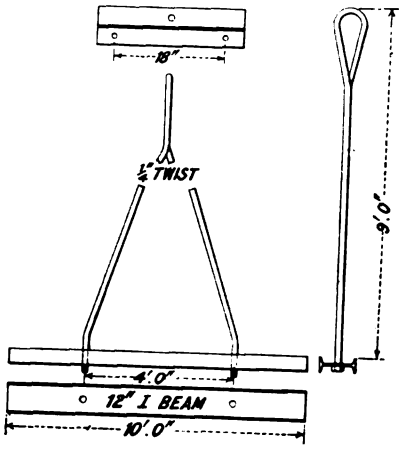

FIG. 6.

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finally found near Fauntleroy Park, approximately 3 miles from Seattle, 500 ft. above the sea level, on a sharp bluff dropping into Puget Sound. A in Fig. 1 shows the position with reference to Puget Sound, whilst B, C and D show Tacoma, Victoria and Tatoosh, all of which reported that they heard the wireless telephone from Mr. Dubilier's laboratory. The Tatoosh station, which is about 140 miles over the Olympic Mountains, finds it impossible with 25 H.P. to communicate with the Bremerton Navy yard near Seattle in the daytime and very difficult at night; daily wireless telephonic communication, however, is commercially held between A and B (Fig. 1).

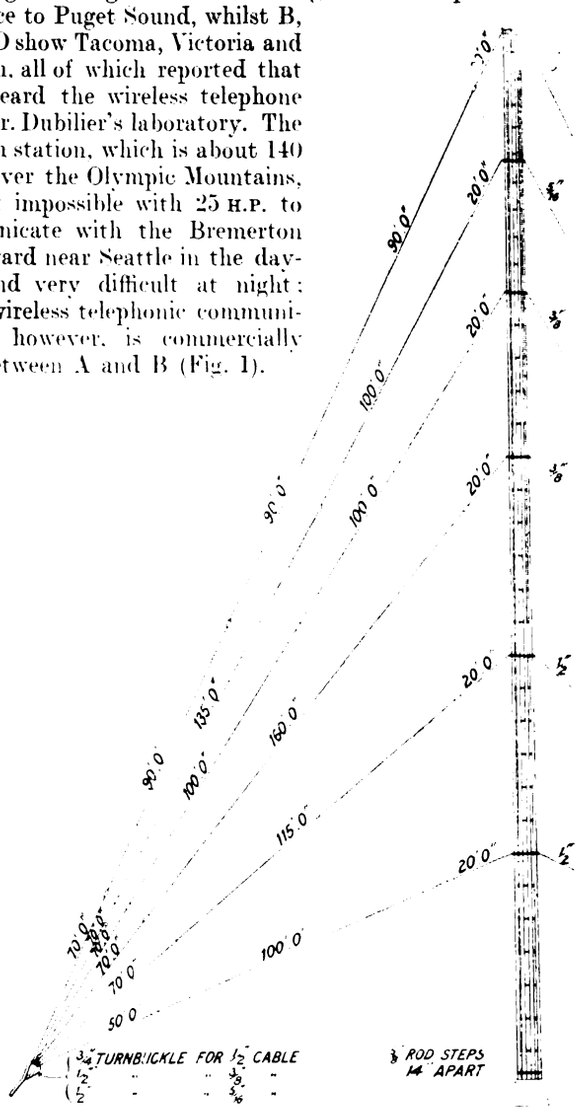


FIG. 7.

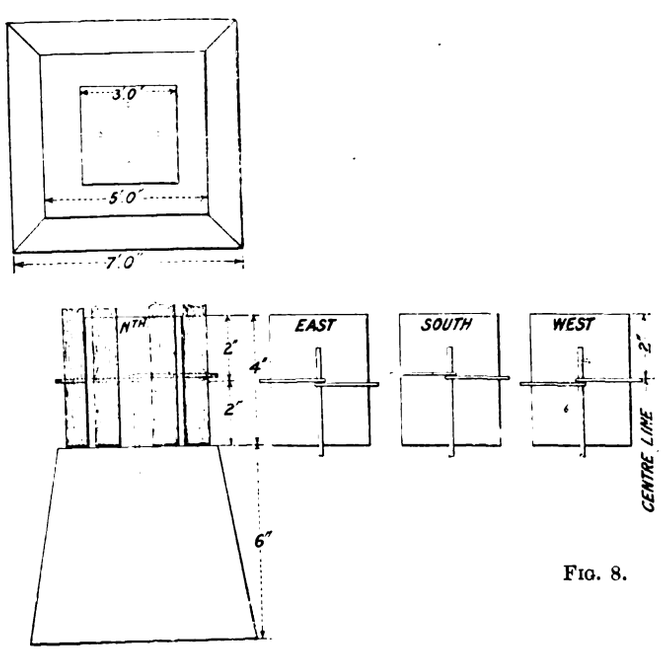


FIG. 8.

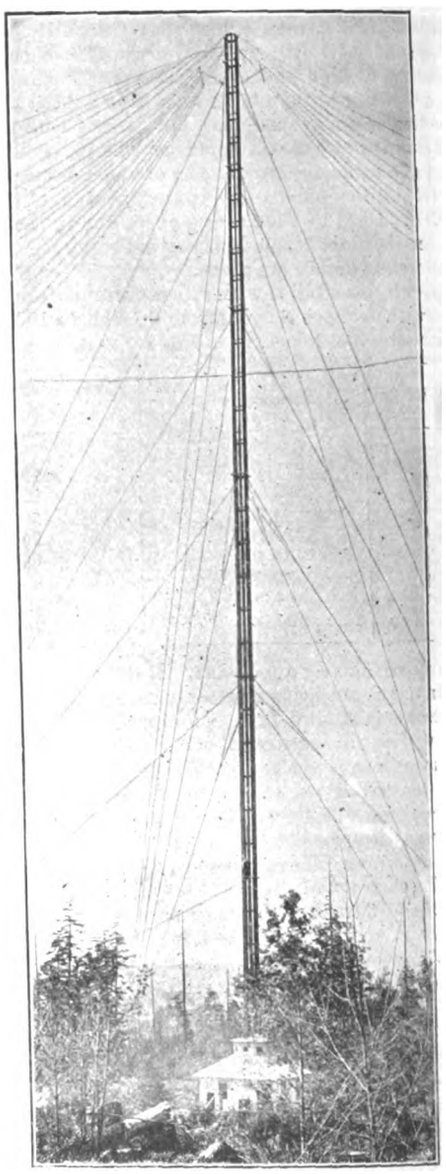
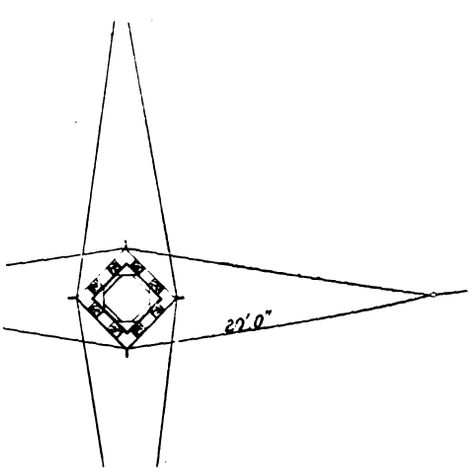


FIG. 9.—AERIAL WIRE SYSTEM AND TOWER OF EXPERIMENTAL STATION AT SEATTLE.



After considering and experimenting with the different forms of aerials, it was decided to adopt the umbrella type, which was found most suited to overcome the surrounding conditions, for mountains arise in nearly all directions to a height of 5,000 ft. or more. The Sound, which varies in width up to 2 miles, is the only water outlet, as will be seen in Fig. 1.

The tower measures 320 ft. from the base, giving it a total height of 820 ft. above sea level; and, to make room for the aerial wire system, 30 acres of high timber had to be cleared.

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Numerous springs exist on the hill, and so it was possible to obtain a permanently damp ground.

Erection of Tower.—Many original ideas were embodied in the design of this mast to withstand the high winds which occur during the winter season. It was necessary to make the mast as flexible as possible and at the same time of the necessary strength.

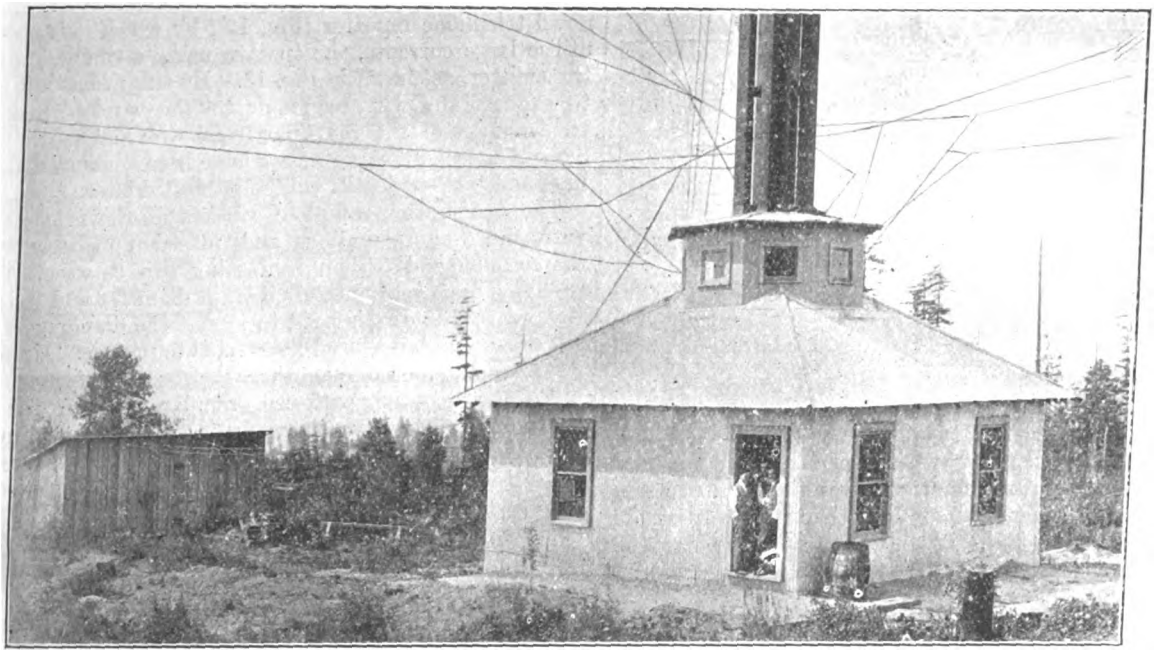

FIG. 10.—VIEW OF OPERATING ROOM, ENGINE ROOM AND BASE OF TOWER.

To support the wooden structure a solid concrete base was imbedded in the ground to a depth of 8 ft., each side measuring 7 ft. at the base and 5 ft. at the top, the total height being 6 ft. Four reinforced steel rods 1¼ in. in diameter were imbedded in the concrete, as shown at A in Fig. 2, which were used for the large bands to hold the base beams, as will be noticed from the illustration. Eight beams were used, two being on each side

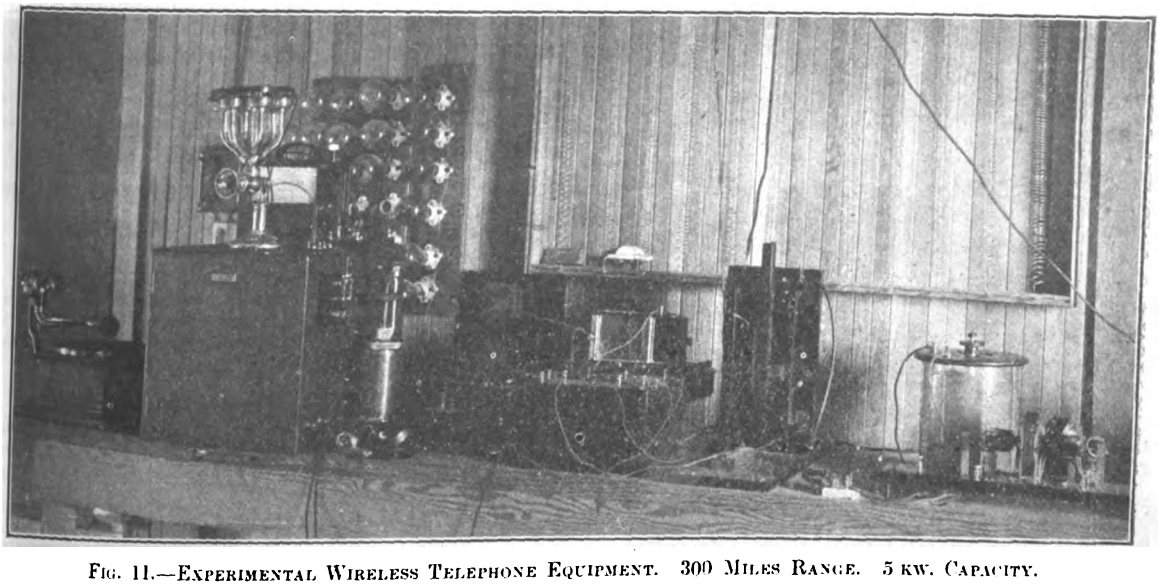

FIG. 11.—EXPERIMENTAL WIRELESS TELEPHONE EQUIPMENT. 300 MILES RANGE. 5 KW. CAPACITY.

the square and bolted to the reinforced rods. These varied length, the first being 8 in. by 10 in. by 5 ft. high, the next ft. high, the next 15 ft. high, &c., each one increasing by ft. up to 40 ft. Thereafter all the beams were made 40 ft. gh, so that the same ratio for interlapping remained all the ay to the top, no two joints being in the same place.

I beams and girders were used to hold the masts together. g. 3 shows the girders reinforced by angle plates, which hold the timbers together from the inside and which were placed every 10 ft. Fig. 5 shows the bands bolted on the outside of the timbers and used for the guys, these being placed 80 ft., 70 ft., 60 ft., 50 ft. and 40 ft. respectively from the base.

For hoisting the timbers, each successive timber was used for a gin pole, and by means of a small engine hoist the work was done very cheaply and quickly. The beams were connected to each other by ⅝ in. iron plates and ⅝ in. bolts, as shown in Fig. 4. The anchors for the guys were made of 12 in. I beams 10 ft. long, and buried 10 ft. deep in the centre of concrete. Through the I beams steel rods are twisted as shown in Fig. 6 and bolted, to which the guy wires are clamped. The guy wires are broken at intervals with strain insulators, and vary from 1 in. in diameter at the bottom to ½ in. at the top, making six sets in all; and for each set four were used at right angles to each other. To prevent the twisting of the tower, they were connected to the steel bands, as shown in Fig. 8. Fig. 7 shows the complete tower with guys, a view being given in Fig. 9.

The Aerial Wire System.—The aerial wire system is of the umbrella type, and is divided in eight sections, each section containing eight wires and running out to smaller poles 120 ft.

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high and 500 ft. from the base of the tower, in all containing about 40,000 ft. of stranded phosphor-bronze aerial wire, so connected that each section or any number may be used at a time.

Operating Room.—Fig. 10 shows the operating room at the base of the tower, the noise of the independent power plant, seen at the left, being excluded. The building is divided into

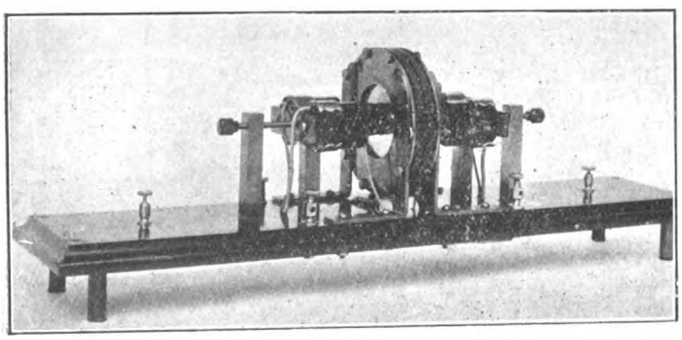

FIG. 12.—TELEPHONE REPEATER USED AS TRANSMITTER.

two sections, one for telegraph work and the other for telephone experiments. The telephone experimental room is shown in Fig. 11, and consists of a complete transmitting and receiving outfit, using the "quenched arc" method. It was decided to name this the "quenched arc," for it is neither a quenched spark nor an oscillation arc, whilst partaking of the nature of both.

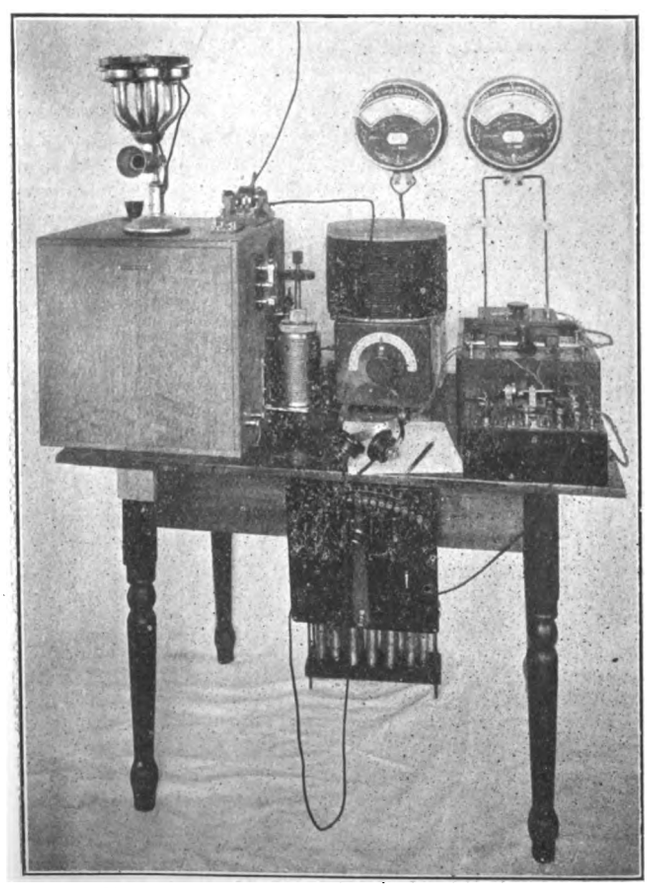

FIG. 13.—COMPLETE STATION, DUBILIER SYSTEM.

The transmitter consists of a newly-designed oscillator. Condensers and tuning coils all meet in the box of the transmitter, shown in Fig. 11. A double-pole double-throw switch is used for making the system direct or loose coupling, and a small aerial switch on top of the box for changing from transmitting to receiving. By means of another switch on top it is possible to use the same transmitter with the addition of a rotary gap as a musical note wireless telegraph system, any note being obtained by simply varying the speed of the motor running the interrupter.

Different telephone transmitters are being experimented with, good results having been obtained with six of the Berliner type connected in parallel and mounted on top of the box (Fig. 11). In the most recent experiments, however, the inventor, in conjunction with Mr. V. Laughter, has evolved a novel telephone repeater (Fig. 12), by which it is possible to utilise large currents, the speaker using a simple low-current transmitter, as shown in Fig. 13. By this means it is possible to connect the wire telephone to the wireless, making the transmission of the voice partly by wire and partly wireless. Several successful experiments have been conducted along this line, and further details will be published later.

The transmitter complete consists of the magnets wound with the 2-ohm windings and placed oppositely with the diaphragms and carbon containing cup between. The diaphragms are approximately 5 in. in diameter and $\frac{1}{28}$ in. thick. A hard rubber disc is used to mount the diaphragms on, and is drilled with large-sized holes so as to prevent "air packing" or talking against one another.

To make contact with the granular mass, circular rings of platinum are used, which are first soldered to the diaphragms. The platinum rings are drilled with small holes around the entire circumference so as to allow a free circulation of air, and through one of these holes the small inlet and outlet tubes are run, the contact being made in the centre of the granular mass. A mica disc is used to retain the granules in the chamber.*

At present 35 H.P. is available, which will be made use of for the telegraph to communicate with a similar station in Alaska.

The receiving apparatus consists of the variometer tuning coil, constructed so that the secondary revolves in the centre of the primary. This was found to give more selectivity than any coil yet tried, besides eliminating static interference. A detector box containing four different detectors—perikon, silicon, iron pyrites and galena—is used, and is arranged so that any detector can be used. It was found that good results can be obtained with almost any form of crystal detector, using a battery giving 0·2 volts, the current being in the direction of rectification. A steel needle on carborundum floating in mercury seems to stand up longer under the strain and does not burn out, and from the experiments made it was found that the articulation is far superior with the carborundum detector than with any other.

THE EFFECT OF VARYING PROPORTIONS OF AIR AND STEAM ON A GAS PRODUCER.†

BY E. A. ALLCUT, M.SC.

Summary.—The author's investigations, which were made on a small gas producer, were mainly with the object of determining the effect on its efficiency of varying proportions of steam. His results are compared with those of Bone and Wheeler.

The experiments here recorded were performed on a small gas producer at the University of Birmingham. The chief object of the research was to determine the influence of varying quantities of steam on the general working and efficiency of a producer plant of small size. The supply of air to the producer was, therefore, kept as nearly constant as possible in all the trials, while the steam supply was varied from nothing to a maximum of 1·14 lb. per lb. of coal. Anthracite peas were used throughout the trials. The steam required was generated within the producer, so that the general conditions closely resembled those under which a modern suction plant works; the sole exception being that the air was forced into the ash-pit by a fan. A series of similar trials were performed in 1906 by Messrs. Bone and Wheeler,‡ on a 2,500 H.P. gas plant.

* *See* THE ELECTRICIAN, Dec. 13, 1910, pp. 462-3.

† Abstract of a Paper read before the Institution of Mechanical Engineers.

‡ "Journal," Iron and Steel Institute, 1907, No. 1.

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The author first discusses the reactions taking place in the producer and shows that the steam supply has an important effect, as it controls the temperature at which the reactions take place, and therefore the composition and yield of gas and the efficiency of the process. If the steam supply is increased above a certain amount per lb. of carbon, the temperature and efficiency of the plant both fall. If, on the contrary, the supply is cut down too low, the temperature rises, gives bad working and increased heat losses, and yields

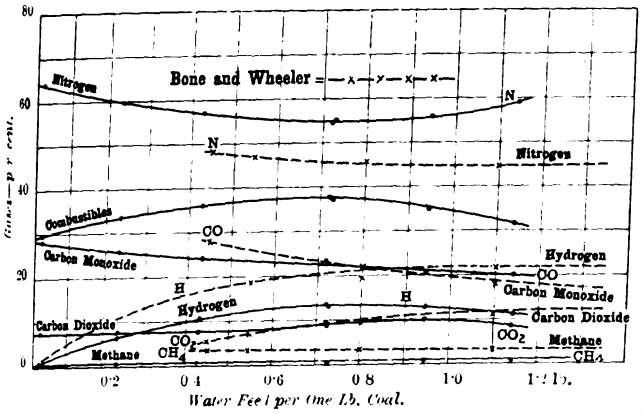

FIG. 1.—GASES. COMPARISON WITH 1906 TESTS.

a poor gas. It was one of the objects of these trials to find the proportion of air and steam that will give maximum efficiency.

A description of the plant, which was made in the workshops of the University of Birmingham, is next given by the author. The washer, Fig. 3, is of novel construction. It consists of a cylindrical shell (18 in. diameter by 48 in. long), closed at the ends, and traversed by a shaft strung with thin discs 17 in. diameter. This shaft is rotated at 76 revs. per min. The discs are alternately pierced at the edge C, and the centre D, so that the gas is forced to pass in a zigzag direction from one end of the washer to the other. The washer is partly filled with water which is picked up by the small vanes on the discs marked C, and dashed intimately into contact with the gas. The large area of wetted surface thus presented to the gas makes this type of washer very efficient as a cooler.

The reason for the adoption of a small plant was to enable it to be tested in a short time. The actual duration of each trial was four hours, but the plant was run for some three or four hours in each case before any readings were taken, to enable the conditions to become steady.

The results of the tests are given in tables and curves. Fig. 1 herewith shows that the percentage of hydrogen in the gas does not increase with increase of water fed into the producer, when the latter

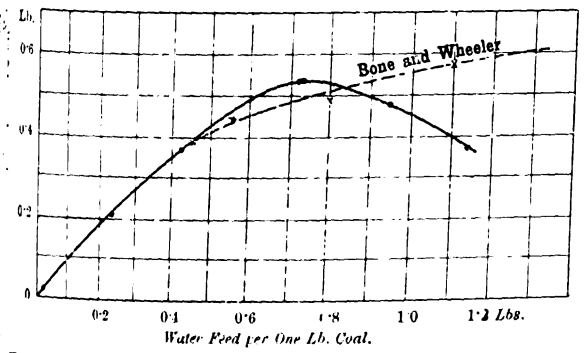

FIG. 2.—WATER DECOMPOSED PER LB. COAL. COMPARISON WITH 1906 TESTS.

exceeds 0·75 lb. per lb. of coal. This corresponds to the decomposition of about 72 per cent. of the total weight of water fed in the producer. This result is very important, as it shows that the maximum amount of steam that can be decomposed by anthracite at a temperature of about 1,832°F. is about 0·535 lb. of coal (Fig. 2). Referring to the curve of Messrs. Bone and Wheeler (shown dotted Fig. 2), it appears from the flattening of the curve that this maximum is in the neighbourhood of 0·625 lb. of water per lb. of coal, for large producers working on bituminous coal. It follows that there can be no advantage, but only loss, in pushing up the steam supply beyond 1½ lb. of steam per lb. of coal for large producers and about ¾ lb. of steam per lb. of coal for small ones. If these values are greatly exceeded, the increased supply of steam merely takes heat from the producer and loses it in the washer. The presence of such excess of steam has, of course, an effect in keeping down the temperature of the producer, and this is advantageous when it is desired to recover ammonia from the gas, but in all other cases such excess is harmful, as it has been repeatedly shown that large quantities of steam are not necessary for the prevention of clinkering. The low percentage of hydrogen in the gas is due to the large quantity of air which had to be used to keep the vaporiser at a sufficiently high temperature to supply the necessary amount of steam, owing to the inefficiency of the internal steam coil.

The most significant result of these trials is that the percentage of CO_2 remains practically constant, in spite of the increasing feed of steam to the fire. The high content of CO_2 in the trials where little or no steam is supplied, is due to a leakage of air through cracks in the lining. Eliminating the 7 per cent. of CO_2 in the first trial as due to this cause, it is found that the maximum rise during the whole of the trials is merely about 2·5 per cent. It would naturally be expected that the increased supply of steam would diminish the temperature inside the producer, and result in the production of increasing quantities of CO_2. This is admirably shown in the trials of Messrs. Bone and Wheeler (the CO_2 is shown dotted, Fig. 1). Why does not the same rise occur in the author's experiments? Readings taken show that the temperature kept fairly constant at about 1,832°F. for a distance of about 18 in. upwards from the grate, and then falls rapidly to about 1,112°F. in the next 6 in. or so. The

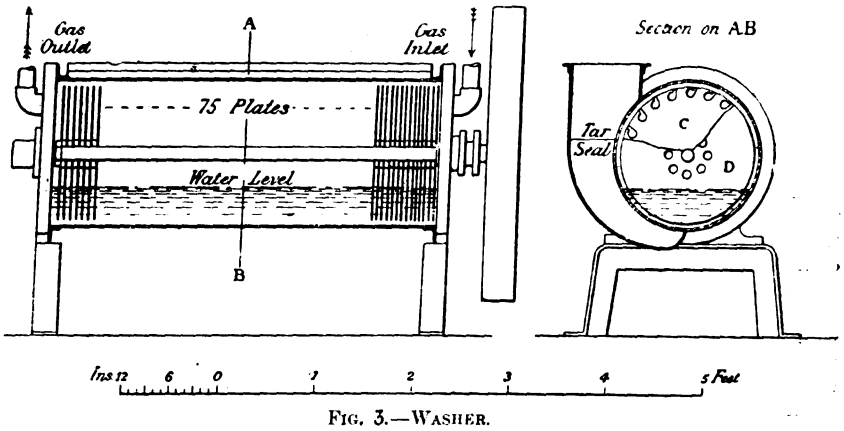

FIG. 3.—WASHER.

first 18 in. may be termed the zone of active combustion, where, owing to the high temperature, the gases produced are almost entirely CO and hydrogen. There is above this about 6 in. or 7 in. of fuel bed in which the temperature is rapidly falling. This would have its due effect in re-forming the CO_2 if it were not so thin. The shallowness of this comparatively cold layer of fuel does not allow sufficient time for these reactions seriously to affect the composition of the gas and the efficiency of the producer.

In a deep fuel bed, say 7 ft. deep, as in the producer used by Messrs. Bone and Wheeler, the first 2 ft. or so will form the zone of active combustion, but the thickness of the bed of cooler fuel above will much more seriously affect the composition of the gas. In fact, the amount of CO_2 in the resulting gas will simply be the result of the reactions corresponding to the mean temperature of the belt above the zone of active combustion, and to the time during which the gases are in contact with the coal in that belt—that is, it will depend upon the depth of fuel in the producer, beyond the zone of active combustion, and the velocity of the gas. This shows that in producers which have a shallow fuel bed, provided there is no leakage, there need not be more than 2 per cent. or 3 per cent. of CO_2 present in the gas. If more than this quantity is present, it is due either to leakage or to the use of too great a quantity of air for the size of the producer. In the latter case, the velocity of air through the fuel is high, and some of the CO_2 formed by combustion in the active zone escapes reduction to CO. The depth of the fuel bed should therefore be cut down to the lowest value consistent with practical working. In large producers a deep fuel bed is necessary, as the larger sizes of coal used in them do not pack as well as the smaller pieces, and the distribution of air across the section of the fuel-mass is apt to be irregular. In such cases it might even pay to have a secondary air supply admitted some distance above the grate. This would have the effect of introducing another zone of active

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combustion, in which the heat evolved by the combustion of the secondary air to form carbon monoxide, would be available for reducing the CO_2 coming from the grate. The depth of the cool layer of fuel above the active combustion zone would thus be reduced, and the re-formation of CO_2 would be greatly diminished.

The calorific value was found to reach a maximum at 0·7 lb. of water per lb. of coal, and the maximum yield of gas to be at about the same point. The efficiency of the producer (the ratio between the heat generated which does useful work outside the producer itself, and the total heat in the coal used) rose from 48 per cent. with no water to 75 per cent. at 0·75 lb., decreasing again above this point.

The highest temperature of the gas leaving the producer was attained where no water was fed into the vaporiser, being about 750°F. A steady fall was maintained with the increase in water-feed until at about 0·7 lb. water-feed the temperature was about 550°F. After this, the temperature remained fairly constant.

The efficiency was found to be proportional to the ratio (oxygen in steam)/(oxygen in air), up to a ratio of 0·65, after which it bends sharply and becomes inversely proportional to that ratio. The down grade of the curve is almost exactly parallel to the results obtained by Messrs. Bone and Wheeler. It appears from this, that the increased supply of steam beyond the point of maximum efficiency causes a decrease in efficiency proportional to the ratio (oxygen in steam)/(oxygen in air). This decrease, in the case of these two producers, is the same for equal rises in the value of the ratio. Whether this also holds for other producers can only be determined by further investigation, but the fact that it is the same for two producers that are so different as these are appears to be significant.

INVESTIGATION OF THE ELECTRICAL STATE OF THE UPPER ATMOSPHERE.*

BY A. J. MAKOWER, M.A., W. MAKOWER, M.A., D.SC., W. M. GREGORY AND H. ROBINSON.

The present experiments were undertaken during August, 1910, to investigate the electrical state of the air at different heights above the ground by mans of kites and balloons, and form a continuation of those carried out in the two previous summers at Glossop. By the kindness of Mr. C. J. P. Cave, who put his kite station at Ditcham Park, near Petersfield, in Hampshire, at our disposal, we were enabled to make observations above ground which, although somewhat undulating, approximated more nearly to flatness than at the Glossop kite station, situated in the most hilly part of the Peak District.

The method of carrying out experiments was similar to that already described, and consisted in flying a kite or, in calm weather, a balloon attached to a steel wire. For measuring potentials the wire was anchored to long ebonite insulating rods, strong enough to take up the pull exerted, and an electrical connection was made by means of a wire supported by long ebonite insulators and running through glass tubing to one pole of a Kelvin-White high potential electrostatic voltmeter, the other pole of which was connected to earth. The potential taken up by the kite was read directly on the voltmeter. The wire which was used was divided up into a number of sections connected together by spring hooks, so that various lengths could be detached from the winding drum, in order to obtain readings at different heights. The height above the ground was determined by measuring the length of wire let out, and the angle of the kite above the horizon, and also from the readings of a self-recording aneroid barometer sent up with the kite. The potential recorded by the voltmeter was assumed to be that of the air surrounding the kite or balloon. The validity of this assumption has already been discussed, and it seems probable that it is not far from the truth.

After each observation of the potential a measurement was made of the current that flowed down the wire when it was earthed through a suitable galvanometer. On one occasion a high resistance of cadmium iodide dissolved in amyl alcohol was inserted in series with the galvanometer. From the reduction thus produced in the current flowing through the galvanometer, it was possible to form an estimate of the resistance of the air from which the kite was collecting electricity. With the kite at a height of 1,400 ft. it was found that the resistance of the air was of the order 1,000 megohms, a number which confirms the estimate made in a previous Paper. In order to get some indication of any variations of the electrical state of the atmosphere during the ascents, which sometimes lasted several hours, measurements were made of the potential gradient near the ground with a radium collector in the usual manner. Although the observations taken in this way just before and just after an ascent were of use, it was found that readings taken while the kites were in the air were useless, as the potential gradient over the ground was completely changed by the presence of the kite; this was made evident by the fact that the readings obtained for the ground potentials were found to vary considerably when the kite-wire was alternately insulated and earthed.

The results of the experiments are given in curves and tables in the Paper, the potential gradients being much steeper on some days than on others. Furthermore, considerable variations frequently occur on the same day. A typical curve is given in Fig. 1.

With a view to ascertaining the rate at which an ascending or descending balloon acquires the potential of the air surrounding it,

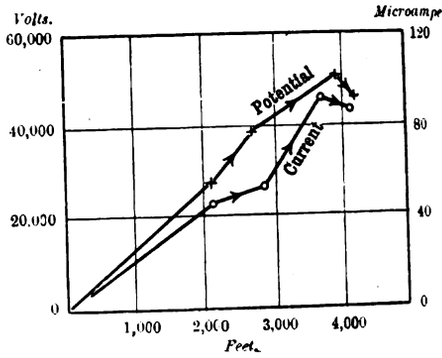

FIG. 1.—AUGUST 12. KITE.

measurements were made of the time taken for the kites or balloons to take up the potential of the air; such observations afford an estimate of the rate of charging up of a balloon suddenly raised to the altitude at which the experiment is being made. The collecting area of the sails of the large kites used by us was about 150 sq. ft. and that of the small kites about 100 sq. ft., reckoning both sides of each sail as available for collecting electricity, and that of the balloon, which was of gold-beater's skin, about 150 sq. ft., so that the collecting areas were small compared with that of a balloon for carrying passengers; but since the rate of charging up is probably proportional to the collecting area and inversely proportional to the electrical capacity, which is proportional to the radius of the balloon, the rate of charging up would be directly proportional to the radius of the balloon, and our measurements therefore give a lower limit to the rate at which a large balloon would acquire the potential of the air under similar circumstances. Two typical curves are shown

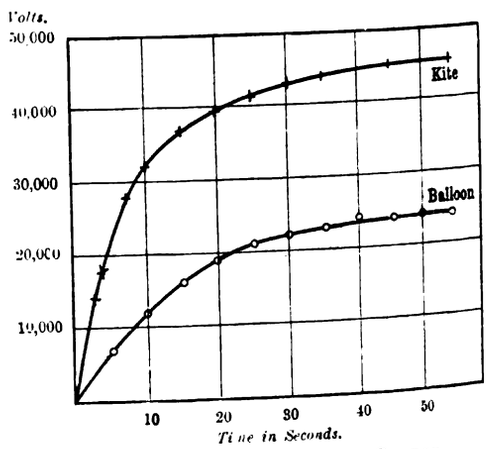

FIG. 2.—RATE OF ATTAINING CHARGE.

in Fig. 2. It may be assumed that the rate of charging up of the balloon at any instant is proportional to the difference of its potential from that of the surrounding air. On this assumption the potential of the balloon at any moment will be given by the equation $V = V_0(1 - e^{-\lambda t})$, where V is the potential of the balloon at any moment, V_0 the potential of the surrounding air, t the time in seconds reckoned from the beginning of the charging, and λ a constant. Investigation showed that the charge acquired was an exponential function of the time in agreement with the above assumption. The value of λ ranged from 0·06 to 0·25.

As a rule a kite acquired its charge considerably more rapidly than a balloon. This fact suggested that the rate of charging depended on the strength of the wind, for it was only in very calm weather that balloon ascents could be made.

* Abstract of a Paper read before the Royal Meteorological Society.

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Experiments on the electrical state of the upper atmosphere have now been carried out by us during three consecutive summers, and it appears that results of considerable interest are obtainable by the methods employed. The problems of atmospheric electricity are, however, so complicated and seem to depend on so many conditions, that there is little hope of arriving at an understanding of the different influences at work by intermittent experiments. Recording instruments were attached to each kite or balloon to register the barometric pressure, the temperature, the humidity, and the wind velocity; but we have not considered it to be useful to publish these records, as we have been unable to establish any connection between these factors and the electrical conditions of the atmosphere. No doubt continuous observations similar to these described above conducted over prolonged periods would reveal the causes producing the large variations occurring in the electrical state of the atmosphere, and it is to be hoped that experimenters will be forthcoming who will be able to devote the necessary time to bringing such an investigation to a successful issue.

OPERATION OF TRANSMISSION SYSTEMS.

At the recent meeting in New York of the National Electric Light Association an interesting informal discussion took place on this subject. The following abstract is based on the account of the meeting given by the "Electrical World":—

Mr. MAX HEBGEN said that the most important factors in securing uninterrupted service on transmission systems were stated to be insulation, mechanical strength, general design of system and operation. He claimed that the factor of safety in the insulation of transmission systems as now employed was too low. For a 100,000-volt system the safety factor should not be less than three, for 50,000 volts it should be four, and for 20,000 volts it should be five. He considered that for all electromotive forces above 20,000 volts the suspension type of insulator was far preferable to the pin type. When the suspension type was employed no difficulty was encountered in obtaining the factors of safety mentioned above. He thought too much attention could not be paid to the mechanical strength of a transmission line where continuity of service was essential. Any wire larger than No. 6 gauge should be stranded; the wire stranded conductor with a hemp centre exposed more surface to wind and ice than did a 7-strand conductor of equal conductivity, so that the advantage of having all the wires subjected to the same stress was more than counterbalanced, and the 7-wire strand was altogether preferable. He said that the clamps for suspension insulators should be connected to the insulator by a hinge joint so that there would be little tendency to bend the wire when the insulator pulled in a direction other than perpendicular to the wire. Transmission lines feeding energy to an important load centre should be in duplicate or triplicate. They should preferably follow different routes, but where this was impracticable the different lines should at least be mounted on separate poles spaced far enough apart to prevent the possibility of one line interfering with another. The lines should be sectionalised by means of outdoor air-break switches, with a cross-over switching station at the middle of the line equipped with switches so arranged that one-half of either line might be cut out and the remaining section continue in operation. In any case where two or more lines supplied energy to the same point, the incoming lines should be controlled by reverse-power relays. Troubles from lightning could be guarded against by high insulation, the installation of one or more overhead earthed wires and the use of electrolytic arresters. Continuity of service depended equally as much on good operators as on good apparatus. In large systems all operations should be controlled by one man who had the position of load dispatcher. The importance of systematic patrolling of the line should not be overlooked.

Mr. J. P. JOLLYMAN (Western Power Co., San Francisco) in a written communication claimed that in order to eliminate interruptions to service power houses should be built on the unit system, only such cross-connections being used as were absolutely necessary for proper flexibility. It was especially essential that all apparatus which might need immediate attention in the event of trouble should be within the reach of every one. Relays should be used sparingly, if at all, because the power-house circuits must not be disarranged by any ordinary disturbances which might come in from the transmission system. The transmission line should preferably be constructed in duplicate on separate poles. In case only one pole line could be erected the arrangements should be such that one circuit might be kept in operation while the other was undergoing repairs. In order that trouble originating on one distributing line might not interfere with other feeders, fuses or relays were necessary on the distribution circuits radiating from sub-stations..

Mr. R. S. KELSCH in a written communication claimed that the most successful method of obtaining continuity of service from the high-voltage transmission line was to use the same factor of safety on the line as was employed in the power house with its reserve generators, duplicate bars, extra exciters, spare transformers, &c. A high factor of safety in insulation was of the greatest importance. Too much economy had been practised in the purchasing of insulators in the past; there were numerous transmission lines in operation to-day that should have a factor of safety in the insulators three times as great as at present.

Mr. W. N. RYERSON (Great Northern Power Co.) expressed the opinion that too much insulation might prove disadvantageous in low-voltage work.

Mr. F. B. H. PAINE (Niagara, Lockport and Ontario Power Co.) remarked that troubles on transmission lines were frequently hard to locate although easy to correct after being discovered. He mentioned the fact that certain line patrolmen now made use of automobile or bicycle head lamps in patrolling the line at night.

Mr. B. F. PEARSON (Southern California Edison Co.) stated that it had been found necessary to subdivide the 118-mile 75,000-volt transmission line in order to continue operation in case of failure to any one part of a circuit. He called attention to a peculiar fault of pin-type insulators upon which cracks developed on the interior petticoat, attributable probably to excessive temperature. Difficulty had been encountered with the pin type of insulator construction on account of birds standing on the steel cross-arms and stretching their wings to reach the live circuit above. This trouble could be overcome by the use of the suspension type of insulators. The interruptions to the Kern River transmission line totalled 160 in a year, most of which occurred during the spring season when the birds were more inclined to stand upon the transmission lines.

Mr. J. R. MCKEE called attention to the fact that the limit of increase in voltage to a transmission system was set by the corona loss rather than by the amount of insulation employed. Experience would seem to indicate that at the high altitudes in Colorado, 100,000 volts was about the limit; in Michigan, where a 110,000-volt system was operating without lightning arresters or overhead earth wires, no trouble was experienced from interruptions, probably on account of the excess of corona loss accompanying any abnormal increase in the voltage.

Mr. G. H. WALBRIDGE said that most of the troubles encountered on the system of the Central Colorado Power Co. had proved to be mechanical rather than electrical. Considerable trouble had been caused by the excessive wind velocities at the high altitude of 13,500 ft., at which a certain part of the transmission line was erected.

Mr. E. L. WEST (Central Colorado Power Co.) remarked that, on account of the condenser effect, when an electromotive force of 100,000 volts was applied on the 190-mile transmission system, an electromotive force of 150,000 volts was obtained at the far end. The clearance between wires had proved to be too small for the high altitudes encountered. By actual measurements made by Government officials, the wind velocity had been found to reach 165 miles per hour at the highest point of the transmission line. In order to prevent breakage of the transmission line, due to kinking, use was now being made of a flexible saddle for connecting the insulator to the line. The hemp-core, six-wire cable had proved satisfactory during the three years it had been in operation.

Mr. RYERSON remarked that the hemp-centre cable used by the Great Northern Power Co. had been found in good condition after five years of service.

Mr. R. G. BLACK (Toronto Electric Light Co.) stated that the six-wire hemp-core cable employed between Niagara and Toronto had given no trouble during the five years of service; the only interruptions to the 90-mile 60,000-volt transmission system had been those attributable to lightning. In May there were three interruptions, but in the previous nine months there was none.

Mr. P. H. THOMAS stated that the enormous currents produced on short circuit could be minimised by the use of series impedance combined with some automatic means of sectionalising the system.

Mr. PEARSON remarked that such a scheme was used in Southern California. It had been found that the synchronous apparatus was not thrown out of step during short-circuits.

PREVIOUS MAGNETIC HISTORY AS AFFECTED BY TEMPERATURE.*

BY PROF. E. WILSON AND L. C. BUDD.

It is well known that if a piece of iron be subjected to a considerable magnetising (previous history) force, and then be tested for permeability corresponding to a lower force, the permeability so obtained may differ widely from the permeability which would have been obtained had the material been previously demagnetised. The effects of previous magnetic history upon permeability and the dissipation of energy by hysteresis have already been studied† at ordinary atmospheric temperature. The object of the present Paper is to examine the effect of variation of temperature upon the influence of wide previous history. The material used has been in the form of rings built up from stampings of stalloy, which is an alloy of iron containing about 3 per cent. of silicon. The stampings are about 0·42 mm. thick, and have internal and external diameters of 32 mm. and 45 mm. Ring 1 was used for high temperatures, and had its windings insulated by hand with sheet asbestos. Ring 2 was used for low temperature, and had its windings insulated with silk. Particulars of the rings are given in the following Table:—

The method of test employs a ballistic galvanometer, and the temperatures are based upon a measurement of resistance of the second-

* Paper read before the Physical Society of London; slightly abbreviated.

† *See* "Journal" Institution of Electrical Engineers, Vol. XXXIV., Part 170, p. 55, and Roy. Soc. "Proc.," A., Vol. LXXXIII., p. 1.

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	Area of core in sq. cms.	Primary turns.	Secondary winding.	
			Turns.	Resistance in ohms at 7°C.
Ring 1.....	1·88	30	42	0·26
Ring 2.....	4·16	47	72	1·66

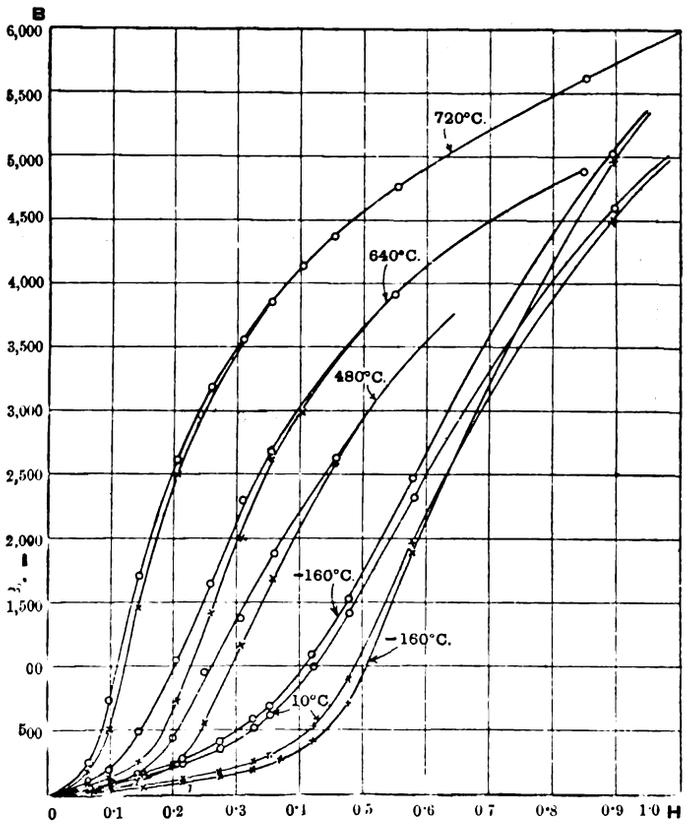

FIG. 1.

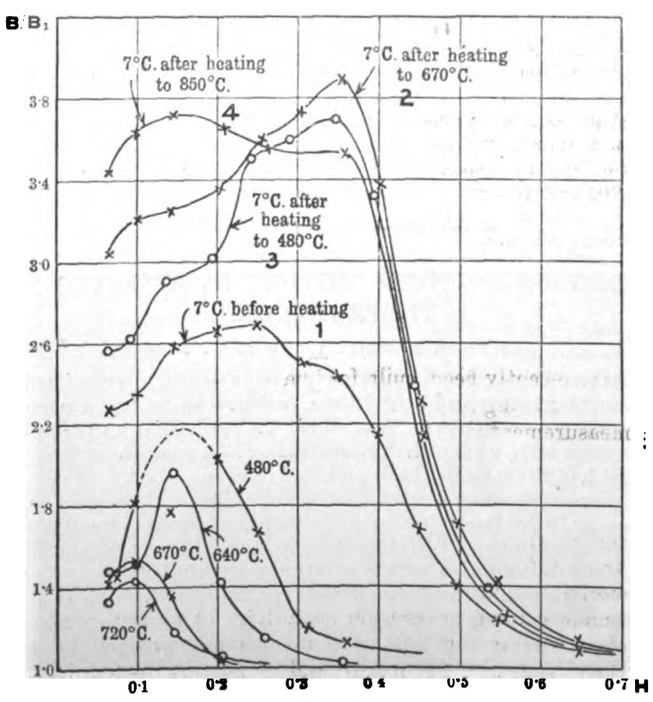

FIG. 2.

ary windings, care being taken that the magnetising force thus employed does not exceed the smallest reversal force used in the experiment. At atmospheric temperature and the temperature of liquid air the procedure was to determine the ordinary B—H curve after the material had been carefully demagnetised. This was done by gradually reducing the primary current given by an alternator at a frequency of 50. When dealing with high temperatures the ring was placed in a furnace heated by gas, and as the temperature was not absolutely steady in any one experiment, it was necessary to apply the previous history force immediately after taking the observation on the demagnetised ring, and then to demagnetise again for the next point, and so on. In all the experiments a previous history force of about 20 C.G.S. units was employed.

Fig. 1 gives a set of curves taken at various temperatures with and without previous history. In every case the upper curve was given by the demagnetised material, and the difference between it and the lower one is due to previous history. It will be seen that in liquid air the effect is most marked, and that it becomes smaller as the temperature increases. The material becomes non-magnetic at about 850°C., and regains its magnetic quality on cooling at 830°C. It seems safe to conclude that just before the temperature at which it becomes non-magnetic is reached the previous history effect has either vanished or become very small indeed.

In Fig. 2 the ratio of the magnetic inductions $B : B_1$ for a given value of the reversal force H, with and without previous history, is given. As received from the makers the material of ring 1 gives, at atmospheric temperature, curve 1. Atmospheric temperature curve 2 was obtained after heating to 670°C. and allowing the material gradually to cool. It will be seen that previous history effect is considerably greater after the specimen has been heated, and the other curves also confirm this, the increase being due primarily to a diminution of the permeability after application of previous history. With regard to the cooling experiment and ring 2, the curves in Fig. 3

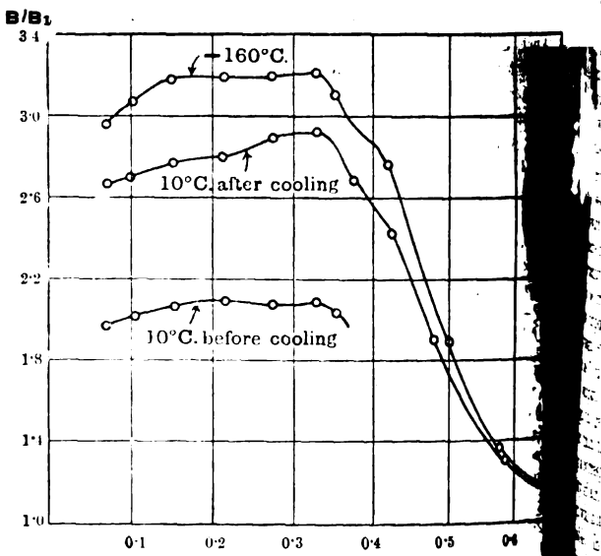

FIG. 3.

show that after the material has been cooled in liquid air, [illegible] vious history effect at atmospheric temperature is greater [illegible] first received, the increase being due to increased permeab[illegible] in the demagnetised condition. In spite of this, the effect o[illegible] history is greater at the temperature of liquid air than at at[illegible] temperature and it is less at high temperatures.

The conclusion is that the influence of large previous history in a 3 per cent. silicon alloy of iron is seriously a[illegible] variation of temperature, being largest at the low te[illegible] and ultimately becoming very small, if not vanishing, [illegible] near which the material becomes non-magnetic. In addi[illegible] heating and cooling have permanent effects upon the quality of this alloy. Previous heat treatment has also considered.

VENTILATION OF TURBO-GENERATORS.*

BY R. B. WILLIAMSON.

It is now universal practice to make turbo-generators [illegible] enclosed and to obtain the cooling by forced air circulation. [illegible] enclosing the generator the air currents can be more effectively directed to reach the parts where heat is generated and at the [illegible] time the noise is greatly reduced. The enclosed machine also [illegible] the advantage that air can be piped to it from outside or from [illegible] sources and discharged into the station, basement or outdoors, as [illegible] be required. The heat units in the discharged air represent [illegible]

* Abstract, based on accounts in the "Electrical World" and "Electric Railway Journal," of a Paper read before the National Electric Light Association.

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per cent. to 6 per cent. of the total station output, and economy would dictate utilising these units for some useful purpose, such as pre-heating the air supplied to the boilers or maintaining a comfortable temperature in a factory. Arrangements are being made to accomplish the latter purpose in a large glass factory now being erected. The generating station is located alongside of the factory and the generators are arranged so that the air can be discharged either upward or downward. In summer the air can be discharged upward by removing a cover plate on top of the generator. In winter the outlet at the top of the generator can be closed and the air discharged downward into a large duct from which it can flow into the factory. The plant will ultimately have four 2,500 k.v.a. units, so that between 400 kw. and 500 kw. stored in the air will be available for heating. This plant will run continuously at full load, so that a steady supply of warm air will be available.

From considerations of the specific heat and weight of air and permissible temperature rise, the author shows that the quantity of air to be supplied should be from 100 cubic ft. to 150 cubic ft. for each kilowatt of internal loss in the generator; 125 cubic ft. is a fair value and will give good results if the circulation in the generator is such that the air can get at all parts where heat is generated.

In estimating the internal loss to be carried off by the air, the windage loss must be included, as this is one of the largest losses in a turbo-generator and contributes to the heating just as much as the core loss or copper loss. A turbo-generator run on open circuit with no excitation and no loss in it other than the windage will show quite an appreciable rise in temperature, in extreme cases as much as 12°C. to 15°C. A great deal of windage loss is due to the skin friction of the rotor, and is independent of the fans. The passage must be arranged so that the air will be guided through the generator with as small an amount of friction as possible.

In a 60-cycle generator of 5,000 k.v.a. (normal) output, running at 1,800 revs. per min. and operating at unity power factor, the internal losses might be as much as 220 kw. Allowing 125 cubic ft. per kilowatt loss, this generator should have about 28,000 cubic ft. per minute for satisfactory cooling. This amounts to 2,270 lb. of air per minute, or over 60 tons per hour. The total internal loss will usually be from 4 per cent. to 6 per cent. of the rated kilovolt-ampere output, being a larger percentage for the smaller machines. As a rough estimate, therefore, the allowance of cooling air may be taken as 5 cubic ft. to 7½ cubic ft. per minute per kilovoltampere rated output. On the above basis the weight of air to be passed through the generator end of a steam turbine unit is in many cases greater than the weight of steam passed through the steam end during a corresponding period of time. In order to handle this large quantity of air, careful attention must be paid to the ducts or pipes through which it is supplied, and the air should be as clean and cool as practicable. In some cases it may be drawn directly from the basement, but this should not be done if the space below the generator is occupied by auxiliaries which heat the air.

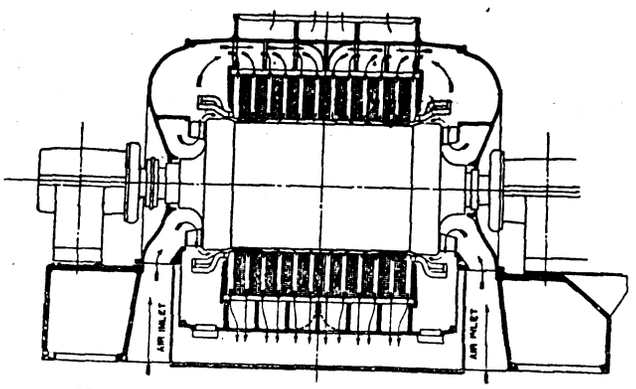
In case cool air cannot be obtained from the basement a pipe or duct should be run outdoors and the opening protected so that rain or dirt cannot be drawn in. Ducts should be as straight as possible and of such cross-section that the air velocity will not exceed 1,000 ft. to 1,200 ft. per minute. When air is drawn from outdoors it is advisable to have dampers arranged so that it can, if necessary, be taken from the basement in cold winter weather.

The air also should be clean. The quantity of air passed through a generator is so large that even a small percentage of dust soon results in a large amount of dirt within the machine. In Europe a great deal of attention has been paid to the cleaning of the air, and numerous forms of air filter have been devised. A filter can be easily made by stretching cheese cloth, cotton or thin flannel between two frames. The cloth is passed around flat strips of galvanised iron and is pulled taut by nuts on threaded studs at each corner. The cloth is threaded back and forth so that the entering air has a large surface of cloth to pass through. The velocity of the air through the cloth is, therefore, very low and a filter unit approximately 3 ft. wide, 3 ft. high and 2 ft. deep can pass 2,000 cubic ft. of air per minute with an air velocity through the cloth not exceeding 10 ft. per minute. With this low velocity the filter does not throttle the flow of air to any great extent, and with the large area so obtained the cloth will not clog up rapidly. By constructing the filter in units as many units as may be required for a given machine can be set in a framework to form a wall through which the air must pass before reaching the generator.

Air filters should be mounted so that they can be easily taken out at intervals and cleaned. Unless they are cleaned from time to time they will become worse than useless by cutting off the air supply entirely. Even when they are provided, the interior of a turbo-generator should be cleaned periodically.

Many different plans have been used for passing the required amount of air through the limited passages within the machines, but the usual practice is to set up the air circulation by means of centrifugal fans at the ends of the rotating field structure. In some cases the air has been supplied by separate centrifugal blowers in the same manner that is customary for an air-blast transformer. This arrangement is advantageous in that the fan can be designed for the highest possible efficiency and the flow of air through the generator can be controlled at will, but is slightly disadvantageous in increasing the number of station auxiliaries.

The major portion of the heat to be dissipated is produced in or at the stationary armature core. According to a method of ventilation extensively used in both this country and Europe, air enters intakes in each of the end housings and after passing through the fans flows into a chamber at the bottom of the stator yoke, whence it is forced through the ducts in the stator core and out at the top. The air divides into two streams, one-half passing up through the core on each side of the machine. With a generator of large diameter the paths for the air become long and the temperature rise correspondingly high.



VENTILATING ARRANGEMENT OF TURBO-GENERATOR.

For large high-speed units a better method is the one illustrated herewith. Instead of passing all of the air up through the machine according to the two-path plan it is introduced behind the core through a number of inlets distributed around the whole periphery and after passing through the ducts is discharged into adjacent chambers. Several advantages are claimed for the multi-path method of ventilation for large machines. One-half of the outside circumference of the stator punchings is exposed directly to air from the fans and the stator is not dependent for its cooling on hot air that has already passed over the rotor before reaching it. The use of a number of short paths in parallel through the core greatly reduces the resistance offered to the flow of air, thus, for a given pressure, allowing a much larger quantity of air to be passed through the machine, or, on the other hand, allowing the use of lower pressure for a given flow.

Petrol-Electric Motor Cars—The "Electric Railway Journal" gives a description of a petrol-electric car, six of which have recently been built for the "'Frisco" lines. These cars are 70 ft. long and 10 ft. 5 in. wide overall. The width, inside measurement, is 9 ft. 6 in. The seats are nearly 4 ft. long, and, as they have no arms, three people can comfortably occupy one of them. The aisle is narrower than is customary on steam railway cars, but, nevertheless, is wider than on many electric cars. Apart from the passenger compartment, which seats 98 persons, the car has a 6 ft. baggage compartment. The petrol-electric equipment consists of an eight-cylinder petrol engine driving an electric generator. The motors are of the standard railway type, and the car is controlled by varying the voltage of the generator and connecting the motors in series or parallel as required. The engine control consists of a combination air valve and gas throttle, by which the engine is started on compressed air, but as soon as it begins running on petrol the air is shut off. With this arrangement the engine need be run only when the car is working. The auxiliary equipment includes a petrol-electric set for lighting and means for securing compressed air. The car described has a maximum speed of about 50 miles per hour on level track, and a scheduled speed of 25 miles per hour with stops 2½ miles apart.

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With "THE ELECTRICIAN" for Sept. 14, 1906, was issued the first of a series of "Industrial Supplements," to be published from time to time with "THE ELECTRICIAN." The fifty-third issue of the Supplement published (Gratis) with the number of "THE ELECTRICIAN" for September 23, 1910, was the last of the monthly issues. "THE COMMERCIAL AND INDUSTRIAL SUPPLEMENT" to "THE ELECTRICIAN" is now issued weekly (Gratis). It will be found towards the end of the present issue.

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LONDON COUNTY COUNCIL LOANS.

A short discussion at the meeting of the London County Council on the 1st inst. gave prominence to some questions of much interest to those concerned in the supply of electrical energy in London, either Metropolitan Borough Councils or Companies. The occasion was a report of the Finance Committee presented for confirmation by the Council, which recommended the sanction of a long list of applications for loans. These applications were from no fewer than 15 Metropolitan Borough Councils, and the amount sanctioned by the Finance Committee and submitted for confirmation by the County Council amounts in the aggregate to about £133,000, which sum must be increased to £148,700 by a loan of £15,700 sanctioned a week previously to Stepney Borough Council for electricity purposes. Of this total, £71,720, or thereabouts, was proposed to be borrowed by Borough Councils for their electricity undertakings, the remaining £77,000 for building town-halls and offices, for street improvements and other purposes.

Mr. HENRY L. CRIPPS, the recently elected alderman, stated that, although he would not then attempt to criticise the policy of the Finance Committee, he thought the general policy of these loans, especially under the altering conditions of the population and ratable value in London, demanded a complete reconsideration. He referred both to the general policy of these loans and to the policy in the case of municipal electricity undertakings;

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it is with the latter, as being more closely interesting to our readers, that we propose to deal.

The expressions "borrowing" and "loans," to denote the operations in question, are wanting in exactness. We may explain this in more detail later, but for the present purpose it may be well to make clear that no money is, either borrowed or lent in the strict meaning of the words. Money standing to the credit or raised for the purpose of the County Consolidated Fund is advanced to the Borough Council, which in its turn shunts the liability for replacement on successive future generations of borough ratepayers, from whom must be levied, by way of a charge on their own revenue or the borough rate, annual sums payable to the County Fund sufficient to replace the advance in a given number of years.

The real transaction, therefore, is one to which the future county ratepayers and borough ratepayers are committed by the County Council and the Metropolitan Borough Councils respectively, the obligation of the borough ratepayers being to pay up the annual instalments to the County Fund, and the obligation of the county ratepayers being, in case of default by the Borough Council, to make up the deficiency themselves. The enterprise, to the financial consequences of which in the future both sets of ratepayers will find themselves committed, is one in whose inception, of course, they had no choice, and as to which, if it turn out ill, they can have no redress.

Alderman CRIPPS made an interesting point of the fact that this year the ratable value of London, for the first time since the introduction of the assessment system some centuries back, had failed to show the constant progressive increase which had been hitherto maintained; while the census showed that this year, for almost the first time since the Roman era, the population resident within the county boundary had ceased its normal rate of increase. It is obvious that if the aggregate ratable value of London diminishes, the rate in the £ required to produce a given sum must increase proportionately. The general annual expense of London's public requirements is not likely to diminish. Moreover, the charges we are now discussing, and the dates by which they must be met, are absolutely fixed in advance. It follows, therefore, that whatever amount in the £ may be the liability imposed on the ratepayers in respect of these loans, it must become proportionately increased automatically if the tendency of the ratable value to diminish now indicated continues.

Alderman CRIPPS expressed the opinion that events have proved that the investors in this country have "underestimated the risks of investment"; in other words, they have been generally satisfied with a rate of interest inadequate to secure them against loss on realisation of principal. He instanced the case of Consols, where the investor, having received interest on his investment for nine years at less than $2\frac{3}{4}$ per cent., now finds that he can only realise £78 for the £100 Consols which he perhaps bought in 1901—only 10 years back—at 98, and as lately as 1906 at 91. Is it prudent, in the face of this lesson, for the London County Council to force the county ratepayers of the future (*volentes nolentes*) into an investment for a fixed period at $3\frac{3}{4}$ per cent. per annum on which (if it be as free from risk as the "premier" security seemed in 1906) they may in five years' time have lost 13 per cent. of the principal? Of course we are aware that the two cases are not exactly analogous; but similar lessons may be learnt from the depreciation in market value of London County stock during the same period.

For an exact forecast of the possible consequences of these loans we must take account of the operation of the sinking fund and the ratepayers' liability with respect to it, and we should also require an estimate of the amount to be yielded in future years by the levy of a rate of a certain amount (say one penny) in the £ on the then ratable value of the county.

Apart from these general considerations, which cover all advances for whatever purpose by the London County Council to Metropolitan Borough Councils, including electricity works, the present condition of the London electric supply question was referred to by Mr. CRIPPS as largely affecting the policy of loans for electricity purposes, especially for new machinery and patchwork purposes at existing stations.

It has been generally admitted among those who have considered the subject in the light of practical experience that combination or consolidation in some form of the electrical undertakings of London is desirable in the public interest. During the last few years Parliament has considered two large schemes for attaining this object. Each in turn failed to command approval. Neither had been sufficiently worked out so as to avoid objections. In the first, it was sought to incorporate a new company which would generate electrical energy in large quantities at stations suitably located, and supply it in bulk to the municipal and commercial undertakers, who in their turn would supply direct to those wanting power. The second scheme proposed the setting-up of the London County Council as the body to generate and supply in bulk to the municipal and commercial undertakers. It is not necessary to repeat the objections which were deservedly fatal to both these schemes at the time.

An alternative proposition which was brought forward in 1908 by the electric supply companies, obtained general assent, and the London Electric Supply Act of 1908 was passed, which provides for combination by agreement among the municipal and commercial undertakers, so that the separate stations and works of all may be made more readily available for the supply within the whole area with greater efficiency and economy. Mr. GORDON, the member for Whitechapel, who has devoted much thought to the subject in Poplar and Stepney, made a strong point of this in the recent discussion. If there is to be any combination of this character, it follows that the entire system now prevailing must undergo radical alteration. Instead of some 14 Metropolitan Boroughs and 13 or 14 companies, each with independent stations and systems designed to meet the requirements of their particular district only, there would be one body, working one comprehensive system designed to meet the requirements of the whole. A great saving of expenditure would be the result. Suppose it

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came to pass that the London County Council should exercise its statutory powers of purchasing the undertakings of the companies, it seems clear that the municipal undertakings must be taken over at the same time, and every piece of patchwork made by the Borough Councils by means of money "borrowed" from the County Council must either be purchased or made the subject of compensation, or be thrown upon the "scrap heap" as waste material. The ratepayers of the future must continue to discharge their obligations to provide the instalments necessary for the extinction of the "loan," although the machinery purchased and installed by the money borrowed had ceased to be productive or to have any value.

The electrical companies of London have had a great opportunity of acting under the legislation of 1908 and formulating a scheme to solve the great problem of the supply of London. So far they seem to have failed. We recognise the difficulty of amalgamation. Each board of directors has its own shareholders' interests as its primary motive, and any reductions in the number of chairmen, directors, engineers, managers, secretaries and their salaries all present considerable difficulties. The only possible method of settling these difficulties seems to be arbitration, to which it is understood some at least of those concerned decline to commit themselves. On the occasion of the discussion by the London County Council to which we have referred there seemed to be a concensus of opinion that if the Companies and Borough Councils maintained longer their policy of inaction Parliament must be asked to provide some means of making the Act of 1908 effective. It is to be hoped that compulsion of this kind will not be necessary, and that the initiative will be taken by those most immediately concerned.

REVIEWS.

(Copies of the undermentioned works can be had from THE ELECTRICIAN Office, post free, on receipt of published price, adding 3d. for books published under 2s. And 10 per cent. for abroad or for foreign books.)

Lignes Électriques. Part I., "Aériennes," by PH. GIRARDET. pp. 181, 5fr. Part II., "Souterraines," by PH. GIRARDET and W. DUBI, pp. 207, 5fr. (Grenoble, 1910: Jules Rey.)

These two books, written primarily for engineering students, have a lucidity and conciseness, typically French, and M. Girardet's work would seem to deserve the praise given to it in the preface by his former teacher, Prof. Pionchon, of Dijon.

The treatment of both systems of electrical distribution is limited to that of actual construction, the reader being assumed to have studied elsewhere the theory of the stresses in lines and supports, and the methods of calculating feeders and networks. The practical and economic features touched upon are of considerable interest, although English and French practice differ materially in both overhead and underground installations.

In Part I. supports for aerial lines are discussed very fully, and the author unhesitatingly proclaims the superiority of reinforced concrete, on account of its advantages in strength, absence of maintenance charges, possibility of long spans, and a lower cost than that of lattice poles.

The question of relative maintenance can be appreciated when, as the author shows, with the lattice type the cost of painting the 1,700 towers required along a line 70 miles long is over £1,000. The weight of reinforced concrete in transport is its chief drawback, and this can only be overcome on long lines by manufacturing the poles on site. The author is so convinced of the value of reinforced concrete that he devotes 12 pages to specifying closely the selection of the materials, the construction of the steel skeletons, the process of moulding the poles, and the general organisation of the operations. So complete and clear is this portion of the book that a good line foreman, without previous experience, but armed with this description, could undertake the construction of a run of ferro-concrete poles with every chance of success.

The surveying of the line, settlement of way-leaves, and the removal of obstructions are dealt with in a very practical way. The actual work of pole planting, erection of towers, fixing the wires, and the efficient management of labour and stores are fully described and partially illustrated.

The design of insulators is not considered theoretically, but some excellent hints are given on the choice of those actually to be used, and the tests they ought to satisfy. The engineer is warned of the folly of attempting to save a few pence per insulator if it entails any risk of breakdown. Copper is assumed as the material for the overhead line in detailing the various operations, but in an appendix a useful summary is given of the properties of aluminium, its handling in line construction, and the conditions of economy which justify its use.

The remainder of the volume is taken up with the legal precautions to be adopted in documents relating to concessions, way-leaves, and the various Government regulations affecting the establishment of lines on public roads, or on private property.

Part II. treats of underground mains, and although it is well arranged and printed, it suffers, like Part I., from a scantiness of illustrations. The authors waste no words in preamble, but proceed at once to describe in detail those practical points with which the technical student must become acquainted, after he has devoted some time to the theory of insulated conductors and networks, if he wishes to qualify as a mains engineer.

The design of a network is only commented upon in order to emphasise its difficulties, and the reader is recommended to accept the results of experience as at least equal in value to those obtained from theory—in many cases not an unwise counsel.

The relative merits of the various classes of underground mains are summed up in the authors' opinion that there is nothing better than armoured, lead-covered, paper-insulated cables, laid direct. Lead-covered rubber mains are dismissed in a single page, as only of historic interest. Descriptions of joint boxes and other cable accessories are simplified by being confined to those for armoured cables only, with the further restriction that any modern supply would be three phase with three-core mains for high tension and four-core for low tension. The popularity of armoured cables in Continental practice is probably due to the great care taken in the actual laying, the provision of a bed of sand in the trench, always being deemed indispensable.

The authors very properly attach great importance to the influence of cost of copper in mains work, and in the second chapter the youthful practitioner is initiated into the mysteries of the latest making-up prices as given in the "Mining Journal." The book abounds in useful hints of this kind. In the twenty odd pages devoted to joint and disconnecting boxes, only one illustration is given, but in spite of this the authors contrive to convey a great deal of useful information as to the general principles of the construction and use of these accessories. The tests of conductivity, insulation and capacity, which must be carried out before cables are accepted from the makers, are concisely stated.

The best section of the book deals with a topic which is rarely considered worthy of a detailed description, but which has a marked effect on the life and service of the cable, *i.e.*, the conditions attending the preparation of the trench, and the drawing-in of the cable.

The authors are fully alive to the importance of the work done by the humble navvy, and dwell with minute care on every step in the sequence of mains laying, from the

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out of trial holes to the final reinstatement of the road surface. While giving valuable technical precautions for the avoidance of damage due to sharp bends in the cable, and laying during cold weather, they do not lose sight of the economies to be effected by careful methods of store-keeping, keeping of accounts, and good management of labour. An excellent condensed account is given at the end of the book, of methods of fault location, with several examples taken from notes of the more troublesome faults actually met with in the authors' practice. This part of the book is in less prominent type, conveying the suggestion that the section will be rarely referred to if the authors' precepts for mains laying are carefully followed!

On the whole this is a useful and illuminating little treatise on the everyday side of mains work, which academic tuition from lack of knowledge or of interest is inclined to ignore.

J. R. DICK.

Automatische Fernsprechsysteme. By A. B. SMITH & F. ALDENDORFF. Parts I. and II. (Berlin: S. Heimann & Sohn.) Part I., pp. 160, M. 3. Part II., pp. 161–327, M. 5.

This book is based on A. B. Smith's "History of the Automatic Telephone," published in "Telephony" (Chicago), and deals in a very interesting manner with the development of automatic systems. The production is, however, largely of historical interest, as, unfortunately, the description (particularly of the Automatic Electric Co.'s system) closes without any lucid particulars of the two-wire system, now being introduced in San Francisco and Chicago, and looked on as the latest and standard practice, and, therefore, of the greatest interest to the engineer.

The first volume gives descriptions and diagrams of the early inventions in the automatic field; the work of the brothers Connolly, McTighe, Smith, &c. The early forms of the system of the brothers Strowger, the work of Lundquist and the brothers Erickson. The remainder of this volume deals with the improvements in and development of the Strowger system by Keith and others: the use of the connectors with contact banks and the associated circuits; party-line working; impulse senders on instruments; group selectors and a description of the early installations.

The first exchange in which the calls were registered was in Chicago, a meter being associated with the first selector, which only records when the necessary impulses are sent to a line that is disengaged but does not respond when the line is busy, and is then automatically returned to the former position when the receiver is replaced. The later practice, however, is to associate the meter with the line switch, and it only registers when the called subscriber answers, but this is not mentioned. This volume finishes with a few details of the construction of the Automatic Electric Co.'s relays and connectors.

Volume II. goes into further detail of later installations of the three-wire systems, that of Los Angeles being interesting, as it is the largest and one of the latest systems so wired. A section deals with the layout and wiring of the plant. Another with the Keith line or individual switch, the perspective views showing the two-wire switch, but the diagram the three-wire one. A page and a third are given to the economy and the suitability of this system to decentralisation. A later system of party-line working is described, and also other installations. The last chapter on the Automatic Electric Co.'s system describes inter-exchange working and the signal repeater which repeats the impulses sent from the sub-station, beyond the condensers in the circuit at the first exchange, to the apparatus at the second.

The Lorimer system is described in the following 63 pages. This is a power-driven system, certain parts of which are continuously revolving. The lines end in no individual electromagnetic devices, but in terminals which are wiped over by brushes so that both the calling and the called lines have to be selected. The system is most ingenious and interesting, but the circuits are very involved. These are, however, described in considerable detail. It is noticeable, however, that the illustration of the instrument impulse sender switch is not of the latest type.

A description of the Clement auto-manual system is given as typical of semi-automatic systems, in which the sub-station instruments are without impulse senders, the operator calling the required line.

The sections or chapters of the books are not numbered, and the division of the work into two volumes is in the middle of a chapter.

W. A.

ACCURACY OF THE BELLINI-TOSI WIRELESS "COMPASS" FOR NAVIGATIONAL PURPOSES.

BY L. H. WALTER, M.A.

Summary.—The author gives results of actual working of the Bellini-Tosi wireless compass.

While there is little doubt that some recent mishaps at sea have again drawn attention to the valuable service which can be rendered by wireless telegraphy, in facilitating rescues, they may also be considered to demonstrate that the ordinary wireless equipment is no actual safeguard against collision or stranding, &c., in time of fog—for wireless telegraphy apparatus was carried by the North German Lloyd liner "Prinzessin Irene," by the Ward Line steamer "Merida," and by H.M. Canadian cruiser "Niobe," to mention only three examples.

By the use of a directive system of wireless telegraphy it is known that the bearing of fixed or moving stations can be readily determined, but no results have hitherto been available. For this reason it appears desirable that some actual figures should be published in order to give an idea of the accuracy with which a ship can be navigated by means of the Bellini-Tosi wireless compass during fog or in thick weather.

The arrangement itself has already been referred to in THE ELECTRICIAN (Vol. LXV., p. 861, 1910), and consists, as is known, of a comparatively small size directive receiving set; the actual size only depending on the dimensions of the ship upon which it is fitted.

The provision of such a directive arrangement on board ship has several advantages, the most important being that the ship's navigating officers are able to make the observations themselves with any care they like. In other methods, such as informing a ship of its position by means of wireless telegraphy, it is necessary to have a directive arrangement at the shore station, and even in such a case the danger of collision between ship and ship is in no way lessened.

Experiments were carried out between the Dieppe station and the destroyer "Bombarde," of the French Navy, and also between the Boulogne-sur-Mer station and the armoured cruiser "Bouvines." The Dieppe station was provided with triangular directive aerials 50 metres in height; the wavelength used by the "Bombarde" was 300 metres. The following table shows the results, the fourth column giving the differences between the bearing as determined by the radiogoniometer and that as deduced from the vessel's course.

Table I.

Observation No.	Bearing from Radiogoniometer.	Bearing from ship's course.	Difference.
1	North 48° W.	North 43° W.	+5°
2	N. 39° W.	N. 36° W.	+3°
3	N. 33° W.	N. 27° W.	+6°
4	N. 24° W.	N. 19° W.	+5°
5	N. 9° W.	N. 3° W.	+6°
6	N. 9° E.	N. 4° E.	+5°
7	N. 9° E.	N. 4° E.	+5°
8	N. 13° W.	N. 6° W.	+7°
9	N. 34° W.	N. 27° W.	+7°
10	N. 46° W.	N. 42° W.	+4°
11	N. 60° W.	N. 59° W.	+1°

The errors shown in column 4 are all positive, the mean error being 5 deg. An examination of the radiogoniometer after the trials showed that this error was due to a faulty setting of the pointer, which was found to be clamped in a posi-

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tion about 5 deg. displaced in the direction which gave rise to the positive error.

The Boulogne-sur-Mer station has already been described in THE ELECTRICIAN (Vol. LXIV., p. 421, 1909); the results obtained in the tests between this station and the "Bouvines," which used a 300-metre wave, and was cruising in sight of the English coast, are shown in Table II.

Table II.

Observation No.	Bearing from radiogoniometer.	Bearing from vessel's course.	Difference.
1	North 72° W.	North 74° W.	−2°
2	N. 70° 30′ W.	N. 72° 30′ W.	−2°
3	N. 69° W.	N. 68° 30′ W.	+0° 30′
4	N. 65° 30′ W.	N. 66° 30′ W.	−1°
5	N. 63° W.	N. 64° W.	−1°
6	N. 58° W.	N. 61° W.	−3°
7	N. 55° 30′ W.	N. 59° W.	−4° 30′
8	N. 51° 30′ W.	N. 56° W.	−4° 30′
9	N. 50° W.	N. 53° W.	−3°
10	N. 46° 30′ W.	N. 49° 30′ W.	−3°
11	N. 45° W.	N. 48° W.	−3°
12	N. 33° 30′ W.	N. 37° W.	−3° 30′
13	N. 33° 30′ W.	N. 34° 30′ W.	−1°
14	N. 31° W.	N. 32° W.	−1°
15	N. 28 °W.	N. 28° 30′ W.	−0° 30′
16	N. 24° W.	N. 25° W.	−1°
17	N. 21° W.	N. 19° 30′ W.	+1° 30′
18	N. 19° W.	N. 17° W.	+2°
19	N. 18° W.	N. 14° W.	+4°
20	N. 14° 30′ W.	N. 11° W.	+3° 30′
21	N. 6° W.	N. 5° W.	+1°
22	N. 8° W.	N. 7° 30′ W.	+0° 30′
23	N. 13° 30′ W.	N. 11° 30′ W.	+2°
24	N. 14° 30′ W.	N. 12° 30′ W.	+2°
25	N. 13° W.	N. 12° W.	+1°
26	N. 16° W.	N. 14° W.	+2°
27	N. 16° W.	N. 16° W.	0°
28	N. 19° 30′ W.	N. 17° 30′ W.	+2°
29	N. 21° 30′ W.	N. 18° 30′ W.	+3°
30	N. 21° W.	N. 21° W.	0°
31	N. 26° 30′ W.	N. 22° W.	+4° 30′
32	N. 28° W.	N. 23° 30′ W.	+4° 30′
33	N. 30° W.	N. 25° 30′ W.	+4° 30′
34	N. 32° W.	N. 28° W.	+4°
35	N. 33° W.	N. 31° 30′ W.	+1° 30′
36	N. 34° W.	N. 34° 30′ W.	−0° 30′

In this case there are two distinct groups of errors, positive and negative, and it is considered by Bellini and Tosi that these are probably due to the deviations of the magnetic compass on board, caused by the ship's sides, according to the different routes followed. The mean of the errors, taking their sign into consideration comes out at 0° 20′ only, while that of their absolute values amounts to 2°. The accuracy of the observations may thus be considered quite satisfactory.

The arrangement of a directive aerial for navigational purposes on board ship has been called a "wireless azimuthal compass," owing to the fact that like its optical equivalent the goniometer or taximeter it enables us to measure the angle which a direction makes with the axial centre line of the ship. The wireless compass has, however, a range which is generally greater than that of the taximeter; on the other hand, while the taximeter gives both direction and sense of the observed point, the wireless compass gives only the direction: the sense has to be obtained by two simultaneous or successive observations.

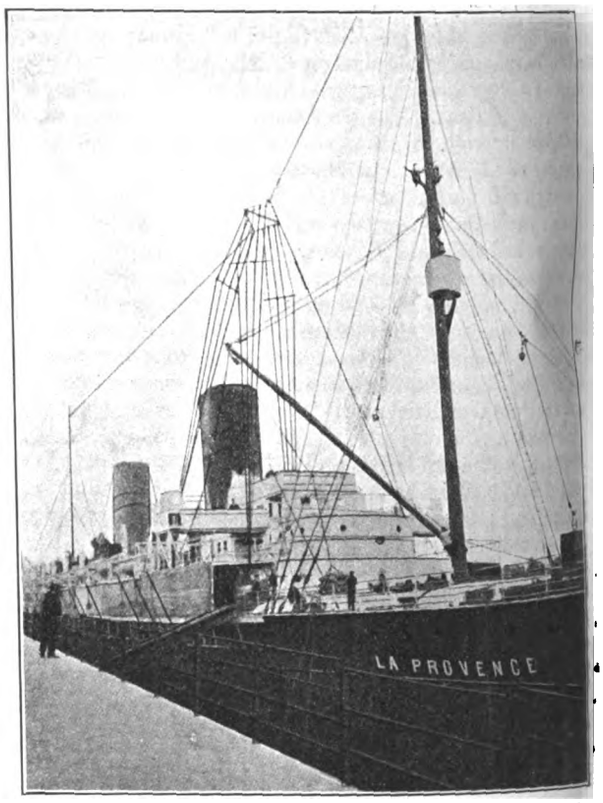
The general arrangement of the "compass" aerial on board a passenger liner is well shown in the accompanying photograph of the "Provence," of the Compagnie Générale Transatlantique. This vessel is fitted with the Marconi system for ordinary wireless communication, but carries in addition, for safety in navigation, the submarine bell signalling apparatus and the Bellini-Tosi wireless compass.

As an instance of the information which the wireless compass affords the navigating officer, the following short log of a trip of the "Espagne" (a sister ship of the "Provence") from Havre to Saint-Nazaire is of interest.

The departure from Havre took place at 1 p.m. At 4:30 the "Espagne," being in sight of the lighthouse at Barfleur, the direction of the Niton station was determined. The bearing, as found by the wireless compass, was 75° on the starboard bow, which was found to agree with that deduced from a knowledge of the ship's position. The distance between the ship and the Niton station was 60 miles, and the signals received were so strong that they could have been made out at a much greater distance. The wave-length of the Niton station was 300 metres.

From 5 o'clock to 5:15 the direction and movements of several vessels were determined, some going north, the others south; the direction of all of these lay between 5° on the port bow and 17° on the starboard bow. At 1:15 a.m. a station was heard at 50° on the starboard bow. At 8:55 a.m. a station was located in the direction of the vessel's axis. At 9:45 a.m. a station at 35° on the starboard bow.

From 9:55 onward a large number of signals were received, of different wave-lengths, all lying between 0° and 20° on the starboard bow. Eventually a French squadron cruising off Lorient was perceived. The signals just referred to were those from the ships of this squadron, so that at the time the signals



VIEW OF S.S. "LA PROVENCE" SHOWING ARRANGEMENT OF THE "COMPASS" AERIAL.

were received the ships were all within the angular zone determined by aid of the wireless compass.

In the same way as with the fixed directive stations the accuracy with which the bearing can be determined by means of the wireless compass was investigated in the course of a lengthy series of trials. For this purpose the French cruiser "Carnot" was equipped with a compass attachment, and carried out the tests at Brest, with the cruiser "Bouvet" and the Brest–Kerlaer station as transmitting stations; the former having a 600-metre wave and the latter one of 300 metres.

The results are shown in Table III., which is typical of many series of observations; the trials in this case having been made with the Brest–Kerlaer station as transmitter. This station was working with reduced energy and a small spark, and yet the signals were well received on the short "compass" aerials at 12 miles, while the signals from the "Bouvet" were very strongly received at 19 miles, so that a greater range could easily have been obtained. The range is nevertheless considerably greater than that at which optical measurements are generally taken.

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Table III.

Observation No.	Bearing from radiogoniometer.	Bearing from optical "taximeter."	Difference.
1	103° Port.	103° Port.	0°
2	98° 30′ „	100° „	−1° 30′
3	116° „	113° „	+3°
4	145° „	140° „	+5°
5	173° „	178° „	−5°
6	145° Starboard.	146° Starboard.	−1°
7	142° „	142° „	0°
8	145° „	145° „	0°
9	80° „	84° „	−40°
10	117° „	114° „	+3°
11	80° „	79° „	+1°
12	75° „	76° „	−1°
13	81° Port.	82° Port.	−1°
14	54° „	57° „	−3°
15	60° „	61° „	−0° 30′

A very important fact has also been established as a result of the numerous tests, and that is that the radiogoniometer gives the same accuracy on board as on land, the masses of metal on the ship exerting no noticeable influence on the indications of the apparatus. In view of these positive results the French Minister of Public Works has decided to equip three "radiophares," or lighthouses with short-wave wireless apparatus, as an aid to navigation and for the benefit of ships fitted with the Bellini-Tosi wireless compass. One installation is to be placed on the lightship "Le Havre," about 7 miles from Cap de la Hève, near Havre, while the other two, to facilitate entry to the port of Brest, are to be located in the lighthouses on the Ile de Sein and at Creach d'Ouessant respectively. The signals to be emitted in time of fog have been fixed as follows: Havre, the letter H (spark note 522 per second); l'Ile de Sein, the letter S (spark note 783 per second); Creach d'Ouessant, the letter O (spark note 522 per second). The signals are to be emitted every 30 seconds and to be repeated *slowly* for at least ten seconds. The wave-length chosen is 80 metres.

CORRESPONDENCE.

UNITS OF RESISTIVITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: While heartily agreeing with Mr. Dellinger's conclusions as to the advantages in certain cases of using the mass resistivity, I most strongly protest against the unscientific names which he uses for the units. He is quite correct in thinking that the introduction of the unit cube into the definition of resistivity has been the cause of much confusion of thought, which, in my opinion, is not confined to students, but extends in many cases to their teachers, text-book writers and even examiners. The slip-shod use of "ohms per cubic centimetre" has been largely responsible for this, but "ohms per grammemetre" is every bit as bad. The best definitions are: "Resistivity is that property of the material in virtue of which it converts energy into heat when an electric current flows through it, and it is measured by the *resistance per unit length of a rod* (or wire) *having a unit cross-section*." "The mass resistivity is measured by the resistance per unit length of a rod (or wire) having unit mass per unit length." The units of length and mass belonging to the system which includes the joule, watt, ohm, &c., are the metre and kilogramme, but a unit of resistivity may be obtained by using any units that may be convenient for the purpose on hand. The microhm-millimetre and microhm-inch are of convenient magnitude, but of course it is not necessary to measure the length in the same unit as that involved in the unit of cross-section. Mr. Dellinger's "ohms per centimetre cube" ought to be "ohm-cms.," his "ohms per metre-millimetre" ought to be "ohms-mms.^{2} per metre," his "ohms per mil-foot" should read "ohms-mils^2 per foot," and his "ohms per metre-gramme" is "ohm-grammes per metre^2."

It is generally agreed that if a and b be any units, a per b means a divided by b, and a-b denotes a multiplied by b. Familiar examples are "miles per hour," "lbs. per cubic foot," "foot-pounds," "foot-pounds per minute," and so on. Unfortunately a few exceptions to these rules have come into common use among "practical" men, partly because of inaccurate conceptions of the relations between the quantities, but chiefly because of that human weakness which makes us all prefer to call a thing by some other than its correct name, especially when the substitute is the shorter of the two. The number of such is at present small, but some have already got such a good foothold and are so convenient to use, that it will be very difficult to dislodge them from a position they ought never to have occupied. Such are, for instance, "candle-foot," "megohms per mile," "ohms per centimetre cube," and "ohms per metre-gramme."

Of course, all of us who are in the habit of using such expressions know exactly what is meant by them, and so many will say that it is pedantic to quibble at them. How many of those people, I wonder, who condone, and even encourage, this production of new exceptions to our rules, are also advocates of the removal of some of the disadvantages under which we labour owing to the ignorance of our ancestors by the heroic means of changing all our weights, measures and coins. If such a gigantic task is too much for us to do for posterity, we can at least see that we do not add any more which will have to be reformed later. For ourselves, it is easier to continue in the way to which we have been accustomed, but each new exception to our general rules for forming and naming units has to be separately learnt and retained in the memory by each succeeding generation; and it thus constitutes an additional burden on all those who come after us, and another encumbrance to them in their pursuit of new knowledge.

Compare, for instance, "Board of Trade unit" with "kilowatt-hour," or "henry" with "secohm" (now, alas! almost forgotten). Both names of each pair stand for the same thing, but the first one is a special convention and has to be remembered as such, whereas the second tells us on the face of it what it is in terms of more familiar units.

If we don't wish our units to resemble the spelling of our language—each word a law unto itself—we must keep the number of special names down to the lowest possible limit, restricting them entirely to quantities whose use is so frequent that the names soon become quite familiar. It is only in such cases that the advantage of a short special name outweighs the disadvantage of having something additional to memorise. Above all, we must not permit exceptions and direct contradictions to our regular rules on the subject.—I am, &c.,

Merchant Venturers' Technical College, DAVID ROBERTSON.
Bristol, August 12.

New Technical Museum at Vienna.—In commemoration of the 60th anniversary of the Emperor Francis Joseph's reign, Austrian manufacturers, with the assistance of the State and the City of Vienna, have initiated this new museum. The foundation stone was laid on June 20, 1909, and the building, which covers an area of about 20,000 sq. yds., is now nearing completion, and will be a lasting monument of the long and memorable reign of the present monarch.

The technical museum has been established to demonstrate the development of industries and crafts in historical succession, also to do justice to the technical achievements of the present day and to promote industrial progress by periodical exhibitions. It is to be a public educational centre spreading the knowledge of the scientific foundations and technical pursuits of the empire. A considerable stock of objects has been secured, as several large and valuable State collections, till now dispersed, are shortly to be brought together. Many links in the chain of technical development are still missing, and therefore technical scientists, manufacturers and craftsmen of all countries are invited to co-operate in the great task and to assist the museum in procuring and selecting suitable objects. Everything appertaining to technical labour is acceptable, and especially tools, machines, apparatus, models, materials, methods of working, finished articles, as well as plans, designs, books, illustrations and manuscripts. The Austrian Government has placed at the disposal of the museum the spacious halls of the Rotunde for storing and selecting donations. The names of donors will be perpetuated by inscription on the gifts and in a memorial book. Further particulars from the office of the Technical Museum, Vienna, I. Ebendorferstrasse 6.

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PHOTOMETRIC UNITS AND NOMENCLATURE.

Owing to pressure on our space during the last few months we have been unable to deal adequately with an article on this subject by Dr. E. B. Rosa, which appeared a short time ago in the "Bulletin" of the Bureau of Standards. In view, however, of the recent contributions to the subject by Mr. A. P. Trotter and Mr. Haydn Harrison in our columns, the following summary of Dr. Rosa's article should prove of interest to our readers.

In an introduction to the article, Dr. Rosa mentions that the subject of photometric units and nomenclature received a notable impulse by the Paper of Blondel, presented to the Geneva Congress of 1896. Since that time various modifications in the proposals there made have been put forward, and the units and nomenclature there proposed have come into use to a greater or less degree. There has, however, been a tendency to recognise as few separate photometric quantities as possible, and some of them have been employed rather loosely in more than one sense. This is partly, at least, due to a lack of clearness in the perception of the physical relation of the various photometric quantities. The Illuminating Engineering Society appointed a committee* on this subject something over a year ago, and it was due to my membership of this committee that I was led to give the matter careful attention. Some of the names are here used in a different sense from what has been usual, and slight changes have been made in some of the symbols. These are in the interest of a more systematic arrangement and also of international uniformity.

Dr. Rosa then proceeds to discuss the mathematical and physical relationships of the various photometric quantities, and finally summarises the photometric relations as follows:—

Luminous flux or light, as the term is used in photometry, is the usual physical stimulus which excites vision. It is propagated by means of the vibratory motion in the ether, and the frequency of the vibrations or the combination of frequencies present in any given case determines the colour. The total quantity of flux F flowing away from a monochromatic luminous source is proportional to the total radiant energy (per second) and to a stimulus coefficient, the latter being the luminous efficiency K_λ for the particular frequency or wave length of the given radiation. Thus the equations $F=K_\lambda^{\prime}W$ and $K_\lambda=F_\lambda/W_\lambda^{\prime}$ express the luminous flux as the power W multiplied by the luminous efficiency K_λ, and if the flux is expressed in lumens and the power in watts, the luminous efficiency is the number of lumens per watt of radiation of the wave length λ. For white or chromatic light K will have a value depending on the distribution of the energy in the spectrum. It is a maximum in the yellow-green region and falls off rapidly in either direction, reaching zero at the limits of the visible spectrum. The luminous efficiency of most light sources is greatly reduced by the amount of radiation outside the visible spectrum, chiefly of longer wave length than that of visible radiation, and the total efficiency of such a source $K=F/W$ is the quotient of the total luminous flux divided by the total radiant power.

For the purposes of definition and of expressing the mathematical relations involved in photometry, it is permissible to confine ourselves to monochromatic light and to consider K a constant, although it does in fact vary somewhat with the magnitude of the flux density. We also assume that all surfaces are perfectly diffusing and obey the cosine law and that there is no absorption in the atmosphere.

The intensity of a point source or uniform luminous sphere is measured by the luminous flux flowing through a unit solid angle whose apex is the given point or centre of the given sphere. Thus from a source of intensity I, light is flowing away at a rate of I lumens per unit solid angle, or a total of $4\pi I$ lumens for the point source or uniform sphere. If the source is not uniform and light is flowing away at unequal rates in different directions, the intensity I in any direction is equal to the flux dF in an elementary solid angle $d\omega$ taken in the given direction. Thus, $I=dF/d\omega$ is a general expression applying to all point sources whether radiating equally or unequally in different directions. If the unsymmetrical source is extended—as, for example, an incandescent lamp or a diffusing globe—the same holds true if the distance at which the measurements are made is sufficiently great so that the distribution of light is practically the same as from an unsymmetrical point source. For less distances than this the intensity is not a constant in a given direction, but varies with r. In this case the equivalent intensity at any point is equal to that of a point source which gives the same flux density, or lumens, per square centimetre at the point that the given source does. The mean spherical intensity I_s is the average value of the intensity and is equal to the total flux F divided by 4π.

The total flux from a given extended source is therefore a constant independent of distance, as is also the mean spherical intensity I_s. The intensity I in a particular direction, however, in the case of extended sources other than spheres varies with the distance, but at relatively great distances the variation is inappreciable. Thus the luminous flux is the fundamental quantity. But while we define I as the flux per unit solid angle, or rate of flux with respect to solid angle, we determine I by comparison with a concrete standard. Thus photometric standards of intensity are standards of light flux, their values being expressed in candles.

If f is the spherical reduction factor with respect to any particular direction, and I is the intensity of a source in that direction, $I_s=fI$. For a unit disc—that is, a small circular disc of uniform brightness—the total flux is π times the normal intensity I_n, whereas the mean spherical reduction factor with respect to the normal is one-fourth. Hence, the total flux is $F=\pi I_1=4\pi I_n$, as for a sphere. In general, for any light source, $F_s=4\pi I_s=4\pi fI$, but for extended sources other than spheres, the value of f as well as I varies with the distance from the source for points relatively near the source.

The specific flux or flux density is the luminous flux per unit of area, or lumens per square centimetre. When the flux falls upon a material surface, we call the specific flux the illumination E. When we speak of the flux coming from a surface, whether it be a self-luminous source at high temperature or a reflecting or radiating surface at low temperature, we call the specific flux the specific radiation, or simply the radiation E′.

Thus the illumination is $E=\frac{F_i}{S}=\frac{dF_i}{dS}=\frac{I}{r^2}$; and the radiation E′ is $E'=\frac{F_r}{S}=\frac{dF_r}{dS}$, where F_i is the incident flux and F_r is the emitted or radiated flux. If m is the coefficient of diffuse reflection or transmission, $(1-m)$ being the absorption, $F_r=mF_i$ and $E'=mE$, where the radiation consists in the diffuse reflection or transmission of a portion of the incident flux or illumination.

The radiation or illumination when large may be expressed in lumens per square centimetre; when small in milli-lumens per square centimetre. The milli-lumen per square centimetre is nearly equivalent to the foot-candle.

The brightness b of a source is the intensity in candles per square centimetre of area taken normally. Thus $b=\frac{I}{S}=\frac{dI}{dS}=\frac{dQ}{dS}$. Brightness, or specific quantity, refers to the quantity of light per unit of area of a source, and is measured in candles per square centimetre. Brightness can refer equally to luminous sources of relatively high specific intensity or to reflecting and radiating sources of low intensities. The latter may be conveniently expressed in milli-lumens per square centimetre. Thus we may say a flame has a specific radiation of 10 lumens per square centimetre or a brightness of 0·8 candles per square centimetre; and a wall has a specific radiation of 10 milli-lumens per square centimetre, or a brightness of 0·8 milli-candles per square centimetre or of 8 candles per square metre.

The quantity Q is proportional to the total amount of light emitted by the source, and is equal to the surface integral of the brightness b. Thus, $Q=\int b dS$. The quantity for a small luminous circular disc of radius a and uniform brightness b is $Q=\pi a^2 b=I_n$. That is, the quantity is equal to the maximum intensity. In this case the whole surface is equally effective in producing the illumination on the test screen by which the intensity I_n is measured. But for an extended disc, the quantity and the normal intensity are not the same.

The total luminous flux is π times the quantity, and the mean hemispherical intensity is half the quantity.

In the case of a sphere of uniform brightness b, the quantity is $4\pi a^2 b$; the intensity $\pi a^2 b$, or one-fourth the quantity. In other words, the total radiation from the sphere is four times as great as from a unit disc of the same normal intensity. The total luminous flux delivered in a given time—that is, the time integral of the luminous flux—may be expressed in lumen-seconds or lumen-hours, according to circumstances. Thus, putting L for the total lighting in the time T, $L=FT$ or $=\int F dT$ if F is variable, where F is in lumens and the time is expressed in the most convenient unit. The flash of a firefly may be expressed in lumen-seconds; the total lighting per gramme of an illuminant, or the total lighting given during the life of an incandescent lamp, is better expressed in lumen-hours.

Since flux of light may also be expressed in spherical candles (4π times the lumens), we may also express the time integral or total lighting in terms of spherical candles and hours. Thus $L=I_s T=\int I dT$ if the spherical candle-power is a variable with respect to T, the value of L being here given in candle-hours.

The photometric quantities employed in the preceding discussion

* The committee consists of Dr. C. H. Sharp (chairman), Prof. A. E. Kennelly, Prof. E. L. Nichols, Prof. A. Blondel, and the writer.

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are shown in the following table, together with the units in which they are expressed.

Photometric magnitude.	Symbol.	Unit.
1. Intensity of light	I	Candle.
2. Luminous flux	F	Lumen.
3. Illumination	E	$\frac{\text{Lumens}}{\text{cm}^2}$ or $\frac{\text{milli-lumens}}{\text{cm}^2}$.
4. Radiation	E′	Lux = metre-candle.
5. Brightness	b	Candles/cm^2.
6. Quantity	Q	Candles.
7. Lighting	L	Lumen-hours.

The symbol F has been employed for the flux (as originally proposed by Hospitalier) instead of Φ, for the following reasons: (1) Φ is the only Greek letter in the series, and it is more consistent to use a Latin letter; F is the initial letter of the word flux. (2) The letter Φ is more or less unfamiliar to many illuminating engineers and also to many printing offices, and it is often confused with the small letter ϕ, which is used for an angle.

The symbol E′ is used for radiation instead of R (as proposed by Hospitalier) because it is so closely related to the illumination, and because the letter R is employed for the distance from the source. Blondel and others proposed to employ the same letter, E, for illumination and radiation, but that gives rise to confusion. On the other hand, E′ gives sufficient distinction and at the same time recalls their close connection. The letter b is used for brightness instead of i for specific intensity because i is used for the angle of emission, and specific intensity is a less desirable name. The quantity is a specific intensity strictly only for small plane areas, not for small spheres or large sources of any form. Quantity of light, Q, is here used as the surface integral of b instead of the time integral of F. It is analogous to quantity of electricity in electrostatics and is more properly employed in the sense here used than with the other meaning. The term lighting, for flux times time, is used in harmony with the usage in France and Germany.

PARLIAMENTARY INTELLIGENCE.

TELEPHONE TRANSFER BILL.

On Friday the House of Commons went into Committee to consider this Bill.

On clause 2 Mr. PETO moved the insertion of words to make it clear that a portion of the £4,000,000 should be devoted to the development of the telephonic system "in rural as well as in urban areas."

Capt. NORTON maintained that there was no object in inserting these words, because the clause would carry out the object which the hon. member had in view.

The amendment was negatived.

On clause 5, Mr. J. F. HOPE said there were still outstanding some points with regard to the staff, and if the further consideration of the bill were postponed to the autumn session an opportunity would be afforded for settling them.

Mr. JOYNSON HICKS said the greater part of the claims of the staff had not been satisfactorily met. There was the question of the pension rights. No telephone employee should be in a worse position under the Post Office.

Mr. H. SAMUEL opposed the motion to report progress and said that of the 18,000 persons now in the National Telephone Company's service only 2,000 were on the pension fund. The State was taking over the whole of the 18,000 and putting 12,000 of them on the pension fund, so that 10,000 of the Company's servants would receive pension rights for the first time and without paying the 2½ per cent. deduction which they paid now. The 300 or 400 men referred to by Mr. Joynson-Hicks were for the most part men engaged in constructional work, and would not be pensionable even if they had been from the first in the service of the Post Office. The Post Office at the present employed 5,000 men of that class, and it would be impossible to give pensions to the new comers and deny them to old servants of the Post Office in the same class. He undertook to postpone the consideration of clause 5 until next week, and in the meantime to have a consultation with the Treasury with a view of reaching an understanding on the question that had been raised.

The consideration of clause 5 was, therefore, postponed.

On clause 6, which contains temporary provisions as to the transfer,

On the motion of Mr. SAMUEL several amendments, designed to bring the terms of the clause into conformity with the agreement which he had made with the National Telephone Co., were also agreed to. He proposed to omit sub-sections 1, 2 and 4, which were unnecessary, and to substitute for the words "the appointed day" a fixed date—Dec. 31, 1911. New clauses providing for an audit of the accounts under the Bill and under the Telegraph Act, 1892, the Telegraph (Money) Act, 1896, the Telegraph (Money) Act, 1898, the Telegraph Act, 1899, the Telegraph (Money) Act, 1904, and the Telegraph (Money) Act, 1907, and making provision as to gratuities to transferred officers were agreed to.

On Wednesday the House of Commons again went into Committee on this Bill.

Mr. H. SAMUEL moved a new clause dealing with provisions as to the superannuation of transferred officers, in substitution of Clause 5. He stated that those members of the company's construction staff who were now pensionable, and also the contract officers pensionable, would be placed on the Post Office establishment, and those of them who were not pensionable would have equal chances with Post Office employés to be placed on the establishment.

The clause was read a second time and added to the bill, clause 5 being struck out.

The bill was then reported, as amended, to the House.

Pacific Cable Bill.—In the House of Commons on Wednesday this Bill passed through the Committee stage and it will be read a third time to-day, Friday.

LEGAL INTELLIGENCE.

Workmen's Compensation.

At Burnley County Court on 11th inst., John Clague and Eliza Crossley sued for compensation in respect of the death of John Clague, junr., overhead wireman, who was fatally injured whilst in the employ of Burnley Corporation. On June 18 deceased was repairing wires in Church-street when a portable furnace burst, and the petroleum set fire to his clothing. He sustained injuries which resulted in his death. Deceased's father was totally dependent on his earnings. The case was adjourned, but it was agreed the father should receive 8s. per week and £10 down.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

*NOTE.—The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application, an asterisk is affixed.*

June 19, 1911.

14,478 RUSHMORE. Systems of electric lighting.*
14,504 WEINTRAUB. Production of periodically varying currents of high frequency. (Convention date, 18/6/10, U.S.)*
14,505 VAUGHAN. (Manley Edwin Stureis, U.S.) Electric transportation systems.*
14,527 ALLGEMEINE ELEKTRICITATS GES. Automatic repayment apparatus having maximum tariff device. (Convention date, 18/6/10, Germany.)*

June 20, 1911.

14,569 HEURTLEY. Electric telegraphy.
14,587 KENT, LACELL & SILICA SYND. Mercury and other vapour, electric lamps.
14,590 STEINBERGER. Telephone mouthpieces. (Convention date, 6/8/10, and 20/8/10, United States.)*
14,604 NEUDOERFFER. Electric pocket-lamps.*
14,613 GWOZDZ. Telephones.*
14,615 SYKES INTERLOCKING SIGNAL CO., SYKES & TARRANT. Electric relays.
14,619 SIMMS & SIMMS MAGNETO CO. Magneto-electric machines.

June 21, 1911.

14,646 RUSHTON. Electrically-driven clocks or watchworks of the primary or self-controlling type.
14,649 BRUNSCHWYLER & INGLI. Metal telegraph poles.*
14,683 SIEMENS BROS. & CO. & RIBER. Telephone transmitters.*
14,685 SIEMENS BROS. DYNAMO WORKS. (Siemens Schuckertwerke G.m.b.H., Germany.) Arc lamps.*
14,704 ODGERS. Operating or controlling electric switches and the like from a distance.*
14,727 MURRAY. Wireless telegraphy.
14,729 CONRADTY. Electrodes for electric arc lamps.*

June 26, 1911.

14,802 FARMER & RAMSEY. Antiseptic telephone caps.
14,803 HOPE. Fusible cut-outs for controlling electric circuits.
14,812 VERITYS LTD. & HIRSCH. Electrical circuit-breakers.*
14,825 HORSTMANN, HORSTMANN & EDGAR. Electric time switches, and other timing devices.
14,882 SWEETING & EAST. Trolley-pole retaining apparatus for electric cars.
14,887 SCHULZ. Telephone system.*
14,938 LAKE. (U.S. Light and Heating Co., U.S.) Battery plates.*
14,942 MILCH. Singlephase alternating current motors of the commutator type. (Convention date, 27/6/10, Austria.)*
14,947 GEPPERT. Method of and apparatus for generating power. (Convention date, 30/6/10, Germany.)*

SPECIFICATIONS PUBLISHED.

1910 SPECIFICATIONS.

11,693 BILLITER. Electrolysis of liquids. (Convention date not granted.)
13,946 B.T.-H. Co. (G.E. Co., U.S.) Electric insulating material.
13,057 LOMAX. Earthing devices for conductors and other electric apparatus.
14,196 SIEMENS BROS. & CO. (Siemens & Halske Akt.-Ges.). Circuits for automatic or semi-automatic telephone exchanges.
14,349 HIRST & MAURICE. Electrically-illuminated letter signs and the like devices.
14,499 PRICE. Electrical machines.
14,680 PARSONS & LAW. Dynamo electric machinery.
14,912 WILKINSON. Electric resistances for electric heating and other apparatus.
14,946 & 14,956 ADAMS MFG. CO. (Cutler Hammer Mfg. Co.) Controllers for electric motors.
15,170 NORTH. Alternating-current electric meters.
19,033 SPECHT & BEIGE. Incandescent electric lamp holders. (12/8/09.)
22,902 MACTAGGART & SCOTT. Telemotor apparatus for ships' steering gear.
25,923 HOPE. Enclosed electric switches.
29,299 SERPEK. Revolving electrical furnaces. (11/8/10.)

1911 SPECIFICATIONS.

6,627 SIEMENS BROS. & CO. (Siemens & Halske Akt.-Ges.) Electric block signalling systems.
6,833 BARRET & GAIFFE. X-ray bulbs and tubes. (7/9/10.)
7,198 MUNRO & RAIL-LESS ELECTRIC TRACTION CO. Trolley bases for electric traction systems. (Divided application on 11,157/10. May 5.)
8,150 ALLGEMEINE ELEKTRICITATS GES. Regulating the voltage of direct-current machines running at variable speeds. (1/4/10.)

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ELECTRIC WINDERS.

In our second Mining Issue we gave particulars of a large number of electric winders. Unfortunately, details from the A.E.G. came to hand too late for inclusion, but as we desire the information to be as complete as possible we think it well to publish the following supplementary list of A.E.G. installations. We also add some details of winders supplied by the Ateliers de Constructions Electriques de Charleroi. The whole will show what great progress has been made.

Owners.	Name of pit.	Depth. m.	Net load. kg.	Max. speed in metres per sec.	Motor H.P.	Supply. System.	Supply. Voltage.	Frequency.	System of Driving.
WINDERS SUPPLIED BY THE ALLGEMEINE ELEKTRIZITÄTS GESELLSCHAFT.									
Gewerkschaft Hollertszug, Kirchen a.d. Sieg	Hollertszug	160	1,000	8·7	200	D.C.	450	...	Ward-Leonard
A. Riebecksche Montanwerke A.-G.	Oberröblingen	86	450	1·5	30	3-ph.	3,000	50	Direct-geared
Bergwerksgesellschaft in Bogoslowsk	Bogoslowsk	515	600	4·2	160	D.C.	500	...	„ „
Von Arnimsche Steinkohlenwerke Planitz	Alexander	224	600	8·5	225	D.C.	500	...	Ward-Leonard
	Alexander	224	600	8·5	225	D.C.	500	...	„ „
Kgl. Berginspektion, Grund i. H.	Meding	220	750	5	95	D.C.	500	...	Battery
Kgl. Berginspektion, Königshütte	Marie	250	1,250	3·5	230	3-ph.	6,000	50	Direct-geared
Donnersmarckhütte, Ober-Schles. Eisen-u. Kohlenwerke A.-G., Zabrze, O.-S.	Michael	500	1,250	5	360	3-ph.	1,000	50	Ilgner
Saar- u. Mosel-Bergwerks Spittel-Karlingen	Pit V.	500	1,250	5	230	3-ph.	5,000	50	„
Usines et Mines de Houille du Grand Hornu near Mons	Pit VII.	1,000	2,600	11	940	3-ph.	1,250	23·5	Direct-geared
	Pit XII.	1,000	2,600	11	940	3-ph.	1,250	23·5	Direct
Bergwerksgesellschaft der Verein. Steinkohlengruben Laura en Vereeniging, Eygelshoven	Pit I.	300	2,400	12	1,000	3-ph.	2,200	50	Ilgner
Maravillas (Mexico)	Maravillas	400	1,600	3·15	250	3-ph.	2,000	50	Direct-geare.
Société anonyme des Charbonnages l'Esperance et Bonne Fortune Montégnée, Liège	St. Nicolas	600	2,400	10	425	3-ph.	1,000	44	Ilgner
Zeche Mathias Stinnes, Essen	Brauck III./IV.	800	4,800	14	2,000	3-ph.	5,000	50	„
Braunkohlengrube Verein. Marie Louise Neindorf	Graf Bülow	100	1,500	5	375	3-ph.	500	50	„
Gewerkschaft Verein. Konstantin der Grobe, Bochum	Pit V.	411	2,200	11	750	3-ph.	3,150	25	Direct-geared
Gewerkschaft Wintershall, Heringen	Wintershall	430	1,800	8	375	3-ph.	500	50	Ilgner
Powell Duffryn Mine Co.	Old Duffryn	168	1,500	2·3	200	3-ph	3,000	50	Direct
Donnersmarckhütte, Oberschles. Eisen- u. Kohlenwerke	Zabrze	220	1,000	4	180	3-ph.	1,100	50	Ilgner
Village Main Reef Gold Mining Co., Transvaal	Village Main Reef	530	910	3·6	140	3-ph.	2,000	50	Direct-geared.
		530	3,650	7·5	720	3-ph.	2,000	50	„ „
Powell Duffryn Mine Co.	Aberewmboi	320	1,500	7·5	312	3-ph.	3,000	50	„ „
Dortmunder Union, Abteilung Bergbau, Mengede	Wohlverwahrt	500	300	2·4	125	3-ph.	2,200	50	„ „
Moselhütte Akt.-Ges., Maizières	St. Marie aux Chênes	180	3,600	7	720	3-ph.	5,000	50	Ilgner.
Gräflich Hugo Lazy, Arthur Henkel von Donnersmarcksche Berg- u. Hütten-Verwaltung in Carlshof	Radzionkau	220	1,250	8	350	3-ph.	2,000	50	Direct-geared.
Oesterreichische Staats-Eisenbahn	Kübeck	500	900	8	200	3-ph.	500	20·8	„ „
Usines et Mines de Houille du Grand Hornu	Pit IX.	633	1,700	8·4	450	3-ph.	1,250	23·5	„ „
Hohenlohewerke Akt.-Ges., Hohenlohehütte	Ida	270	750	6	185	3-ph.	500	50	Ilgner.
A.-G. Kaliwerke Hattorf, Philippstal	Hattorf	800	1,800	2·5	300	3-ph.	220	50	Direct.
Verwaltung der Makijewschen Kohlengruben, L. W. Markow, Charzysk	Makijewka	300	1,500	7·5	280	3-ph.	2,200	50	Ilgner.
Donnersmarckhütte, Oberschles. Eisen- u. Kohlenwerke	Abwehr	450	2,500	15	2,560	3-ph.	1,000	50	„
Eschweiler Bergwerksverein	Eduard	550	3,300	16	3,260	3-ph.	5,500	50	„
Deutsch-Luxemburg. Bergwerks- u. Hütten A.-G.	Oettingen III.	65	2,500	3	385	3-ph.	5,000	50	Ward-Leonard.
Bergwerksgesellschaft Teutonia	Rudolf	800	2,800	15	1,380	Steam			Buffer Bat.-lf.
Riebecksche Montanwerke A.-G., Leipzig	New Pit Amsdorf	115	1,500	4	176	3-ph.	500	50	Ilgner. Yard.
Powell Duffryn Mine Co.	George	450	3,000	3	450	3-ph.	3,000	50	Direct-geared.
Cie. des Mines de Marles, Auchel	St. Firmin	362	3,500	11·5	900	3-ph.	3,000	25	„
	St. Abel	507	3,500	11·5	1,000	3-ph.	3,000	25	„
Schöndube & Neugebauer	Trompillo	500	800	7	375	3-ph.	1,040	50	Ilgner.
Mansfeldsche Kupferschiefer bauende Gewerkschaft, Eisleben	West Paul	690	2,200	15	1,265	3-ph.	3,000	50	„
	East Paul	690	2,200	15	1,265	3-ph.	3,000	50	„
Cie. Nouvelle des Mines de Portes et Sénéchas	——	370	2,200	6·5	285	3-ph.	1,000	46·7	Direct-geared.
Oesterreichische Staats-Eisenbahngesellschaft	Theodor	600	1,400	10	660	3-ph.	3,000	50	Direct.
The Durham Electricity Supply Co.	Tribley	40	1,000	2·5	80	3-ph.	6,000	40	Ilgner.
Bergwerksgesellschaft Hibernia	Blumenthal	800	1,250	5	230	3-ph.	5,000	50	Direct-geared.
	Shamrock V.	800	1,250	5	230	3-ph.	5,000	50	„ „
	Shamrock VII.	800	1,250	5	230	3-ph.	5,000	50	„ „
Gelsenkirchener Bergwerks A.-G.	Rheinelbe II.	1,000	5,800	20	3,170	3-ph.	5,000	50	Ilgner.
Königl. Berginspektion Grund	Hilfe Gottes	400	1,800	4	200	3-ph.	500	50	Direct-geared.
Aachener Hütten, Aktien Verein, Esch	Deutsch-Oth	90	6,000	3·5	530	D.C.	500	...	Ilgner.
Charbonnages du Poirier	St. Charles	1,200	4,200	9·8	960	3-ph.	3,000	25	Direct.
Braunkohlengrube Concordia Nachferstedt	Pit VII.	95	1,500	5	215	D.C.	440	...	Ilgner.
Charbonnages du Poirier	St. Louis	800	1,800	4·5	260	3-ph.	3,000	25	Direct-geared.
Mines de Pennaroya	St. Antolin	500	4,000	10·6	930	3-ph.	5,000	25	Direct.
Fürstl. von Donnersmarcksche Bergwerks- und Hütten-Direktion	Donnersmarckgrube, Pit II.	600	4,800	16	1,250	3-ph.	3,000	50	Ilgner.
Königl. Berginspektion III., Bielschowitz	Zero	506	2,400	12	1,250	3-ph.	6,000	50	„
Sté. Anonyme des Hauts-Fourneaux et Fonderies de Pont à Mousson	Pont à Mousson	142	3,000	7	730	D.C.	250	...	„
Bergbau-Akt.-Ges. Concordia	Pit II.	150	1,500	5	185	3-ph.	5,000	50	Direct-geared.
Privileg. österr.-ung. Staats-Eisenbahngesellschaft	Michael	230	900	9·3	374	3-ph.	500	20·8	Direct.
Fürstl. von Donnersmarcksche Bergwerks- und Hütten-Direktion	Deutschlandgrube, Pit I.	430	2,600	15	1,160	3-ph.	3,000	50	Ilgner.
Aktien-Gesellschaft Kaliwerke Hattdorf	Hattorf	713	2,400	12	900	3-ph.	5,000	50	„
Gewerkschaft Deutscher Kaiser Hamborn	Pit VII.	700	6,800	16	3,200	3-ph.	5,000	50	„

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ELECTRIC WINDERS—*Continued.*

Owners.	Name of pit.	Depth. m.	Net load. kg.	Max. speed in metres per sec.	Motor H.P.	Supply. System.	Supply. Voltage.	Frequency.	System of Driving.
Phönix, Aktien-Ges. für Bergbau und Hüttenbetrieb, Ruhrort	Pit IV.	519	4,500	15	1,900	3-ph.	2,000	46·7	Ilgner.
The Mount Lyell Railway & Mining Co.	North Lyell	457	1,270	7·6	360	3-ph.	3,000	50	,,
Kgl. Berginspektion I., Königshütte	Bahn II.	190	2,500	10	715	3-ph.	6,000	50	Ward-Leonard.
Bleiberger Bergwerks-Union, Klagenfurt	Antoni	600	1,200	5·5	325	3-ph.	3,000	42·5	Ilgner.
G. v. Giesches Erben, Schoppinitz (O.-S.)	Nickisch	400	3,000	10	1,300	3-ph.	2,000	50	,,
Powell Duffryn Steam Coal Co.	Abercwmboi	220	2,750	8	630	3-ph.	3,000	50	Direct.
Société des Mines de Murville	Pit II.	210	3,200	10	950	3-ph.	5,000	50	Ilgner.
Kgl. Berginspektion II., Zweckel b. Gladbeck	Pit V.	800	5,200	12·5	2,300	3-ph.	3,000	50	,,
	Pit VI.	800	5,200	12·5	2,300	3-ph.	3,000	50	,,
New Modderfontein Gold Mining Co. (Ltd.)	New Modderfontein	1,220	3,640	10	750	D.C.	500	...	Series-parallel.
Société des Mines de Dourges	——	525	6,200	12·4	3,300	3-ph.	5,000	50	Ward-Leonard.
Mines de Blanzy	Puits des Alouettes	770	4,800	16	2,320	3-ph.	5,000	50	Ilgner.
Charbonnages du Poirier	St. Andrée	1,200	4,200	9·8	960	3-ph.	3,000	25	Direct.
Staatsmijnen Limburg	Emma	400	1,900	4	280	3-ph.	2,000	50	Ward-Leonard.
Gelsenkirchener Bergwerks-A.-G., Gelsenkirchen	Rheinelbe I.	600	5,200	20	3,560	3-ph.	5,000	50	Ilgner.
Mines de Pennaroya	San Raphael	200	2,800	5	320	3-ph.	5,000	25	Direct-geared.
Charbonnages du Poirier	St. Charles	1,000	1,400	4·5	260	3-ph.	3,000	25	,,
Fürstl. von Donnersmarcksche Bergwerks-und Hütten-Direktion	Donnersmarckgrube, Pit I.	600	4,800	16	1,250	3-ph.	3,000	50	Ilgner.
Direktion des Steinkohlenbergbaus Orlau-Lazy Dombrau	Kaiser Franz Josef	750	4,000	15	2,000	3-ph.	3,000	42	,,
Cie. Fermière de Charbonnages A. Auerbach	Ludmila	640	1,700	4	240	3-ph.	3,150	50	Direct.
Bergwerks-Gesellschaft El Guindo	Main	500	3,500	4	425	3-ph.	1,150	50	Ilgner.
Randfontein Estate Gold Mining Co.	Randfontein Central	850	3,200	10	1,200	3-ph.	2,000	50	Ward-Leonard.
		850	3,200	10	1,200	3-ph.	2,000	50	,, ,,
		850	3,200	10	1,200	3-ph.	2,000	50	,, ,,
		850	3,200	10	1,200	3-ph.	2,000	50	,, ,,
		850	3,200	10	1,200	3-ph.	2,000	50	,, ,,
East Rand Proprietary Mines (Ltd.)	Angelo	915	3,000	15·2	1,700	3-ph.	3,000	25	Direct.
		915	3,000	15·2	1,700	3-ph.	3,000	25	,,
East Rand Proprietary Mines (Ltd.)	Angelo	915	3,000	15·2	1,700	3-ph.	3,000	25	,,
		915	3,000	15·2	1,700	3-ph.	3,000	25	,,
		915	3,000	15·2	1,700	3-ph.	3,000	25	,,
J. Eckstein & Co., Johannesburg	Ferreira Deep, Pit I/1	1,455	2,730	10·15	960	3-ph.	2,000	50	,,
	,, ,, Pit I/2	1,455	2,730	10·15	995	3-ph.	2,000	50	,,
	,, ,, Pit II/1	1,106	2,730	10·15	906	3-ph.	2,000	50	,,
	,, ,, Pit II/2	1,105	2,730	10·15	906	3-ph.	2,000	50	,,
Bergwerks-Gesellschaft Glückauf-Saarstedt m.b.H.	Kaliwerk Schnde	750	3,000	10	850	3-ph.	2,000	50	Ward-Leonard.
Rombacher Hüttenwerke, Rombach	Mont dis Pauline	180	3,600	7	720	3-ph.	5,000	50	Ilgner.
Fölsch Schuffgotsch'sche Werke, G.m.b.H., Beuthen (O.-S.)	Lithandra Hans-Carl	360	2,200	14	1,280	3-ph.	6,000	50	Ilgner.
General Mining & Finance Corpn., Johannesburg	Cinderella Deep	469	2,730	2·53	160	3-ph.	500	50	Direct-geared.
Bleiberger Bergwerks-Union Klagenfurt	Rudolf	245	1,600	5·5	325	3-ph.	3,000	42·5	Ilgner.
J. Eckstein & Co., Johannesburg	Nourse Mines	512	2,730	10·15	825	3-ph.	2,000	50	Direct-geared.
	,, ,,	270	1,365	14·2	1,080	3-ph.	2,000	50	,, ,,
	Glen Deep	662	3,640	10·15	1,050	3-ph.	2,000	50	,, ,,
Bergwerks-Akt. Ges. Consolidation, Gelsenkirchen	Oberschuir	1,000	2,200	14	1,100	3-ph.	5,000	50	W.-L./Ilgner.
Bergwerkschaft Graf Renard, Grubenverwaltung	Ludmilla	90	1,200	3	150	3-ph.	3,000	50	Direct-geared.
Steiger Eisenindustrie Ges., Kladno	New Smečna-Sternberg	400	1,400	7·2	470	3-ph.	5,300	25	Ilgner.
Bergwerkschaft Weidtmannshall, Heringen a.d. Werra	New	480	1,900	8	712	3-ph.	500	50	Direct-geared.
J. Eckstein & Co., Johannesburg	Geldenhuis Deep	1,265	2,730	10·15	1,370	3-ph.	2,000	50	,, ,,
	Glen Deep	820	2,730	10·15	950	3-ph.	2,000	50	,, ,,
	Geldenhuis Deep	1,260	3,640	10·15	1,090	3-ph.	2,000	50	,, ,,
	Jumpers Deep	1,495	2,730	10·15	1,470	3-ph.	2,000	50	,, ,,
	New Modderfontein	622	2,730	15·25	2,120	3-ph.	2,000	50	Direct.
Fürstl. von Donnersmarcksche Bergwerks- und Hütten-Direktion	Deutschlandgrube, Pit III.	430	2,600	15	1,160	3-ph.	3,000	50	Ilgner.
Bergwerkschaft Deutscher Kaiser, Hamborn	Pit VII.	700	6,800	16	3,200	3-ph.	5,000	50	,,
Ostrawitzer Akt.-Ges. für Bergbau und Eisenhüttenbetrieb	Myslowitz Janows	350	1,800	6	400	3-ph.	3,000	50	Direct-geared.
J. Eckstein & Co., Johannesburg	Nours Mines	480	1,230	13·75	1,390	3-ph.	2,000	50	Direct.
	Glen Deep	435	2,730	15·3	1,820	3-ph.	2,000	50	,,
	Crown Deep	360	2,730	15·6	1,370	3-ph.	2,000	50	Direct-geared.
	Geldenhuis Deep	1,320	2,730	10·15	1,470	3-ph.	2,000	50	,, ,,
	,, ,,	1,540	2,730	10·15	1,740	3-ph.	2,000	50	,, ,,
	,, ,,	320	2,730	10·15	1,140	3-ph.	2,000	50	,, ,,
General Mining & Finance Corpn.	Cinderella Deep	1,270	4,550	17·8	2,720	3-ph.	6,000	50	Ward-Leonard.
J. Eckstein & Co., Johannesburg	Village Deep	1,670	3,640	10·15	1,590	3-ph.	2,000	50	Direct-geared.
	Langlaagte Deep	655	4,550	10·15	1,310	3-ph.	2,000	50	,, ,,
	Crown Mines	850	3,640	10·15	1,540	3-ph.	2,000	50	,, ,,
	,, ,,	850	3,640	10·15	960	3-ph.	2,000	50	Direct.
	Crown Deep	403	2,730	15·7	1,460	3-ph.	2,000	50	Direct-geared.
Werksch. Einigkeit, Ehmen bei Fallersleben	——	700	1,500	14	700	3-ph.	2,000	50	Ward-Leonard.
General Mining & Finance Corp.	Meyer & Charlton Mine	1,260	4,550	10·15	990	3-ph.	2,000	50	,, ,,
Compañia Minera de San Rafael	Soledad	550	800	7·25	300	3-ph.	1,040	50	Ilgner.
Modderfontein "B" Gold Mining Co.	Modder B.	229	5,450	7·6	1,100	3-ph.	3,000	50	Ward-Leonard
		365	9,800	5	400	3-ph.	2,000	50	Direct-geared.
		365	9,800	5	400	3-ph.	2,000	50	,, ,,
		365	9,800	5	400	3-ph.	2,000	50	,, ,,
		365	4,900	5	230	3-ph.	2,000	50	,, ,,
		365	4,900	5	230	3-ph.	2,000	50	,, ,,
		365	4,900	5	230	3-ph.	2,000	50	,, ,,
J. Eckstein & Co., Johannesburg	Rose Deep	473	2,730	10·15	830	3-ph.	3,000	50	,, ,,
Union A.-G. für Bergbau, Eisen- u. Stahl-industrie, Dortmund	A. v. Hansemann Pit III	140	1,440	3·5	180	3-ph.	3,000	50	,, ,,

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ELECTRIC WINDERS—*Continued.*

Owners.	Name of Pit.	Depth. m.	Net load. kg.	Max. speed in metres per sec.	Motor H.P.	Supply. System.	Supply. Voltage.	Frequency.	System of Driving.
"Saale," Bergwerksgesellschaft m.b.H., Schlettau b. Halle a.S.	Saale	900	1,600	12	680	3-ph.	3,000	50	Ilgner.
Gewerkschaft Hohenzollern, Freden a.L.	Pit II.	900	1,600	12	680	3-ph.	3,000	50	"
H. Eckstein & Co., Johannesburg	Crown Mines	1,080	7,270	17·8	5,600	3-ph.	2,000	50	Ward-Leonard.
		140	1,440	3·5	180	3-ph.	2,000	50	Direct-geared.
Gewerkschaft Wintershall	Grimmberg	430	1,900	8	712	3-ph.	500	50	" "
Gewerkschaft Hüpstedt	New	850	1,900	6	712	3-ph.	2,100	50	" "
		850	1,800	6	420	3-ph.	2,100	50	" "
		850	1,800	6	420	3-ph.	2,100	50	" "
		850	1,800	4	420	3-ph.	2,100	50	" "
H. Eckstein & Co., Johannesburg	Rose Deep (Ltd.)								
	Glen Deep Sect.	905	2,660	10	1,250	3-ph.	2,000	50	" "
Randfontein Estates G.M. Co. (Ltd.)	Randfontein Central	1,140	3,180	8·1	900	3-ph.	2,000	50	Ward-Leonard.
J. Eckstein & Co., Johannesburg	Durban Roodeport Deep	1,415	1,910	7·6	1,000	3-ph.	2,000	50	Direct-geared.
	Elpidifor	514	7,200	14	3,160	3-ph.	3,000	50	Ilgner.
Paramonoff, Rostow a. Don	Meyer & Carlton G. M. Co.	1,260	1,820	5·1	360	3-ph.	2,100	50	Direct-geared.
The General Mining & Finance Co. (Ltd.)	North	160	1,100	6	300	3-ph.	2,000	50	" "
Gewerkschaft Steinkohlengrube Beatensglück	New	480	1,990	8	712	3-ph.	5,500	50	" "
Gewerkschaft Gebra Obergebra		480	1,900	8	712	3-ph.	5,500	50	" "
		310	1,809	6·35	420	3-ph.	5,500	50	" "
		310	1,809	6·35	420	3-ph.	5,500	50	" "
Gewerkschaft Heiligenroda	New	380	1,809	6·53	500	3-ph.	525	...	" "
Phönix A. G.	Pit VI.	519	4,560	15	1,900	3-ph.	2,000	46·7	Ilgner.
Gew. des Steinkohlenbergwerks Matthias Stinnes, Karnap bis Essen	Zeche Matthias Stinnes Pit IV.	800	4,800	14	2,000	3-ph.	5,000	50	"
Compagnie des Mines. de Houille des Ligny des Aire, Frankreich	Haupt Pit II.	400	2,300	10	510	D.C.	500	...	"
Olbernhauer Anthracitwerke G.m.b.H.	Gabrielazeche, Main	200	500	5	110	3-hp.	2,000	50	"
Gew. des Steinkohlenbergwerks Ewald Herten i.W.	Zeche Ewald Wetter	800	3,400	10	810	3-ph.	5,000	50	Ward-Leonard.
Gewerkschaft Concordia, Dermbach	Main	600	1,500	8	350	D.C.	500	...	Direct.
D. Davis & Sons, Ferndale	Pit IX.	511	4,050	17	1,930	3-ph.	2,200	25	Ilgner.
Société Anonyme d'Ougrée Marihaye, Flemalle Grande, Belgium	Main	1,000	2,800	14	1,600	D.C.	550	...	"
Kgl. Berginspektion IX., Friedrichsthal	Ost. Maybach	600	3,600	8	1,100	3-ph.	2,000	50	Ward-Leonard.
Gewerkschaft Grossherzog Wilhelm Ernst zu Weimar, Hanover	Oldisleben	550	3,000	9	665	3-ph.	2,000	50	Ilgner.
Gewerksch. d. Konsol. Wenzeslaus- u. Ferdinandgrube, Mölke	Kunigunden	750	5,600	12·5	1,200	3-ph.	3,000	50	"
Gewerkschaft Immenrode, Halberstadt	Main	1,000	3,200	14	1,600	3-ph.	5,000	50	"
Gewerksch. d. Konsol. Wenzeslaus- u. Ferdinandgrube, Mölke	Kurt	310	1,200	5	300	3-ph.	3,000	50	Direct-geared.
Kgl. Berginspektion III., von der Heydt	Steinbach	700	2,000	17·5	1,530	3-ph.	5,000	50	Ilgner.
Nordhäuser Kaliwerke A.-G., Wolkramshausen	Heins	600	1,700	5	275	3-ph.	5,000	50	Direct-geared.
The Oregum Gold Mining Co., Colar Goldfield	Main	900	2,550	5	530	3-ph.	3,300	25	" "
The Champion Reef Co. Colar Goldfield	Main	900	2,550	5	530	3-ph.	3,300	25	" "
		900	2,550	5	530	3-ph.	3,300	25	" "
The Noondydroog Co., Colar Goldfield	Main	900	2,550	5	530	3-ph.	3,300	25	" "
The Balaghat Co. Colar Goldfields	Main	900	2,550	5	530	3-ph.	3,300	25	" "
Nordhäuser Kaliwerke A.-G., Wolkramshausen	Hein	600	3,400	15	1,100	3-ph.	5,000	50	Ilgner.
Fried. Krupp A.-G. Essen-Ruhr	Hannover	845	4,000	13·5	1,720	3-ph.	5,000	50	"
		840	4,000	13·5	1,720	3-ph.	5,000	50	"
Mines de la Mourière	Main	250	5,000	10	1,120	D.C.	500	...	Ward-Leonard.
A.-G. Kaliwerke Neu-Bleicherode	Main	670	2,000	12	910	3-ph.	5,000	50	Ilgner.
Kons. Fuchsgrube, Neu-Weisstein	Hans-Heinrich	300	1,800	7·5	520	3-ph.	3,000	50	"
Kg.. Berginsp. XI., Camphausen	Pit IV. Camphausen.	710	4,000	18	2,470	3-ph.	5,000	50	"
Eschweiler Bergw.-Verein, Alsdorf	Eduard Anna II.	550	3,300	16	2,600	3-ph.	5,500	50	"
Micklefield Coal & Lime Co.	Main	274	1,830	12·9	820	3-ph.	2,000	50	"
Eckstein & Co., Johannesburg	Robinson Gold Mining Co., No. 1	820	4,540	10·2	1,150	3-ph.	2,000	50	Direct-geared.
	Ditto, No. 2	1,020	4,540	10·2	1,370	3-ph.	2,000	50	" "
	Ditto, No. 2	1,020	4,540	10·2	1,000	3-ph.	2,000	50	" "
	Village Main Reef, Gold Mining Co. No.1	435	3,640	15	1,960	3-ph.	2,000	50	" "
	Ditto, No. 2	646	2,720	10·5	1,110	3-ph.	2,000	50	" "
The New Kleinfontein Group Central Administration	Rand Klip Gold Mine	610	910	7·1	420	3-ph.	3,000	25	" "
	New Kleinfontein Subsidiary	760	1,820	9·15	505	3-ph.	3,000	25	" "
	Orient	400	1,820	7·6	500	3-ph.	3,000	25	" "
Bergbaugesellschaft, Hannover-Thuringen	Heiligen-mühle	825	3,000	10	1,660	3-ph.	3,000	50	Ilgner.
Eckstein & Co.	City & Suburban G. M. Co.	600	2,230	10·5	900	3-ph.	2,000	50	Direct-geared.

WINDERS SUPPLIED BY THE ATELIERS DE CONSTRUCTIONS ELECTRIQUES DE CHARLEROI.

Sté. Ame des Charbonnages Elisabeth, Auvelais	Bellevue	500	5,600	7	240/280	3-ph.	3,000	30	Ilgner.
Sté. Ame des Houillères d'Anderlues	——	700	3,500	4·7	140	3-ph.	500	50	"
Sté. Ame des Charbonnages Elisabeth, Auvelais	Baulet	400	5,600	5·3	190/226	3-ph.	2,850	50	"
		400	3,200	1	50	3-ph.	2,850	50	"
Sté. Ame des Charbonnages Noel-Sart-Culpart	Gilly	300	2,850	9·4	115/120	3-ph.	3,000	50	"
Sté. Ame des Charbonnages de et à Bascoup	Siège No. VI.	800	9,400	11·0	1,650	3-ph.	3,000	50	"
Sté. Ame des Charbonnages l'Espèrance et Bonne-Fortune, Montegnée	St. Nicolas Montegnée	850	4,960	9·4	200/345	3-ph.	1,000	44	"
Sté. Ame du Charbonnage du Bois-Communal, Fleurus	Sainte-Henriette	800	7,280	8·8	425/590	3-ph.	220	50	"
Sté. Ame des Charbonnages de Bonne-Fin, Liège	Sainte-Marguerite	407	6,020	6·3	300	3-ph.	3,700	50	"

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COMMERCIAL AND INDUSTRIAL SECTION.

MUNICIPAL, FOREIGN & GENERAL NOTES.

BRITISH NOTES.

Ashton-under-Lyne.—The salary of the assistant electrical engineer (Mr. W. A. Wales) has been increased by £25 per annum.

Burnley.—The Rural Council have assented to the proposal of the Corporation to apply for a provisional electric lighting order for the parish of Reedley Hallows.

Carlton Hotel Fire.—Mr. H. B. Renwick, chairman of the Electric Supply Publicity Committee, Moorgate-court, London, E.C., has written to the press pointing out that the statement that the recent fire at the Carlton Hotel was caused by the fusing of an electric wire is without foundation. The Electric Supply Company, who supplied the hotel, had made a thorough investigation, and gave full assurance that there was no evidence whatever to connect the fire with any electrical source. Further, the official London County Council report of the London Fire Brigade gives the supposed cause of fire as "unknown."

Clydebank.—The Tramway Committee have been authorised to make a definite offer to Glasgow Corporation for the completion of the tramway bridges, but the Corporation are to be asked to give an undertaking for the proper working of the bridges and the completion of the tramway undertaking.

Ealing.—At last week's Council meeting the Mayor (Councillor Roose-Francis) congratulated the borough electrical engineer (Mr. J. D. Knight) and the Electricity Committee on the fact that the profit on the electricity supply department for the past year was £1,700.

The Committee recommended the purchase of 35, Bond-street for £1,200 and to authorise the expenditure of £500 in necessary alterations, heating and lighting, the £1,700 to be provided out of reserve.

Ald. PEAL, moving the adoption of the report, said the electricity staff was crowded out and the heating of the offices was unsatisfactory. New offices were, therefore, necessary.

The matter was, however, deferred for a month.

Electric Lamps in Mines.—An inquest was held last week at Brynceithein (Glam.) on two miners named Rogers and Davies who were killed on 29th ult.

Evidence was given to show that deceased were found in a place known as "Waller's Top Hole," which was being driven for connecting to the tip-airway.

A witness named Evans said he and another man named Lewis had charged a hole when working in the pit but he was rendered unconscious by an escape of gas. When he recovered consciousness he remembered someone pulling him down from the top hole to the bottom. The hole he had driven was about 2 in. wide, and the thickness of the coal about 2 ft. 6 in. The coal above that must have been much thinner, and directly Lewis touched it it scattered. It was commonly known that since a fall occurred three or four weeks ago there was gas in the place they were working towards, and the place had been stopped. Everything went on all right until the fall occurred, and then the company concentrated their efforts on getting the air round by the upper connection. It was with that object that they were working at the stump of coal. They worked with electric lamps, and the manager left his safety lamp 30 or 35 yd. away.

Col. PEARSON (mines inspector): You were given electric lamps to work in a place which contained gas?—Yes, sir.

Is that regular?—No.

Do you know it is in contravention of General Rule No. 1 that any man shall work in any place where there is an accumulation of gas?—No answer.

You did it on the instruction of the manager?—Yes. After plugging the hole there was no gas in the place.

Col. PEARSON: If you had had a safety lamp it would have indicated danger. Was it not a wrong thing to put electric lamps into your hands?

Mr. KENSHOLE (for the company) said he could not agree. There was nothing in the rules to prevent the use of electric lamps.

Col. PEARSON said the rules specifically stated that safety lamps should be used where there was gas.

Mr. KENSHOLE contested the point whether an electric lamp was not a safety lamp within the meaning of the Act. There were many collieries where electric lamps were in general use.

The CORONER (to witness): What would have happened if you had had safety lamps?—It might have been that the whole colliery would have been blown up.

Would you have had time to get out after the burst of gas if you had had a safety lamp?—No.

After hearing the evidence, the jury returned a verdict of "Misadventure," and found that deceased had died through suffocation. They added that if the deceased men had been using safety lamps at the time the deaths would not have occurred.

Garvagh (Ireland).—A meeting of ratepayers is to be called to consider a proposal to adopt public electric lighting. Electric current would be supplied by a local mill owner, Mr. Samuel Stewart.

Glasgow.—The motor men and conductors of the Corporation tramways went out on strike on Saturday morning last. A limited service of cars was, however, run until Tuesday, when the strike collapsed and the full service was resumed.

Harbour Lighting.—Irvine Harbour Trust last week decided to engage an electrical engineer to prepare a report on the probable cost of lighting the harbour by electricity and what further use could be made of electricity with a view to cheapening cost in any other branch of the harbour plant.

Hessle.—The Urban Council have decided to purchase electricity in bulk from Hull Corporation. It is estimated that Hessle will take about 70,000 units at the outset at 2d. per unit.

Inquest.—An inquest was held on Tuesday at Middlesbrough on a caulker named Best, employed at Smith's Dock.

Evidence was given that an electric crane runs along the dock jetty and that the power cables were placed in a conduit. Best, whilst walking along the jetty, dropped a packet of white lead which fell into the conduit, and in trying to recover it he touched the live wires and was killed.

A verdict of accidental death was returned.

Light Railways.—The Board of Trade have confirmed the County of Hertford (Cheshunt) Light Railways Order, 1911, authorising the abandonment of part of the railway authorised by the County of Hertford Light Railways Order, 1906, and reviving the powers of the County Council in respect of the remainder of that railway, and for other purposes.

Lytham.—The Council have been notified that a company proposes to apply for a provisional electric lighting order.

Morecambe.—The Board of Trade have sanctioned a loan of £4,617 for doubling the tramway track to Bore and £800 for additional cars.

Osram Lamp Patent Litigation.—The Osram Lamp Works (Ltd.) are issuing a notice relating to the action recently brought by them against the British Tungsten Lamp Co. and another for infringement of their letters patent, in which they state that an order was, by consent, made on 26th ult., whereby it was (among other things) ordered that:—

The defendants, their servants, agents and workmen be restrained during the continuance of certain letters patent from importing into and from making, selling, offering for sale, supplying and using any illuminating bodies, or electric lamps containing illuminating bodies, made according to or in manner described and claimed in the specification of such letters patent, or according to or in manner only colourably differing therefrom, and generally from infringing the rights of plaintiffs under the said letters patent, and that defendants do pay to plaintiffs the sum agreed for damages sustained by plaintiffs or to be sustained by reason of the infringement of the said letters patent by defendants by manufacture and sale prior to the date thereof of lamps and filaments and the sale of the lamps then in stock or by reason of the user of such lamps and filaments, and that defendants do pay to plaintiffs their taxed costs of the said action.

Railless Trolley Traction.—Dundee Tramways Committee have instructed the manager (Mr. Fisher) and the city electrical engineer (Mr. H. Richardson) to prepare plans, &c., for introducing the railless trolley system of traction on the Clepington-road route.

Dewsbury Council have been in negotiation for some time with the Yorkshire (Woollen District) Electric Tramways (Ltd.) in regard to certain proposed extensions of the tramway system.

The local lines are held by the company on a lease from the Council for 28 years and extensions must be matter for negotiation. The Corporation must provide the capital expenditure. If the company fails to meet the wishes of the Corporation for a new line after six months' notice, the Corporation may themselves make and work the extension line. Such notice has been given in regard to a tramway to Westboro' and it will expire next month. In the meantime the company have replied that after giving the proposal careful consideration they are unable to see that the capital expenditure necessary would be justified for many years to come, but they offer as an alternative to prepare estimates for undertaking the rail-less trolley system on the route. The Parliamentary and Tramways Committee have considered the matter and instructed the borough surveyor to prepare plans of alternative routes to Westboro'.

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On Aug. 1 they inspected the Leeds rail-less trolley system, but they report that they are not favourably impressed with its suitability for the steep gradients to be encountered on the Westboro' route.

St. Anne's-on-Sea.– There are over 1,000 consumers now connected to the electricity supply mains, an increase of about 100 consumers in 12 months.

Stalybridge, Hyde, &c., Tramways.—It has been decided to reconstruct the Ditcheroft Hill tramway route.

Walsall.—The Assistant Electrical Engineer has been instructed to make good the damage caused by the recent fire at Butts-road sub-station by altering the existing switchboards so as to bring them more up to date, at a cost of £125.

A coal elevator is to be provided for the new boiler at a cost of £120. The Tramways manager has been instructed to have one of the cars fitted with speed indicators, and to arrange for each motorman in turn to handle the cars so as to obtain some training in the judgment of various speeds.

Wishaw.—At Monday's meeting of the Council it was reported that there was a deficit of £81 on the past year's working of the electricity department, against £417 in 1910.

Yarmouth.—Electric lighting is to be adopted at Southtown. Electric current is to be taken from the trolley wires and the lamps are to be hung from the posts on anti-vibration holders.

COLONIAL AND FOREIGN NOTES.

Argentina.– The concessionaires of the proposed electric tramway from Buenos Ayres to the Tigre have applied to the La Plata Government for permission to extend the original route.

Australasia.—An Act of the New South Wales Legislature of December, 1910, authorises the construction of an electric tramway from Darley-road, Randwick, to Coogee, at an estimated cost of £81,763.

Erskineville Council has contracted with Sydney (N.S.W.) City Council for the supply of electricity for lighting and power. The Erskineville Council are to pay £3 per annum for 40 c.p. incandescent lamps, £3. 7s. 6d. for 50 c.p., £3. 17s. for 60 c.p., and £6 for 100 c.p. lamps. For arc lamps of 1,500 c.p. they are to pay £16, 2,000 c.p. £19, and for 2,500 c.p. lamps £22.

Waterloo (N.S.W.) Council have entered into a contract with Sydney City Council for lighting the municipality with electricity and supplying power to the factories in the district. The City Council now have the right of supplying electric light and power to Botany, North Botany, Alexandria and Waterloo. The other municipality in the division is Redfern, the Council of which has virtually agreed to accept the offer of the City Council to purchase their goodwill for £20,000.

The Federal Cabinet recently decided that provision should be made when calling for tenders for telephone switchboards to give makers of automatic boards an opportunity of competing, and the Postmaster-General was so far favourably impressed with the working of this device that, although tenders had already been invited with respect to a manually-operated switchboard for Perth, new tenders are to be called for either manual or automatic operation. The exchanges at Norwood and Unley (S. Aus.) and at Geelong (V.) also require new switchboards, and in these cases also tenders will be asked for both manual and automatic forms.

The poll of the Hawthorn (V.) ratepayers has resulted in a large majority in favour of the agreement with the City Council and Melbourne Electric Supply Co. for street lighting.

Christchurch (N.Z.) electric tramways made a net profit of £2,200 on their last year's working.

Preston (V.) Shire Council have adopted an electricity supply scheme prepared by Messrs. Lincolne & McDougall and estimated to cost £4,524.

In future specifications for copper wire for the railways and tramways of New South Wales the following paragraph is to be inserted :—" Other things being equal, preference will be given to tenderers offering to supply Australian copper wire, provided it complies with all the requirements of this specification." The Federal Postmaster-General has also agreed to insert this paragraph in his specification.

The Inverell (N.S.W.) municipal electricity works will commence the supply of current in September.

The ratepayers of the Mangaweka Rangitikei district (N.Z.) have approved a proposal to raise £10,000 for electricity supply and other new works.

Recently Alexandria Municipal Council entered into a 10 years' contract with Sydney City Council for the electric lighting of its thoroughfares and for the supply of electrical energy for private lighting and power.

Prahran and Malvern Tramways Trust have accepted a tender for the construction of the permanent way of the Dandenong road line.

The Royal Commission on the railway and tramway services of Melbourne and suburbs has taken further evidence.

Mr. JOHN CLAYTON, town clerk of Melbourne, advocated municipal in preference to Government control of the tramways, and compared the management of the Prahran-Malvern system with that of the St. Kilda-Brighton system controlled by the Railway department. He was also of opinion that the compensation due to the municipalities, if the Government should decide on State control, would be very large, the present working value of the capital invested in the tramways being £1,500,000. With regard to the distribution of profits between the municipalities, he advocated the car-mileage basis. He considered that a municipal management would be more likely to build new lines, and so relieve congestion in the central area, than would a Government control. A betterment rate for a tramway undertaking would prove impracticable. In some cases the tramway would take business from a small district to a larger but neighbouring one, so that a "worsement" rate was a proper complement to the other. He was in favour of extension to districts not now served in preference to the electrification immediately of the existing systems. Electrification in Melbourne would come in time, though in the principal streets of the city practically nothing could be gained. He did not think the advantages would warrant immediate electrification of the present system.

Mr. PERCY ROSLING, president of the Victorian Institute of Electrical Engineers, advocated the overhead electrical system on the grounds of economy in construction and facility of supervision and maintenance. The aesthetic objections to an overhead service did not appeal to him. He preferred the central to the span wire system; span wires were unsuitable to Melbourne streets on account of the great sag, due to the width of the streets. On the question of electrifying the suburban railways, he preferred direct-current to high-tension alternating current.

Mr. W. G. TOOP GOODMAN, chief engineer and general manager of the Adelaide tramways, prepared the following figures respecting the comparative cost of conduit, span-wire, and central-pole constructions: (a) Cost of constructing a conduit system for electric traction, including conduit, conductor rails, boarding, insulators and permanent way, with wood block paving, £21,000 per mile of single track. (The estimate included an average percentage for special work and 15 per cent. for engineering and contingencies); (b) Cost of permanent way, with tarred macadam surface and steel span-pole construction, £6,765 per mile of single track and £11,820 double track. For wood span-hole construction and permanent way, with plain macadam surface, he estimated the cost per mile of single track at £5,350, double track £9,730. (c) The cost of permanent way, with tarred macadam finish and steel centre-pole construction would be £11,480 double track. The cost of overhead construction would be: Steel span-pole construction (double track), £1,710 per mile; steel centre-pole construction (single or double track), £1,570 per mile; wood span-pole construction (single or double track), £960 per mile. He was of opinion that the present cable conduits would not be suitable for electric traction. In Adelaide the cost of maintenance of the overhead system was 1·18d. per car-mile, but the maintenance cost of a conduit system would be at least ½d. more, and that on an extensive system would run into very large figures. Eventually the superiority of electric traction would justify the conversion of the Melbourne system to electric, though it would take some years to do so. During the last three or four years great developments had taken place in the alternating-current system, and at present it was difficult to get figures that would enable him to draw a fair comparison between direct and alternating current. For purely suburban traffic the balance was in favour of the direct current if the area be limited, but if an unlimited area be taken with lines extending 40 or 50 miles out of Melbourne, it was an open question. Electrification would make it more than ever necessary to re-duplicate the railways, especially that to Caulfield, though that would have to be done whether electrification were adopted or not; and it would be better to re-grade and re-duplicate at the same time. He strongly advocated electrification, and added that, service for service, electric traction was dearer than steam. But with electric traction the quicker service and increased facilities would result in an increase of traffic that would more than compensate for the extra cost of operation.

Mr. Walter Karplus, chief electrical engineer of Siemens Bros. Dynamo Works, stated that the fact that 90 per cent. of the electric tramways of the world were operated by the overhead system was evidence that that method of traction was considered the best available. The most important considerations that had operated against the adoption of the conduit system were its initial cost, its maintenance cost and its working expenses. If anything went wrong, the time occupied in setting things right was greater. He would not recommend the conduit system even for the busiest streets in the city. He advocated the overhead system with standards on each side of the streets in the city, but centre poles outside the city wherever the streets were wide enough, and side poles with projecting brackets in the narrower streets.

A sub-committee of the Victorian Institute of Electrical Engineers has been appointed to consider the question of licensing electrical wiremen.

Temora (N.S.W.) is to have electricity supply works at a cost of £[illegible].

Birchip (V.) electricity works were inaugurated on July 11.

ELECTRICITY SUPPLY TABLES AND DATA.

This Valuable Set of Tables and Engineering Data relating to Electricity Supply and to Electric Traction on Railways and Tramways in the United Kingdom, the Colonies, and some important places abroad, is now ready, and can be obtained complete in handy book form, price 6s. 6d. post free, or on very hard paper for rough or constant use, price 8s. 6d. post free. A complete Index is included.

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Nugawading (V.) Shire Council have instructed Mr. McDougall (of Lincolne & McDougall) to prepare a scheme of electricity supply for the district.

Negotiations are proceeding between Hobart City Council and the local tramway company for the purchase of the company's undertaking. The company have agreed to sell for £250,000, but the Council only offer £150,000.

Customs Decisions.—Under the Netherlands customs tariffs automatic reversing switches for electric lifts pay 5 per cent. ad valorem duty (as "iron wares"), but slates for use in the manufacture of switchboards and insulators are admitted free.

Japan.—The "Osaka Asahi" says the manufacture of electric wire appears to have good prospects in Japan, and the demand is now not less than £1,400,000 per annum.

Last year the output of wire by the Furukawa Mining Firm (the proprietors of the Ashio copper mine) was twice as large as that for the preceding year. The annual production of copper in Japan is about 120,000,000 lb., of which 24 per cent. is consumed for electrical work, and according to an authority, the total amount of capital invested in the wire making industry is about £1,000,000. The value of the annual production of uncovered wire in Japan is about £750,000, that of wire covered with cotton about £530,000, and that of wire covered with rubber about £300,000. Besides these, telegraph cables and galvanised wire are produced to the value of about £130,000 a year. Of rubber-covered wire the Japanese supply 70 per cent. and foreign firms 30 per cent. of the demand; galvanised wire about equally. Foreign firms still supply 80 per cent. of telegraph cable requirements. Electric wires and cable are still imported into Japan to the value of over £300,000 a year. Japanese makers cannot yet compete successfully with foreign firms in price, but have made progress in skill and workmanship. The demand for underground and short lengths of submarine telegraph cables and military telegraph wires is said to be met from local sources, and the Japanese Government has increased the duty on electric wires about three-fold to protect the Japanese industry.

The Yokohama Electric Wire Co. is about to open a new factory for insulated wires, the capital (£60,000) to be jointly contributed by that company and the Furukawa Mining Firm. A scheme is also on foot in Tokyo to set up works for the manufacture of electrical machinery, the concern to be a branch of the A.E.G., of Berlin. Other enterprises of a similar nature are in contemplation, largely with a view to meet the increasing demand of the Russian littoral, Korea, India and Australia.

Paris Telephone Service.—The text of a decree, dated July 29, has been issued, authorising the expenditure of 11,667,700 frs. (about £466,708) for improving and extending the Paris telephone service.

Russia.—Mr. H. Cooke, H.M. Commercial Attaché, reports that the Imperial assent has been granted to a proposal by Mr. Ushkoff to form a company for the construction, without guarantees from the Government, of an electric railway in the Crimea from Sevastopol, via Yalta, to Alushta, with a branch to Balaklava. The total length of line will be about 84 miles. A printed pamphlet (in English) can be seen at 73, Basinghall-street, London, E.C.

In a consular report on the trade of Kharkov, Mr. Vice-Consul Blakey states that in the heavy engineering, and particularly in electrical engineering, the Germans have shown more enterprise than the British.

The Germans have branch offices under their own management with experienced engineers at the head, a staff of suitable men and branch factories in Russia to supply parts of contracts that cannot profitably be imported. They have thus established a reliable trade, while the British remain dependent upon the good-will of their agents. In the trade in machine tools, agricultural machinery and portable engines German firms have a large share. The trade in electrical machinery and in semi-portable engines is entirely in their hands. In steam engines they do a good trade and hold a high reputation. The hold a large proportion of the imports of oil, gas and Diesel motors. In mining machinery and coal-washing plants, and in transporters and in brick-making machines they also lead. Mr. Blakey is assured that the British manufacturer could well compete in everything but electrical engineering if he were as well served by a sales department in Russia as his German rival.

South Africa.—At the Klerksdorp municipal electricity works a gas-driven set was recently installed, including a 78 B.H.P. Hornsby twin-cylinder gas engine (with suction gas-producing plant) coupled to an E.C.C. dynamo.

Johannesburg Council have adopted a revised tariff for domestic electric lighting, by which dwelling houses are to be rated on a basis of six units per room per month at 6d. per unit, and the balance at 1½d. per unit. As an alternative, an extra meter with time switch can be fixed at the consumer's cost, and energy consumed between 5 p. m. and 11 p.m. charge at 6d. per unit, and during the remaining hours at 1½d.

Ladysmith Corporation have arranged to supply electrical energy to the South African Railway at Ladysmith (O.F.S.) Junction and the new yard, with a guaranteed consumption of 168,000 units per annum.

Spain.—Don Garcia de Pruneda has applied to the Ministry of Fomento for a concession for constructing and working an electric tramway in Madrid.

The Société anon. des Tramways de Barcelone has applied to the Ministry of Fomento for a concession for the construction of an electric tramway in Barcelona.

Telegraphs in the United States.—An interesting open letter addressed by the Postal Telegraph Cable Co. of New York, to the Attorney-General of Texas, is in circulation, and shows the keen competition, which is the leading feature of telegraphic matters on the other side. The open letter to which we refer deals with the efforts that have been made by the Postal Telegraph Cable Co. of New York during the past 25 years, the competition which these efforts have invited, and a general review of the situation as it stands to-day.

Venezuela.—The British Vice-Consul at Maracaibo reports that there are openings at present for electric tramways in the town of Maracaibo. Various offers have been presented to the Municipality but none has been approved so far.

Wireless Telegraph Note.—According to a note from America, wireless telegraphy is entering into keen competition with the telephone in certain large business houses in New York and Philadelphia. The note concludes: "The ease and rapidity of wireless communication suggested the use of the stations as a substitute for the telephone, with the result that the latter has been completely ousted." We do no more than record the statement published.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Aberdeen.—The revenue of the tramways department for the year ended May 31 was the highest in the history of the undertaking—£73,470, against £71,121 in 1910.

In his report the general manager (Mr. R. S. Pilcher) states that the revenue had been practically stationary for the previous four years. The increase is attributed to the weather, the winter having been exceptionally mild, and there being practically no snow or severe frost. The working expenses were £39,674. 17s. 6d., a decrease of £777.

The total revenue was £73,470, including £72,417 traffic receipts, and the total working expenses were £39,675, leaving a gross profit of £33,795. After paying interest and sinking fund, and providing for depreciation, &c., £17,459 was carried to the renewal account. The capital expenditure is £315,395. 18,027,584 passengers were carried, against 17,156,050, and 1,619,503 car-miles run, against 1,585,137.

Beckenham.—The accounts of the electric supply department for the year ended March 31 show total nett capital expenditure of £94,234.

The amount borrowed for "free" wiring was £27,000, of which £14,959 is outstanding, making the total indebtedness £109,192, and the annual repayment of principal and interest being £10,570. The total receipts were £10,925 for private lighting, £340 for public lighting, £2,277 for traction, and £2,209 meter rents. The total expenses were £7,066, but after meeting charges there was a nett deficit of £1,062, but deducting sale of "free" wiring installations and adding previous loss (£251) the total deficit was £1,094.

The Chairman of the Electricity Committee (Mr. Sjollema), who moved the adoption of the accounts at the last Council meeting, referred to the excellent work done by the showroom in increasing the popularity of electricity, and thought they ought to take the profit made on the fittings sold.

Glasgow.—In presenting the accounts of the electricity department for the year ended May, Bailie Willock stated at the meeting of the Corporation last week that the depression from which the department had suffered, in common with other industrial concerns during the past three years, was disappearing.

The revenue account showed a substantial increase and the cost of working had improved. After depreciation had been deducted there was a net increase in capital expenditure of only £36,281, half due to extensions of mains. Revenue had increased from £245,959 to £260,526, an increase of £14,567, which had been derived largely from power consumers. The use of electricity for power had undoubtedly conduced to social welfare. Not only did it ensure a purer atmosphere in works and factories, but in other ways it increased the efficiency of the workers, and by bettering their working conditions improved the quality of their work. There had been practically no increase in public lighting during the year. Although 5,826,000 more units had been generated, the coal bill had only gone up £1,231, and that was wholly due, not to the increased units, but to the extra 9d. per ton paid for coal. The saving in coal consumed during the year was equivalent to about 15,000 tons, or a money saving of £6,000. The other items in the cost of generating had fallen ¼d. per unit sold, or a total saving of £2,500. Those were remarkable figures, and the engineers and general staff of the department were to be congratulated on the keen interest and the scientific intelligence which they brought to bear on their work. No other similar undertaking in the kingdom had shown such gratifying figures in any one year. The cost of distribution showed a slight increase, £1,647 having been spent on a thorough

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overhaul of mains, cables and meters. Repairs of public lamps and management expenses had decreased, while taxes and assessments show an increase of £1,008. The statutory and other obligations in the shape of interest, sinking fund and depreciation showed an increase of £3,967, but relatively to the output there was really a decrease of ⅛d. per unit. The average price received during the past year had been just over 1¼d. per unit, and the cost of production had been just under 1¼d. per unit. The difference between the two was a surplus of £6,680 on the year's operations, and that sum the Committee had recommended to be carried to reserve. With the reduced price at which coal for the current year had been purchased, with an increase in consumption from lighting consumers, and the economies which the Committee had always an eye to, it was confidently anticipated that next year it would be possible to make a reduction in the rates to certain classes of consumers, although, with present prices for energy and the improved efficiency of incandescent and arc lamps, electricity was as cheap an illuminant as was available, while for power, both to large and small consumers, it was unequalled.

The accounts were approved.

Hove.—The accounts of the Aldrington electricity undertaking for the year ended March 31 show total receipts of £951 and expenses £598, leaving a gross profit of £353.

After meeting loan charges there was an adverse balance of £207 against a debit balance last year of £404. The purchase of electricity had cost £407, and the sale had realised £825.

Ilford.—The accounts of the electricity department of the Urban Council for the year ended March 31 have been issued.

The capital expenditure is £182,523, against £181,326. The total revenue was £31,805 (including £18,893 from consumers, £4,669 from tramways department, £7,206 from public lighting, and miscellaneous receipts £1,037), against £29,747 in 1909-10. The gross profit was £13,969 (£12,866), or 7·78 (7·42) per cent. on average capital. After paying interest (£6,117, against £5,754) and sinking fund (£6,452, against £5,543), there was a nett profit of £1,400, against £1,569. The number of units sold was 3,299,927 (1,225,658 private lighting, 531,842 power and heat, 546,290 public lighting and 996,137 traction), against 3,152,591 in 1909-10. The average price obtained was 2·02d. (against 2d.) per unit. There are 3,863 (3,543) consumers, the maximum load was 1,809 kw. (1,665 kw.), the load factor was 20·82 (21·61) per cent., and the units sold per consumer for private lighting were 455 (438). The cost of coal was 0·46d. (0·48d.) per unit, and the total costs were 1·02d., against 1·03d. per unit.

Nelson.—The accounts of the electricity supply and light railways departments for the year ended March 31 have been issued.

The income of the electricity department was £10,665, including £4,346 from private lighting supplies, £441 power and heating, £392 bulk supplies and £4,810 traction. The expenses were £5,181 and after paying interest and sinking fund instalment (£4,564) there was a net profit of £922. The total capital expended is £74,878, increase £177 over 1910. 1,062,176 units were generated and 920,456 units sold. The equivalent of 37,030 8 c.p. lamps is connected, against 34,500 8 c.p. and the horse-power of motors connected is 345 against 310.

The light railways carried 2,118,878 passengers, against 2,001,538, and 203,708 car-miles ran, against 200,115. After paying all expenses, including interest and sinking fund there was a deficit of £784 against an estimated loss of £1,146.

Salford.—The accounts and annual report of the general manager of the tramways department for the year ended March 31 have been issued.

The total length of lines owned by the Corporation is 36¾ miles, but 38¼ miles are also operated on lease, &c. The total income was £242,862, including £242,796 (10·004d. per car-mile) traffic receipts. The working expenses were £155,585, leaving a gross profit of £87,277. Interest and redemption of loans, &c., required £46,633, rents of leased lines came to £26,598, depreciation and renewals fund to £692 and after paying £185 for repairs, &c., of Bank-street cottages the net profit was £18,750. The passengers carried numbered 46,659,553, an increase of 718,778 and the car-miles run 5,824,474, an increase of 177,046. 9,301,713 units of electrical energy were used, or 1·66 units per car-mile. The gross capital expenditure is £721,338.

Watford.—The accounts of the electricity department for the year ended March 31 show gross capital expended £99,230, an increase of £3,807 during the year, but the net capital expended is £74,718.

The revenue was £13,791, including £9,033 nett from the sale of current by meter and £4,598 from public lighting. The total expenditure was £6,296, leaving a gross profit of £7,495. Interest on mortgage debentures absorbed £2,602, and instalments of principal £4,103, leaving a net profit of £791. 1,142,546 units were sold (789,361 for private lighting and power and 353,185 for public lighting) and the total maximum supply demanded was 760 kw.

In the report of the engineer and manager (Mr. F. W. Purse) it is pointed out that the total revenue increased by £1,145, while the working expenses increased only by £230; the capital charges increased by £398 and the net profit by £517. The temporary depression occasioned by the metal filament lamps had been overcome and there was every reason to expect that the future progress would be even greater than during the past year. The coal (0·5d.), works (0·88d.) and total costs per unit (1·32d.) were the lowest on record. The number of new consumers was 199 (against 143), equivalent to 8,515 32-watt lamps; the total consumers were 1,092 equivalent to 63,833 32-watt lamps.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

The WESTMINSTER ELECTRIC SUPPLY CORPORATION invite tenders for supply, delivery and erection at their Davies-street station of battery boosters and switchboards. Copies of specification, with drawing and general conditions can be obtained from the Secretary of the Corporation, Eccleston-place, Belgravia, S.W., to whom tenders should be sent by 10 a.m. of Sept. 12. Specification can be seen at (but not obtained from) the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster, S.W. See also an advertisement.

Tenders are invited (up to Oct. 3) for the supply of 42 miles of telephone cable to the Postmaster-General's department in VICTORIA. Tender forms, &c., from the Commonwealth offices, 72, Victoria-street, London, S.W. See an advertisement.

CLEETHORPES-WITH-THRUNSCOE Urban District Council invite tenders for the supply, delivery and laying down of a system of vulcanised bitumen distribution and feeder cables on the low-pressure three-wire d.c. system. Specification, conditions of contract and form of tender from the clerk of the Council, Mr. B. Greaves, Council offices, Cleethorpes, to whom tenders must be sent by noon of Saturday, Sept. 2. Specifications and general conditions of contract may be seen at the offices of the consulting engineers, Messrs. Vesey Brown & Hall, Milburn House, Newcastle-on-Tyne.

The Council of the County Borough of WEST HAM invite tenders for (*a*) water tube boilers, (*b*) coal handling and discharging plant, (*c*) 5,000 kw. turbo-alternator, with condensing plant, (*d*) river service pipe-work, (*e*) centrifugal pumps, (*f*) 750 kw. converter (two-phase to d.c.). Specification, form of tender, &c., from Mr. H. H. Couzens, engineer and manager, 84, Romford-road, Stratford. Tenders to the town clerk, Mr. Fred E. Hilleary, Town Hall, Stratford, E., by 10 a.m. Aug. 31.

Tenders will be received until noon Monday, Sept., 18 for the supply of Swedish, Norwegian, Finland or Russian red fir telegraph poles, for the GENERAL POST OFFICE. Forms of tender from the Controller of Stores, Mr. G. Morgan, Stores Department, G.P.O., 17 and 19, Bedford-street, London, W.C.

IPSWICH Corporation want tenders by Aug. 24 for one year's supply of paper-insulated underground cables. Specification from Mr. F. Ayton, Electricity Works, Constantine-road, Ipswich.

WEST HAM Guardians invite tenders for 12 months' electrical stores. Tenders to chairman by 11 a.m. Aug. 31.

Tenders are invited up to Sept. 26 for the supply of telephone material and 30 miles of telephone cable to the Postmaster-General's Department in VICTORIA. Specifications, forms of tender, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W., See also an advertisement.

Tenders are invited up to Aug. 30 for supply of porcelain insulators, copper wire, sleeves, &c., to the Postmaster-General's department in SOUTH AUSTRALIA; and up to Sept. 5 for the supply of (*a*) 10,000 protectors and (*b*) sundries to the Postmaster-General's Department in VICTORIA. Tender forms and specifications at the Commonwealth Office, 72, Victoria-street, London, S.W.

The Metropolitan Water and Sewerage Board, Albert-street, BRISBANE, Queensland, want tenders by noon Jan. 30 next for supply and erection, of one, two or three complete units, each consisting of power generating plant and pump or pumps to lift not less than 6,000,000 gallons per day. Particulars from the Secretary, and forms from the Agent-General for Queensland.

The Municipal Council of BUDAPEST, Hungary, require tenders for the manufacture and supply of plant for a steam-driven electrical generating station, including two groups of three-phase turbo-generators (5,000 kw. each), 10,000 volts 50 cycles, boiler equipment for mechanical output of 5,000 kw. with reserve, pipeline, central switching and accessory equipments, travelling crane for engine room and coal-conveying plant. Specifications, &c., can be obtained at the Presidial Section of the Council, 9: IV., Városház-utca 16, II. 1, Budapest. Tenders by 11 a.m. Sept. 30.

The BOMBAY, BARODA & CENTRAL INDIA RAILWAY Co. want tenders by noon Aug. 22 for supply of steam engines and d.c. dynamos, air compressors and centrifugal pumps. Forms of tender, &c., from the Secretary, 110, Bishopsgate, London, E.C.

Tenders will be received at the Town Hall, SYZRAN, Russia, on Oct. 14, for the construction of an electric tramway and the supply of electrical energy for lighting.

The Public Works Department, Madrid, will receive tenders on Sept. 20 for the concession for the construction of the RENTERIA electric tramway.

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The time for the receipt of tenders by the Ministry of Public Works, Constantinople, for an electric power and tramway concession for JERUSALEM, is extended to Sept. 13. Specifications (in French) can be seen at 73, Basinghall-street, London, E.C.

The Municipal Commissioners of PENANG invite tenders for the supply and delivery, f.o.b. British port, of one 500 kw. steam dynamo engine or turbine with ejector condensing plant and switchgear. Specifications, general conditions and form of tender may be obtained from the consulting engineers, Messrs. Preece, Cardew & Snell, 8, Queen Anne's-gate, Westminster, S.W., to whom tenders (in duplicate) are to be sent by noon of Tuesday, Sept. 5.

TENDERS RECEIVED AND ACCEPTED.

The Balmain Electric Light & Power Supply Co. (Balmain, Australia) have placed an order with Willans & Robinson for a 500 kw. Willans impulse disc and drum mixed-pressure steam turbine, coupled to a General Electric alternator and exciter. The turbine will exhaust into a vacuum-augmentor surface condensing plant, which Willans & Robinson will also supply.

Sydney (N.S.W.) Municipal Council have accepted the following tenders:—

Noyes Bros., for the supply of electric motors; with the local agents of Ferranti Limited and the Allgemeine Elektricitäts Gesellschaft, for electricity meters; Union Electric Co., five Excello flame arc lamps and arc lamp carbons; British Insulated & Helsby Cables, for cables (11,000 volt), £2,420; Gordon, Marr & Sons, bases for steel poles (351), c.i. arc lamp bases, £170; G. H. Olding, tower and pole erecting waggons (two of each), £329; Australian General Electric Co., transformers and switchgear, £417; British General Electric Co., "Osram" lamps (with a guaranteed life of 2,000 hours), £533. 6s. 8d.

Willans & Robinson have received an order from the War Office for three Willans-Diesel direct-current generating sets to the specification of Messrs. Kennedy & Jenkin for the Bordon Camp electricity supply.

Bangor Council have placed an order with the Diesel Engine Co. for a 100 kw. Diesel oil-driven generating set.

Walsall Council have accepted the tender of J. Storey & Sons for supplying two sets of jet condensing plant at £1,163.

The contract for the pumping machinery for the Montreal filtration scheme has been let to the British Electric Plant Co. at $40,000.

Government Contracts.—The British Government Departments have placed the following contracts during July:—

India Office (Stores Department):—British Insulated & Helsby Cables and W. T. Henley's Telegraph Works Co., cable; British Westinghouse Electric & Mfg. Co., dynamos.

Crown Agents for the Colonies.—Mavor & Coulson, electric light plant and fittings; Bullers Ltd., insulators; British L. M. Ericsson Mfg. Co., telephone material; T. Bolton & Sons, copper wire.

H.M. Office of Works.—Howell J. Williams (Ltd.), Western telephone exchange erection; Browett, Lindley & Co., generating set for South Kensington.

G.P.O. (Stores Department).—British Insulated & Helsby Cables, telephone cases, signalling apparatus, jacks, &c.; Western Electric Co., loading coils and protectors; Western Electric Co., generators; Gent & Co., house telephone apparatus; British L. M. Ericsson Mfg. Co., and British Insulated & Helsby Cables, telephones; Peel-Conner Telephone Works, inset transmitters; Millars Karri & Jarrah Co. (1902), wood arms; W. T. Henley's Telegraph Works Co., indiarubber and cotton core cable; Siemens Bros. & Co., submarine cable; J. Wilesmith & Co., casing and covers for electric wiring; G. Skey & Co., earthenware ducts; Bullers Ltd., insulator spindles; F. Smith & Co., copper wire; C. MacIntosh & Co., flameproof wire; R. Johnson & Nephew, galvanised iron wire.

G.P.O. (Engineering Department).—Spencer & Co., band conveyor at Bristol P.O.; Western Electric Co., telephone exchange extensions at Hendley, Croydon and Central Exchange (London); Peel-Conner Telephone Works, telephone exchange equipment at Blackpool and Worcester; British Insulated & Helsby Cables, telephone exchange equipment, Worthing.

Commissioners of Woods.—Wellman Bros & Co., electrical installation Cumberland Lodge, Windsor Great Park.

Commonwealth Tenders.—The following contracts have been placed by Australian Government Departments:—

South Australia Postmaster-General's Dept. India Rubber, Gutta Percha & Telegraph Works Co., 3,000 primary battery zincs, 8¼d. each. Western Australia Railway Department. Doulton & Co., 5,000 Cordeaux insulators, £170. 14s. 6d.; Public Works Department. General Electric Co., triple expansion pumping engine, £1,580.

BUSINESS NOTICES.

The partnership between Messrs. Wm. Charles Cloete Hawtayne and Geo. Alex. Zeden, carrying on business as consulting engineers, Queen-street-place, London, E.C., under the style of Hawtayne & Zeden has been dissolved as from June 30, 1911. Debts by Mr. C. C. Hawtayne who will continue in his own name.

The London & Rugby Engineering Co. (Ltd.) 10, Bush-lane, Cannon-street, E.C., have acquired the business of Messrs. J. L. Cateaux & Co., including all assets and liabilities, as from July 1, 1911. Accounts owing by Messrs. Cateaux & Co. will be settled by them as they become due. The company will be managed by the principals of the old firm.

Mr. F. L. Rawson, consulting engineer, has removed his offices to 3, London Wall-buildings, E.C.

Patent Development.—The proprietors of patent No. 4,927/07 for "Improvements in or relating to electric furnaces" desire to make arrangements for exploiting same in this country. Communications to Messrs. Haseltine, Lake & Co., patent agents, 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

The owners of patent No. 23,501/99, relating to "Improvements in Vacuum Tube Lighting," and patent No. 12,582/02, relating to "An Improved System of Electric Lighting," also desire to negotiate with electrical engineers with the view of granting licences. Applications of Messrs. Lloyd Wise & Co., patent agents, 46, Lincoln's Inn Fields, W.C.

BANKRUPTCIES, LIQUIDATIONS, &c.

Frederick Vickers (trading as Frederick Vickers & Co.), electrical engineer, 286, Oxford-road, Manchester, has been adjudicated bankrupt. First meeting of creditors Aug. 23 at O.R.'s, Byrom-street, Manchester, and public examination on Aug. 25 at the Court House, Quay-street, Manchester.

A dividend of 3s. 4d. in the £ is payable at 27, Brazennose-street, Manchester, to creditors of Chas. Hellyer Pearson, electrical engineer, &c., 51A, Mosley-street and Stockton-street, Manchester, and 4, Manchester-road, Hyde.

A meeting will be held on Sept. 15 at 1, Cecil-chambers West, London, W.C., to receive an account of the winding up of the Lepel Wireless Synd. (Ltd.)

A meeting will be held on Sept. 12 at 52, Moorgate-street, London, E. C., to receive an account of the winding up of the Rosario Electric Co. (Ltd.)

A meeting will be held on Sept. 12 at 23, Grafton-street, London, W., to receive an account of the winding up of the Alliance Electrical Co. (Ltd.). This company was wound up with a view to the sale of its undertaking to the Alliance Electrical Stores (Ltd.)

COMPANIES' MEETINGS AND REPORTS.

DUBLIN & LUCAN ELECTRIC RAILWAY CO.—Gross receipts for the half-year amounted to £3,455. 11s. 3d., a decrease of £6 on the corresponding period of 1910, whilst expenditure increased by £276. 13s. 8d., mainly in coal and repairs to plant. After providing debenture interest the available balance is £919 17s. 3d., and the directors recommend payment of the usual half-yearly preference dividend, £444. 17s. 3d. being carried forward.

GREAT NORTHERN RLY. CO.—At the meeting last week the chairman (Lord Allerton) said the company had spent £143,000 on the Great Northern, Piccadilly and Brompton Railway in making the connection at Finsbury Park. They received from that company in the half-year £4,922 and from the Great Northern and City Co. £8,675.

LANCASHIRE & YORKSHIRE RLY. CO.—At the meeting last week the chairman (Sir Geo. Armytage) stated they were paying 4¼ per cent., the best dividend paid for 11 years. They had continued the electrification of their line to Town Green. Half of the total increase in the number of passengers was on their electrified lines—their last extension to Town Green was already showing gratifying results.

LIVERPOOL OVERHEAD RAILWAY CO.—The chairman (Sir Wm. Forwood) stated at the meeting on Tuesday that it was gratifying to place before the meeting a statement of a distinctly encouraging character. The improvement was due to the increased trade of the port, good weather and economy in working. During the past few years they had strengthened the main structure from end to end, and the cost had been paid out of revenue. During the past half-year they had carried on their railway and tramlines 5,393,597 passengers, against 5,090,080 during the same half last year, but the value per passenger had fallen from 1·72d. to 1·69d., owing to an increased proportion of workmen's traffic. Their revenue showed the satisfactory increase of £1,968, and they had earned that increased revenue at a cost of only £382. Their expenditure worked out at 66·16 per cent. of revenue, against 69·84 per cent. Their cost per train-mile had been 12·02d., against 14·2d. on the City and South London, and 21·51d. on the Mersey Railway. Their railway carried 4,226,410 passengers, the City and South London carried 12,413,000, and the Mersey Railway 6,027,000. All they wanted was increased traffic. They had £10,841. 6s. 1d. available for dividend, and recommended payment of the preference dividend and 1 per cent. on the ordinary shares, which would leave £4,665. 9s. 1d. to be carried forward. The bill for consolidating their borrowing powers, and to enable the Mersey Dock Board to guarantee the interest on the debenture stock, now awaits Royal Assent.

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LONDON ELECTRIC RAILWAY CO.—Lord Geo. Hamilton stated at the meeting last week that the capital expenditure during the half-year amounted to £47,222. The most important item of that expenditure was the cost incurred in the establishment of the "escalator" at Earl's-court, which would very shortly be completed. Extensive alterations were also being made at the Highgate Station on the Highgate-Hampstead line. The London Electric Railway Act of 1900, which received the Royal Assent on June 2, authorised the extension of the Bakerloo line to Paddington Station and the Hampstead-Highgate line from Charing-cross to the Embankment. Tenders for those two extensions had been received by the company; the contract would be let within a few days and the work would be proceeded with continuously. The gross receipts for the six months amounted to £392,817, an increase of £27,193 over the corresponding period for the preceding year. The working expenses were £174,919, an increase of £7,699. The ratio of working expenses to gross earnings had diminished to 45·53 per cent. They proposed to pay 4 per cent. on the preferred stock and 1 per cent. on the ordinary stock, and to carry forward £14,506, as against £12,401 for the corresponding period last year. Not a single serious accident occurred among the millions of passengers carried during Coronation week, a result which reflected high credit both upon those who made as well as those who gave effect to the arrangements. The negotiations with the Underground Electric Railways Co. of London for the sale of the power-house to the Joint Committee of the London Electric and District Railways had been successfully concluded, and he could safely say that the bargain was a fair one for all the parties concerned.

METROPOLITAN DISTRICT RAILWAY CO.—Lord Geo. Hamilton, who presided at the meeting last week, stated that the capital expenditure for the past half-year was £88,663, of which £12,472 was spent upon reconstruction and improvement of stations, and £39,517 on the construction of new cars. For the current half-year they estimated they should spend £90,000 on capital account, including £51,000 for new rolling stock, leaving £78,000 to be incurred in subsequent years. There was an increase of £27,124 in gross receipts, and in passengers of 4,359,000 over the number carried in the corresponding period of last half-year. The Coronation and its festivities contributed to the increase, also the opening of the Earl's Court Exhibition grounds. But apart from the Coronation their traffic showed a general and satisfactory increase. Their working expenses showed an increase of £9,410, due to improved and increased train service, extensions, improvements in rolling stock, &c. The operating expenses per car-mile showed a reduction of 0·006d., and per car-hour of 0·259d. The percentage of operating expenses to gross receipts was 46·69. The arrangements made to meet the exceptional strain of the Coronation week worked most successfully, and reflected high credit alike upon the directing staff and employes under them. There was no hitch throughout the period, and not a single accident amongst the millions of passengers carried. They had a balance available for dividends of £82,091, an increase of £20,715 including the balance of £2,020 from last half-year. They proposed to pay the full dividend on the 4½ per cent. first preference stock, leaving a carry forward of £14,277, against £8,528. Although sufficient had been earned to pay a small dividend on the 5 per cent. second preference stock the directors did not recommend any payment. The half-year had been an exceptional one, and the directors deemed it advisable to take advantage of the opportunity to strengthen the reserve funds. It was 27 years ago that the last full dividend on the first preference stock was paid; that dividend gradually diminished, and from June, 1900, to Dec., 1909, it ceased altogether, but now they had the full 4½ per cent. The development of the traffic had been satisfactory and continuous in recent years. Rapid progress continued to be made with the widening of the railway between Ravenscourt Park and Acton-lane junction. They expected to work over the new lines by November. That would afford their company an opportunity of working a closer and more regular service of trains to Ealing and other points on the western lines. Another improvement which will benefit their company was the extension of the London Electric Railway from Charing Cross to the Embankment station. The lessee companies of the East London Railway had agreed to a scheme for electrifying that line. Negotiations were in progress with the East London Co., and it was hoped that matters would be finally adjusted, so that the work could be put in hand at a very early date. One of the lessee companies was to provide the necessary capital required for the electrification of the line. Terms for the supply of electrical energy, which was to come from the Lot's-road power house, had been agreed with the District Company. The negotiations with the Underground Electric Railways Co. of London for the sale of the Lot's-road power house to the Joint Committee of London Electric and the District Companies had been concluded, and the bargain was a fair one for all parties concerned. The power house would be transferred to a Joint Committee of six, three members of the Board of that company and three members of the Board of the London Electric Railway Co.

NEW GENERAL TRACTION CO. (LTD.)—Baron E. B. d'Erlanger stated at the meeting on Friday that the dividends and interest received from their sub-companies amounted to £22,656, against £19,482 in the previous year. The Coventry Co. paid 5⅞ per cent. dividend, against 3½. The dividend from Norwich showed a decrease of £900, but they received from their Philadelphia undertaking 4 per cent. instead of 3 per cent. The general expenses showed an increase of £355. The resulting balance was £3,674. 18s. 6d., compared with £500. 19s. 4d. Coventry Corporation had given notice of intention to acquire the local tramways. The Corporation had been invited to name the amount which they would be prepared to pay for the undertaking, but they were unwilling to do so, and as the company were unwilling sellers it was not prepared to state a price at which it would sell. Consequently the matter would be the subject of arbitration, the date of which was not yet fixed. The Douglas Southern Tramway pursued the even tenor of its way, and paid a dividend of 5 per cent. on its preference shares for the year ended October, 1910, the same as in the preceding year.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES, &c.

NEW COMPANY.

BRAUNTON ELECTRIC LIGHT & POWER CO. (LTD.) (117,202.)—Reg. Aug. 10, capital £5,000 in £1 shares, to carry on the business indicated by the title, and to adopt agreements between S. I. Knill and the Parish Council of Braunton and between S. I. Knill and Crompton & Co. First directors T. Yeo, H. S. G. Clarke and H. K. Symonds.

STATUTORY RETURNS.

AFRICAN DIRECT TELEGRAPH CO. (LTD.)—In the return to June 14, capital is £300,000 in £10 shares. 23,600 shares taken up. £236,000 paid. Mortgages and charges £8,600.

LANDAULET CO. (LTD.)—Return to June 7 gives capital £50,000 in £10 shares. 3,928 shares taken up. £39,280 paid. Mortgages and charges £6,000.

MORTGAGES AND CHARGES.

ELECTROMOBILE CO. (LTD.)—Particulars of £11,807 debentures, created Aug. 3, have been filed, amount of present issue being £6,566. 18s. 11d. Property charged: Company's undertaking and property, present and future, including uncalled capital. No trustees.

Issue on Aug. 3 of £10,000 debenture stock, part of a series secured by trust deed dated Dec. 9, 1903, between the North of England Trustee, Debenture & Assets Corpn. and this company also received. The stock was limited in the first instance to £40,000, but has been increased to £50,000.

LODGE-MUIRHEAD WIRELESS & GENERAL TELEGRAPHY SYND. (LTD.)—Particulars of £10,000 debentures, created July 21, have been filed, the whole amount being now issued. Property charged: Company's undertaking and property, present and future, including uncalled capital. No trustees.

CITY NOTES.

MEMORANDA (Aug. 10).—Bank rate 3 per cent. (March 9, 1911.) Price of silver, 24⅞d. per oz. Consols 78⅝ for money and for account. Consols Pay Day, Sept. 1; Stock and Shares Continuation Days, Aug. 29 and Sept. 12; Ticket Days, Aug. 30 and Sept. 15; Pay Days, Aug. 31 and Sept. 14; Mining Shares Carry Over Days, Aug. 28 and Sept. 11.

PRICES OF METALS (London).—*Copper*, cash, 56½; three months, 57. *Lead*, English, 14¼—14½; Foreign, cash, 14; three months, £14. *Spelter*, 27—27½. *Tin*, English, 191—193; Foreign, cash, 190; three months, 187. *Iron*, Cleveland, cash, 47/6, three months, 48/3.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—The number of units delivered to consumers during the five weeks ended June 30 were 1,050,023, compared with 995,992 units in the corresponding five weeks of 1910.

W. T. HENLEY'S TELEGRAPH WORKS CO. (LTD.)—The directors have declared an interim dividend on the preference shares at the rate of 4½ per cent. per annum (less tax), and on the ordinary shares at the rate of 10 per cent. per annum (tax free) for the half-year ended June 30, both payable Sept. 1.

NEWCASTLE & DISTRICT ELECTRIC LIGHTING CO. (LTD.)—The directors have declared an interim dividend at the rate of 3 per cent. per annum for the half-year ended June 30, absorbing £4,456, and carrying forward £6,885, against £2,917 for the corresponding half-year of 1910.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed Aug. 30 a special settling day in £200,000 5 per cent. mortgage debenture stock of the *British Insulated & Helsby Cables (Ltd.)* and have ordered the further issue of £205,480 4½ per cent. perpetual consolidated mortgage debenture stock, $500,000 additional common stock and $250,000 additional 5 per cent. consolidated first mortgage bonds of $1,000 each of the *Shawinigan Water and Power Co.* to be quoted in the Official List. The Committee have also been asked to allow £1,000,000 general mortgage 4½ per cent. 30-year gold bonds of $1,000 each of the *Consolidated Gas, Electric Light and Power Co. of Baltimore* and $7,580,000 1st mortgage sinking fund 5 per cent. gold bonds of $1,000 each of the *Pennsylvania Water and Power Co.* to be quoted.

TYNESIDE TRAMWAYS & TRAMROADS CO.—The directors recommend a dividend of 1¼ per cent. per annum (1s. 6d. per share), less tax, on the ordinary shares for the half-year, placing £1,000 to reserve for renewals, depreciation, &c., writing £530 off preliminary expenses and carrying forward £620.

UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON (LTD.)—Interim on the income bonds for the half-year ended June 30 at the rate of 1 per cent. per annum (tax free) will be paid on Sept. 1.

WASTE HEAT & GAS ELECTRICAL GENERATING STATIONS (LTD.)—The directors have declared an interim dividend at the rate of 5 per cent. in respect of the half-year ended July 31 (less tax), payable 31st inst.

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ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Aug. 9	1,796	+ 128	10	16,648	+ 1,267
Airdrie	„ 4	208	+ 6	31	6,694	+ 42
Anglo-Argentine	„ 12	50,359	+ 7,220	32	1,560,957	+ 150,622
Ashton-under-Lyne	„ 12	443	+ 64	20	8,412	+ 587
Ayr Corporation	„ 12	550	— 22	13	5,590	— 8
Barnsley	„ 4	185	— 31	31	5,581	+ 308
Barrow	„ 4	381	— 55	31	8,730	+ 513
Bath Electric Trams, Ltd.	„ 9	1,328	+ 337	32	26,756	+ 1,040
Birmingham Corporation	„ 12	9,274	+ 3,076	19	151,502	+ 21,764
Birmingham & Midland	„ 4	913	— 285	31	27,711	+ 1,486
Blackpool & Fleetwood	..	..	..	..	..	..
Blackburn Corporation	„ 9	1,163	— 75	†20	23,476	+ 1,998
Bolton Corporation	„ 13	2,817	+ 232	20	46,853	+ 3,659
Bombay	July 14	2,779	+ 152	28	79,880	+ 4,769
Bournemouth Corporation	Aug. 9	2,932	+ 448	19	35,271	— 2,079
Bradford Corporation	„ 12	6,065	+ 664	19	109,456	+ 8,865
Brighton Corporation	„ 13	1,780	+ 406	¶19	22,009	+ 1,501
Bristol Trams & Carriage	„ 11	8,677	+ 2,561	19	140,743	+ 14,513
Burnley Corporation	„ 12	1,465	+ 126	19	19,184	+ 2,374
Burton Corporation	„ 11	416	+ 128	19	5,619	+ 569
Cardiff Corporation	..	..	..	..	..	..
Calcutta Tramways Co.	„ 12	R59,636	+ R5,732	6	R351,042	+ R35,664
Caterham-Redruth	„ 12	137	..	32	3,905	+ 34
Cleveland Corporation	„ 5	2,499	— 418	18	46,563	+ 4,368
Central London Railway	„ 12	4,078	— 638	6	27,270	— 5,172
Chatham & Dist. Lt. Rys.	..	..	..	..	..	..
City & South London Rly.	„ 13	3,117	+ 119	6	18,693	+ 125
Coventry Corporation	„ 4	1,170	— 2,020	31	81,927	— 6,330
Croydon Electric Trams Co.	„ 10	573	+ 18	32	15,906	+ 368
Croydon	..	..	..	..	..	..
Darlington & Dist. Trams	„ 4	607	+ 47	31	14,850	+ 2,062
Derby Corporation	„ 12	437	+ 128	19	5,267	+ 893
Dublin & Lucan Railway	„ 11	213	+ 28	6	1,057	— 18
Dublin United	„ 11	7,049	+ 967	6	45,723	+ 9,472
Dudley-Stourbridge	„ 4	916	— 607	31	25,526	+ 1,382
Dundee Corporation	„ 9	1,165	— 9	¶12	14,935	— 135
Durham Council	„ 12	1,221	+ 201	19	21,449	+ 1,338
Dover Corporation	„ 12	467	+ 85	19	7,034	+ 637
Eastbourne & Dist. Trams	„ 4	1,117	— 22	31	31,957	+ 1,674
Edinburgh Corporation	„ 12	16,584	— 1,534	§10	196,859	+ 14,407
Exeter Trams	„ 12	136	+ 16	32	3,911	+ 269
Exeter Corpn.	„ 9	446	+ 125	6	2,127	+ 291
Gravesend-Northfleet	„ 4	245	— 25	31	6,439	+ 78
Great Northern & City Rly.	„ 12	1,328	+ 70	6	8,255	+ 811
Glasgow & Port Glasgow	„ 4	850	+ 123	31	21,859	+ 2,785
Grimsby Corporation	..	..	..	..	..	..
Liverpool Tramways	„ 4	376	— 52	31	8,110	+ 625
Lough Elec. Trams Co.	„ 14	2,034	+ 322	6	8,235	— 74
Hong Kong	..	..	..	..	..	..
Huddersfield Corpn.	„ 12	2,135	+ 309	19	38,909	+ 3,991
Hull Corporation	„ 12	2,967	+ 295	19	55,000	+ 2,319
Ilkeston District Council	„ 12	697	+ 171	20	11,055	+ 533
Ilkley Urban District Council	„ 9	161	+ 32	19	2,592	+ 127
Ipswich Corporation	„ 12	716	+ 130	19	9,187	+ 603
Isle of Thanet Co.	„ 12	2,613	+ 592	45	25,618	+ 1,238
Jersey	„ 4	165	— 23	31	4,025	+ 223
Keighley Corporation	..	..	..	..	..	..
Kidderminster & District	„ 4	136	— 200	31	3,448	+ 55
Kilmarnock Corporation	„ 12	155	+ 8	13	2,370	+ 276
Lancashire Trams Co.	„ 10	1,560	+ 87	32	44,563	+ 502
Lancashire United	„ 9	1,598	+ 191	32	42,716	+ 1,210
Langton	„ 4	254	— 49	31	5,194	+ 124
Leamington Corporation	„ 12	8,557	+ 1,646	19	147,306	+ 10,275
Leeds Corporation	„ 12	2,933	+ 708	19	50,361	+ 4,843
Leicester Corporation	„ 12	775	+ 73	‡13	9,273	+ 836
Leith Corporation	..	..	..	..	..	..
London Corporation	„ 5	12,128	— 246	31	357,217	+ 13,329
London Overhead Rly.	„ 13	1,842	+ 269	6	9,881	+ 748
Lynton&ColwynBayRy.	„ 11	1,005	+ 184	36	9,544	+ 309
Lancs County Council	„ 2	43,874	— 2,073	‡18	805,195	+ 53,073
Lancs. Elec. Ry. Co.	„ 12	11,180	+ 855	6	73,455	+ 2,160
Maidstone United	„ 12	9,821	+ 2,710	32	212,815	+ 9,785
Manchester Corporation	„ 12	649	+ 172	45	8,576	+ 432
Manchester Corporation	„ 12	16,904	+ 1,883	20	315,234	+ 18,409
Metropolitan Railway	„ 12	1,927	+ 80	6	11,427	— 387
Metropolitan Dist. Railway	„ 4	209	— 96	31	6,373	+ 15
Metropolitan Elec. Trams	„ 12	10,140	+ 1,039	6	66,157	+ 4,006
Middleton	„ 4	9,516	— 422	31	269,468	+ 41,373
Middlesbrough Corporation	„ 4	390	— 14	31	10,380	+ 674
Newcastle-on-Tyne Corp.	„ 12	215	+ 50	§19	3,587	+ 725
Newport (Mon.)	„ 12	4,389	+ 552	19	83,524	+ 5,683
Newport Corporation	..	..	..	..	..	..
Northampton Corporation	„ 10	727	+ 210	19	10,837	+ 1,064
Nottingham & Hyde	„ 4	621	+ 7	31	17,496	+ 495
Nottingham Corporation	„ 13	2,137	+ 228	20	40,491	+ 2,543
Oldham (B.) Corporation	..	..	..	..	..	..
Oldham (A.) Elec. Trams	„ 11	1,517	+ 1,517	32	51,598	+ 7,273
Pontypridd	„ 4	146	— 34	31	3,872	+ 357
Portsmouth Corporation	„ 12	3,716	+ 699	19	47,372	+ 5,436
Potteries	„ 4	2,005	— 12	31	59,588	+ 5,642
Preston Corporation	„ 9	789	— 72	19	15,143	+ 1,020
Reading Corporation	„ 10	715	+ 85	19	13,114	+ 1,322
Rochdale Corporation	„ 4	483	— 54	31	6,035	— 246
Rotherham Corporation	„ 14	5,005	+ 179	§19	96,992	+ 5,162
Rouen	„ 2	$11,500	+ $632	5	$61,000	+ $5,896
Rugby	„ 4	72	— 28	31	1,545	+ 50
Salford Corporation	„ 13	6,769	+ 932	19	130,091	+ 9,304
Sheffield Trams	..	..	..	..	..	..
Shropshire Metropolitan	„ 4	982	— 243	31	25,339	+ 1,178
Southampton	„ 4	899	— 255	31	27,562	+ 1,802
South Shields Corporation	„ 9	1,701	+ 452	19	24,265	+ 3,196
Southport Corporation	„ 9	1,532	+ 470	19	13,993	+ 1,958
South Staffs Tramways	„ 4	367	— 115	31	9,234	+ 254
Stalybridge, Hyde, &c., Jt. Bd.	„ 12	820	+ 103	19	15,537	+ 1,373
Stockport Corporation	„ 13	1,895	+ 502	19	26,770	+ 3,629
Stockton & District	„ 12	670	+ 195	41	18,938	+ 1,450
Stoke Trams	„ 4	1,239	— 518	31	34,716	+ 1,723
Sunderland Corporation	„ 9	203	+ 28	19	3,038	+ 355
Swansea and District	„ 4	48	— 11	31	1,293	+ 13
Swindon Trams Co.	„ 4	512	— 215	31	7,708	+ 26
Todmorden Corporation	„ 9	652	+ 82	6	3,357	+ 198
Torquay Corporation	„ 12	1,611	+ 513	19	22,684	+ 3,715
Walsall Corporation	„ 12	687	+ 183	32	17,888	+ 786
Warrington Corporation	„ 10	426	+ 43	19	7,648	+ 209
Weaver-Mare	„ 10	3,044	+ 601	19	53,298	+ 5,606
Wellington Co.	„ 4	371	— 275	31	4,253	+ 167
Wellington Corpn.	„ 4	447	— 184	31	13,612	+ 474
West Ham	„ 9	1,232	+ 172	19	19,636	+ 1,329
Wigan	„ 4	362	— 140	31	8,925	+ 314
Wolv'ton W.R. Trams	„ 4	109	— 24	31	3,054	+ 77
Woollen District	„ 13	1,694	+ 103	33	42,461	+ 2,347
Worcester	„ 4	1,083	— 17	31	32,383	+ 2,228

comparisons are with the corresponding period last year. • Partly electrical.
† Minus 3 days. ‡ Minus 2 days. § Plus 3 days. ¶ Plus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Sheet	Last Dividend	Name.	Price Wed., Aug. 16.	*Rate per cent. Yielded.	Dividend Due.	Business Week to Aug. 16. Highest.	Lowest.
		Electricity Supply.		£ s. d.			
10	6/0	†Bournemouth & Poole Elec. Sup. Ord.	7¼ —8¼	7 10 0	Mar, Sep	..	..
10	4/6	†Do. 4½ per Cent. Cum. Pref.	8½ —9½	4 17 3	Feb, Aug	10⅛	..
10	6/0	Do. 6 per Cent. Cum. Second Pref.	10½ —10¾	5 16 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101 —103	4 6 6	Jan, July	..	..
5	5/6	†Brompton & Kensington Elec. Sup. Ord.	7⅞ —8¼	6 5 0	March	..	..
5	3/6	†Do. 7 per Cent. Pref.	7⅞ —7⅞	4 11 9	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Deb. Stock	98 —101	4 0 6	June, Dec	..	..
5	2/6	†Charing Cross (W. End & City) El. Sup. Co.	3¾ —4¼	5 0 0	Feb, Aug	4¼	..
5	2/3	Do. 4½ per Cent. Pref.	4½ —5	4 12 3	Feb., Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	94 —98	4 3 3	Jan, July	95¼	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	100 —102	4 8 3	..	100¼	..
5	2/3	Do. City Undertaking 4½% Cum. Pref.	3⅞ —4¼	5 10 6	Jan, July	..	..
5	3/0	Chelsea Electric Supply Ord.	4 —4¼	5 11 0	March	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	93 —100	4 11 0	June, Dec	99¼	..
10	8/0	City of London Electric Lighting Ord.	12¾ —12¾	4 16 0	Feb, Aug	12⅛	..
10	6/0	Do. 6 per Cent. Cum. Pref.	12¼ —12¾	4 17 0	Jan, July	..	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	120 —123	4 2 3	June, Dec	..	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	100 —103	4 8 6	Jan, July	..	..
St.	5%	County of Durham Elec. P. D. 5% 1st Mort. Deb. Stk.	89½ —91½	5 10 6	Jan, July	..	..
10	4/0	†County of London Elec. Supply Ord.	7⅜ —7¾	3 5 9	Feb, Aug	..	..
10	6/0	†Do. 6 per Cent. Cum. Pref.	11 —11½	5 6 6	Mar, Sept	10⅜	..
St.	4½%	Do. 4½ per Cent. Deb Stock (red.)	108 —110	4 2 6	Jan, July	..	..
St.	4½%	Do. Second Deb. Stock	100 —103	4 7 6	May, Nov	..	..
..	..	Edmundson's Elec. Corp. Ord.	⅛ —¼	..	Jan, July	⅛	..
5	..	Do. 6 per Cent. Cum. Pref.	2½ —2⅝	..	May, Nov	2½	2½
St.	4½%	Do 4½ per cent. 1st Mort. Deb. (red.)	84 —87	5 3 4	July	..	..
5	4/0	Folkestone Electricity Supply Co. Ord.	4¼ —4½	6 13 3	April, Oct	..	..
5	2/6†	Do. 5 per Cent. Cum. Pref.	4½ —5½	4 15 3	Mar, Sept	..	..
St.	4½%	†Do. 4½ 1st Deb. Stock (red)	95 —98	4 13 3	Feb, Aug	..	..
5	5/0	Hove Electric Lighting Ord.	6½ —7½	6 4 0	April, Oct	..	..
St.	4½%	Isle of Wight E. L. & P. Co. Deb. Stk.	88 —91	4 19 0	..	..	..
5	4/0	Kensington & Knightsbridge Ord.	7 —7½	6 18 6	Feb, Aug	..	..
5	6%	Do. 6 per Cent. 1st Pref.	5¾ —6	5 0 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	91 —93	4 6 0	..	..	..
St.	4%	†Kensington & Knghtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	96 —99	4 1 0	April, Oct	..	..
St.	4½%	Kent Elec. Power Co. Irred Deb. Stk.	78 —82	5 9 9	Jan, July	..	..
3	1/2½	London Electric Supply Ord.	1¾ —2⅛	3 0 0	Mar, Sept	..	..
5	3/0	Do. 6 per Cent. Pref.	4¾ —5	6 3 0	Mar, Sept	4¾	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb	89 —92	4 8 0	Jan, July	89½	..
5	3/0	†Metropolitan Electric Sup. Ord.	3⅞ —4¼	6 0 0	April, Oct	4¼	..
5	2/3	Do 4½ per Cent. Cum. Pref.	4¼ —4½	4 17 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	101 —103	4 8 3	June, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	95 —87	4 1 6	Jan, July	..	..
..	4½%	Midland Elec. Corp. for P.D. 4½ 1st Mort. Debs	96½ —98½	4 12 6	..	..	..
5	2/0	†Newcastle Elec. Supply Ord. (1-50,000 & 57,010-137,500)					
5	2/6	†Do. 5 per Cent. non Cum. Pref.	3¾ —3¾	6 4 0	Feb, Aug	..	..
100	4½%	Do. 4½ per Cent. 1st Mort. Deb.	3¾ —4¼	6 5 0	Feb, Aug	..	..
100	5%	North Metro. Elec. Power Sup. 5 Morts.	97 —99	4 12 0	Jan, July	102¼	..
1	6%	Northampton Elec. Lt. & P. Ord.	101 —104	4 17 6	..	..	..
1	5%	Do. 5% Pref.	1¼ —1⅝	4 11 6	Feb, Aug	..	..
St.	4%	Do. 4% Debs.	1⅜ —1⅝	4 6 0	Feb, Aug	..	..
10	6/0	Notting Hill Electric Ord.	99 —101	3 19 0	June, Dec	..	..
5	4/3	Oxford Electric Ord.	..	5 17 6	March	..	..
St.	4%	Do. 4% Deb. Stk.	6¼ —6¾	5 11 6	March	..	..
5	5/0	†St. James' & Pall Mall Elec. Ord.	91 —94	4 5 1	..	..	..
5	3/6	†Do. 7 per Cent. Pref.	8¼ —9¼	5 11 0	Feb, Aug	9⅜	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	6¼ —7½	5 0 0	Feb, Aug	7⅛	..
5	4/0	Smithfield Markets Electric Sup. Ord.	84½ —89½	4 2 0	Jan, July	..	..
5	5%	South London Electric Supply Ord.	1⅜ —1⅝	..	Feb.	..	..
St.	5%	Do. 5% 1st Mort. Stock (red.)	2¾ —3	6 5 6	April	..	..
1	0 8½	South Metrop'n Elec. Lt & Power 7% 1st Pref	98½ —101½	5 0 6	..	..	..
1	0/7½	Do. 6 per Cent. 2nd Pref.	1⅜ —1⅝	5 18 0	Feb, Aug	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	⅝ —¾	6 17 0	Feb, Aug	..	..
5	1/3	Urban Electric Supply Ord.	97 —100	4 11 6	April, Oct	..	..
5	1/3	Do. 5 per Cent. Cum. Pref.	⅛ —¼	..	April, Oct	⅛	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	2½ —3	8 6 0	April, Oct	..	..
5	5/0	†Westminster Elec. Sup. Ord.	87 —89	5 2 3	April, Oct	89	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	7½ —8	6 15 6	Mar, Sept	8	7½
			5 —5⅛	4 3 6	Jan, July	5⅛	..
		Electric Railways and Tramways.					
1	..	Bath Elec. Trams Pref. Ord.	⅛ —⅜	..	April	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	⅛ —¼	8 0 0	Jan, July	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	79 —83	5 8 6	April, Oct	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Deb. Stock.	91 —93	4 17 9	Jan, July	92	..
10	4%	Bristol Tramways & Carriage Ord.	6 —6½	6 8 0	Feb, Aug	..	..
10	4%	Do. Cum. Pref.	7 —7½	5 10 0	..	..	..
St.	4%	Do. 4 per Cent. Debs.	100 —101	3 19 2	Feb, Aug	..	..
10	..	British Electric Traction Ord.	1 —1¼	..	June, Dec	1¼	1⅛
10	..	Do. 6 per Cent. Cum. Pref.	3¾ —4	..	Feb, Aug	3⅞	3⅞
St.	5%	Do. 5 per Cent. Perpetual Debs.	94 —97	5 4 6	April, Oct	95¼	94½
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	76 —80	5 14 6	May, Nov	..	..
St.	3%	†Central London Ordinary Stock	67 —69	4 8 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Pref. Stock	85 —87	4 13 0	Feb, Aug	87	..
..	6/4	Do. 4½% Pref. Scrip 50% pd	63 —65	..	..	..	..
St.	2%	Do. Deferred Stock	48 —50	4 2 0	Feb.	51	50½
100	4%	Do. 4 per Cent. Debs.	102 —104	3 16 11	Jan, July	104¼	103
5	2/6	City of Birmingham Trams, 5% Cum. Pref.	4⅛ —5⅛	4 19 6	April, Oct	..	..
100	4%	Do 4 per Cent. 1st Mort. Debs.	99 —102	3 18 9	April, Oct	..	..
St.	1½%	City & South London Rly. Con. Ord.	27 —30	5 17 0	Feb, Aug	29	..
St.	5%	Do. 5 per cent. Perp. Pref. (1891)	108 —110	4 11 9	Feb, Aug	..	..
St.	5%	Do. (1896)	104 —106	4 16 0	Feb, Aug	..	..
St.	5%	Do. (1901)	103 —105	4 17 0	Feb, Aug	..	..
St.	5%	Do. (1903)	102 —104	4 16 0	Feb, Aug	104	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	102 —104	3 17 9	May, Nov	104	103½
10	6/0	†Dublin United Trams, 6 per Cent. Pref.	12 —13	4 16 0	Feb, Aug	..	..
10	12/0	Gateshead and District Trams Ord.	8¾ —8¾	6 19 0	..	..	..
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	⅛ —1⅛	..	Feb, Aug	..	..
5	..	Hastings & District Elec. Trams, 6% C. P.	..	..	Mar, Sept	..	..
St.	4½%	Do. 4½ Deb. Stock	75 —80	5 10 0	April, Oct	..	..
10	..	Imperial Tramways Ord.	3 —3½	..	Mar, Sept	..	..
10	..	‡Do. 6 per Cent. Pref.	4 —4½	..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Debs.	72 —74	6 3 6	Jan, July	..	..
..	2/0	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	2¼ —2½	5 0 0	Mar, Sept.	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	77 —82	5 1 0	Jan, July	..	..
10	6/0	†Lanarkshire Tramways	9½ —10½	5 15 0	Feb, Aug	..	..
St.	5%	Lancs Utd. Trams, 5% Prior Lien Deb. Stk.	79 —82	6 4 0	Jan, July	..	..
St.	4%	London Electric 4% Deb. St.	96 —98	4 2 6	..	97½	97½
St.	4%	†Do. 4% Pref.	82½ —83½	4 16 6	..	83½	82½
10	..	London United Trams, 5% Cum. Pref.	3½ —3¾	..	Jan, July	3¾	3⅜
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	73 —76	5 7 6	Jan, July	74¼	..
St.	..	Mersey Con. Ord. Stock	6 —8	..	Feb, Aug	..	..
1	1/1½	Metropolitan Elec. Tramways Ord.	⅝ —1 1/32	6 0 0	..	⅝	..
1	..	Do. Deferred	⅜ —⅝	..	April	⅜	..
1	0/6	†Do. 5 per Cent. Cum. Pref.	¾ —1	5 8 0	Feb, Aug	⅝	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	99 —101	4 10 0	Jan, July	99	..
St.	5%	Do. 5 per Cent Db. Stk	102½ —104½	4 16 6	..	..	..

• No allowance has been made for accrued interest or redemption.
† Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Share	Last Dividend	Name	Price Wed., Aug. 16	*Rate per cent. Yielded £ s. d.	Dividend Due	Business Week to Aug. 16 Highest	Lowest
		Electric Railways and Tramways—*Continued.*					
St.	2%	†Metropolitan Railway Consolidated	44½—45	3 18 3	Feb, Aug	45	..
St.	3%	Do. Surplus Lands Stocks	66—68	3 15 6	Feb, Aug	67	..
St.	3½%	Do. 3½ per Cent. Preference	88—90	3 18 6	Feb, Aug	89½	—
St.	3½%	Do. 3½ per Cent. "A" Preference	87—89	3 19 6	Feb, Aug	88	..
St.	3½%	†Do. 3½ per Cent. Convertible Pref.	87—89	3 19 6	Feb, Aug	87½	..
St.	3½%	Do. 3½ per Cent. Debenture Stock	92—94	8 14 6	Jan, July	92½	..
St.	3½%	Met. Rly. 3½ per Cent. "A" Deb. Stock	91—93	3 16 0	Jan, July	..	—
St.	..	Metropolitan District Railway Ord.	25½—26	..	Feb, Aug	25½	25½
St.	3½%	†Do. 4½% First Pref.	87—89	5 2 0	Feb, Aug	87	90½
St.	3½%	†Do. Assented 1st Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	74—76	4 13 6	Feb, Aug	75½	..
St.	3%	Do. 3 per Cent. Consoltd. Rent-charge	76—78	3 18 0	Jan, July	77	..
St.	4%	Do. 4 per Cent. Midland Rent-charge	102—104	3 17 9	Jan, July	..	—
St.	6%	Do. 6 per Cent. Perp. Deb. Stock	145—147	4 2 0	Jan, July	145½	..
St.	4%	Do. 4 per Cent. Ditto	96—98	4 2 6	Jan, July	98	..
1	4½d.	Potteries Electric Traction Ord.	[illegible]	6 11 3	April, Oct	..	..
1	0/6	†Do. 5 per Cent. Cum. Pref.	[illegible]	8 9 6	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	88—91	5 0 0	May, Nov	..	..
1	1/2⅗	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	[illegible]	10 2 0	..	—	..
St.	4%	Do. 4 per Cent. Deb. Stock	73—78	5 6 0	Jan, July	..	..
100	5%	Sunderland Dist. Elec. Trms. 5% 1stMtDb.	..	8 4 0	Jan, July	60	..
—	10/0	UndergdE.Rys.Lon.6% In. bds with coup 7	59—61	1 13 3	June, Dec	64½	63
—	5%	Do. 5% Prior Lien Bonds	100½—101½	4 19 0	..	—	..
—	4½%	Do. 4½% Bonds with coup. 8	99—101	4 10 0	..	..	..
—	4%	Do. 4 per Cent. 1st Power Ho. Dbs.	101—103	3 18 3	..	..	..
5	—	Yorkshire (W.R.) Elec. Trams. Ord.	¼—⅜	..	March ..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	2⅛—2⅞	..	..	..	..
St.	4½	Do. 4½ per Cent. 1st Debs.	80—85	5 9 6	Jan, July	82½	82
		Electric Manufacturing, &c.					
St.	4½%	Anchor Cable Co. 4½ % Deb. Stock	99—101	4 10 0	—	..	..
1	1/2⅗	Aron Electricity Meter Ord.	⅛—¼	..	..	..	..
1	0/7⅕	Do. 6% Cum. Pf.	[illegible]	7 10 0	April, Oct	5⅜	5⅛
1	3/2⅗	Babcock & Wilcox Ord.	5⅛—5⅜	4 15 0	April, Oct	..	..
1	0/7½	Do. Pref.	1⅛—1¼	4 0 0	..	..	..
5	6/0	British Insulated & Helsby Cables Ord.	6⅞—7⅛	6 15 6	July, Feb	7¼	—
5	3/0	†Do. 6 per Cent. Pref.	5¼—6¼	5 0 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	102—104	4 7 0	Jan, July	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt.Db.	96—99	4 11 0	Mar, Sept	..	..
5	..	British Westinghouse 6 per Cent. Pref.	[illegible]	..	Feb, Aug	[illegible]	—
100	6%	Do. 6 per Cent. Prior Lien Dbs. (rd.)	102—104	5 17 0	..	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	59—62	6 6 6	Jan, July	61	..
St.	4½%	BrushE.Eng. Co. 4½% Perp. 1st Deb.Stock	58—63	7 8 6	Mar, Sept	62	61½
St.	4½%	†Do. Perpetual 2nd Deb. Stock	39—44	10 10 0	Jan, July	..	..
5	10/0	Callender's Cable Con. Ord.	9—9½	8 2 0	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅞—5⅛	4 17 6	Jan, July	9⅛	..
St.	4½%	Do. 4½ per Cent. 1st Mort Debs. (red.)	101—103	4 8 0	Nov, May	[illegible]	..
1	1/6	Castner-Kellner Alkali Co.	3⅛—3⅜	5 4 3	May, Nov	[illegible]	[illegible]
St.	4½%	†Do. 4½ per Cent. 1st Mort. Deb. (red.)	102—105	4 7 0	Feb. Aug	—	..
1	1/0	Chadburn's (Ship) Telegraph Ord.	1 1/16—1 3/16	5 19 0	March ..	..	..
1	0/8⅛	†Consolidated Electrical Co.	[illegible]	7 8 9	August ..	..	..
1	0/6	Consolidated Signal Co.	[illegible]	8 7 6	April, Oct	..	..
1	0/7½	Do. 6 per cent. Cum. Pref.	[illegible]	7 6 6	April, Oct	..	..
3	..	Crompton & Co (Nos. 1 to 85,000)	[illegible]	..	Jan, July	..	..
100	5%	Do. 5 per Cent. 1st Mort. Debs. (red.)	57½—67½	8 0 0	Jan, July	..	..
5	1/0	Dick, Kerr & Co. Ord.	[illegible]	5 14 0	Sept.	..	..
5	0/7½	Do. 6 per Cent. Cum. Pref.	[illegible]	5 6 0	Sept	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	95—98	4 13 3	Jan, July	..	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	[illegible]	..	Feb, Aug	..	..
..	..	Do. (£5 paid)	1⅞—2⅛	9 3 0	Feb. Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (red.)	67—71	5 16 0	June, Dec	—	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	78—81	6 3 6	Mar, Sept	..	..
2	2½%	†Electric Construction Co.	[illegible]	6 3 0	Jan, July	..	..
2	2/9⅜	†Do. 7 per Cent. Cum. Pref.	[illegible]	7 4 6	July	..	..
St.	4%	Do. 4 per Cent. Perp. 1st Mort. Debs.	73—78	5 6 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	8½—9	5 14 0	June, Dec	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs	88—93	4 8 6	Mar, Sept	..	..
5	10/0	‡Henley's Telegraph Works Ord.	12½—12⅞	5 16 6	Feb, Aug	12½	12½
5	2/3	Do. 4½ per Cent. Pref.	[illegible]	4 9 0	Feb, Aug	[illegible]	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	106½—108½	4 3 6	Mar, Sept	..	..
10	15/0	India Rubber, Gut. Per., &c., Works	11½—13½	6 0 0	Feb, Aug	..	..
10	5/0	Do 5 per Cent. Cum. Pref.	9½—10½	4 19 0	..	..	..
100	4%	Do. 4 per Cent. Debs. (red.)	95—97	4 3 3	April. Oct	..	..
1	..	National Elec. Construction Co.	[illegible]	..	April	..	..
1	..	Richardsons, Westgarth & Co., Ltd. Ord.	[illegible]	..	Nov	..	..
1	..	Do. 6 per Cent. Cum. Pref.	[illegible]	..	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. Perp. Deb. Stock	77—80	5 14 6	Jan, July	..	..
5	..	Simplex Conduits 6 per Cent. Cum. Pref.	4⅞—5	..	..	..	..
12	12/0	Telegraph Construction & Maintenance	35—36	6 15 0	Mar, July	35½	35
100	4%	Do. 4 per Cent. Deb. Bonds (1909)	100—102	3 19 3	Jan, July	34[illegible]	..
1	1/0	Vickers, Sons & Maxim, Ltd., Ord	2 1/16—2⅛	4 13 0	..	2½	2[illegible]
1	0/6	Do. 5 per Cent. non-Cum. Preference	1 1/16—1 1/16	4 3 0	..	..	..
St.	5%	Do. 5 per Cent. non-Cum. Preferred	108—112	4 11 0	..	—	..
St.	4%	Do. 4 per Cent. 1st Mort. Db. Sk. (red)	99½—101½	3 19 6	June, Dec	—	..
100	4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.)	103—105	4 6 6	June, Dec	..	..
100	5%	Do. 5 per Cent. 3rd Mort. Debs Scrip	103—105	4 16 0	..	..	..
10	12%	J. G. White & Co. 6% Cum. Pref.	14½—15½	7 14 10	..	..	..
1	..	Willans & Robinson Ord.	[illegible]	..	Apr, Oct	..	..
5	..	Do. 6 per Cent. Cum. Pref.	⅞—1	..	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	55—65	6 3 0	May, Nov	..	..
		Telegraphs.					
10	..	Amazon Telegraph	7⅛—7⅞	..	June, Dec	..	..
100	5%	Do. 5 per Cent. Debs. (red.)	98½—100½	5 0 6	Jan, July	..	..
St.	15/0	†Anglo-American	67½—68½	4 8 0	F,My,Ag,N	67½	67½
St.	30/0	†Do. Preferred	111½—112½	5 7 0	F,My,Ag,N	112	111⅞
St.	30/0	Do. Deferred	25½—25⅞	5 7 0	F,My,Ag,N	25 11/16	25 11/16
St.	4%	Commercial Cable 4 per Cent. Deb. Stk.	88—89	4 10 6	Jn,Ap,Jy,O	89	..
10	6/0	Cuba Submarine Ord.	10½—11	5 13 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	17½—18½	5 13 0	Feb, Aug	..	..
5	2/0	Direct Spanish Ord.	3½—4	5 0 0	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	8⅛—8⅞	5 16 0	April, Oct	—	..
50	4½%	Do 4½ per Cent. Deb.	100—102	4 9 0	Jan, July	..	..
10	3/0	Direct United States Cable	8—8½	6 3 0	Ja,Ap,Jy,O	8½	..
100	4½%	Direct West India Cable 4½%Rg.Db.(rd.)	99—101	4 10 0	June, Dec	..	..
St.	25/0	Eastern Ordinary	137—138	5 2 0	Ja,My,Jy,O	137	..
St.	17/6	Do. 3½ per Cent. Pref. Stock	84½—85½	4 2 6	Ja,My,Jy,O	85½	84[illegible]
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (red.)	102—104	3 17 9	May, Nov	103½	102
St.	2/6	Eastern Extension	13⅛—13⅞	5 3 0	Ja, Ap, Jy, O	13 11/16	13⅛
10	4%	†Do. 4 per Cent. Deb. Stock	100½—102½	3 19 0	Feb, Aug	101	..
25	4%	Eastern and S.Af., 4% Mauritius Sub.Debs	100—102	3 19 0	May, Nov	..	..
10	5/0	G.N (of Copenhagen), with Coupon 83	31—32	5 14 3	Jan, July	..	..
25	52/6	Indo-European	56½—58½	5 6 6	May, Nov	58½	..
100	5%	Mackay Companies Common	85—88	5 15 0	Ja,Ap,Jy,O	..	..
100	4%	Do. Preference	72—74	5 8 0	Ja,Ap,Jy,O	..	..
1	1/0	†Marconi's Wireless Teleg. Co.	2⅛—2⅜	..	April	2	..
100	4%	Pacific & Europe'n Tel.4%Guar.Dbs.(red.)	99½—101½	3 19 9	June, Dec	..	..
2½	1/3	West Coast of America	1⅛—1¼	5 0 0	May	..	..
100	4%	Do. 4 per Cent. Debs.	98—100	4 1 0	Jan, July	..	..
10	1/6	West India & Panama	2⅛—2⅜	4 13 0	May, Nov	2[illegible]	..
10	6/0	Do. 6 per Cent. 1st Pref.	10½—10⅞	5 16 6	May, Nov	10⅞	—
10	[illegible]	[illegible]	[illegible]—10⅛	6 0 0	May, Nov	..	..
[illegible]	[illegible]	[illegible]	101—103	4 15 0	Jan, July	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	106—109	3 14 3	—	—	—
[illegible]	[illegible]	[illegible]	101—104	4 8 0	—	—	—

Share	Last Dividend	Name	Price Wed., Aug. 16	*Rate per cent. Yielded £ s. d.	Dividend Due
		Telephones.			
100	2$	Amer. Telephn. & Telegh. Cap. St.	137—139	5 16 0	Jan, July
..	4%	†Do. Coll. Trust $1,000 4 per Cent. Bds.	94—96	4 4 0	..
St.	4%	Do. 4% Cons. Bonds 1936	107—109	3 14 0	..
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101½—103½	4 17 6	Mar, Sept
5	4/0	†Chili Telephone	6 13/16—7 1/16	4 5 9	August
1	0/7½	Monte Video Telephone Ord.	[illegible]	6 0 0	Nov ....
1	0/6	Do. 5 per Cent. Pref.	[illegible]	5 11 0	May, Nov
St.	6%	†National Co. Pref. Stock	104—106	5 14 0	Feb, Aug
St.	6%	†Do. Def. Stock	118—120	5 [illegible] 0	Feb, Aug
10	6/0	†Do. 6 per Cent. Cum. 1st Pref.	10—10½	5 11 6	Feb, Aug
10	6/0	†Do. 6 per Cent. Cum. 2nd Pref.	10—10½	5 11 6	Feb, Aug
5	2/6	†Do. 5 per Cent. non-Cum. 3rd Pref.	5 7/16—5 11/16	4 11 3	June, Dec
St.	3½%	Do Deb. Stock 3½ per Cent. (red.)	98—100	4 1 0	Jan, July
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	98—100	4 1 0	..
..	4½%	New York Telephone Co. 30 yr. Bnds.	102½—103½	4 7 6	..
1	1/0	Oriental	1 1/16—1 1/16	4 18 0	April, Oct
1	0/7½	Do 6 per Cent. [illegible]m. Pref.	1⅛—1¼	4 16 0	April, Oct
St.	4%	Do. 4 per Cent. Red. Deb. Stock	88—90	4 10 0	Jan, July
St.	4½%	Telephone Co. of Egypt 4½%Db.Stk.(red.)	99—101	4 10 0	Jan, July
5	5/0	†United River Plate Ord.	7 1/16—7 3/16	5 5 0	July ....
5	2/6	Do. 5 per Cent. Cum. Pref.	5½—5½	4 13 0	June, Dec
St.	4½%	Do. 4½ Deb. St. Red.	102½—104½	4 7 0	Jan, July
		Financial, Invest[illegible] &c.			
5	3/0	Elec. & Gen. Investme[illegible]% Cum. Pref.	4—4½	7 1 0	Jan, July
10	6/0	Globe Telegraph & Trust	10 13/16—11 1/16	5 10 0	Sp,DcMrJe
10	3/0	Do. 6 per Cent. Pref.	13—13½	4 10 9	Sp,DcMrJe
10	6%	Submarine Cables Trust (Cert.)	131—134	4 10 9	April, Oct
		Colonial and Foreign Electric Railways, Tramways, &c.			
5	2/9	Anglo-Argentine 5½% Cum. 1st Pref.	5 5/16—5 7/16	4 17 6	April, Oct
5	2/9	Do. 5½% Cum. 2nd Pref.	4 13/16—5 3/16	5 [illegible] 6	Jan, July
St.	4%	Do. 4% Deb. Stock	94—96	4 3 4	June, Dec
St.	4½%	Do. 4½% Deb. Stock	100—102	4 9 0	..
St.	5%	Do. 5% Deb' Stock	100—102	4 19 0	..
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)	102—105	4 16 6	Jan, July
5	4/0	Brisbane Electric Trams. Invest. Ord	6⅛—7	5 14 0	May ....
5	2/6	Do. 5 per Cent. Cum. Pref.	5—5⅛	4 17 6	May, Nov
St.	4½%	Do. 4½ per Cent. Db. Prov. Certs.	102—105	4 7 0	Jan, July
St.	8%	British Columbia El..Rly. Df.Ord.	142—145	5 11 6	Mar, Sept
St.	6%	†Do. Pref. Ord. Stock	119—123	4 19 0	May, Nov
St.	5%	Do. 5% Cum. Perp. Pref. Stock	106—109	4 13 0	Jan, July
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	100—103	4 7 6	April, Oct
100	4½%	Do. Vancouver Power Debs.	101—104	4 3 3	Jan, July
St.	4½%	Do. 4½% Perp. Con. Deb. St.	102½—104½	4 2 0	..
St.	5%	†Buenos Ayres Lacroze Trams 1st Mt. Db.	97½—99½	5 3 0	Mar, Sept
St.	6%	†Buenos Ayres Port & City Tram, 1st Mt. Deb. Stock	92—96	6 8 0	Feb, Aug
5	3/6	Calcutta Tramways (1 to 137,610)	5½—6½	4 19 6	Mar, Sept
100	2/6	Do. 5 per Cent. Cum. Pref.	5—5½	4 17 6	Jan, July
1	4½%	Do. 4½% 1st Deb. Stock (red)	102—105	4 5 9	Jan, July
St.	..	Cape Electric Tram Shares	[illegible]	..	F,My,Ag,N
5	1/3	†City of Buenos Ayres Trams Co. (1904) Sh.	5 1/16—5 5/16	4 8 0	June, Dec
St.	4%	Do. 4 per Cent. Deb. Stock	94—97	4 4 0	May, Nov
..	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.	95—100	5 2 6	..
1	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	99—102	4 18 0	Feb, Aug
100	5%	Hong Kong Tramways Co. 5 per Cent. 1st Mort. Debs.	77—81	6 6 6	June, Dec
1	..	Kalgoorlie Elec. Trams Sh.	[illegible]	..	..
100	5%	‡Do. 5 per Cent. "A" Deb. Stock	92½—95½	5 4 6	Jan, July
5	6%	Do. 6 per Cent. "B" Ditto	63—67	8 15 0	Jan, July
5	0/6	Lisbon Elec. Trams. Ord.	1—1⅛	4 16 0	July ....
100	0/7½	Do. 6 per Cent. Cum. Pref.	1—1⅛	4 16 0	Jan, July
St.	5%	Do. 5 per Cent. Reg. Mort. Debs.	97—101	5 1 0	Jan, July
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	95—98	5 3 6	Jan, July
100	5%	Manaos Trams and Lt. Co. 5% Debs	90—93	5 9 6	..
..	5%	†Manila Elec. Ry. $1,000 Gold Bonds	97½—99½	5 1 0	Feb, Aug
100	$1½	Mexico Trams Co. Com. St.	120½—122½	5 15 6	..
..	5%	Do. Gen. Con. 1st Mort. 5% Gold Bds.	99½—100½	5 0 0	..
St.	6%	‡Do. 6% 50 yr. Mort. Bds.	99—101	6 [illegible] 3	..
St.	4½%	†Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922) (Nos. 601 to 2,000)	100—102	4 9 0	Feb, Aug
St.	4½%	Do. do. (Nos. 1 to 4,600)	102—104	4 7 6	May ....
1	0/6	Perth Elec. Trams Ord.	⅞—1	2 7 2	Jan, July
St.	5%	Do. 1st Mt. Db. Stock	101½—103½	4 17 6	..
5	3/0	Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	5⅛—5⅜	5 8 0	—
St.	4½%	Do. 4½% 1st Mort. Deb. Stk.	98—101	4 10 6	—
100	$1½	Rio Janeiro Tram, Lt. & P. Co.	116—117	4 5 9	—
..	5%	Do. 30 yr. Gold Bnds.	101—102	4 18 0	—
100	5%	Do. 50 yr. Mt. Bnds	97½—98½	5 2 0	—
..	$2½	Sao Paulo Tramway, Light & Power Co. $100 Stock	178—181	5 11 6	June, Dec
..	5%	Do. 5 per Cent. 1st Mt. $500 Db.	103—105	4 15 3	Feb, Aug
100	4½%	Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	99—101	4 10 0	..
		Colonial and Foreign Electricity Supply, &c.			
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	5¼—5⅜	5 8 0	Mar, Sept
10	6/0	Bombay E.S. & T. 6% Cm. Pf.	10⅞—11⅛	5 9 0	Jan, July
St.	4½%	Do. 4½ per Cent. Deb. Stk. (red)	97—99	4 12 6	April, Oct
..	5%	Do. 5 per Cent. 2nd Mort. Deb. Stock	96½—98½	5 2 0	..
5	5/0	Calcutta Elec. Supply Ord.	6⅞—7⅛	5 19 6	..
5	2/6	Do. 5% Cum. Pref	4⅞—5⅛	4 13 0	..
100	5%	Calgary Power Co. 5% 1st Mort. Bnds	96—98	5 2 0	..
100	7/2½	Canadian Gen. Elec. Co. Com. St.	110—115	6 4 3	..
100	$3½	Do. 7% Cm. Pf. Stock	121—125	5 14 0	..
100	5%	Castner Electrolytic Alkali Co. (of U.S.A.) 1st Mort. Stl. Debs.	94—99	5 3 6	..
500	5%	Elect. Development Co. of Ontario	87—89	5 14 0	..
St.	5%	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	84½—87½	5 4 0	..
5	..	Indian Elec. Sup. & Trac. Co.	1—1⅛	..	..
10s	..	Kalgoorlie Elec. Power & Ltg. Ord.	[illegible]	..	..
1	..	Do. 6 per Cent. Cum. Pref.	[illegible]	8 6 6	..
..	0/7½	Kaministiquia Power Co. 5% Gold Bnds.	101—103	4 18 0	..
5	5%	Madras E. S. Corp. Ord.	2⅛—3⅛	..	..
St.	..	Melbourne E. S. Co. Cons. Ord. St.	35—40	..	..
St.	..	Do. 5% 1st Mortg Deb. Stock	95—97	5 4 0	..
500	5%	Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	89½—90½	—	..
..	5%	Mexican Lt. & Power Co. Com. St.	89—91	5 11 0	..
St.	..	Do. 7% Cum. Pref. St.	110—112	4 9 0	..
St.	$1	†Do. 5% 1st Mort. Gold Bnds.	97—98	4 6 0	F,My,A,N
500	$3½	Monterey Rly. L. & P. Co. 1st Mort. Db. Sk.	89½—91½	6 6 6	..
St.	5%	†Montreal Lt. Ht. & Power Co. Cap. St.	165—170	5 2 6	April ....
100	5%	Northern Lt. Power & Coal 5% Gd. Bds.	42—44	5 10 6	May ....
100	8/2½	River Plate Electricity Co. Ord. Stk.	218—228	5 18 6	Jan, July
St.	5%	Do. 6 per Cent. non-Cum. Pref. Stk.	107—114	5 16 0	..
St.	£10	Do. [illegible] Cent. Deb. Stock	101½—103½	4 7 9	Jan, July
St.	6%	[illegible] Power Co. Ca[illegible]	116½—118½	5 5 0	..
100	5%	[illegible]	107—109	4 17 6	..
[illegible]	[illegible]	[illegible] Mt. Db. St.	103—105	4 5 0	Jan, July
[illegible]	[illegible]	[illegible] 4½% Db. St.	99—101	4 12 6	..
[illegible]	[illegible]	[illegible] Co. Pref.	11/16—1	4 6 0	..

* [illegible] for accrued interest or redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have [illegible]

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NOTES.

Labour Unrest.

"COMPLETE paralysis" did not overtake the railways, and in only a few cases was there even partial paralysis. Some of the underground and tube railways of London were affected in varying degrees, but most maintained a reasonably good service. At no place has there been serious trouble with electrical workers, although at one period the situation at Liverpool was alarming. There, we are officially informed, the men employed by the Corporation Electric Supply Department had no grievance whatever with respect to their employment, but were withdrawn by the orders of the local strike committee. The only effect was to curtail the tramway, power and lighting supplies, and, incidentally, to provide certain young professional and independent men with a novel experience. These young men immediately came forward and volunteered to assist in the running of the generating stations. As a result, a modified tramway service was kept going during the day and the city was lighted by night.

A REQUEST was sent to the Government that navy stokers and electricians should be detailed for the duty of keeping the supply going in the absence of the employés, but it is doubtful whether matters had reached the stage when State assistance becomes necessary. It is probable that great danger to the public would result from a cessation of supply of electricity for lighting purposes, and the duties of police and military might be rendered impossible of execution. In such an event it would undoubtedly become necessary for the Government to take steps to secure that supply should be maintained whether the supply authority were a company or a municipality. There would be no question of taking sides with employer or employed; the safety of the public would necessitate State assistance as distinct from mere protection. Fortunately, the necessity has not yet arisen; but, as prevention is always better than cure, perhaps the time is not inopportune for the consideration of legislation aimed at breaches of contract on the part of those workmen engaged in the supply of electricity, gas and water.

Drawn Wire Lamps.

ON another page of this issue we refer to the factory which the British Thomson-Houston Co. have equipped at Rugby for the production of metal lamps. Until quite recently this factory was devoted to the manufacture of pressed filament lamps, but developments have recently taken place resulting in the replacement of the old equipment by plant and apparatus for the manufacture of drawn wire tungsten lamps in large quantities. The drawing down of tungsten to wire of very small section must be regarded as a notable step in the development of the metal lamp, and although the Company have not yet divulged particulars of the means by which the improvement has been brought about, there can be no mistake about the ease with which the wire, when drawn, is handled and attached to the supporting frames inside the lamps. This development has resulted in the production of a lamp which, at the time of its purchase, may be handled with comparative impunity. This is a point of great importance, for the most serious defects of metal lamps have been

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experienced before use. Further, it is probable that the new process will result in lessening the cost of manufacture; for the placing of the drawn filament in position on the supports is performed in two operations, as compared with at least half-a-dozen in the case of the pressed filament. The new "Mazda" lamp enters the field at an important moment; at the Olympia Exhibition next month great efforts will be made to bring electricity consuming devices of every description before the public, and any process of manufacture which promises a reduction in the price of metal lamps is therefore to be welcomed.

Compulsory Electrification.

For some time past the authorities of Boston (U.S.A.) have been coquetting with the traffic problem in that city, with the result, as will be seen by reference to another column, that a bill has been introduced into the Massachusetts State Legislature making compulsory the electrification of all railway lines within the 10-mile radius. This is a drastic measure, and must, we feel sure, like most other amateur legislation, have been proposed as a remedy for existing troubles without proper consideration of the problems involved. It is not to be wondered at, therefore, that the New York, New Haven and Hartford Railway Co., the undertaking primarily concerned, have entered a protest against this high-handed proceeding. While we are naturally favourable to the employment of electric traction where its use is likely to be beneficial either at once or in the future, we have never lost sight of the fact that all changes of this kind must be gradual and voluntary. As the railway authorities point out, the change will cost £8,000,000, a sum which cannot be raised without neglecting the requirements of other districts, while so large an increase in the capital account is not unlikely to have a bad effect on railway securities generally and to cause a general increase in passenger and goods rates, besides decreasing the dividends.

It is as well (for schemes of this kind have also been proposed in this country) that we should recognise that all changes from steam to electrical working must be gradual. The fresh capital expenditure necessary makes careful consideration of each scheme essential, and although we are not well enough acquainted with the traffic conditions at Boston to say how far its suburban lines would respond to electrification by an increase in traffic, it is evident that the railway company have grave doubts on the point. Surely, too, if the municipal authorities are of opinion that the electrification of these lines is essential for the public welfare, it would be better for them to provide the funds by loan than to expect the directors of a railway company, having their shareholders to consider, to spend fresh capital in gratification of their whims. The whole affair, taking place as it does in a free country, is not without a taste of mordant humour.

Cable Interruptions.	Date of Interruption.
Assab—Perim	July 8, 1909
Latakia—Palura	May 26, 1910
Zanzibar—Mombasa	July 11, 1911
Sabang—Koetaradja	Aug. 18, 1911
Kotonou—Grand Bassam	Aug. 23, 1911
Saigon—Pontianak	Aug. 23, 1911

Energy Losses in Telephony.—In an article published in the "Elektrotechnische Zeitschift," Mr. F. Breisig gives an account of some experiments undertaken by him with a view to determining the different losses in telephone apparatus. For the tests a permanent alternating current with a frequency of 800 was used. The telephone was used in the same way as it is employed in practice, namely, the receiver being taken off during speaking. The connections of the central battery system were used. It was found that, during receiving, out of the total electrical energy received 70·5 per cent. was lost in the microphone, 1·6 per cent. in the bell, 18·4 was supplied to the telephone, the loss in the primary winding being 3·4, in the secondary winding 3·4 and the losses in the other coils 2·7. The chief source of loss was in the microphone, and, since it is entirely unnecessary while receiving, it might be short-circuited at that time, but this would cause trouble on account of its high resistance. To avoid this trouble and to reduce the alternating-current impedance, a condenser of 2 mfd. was connected in parallel with the microphone when receiving. When speaking, it was disconnected by means of a simple switch. With this arrangement the above figures of losses were greatly changed. The loss in the microphone was now only 12·2 per cent., the loss in the bell 1·1, while 57·2 per cent. of the energy was delivered to the telephone and 29·6 was lost in the coil. The influence of the microphone might also be reduced successfully by using a higher number of turns for the primary coil.

Electric Tramway Regulations in New Zealand.—According to "The Times Engineering Supplement" the Government of New Zealand has made its first move towards exercising the unlimited powers of regulation of tramways that it recently obtained by the passing of an amending Tramway Act. This Act was before Parliament for three years, and in each year vigorous opposition by the municipal authorities of the country was made to it on the grounds that the present services were efficiently and successfully operated by the City Councils concerned, and that Government interference to the extent made possible by the Bill meant State management without State financial responsibility. The new law makes it possible for the Minister of Public Works to impose regulations, even to the extent of overriding authorising orders, without reference to any one; but the first batch proposed have just been referred to the municipal tramway authorities for their suggestions. Included are stringent provisions as to overcrowding, carrying passengers beyond the seating capacity of cars, and many traffic details, while car construction must be brought into conformity with the provisions now laid down. It is even decreed that portable steps must be carried on some classes of cars, and set down on the roadway when demanded by passengers. Very small scope is left to authorities in their future choice of plant, almost every item being placed on a compulsory list. One regulation stipulates that the gap on car lightning arresters shall be $\frac{1}{32}$ in., and minute directions for valves, details of sanding gear, &c., are laid down. The publication of these regulations has roused a storm of protest, ridicule, and even defiance. One Mayor describes the regulations as "a gigantic steal" intended to force the cities to hand over the tramways to the Government. The engineer of the Wellington tramways has advised his Council that it will cost that system £75,000 to comply with the regulations, that the additional annual cost will amount to £40,000 and that fares will have to be increased about 50 per cent. to meet the outlay.

Compulsory Electrification of Railways.—According to "Engineering News," the Bill which will make compulsory the electrification of the Boston railway termini is being strongly opposed by the New York, New Haven & Hartford Railroad Co. In a circular letter the Railway Company says:—

Except where use of tunnels is rendered less dangerous by use of electricity, there has been no compulsory electrification of railroads. All the electrification of the New Haven has been without compulsory legislation. The New Haven has repeatedly stated its desire and willingness to electrify. This year it proposes to electrify from Readville on the Boston & Providence and to Beverly on the Boston & Maine. Electrification of

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short distances, say 10 miles, has never been found at all economical, and a compulsory electrification within a 10-mile limit will be unusually uneconomical. Money required for electrification must be raised by the issue of new securities, and unless the money for electrification is wisely and economically expended, there will be placed upon railroad transportation a very serious charge which can only be met by increased freight and passenger rates. The best business interests of New England require these rates to be kept as low as possible, consistent with safety. It is proposed to discriminate against every other city and town of this Commonwealth in favour of the district within 10 miles of the city of Boston. It is estimated that the cost of electrification in this district will amount to approximately $40,000,000 (£8,000,000). If the railroads are called upon to make this expenditure in the city of Boston and vicinity; and if the proceeds of securities which the railroad corporations can find the public willing to purchase must be expended in this electrification, then other railroad improvements must necessarily wait. Electrification in other parts of the Commonwealth must wait because there is a limit to the amount of money which the public will invest in railroad securities. If it is understood by the investing public that the Massachusetts legislature proposes deliberately to take the management of its railroads out of the hands of the boards of directors, and to pass that management over to the State Railroad Commission, we venture to assert that investors in Massachusetts railroad securities will be much less willing to add to their investments. We especially recall to the attention of the Senate the report of the majority of the "Big Four Commission" and the statement of Prof. Geo. F. Swain before the joint committees of this legislature. We respectfully request that the judgment of 11 out of 16 members of the "Big Four Commission" be followed by the legislature; and that the management of the railroads be allowed to remain with the railroad directors, subject to the supervision, regulation and recommendation of the Board of Railroad Commisioners. We do not in this brief statement consider whether the Bill is or is not constitutional.

Railway Commission.—In connection with the serious labour trouble in the railway world, the Government have appointed a Royal Commission of five members to consider and report upon the working of the present Conciliation Boards. The members of the Commission are: Sir David Harrell, K.C.B., K.C.V.O. (chairman); Sir Thomas Ratcliffe Ellis; Mr. Arthur Henderson, M.P.; Mr. C. Gabriel Beale (Birmingham), solicitor to the Midland Railway Co., and Mr. John Burnett, formerly Labour Secretary to the Board of Trade. Mr. J. J. Willis, of the Board of Trade, is secretary to the Commission.

French Submarine Cables.—The French c.s. "François Arago," of the Société Industrielle des Téléphones, left Calais on the evening of Thursday, August 17th, to lay cables on the West African coast between Libreville-Cap Lopez and Loango Pointe Noire in the Congo region, to the order of the Ministry of the Colonies for French Equatorial Africa. The cable has been manufactured by the Société Industrielle, the core having been made at the works at Bezons. Its total length is some 300 nauts. The "François Arago" is due at Libreville early in September, and it is expected that the cables will be laid and open for traffic in October. The French Government engineer on the expedition is M. Marcel Charruau. The engineer-in-chief is M. Maurice Roussel, who has been associated with the Société for many years.

Electrically Driven Luggage Trucks.—According to the "Railway and Engineering Review" a truck driven by accumulators is being used by the Erie Railroad at Jersey City. The power for operating the truck is derived from a single storage battery consisting of two sets of 12 cells each, the capacity of which is 120 ampere-hours at 60 volts. Power is taken from the batteries through a fuse, circuit breaker and a drum-type controller, the latter being mounted in ball bearings between the two frame members. It is connected to a set of resistances, and is operated by a vertical lever moving in a vertical plane within convenient reach of the operator's left hand, through an arc of about 120 deg., giving five forward speeds and five reverse. No power can be transmitted to the controller, however, unless the foot pedal, which simultaneously releases the band brake on the jack shaft and throws in the circuit breaker, has been pushed down. The controller regulates the amount of current sent into the motor through resistances which are placed between the controller and the jack shaft. The 2½ H.P. motor is also mounted between the frame members, just behind the leading axle. The form of drive employed allows of speed changes in five steps of from 2 to 12 miles per hour, in either direction, under a load of about 2,500 lbs. on a truck 10 ft. 2 in. in length, and 42 in. wide.

Current Topics.

Subjects of current interest dealt with in this issue include the following:—

We describe a new underground electric railway in Paris—the North-South line.

At a recent meeting of the American Institute of Electrical Engineers, Mr. Bancroft Gherardi read a Paper on "The Commercial Loading of Telephone Circuits in the Bell System."

We give an abstract of a Paper read by Messrs. J. T. Morris and T. H. Langford before the Physical Society on "The Method of Constant Rate of Change of Flux as a Standard for determining Magnetisation Curves of Iron."

The British Thomson-Houston Co. are now supplying lamps in which drawn filaments are used. A description is given of the production of the new lamps at Rugby.

We analyse the accounts of the Glasgow Corporation tramway department for the year ended May 31, 1911. After allocating 2·24d. per car-mile for depreciation, £68,678 is handed over for the relief of the rates.

A description is given of the automatic telephone installation of the Illinois Tunnel Co. at Chicago.

The report of Lieut.-Col. P. G. von Donop, R.E., on the tramway accident on the Stalybridge tramways has been issued.

Some particulars are given of a scheme for the formation of a trust syndicate to control the electric lighting and traction concessions at Constantinople.

The award of the Board of Trade arbitrator, Mr. Askwith, K.C., in connection with the recent Leeds tramway dispute is given in another column.

Parliamentary.—The Royal Assent was read to a number of new Acts on Friday.

In the House of Commons on Monday Mr. Churchill was questioned as to the cause for sending soldiers to occupy the Poplar electricity works during the recent strike troubles in the East End.

On Friday the Postmaster-General stated, in reply to a question, the principles upon which the various Government Departments acted in carrying out the fair wages clause.

Companies' Reports.—The reports of the following companies are abstracted: British Continental Electricity Co., Brown, Boveri & Co., Kalgoorlie Electric Tramways and Perth (W.A.) Electric Tramways. A dividend of 7 per cent. has been declared by Brown, Boveri & Co., against 8 per cent. in 1909-10. The report deals with the condition of the electrical industry on the Continent and the problems involved in railway electrification.

OBITUARY.

THE REV. F. J. JERVIS-SMITH, F.R.S.—We regret to record the death of the Rev. Frederick John Jervis-Smith, F.R.S., which occurred at Battramsley House, Lymington, on Wednesday last. The deceased was in his 64th year. He was educated at Pembroke College Oxford, and for two years was vicar of St. John's, Taunton. Subsequently he was appointed University Lecturer in Mechanics at Oxford and Millard Lecturer in Experimental Mechanics and Engineering at Trinity College. He was a member of the Committee on Explosions at the Home Office in 1895-96, and was the inventor of several forms of dynamometers, integrators and chronographs.

S. H. BURBURY.—We also regret to have to record the death, at 80 years of age, of Mr. S. H. Burbury, F.R.S., who is best known for his work in mathematical physics. He was the joint author (with Mr. H. W. Watson) of works on "Electrostatics" and "Electrodynamics."

PERSONAL NOTE.

The German Emperor has nominated Sir W. Ramsay, K.C.B., F.R.S., professor of chemistry in University College, London, and president-elect of the British Association, to the Order Pour le Mérite, for his services to science.

APPOINTMENTS VACANT AND FILLED.

An assistant lecturer and demonstrator in physics is required at the East London College). Commencing salary £150. Particulars from Prof. C. H. Lees, or the Registrar, at the College, Mile End-road, E.

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A lecturer in the engineering department (commencing at £150 to £180 and rising to £250) and a chief assistant in the chemistry department (commencing £150 to £170 and rising to £250) are required at the Borough Polytecchnic Institute, Borough-road, London, S.E. Conditions, &c., from the principal, Mr. C. T. Millis.

A lecturer and instructor in telephony (for one evening) and a teacher of manipulative telegraphy (for two evenings per week) are required at the Wimbledon Technical Institute. Applications to the Principal, Gladstone-road, Wimbledon. See an advertisement.

An electrical engineer is wanted familiar with electrical and mechanical design of d.c. motors. Applicants must be technical graduates and read and speak English. See an advertisement.

One or two draughtsmen are wanted by a large electrical firm. Must be used to switchgear design, &c. See an advertisement.

Marconi's Wireless Telegraph Co., Watergate House, Adelphi, London, W.C., have vacancies for two electrical engineers in Spain. See advertisement.

An assistant draughtsman is required by Messrs. Harland & Wolff (Ltd.), Belfast, to prepare wiring plans and diagrams and get out quantities, &c., of installations for ships. See an advertisement,

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Mr. R. F. Pack has been appointed general manager of the Toronto Electric Light Co.

Mr. Oscar Beabey, late of the San Paulo Railway, has been appointed telegraph engineer to the Buenos Ayres Pacific Railway Co.

Mr. H. Vickers, Wolverhampton, has been appointed assistant tramways engineer at Bournemouth.

EDUCATIONAL NOTICES.

University of Sheffield.—The faculty of applied science comprises the departments of engineering, metallurgy, coal mining and architecture. The courses in engineering or in metallurgy extend over three years and prepare respectively for the degree of B.Eng. or B.Met. of the university. The lecture courses commence on Oct. 4, and the technical laboratory courses on Sept. 18. Prospectuses and other particulars from the registrar, Mr. W. M. Gibbons.

University of Durham.—Armstrong College, Newcastle-upon-Tyne.—The 1911-12 session commences Sept. 25. There are departments of mechanical, marine, civil and electrical engineering, naval architecture, mining, metallurgy, agriculture, pure science, arts and letters. Particulars may be obtained from the secretary, Mr. F. H. Pruen, M.A.

Imperial College of Science and Technology.—During the 1911-12 session an advanced course of instruction on the systematic design and manufacture of dynamo-electric machinery will be given at the City and Guilds (Engineering) College, Exhibition-road, London, S.W., under the general supervision of Prof. T. Mather, F.R.S.

The course is intended for post graduates and other fully qualified students, the number of whom will be limited. The lectures (about 45 in number) will be delivered during the first half of the session by Mr. W. E. Robson, M.I.E.E., and the practical work will commence in October and continue throughout the session. Ratings, frame sizes, windings, &c., for complete lines of machines will be considered in detail, as well as works organisation for systematic manufacture. In addition to lectures, practice in designing, estimating and drawing office work will be given, and advanced laboratory work relating to the limiting conditions existing in modern machines. Applications for admission to the Dean of the College, Exhibition-road, London, S.W.

City and Guilds Technical College.—This college provides a scientific training for students preparing to become electrical and mechanical engineers or chemists, and for engineering pupils who desire to supplement their practical training by a two years' course of instruction in the principles of engineering science. There are also arrangements for three-year courses in engineering. Particulars at the college, Leonard-street, City-road, London, E.C., or from the City and Guilds of London Institute, Gresham College, Basinghall-street, London, E.C.

Glasgow and West of Scotland Technical College.—The diploma of the college is granted in the departments of civil, electrical and mechanical engineering, mining, naval architecture, chemistry, metallurgy, mathematics and physics, building and textile manufactures. The courses of study usually extend over three sessions, and holders of the diploma are eligible for the degree of B.Sc. in engineering of the University of Glasgow, after attendance for at least one session at prescribed university classes. The laboratories are well equipped, and facilities for research are afforded in the departments of physics, electrical engineering, chemistry, metallurgy, mechanics, &c. The preliminary examination begins on Sept. 18, and names of candidates must be sent in by Sept. 1. The day classes begin Sept. 26 and the evening classes Sept. 21. Calendar (by post 1s. 4d.) and prospectuses (gratis) will be sent on application to the Director.

City of Bradford Technical College.—At this college there are full day courses qualifying for the college diploma in civil, mechanical and electrical engineering. The next session commences Sept. 18. The new power house, especially arranged for experimental and educational work, will be opened during the session, and the equipment of the electrical engineering laboratories and machine room has also been considerably extended and brought up to date. Calendar, containing particulars of all courses, on application to the director of education, Mr. A. C. Coffin.

University of Birmingham.—The session commences Oct. 2. The full courses extend over four years, and students who enter after matriculations and who pass successfully the examinations at the end of each year will be entitled to the degree of Bachelor of Science in the branch of engineering to which they devote themselves. The technical engineering classes are detailed, and a list of the professors, lecturers, &c., is given in an announcement on another page.

Northampton Polytechnic Institute, Clerkenwell, London.—The full day courses in the theory and practice of mechanical and electrical engineering, and in electro-chemistry will commence on Oct. 2, and entrance examinations will take place on Sept. 27 and 28, at which five entrance scholarships will be offered. The courses for mechanical and electrical engineering include periods spent in commercial workshops, and extend over four years, and they also prepare for the degree of B.Sc. in engineering of the University of London. There are also full and partial day courses in technical optics. Particulars from the Principal, Dr. R. Mullineux Walmsley.

University of Bristol.—Prospectuses and particulars of the faculties of arts, science, medicine and engineering (civil, mechanical, electrical and motor car) and of the secondary training department, day training colleges, evening classes, halls of residence, scholarships and bursaries will be sent on application to the registrar, Mr. James Rafter. The session in the faculty of engineering commences Sept. 15 and in faculties of arts, science and medicine on Oct. 2.

University of Liverpool.—The courses of study in the faculty of engineering, leading to the ordinary degree of B.Eng., extend over at least three years, and they are so arranged as to afford a general scientific training for those who intend to become engineers, naval architects or architects and surveyors. There is a two-years' course, leading to a certificate in engineering, for students who do not proceed to a degree, and in the honours schools students may specialise in some branch of the profession. Facilities for post-graduate and research work are also afforded in the honours schools.

South-Western Polytechnic Institute.—This institute provides a complete three-years' course, leading to a diploma or university degree, in electrical engineering. A four-years' course is held in the evening. Separate courses of lectures and practical work are given in elementary, intermediate and advanced electrical engineering, electrical design, a.c. and polyphase currents, wiring and fitting, &c. Particulars from the Secretary, Manresa-road, Chelsea, S.W.

ARRANGEMENTS FOR THE WEEK.

BRITISH ASSOCIATION.

Wednesday, August 30th.

Meeting at Portsmouth. Presidential Address by Sir Wm. Ramsay K.C.B., F.R.S.

Thursday, August 31st.

Addresses by the Presidents of the Various Sections. To Section A (Mathematical and Physical Sciences) by Prof. H. H. Turner. To Section G (Engineering) by Prof. J. H. Biles. To Section L (Educational Science) by the Right Rev. Bishop J. E. C. Welldon.

A list of the various Papers to be read during the meeting, which lasts until Wednesday, September 6, was given in our issues of July 21 (p. 572) and July 28 (p. 612). The actual days on which these Papers will be read will only be announced at the meetings.

THE LONDON ELECTRICAL ENGINEERS.

Officer Commanding, Col. H. M. Leaf.

The following orders have been issued :—

Head-quarters will be closed for instruction, but will be open for office work as under until further orders :—

Monday to Friday, 10 a.m. to 4 p.m.
Saturday, 10 a.m. to 12 noon.

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GLASGOW CORPORATION TRAMWAYS.

During the last few years the revenue of these tramways has been practically stationary, but for the year ended May 31 last the normal development seems again to have been resumed. Thus, the receipts which a year ago were £896,720, compared with £892,751 in 1908-9, have risen to £949,489, an increase of £52,769. As the working expenses only rose by £30,268 to £533,179, it will be seen that a larger profit had to be dealt with. This resulted in a greater contribution to the "Common Good," viz., £68,678 as against £53,028 in the previous year, and this Fund has now benefited to the extent of £448,466 since 1894. It may be noted that by section 30 of the Glasgow Corpn. Act, 1909, any surplus remaining after payment of working expenses, interest, sinking fund and depreciation is to be handed over to the "Common Good," to be applied at the discretion of the Corporation.

The number of car-miles run during the year was 21,704,237, compared with 20,974,016 in 1909-10, the corresponding receipts per car-mile being 10·46d. and 10·22d. respectively.

The total number of passengers was 237,967,307—an increase of 15,236,736—and the number carried at each fare was as follows :—

Fare.	Number.	Per cent
½d.	66,290,055	27·86
1st two stage	5,573,508	4·61
2nd two stage	5,398,884	
1d.	130,519,231	54·85
1½d.	19,408,739	8·15
2d.	5,879,305	2·47
2½d.	2,453,123	1·03
3d. and above	2,444,462	1·03
	237,967,307	100·00

The average number of journeys per head of population per annum was 206·9, as against 184 journeys per head of population at Manchester (*See* THE ELECTRICIAN, August 11, 1911, p. 693).

In view of the prosperity of their tramways it is not surprising that the Corporation have been able to make certain concessions to passengers. Thus, from January 1 last all children up to 15 years of age are charged half fare. Free travelling facilities are also given to all blind persons resident in the city (it is estimated that this concession will cost £550 per annum). The Corporation are also experimenting with two-stage 1½d. tickets. These entitle passengers to travel two consecutive ½d. stages on one car, and another two consecutive ½d. stages on a second car. An increased scale of wages for motormen, conductors, cleaners, labourers, &c., came into force as from June 1, 1911.

The stock of cars at May 31 was 803, whilst 50 cars are under construction. The cars at present in use comprise 621 with top covers, 71 standard cars, 110 converted horse cars and 1 school car. The Tramways Committee have decided to fit covers on all cars with the exception of the converted horse cars. The experiments with the use of vestibules having been found satisfactory, the Committee have decided to equip all the cars with a suitable vestibule in order to protect the motormen during inclement weather.

The total length of single track in operation at May 31 was 96½ miles, excluding depot connections, crossings, &c. Of this total, 2 miles were in Paisley over which the Corporation have running powers, whilst 8¾ miles are leased from the Corporation of Govan.

It is interesting to notice that the use of meters on the cars has been under consideration, and a number of meters are being installed. In this connection we may mention that the total number of units used per car-mile for traction and car lighting was 1·31, as against 1·28 in 1909-10, and 1·25 in 1908-9; the total number of units used on the cars was 28,345,441. It will be remembered that the tramway undertaking possesses its own power station, and the power expenses are stated as follows, the cost per unit being based on the number of units sent out from the power station to the sub-stations, viz., 30,298,917.

		Cost per unit sent out.
Salaries and wages	£11,425	0·09d.
Fuel	16,595	0·13d.
Oil, waste, water, &c.	2,496	0·02d.
Repairs to steam plant	2,829	0·02d.
,, electrical plant	1,679	0·01d.
,, ducts, feeders, &c.	3,663	0·03d.
,, station buildings	1,287	0·01d.
	£39,974	0·31d.
Proportion of rents, rates and taxes	£6,384	0·05d.
,, insurance	333	0·00d.
,, management	1,000	0·01d.
Depreciation	58,935	0·47d.
Interest	18,312	0·15d.
Sinking fund	22,979	0·18d.
	£147,917	1·17d

With reference to the basis on which the above figures are determined, the following particulars as to the output are of interest :—

Units generated—		
Alternating current		30,649,600
Direct current (500 volts)		813,997
Direct current (100 volts)		199,561
Total units generated		31,663,158
Used at power station		1,364,241
Total sent out to sub-stations		30,298,917
Used in sub-stations	257,517	
Used in depots, &c.	1,596,808	
Estimated loss	99,151	
Total supplied for traction load		28,345,441
Loss in conversion and transmission		1,437,791
Supplied from d.c. 'bus-bars		26,907,650
Maximum load on power station		9,100 kw.
Load factor		39·7 %
Coal per unit generated		2·88 lbs.

We give below an analysis of the Accounts for the whole tramway undertaking for the 12 months ended May 31, 1911, together with the cost per car-mile of each item. The corresponding figures per car-mile for the previous year are also included.

		Cost per car-mile. 1910-11.	1909-10.
Traffic Expenses.			
Superintendence	£5,531	0·06d.	0·06d.
Wages of motormen and conductors	191,587	2·12d.	2·14d.
,, other traffic employés	11,668	0·13d.	0·14d.
Motormen's bonus	3,096	0·03d.	0·04d.
Cleaning and oiling cars	31,657	0·35d.	0·32d.
Cleaning track	4,495	0·05d.	0·06d.
Fuel, light and water for depots	2,559	0·03d.	0·03d.
Ticket check	10,957	0·12d.	0·12d.
Uniforms	6,377	0·07d.	0·09d.
Miscellaneous	2,865	0·03d.	0·04d.
Total Traffic Expenses	£270,792	2·99d.	3·04d.
General Expenses.			
Salaries and wages	£7,444	0.08d.	0·08d.
Store expenses	961	0·01d.	0'01d.
Rents, &c.	4,160	0·05d.	0·04d.
Rates and taxes	61,025	0·68d.	0·71d.
Printing and stationery	1,985	0·02d.	0·02d.
Fuel, light and water for offices	421	0·00d.	0·01d.
Law expenses	529	0·01d.	0·00d.
Insurance	21,449	0·24d.	0·24d.
Parliamentary expenses	40	0·00d.	0·00d.
Deputation and travelling expenses	372	0·00d.	0·00d.
Miscellaneous	6,659	0·07d.	0·06d.
Total General Expenses	£105,045	1·16d.	1·17d.
Repairs and Maintenance.			
Permanent way	£55,248	0·61d.	0·46d.
Electrical equipment of line	8,368	0·09d.	0·08d.
Buildings and fixtures	6,864	0·08d.	0·05d.
Workshop tools, &c.	1,003	0·01d.	0·01d.
Cars	26,742	0·30d.	0·30d.
Electrical equipment of cars	19,450	0·21d.	0·21d.
Other rolling stock	1,768	0·02d.	0·03d.
Miscellaneous —	140	0·00d.	0·00d.
Total Repairs and Maintenance	£119,583	1·33d.	1·14d.

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		Cost per car-mile. 1910-11.	1909-10.
Power Expenses	£37,759	0·42d.	0·41d.
TOTAL WORKING EXPENSES (*ex.* capital charges, &c.)	**£533,179**	**5·90d.**	**5·76d.**
Capital Charges, &c.			
Rental of leased lines	£10,027	0·11d.	0·11d.
Interest	75,168	0·83d.	0·83d.
Sinking fund	89,794	0·99d.	0·97d.
Income tax	13,492	0·15d.	0·18d.
Parliamentary expenses ("Common Good")	15	0·00d.	0·02d.
Depreciation and renewals	202,579	2·24d.	2·22d.
Total Capital Charges, &c.	**£391,075**	**4·32d.**	**4·33d.**
TOTAL EXPENSES (*inc.* capital charges)	**£924,254**	**10·22d.**	**10·09d.**
Revenue.			
Traffic revenue	£946,021	10·46d.	10·23d.
Rents and dues	2,854	0·03d.	0·03d.
Sale of electrical energy	613	0·01d.	0·01d.
Interest on investments	43,214	0·48d.	0·43d.
Lines rented to Dumbarton Tramways	230	0·00d.	0·00d.
TOTAL REVENUE	**£992,932**	**10·98d.**	**10·70d.**
Balance	£68,678	0·76d.	0·61d.

This surplus, as mentioned above, goes to the "Common Good."

A feature of the Accounts is the large contribution for depreciation and renewals. The method on which this sum is arrived at was given in our analysis of last year's Accounts (THE ELECTRICIAN, November 4, 1910). The Depreciation and Permanent Way Renewals Fund now stands at £1,702,915, whilst the General Reserve Fund balance is £50,832.

The gross capital expenditure at May 31, 1911, was £3,921,407. Of this total, £2,121,147 had been written off and set aside for depreciation at that date. The various items comprised in the above expenditure are as follows :—

	Gross amount.	Net amount.
Permanent way	£1,104,791	£562,860
Electrical equipment of line	722,324	403,809
Ground	168,497	165,751
Buildings, &c.	557,719	293,232
Power station and sub-station plant	459,971	168,680
Tools, &c.	37,896	10,177
Electric cars	507,660	181,285
Horse cars	54,192	—
Horses	250,786	1,636
Other rolling stock	16,189	5,256
Office furniture	6,593	329
Lease of Govan and Ibrox Tramways	4,057	3,011
Miscellaneous	30,731	4,233
	£3,921,406	£1,800,259

THE DEVELOPMENT OF THE METALLIC FILAMENT.*

BY DR. MONASCH.

The first tungsten lamp was exhibited in Germany at the annual meeting of the Verband Deutscher Elektrotechniker in May, 1906. It was at once seen that a great change was impending, though the new lamp had at that time many obvious defects ; among these were its fragility, its cost, and the fact that the smallest size that was then possible was too large for domestic purposes. Thus the 40 c.p. lamp for 110 volts was composed of long loose loops, which had to be maintained in a vertical position, and which were little adapted to withstand the rough usage of transport.

New ideas are generally regarded with suspicion ; but in this instance the reverse was the case, and countless persons busied themselves with the problem of turning out a marketable product that should take 1·1 watts per candle-power, and should burn for 1,000 hours ; factories which had hitherto turned out carbon filaments took the matter in hand, and many competitors arose, starting with much too little capital, many of whom have since disappeared. All sorts of fancy trade names began to be attached to the various products ; and for 100 volts, lamps are now to be had ranging from 16 to 1,000 c.p. and a very nearly similar range for 250 volts. All these lamps can be suspended in any position ; but mechanically they are, of course, not so strong as the old carbon filaments, since they are much longer and thinner, and at the same time made of a more brittle substance. Still, cases are known where these lamps are giving satisfaction even when exposed to regular periodic shocks or vibrations.

Naturally enough the problems to be solved were very difficult. Apart from the construction of the filament itself, most of the questions that arose were of a mechanical nature. Instead of a series of freely hanging loops, it was soon found advisable to anchor them at various points. The materials of which these anchors were to be composed led to an exhaustive test of almost every substance under the sun. Gradually a sort of normal construction became more or less standardised, with short loops, a kind of springy grip, and a central glass support for the whole.

In 1906 there were general complaints that 16 c.p. lamps seemed out of the question, but these were put on the market for 110 volts in 1909, and there seems nothing in principle to prevent the manufacture of similar lamps for 10 c.p. But the makers take little interest in the latter problem, partly because the sphere of usefulness of such lamps is actually very limited, and partly because the demand for the higher powers is so great that there is some little difficulty in meeting it. When lamps took 3·5 watts per candle-power, the 10 c.p. lamp may have been needed ; but they were generally used in places where they were very infrequently alight, and took more current than a 25 c.p. tungsten lamp, which has to all intents replaced it. An increasing desire for comfort makes one desire to see clearly rather than dimly, and it is nearly time for the total abolition of the 10 c.p. lamp, which hardly suits modern requirements and possibilities.

On the other hand, the tungsten lamp has invaded the sphere of the arc lamp. Normally carbon lamps were made up to 50 c.p. A lamp giving 100 c.p. would take 350 watts, which is as much as a 6-ampere arc lamp. But with 1-watt lamps things are quite different. Remané showed at Erfurt that the high candle-power tungsten lamps were more economical than open alternate-current arc lamps. With direct current they were superior to those of the Jandus type taking three amperes, but with larger currents the advantage lay with the arc lamp. In spite of this, the tungsten lamp has in the course of time displaced many an arc lamp owing to the ease with which it can be used ; there is no need for attendance, no store of carbons has to be kept, and there is no regulating mechanism to get out of order. It can therefore be said that the tungsten lamp is used up to 1,000 c.p. nowadays, while anything beyond this is allotted to the arc lamp.

In the practical application of the lamp, many curious phenomena were observed. If considerable groups of lamps were switched on at once, the fuses often blew without any apparent reason. The oscillograph, however, showed that at the moment of starting, the tungsten lamp takes seven or eight times as much current as the normal, while the tantalum lamp takes four or six times, and the carbon lamp only 0·7 times the normal current. This is, of course, explained by facts relating to the resistances of the filament when cold and hot, the newer lamps having the ordinary properties of metals. The tantalum lamp is made of a drawn wire, and its peculiarities on alternating current are well known ; inter-molecular actions go on, the wire becomes crystalline, the molecules become displaced with regard to one another, and the whole shape of the wire becomes irregular. It was supposed in the first instance that the same thing would happen with the tungsten lamp. But this has not turned out to be the case. Tungsten lamps are composed of sintered particles, and experience has shown that if the filaments are properly anchored, they are capable of burning for 2,000 hours on alternating current. There is therefore practically little difference between alternating and direct current. Lately tungsten lamps have been made in America out of a drawn tungsten wire, and this type of lamp certainly shows the same peculiarities as the tantalum lamp, and the same changes of molecular structure on alternating current.

On alternating current there are other effects that are certainly very apt to be fatal to the lamps. An increase of voltage is very injurious, and shocks due to variations of voltage may destroy a lamp at once. Kinsloe has lately investigated some matters in regard to this. He examined the influence of the shape of the voltage-wave on the life and specific efficiency of the lamp. It has usually been assumed that the candle-power, efficiency, and life of the lamps depend on the mean effective value of the voltage, and are independent of its maximum value. Kinsloe ran a number of lamps on 110 volts, with a sine-wave, giving a maximum of 155 ; and others, also on 110 volts, with a very peaked wave which had a maximum of 174. He found that the carbon, tantalum and tungsten lamps had shorter lives and lower candle-power on the peaky voltage, and microscopic examination showed a greater tendency in this case to changes of structure and to become brittle. These results seem very important, and it is much to be desired that they should be further examined by other experimenters.

* Abstract of an article in the "Elektrotechnische Zeitschrift."

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Another question relating to the use of tungsten lamps on alternating current is not without interest, and this is whether they can be used with a frequency of 25. A carbon lamp burns well without flickering under these conditions, and a frequency of 25 is gradually coming into extended use on railways. American investigators report that a 25 c.p. metal lamp flickers intolerably on 110 volts with this frequency; with a frequency of 40, there is still a notable flicker, which however disappears with a 50 c.p. lamp. This result is naturally to be expected, for the higher the candle-power, the thicker the filament becomes and the greater is its heat capacity; it will therefore cool more slowly during the fluctuations of the current, and its light will be more steady. Merrill has found that there is a critical frequency at which flickering begins, and this critical frequency can be considered to be a function of the product of the mean illumination and of the percentage variation of the illumination. The question as to whether a lamp flickers depends therefore largely on the mean value of the illumination. If we want to judge the flickering of lamps on a given low frequency, and concentrate our attention on any considerable surface illuminated by the light, the flickering always appears less if the distance between the lamp and the illuminated surface is increased, till finally, with a dim kind of lighted surface, the flickering seems entirely to disappear. This is due to some peculiar property of the eye, and might make it possible to use tungsten lamps on a low frequency, provided the illumination required on any particular surface is not high.

THE COMMERCIAL LOADING OF TELEPHONE CIRCUITS IN THE BELL SYSTEM.*

BY BANCROFT GHERARDI.

Summary.—The author first describes the method of loading underground telephone cables and the precautions necessary to minimise losses. He then refers to the New York–Philadelphia cable with heavy loading, and the results that have been obtained. Overhead lines are next considered, and finally the loading of submarine cables.

Before describing some of the practical applications of loading to open-wire lines and cables, the author mentions briefly the results of the fundamental work on this question.

The problem of loading underground cables is as a whole easier than that of loading open-wire lines and is, therefore, first discussed. At the present time we are making very general use of two styles of

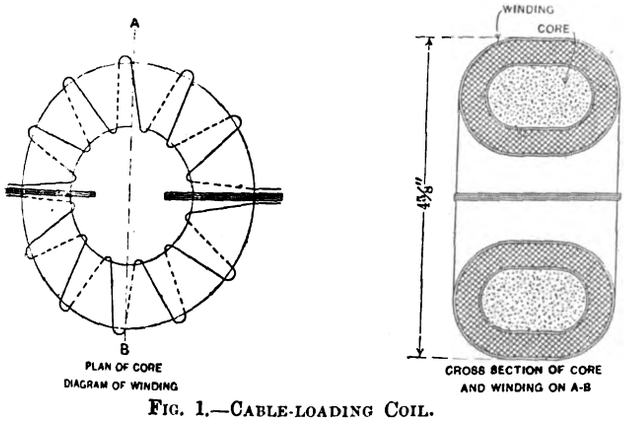

FIG. 1.—CABLE-LOADING COIL.

loading for telephone cables, one of which is characterised as "medium" loading and the other "heavy" loading. In a few cases a third style of loading, known as "light" loading, is employed. These three styles of loading differ in the amount of inductance placed upon the lines, and hence in the improvement in transmission obtained from the loading. The heavy loading, as the term would suggest, places the greatest amount of inductance on the line and requires coils placed at closer intervals. This heavy loading employs about 0·2 henry per mile and the spacing between coils is about 1¼ miles; medium loading provides 0·1 henry per mile with the coil spacing of about 1¾ miles; light loading employs 0·05 henry per mile with a spacing of about 2½ miles. The coils of these various loadings are made up on similar cores, so that the coils differ only in reference to the windings placed thereon.

A description of the coil employed for medium loading and the method of applying it to the lines is as follows:—The coil is of the toroidal type, that is, it has an iron core like a ring. Fig. 1 shows a cable coil. The coil is made up of very fine iron wires. Two copper windings are placed on the core, one to go on each side of the line. These windings are also indicated in Fig. 2 which shows the way the coils are connected in to the line. The windings magnetise the core in the same direction, that is, the mutual induction is added to the self-induction. Over these windings there is placed a layer of tape for mechanical protection, and the whole coil is then thoroughly dried and immersed in compound to keep out moisture.

Before leaving the design of the coil it is interesting to consider the precautions which are taken to reduce losses in it. The first loss to be considered is a dissipation loss resulting from the resistance of the copper winding of the loading coil itself. This loss cannot be entirely eliminated, but it may be reduced as much as may be desired by increasing the cross-section of the winding. There are, however, practical limits to this, as the increase in the size of the winding increases all the mechanical dimensions of the coil and also tends to increase certain other losses. A second possible loss in loading coils may also develop in the copper winding. If the cross-section of the conductor used for winding the coil is large, eddy currents may form within the conductor itself and these would produce substantial losses. Practically this factor is small in cable loading coils, but in open-wire coils where a conductor of greater cross-section must be employed it has been found necessary to strand this conductor and to insulate the various strands from each other.

In the iron core of the loading coil there are also several possible losses. In the first place, there is the hysteresis loss. After a great deal of work it has been found practicable to obtain special grades of iron which, when worked within certain limits of magnetisation, are substantially free from hysteresis losses. This at once imposes a limitation on the design of the loading coil and affects the proportioning of all of its parts.

Another loss which may take place in the core of a loading coil is that due to eddy or Foucault currents which may develop in the material of the core itself. In the case of loading coils it has been necessary to construct the cores of extremely fine wire and to coat this wire with a film of insulating material.

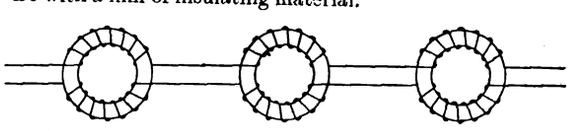

FIG. 2.—DIAGRAM OF LOADING COIL WINDINGS AND METHOD OF CONNECTING INTO A LINE.

Certain other losses also must be guarded against. If a loading coil when magnetised gave an external magnetic field and there were any conducting materials in this field, eddy currents would be produced in this conducting field and would represent a loss of energy through the circuit. Similarly, if there were any iron or other magnetic substances in this field there would be likely to be hysteresis losses in this iron. These losses have been guarded against by adopting the toroidal form of coil already described and placing the windings on it in such a manner that practically no external magnetic field is in any case produced. The designing of loading coils in this manner has not only eliminated external losses but makes it possible to place loading coils in close proximity to each other without introducing cross talk between the circuits involved.

The direct current resistance of the medium-loading coil is about 4 ohms. The alternating current resistance of this coil at a frequency of about 800 periods a second is about nine ohms. This relatively small increase of resistance at such a high frequency is a good indication of the skilful design and careful manufacture of these coils.

The results obtained by applying medium loading to No. 19 B. & S. gauge underground cable, having a capacity of about 0·070mfd. per mile, are shown in Fig. 3. In this figure is also shown the transmission efficiency of the unloaded cable. These transmission efficiences are measured in terms of what we call standard No. 19 gauge cable. This standard is cable having a resistance of 88 ohms per loop mile and a mutual capacity of 0·054 mfd. per mile.

The efficiencies of the loaded circuits, shown in Fig. 3, are those obtained with sub-station instruments located directly at the ends of the loaded circuits. One curve is given showing the results obtained by the use of terminal transformers and the other without the use of such devices. These curves bring out clearly a peculiarity of loaded circuits which should be considered at this point. The loading of a circuit, either underground or aerial, brings in at the ends of the loaded circuit, whether the circuit is connected directly to sub-station instruments or to unloaded circuits, an effect which we have called reflection losses. That is to say, at the ends of the loaded circuit there are certain losses which take place which are substantially independent of the length of the loaded circuit involved. These losses as between loaded and unloaded circuits are dependent upon

* Abstract of a Paper read before the American Institute of Electrical Engineers.

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the relative electrical characteristics of the loaded and unloaded circuits. In the case of sub-station instruments, connected directly to the ends of a loaded circuit, the terminal losses are dependent upon the relative electrical characteristics of the sub-station instrument and of the loaded line. Terminal or reflection losses, of course, also exist between unloaded lines of different characteristics, for instance, as between unloaded underground cable and unloaded aerial lines. They would also be found between sub-station instruments and unloaded lines of various kinds. In all these cases, however, they are small in magnitude and it is only in the case of loaded lines that they assume such proportions that they must be given consideration in connection with general engineering.

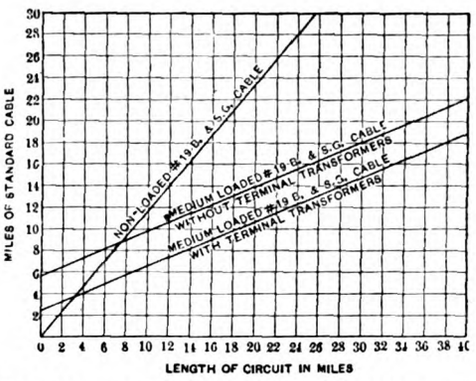

FIG. 3.—EFFICIENCY OF NO. 19 B. & S. GAUGE CABLE, UNLOADED AND MEDIUM LOADED, WITH SUB-STATION APPARATUS LOCATED DIRECTLY AT THE ENDS OF THE CIRCUITS.

I have been speaking of the terminal losses observed in connection with loading as though they pertained particularly to the loaded line. It has been convenient so to speak of them, but, of course, they actually pertain to the combination of loaded lines with unloaded lines or standard sub-station equipment, and properly are no more associated with one than with the other, but rather result from a combination of the two.

Various devices have been successfully employed to reduce terminal losses, although no plan has been worked out which would completely eliminate them. The plan used most successfully to-day for eliminating terminal losses is a device known as a terminal transformer. This is a transformer or repeating coil which differs from the standard telephone repeating coil in that there are more turns on one winding than on the other. It is used in the same

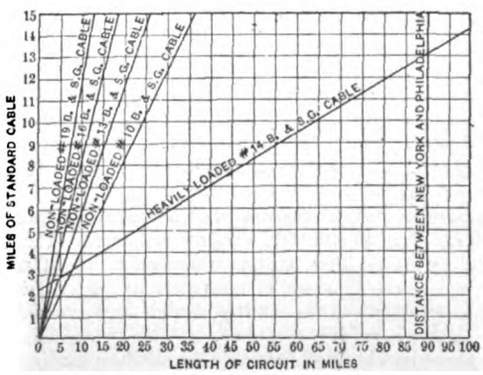

FIG. 4.—EFFICIENCY OF NO. 14 B. & S. GAUGE CABLE WITH HEAVY LOADING (NEW YORK–PHILADELPHIA CABLE); TERMINAL LOSSES WITH TERMINAL TRANSFORMERS AND ONE MILE LOOP; ALSO UNLOADED CABLES OF VARIOUS GAUGES.

way as an ordinary transformer in electric light practice, the high potential side being connected with the loaded line and the low potential side with the unloaded line. For ordinary conditions of loading the ratio of the two windings is usually either 1 : 1·4 or 1 : 2. The effect of the terminal transformer in reducing terminal losses is well shown in Fig. 3. The terminal loss for the two ends of a medium loaded line without terminal transformers is about 5·75 miles of standard cable. With terminal transformers this is reduced to 2·5 miles. These figures are for cases where the telephone sub-station apparatus is located directly at the ends of the loaded line. Where, between the loaded line and the sub-station apparatus, there is a length of unloaded line it is found that terminal losses are not so great as if the terminal apparatus were directly at the ends of the loaded line.

While terminal losses are substantially independent of the length of the loaded line, they are affected by the character of the loading of the line. The heavier the loading the greater the reflection losses. While with medium loading the reflection losses, with no unloaded cable at the ends of the circuit are 5·75 miles without terminal transformers and 2·5 miles with terminal transformers, the corresponding figures for heavy loading are 7·8 miles and 3·5 miles. These figures are, of course, reduced as in the case of medium loading, by having unloaded cable at the ends of the loaded circuit.

If it were not for these terminal losses it would be practicable, theoretically at any rate, to increase indefinitely the efficiency of a 19 gauge circuit by adding more and more inductance to it. Even without terminal losses, however, this could not practically be done, because more and more loading coils would have to be added as more inductance was added, and these would in turn bring in larger and larger losses, until finally the further gains from adding inductance would be offset or more than offset by coil losses. The increasing effect of leakage as the weight of loading is increased also has a limiting effect. Aside from these effects, terminal losses, which increase as the amount of inductance added to the circuit is increased, place a limitation beyond which it is not advantageous to increase the amount of loading on the circuits.

For underground circuits requiring a greater transmission efficiency than can be obtained by the use of heavily loaded 19 gauge cable circuits, it has been found best, all things considered, to employ a larger gauge of wire rather than to load more heavily. Many cables containing 16, 14, and 13 B. & S. gauge conductors have been laid and loaded.

The most interesting existing cable containing large gauge conductors is the New York–Philadelphia cable which was laid several years ago between these two points in order to provide additional circuits and to insure the service against storm damage. Most of the circuits in this cable are 14 B. & S. gauge and they are heavily loaded. That is, there is 0·2 henry per mile added to the cable

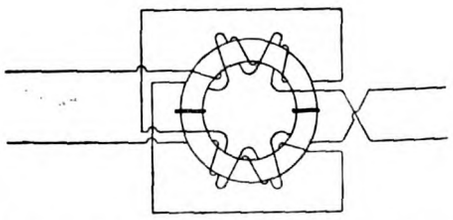

FIG. 5.—DIAGRAM OF WINDING OF LOADING COIL FOR CIRCUITS FORMING THE SIDES OF PHANTOM.

circuits by means of loading coils. The results obtained on these circuits are given in Fig. 4, assuming average terminal conditions. The results obtained by this loading are most satisfactory. The distance between New York and Philadelphia, following the route of the cable, is 90 miles. It will be seen that for this distance the circuits have an efficiency of 13 miles of standard cable. If unloaded, these circuits would have an efficiency of about 60 miles of standard cable. Over such circuits no commercial service could be given between New York and Philadelphia.

While this New York–Philadelphia cable represents the longest loaded underground cable to-day in use anywhere in the world, a project has been approved and is now under way which will far surpass it. This project is for an underground cable extending between New York and Washington in one direction and New York and Boston in the other. The largest conductors in this cable will be No. 10 B. & S. gauge and by means of loading we confidently expect that we will be able to obtain thoroughly satisfactorily results between New York and either Boston or Washington, and that it will even be possible to obtain service through this cable between Washington and Boston should storm-damage to the open wire lines render this necessary. The loading of this cable will be of particular interest as it will represent the first large application of the phantoming of loaded cable circuits and the loading of phantom cable circuits. In order to accomplish these results it is necessary to adopt special arrangements of the windings of the loading coils. The windings on the loading coil used for loading the side circuits are arranged as shown in Fig. 5. With this arrangement of winding, the effect of the telephone current in the side circuit, which current flows in opposite directions in the two sides of the circuit, is to magnetise the core of the loading coil in the same direction throughout and to produce no consequent poles. The loading coil thus acts, in so far as the side circuit is concerned, exactly like the loading coil with

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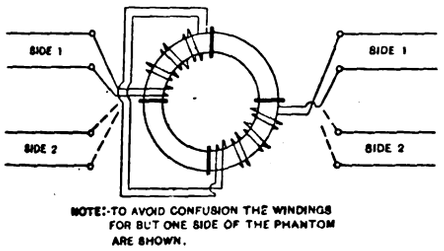
the simple winding shown in Figs. 1 & 2. In building up a phantom circuit this side circuit, however, becomes one side of the phantom, and the telephone current in the phantom circuit traverses the two wires of the side circuit in parallel. Such a current flowing through the windings of such loading coils as are shown in Figs. 1 and 2 would magnetise the two sides of the core in opposite directions and produce consequent poles at the two sides of the core. This would not only bring in serious losses, but also cross talk which would be very difficult to deal with. The current in the phantom circuit flowing through a coil with windings on it as shown in Fig. 5 does not magnetise the loading coil at all, as each winding is neutralised by a corresponding winding on the other side of the line. Such coils may be used effectively to load the side circuits of a phantom combination and in as far as the phantom itself is concerned they act only as resistance which is very small in amount. This, however, does not load the phantom circuit, which of course is a desirable result to attain. To load the phantom circuit a coil with windings as shown in Fig. 6 is employed. It will be seen by tracing out the winding of this coil that to the current flowing in the phantom circuit it acts like an ordinary loading coil, that is, all windings magnetise the core in the same direction. To currents flowing in either side of the side circuits, however, it acts only as dead resistance. The arrangements described above in connection with the application of loading coils to phantom circuits and to the side circuits of phantom circuits have been successfully applied to open-wire lines as well as to underground cables.

Loading Open Wire Lines.—Gratifying as have been the results obtained from the use of loading on underground cables, its application to open-wire circuits has also resulted in most noteworthy improvements in their efficiency. The general plan of loading open-wire circuits is similar to that used on underground cable wires. On account of the differences in the electrical characteristics of open-wire circuits, as compared with cable circuits, however, the design and spacing of the loading coils is materially different from the coils and the spacings used on the underground cables. In general,



IG. 6.—DIAGRAM OF WINDING OF LOADING COIL FOR USE ON PHANTOM CIRCUITS.

ly heavy loading is used on open-wire lines on account of the reater length of these lines. The coils themselves are substantially rger than those employed on cable circuits for two reasons—in the st place the coil is subject to damage by lightning. In order to inimise this difficulty the coils must be built to have high break-wn strengths against lightning discharges. All aerial coils are ilt so that they will stand a breakdown test of 8,000 volts. This, course, considerably increases the size of the coil. The coil is rther increased in size by the fact that, as an aerial circuit is initially good deal more efficient than an underground circuit, it is neces-ry that the coils used in loading it should have smaller losses than re permissible in underground cable loading coils. The outside ameter of the aerial loading coil is about 10 inches and the resistance the two windings of the coil to direct current is 2·5 ohm, while to ternating currents of a frequency of 800 periods a second it is 5 ohm. In addition to building the coil so that it has a breakdown rength of 8,000 volts, each coil is protected by a pair of lightning resters adjusted to operate at 3,500 volts. These precautions ve proved sufficient to reduce trouble from lightning on aerial ading coils to a negligible amount.

Low insulation which is sometimes encountered on open-wire lines, rticularly in periods of bad weather, proved at the start a serious fficulty in connection with the loading of open-wire lines. This, owever, has been overcome by removing the worst causes of low sulation and in some cases by the use of improved insulators, and the present time low insulation is not proving a serious factor in nnection with the application of loading to overhead lines.

In connection with the loading of open-wire lines the problem arranging them so that they will be free from substantial cross lk has required attention. Due to the fact that much of the oss-talk disturbances in telephony are from electrostatic induction is to be expected, and it is found in practice, that the loading of a circuit increases its tendency to cross talk. In the early applications of loading to open-wire lines some trouble was experienced from cross talk and special transposition systems were devised to overcome these difficulties, and it was further found necessary to locate the loading coils with special reference to the transpositions. On underground cables it has been found that loading also increases the cross talk somewhat, and in these we arrange to reduce the capacity unbalances in order to reduce cross talk to a sufficiently low point.

The loading coils for use on open-wire circuits are placed in individual cast-iron cases and these are placed on the poles or crossarms. The line is carried to the loading coil by means of bridle wire. The lightning arrester is placed in a separate case and bridle wire is also extended to it.

The results obtained by the use of loading coils on the No. 8 B.W. and No. 12 N. B. S. gauge wires, which are the standard sizes used in the long distance plant of the Bell system, are shown in Fig. 7, in which for the purpose of comparison the efficiencies of the unloaded circuits are also given. This diagram shows terminal losses with the conditions which may be considered as average. The general reflection loss problem with overhead lines is the same as with underground cables, and has been discussed above. As will be seen from Fig. 7, the results obtained from loading open-wire lines have been more than to double their transmission efficiency when used in considerable lengths.

One of the very valuable results which has followed from the loading of open-wire lines has been that it has made a very substantial extension to the distance over which long distance service can be given. Up to the time that loading was successfully applied to No. 8 B. W. G. wires, about 1,000 miles represented the greatest distances over which commercial service was maintained. By the

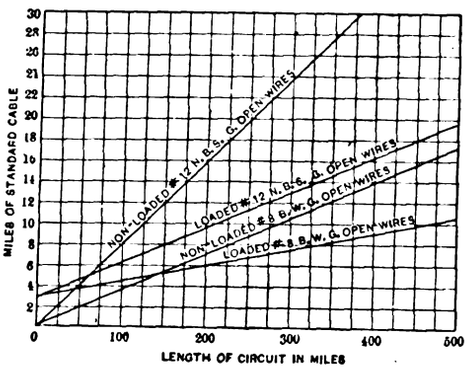


FIG. 7.—EFFICIENCY OF NO. 8 B.W.G. AND NO. 12 N.B.S.G. OPEN WIRE LINES, LOADED AND UNLOADED, WITH AVERAGE TERMINAL CONDITIONS.

loading of No. 8 circuits this has just been extended to 2,000 miles, so that to-day it is practicable to obtain a successful telephone conversation from New York to Denver. The actual distance between these two points by the route which the line follows is 2,010 miles.

A very important use has been made of loaded cables in bringing loaded open wire lines into large cities. Loaded cables have also been used to bring unloaded open-wire lines into thickly settled communities, but in this case the gains have not been so great because it is not practicable to place terminal transformers for reducing the reflection losses between the outer end of the underground cable circuits and the aerial lines, and hence reflection losses are experienced.

This practical impossibility of placing reflection reducing devices between open wire and cable has also made it impossible to obtain the full benefits from loading in those cases where short stretches of cable are placed in the middle of toll lines—*e.g.*, in communities where the appearance of the open wires is objected to and requests are made to place them underground.

Loading of Submarine Cables.—The problem of loading submarine cables is a mechanical one rather than one concerning the principles of loading. In this country a 16 B. S. & G. dry core paper submarine cable about 5 miles long and containing loading coils spaced about 2 miles apart has been successfully laid across Chesapeake Bay and is now in operation. There has also been talk of laying a dry core loaded submarine cable across Puget Sound for a distance of 16 miles. The situation in the United States, however, is not such that large numbers of loadeed submarine cables of any great length are required. Abroad, however, particularly between England and the continent and between England and Ireland, submarine cables of considerable length are needed for telephone purposes and in these situations loaded gutta-percha submarine cables have been employed with successful results.

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Extent of Loading.—Although the loading art was born in 1900, and its successful commercial application on an extensive scale to our plant dates only from about 1903, there are already in the United States over 85,000 miles of loaded open-wire circuits and over 170,000 miles of loaded underground cable circuits.

Thus, the year 1900, in which the loading patents were issued to Prof. Pupin, marked the beginning of an important era in telephone work. I do not know of any problem in electrical science and electrical engineering which has required greater skill, technical ability and diligence on the part of those engaged in its solution, than has the working-out and the application of loading.

ELECTRIC STEEL PROCESSES AS COMPETITORS OF THE BESSEMER AND OPEN HEARTH.*

BY A. E. GREENE.

Electric furnace processes in steel manufacture have heretofore been largely used for the production of high-grade steel, and have not been considered competitors of the Bessemer and open-hearth processes for making ordinary grades of steel. The object of this Paper is to discuss certain characteristics of the processes commonly employed for making ordinary steel, and thus to lead up to the consideration of a new electric-furnace process which, by reason of improved economy of metal, bids fair to take a place of prominence in the development of a successful competitor to the Bessemer and open-hearth processes. The characteristics of these old processes to which attention is particularly called are the unavoidable losses of metal incident to such steel processes and the chemical reactions responsible for the great losses that occur. For instance in the Bessemer process alone in the United States, the loss of metal by undesired oxidation, vaporisation, &c., amounts according to some authorities, to half a million tons per annum, assuming a total production of ten million tons of Bessemer steel.

The chief advantage of the electric furnace does not consist simply in its ability to produce extremely high temperatures, but rather in the fact that it provides a means of maintaining a charge at any given temperature, thereby enabling one to control the composition of the atmosphere at will. This control enables us to accomplish hitherto unthought-of results. In this connection it will be of interest to consider for a moment the meaning of the term "neutral" as commonly applied to the atmosphere within furnaces in general, including electric furnaces. "Neutral" means inactive. But the atmosphere if of proper composition may react in such a way as greatly to aid a metallurgical process; for instance, the atmosphere in a steel-producing furnace might be reducing toward iron oxide and prevent the steel from oxidising; or it might be oxidising toward carbon or phosphorus and thereby eliminate them. Now, it is a most interesting fact that we can have an atmosphere which is reducing with respect to iron oxide and nevertheless oxidising toward carbon or toward phosphorus. The principle underlying that fact is the basis of a new process for oxidising carbon out of iron without oxidising the metal itself. The conditions under which such reactions might theoretically be carried out are well worth considering. If molten pig iron be placed in a closed crucible, made of magnesite for instance, and kept at a uniform high temperature, and the space above the iron in the closed crucible filled with CO_2 gas, the gas and iron will react and finally come to a state of equilibrium. The reaction might be represented as follows:

$$CO_2 + Fe = FeO + CO.$$

Under the equilibrium conditions which would be reached the ratio of the amounts of the two gases present would have a given value for the particular temperature. If we then replace the mixture of these two gases by another mixture containing relatively more CO and less CO_2 than the equilibrium mixture, and allow this new mixture to react with the iron and the iron oxide, some of the FeO would be reduced and the CO_2 component of the gas increased. This replacement could be made continuous by successive introductions of the new mixture. In this way reduction of iron oxide could be carried practically to completion, and moreover, this could be done by means of a gas containing an oxidising agent for carbon.

This was the theory on which the American Electric Smelting and Engineering Co. started in its experiments several years ago to develop a practical process for converting pig iron into steel and refining it without oxidising the iron and other valuable constituent metals. An extensive series of experiments has been carried out. The first experiments were made in small, electrically-heated magnesite crucibles, holding only a few pounds at a charge. Pig iron and various other metals were treated at different temperatures with various mixtures of oxidising and reducing gases for the purpose of ascertaining what ratio of reducing gas must be present to prevent oxidation. Almost pure CO_2 gas was used in some instances, and CO gas in others, and then various mixtures of such gases. It was found that a wide range of composition would still accomplish the desired results. It was found that producer gas might easily be made to serve the purpose, and that a producer gas containing as little as 4 per cent. of CO and as much as 15 per cent. of CO_2 would, when blown into molten pig iron at a temperature of about 1,450°C., eliminate the carbon with practically no oxidation of iron, manganese or silicon.

The process consists in providing in a 300-lb. induction furnace a bath of molten low-phosphorus pig iron containing, for example, the usual proportion of manganese, silicon and carbon. The charge preferably contains sufficient manganese and silicon to meet slightly more than the specification for the particular steel to be made. The temperature of the bath is raised to something over 1,425°C., which is maintained by the electric heating, while a gaseous mixture containing CO and CO_2 is blown into the metal in much the same way as air is blown into a Tropenas converter. This mixture may contain 12 to 18 per cent. of CO_2 and 5 per cent. or more of CO.

The rate of elimination is a little slower than with the Bessemer process for the same rate of blowing, but it was found that the gas could be blown into the metal without any formation of slag on the surface of the metal, and without any boiling. If an oxide slag had formed before the blow, as might happen when rusty scrap was melted to make up the charge, it was possible practically to completely reduce this iron oxide during the blow simultaneously with the removal of carbon. In this small furnace pig iron can be converted into steel with as small a loss of iron, manganese and silicon as 2·5 per cent., including losses in charging and spills in handling the steel. In view of the difficulty of handling molten steel in such small quantities as only 200 lb. without losing a few pounds this loss seems extremely low. In small Bessemer vessels holding as little as 300 lb. the loss of metal is said to be not less than 20 per cent., apart from the loss of weight by oxidation of carbon.

The most convincing evidence that oxidation does not take place in the process may be found in connection with the loss of manganese. In converting a 13·4 per cent. spiegel into manganese steel, we have done this without any additions of any kind, and have produced a steel containing over 12·5 per cent. manganese, and this was without the use of a slag to prevent vaporisation. The carbon was reduced from over 4 per cent. to 1·2 per cent. In later tests, using a lime slag, the vaporisation loss has been further diminished, and no difficulty is found in obtaining very low carbon manganese steel. The process can also be applied to making manganese steel from pig iron and manganese steel scrap. The power consumption need not be more than 500 kw.-hours per ton, and at a cost of 0·5d. per kilowatt-hour, the power cost would not amount to more than £1 per ton. The value of the manganese which can be saved is considerably in excess of this. Such application of the process as just described is suitable for utilising any kind of alloy steel scrap such as armour plate and tool steel scrap, not only cutting down losses and additions, but producing a higher grade of product.

The process described above for oxidising carbon without oxidising iron is similarly applicable to the removal of phosphorus. It is found that phosphorus can be oxidised out of iron and kept out by means of lime. This can be done with practically no oxidation of iron and manganese. It has been done at pig iron melting temperatures below 1,350°C. without oxidising the carbon, and at high temperatures, above 1,500°C., and up to 1,900°C. after the carbon has been oxidised. And beside the sulphur can be taken up and held in the same slag that holds the phosphorus. This action is attributed to the absence of oxide of iron in the slag.

A low-grade pig iron has been converted into a high-quality steel in one continuous operation in this way, taking out the carbon without oxidation of the iron and manganese and then, with a lime slag on top of the metal, by continuing the blow of the gaseous mixture, the phosphorus has been oxidised and eliminated. The phosphorus was found combined with the lime as calcium-phosphate, and practically all the sulphur was found in the slag as calcium-sulphide. Such a conversion of molten pig iron into refined molten steel has been carried out as just outlined in less than 30 minutes, which indicates that the reaction takes place quite rapidly and that the problem of installing the process in large vessels of 10 or more tons capacity is a mechanical one of getting the gas into the metal.

It may be of interest to compare the operation of making steel castings in a small plant using a side-blown Bessemer converter and in one fitted with an electric converter using the process described in this Paper. In the Bessemer plant, molten low-phosphorus pig iron is poured into the converter and blown until the carbon is practically out. The vessel is acid-lined and no phosphorus or sulphur can be

*Abstract of a Paper read before the American Electrochemical Society.

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removed, so that the highest quality of iron must be used. This grade of iron usually contains about 2 per cent. of silicon and 0·5 to 1 per cent. of manganese. As already stated the total loss of weight during the conversion often averages 18 per cent., and as much as 12 or 13 per cent. of metallic iron may be oxidised. In a small plant recarbonising and deoxidising is usually done by adding ferro-manganese and ferro-silicon in the ladle, and even in this part of the process there is a further loss due to the oxidation of these alloys in entering the steel.

To get some idea of the value of the metal lost by oxidation, consider a small plant making, say, 20 tons of castings per day from 32 tons of molten steel and converting about 39 tons of molten pig iron per day to make the 32 tons of molten steel. Of the 7 tons loss, about 5 tons is metallic iron. The loss per year of 300 days would be 1,500 tons. If this metal had been saved as steel its value, at £6 per ton, would be £9,000. Such a loss is clear waste. Besides the iron there are other losses. Suppose the specifications require 0·60 per cent. of manganese; the cost of the 80 per cent. ferro-manganese required to give 0·60 per cent. manganese in the steel might easily be 1s. 10½d. per ton of steel or £864 per year. Practically one-third of the weight of ferro-manganese in the steel is lost in slag.

If it is possible to eliminate carbon without eliminating manganese it would be very simple to use a pig iron containing sufficient manganese to meet final steel specifications and not only would it be possible to dispense with the ferro-manganese additions costing about 1s. 10½d. per ton of steel, but the 0·6 per cent. of manganese saved would mean 0·6 per cent. more steel from the same weight of pig iron. It is by the saving of such metal that the increased cost of the electric-converter process will be much more than justified.

This electric converter process may be compared with the Bessemer process from two standpoints; first, assuming that only low phosphorus and low sulphur pig iron is used; and, second, assuming that impure iron is used. The programme of the electric-converter process for treating low phosphorus and low sulphur iron would be as follows: The molten pig iron is charged into a basic-lined electric converter. The type of converter which has most advantages for this purpose is an induction furnace having a main central hearth into the back side of which the tuyeres enter, and having two or more induction channels connecting with this main hearth.

The pig iron ordinarily would contain 1·5 per cent. of silicon and 0·75 per cent. to 0·85 per cent. of manganese. If low silicon iron could be readily had it would be so much the better for this process. But high silicon iron, which is more common, may be worked by the process, it merely involving the additional steps of lowering the content of silicon. Lime or limestone may be used for this purpose and is charged into the molten iron at the start. The metal, heated to about 1,450°C. is blown with a gaseous mixture which might well contain about 8 per cent. CO and 15 per cent. CO_2. The carbon is taken out until a fracture sample shows that the proper carbon remains. It is possible, by timing the blow to come very close to the desired percentage of carbon. The loss of manganese will be small enough so that the final percentage should not differ more than 0·05 or 0·10 per cent. from the percentage at the start. The silicon may be entirely removed or only in part. Finally any killing treatment desired may be given to the steel after the desired analysis is attained. In this process the oxidation loss of iron and manganese common in Bessemer practice can be almost entirely avoided.

The operation when high phosphorus and sulphur iron is used is quite similar to that just described. The raw material of course consists of low-grade iron. It is charged molten into the electric converter and lime is added to take up and hold the phosphorus and sulphur. In one method of operation the blow of gas is continued until practically all the carbon is oxidised and eliminated, a few tenths of 1 per cent. only remaining, and likewise until the silicon is practically all taken up by the lime, as calcium silicate. Continuation of this blow in the presence of the lime slag then takes out the phosphorus without formation of iron oxide. The interesting feature is that sulphur is also taken out and held out of the metal by that same slag. By this treatment the heavy loss of iron in the basic slag common to basic processes is avoided, and at the same time the slag is enabled to take up sulphur, which is in marked contrast with the basic process wherein the presence of iron oxide in the basic slag prevents such removal of sulphur to any great extent.

As compared with the combination process using a Bessemer converter and an electric furnace, the electric converter process presents several important advantages: First, the complete process is carried out in a single vessel thereby avoiding the inconvenience and loss of time, heat and metal contingent on transferring molten steel from one furnace to another and also avoiding the necessity of twice heating the same metal; second, the attractive feature of the basic Bessemer process, namely, the rapid elimination of phosphorus, may be taken advantage of without incurring its disadvantages in the loss of metal by oxidation and danger of over-blowing the steel; third, specially skilled operators are not essential to success of the process as there is no danger of over-blowing; fourth, high sulphur iron can be used, and this alone is a most important feature because of the large amounts of ore high in sulphur; fifth, the necessity of removing one slag and replacing it by another is avoided; sixth, the additions necessary in other processes are either greatly lessened or entirely avoided and also the losses attending those additions; and there are other advantages, among them being the ability to give the molten metal a killing treatment and to closely regulate its temperature all in one single furnace.

Little has been said in this Paper about furnaces. In the tests of this process various types have been used, including the induction type to which reference has already been made. The process is at present installed for test in a 2-ton furnace. The induction furnace has shown important advantages, in that it produces the heat where most heat is needed and does so without the heavy electrode cost attendant upon arc-furnace operation. In the operation of this process in large induction heated furnaces, we believe, that less than 30 kw.-hours per ton of steel will be required. This may sound very radical, yet when it is remembered that steel can be kept molten in induction furnaces at the present time with an expenditure of about 80 kw. of power per ton and that it has been possible to carry out the process of this Paper in less than one-third of an hour, the estimate is very reasonable. Such a low power consumption as 30 kw.-hours per ton, costing, at 0·25d. per kw.-hour, only 7½d. per ton, makes the use of electric heat assume an entirely different aspect in the development of a competitor of the converter or open-hearth furnace.

THE NEW PARIS UNDERGROUND RAILWAY.

THE NORTH-SOUTH LINE.

An electric subway, the North-South line, upon which the constructional work was begun several years ago, has recently been opened for traffic in Paris. Owing to the fact that it was from the start an entirely distinct enterprise from the Metropolitan Subway, the work was carried forward more rapidly

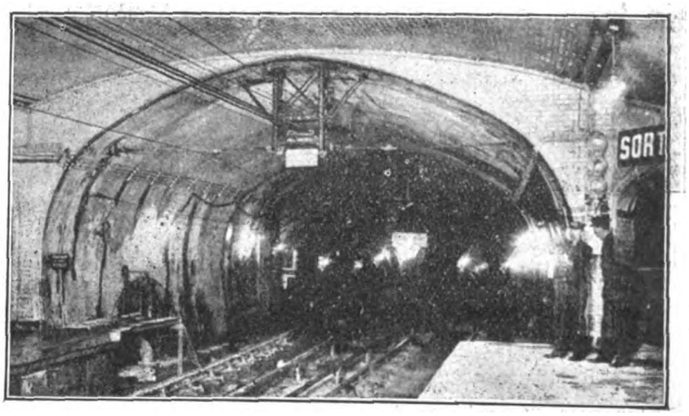

FIG. 1.—VIEW SHOWING OVERHEAD AND THIRD-RAIL CONSTRUCTION.

than would have been the case if it had been included in the present plans of the latter company. Our representative has had occasion to make several trips over the new subway since its official opening early in November last, and he informs us that the company appears to have taken great pains to introduce all the improvements made evident by the experience already acquired upon the other subway. Seeing that the line connects the southern quarter of Vaugirard with the northern Montmartre quarter, thus putting into direct communication the Montparnasse and the St. Lazare railway stations, it is likely to be well patronised. The double-track tunnel is of about the same dimensions as on the other system, with which there are four crossing points. Interchange stations allow the passengers to make a transfer between the two railways upon the same ticket. It will be remembered that where it crosses the Seine the line runs in a double iron cylinder, using two parallel single-track tubes. On the rest of the line, however, the standard elliptical section of tunnel is employed.

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Motor cars and trailers of the same general appearance as those employed on the Metropolitan cars are also used on this line, though there are some differences in detail. One of the main differences in operating the trains lies in the use of the track rails as an earthed neutral conductor, and the employment of both a third rail and overhead trolley wire for supplying energy to the motors. In the case of two 600-volt direct-current motors, which is the standard equipment per train here as well as on the other subway, one motor is supplied from the third rail, returning to the track or earth, and the second from the trolley to earth, using 1,200 volts between the third rail and trolley. To keep the voltage constant at 600 volts on each motor the balance is maintained by the multiple unit control apparatus on the motor cars. As this does not allow the use of an uneven number of motor cars (three cars are sometimes used on the other line), the capacity of the motors is increased, so as to make them capable of drawing the maximum train load with two motor cars in all cases. Each motor car thus carries four motors, each of 125 H.P. The motors and controlling devices were built at the French Thomson-Houston Co.'s shops at Paris. Economy in wiring over the 600-volt system is secured by the use of a pressure of 1,200 volts, and there will be less earth leakage.

A special station did not have to be erected for the supply of current, seeing that this can readily be obtained either from the St. Denis or the Ivry stations in the suburbs. It is transmitted through underground cable to the two sub-stations of the subway as three-phase current, the pressure being from 10,000 to 15,000 volts. Each of the sub-stations is equipped

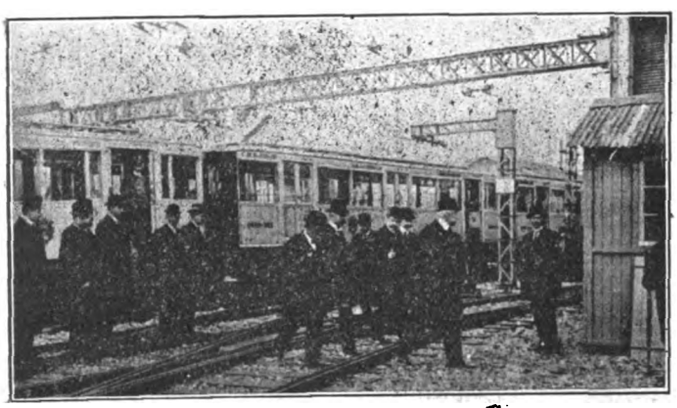

FIG. 2.—VIEW OF ONE OF THE TRAINS.

with transformers and rotary converters, whence 1,200 volts direct current is supplied to the line. Owing to the short length of the subway (9 miles) not more than two sub-stations were needed. There are at present 18 passenger stations opened for traffic between the Versailles Gate and a point somewhat beyond the St. Lazare station. The rest of the subway will be opened later on, and eventually there will be 31 stations. As before, the stations are of general elliptical section, with the two tracks lying in a depression between the station platforms. A white enamelled brick lining is used, picked out with coloured bricks. Two of the subway stations are worthy of note. One of these lies under the Rue de Vaugirard. It is built of reinforced concrete, as the narrow space between the house foundations did not allow masonry side walls to be used. Under the Place du Havre, in front of the St. Lazare station, a round underground hall, which did not figure in the original plans, has been built. The city of Paris gave a subsidy towards the cost of its construction, and it contains the ticket offices, news stands and a large circulating area. From here passengers can take different passages leading to the North-South or Metropolitan Railway, to the St. Lazare railway station or to the street.

First and second-class cars with about 80 places are used. They are mounted on double bogies in the case of both motor cars and trailers. The train is made up of a motor car at each end, together with a variable number, generally two or three, of ordinary cars. Special care has been paid to the illumination and ventilation of the cars. The ventilation is carried out through overhead openings. The motor cars differ from those on the other lines in the addition of a controller cabin at one end, otherwise the outside appearance and seating room is the same. The trains are run indifferently from one end or the other, so that there was no necessity for a loop to be built at the terminal stations.

As regards the financial and operating conditions of the Paris subways, it should be noted that the Metropolitan Co. is engaged in constructing a system of subways which is designed to cover the city as far as possible, and this work has been designed to be carried out in three parts, some of the lines being now completed while others are still under construction. When the whole of the plans are carried out there will be about 70 miles of Metropolitan lines. In the case of this system the tunnel work is carried out by the municipality and the tracks and wiring, &c., by the Metropolitan Co. But in the case of the North-South subway quite a separate arrangement was made with the city authorities, and the company undertook the whole of the construction work. Both subways will be taken over by the city after a period of 35 years, dating from the completion of the entire subway system. Our illustrations show a view of the tunnel with the overhead wires and third rail, and the general appearance of one of the trains.

THE METHOD OF CONSTANT RATE OF CHANGE OF FLUX AS A STANDARD FOR DETERMINING MAGNETISATION CURVES OF IRON.*

BY J. T. MORRIS AND T. H. LANGFORD, B.SC.

Summary.—An investigation is here described of the differences between the magnetisation curves for a given sample of iron when determined by the following methods: constant rate of change of flux, step-by-step method, method of reversals, and alternating current. The "uniformly varying flux" method appears to possess advantages over the older methods, and is recommended by the authors.

INTRODUCTION.

Doubts must have arisen in the minds of many investigators as to how nearly the magnetisation curves of a sample of iron obtained by different methods would agree with one another. Discrepancies which have been found from time to time may be attributed to:—(i.) Inaccuracies in experimenting; (ii.) Lack of exact repetition of previous conditions; (iii.) differences inherent in the methods employed.

The present research was instituted with the object of studying the last of these three causes, and obtaining definite information as to the magnitude of these differences (*a*) between the magnetisation curves for a given sample of iron when determined by the older methods, in which the flux is changed suddenly, and (*b*) by a method in which it is changed slowly and at a uniform rate.

The relation between the magnetising force H and the flux-density B produced by it in a specimen of magnetic material is usually determined by one of the following methods:—(*a*) Ballistic Methods; (*b*) Alternate-current Methods; (*c*) The "Fluxmeter"† Method; (*d*) Magnetometric Methods; (*e*) Attraction Permeameter Methods.

Permeameter measurements have the advantage of rapidity, but the accuracy attainable is not very high, owing to the indefinite degree of contact between the specimen and the yoke. This method is generally employed only for workshop tests. The magnetometric method is liable to inaccuracies due to the lack of uniformity in the magnetisation of the sample, including the indeterminate position of the poles and their demagnetising action. Alternate-current methods have the disadvantage that they are indirect, the required values of the current and flux-density having to be deduced from the observations by a complicated method if accuracy is to be ensured. When the greatest accuracy is required, ballistic methods on ring samples are, therefore, those to which resort is usually made. The test is commonly made by one of two methods. In one of these the current through the primary winding is increased up to a certain value and then suddenly reversed to obtain a reading; in the other method the current is increased or diminished by a step at a time,

* Abstract of a Paper read before the Physical Society. A brief account of the discussion that followed the reading of this Paper appeared in THE ELECTRICIAN for May 26, p. 258.

† "Some New Electrical Instruments," THE ELECTRICIAN, Vol. LVI., p. 560, 1906.

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and the consequent ballistic reading taken. This difference in the character of the magnetic change to which the iron is subjected is liable to cause differences in the results obtained, partly owing to magnetic "creep" or viscosity.

A method proposed by C. F. Scott, and apparently first described by J. S. Peck,* as applied to large transformers, possesses the marked advantage over ballistic methods that the variation of the flux takes place at a known and constant rate, enabling experiments to be repeated under exactly similar conditions. Rates of change varying from 50 to 250 lines per square centimetre per second were actually employed in the experiments. Further, standardisation can be more readily performed, as a mutual induction is not required. This method has been modified by Dr. D. K. Morris so as to render it practicable for tests on small samples of iron.†

Method of "Constant Rate of Change of Flux."—Consider an iron ring in which a flux, N, is produced by a current, C, flowing in a primary winding. If the primary current be varied at such a rate that the induced E.M.F., E, in a secondary wiring is maintained at a constant value, the flux N is known to be varying at a constant rate, $dN/dt=k$.

In this case the total change of flux through the ring is simply proportional to the time during which it has taken place.

If n_2 be the number of turns on the secondary winding, and E be the value of the constant E.M.F. in volts induced therein, we have

$$E=dN/dt\times n_2+10^8=kn_2/10^8$$

and total change of flux $(N_2-N_1)=k(t_2-t_1)=E\times 10^8(t_2-t_1)In_2$.

Hence a magnetisation curve can be deduced from readings of current and time when the current is varied at such a rate that the secondary induced E.M.F. is constant and of known value. Since

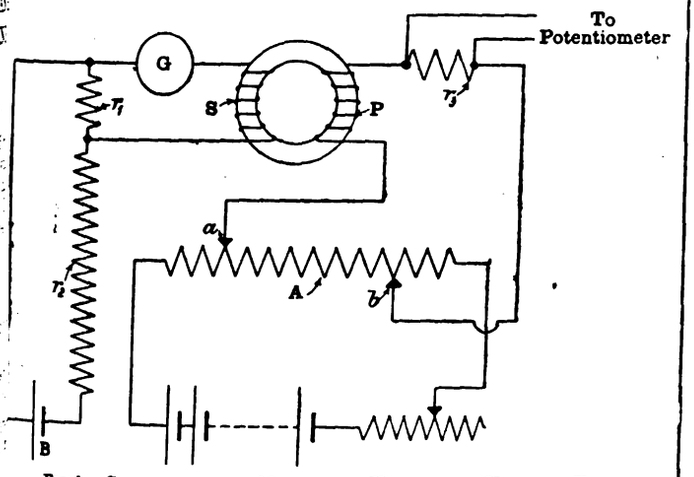

FIG. 1.—CONNECTIONS FOR METHOD OF UNIFORMLY VARYING FLUX.

the rate at which the flux is varied can be made as slow as desired, any "creep" in the magnetisation due to magnetic viscosity will be recorded. This method, therefore, appears to be preferable to others as the standard method for determining the fundamental magnetic properties of iron.

The following experiments were undertaken to investigate the differences, if any, between the results obtained by this and by other methods:—(I.) Method of constant Rate of Change of Flux, or, more shortly, that of "Uniformly-varying Flux" (or "Constant Induced Voltage," as it has been termed by previous writers). (II.) "Slow Cyclic" Hysteresis Loops. (III.) "Step-by-step" Magnetisation Curve. (IV.) "Step-by-step" Hysteresis Loops. (V.) Method of Reversals. (VI.) Alternating-current Magnetisation Curve. Before each reading recorded by methods (II.), (IV.) and (V.) the iron was brought into a cyclic condition by carrying it through a sufficient number of cycles of magnetising force of the same maximum value, some 50 cycles being generally sufficient for this purpose.

Method of uniformly varying Flux.—In Fig. 1 is given a diagram of connections. The voltage induced in the secondary winding S is balanced by the fall of potential over a known resistance, r_1, in series with a known resistance, r_2, across a cell, B, of known E.M.F., equality being indicated by a zero reading on a galvanometer, G. The battery B is closed on to the circuit r_1r_2, and simultaneously the primary current is caused to begin to change by means of the rheostat A, and the experimenter has continuously to adjust the rheostat at such a pace as will maintain the galvanometer reading at zero. This adjustment requires some skill, but an average experimenter easily acquires this with a little practice.

* "Electrical World and Engineer," Vol. XXXVII., p. 1,083, 1901.
† "Journal," I.E.E., Vol. XXXVII., pp. 282–294.

In making a hysteresis test the primary current is continuously varied from a maximum positive value to an equal negative value by a specially designed resistance,* in which two sliders, *a*, *b*, connected to the primary winding P, are moved in opposite directions across the edges of the zig-zag strip resistance A.

The primary current is measured on a potentiometer by the voltage drop across a known resistance, r_3, the exact times at which the current has certain convenient values being recorded by a chronographic arrangement.

The above electrical connections could be simplified if the galvanometer were directly closed on to the terminals of the secondary winding, but this arrangement has some objections—(1) that it is difficult to allow for the uncertainty in the value of the secondary E.M.F. induced during the time that the galvanometer deflection is attaining its normal magnitude; and (2) that a separate operation has to be performed in order to standardise the galvanometer. A further slight objection is that there is an opposing magnetomotive force due to the current flowing in the secondary winding. This, in general, however, is so small as to be negligible.

Data of Specimen used.—The ring was made up of 24 stampings, 6 in. external and 5 in. internal diameter, of Sankey's best transformer iron, manufactured about the year 1900, of 24 S.W.G. The mean magnetic length of the ring was found by measurement to be 43·93 cm. The sectional area of the ring was determined from its weight and specific gravity. The stampings were insulated from one another by thin paper rings, and the complete ring was lapped over

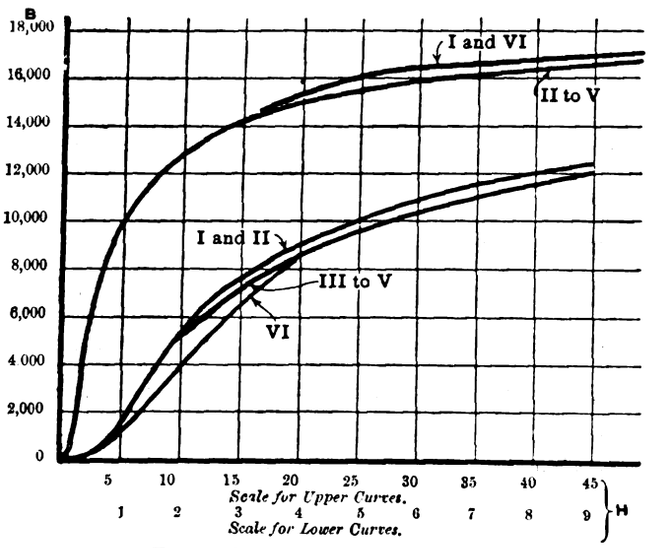

FIG. 2.—MAGNETISATION CURVES.

with insulating tape and wound with two No. 19 D.C.C. wires laid side by side, giving two windings of 147 turns each.

Experimental Results.—The results obtained experimentally by the above-described methods (I.) to (VI.) are given in the form of curves in Figs. 2, 3 and 4. The magnetisation curves are shown in Fig. 2, the initial parts being shown separately to an enlarged scale of H. In Fig. 3 the results are shown in the form of permeability curves, and in Fig. 4 in the form of reluctivity curves. In Fig. 5 the differences between the flux-density obtained by method (I.), and by methods (II.), (III.), (IV.) and (V.), with the same magnetising force, are plotted to a greatly enlarged scale against B as obtained by method (I.) The divergence of the magnetisation curve obtained by method (VI.) from the standard curve obtained by method (I.) is too great to allow of its being shown in Fig. 5, but is apparent in Figs. 2, 3 and 4.

Fig. 6 shows hysteresis loops taken by methods (II.) and (IV.), the maximum value of H being the same in each case.

The above experiments were carried out in the electrical engineering department of the East London College (University of London)

DISCUSSION OF RESULTS.

An examination of the divergencies shown in Fig. 5 has led the authors to divide, for purposes of consideration, the curves into three parts: (1) From zero to the approximate point of maximum permeability (B=5,000); (2) from this point to B=15,000; (3) above B=15,000.

Curves below B=5,000.—These may be divided into two groups: (*a*) Those in which the magnetisation curve is determined with the flux always changing in the same sense, the iron having previously

* J. T. Morris, R. M. Ellis and F. Stroude, "The Design of a Continuously Adjustable Rheostat," THE ELECTRICIAN, Vol. LXI., p. 400, 1908.

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been completely demagnetised; and (*b*) those in which each reading is determined after the iron has been carried through a sufficiently large number of cycles of magnetising force to obtain constancy in the corresponding value of the flux-density.

Considering first those which belong to group (*a*), we have two cases: (i.) That of the magnetisation curve obtained by the uniformly varying flux method (method (I.)) and (ii.) the magnetisation curve determined by the step-by-step method (method (III.)) It will be noted in Fig. 5 that there is a difference between these two curves of, broadly speaking, some 250 lines per square centimetre, from $B=1,000$ to $B=12,500$, and that the step-by-step method is deficient by this amount. This difference appears to be due to some flux not

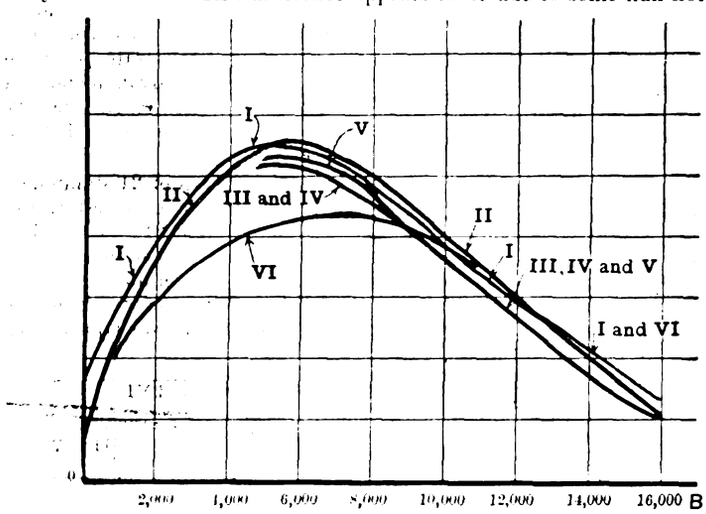

FIG. 3.—PERMEABILITY CURVES.

being recorded in the portion of the magnetisation curve below $B=500$ in the step-by-step method. It is quite probable that this is due to the known behaviour* of iron under weak magnetising forces. When a magnetising force of, say, $H=0{\cdot}2$ is suddenly applied, the flux at once changes by a certain amount and afterwards continues to change, though at a diminishing rate; this latter "creep" would not be recorded by an ordinary ballistic galvanometer, and therefore would not wholly be taken account of in the step-by-step method, but it is included in method (I.)—that of uniformly varying flux. (The time of one complete swing of the ballistic galvanometer used throughout these experiments was 8·6 seconds.)

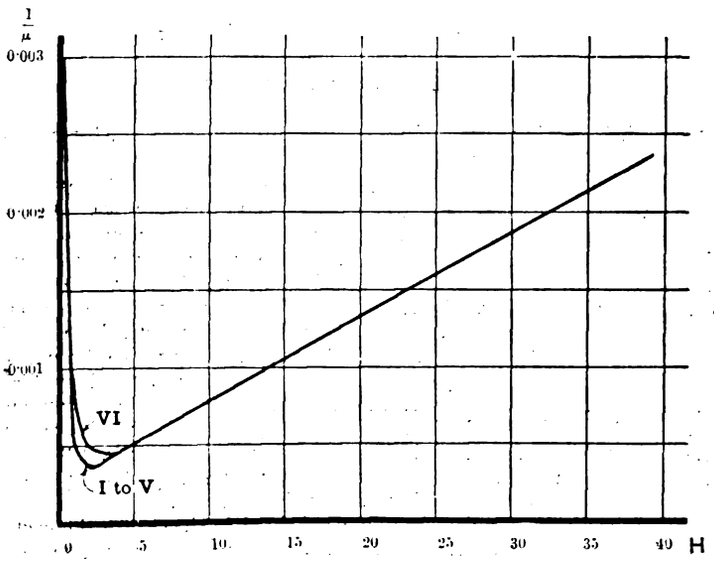

FIG. 4.—RELUCTIVITY CURVES.

Investigation of the amount of "creep" showed that this effect, although appreciable, does not appear to account wholly for the observed deficiency in the ballistic magnetisation curve. It will be noticed that all the curves in Fig. 5 start with a sharp downward inclination from the axis, showing that during the initial part of the magnetisation curve the highest value of B for a given value of H is attained by the method of uniformly varying flux, or, in other words, a higher value of H is required to produce the same observed value of B by the other methods. One reason for this may be that when the flux is changed suddenly, as in ballistic methods, an excess magnetising force may be required to counteract the demagnetising force due to eddy-currents caused in the laminations, and this may become considerable when the change of flux is very rapid. In order to investigate this point, an estimate was made of the demagnetising force due to eddy-currents, and this was found by calculation to be about $0{\cdot}00000046 \times dB/dt$. Now the excess H, for a flux-density of 500, required for the step-by-step method, as compared with the uniformly varying flux method, amounts to about 0·15, and this amount would be accounted for by eddy-currents if the change from $B=0$ to $B=500$ took place in about 0·0015 second, which does not seem unlikely. In the case, however, of the magnetisation curve drawn through the tops of the hysteresis loops obtained by the uniformly varying flux method another explanation must be sought, as the rate of change of flux, dB/dt, is too small to produce appreciable eddy-currents. It may be that, on slowly increasing the magnetising force from zero to a certain value and then carrying it through cycles having this value for a maximum, the value of B obtained initially may be greater than the value obtained after the iron has attained the cyclic state, owing to the first loops being unsymmetrical about the axis of H.

With regard to group (*b*), which includes methods (II.), (IV.) and (V.), it is difficult to find any rational explanation for the differences observed. The authors have, however, been impressed with the idea that when a sudden change of considerable magnitude is made in the magnetising force the instantaneous flux variation, as compared with

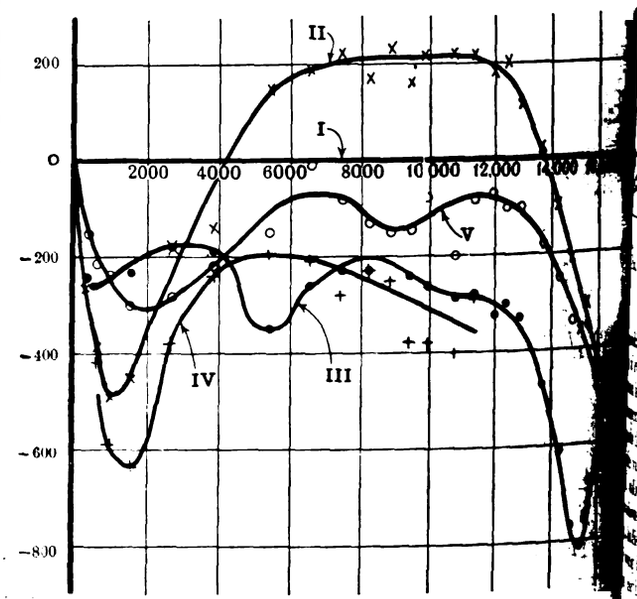

FIG. 5.—CURVE SHOWING DIFFERENCES BETWEEN MAGNETISATION CURVES OBTAINED BY VARIOUS METHODS.

the total flux variation, may depend on the steepness of the magnetisation curve at the point attained instantaneously by the flux; in other words, it might depend not so much on the permeability at that point as on the rate of change of induction with magnetising force—*i.e.*, on dB/dH. One is led to imagine that if dB/dH is great, then the stability of the molecular magnet grouping is correspondingly weak, and, keeping the Ewing model in view, one would predict that, for a sudden large change in the magnetising force, a magnetic creep depending to a certain extent on this factor dB/dH would be expected.

It will be observed from Fig. 5 that the maximum deficiency in B as obtained by methods (II.), (IV.) and (V.), occurs at about that part of the magnetisation curve where $B=2,000$, and if dB/dH is plotted it will be seen that this is where dB/dH attains its maximum value. It appears probable, therefore, that the maximum value of B attained when the iron is carried through a sufficiently large number of cycles of H depends to some extent upon the slope of the magnetisation curve at that point, B having a diminished value where the magnetisation curve is steepest.

Curves between $B=5,000$ *and* $B=15,000$.—The results appear to indicate that over this range the value of B attained for a given value of H increases as the magnetising force is carried through successive cycles, until finally a steady value of some 200 lines per square centimetre in excess of the initial value is attained.

Curves above B=15,000.—As considerable divergencies were obtained in the upper regions of the magnetisation curves by the various methods examined, it was thought that the temperature of the iron

* J. A. Ewing, "Magnetic Induction in Iron and Other Materials," p. 124.

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might have some bearing on these discrepancies, for in some of the experiments the full magnetising current may have caused a rise of 100°C. in the worst case. Further investigation showed this to be the case; and the authors therefore conclude that the results obtained above B=15,000 are of little scientific value.

The degree of accuracy attainable by the various methods is next discussed, and the authors emphasise the fact that if determinations

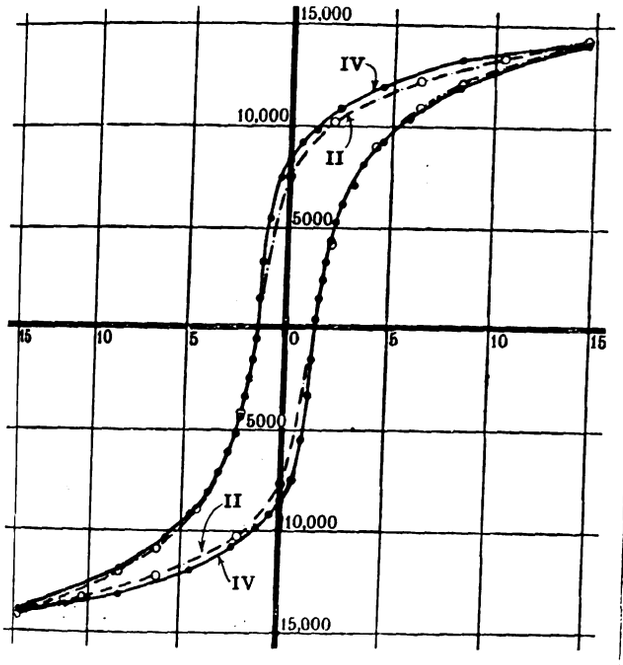

FIG. 6.—HYSTERESIS LOOPS BY METHODS II. AND IV.

of permeability upon the same sample are to be repeated with an accuracy of even 5 per cent. on the lower portions of the magnetisation curves it is essential that the ring be not subjected to considerable rises of temperature, say of 100°C., even for short periods.

As regards the time required for determinations by the various methods experimentally examined, ballistic methods are undoubtedly the most tedious, particularly when, for great accuracy, a ballistic galvanometer with a long period of swing is employed. The alternating-current method (VI.) has considerable advantages in this respect, a full set of readings of magnetising current and induced voltage occupying a very short time. When, however, it is necessary to take oscillograms at various points in order to plot curves of form factors, the time required is enormously increased. The method of uniformly-varying flux (method (I.)) is peculiarly adapted for use where time is a consideration, and at the same time a high degree of accuracy is desired. A complete magnetisation curve may be taken in a very few minutes, and the mean of many such curves obtained in, say, one hour, the iron being demagnetised between each test.

CONCLUSION.

The method of "uniformly varying flux" appears to possess advantages, both scientific and practical, over the older methods in use for the testing of ring samples of magnetic materials. It avoids difficulties due to eddy-currents and magnetic viscosity, which effects make themselves due primarily to rapid or irregular changes of flux. It also has the practical advantage that experiments may be carried out with rapidity, accuracy of repetition, and under standard or predetermined conditions of magnetic change.

The authors, therefore, would commend this method to the careful consideration of those interested in the carrying-out of magnetic tests, especially where great accuracy under definitely known conditions of experiment are essential.

THE MAKING OF WIRE LAMPS.

A VISIT TO THE "MAZDA" FACTORY OF THE BRITISH THOMSON-HOUSTON CO.

A party of visitors, made up of representatives of the daily and technical Press, was taken down to Rugby on Wednesday last week by the engineers of the British Thomson-Houston Co. The object of the excursion was the inspection of the new factory which has been erected by the Company for the production of "Mazda" lamps. These lamps have been on the market for some time past, and the factory in question has been used for their manufacture for the British market. The initial equipment was put down for the production of squirted or pressed tungsten filament lamps, and considerable ingenuity was displayed by the experts of the Company in the methods and apparatus employed in connection with this equipment. We were unofficially shown through the factory some three months ago, and were thus able to appreciate the change that has been made by the introduction of a process which it was the object of the Company to bring specially to the notice of the visitors on the present occasion.

Our readers will already be well acquainted with the general processes employed in the manufacture of pressed tungsten filament lamps; it is, therefore, of interest to turn to an innovation which has all the appearances of revolutionising the manufacture and general operation of metal lamps. The drawn tungsten filament lamp is not essentially new, because it was introduced by one of the Siemens firms some two years ago; but the B.T.-H. Co. appear to have carried the drawing-down of tungsten wire a stage further, judging by what they were able to show us in specimens of tungsten wire. It is this development in lamp manufacture to which the Company is anxious that special attention should be directed.

We understand that extensive experiments have been carried out in the United States in the laboratories of the General Electric Co., and that these experiments have resulted in the drawing-down of tungsten into extremely fine sizes of wire, even as low as 0·001 in. diameter. This wire has been found to be extremely flexible, ductile and highly durable. It is possible to handle it with ease and place it conveniently on the supporting hooks which are now commonly employed on the glass stems in metal lamps. This necessarily eliminates a number of processes in metal lamp manufacture. Pressed tungsten filament must be cut up into short loops. These have to be measured and subsequently weighed, the last-named process being the only reliable check on the resistance of each loop.

FIG. 1.—ONE OF THE DEPARTMENTS IN THE "MAZDA" WIRE LAMP FACTORY.

Each loop is then hung up on one of the hooks on the lamp stem, and the free ends welded to supports on the lower part of the stem. These are all delicate operations, and cannot be done properly unless the female workers are carefully trained.

Drawn tungsten wire, of course, renders such operations unnecessary. One end of a given length is fastened to the incoming terminal of the lamp, and the wire is then looped round on the supporting hooks and the remaining end fixed to the other terminal. The

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pinching-up of these ends to the two terminals completes the operation. What it means is that the connecting of the filament to its supports in the case of the tungsten drawn wire is confined to two operations, as compared with some half-dozen in the case of the pressed filament.

Turning now to the "Mazda" lamp factory itself, the general lay-out of the building is in accordance with present-day practice. The operators are given an abundance of room, light and air. In the summer the last mentioned is cooled and in the winter it is heated. Everything is carried out on the departmental system, and the groups in the chain of processes are kept as contiguous as possible. The heavier portions of the equipment, such as the exhausting plant and the ventilating apparatus, are confined to the basement, the upper floors being devoted to space for the operators themselves. A general view of one of the departments is shown in Fig. 1.

Fig. 2.—Mazda Drawn Tungsten Filament Lamp.

The operations in the manufacture of all incandescent lamps may be subdivided into three broad heads: Those dealing with the glass portion of the lamp and the supports for the filaments; those relating to the attaching and sealing in of the filament itself; and those in which the lamp is aged, tested and capped. In the glass department of the "Mazda" factory we noticed many interesting and ingenious machines which contribute towards accuracy in result and rapidity in production The operator is depended upon to a minimum extent, and is required mainly to superintend the operation of machines. Where manual operations are concerned the "Mazda" lamp employés have been well trained and gave a striking demonstration of their deftness in the handling of extremely fine parts in bunsen flames.

As we have already stated, the actual manufacture of the tungsten wire was not shown to the visitors. They were, however, assured by the management that the work was carried on in the factory, and were conducted past the door of the department in which it was proceeding. To technical men present the principal centre of interest was a group of benches on which the Mazda wire filaments were wound on the supports. In regard to the latter, we understand that in certain types of lamp a pure molybdenum hook is used, and that in other patterns the support is formed of copper, constantan and platinum. These particular metals have been adopted, as their expansion coefficients are nearly the same as that of the filament employed. The drawn wire is supplied to the operators on small reels and is cut off in lengths which are just sufficient to go round the supporting hooks. The free end of the wire is attached to one of the terminals of the lamp before the length is cut off. After cutting, a small brass clip is attached to the loose end and acts as a weight to keep the wire from coiling up. The wire is handled just like linen thread and looped round the supports on the glass stem. The free end is then pinched on to the remaining terminal, and the length of wire is drawn taut by a slight downward pressure on this terminal. The cage is then ready for the sealing department. No other chemical process is employed in connection with the filament after this point. We understand that in the Siemens method the wire is made up of an alloy of nickel and tungsten, and after placing in position the cage is immersed in oil and subjected to a high flashing voltage which drives off the nickel, leaving only tungsten. The B.T.-H. Co. have succeeded in dispensing with this particular process, and have, therefore, simplified the operations considerably. After sealing in, the lamps are subjected to a short ageing test, in which they are slightly overrun for a number of hours. At the conclusion of this test they are photometered and passed on to the capping department. One of the new "Mazda" lamps is shown in Fig. 2.

At the luncheon which was given after the inspection of the factory it was announced that the B.T.-H. Co. were completing arrangements to supply "Mazda" wire lamps in all the present commercial sizes. For the time being they are prepared to accept orders for the 50 and 60-watt sizes for voltages from 200 to 260, and the 60-watt size for voltages up to 130, and the 10 watt for 25 volts. Until October 31st, 1911, the smaller candle-power "Mazda" lamps will be supplied with pressed filaments, after which date wire filaments will be used. Mr. H. N. Sporburg, who presided at the luncheon, stated that the efficiency of the new "Mazda" wire lamp is about 1·35 watts per British candle, and that the life of the lamp is practically the same as that of the pressed filament type. He pointed out particularly that the company attach special importance to the durability of the filament, particularly when it is first delivered, owing to the fact that it is practically a continuous length having a uniform diameter, the last-named quality being of special value. He explained that the filament becomes more brittle when used, but this is, of course, only to be expected. He thought that in placing in the hands of the public a wire lamp of high efficiency which could be roughly handled before it was put on circuit, and which would subsequently give to the electricity consumer every satisfaction during life, the B.T.-H. Co. had effected a noteworthy improvement in modern lamp manufacture. He also stated that 30,000 Mazda wire lamps were being turned out every week, representing the use of 150,000 ft. of wire.

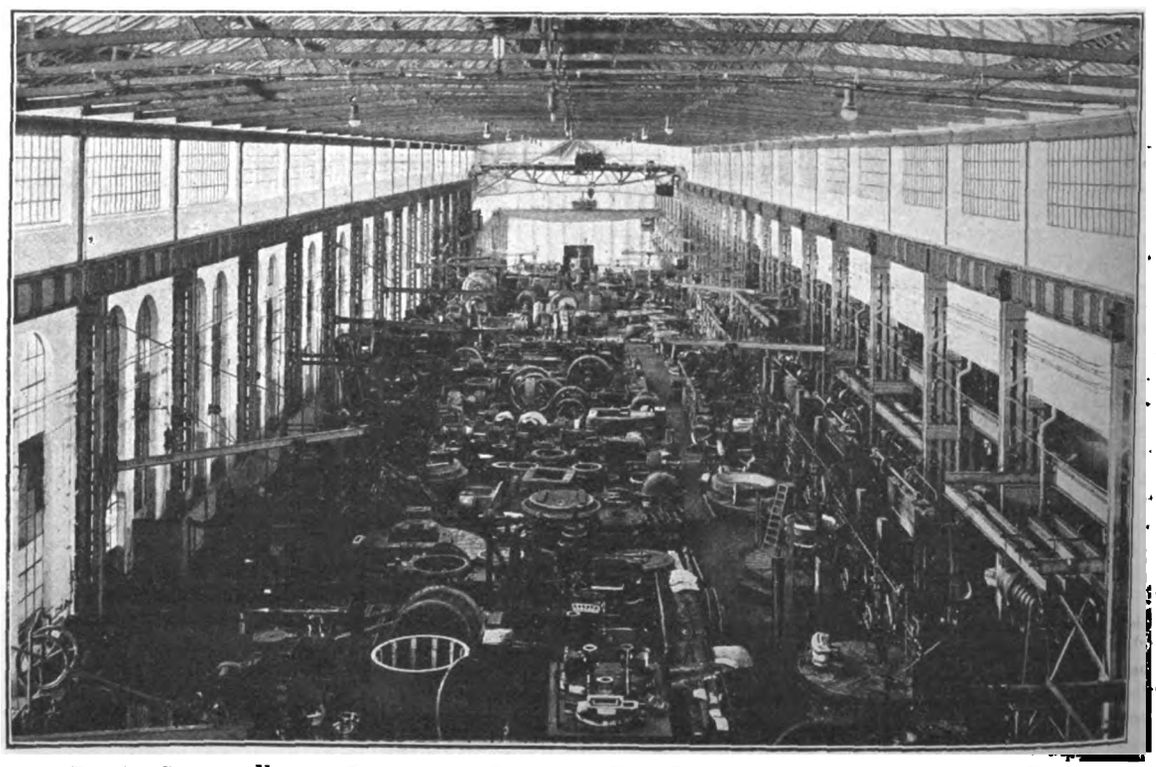

Fig. 3.—General View of Turbine and Generator Shop, British Thomson-Houston Works, Rugby.

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The officials of the Company spared no pains to make the trip to Rugby interesting for the visitors, and the heavy engineering portion of the works was thrown open for inspection. Particular interest was taken in the steam turbine department, where a large number of machines of various sizes were shown in process of construction and also running on the test plate. The turbine shop (Fig. 3) is one of the most imposing portions of the B.T.-H. works, and the visitors were particularly impressed by the large amount of work which was going through. We gathered that the Company are also very busy in the other departments of the works. In conclusion, we would particularly express our thanks to Mr. Francis Willcox, Mr. I. W. Howell and Mr. F. McNeil, who conducted us through the factory and supplied us with much useful information.

EFFICIENCY IN THE ELECTROLYTIC PRODUCTION OF METALLIC CALCIUM.*

BY F. C. FRARY, H. R. BICKNELL AND C. A. TRONSON.

Most of those who have worked on the electrolytic production of calcium have been content to describe their methods and apparatus, with perhaps an analysis of a selected lump of their product, but to say nothing of the current efficiency obtained. Muthmann,† in the discussion of a Paper by Rathenau, states that by using an electrolyte consisting of two parts of calcium chloride to one part of the fluoride, and raising the iron cathode as the metal accumulated, he obtained a "good" yield. Goodwin,‡ electrolysing pure calcium chloride in a similar way, obtained a current efficiency of 21·5 to 41·9 per cent. Woehler,§ using an electrolyte containing 100 parts of the chloride to 17 parts of the fluoride, claims an efficiency of over 80 per cent. He used a current of 40 amps. at 33 to 38 volts, but does not say how often or for how long a time this efficiency could be obtained. Tucker and Whitney‖ improved the apparatus of Goodwin, and claim an efficiency of 60 per cent., using the pure chloride as electrolyte, but give no data to support their claim. As far as we are able to ascertain, no one else has published any results on the efficiency of the various processes which have been proposed.

During previous work by Frary and Badger in the Minnesota University laboratory efficiencies as high as 46 per cent. were obtained, but, unfortunately, the only runs in which the necessary data were taken were made under unfavourable conditions. As it was certain that better results could be obtained, and had been obtained, in some of the runs for which no data were at hand, these were not published at the time, and the work was continued by the present authors.

The apparatus used was the same as that described by Frary and Badger, and consisted essentially of a large crucible of Acheson graphite having a water-cooled bottom and serving as anode, and a water-cooled iron cathode a little over an inch in diameter. The crucible was enclosed in a protective layer of refractory material, and special pains were taken with the contact between it and the positive cable. The cathode could be raised or lowered at will by means of a screw mechanism.

From preliminary experiments, it was decided that the occasional feeding of the fresh electrolyte and irregular raising of the cathode were two important causes of low efficiency. Intermittent addition of electrolyte caused irregularities in the height of the melt and of its temperature, especially the latter. Too great cooling of the electrolyte caused the deposition of the metal in a spongy form, in which state it was readily lost. Spongy portions were also formed when the stick of metal extended too far below the surface of the melt, the current-density¶ being insufficient to melt the metal at the point of contact with the electrolyte, and thus produce a solid stick. This spongy metal was very likely to be dislodged and swept away by the vigorous convection currents which were always present; it also gave trouble by growing toward one side or other of the crucible, causing an increase of current at that point, with consequent increased growth of metal and a higher temperature, until finally the calcium on the edges would melt, and, being connected with the main stick only by thin pieces of metal, would be easily swept away by the electrolyte. When the end of the stick of metal was kept just below the surface of the electrolyte, the spongy metal first formed melted almost at once, and its surface tension drew it into a compact globule which was almost immediately frozen by the cooling effect of the rest of the stick and the water-cooled cathode. Thus a solid stick was easily obtained.

In starting up a run, the cold fused chloride remaining in the crucible from a previous run was heated until dry by directing the flame of a blow lamp upon it. Then a small portion of it was fused by drawing an arc from the side of the crucible with the aid of a graphite rod. A small current was used until contact was made with the cathode, when more current was put on and the graphite rod removed. As soon as good contact was assured, the direct current was shut off, and an alternating E.M.F. of about 30 volts applied. The current usually rose rapidly to about 200 amps., being regulated by raising or lowering the cathode, and the upper part of the crucible was soon filled with the molten chloride. A sufficient supply of electrolyte was added at this time to fill up the crucible, and when all was ready the alternating current was thrown off and the direct current thrown on. The current varied very little during each run, as it was taken from the 110-volt lighting circuit through a constant resistance. There was no trouble with the so-called "anode effect," except when the electrolysis was started before a sufficient amount of the electrolyte had been melted down by the alternating current.*

Since Ruff and Plato,† Muthmann‡ and Woehler§ have recommended the use of a mixture of the chloride and fluoride as the electrolyte, the authors decided to try it and see if it offered any advantages. The fluorspar was first partially purified by treatment with concentrated hydrochloric acid to remove the iron. It was mixed with the chloride in the proportion of 16·5 parts to 100, as recommended by Ruff and Plato. A new crucible was made for use with this electrolyte, having the same size as the other, but a different arrangement of the water cooling. The bottom of the crucible was turned out on the lathe so as to fit loosely over the hollow brass cooling cylinder of the Borchers‖ furnace for the electrolysis of fused salts. The crucible was then turned upside down, this space filled with a strong copper sulphate solution and copper deposited until the cylinder would not enter the space. The copper was now turned out on the lathe to fit the cylinder, and the whole of the outside of the crucible and cylinder protected from the air by a coat of Portland cement and carborundum fires and held in place, as before, by a tin former. The contact, being made through the water-cooling cylinder, was kept cool and did not burn away, as the other crucible did in the course of time. A more complete protection of the outside of the crucible was also possible.

With this crucible and the above-mentioned electrolyte, a new series of runs was made. Considerable trouble was found in making smooth solid sticks of metal with this electrolyte. The particular advantage of this mixture is supposed to be its low melting point (660 deg.). This appears to us to be a disadvantage, as the bath must be worked as a temperature of nearly 750 deg. in order to get a solid stick of metal, and the bath is so fluid at the working temperature that convection currents are more violent and more likely to sweep away the metal from the end of the stick, forming an arc. We had a great deal of trouble from this cause. Reduction of the current did not bring the desired result, as the efficiency decreased markedly.

During the runs with this electrolyte only the chloride was added, it being assumed that the fluoride would not be decomposed. However, at the close of these experiments, a sample from the top of the melt showed only 2·21 per cent. of insoluble matter, so, evidently, much of the fluoride had been lost. This loss was probably largely mechanical, and due to the violent spattering of the electrolyte.

Samples were also taken from the electrolyte in the lower part of the crucible, which had been kept frozen during the electrolysis by the cooling coil, and so, presumably, retained its original composition, and attempted to isolate the fluochloride of calcium described by Poulenc¶ and Defacqs.** but found none of it.

From the experience obtained with both electrolytes it is believed that the plain chloride is a little more satisfactory than the mixture of the chloride and fluoride in point of efficiency, and decidedly easier to manipulate. It has been shown that satisfactorily high efficiencies can be obtained with it, and that the efficiency is more largely a matter of careful regulation of conditions than anything else.

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* Abstract of a Paper read before the American Electrochemical Society.

† "Z.f. Elektrochem.," X., 508 (1904).

‡ "Jour." Am. Chem. Soc., XXVII., 1403 (1905).

§ "Z.f. Elektrochem.," XI., 612 (1905).

‖ "Jour." Am. Chem. Soc., XXVIII., 84 (1906).

* In most cases a rod of about 1 cm. diameter was obtained, so the cathode area was about 1 to 1½ sq. cm.

* A sample of the electrolyte was taken at such a time when the "anode effect" had been more than usually troublesome, and the percentage of silica present determined. Only 0·056 of 1 per cent. was found, confirming the results obtained in the previous Paper, and indicating that current-density rather than impurities should be blamed for this "effect."

† "Ber.," XXXV., 3612 (1902); XXXVI., 491 (1903); "D.R.P.," CLIII., 731 ("Chem. Centr.," 1904, ii., 802).

‡ "Z.f. Elektrochem." X., 508 (1904).

§ "Z.f. Elektrochem.," XI., 612 (1905).

‖ Borchers, "Die Elektrische Oefen," 1907 ed., pp. 35 and 36.

¶ "Ann." Chim. Phys. (7). 2, 5 (1894).

** "Ann." Chim. Phys. (8), 1, 337 (1904); "Compt. Rend.," 137, 1251 (1903); "Jour." Chem. Soc., 86, ii., 123 (1904).

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THE PROGRESS OF THE METAL FILAMENT.

From the manufacturing point of view, the progress of the metal filament has been steady and successful. It may be that some have fallen by the way, but the ranks have closed up, and the march forward has been resumed. Here and there it seems that patents have been taken out that are likely to be valuable, but the methods adopted in many cases are known only to those in the manufacturer's confidence. Still it seems likely that most of the methods resemble one another in that they consist of some plan for making a homogeneous thread out of a raw material, which consists of a powder mixed with an agglutinant. This is, therefore, somewhat different in principle from that by which the old carbon lamp was made, where the raw material most generally used was a solution of cellulose in zinc chloride. Thus, in the one case the filament is made from a more or less liquid mass, fairly homogeneous in its constitution; in the other, the filament is made from a mixture of powders with a certain amount of added fluid, which is doubtless kneaded till some approach to homogeneity is obtained. It will be remembered that this latter process is similar to that by which the Nernst lamp was produced, and though very serious difficulties were encountered, even in making the filament itself, they were largely overcome. The same thing has happened with the tungsten lamp, and everybody concerned deserves the thanks of the community for their efforts. We may hope that they are also receiving their reward in some more tangible form.

In the case of the tungsten lamp, however, the difficulties to be surmounted in the early days, say about five

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years ago, were really formidable. The tungsten of commerce is very impure, and consists of a sandy powder, which seems almost as unlikely as sand itself to yield readily to any agglutinant. Further, the low resistance of the metal together with the consequent length of the filament was a further obstacle. Even so, it can hardly be said that the present filaments are as successful from the point of view of mechanical strength as we hope they will become with further years of experience.

Dr. MONASCH's article, of which we publish an abstract in the present issue, draws attention to some of the more obvious points which have been provisionally standardised; the most important are probably matters relating to the anchoring of the filament, and the general construction of the bulb in which it is enclosed. There is at any rate something approaching to uniformity in the methods adopted by different manufacturers with regard to these points. Dr. MONASCH reports the curious experience of American makers with regard to drawn tungsten wires, which have been proposed as a substitute for the powder mixtures. It seems that such wires behave with alternating current exactly in the same way as the tantalum filament; the molecular structure changes, and, for practical purposes, with alternating current, this is a very grave defect. Naturally enough, it was at first supposed that the tungsten filament, compounded of powders, would behave in the same way, but this has not been found to be the case. This is merely stated as an experimental fact; the why and wherefore is probably as mysterious as ever. We notice also that Dr. MONASCH draws attention to the results published by KINSLOE, who finds that the form of the voltage-wave affects the life and light, and that on a peaky voltage both are deleteriously affected. This result seems curious, and it is only right to say that it has not been universally accepted as conclusive. Others have stated that it is quite contrary to their opinion, and further work seems to be necessary before this can be regarded as an accepted fact.

All these things are necessarily associated with certain dislocations on the commercial side. The trading effect on the central stations is well known, though the worst is over. At the time when the Nernst lamp was in the hands of its original exploiters the general disaster that was thought to be impending from the point of view of the interests of the supply stations was admittedly in their minds, and they had plans by which they thought it might be mitigated. These troubles, however, did not then come to pass, and such palliatives as might be possible in a case where patents of a valid nature, covering more or less the whole field, were concerned, were obviously out of the question in the case of the tungsten lamp; for here nothing could be concentrated in a few hands beyond details relating to methods of manufacture, and patents could not be so broadly construed as to cover more than a part of the field. Therefore, in the present case all sorts of precautions had to go by the board, and everyone has had to do what seemed to him best, or in other words, to wait till the storm blew over. There seems little fear that the central stations will suffer any permanent harm; on the contrary, after the few lean years, there appears every prospect that a wider field is opening with a general expansion of business.

So much has been done in five years that it is reasonable to expect even greater advance in the coming years. Whether this will take the form of developments on present lines, or in further discoveries in the realm of refractory substances, it is not yet possible to say. It may be that there are other substances, lying around us, that might improve on the results tungsten has given. Probably tungsten itself was tried many a time before anything was done that looked hopeful; its low resistance and its sandy texture would lead the casual observer to think that it would be useless to devote time to its further study. If, indeed, it is to be supplanted, it is more than likely that its successor will be some other metal, now well known, but difficult to obtain in a sufficiently pure form. But even if any such metal exists, it will need more than a few casual experiments before anything definite can be known, and, in so far as making money is concerned, it would probably pay much better to devote energy to work on present lines than to hunt at random after a will-o'-the-wisp. Luckily for human progress, the inventor never believes this; and he occasionally has his reward.

REVIEWS.

(Copies of the undermentioned works can be had from THE ELECTRICIAN Office, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.)

Die Wechselstrom Technik. 2nd edition, edited by E. Arnold. Vol. I., "Theory of Alternating Currents," by J. L. LA COUR and O. S. BRAGSTAD. (Berlin: Julius Springer.) Pp. xiv. + 922. M 24 net.

This book is published as the first part of the well-known work of Prof. Arnold, and is intended as an introduction to the other volumes, which deal in detail with the construction and performance of transformers and machines. The present work, however, does not limit itself to the portion of the theory required for the later volumes, but goes a good deal further than is usual in an engineering treatise. The ground covered is most extensive, and one can hardly do full justice to it in the limits of a short review.

After the fundamental definitions, it begins with the theory of vectors, the representation of reactance, capacity, &c., and the operations with vectors as complex quantities in the symbolic system. The transformation of co-ordinates and the theory of inversion is given next with some applications. In Chapter IV. we find the first examples; they are well chosen, and include all points to make them representative of their kind. We are afraid, however, that two examples only are rather too few to show the practical application of the preceding theory.

In Chapters V. to X. are given the conditions affecting the working of alternating-current circuits, as well as the alterations caused by the introduction of magnetic material. Terms such as admittance, conductance and susceptance, in different combinations, are discussed and their relations stated by means of much mathematical apparatus. The theory of the transmission line is included, together with the means of keeping constant potentials at the ends. As a conclusion, there follows the construction of diagrams for a system on open circuit, on short-circuit and under normal working conditions.

These first 10 chapters, covering over 200 pages, lean very strongly on Steinmetz's "Alternating-current Phenomena," and, although the matter is treated often in a more mathematical manner, the resemblance is most striking, and it appears to us that this point should, in fairness, have been mentioned by the authors in their opening remarks.

In Chapter XI. the authors discuss the theory of the wave-form, and give mathematical and graphical methods for

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splitting waves into their harmonics. A separate section is devoted to Fleming's method of determining the effective value of a wave. The Fischer-Hinnen method of calculating the harmonics, however, is not mentioned, although it is a very useful one, even if not always entirely accurate. After explaining the use of an equivalent sine wave in place of the various harmonics, the authors show the effect of the wave form on the performance of various machines, and give the results of some experimental work carried out in Prof. Arnold's Laboratory.

In the next four chapters follow the laws of polyphase currents, and extensive use is openly made of Steinmetz's methods of calculating potentials, currents and higher harmonics in such systems. At the end the authors give a scheme for a polycyclic system which they have devised for distributing over the same network current at high frequency for lighting, as well as at low frequency for power purposes. This system, however, does not seem to have yet found any practical application.

A large section is devoted to the description of instruments for measuring pressure, current, power, phase displacements, &c. Many engineers will disagree with the authors' statements that the three-voltmeter and three-ammeter methods are of no practical importance. The suggestion that properly-built wattmeters should be used instead is hardly acceptable, as in practical working it is not always possible to obtain them for an occasional measurement, and the old methods will always be a welcome help out of the difficulty. The instruments described are almost entirely of German manufacture, although the names of the British originators, such as Thomson, Cardew, Swinburne, Duddell, &c., are given.

In the next section, the iron losses and their relation to frequency, ageing, &c., are discussed, as well as the standard German tests, and a few particulars are given as to the composition of alloys used of late years in place of charcoal iron. Some information regarding stampings worked at very high frequencies, say 500 cycles, as used in wireless telegraphy generators, would here have been appreciated. This, from an engineering point of view, most important section is not nearly so thoroughly treated as the weight of the subject would have required, but as it is taken up again in the second volume in connection with transformers we assume that it was included here mainly for the sake of completeness.

The properties of dielectrics are thoroughly enquired into in Chapter XX., and methods explained by which the strain on the insulation can be reduced.

As an introduction to electrolytic cells, the authors give the theory of electrolysis with continuous current and full particulars of primary and secondary cells, which one would hardly expect in a book on alternating current. The study of the alternating arc opens with a chapter on the conductivity of gases and the resistance of air to discharges; after which follows a description of the arc between carbons, the arc in a mercury tube, the mercury rectifier and the process of electric smelting.

The last portion of the book deals with the phenomena appertaining to electric circuits and their constants. Amongst important sections should be mentioned the one referring to the increase in resistance of a solid conductor due to eddy currents, as well as that on the calculation of the magnetic forces acting between conductors of a machine subjected to a sudden rush of current. The causes of damped and free oscillations in networks are then investigated, and their natural periods calculated. The conditions of resonance in networks consisting of several parallel circuits, each containing capacity and inductance, form a very important section. The danger of switching in highly saturated transformers, when the flux cannot be established instantly, or of short-circuiting a generator when the flux cannot disappear at once, is well explained and illustrated with the well-known example of the breakdown on the Manhattan Railway in 1903.

Systems in which capacity and inductance are evenly distributed along the line are considered next, with special reference to long telegraph cables. Power transmission with continuous current and an overhead line is also investigated. The closing chapter discusses the theory of surges along different networks and suggests means of damping them down. After describing and criticising the various arrangements of arresters proposed to protect machines and apparatus, the authors touch upon the question of how far a surge penetrates the winding of a machine.

From this short *résumé* it will be apparent that the book covers most thoroughly the whole ground of alternating-current theory; if anything should be criticised, it should be the fact that the authors, in their anxiety to give a very complete account of every question, have included a large amount of matter which is not essential to the subject, and thus reduces the perspicuity. As examples of this, we would mention the primary and secondary cells in Chapter XXI., the electric discharges in gases in Chapter XXII., the theory of commutation in Chapter XXIV., and the continuous-current transmission line in Chapter XXV. We are also afraid that the book will prove rather inaccessible to a large number of engineers and students on account of the difficulties offered by its mathematics and abstract representations of systems, as well as because of the paucity of the examples. A comparison with Steinmetz's, Thompson's, Ferraris' or Karapetoff's works comes quite naturally to one's mind, where practical examples are worked out at the end of every chapter to make the reader familiar with the magnitude of the quantities under consideration.

To some extent this volume outbalances the whole work, as it makes one feel that, in addition to the construction of machines, there should be practical parts to follow, dealing with the design and lay-out of distributing networks, construction of switchgear and switchboards, protecting apparatus, &c.

The references to other works given in the book are very incomplete and not in accordance with the accuracy of the authors in every other direction. A short list of publications could easily be given at the end of each chapter if continuous references through the text are found undesirable. The book must have cost an enormous amount of work to compile, especially as the previous edition had to be re-written entirely. The first edition of 1903 contained also the theory of the transformer, which has now been transferred to Vol. II., and its place is now taken by the theory of transient phenomena. All plates, diagrams, &c., are entirely new, the lettering adopted being in accordance with the recommendations of the International Committee.

In conclusion, we should like to say that, despite the minor faults mentioned, full credit should be given to the authors for the high value of their work, which will be a welcome addition to the reference library of any engineer, and that its usefulness would be still further increased if in a future edition all secondary matters and unnecessary mathematical complications were omitted. R. ORSETTICH.

Elementary Principles of Alternating-Current Dynamo Design. By A. G. ELLIS. (London: Blackie & Son.) Pp. vi.+305. 12s. net.

The most exasperating kind of book to a reviewer is one that absolutely refuses to excite his wrath or to arouse his enthusiasm. It is surely an indifferent kind of book where every bit of praise can only be bestowed grudgingly and all condemnation must be mollified.

This is the position, however, we feel Mr. Ellis has placed us in. To praise his book for its excellence would be exaggeration, but it would be equally unjust to condemn it for its worthlessness.

Of course, no one will deny the author his right to treat design in his own way, but for our part there is but one test for any book on *this* subject, namely, its practical utility. From this point of view there are only two ways in which such a book can be profitably written. Firstly, as a text-book for the student or teacher; secondly, as a handbook for the engineer. For the former, the present book is far too general and unmethodical; for the latter, there is too little evidence of the author's familiarity with modern design and practical data to be authoritative.

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Had such a book appeared some years ago, it might possibly have met with more appreciation, but with the stringent methods of training recently developed both here and abroad, along with the immense amount of accurate information in all branches of engineering which is now available, we cannot class the present book as first-rate. The method followed by Mr. Ellis is largely that used by his former chief, Mr. Hobart; but we think he would have been better advised to work on the more scientific lines adopted in the leading treatises on design and electrical engineering.

The reason therefore that we do not heartily recommend the book to the student or engineer wishing to study design is because he can get his wants supplied better elsewhere. Although there are a number of details where we might join issue with the author, especially on his design, particulars and methods of calculation, yet it is the treatment as a whole that "leaves us cold."

S. P. S.
R. G. J.

AUTOMATIC TELEPHONE SYSTEM AT CHICAGO.*

BY C. M. BRADFORD.

Summary.—A description is given of the automatic apparatus used in Chicago on the system operated by the Illinois Tunnel Co.

The independent telephone system operated by the Illinois Tunnel Co. in Chicago comprises eight exchanges, equipped with automatic switchboards. The district which is covered by the system at present extends for over 8 miles, embracing the stock yards and a large portion of the residential district on the south side of the town, the business district of the Loop and vicinity and reaches well into the residential district on the north side. There are eight exchanges.

The trunking system is based on the usual scheme of having all the numbers in each exchange commence with a figure which is used only in that exchange or its branches. For example, all the numbers in the Chronicle building exchange commence with the figure "3" and run from 31,000 to 36,500. The North exchange is a subsidiary to the Chronicle exchange, and its numbers run from 37,000 to 38,500. Connector switches—third selectors and line switches—are installed at the North exchange, but no first selectors or second selectors; consequently anyone calling the North exchange from the Brooks building, for example, operates a first selector switch in the Brooks building exchange, which selects an idle trunk to the Chronicle exchange; he there operates a second selector switch, which picks out an idle trunk to the North exchange. A third selector is there operated and extends the connection to a connector switch at North, which completes the connection to the person desired.

Provision is made for handling calls to the long-distance switchboards in the usual way, by having the words "long distance" printed on each dial number disc at the back of the "0" finger hole, so that in the near future, when the long-distance board is in operation, any subscriber will be able to secure a recording operator by turning his dial once from this finger hole. Information clerks can be rung up from all exchanges by calling the number 392, and the complaint clerks by calling the number 393.

The information and complaint clerk's desk is installed at the Chronicle building headquarters, and all calls of these kinds are received there from the entire system. The board has four positions, so designed that a call causes lamps to glow in all four positions, and the first idle operator answers it. The first five information trunks are represented in the first position by white lights, in the second by red and in the third and fourth by green lights. Five other information trunks end in white lights in the third position, red lights in the fourth position and in green lights in the two other positions. The trouble trunks end in white lights in the second and fourth positions, and in red and green lights in the other positions. Each operator answers white lights first, red lights next and then if idle answers green lights. In this way distribution of the load is secured without eliminating co-operation. This arrangement gives a very rapid and satisfactory service. The board is now handling about 2,400 calls per day, most of which are enquiries for the numbers of new subscribers.

Subscribers' complaints are distributed from the complaint desk to the record clerks' desks located at the various exchanges by means of telautographs. These ingenious devices enable the complaint clerk to send by wire an autograph copy of each complaint to the record clerk at the exchange in which the complaint should be investigated. This clerk acknowledges receipt of the complaint by a signal. With this system no complaints are lost—all are transmitted quickly and receive prompt attention.

A "wire chief's" desk is installed at each of the exchanges, except at two of the auxiliary exchanges. At these latter testing outfits are installed, but arrangements are made so that lines at these exchanges may be tested also from their respective main exchanges. Following the practice adopted in most of the later automatic systems, the "wire chief" does not test the lines by means of the old-fashioned shoe or test-jack plugged in at the cross connecting frame, but by means of test connector switches, one of which is mounted on each line switch unit. By using these switches the wire chief can test any line, either in or out, without the aid of a rack man or other assistants. This makes the testing of the lines considerably more rapid and economical than by the old method and saves a great deal of wear and tear on the protectors of the cross connecting frame.

When the long-distance board is installed these special switches will be used by the long-distance operators in setting up connections. This will make it possible to supply more current on each long-distance connection than is supplied on a local connection. It will also be possible for a long-distance operator to call an automatic telephone line and hold it while waiting for the completion of a long-distance connection without automatically ringing the local telephone bell.

The remaining exchange equipment comprises the automatic switchboards and power plants, which are of the standard type of the Automatic Electric Co., and very similar to those installed at San Francisco, Spokane, Calgary, Havana, and in other later systems. Some details about this equipment may, however, be interesting.

Each exchange is equipped with apparatus for individual lines—four-party lines and private branch exchange trunks. Line switch units of the usual type are employed, which carry 100 line switches with two master switches on one side and banks for 15 connector switches, with 10 regular connectors and one test connector mounted on the other side. The master switches on the line switch side are not linked together, but each operates its group of 50 lines independently. Seven trunks are installed from one group of 50 line switches and eight from the other to secondary line switches. Primary line switches are arranged in sections of 2,000 each, each section being served by 100 first selector switches. Consequently, the 300 trunks from the 2,000 primary line switches pass through 300 secondary line switches arranged in 10 groups of 30 each; then through 100 trunks to 100 first selector switches. Local connections are then trunked through second and third selectors in the usual way. Connections outgoing from any exchange to other exchanges are trunked from first selector switches through another group of secondary line switches for the purpose of making trunks between exchanges as efficient as possible. This practice is the same as that used in San Francisco. Each such trunk also passes through a repeater, so that a calling party receives talking current from the battery at his own exchange. Talking current is, of course, supplied to each called party from the connector switch employed at his exchange. The four-party line line-switch units carry 21 connector banks with 20 regular connectors arranged in four groups of five each, and one test connector. The rotary connection or private branch exchange line-switch units carry 21 connector banks, also with 15 regular connectors and one test connector. These switches make it possible to give a private branch exchange subscriber any number of trunks, all of which appear under one number in the directory, for by means of them a calling party is automatically switched to an idle trunk.

The power plants at the various exchanges consist of pink Tennessee marble switch panels, equipped with the full complement of knife switches, circuit-breakers, ammeters, voltmeters, &c. Each exchange is served by one large storage battery. In order to make it practical to charge the battery and to use it at the same time without materially raising the voltage on the bus bars to the automatic switchboard, counter E.M.F. cells are installed in each battery room. These are connected to a counter E.M.F. cell switch mounted on the power panel, so that the cells may be cut in and out one at a time on the leads from the battery to the switchboard. Further to aid in keeping the voltage on the switchboards properly regulated, a Weston voltage alarm relay is installed in connection with each switchboard, so that if the voltage drops below or rises above predetermined points an alarm bell will immediately be rung. Duplicate motor generators for charging and duplicate machines for ringing individual lines are provided, as well as duplicate harmonic converter outfits for ringing on party lines. These are mounted on marble panels and are installed at each exchange as a part of the power switching board.

The subscribers' instruments are of the latest type, equipped with a two-wire calling device and direct-current receivers. A party-line telephone is the same as an individual line, except that the ordinary

*Abstract of an article in the "Telephone Engineer."

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individual line ringer is displaced by a harmonic ringer. Private branch exchanges of three different types are in operation in connection with the Chicago system—namely, intercommunicating systems of the push-button type, systems using small manually-operated switchboards the same as those commonly used in connection with manual central exchange systems, and full automatic switchboards.

As has already been mentioned in connection with the rotary connectors, spoken of in the description of the exchange equipment, each of the private branch exchange systems of the first two types may have several incoming trunks and an incoming call is switched to an idle trunk by means of the rotary connector switches at the exchange. An idle outgoing trunk is selected by the calling subscriber using a push-button intercommunicating system. Each trunk is represented in each push button box by a key, so that a subscriber wishing to make a call presses a key corresponding to one trunk, and if he then receives the busy signal he tries another trunk.

An idle outgoing trunk from a switchboard employing an operator is, of course, selected by the operator in the usual way. She then proceeds to secure the party desired by switching her calling device on to the idle trunk and operating it in the usual way; or, if the subscriber has a telephone equipped with a calling device and desires to call the number himself, or to make a number of calls in succession, without bothering the operator, she connects him through to a non-busy trunk and he calls whoever he wishes. The trunks may be two-way, or separate trunks may be used for incoming and outgoing business as desired. These boards are so designed that each operator has double lamp supervision over all calls through her board. The equipment operates on 24 volts, using current furnished from the large storage battery at each central office. The battery supply leads are bridged with dry cells and condensers.

The Chicago telephone public has been very favourably impressed with the service given by the new company. It was, of course, expected that patrons would be pleased with the elimination of the operator and with the speed of the service given by the new system, but the Tunnel Company's officials have been considerably surprised by the large number of compliments they have received on the excellence of the transmission through the new system. The amount of calling through the various offices is rapidly increasing and becoming quite heavy as the list of subscribers grows and the public learn more and more to use the new telephone. The service is especially popular among the brokers on La Salle-street, where quick numerous connections are desired during Stock Exchange hours. A supervisor in the Brooks building exchange who happened to be watching calls made by one of these brokers a few days ago timed a few of his connections with a stop watch, and found that in 65 seconds by the watch the broker called four different parties in succession, talked to each, and disconnected.

THE MAGNETIC PROPERTIES OF NICKEL STEEL.*

BY DRS. E. COLVER-GLAUERT AND S. HILPERT.

Summary.—The authors give an account of a number of tests they have made on various alloys of nickel-steel. The magnetic investigations were carried out with a Du Bois magnetic precision balance, the material being heated in an electric furnace, while alcohol or petrol ether cooled with liquid air was used for the lower temperatures.

For a considerable time a certain school of thought, following the views published by Osmond, has considered that the various magnetic phenomena exhibited by iron and its alloys are solely due to allotropic modifications of the metal, and that α-iron, which is supposed to be stable below 730°C. when in a pure state, is magnetic, whilst the β and γ varieties are non-magnetic. The latter are said to be only stable above 730°C. and 890°C. respectively when in a pure state, but may be preserved at lower temperatures either by rapid quenching or by the addition of foreign elements, when a material which is non-magnetic at normal temperatures results. A certain amount of difficulty was encountered, since it was alleged that martensitic and austenitic steels consisted of either β or γ-iron, and many of these steels are strongly magnetic. The explanation given for this fact was that the quenching or other means of preservation had been inadequate to retain the whole of the iron in the β (or γ) condition, and that there was thus a certain quantity of iron which had changed into the α condition intermixed with the other varieties. This, however, does not appear to be very plausible, since in such a case, owing to the finely divided and distributed nature of the magnetic substance, the magnetisability of the whole could only be very low, whereas the exact opposite is the case.

This difficulty appeared to have been surmounted when Maurer* was able to produce a practically non-magnetic steel, consisting of pure austenite, by the rapid quenching of an alloy containing about 2 per cent. of carbon and 2 per cent. of manganese. Against this evidence it may be stated that such an alloy must be regarded as a special case, as the conditions are so complicated that it is impossible to draw any conclusions from such a product and to assume that they are also correct for pure iron. The authors' present series of steels also provide much evidence against the so-called austenite being a non-magnetic material.

One of the authors has recently studied this question,† with regard to pure iron, and proved conclusively from purely magnetic data that β-iron cannot exist. It was further possible to prove that even if γ-iron is non-magnetic when in equilibrium, there is no proof that it need be so when under-cooled, and there is no magnetic distinction between α and γ-iron.

Quenching the 5 per cent. nickel steel from 600°C. causes, as might be expected, only a very small difference in properties as compared with the same steel when slowly cooled. In both cases the microstructure shows the material to consist of ferrite and pearlite. When the steel is quenched from 900°C. a marked change occurs. The coercive force is more than double that of the previous ones, the maximum induction is considerably lower, and the curve has the appearance that is associated with a hard steel. The micro-structure shows the whole mass to be of a medium coarse martensitic nature. Contrary to this, however, quenching from 1,240°C. produces a softer material with a coercive force considerably below that of the specimen quenched from 900°C., whilst the maximum induction closely approximates to that of the slowly cooled alloy. This quenching temperature is far above that of the critical points of carbon steels, and is most certainly within the γ-range of temperature, in spite of which the magnetic properties are almost identical with those of a steel which has had every possible opportunity of assuming the α condition. The micrographic examination reveals two constituents, one of which assumes a much darker colour than the other. The lighter coloured one appears to have a pitted surface, and in places there are patches of a very coarse martensitic nature.

The changes which occur during the thermal treatment of the alloy containing 25 per cent. of nickel are of a much more complicated nature. It may be regarded as representative of the irreversible nickel steels, since at this point the temperature-hysteresis of the series reaches its maximum. As delivered from the works, this steel is non-magnetic, and quenching from 600°C. (in the γ-range according to Osmond) does not affect this property. If the quenching temperature is raised to 900°C. the material becomes slightly magnetic, whilst if it is still further increased to 1,240°C. the alloy becomes strongly so; in fact, it possesses a permeability approximately equal to one-fifteenth that of pure iron. The authors regarded the non-magnetic condition as the stable one for this alloy, and were therefore greatly surprised on finding that the slowly cooled specimen was even more strongly magnetic than the one quenched from 900°C. It was thought that probably some cause for this would be revealed if the steels were cooled to such a point as where they re-assume strongly magnetic properties. This point is quoted differently by various investigators. Hopkinson places it at —52°C., but both Osmond and Dumas assume it to be slightly above zero. The authors' steels were cooled to zero several times but no change in the magnetic properties could be detected. The further cooling was undertaken in three stages, and conclusively proved that there is no sharply defined temperature at which the steels become completely magnetic, as is shown in the theoretical diagrams published by Guertler and Benedicks, in addition to the previously mentioned investigators, who constructed their diagrams from the practical results of experiment, but that the change begins probably at some temperature a little above —50°C. and gradually proceeds as the temperature falls, being more or less complete at —180°C. A most remarkable fact is that when the latter temperature is reached the alloys are in the same relative positions as regards their induction curves as they were before any cooling took place, and that the slowly cooled alloy and the one quenched from 1,240°C. are more magnetic than the others by practically the same number of units as they were in the original state, despite the fact that, at intermediate stages, the properties have varied very considerably. The only explanation of this fact seems to be that by quenching from a high temperature or slowly cooling a certain amount of a strongly magnetic material is produced which persists through all subsequent treatment. If this were mixed with a fairly large proportion of the non-magnetic substance (which occurs nearly pure in the alloy when quenched from 600°C. or 900°C.) it would account for the fact that, though *per se* the substance is strongly magnetic, the mixture only appears partly so. The unmagnetic sub-

* Abstract of a Paper read before the Iron and Steel Institute.

* "Zeitschrift für Electro-Chemie," 1909. † "Metallurgie," 1910.

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stance, of course, becomes magnetic when cooled to low temperatures, and thus permits the permeability of the previously magnetic one to be more accurately estimated. If the originally magnetic substance were only magnetic to the degree shown by its induction curve, it is improbable that after cooling to −180°C. it would retain its original advance over the rest of the material; but if it originally possessed the permeability shown by the curve after the cooling, it would appear that this treatment has rendered the non-magnetic substance a better conductor, thus enabling the true value of the original material to be measured, whilst previously this was impossible owing to the finely divided state of the substance. The micrographic examination of these alloys does not afford any explanation of their magnetic properties.

To provide a theoretical explanation of these results is also a matter of great difficulty, being very much complicated by the behaviour of the alloy when slowly cooled, but the authors hope to obtain more information on the subject by a further set of experiments, which will consist in re-heating the alloys to various temperatures for a considerable time, and by noting the magnetic changes to form a clearer idea of the exact conditions under which the alloy assumes the unmagnetic state. As a tentative explanation of the facts, it appears as if a strongly magnetic substance were formed at high temperatures, which is not indicated in the equilibrium diagram, and that this disassociates at some point between 600°C. and 900°C., but tends to re-form below the former temperature, under favourable conditions (very slow cooling). This opinion will probably have to be modified very considerably when more data is obtained, but in the light of present knowledge it seems to be the only possible explanation in accordance with the facts.

The 33 per cent. nickel alloy is only very slightly affected by the drastic thermal treatment to which it was subjected, and it seems possible that there may be some connection between its remarkably low coefficient of expansion, and the very small change in its magnetic properties. The coercive force in every case is exceptionally small, and the material seems to be extremely soft (magnetically). There is a slight increase in the hardness as the temperature of quenching rises, the maximum induction showing a very small reduction, the coercive force an increase, and the general shape of the curve is that of a harder material, though as regards the latter property, the specimen quenched from 600°C. seems to be as hard as any of the series. The steels are unchanged by cooling below zero. The metallographic examination also shows only comparatively little change.

The following conclusions are drawn from these experiments: 1. A 5 per cent. nickel steel is hardest (magnetically) when quenched in the neighbourhood of 900°C. Quenching from higher temperatures results in a softer material. 2. The changes which occur during the thermal treatment of a 25 per cent. nickel-iron alloy are of a far more complicated nature than has previously been thought. At high temperatures there probably exists a product which may be preserved by rapid quenching, and is then strongly magnetic, and persists to the temperature of liquid air. This product does not exist in the region between about 600°C. and 900°C., but for another which is also magnetic can possibly occur at about 300°C. There is very little connection between the magnetic properties and metallographic structure. There is no sharp magnetic change point for this alloy below zero, but the permeability gradually increases as the temperature decreases from about −50°C. to −180°C. 3. The magnetic properties of a 33 per cent. nickel-iron alloy are only very slightly affected by thermal treatment. Despite the "γ-iron structure" produced on this steel by the more general etching media, it is strongly magnetic and soft. 4. There is no connection between magnetic properties and micro-structure. 5. There is no evidence that if γ-iron exists it is non-magnetic. 6. The microstructures of commercial nickel steels are practically the same as those of meteoric iron.

NOTES ON DESIGN, CONSTRUCTION AND OPERATION OF HIGH TENSION ELECTRIC TRANSMISSION LINES.*

BY C. D. GRAY.

The author discusses some of the points that should be considered in designing, constructing and operating aerial high-tension transmission lines, voltages above 10,000 being considered as high tension.

The distance to which power can be transmitted economically depends on the cost of fuel and labour, the railroad facilities of the district and the first cost of the complete power development. The present limit seems to be from 200 to 250 miles on the Pacific coast. The longest one in the east is that from Niagara Falls to Syracuse, about 160 miles. These limits are being extended by the introduction of higher voltage apparatus, so that to-day 150,000 volts is not considered beyond the bounds of reason, 110,000 being now used on four or five systems.

The possibility of building steam plants at the coal-fields where culm or other cheap grades of fuel could be used, for transmitting power to neighbouring cities has been proposed. There is one company doing this at the present time in Pennsylvania, the Harwood Power Co., which distributes power at 30,000 volts.

Voltage and Size of Wires.—Coming now to the transmission line, the voltage and number of circuits are usually the first points to be decided. These depend more particularly on the amount of power to be transmitted and the allowable loss and the distance, but the character of the load in respect to power factor, load factor, desirability for securing continuous service and character of country over which the line is to run, are also points to be considered. In general the voltage is determined from the allowable losses in the line with the most economical size of conductor. Kelvin's rule applies fairly well to this determination. A so-called "rule-of-thumb" method is that the pressure in kilovolts shall be equal to the distance in miles. In any case this problem usually resolves itself into a "cut-and-try" method for the first attempts in determining the size of the conductor, which can be carefully calculated later. A starting-point for conductor size is usually No. 4 copper or No. 2 aluminium for the smallest size to be used on short spans, and No. 2 copper and No. 0 aluminium for longer spans on account of mechanical strength. This being the starting-point, the voltage may then be determined to keep the loss within the limits desired. By loss is meant the actual C^2R, or ohmic loss (and not the voltage drop). This is usually kept from 5 to 10 per cent. of the delivered power. When duplicate circuits are installed, it is satisfactory to allow this loss when both are in service. If one is out for a time the generating voltage can be raised sufficiently to keep the delivered voltage at its proper value.

The number of circuits to be installed depends on the amount of power to be transmitted and the continuity of service required. In general, if it is necessary to keep the initial cost of the development low, and the system to be supplied has another plant or a steam plant kept under steam with engines or turbines floating on the system, it may be the best engineering to instal but one circuit. In many cases, where the voltage allows, the poles or towers may be equipped for two circuits and but one installed at first until the demand for power increases sufficiently to warrant the cost of installing the second circuit, or the loss becomes too great on one circuit.

In regard to the advisability of installing two circuits on one line of poles or towers, this is entirely feasible up to 35,000 volts on wood poles. With steel towers, duplicate circuits of any reasonable voltage can be employed. This type of construction is cheaper than the installation of each circuit on its own poles or towers, but has the slight disadvantage that some causes of interruption will put both circuits out of service simultaneously, such as falling trees or large branches that will touch both circuits at the same time. Greater care must also be used in repair work on account of the proximity of the live circuit. There is no advantage in single lines in respect to the usual causes of interruption, such as lightning, surges, mechanical breaks in wires, insulators, pins, poles or towers, caused by wind or ice strains on conductors and such as short circuits or earths caused by conductors swinging together or into the supporting structures.

Another problem that arises is to determine the connection of the circuits, whether delta or star, and if star, whether to earth the neutral at the power-house and sub-stations or not. Engineers differ in regard to this question. For voltages up to 45,000, it is probably better to operate delta in most cases, and above that value to connect star with the neutral earthed, although some systems at higher pressures are operated delta, the Central Colorado Power Co. being an example.

The delta-connected circuit can be operated on two wires, and if single-phase transformers are used one of a bank of three can be taken out without appreciably disturbing the voltage relations, the only effect being that it reduces the capacity of the bank. The voltage between any wire and earth is greater with the delta system for a given voltage between wires than for the star-connected system.

The star circuit can be operated on two wires, provided there is a "dead earth" at both ends of the line, but the voltage on the phases is apt to be somewhat unbalanced, depending on the conditions of the earth, their number and distance apart. Two transformers can also be used with the same disadvantage. The earthed neutral star-connected system lends itself better to the use of the Nicholson and other similar methods of testing for broken insulators or earth on the system.

The size of conductor is dependent not only on the losses but also on the sleet and wind conditions, especially for steel-tower construction. The allowance to be made for these factors depends on the section of country traversed by the line and the factor of safety de-

* Abstract of a paper read before the Brooklyn Engineers' Club.

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sired. It is generally safe to use 8 lb. wind pressure on the projected area of the wire, together with ½ in. radial thickness of sleet in sections where sleet forms. This wind pressure is equivalent to an actual velocity of about 56 miles per hour or an indicated velocity of 70 miles per hour.

The amount of sleet to be considered is a much-debated question, especially with aluminium wire. Some engineers say that sleet will not form on a live conductor and not at all on aluminium. The writer believes that it will form on aluminium, especially after the wire has been installed for some time so that the initial greasy coating has had time to wear off and the oxide has formed on the surface. While sleet is not apt to collect on a live wire with high voltage, still there is always danger of the wire becoming dead, due to some interruption, and then the sleet does form.

From a reconnaissance of the district it may be decided whether it would be best to use poles or towers. If there is any question in this respect, the approximate cost of right-of-way, clearing, hauling material, digging holes, &c., must be found, also whether or not the locality is subject to wind, sleet or lightning storms of especial severity. All of these factors must be considered before deciding upon a definite route.

Right-of-way.—The problem of securing reasonable prices for rights-of-way is much more difficult for a high-tension line than for a railroad, as there are no attendant advantages to the land owners unless they are broad-minded enough to realise that the general community will be benefited by cheap power which will benefit them indirectly. Such persons are, however, usually scarce. The right-of-way may be purchased in fee-simple, in which case it may be fenced or not, depending upon circumstances. Usually the farmers are allowed to cultivate the land provided they do not injure or interfere with the line in any way. This is advisable as it keeps down grass and brush which might cause trouble from fires or require cutting periodically. The right to enter the right-of-way strip either by patrolmen or repair waggons should be reserved. It is best to have nothing stated in the deeds regarding cultivation, but to allow it, so that in case the power company desires, it may fence off its property.

Often easements are obtained for setting poles or towers. These may be perpetual or limited by time, preferably the former. In this case the right to enter the property, patrol the line and repair it must be secured. If possible the centre line should be defined across each property without the number and location of poles or other structures specified, as it often happens that additional ones may be desired later, which gives the owner an opportunity for cancelling the original contract and demanding exorbitant prices under the new agreement.

The width of right-of-way to be secured depends on the number of pole lines and the cost of land, but should not be less than 100 ft. for any important line and should be entirely cleared of trees and brush, and if the section is subject to forest fires, fire trenches should be ploughed along its edges to help protect the structures from damage and prevent fires from crossing the right-of-way if possible. All trees outside this right-of-way strip that would reach the line in falling should also be cut. All timber and brush should be disposed of in some way or burned so that dead branches will not be picked up by the wind and blown across the circuits or furnish fuel for forest fires. If easements are secured the clearing should be done in the same manner. In rough country it may be necessary to make waggon roads or paths so that the construction, patrolling and repairs may be done more easily. After the right-of-way options have been secured for the entire line, with more or less flexibility as to route, a survey party should be put into the field and the centre line of the right-of-way located.

Construction Features.—The type of construction to be adopted depends on the importance of the system, number of circuits needed, first cost of construction and the cost of maintenance and repairs. The cheapest in regard to first cost for a single circuit is of course a wood-pole line, the poles being spaced as far apart as possible consistent with safety. This depends on the size of conductor and the wind and sleet conditions to be encountered. In the writer's opinion 200 ft. is the maximum span allowable and from 125 ft. to 150 ft. is better for average conditions with moderate-sized conductors. This refers to a single three-phase circuit with an earth wire for lightning protection.

The stresses in the wire and poles should allow for a factor of safety of at least two under maximum wind, temperature and sleet conditions.

The kinds of timber principally used in wood-pole construction are chestnut, cedar, cypress or juniper, red wood and pine, the latter being used principally when impregnated or treated with some wood preservative. All of these woods will rot more or less at the ground line and may be protected to prevent this action. As the price of poles goes up, due to the scarcity of timber, it becomes more necessary to prolong their life or make use of concrete or steel construction.

The methods of treating are (1) impregnating the entire pole by the vacuum process, using creosote, zinc chloride or other wood preservative; (2) the open-tank method of boiling the butt in one of the same preservatives for 7 or 8 ft., and (3) the brush treatment of the entire butt or only the section around the ground line extending 2 ft. below and 1 ft. above the ground. In the writer's opinion the treatment of the entire pole is not justified, and possibly the open-tank method may also be too expensive at the present time. It is then a question of using the brush treatment, which may increase the life from 25 to 50 per cent.

Wood Poles v. *Steel Towers.*—Among the advantages claimed for wood construction are cheapness in first cost, ease of construction, the insulation of the pole between the conductor and the ground (which is of doubtful value on high potentials), and the possibility of having a cross-arm or pole top burn off from an arc caused by a defective insulator without interrupting the service. A single line of poles of this kind may in some instances be installed at the side of highways, electric or steam railways where permitted, thus saving the cost of right-of-way and rendering patrolling easy.

Some engineers and operating men prefer two wood-pole lines each carrying a single circuit, to a double-circuit wood-line, even though the first cost and maintenance are much greater, believing that two circuits on separate structures even on the same right-of-way are not so liable to interruption from a common cause, and also that repairs can be made on one safely while the other is alive. Some prefer two wooden-pole lines to a double-circuit steel-tower line for the same reasons, even with the greater cost of the pole lines and the much greater cost of maintenance.

It has always seemed to the writer, however, that the steel construction is the better on account of the fewer insulators per mile and the lower cost of construction and maintenance. The life of the best wood construction is not over 12 to 15 years, while steel towers should be good for an almost indefinite period, provided they are properly maintained.

No data is available regarding the life of steel towers, as they have not been used long enough to determine their life, especially if galvanised. Galvanising should be good for 10 or 12 years, and then, by painting every two or three years with some good preservative paint, such towers ought to last 40 to 50 years or even longer.

Single-circuit pole construction does not lend itself well for supporting an earthed arrester wire over the power conductors, as some sort of an iron support must be used. On a double-circuit wood-pole line this wire can be carried on the top of the pole, preferably installed on a pole-top pin and insulator, the insulator merely being used to furnish a smooth support for the wire and to which it can be tied. Among the other disadvantages of wooden construction are the increasing cost of poles in all sections of the country, the decreasing factor of safety of the line with the age of the poles and the difficulty of transporting poles in mountainous regions.

For wood construction the cross-arms should be of extra size. Iron pins with separable thimbles for cementing into the insulators should be used, and in general the construction should be the best in all respects.

Concrete poles are coming into use, replacing wood, but they have been of such recent construction that no conclusion can be made regarding their durability. They will doubtless be used more and more as wood increases in price and more data is available regarding their characteristics. The practical disadvantages of concrete poles are their high first cost in manufacturing, hauling and erection, and the difficulty of obtaining uniform product. There is also the problem of fastening the cross-arms to the poles so that the fastening will be substantial and not corrode.

Wood and concrete poles lend themselves best to the use of pin-type insulators which may be used with reasonable safety up to 66,000 volts, beyond which voltage suspension-type insulators must be used. The latter require greater lengths of supporting cross-arms on account of the tendency of the insulators to swing as pendulums about their supports, which increases the strain on the cross-arm and the torsional effect on the pole.

We will not consider tubular or small built-up latticed steel poles, the cost of which is too high to consider for high-tension line work. In some cases where the lines are run along railroad rights-of-way such as the New York Central, New Haven or Long Island railroads, where the voltage is restricted to from 11,000 to 22,000 volts, they may be used, but their cost is very high.

Steel-tower, long-span line construction is the best in nearly all cases where private right-of-way or easements can be secured, if it is possible to use high voltage so that the conductor is kept within a reasonable size. These towers should be made up of small structural shapes such as angles and channels. Some engineers and manufacturers of towers make use of rods, flats and pipes, but it is best to use only angles and channels bolted together in the field. Certain mem-

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bers, however, such as cross-arms for holding the insulator supports and the earthed wire support, may be made of two channels latticed together and riveted in the shop so that the whole member can be galvanised. The other members should be galvanised after the holes are punched, galvanised or sherardised bolts being used in all cases.

In designing towers of this kind it should be borne in mind that they cannot be designed by ordinary structural or bridge formulæ, as the factor of safety and deflection of the different members are so different. A factor of two or three is used and deflections that would not be safe in other types of construction, so that the design is more or less the result of experience and of tests on sample towers built up and actually tested with the different loads and combinations of loads that may be imposed in actual service. In making such tests, if the material for the test tower has not been galvanised, an allowance should be made, as the strength may be decreased from 15 to 20 per cent. by galvanising.

Towers should be designed for the standard height and strength desired and then extensions of 10, 20 or 30 ft. should be designed to fasten to the bottom of the standard towers to make higher ones. These extensions should be arranged to bolt to the corner legs of the towers without any drilling or fitting in the field. All towers should be designed to take the same wire stress as the standard towers, in fact the stress in the wires and the clearance to ground should be kept constant and the sag and span varied. In this type of construction it is interesting to note that the cost of line per mile is practically the same for different heights of towers and lengths of span with the same size conductor and stress on it. This statement, of course, applies within certain limits and could not be used in all cases.

Double-circuit towers of the ordinary construction support six power conductors, one earth wire and two telephone wires. The towers should withstand torsional stresses due to one circuit being broken on one side of the tower, or both circuits being broken on the same side, that is each tower should be a dead-end tower.

The spacing and location of wires differ for different voltages, but a safe rule to follow is that on long spans nothing less than 60 in. be used up to 60,000 volts, and this increased 1 in. for each 1,000 volts over 60,000. With suspension-type insulators care should also be taken to see that when the insulators swing with the wind they do not come too near the supporting structure. It is usual to assume them swinging to an angle of 45 deg. from the vertical, and in this position the wire should not be nearer the supports than 20 in. for 60,000 volts, plus $\frac{1}{2}$ in. for each 1,000 volts over 60,000. It often happens that light wires, especially aluminium, will swing beyond 45 deg. In fact, the writer has seen wires blown out nearly horizontal, in which case the clearance mentioned above should be maintained with the horizontal position of the wire. Power wire should be at least 22 or 23 ft. above the ground at the lowest part of the span and the telephone wires might be 6 ft. lower. This minimum clearance depends on local conditions.

The anchors for the towers are always separate from the corner members and arranged to bolt to them, so that they can be set before the towers are erected. The best form of anchor consists of an angle about 6 ft. long with a cross consisting of two pieces of the same material about 2 ft. long bolted to it. This type will usually develop enough holding-down power to satisfy the requirements in all kinds of ordinary soil.

Field Construction.—The cross arms, earth wire supports and insulator pins are usually put on before the poles are raised and the insulators installed later just previous to the stringing of the wire, to prevent breakage and loss by theft or otherwise. Often times for voltages of 35,000 or less, the insulators are installed when the poles are on the ground.

The wires are usually strung by hand or with a team. If the ground is rough or aluminium wire is used, which is easily abraded by dragging on the ground, it is run through snatch blocks attached to the poles or towers so that it does not touch the ground.

In the construction of the line, the holes are usually dug by one gang and the anchors set and tamped in by another. The towers are assembled complete on the ground by one gang and erected by another gang, the erection usually being done by the use of a gin-pole or derrick. All the wires are usually installed at the same time and the telephone wires connected up for use with portable telephone sets, so that the construction gangs can keep in touch with each other and the construction office.

The methods of fastening the wires to pin-type insulators consist of different ties or mechanical clamps. For ties, the double or so-called Mershon tie is good, especially for aluminium wire where it is necessary to protect the wire for some distance beyond the insulator head against arcs from the upper petticoat. This tie consists of two ties, one on each side of the insulator. One end of the tie wire is started at the head of the insulator and served around the main conductor outward for 3 or 4 in., the wire is then carried around the tie-wire groove of the insulator and the end again served outward from the other serving until the main conductor is covered for 3 or 4 in. beyond the edge of the upper petticoat of the insulator. Another similar tie is used on the other side of the insulator. It is usual to protect the conductor in the wire groove of the insulator with a sleeve of the same material as the conductor. This sleeve extends just beyond the head of the insulator. It is usually of U section with the ends swaged out, so that it will not cut the conductor, and when it is installed it is hammered down on the top so that it will be held in place.

Mechanical clamps are also used, but, in the writer's opinion, are not so good as the above tie as they tend to cut and abrade the conductor and do not protect it from arcs. The above protecting sleeve and method of tie is especially desirable when aluminium wire is used, which is more easily abraded and affected by arcs than copper. For use with suspension insulators, various types of mechanical clamps are used, designed so as not to injure the wire.

The problem of obtaining satisfactory methods of splicing the conductors on long-span work is a difficult one, as the strength of the conductor is limited by the strength of the joint. The joints that seem best adapted to this work are the twist-sleeve joints made longer than usual so that three or more complete twists of the conductor can be made.

The author finally discusses the proper operation of the line and also gives a few details of costs of construction. These show a slight increase in cost of a single-circuit steel-tower line over a wood-pole line. Also a saving in cost of a double-circuit steel-tower line over two single-circuit wood-pole lines or steel-tower lines. In the writer's opinion, the double-circuit steel-tower line is the one to instal in most cases where two circuits are needed, unless the system is a very important one and the initial expense of two lines on separate routes is justified in order to secure continuous service.

MR. ROSLING'S ADDRESS TO THE VICTORIAN INSTITUTE OF ELECTRICAL ENGINEERS.*

On the first page of our rules you will find the objects of this institution, viz.: (1) The exchange of ideas and information on electrical science and kindred subjects, by the reading and discussion of Papers. (2) The furtherance of the interests of electrical engineering by concerted action. (3) The cultivation of friendly relations between the members of the various branches of electrical engineering and its allied industries.

We have carried out the first and third items with some success and pleasure, but we have not done very much in furthering the interests of electrical engineering by "concerted action."

I propose to bring to your attention some opinions that I have heard expressed upon certain conditions at present prevailing, which press hardly upon electrical engineers in Australia generally and on the industry in Melbourne particularly. I refer more especially to the combination of professional with contracting work, a practice condemned alike by clients, consultants and contractors in other civilised countries, and to the unlimited powers in favour of the purchaser inserted in the "general terms and conditions" usually issued with specifications calling for public tenders.

Electrical engineering is itself a comparatively young industry, but has made phenomenal growth, and here, in Australia, a young country as far as civilisation is concerned, the growth has been perhaps more rapid than in the older countries. In all phases of life, certain practices, which in youth are quite mete and proper, must be put aside as beneath the dignity of maturer years; so with electrical engineering. In a young country with a scattered population, in the early stages of development, it is hardly to be avoided that contractors should do almost the whole of the advising and consulting work, but, as the industry grows, it becomes more and more advisable to separate the consulting from the contracting work. Further, the qualities required for excelling in either branch are diametrically opposed; a good consulting engineer should be entirely impartial in formulating the scheme which he considers will be most economical and satisfactory in use, and in choosing the plant which he considers will give the best results, whereas a good contracting engineer should be a firm believer in the particular plant he has to sell, and should use his best endeavours, if his plant does not suit a scheme, to make the scheme suit his plant.

When a contracting engineer considers the question of preparing a scheme for public tender, there are three courses open to him. Firstly, he can prepare the specification to the best of his ability, and

* Abstract of the Presidential Address delivered by Mr. P. Rosling.

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stand aside altogether as a contractor, but adjudicate on the merits of the respective tenders. This is perhaps the least objectionable method, but it may prevent him recommending the use of certain plant which he, as a contractor or a supplier, is interested in, and which he believes to be the best of its kind, and he may have to accept a tender from a firm for plant which he has previously considered of an inferior nature. Moreover, he is almost certain to find that he does not receive full and proper tenders from certain firms who are naturally shy of putting the whole of their information before a probable future competitor.

Secondly, he can prepare the specification or specifications for the work, send in a tender to his own specification, and leave it to some other engineer to adjudicate on the tenders and supervise the carrying out of the work. One objection to this method is that besides divided responsibility, it is highly improbable that the adjudicator will see eye to eye with the author of the specification, and the scheme as carried out will differ in detail from the original design, usually causing the client extra expense, or a loss to the contractor, who has to work to one man's specification as interpreted by another. The greatest objection, however, to this method is that, whether he does or not, the contractor preparing the specification is credited by his competitors with ear-marking certain details of the plant or method of installing the same, in order to give himself an advantage in tendering, thus giving rise to a spirit of uncharitableness.

On the third course, where the contractor prepares the specification, tenders himself, and adjudicates on the different tenders, and finally supervises the carrying out of the contract, it is hardly necessary to comment.

There seems to be the probability of several large schemes of electrical power installation coming to a head in the immediate future, and these, together with country town lighting and extensions to present plant, should provide scope for one or two engineering firms carrying on consulting work only; and if we, as an institute, possibly in connection with our friends in New South Wales, follow the example of the English and American institutes, and set our faces against the practice of contracting engineers preparing schemes for public tenders, the public would very soon see that it was to their advantage to follow our lead.

While on the subject of consulting engineers, it is to be hoped that here in Australia we may begin where the leading consulting electrical engineers in England and America have already arrived, namely, that the consultant in his specification will state what is to be accomplished, and broadly how it is to be done, and give such details as the power that is to be installed and the overload and efficiency required, leaving the manufacturers and the contractors to state how they will give the desired results with their standard apparatus.

With regard to conditions of tendering, it is the favourite practice in Australia to specify that, in case of disagreement, the decision of the buyer or his engineer for the time being is to be final and binding on both parties, that is, the contractor is to have no redress whatever over some quite legitimate misunderstanding. Such terms are sufficiently onerous when a contractor is dealing with an engineer whom he has found to be fair and reasonable, but with general terms and conditions, put in the words "the engineers or officers for the time being," in what sort of position is a contractor should anything happen to the engineer during the completion of the contract, and a stranger, with quite different ideas, supervises the completion of the contract. He probably does not see eye to eye with his predecessor, and the unfortunate contractor, having agreed to the general terms and conditions, may be in a very precarious position.

At present, I understand, some firms refuse to quote to such terms, and others put in a percentage to cover contingencies, even, I believe, in some cases insuring the life of the engineer for the time the contract is likely to last, for an amount they may consider they may lose through the change of engineers during the course of the contract, but as contingencies of this nature are pure guesswork, it brings an element of gambling into the contract which is quite out of place.

All this uncertainty and trouble could be done away with by inserting a proper arbitration clause. Contracting engineers do not mind how stringent terms and conditions may be so long as they feel that in the event of serious disagreement they can refer the matter to an entirely independent authority; and I cannot see how any competent broad-minded engineer can object to an arbitration clause.

Such alterations to present conditions cannot be brought about all at once, but if members of this institute, and our friends in New South Wales, would agree to recommend that no member should act in the dual capacity of contractor and consultant for a scheme for which public tenders are to be called, and, further, that any member, when preparing specifications for public tenders, should insert a proper arbitration clause in the general terms and conditions, I think that before long the present unprofessional and uncommercial conditions would cease to exist.

Another matter which we, as a local body, ought to take in hand is the education of the Electricity Committee of the Melbourne Town Council on the question of rates for power and heating. It has been shown conclusively in the daily Press how much more economical electric lighting is than gas; but for heating and power we are in competition with coal as well as with gas, and although, starting on the same basis, the present rates show many advantages in favour of electricity, the margin of cost is often not sufficiently wide to induce people to discard their present plant and substitute electric heaters, cooking apparatus and motors.

In developing a load for an electricity station, you are met with the problem that costs can be reduced only by increasing the output of the plant installed, and usually that the output can only be increased by reducing the prices. There are two methods of meeting this problem: one is to be content to go very slowly and allow the load to increase through the numerous advantages electricity has over its rivals almost irrespective of cost, and very gradually reduce prices as the increased load reduces cost; the other is to make up your mind what your output is likely to be at a certain date, with prices per unit that that output will justify, and offer your current at the price, irrespective of a possible present loss, and leave no stone unturned to ensure that your estimate of output will be found to be under rather than over the mark.

As an example, the author refers to one of the power companies in England. It is not necessary, however, to go outside Australia for an example of the benefit of cheap power rates. Sydney has now a flat rate of 1½d. per unit and a sliding scale rate of 4s. per month per horse-power capacity installed, plus ¾d. per unit used. With the flat rate of 1½d. per unit (the sliding scale rate has only just come into force), Sydney's output for power and heating is more than double that of Melbourne, where the charge is 2d. per unit on the flat rate, or 2½d. per unit for the first 75 hours' full load use per month, and ½d. per unit thereafter, a sliding scale which, on the average, does not prove of much use.

Working from the present averages, and the result of Sydney practice, if the Melbourne Council made the power rate 2d. per unit for the first 45 hours' full load use per month and ¾d. thereafter, it would greatly encourage the use of motors, and would bring cooking and heating electrically into prominence, as it would bring the price to the average householder to about 1d. per unit for these purposes. For large users the price should be reduced still further, depending upon the hours worked, even down to ½d. per unit for a 24-hours' load, or for a limited hour supply.

Ethically, I believe, it is open to argument whether a municipal council should endeavour to run its various departments to show a profit for the relief of the rates, or should so adjust prices as to leave each commercial department just paying its way after allowing proper depreciation and sinking funds. Commercially, however, situated as we, the ratepayers, are in Melbourne, it is extraordinarily short-sighted to turn over electricity profits to the relief of rates, instead of reducing prices to consumers.

In a modern city like Melbourne, with its mild winters and hot summers, there should be neither coal nor gas used outside the electricity generating station. Electricity is the ideal means of supplying power, heat and light, and it only rests with the Electricity Committee to embark upon a bold and vigorous policy in order to make the electricity supply scheme a most valuable asset to the ratepayers, at the same time making Melbourne one of the best electrified cities in the world.

Another reason which is probably helping Sydney to go ahead faster than Melbourne in electrical matters is that they are not there handicapped by the single-phase system, for, although this is perhaps the best and simplest system for transmitting current over large areas for lighting purposes only, it is hopelessly behind a two-phase or three-phase system directly power begins to assume a noticeable portion of the load.

Melbourne used to be considered the leading business and manufacturing town in Australia, but, as far as the use of electricity is concerned, it is content to take second place to Sydney. Not a little blame for this state of things must be put to the debit of the Melbourne City Council for the way they have neglected the interests of the ratepayers in failing to give them the advantages of a cheap power supply, and some little blame must be attached to the electrical engineers in Victoria for not being more energetic in inducing people outside the industry to take more interest in the way the industry is throttled.

The foregoing address was prepared before I had the pleasure of reading Mr. Forbes Mackay's most interesting address to the Electrical Association of New South Wales, and I find that, to a certain extent, we are in phase with one another. One paragraph I take the liberty of quoting verbatim:—

"It rests with us to see that the public has constantly kept before it the fact that electricity is the form of energy best suited for use for

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all purposes—in the office, in the home and in the factory. I consider it nothing short of a crime against humanity to instal any but the most wholesome, convenient and economical public services in new towns and cities. But if those who should do not insist, and insist in the most public way, on the mistake which will be made if old-fashioned, unwholesome, inconvenient and uneconomical services are installed, they will continue to be installed. The average man, whether he thinks it of himself or not, is conservative. In mechanics, we are taught that a body which has been put in motion tends to move in a straight line. It requires the application of force to cause a change in the direction of motion of a body. A man in his life resembles the moving body, inasmuch as if he be not pushed or pulled in one direction or another, he tends to do to-morrow what he is doing to-day, and to go on doing it as long as he lives. Each of us must push or pull as many members of the public as we are able to influence in the direction of discarding old-fashioned methods of lighting, heating, cooking and driving machinery in favour of what I am convinced is the only perfectly satisfactory method."

THE ACCIDENT AT MILLBROOK ON THE STALYBRIDGE, HYDE, MOSSLEY AND DUKINFIELD ELECTRIC TRAMWAYS.

The report of Lieut.-Col. P. G. von Donop, R.E. regarding the accident which occurred at Millbrook on the Stalybridge, Hyde, Mossley and Dukinfield Tramways on June 5th last has now been issued by the Board of Trade.

It will be remembered that the driver of a car descending this hill lost control and that the car on reaching the curve at the bottom overturned. Thirteen passengers, of whom one subsequently died, were seriously injured and 20 others were slightly injured. The car was of the four-wheel, single-truck type and was fitted with hand and magnetic track brakes. There are compulsory stops at the top, bottom and halfway down the hill and speed is limited to four miles an hour. The steepest gradient is 1 in 11·4. The approach to the top of the hill is on a right-handed curve and at the top there is a left-handed curve. The rails appear to have been in a slippery condition.

The driver had already taken the car once down the hill on the morning of the accident and both then and on other previous occasions the same day the magnetic brake had acted satisfactorily. According to his evidence, before the accident the driver brought his car to the top of the hill, and stopped. Then he started and gradually moved his controller handle over the braking notches till he reached the fourth and last without effect. Then he shut off the magnetic brake altogether and tried to stop the car with the hand brake. In connection with this evidence the inspector points out that the driver acted entirely contrary to instructions. According to the rule for coasting gradients he should have set the controller handle at the fourth braking notch, and eased off his brake; on the gradient on which the car was standing no application of power was necessary to start the car, as it would have at once commenced to run forward by its own weight, and the magnetic brake would then have come into action whilst it was travelling at a low rate of speed; if this speed was found to be too low, the controller handle might then have been moved to the third notch, which would have allowed a slightly increased speed to the car before the brake came into action again. The special object of this rule is to ensure that in coasting down a hill the brake is applied whilst the car is running at a very low rate of speed, but the driver's action in first applying power and then applying the magnetic brake at the second notch would have prevented the brake from coming into action until the car had attained a comparatively high rate of speed. It may also be pointed out at the same time that the driver admitted that he had entirely neglected to carry out the instruction to test his magnetic brake before starting down the steep gradient.

According to the conductor's evidence the car was stopped at the top of the hill, but of the 10 passengers whose evidence was available, seven were positive the car did not stop, one first said it did not stop and then stated it did, while two were not certain whether it stopped or not. The driver and conductor on a car which had just ascended the hill and was standing at the top both stated that they were watching the car to which the accident occurred and that it did not stop. Further, they stated that the driver was applying his hand brake very hard and that shortly after running past the compulsory stopping place they saw him apply the magnetic brake. Neither witness could, however, state whether the hand brake was released before the magnetic brake was applied.

From the above evidence the inspector concludes that the car failed to stop at the top of the hill and that it ran past the compulsory stopping place at a high rate of speed. At the inquest the driver of the car admitted that he did not stop the car.

The inspector concludes that there are no grounds for attributing the runaway to any defect either in the hand or in the magnetic brakes. He has no hesitation therefore in deciding that this runaway must be attributed in the first instance to want of care on the part of the driver, in allowing his car to approach the top of the hill at a considerably higher speed than that allowed by his regulations; and, secondly, to the driver's want of skill in the manipulation of his brakes when he lost control of the car.

The Westinghouse Brake Co. are now fitting their magnetic brake equipment with an additional contrivance, which enables the track brake to be applied mechanically as well as magnetically; the driver has thus the power to apply the track brake, even though the wheels of the car are not revolving. For gradients such as those which exist at Stalybridge, this device would form an additional safeguard, and the Joint Board might be asked, the inspector thinks, to consider the advisability of fitting it on their cars.

As regards the overturning of the car the curve was examined after the accident and it was found that at one point its curvature was 56 ft. The superelevation was also examined and was found to be very irregular. The maximum was 2¼ in., but at some points, even where the curvature was sharp it was as little as ⅛ in. Under these circumstances it was almost inevitable, Col. von Donop considers, at the speed at which the car was travelling that it should be overturned.

This is now the third case, the inspector points out, which has occurred on this hill of a car having been allowed to get out of the control of the driver, and there is clearly no assurance that it will not occur again. To a runaway car, the curve at the bottom of this hill is an almost certain source of danger, and it is imperative that some steps should be taken to minimise the danger arising from it. The want of uniform superelevation could be corrected by banking up the road, and this should in any case be done forthwith. But the curve itself requires relaying so as to do away with the very sharp portions of it which now exist. It should, in fact, be so relaid that the curvature should at no point be sharper than the 1½ chains radius originally approved for it. This is a more difficult matter, as it will probably entail some widening or diversion of the road. But until this alteration to the curve is carried out, Col. von Donop does not consider that any top-deck car should be allowed to travel on this hill. The improvement on this curve is a matter calling for the Joint Board's urgent attention.

TRAMWAY AWARD UNDER CONCILIATION ACT.

In connection with the recent dispute between the Leeds Tramways Committee and their tramway employes, as the Committee failed to effect a settlement with representatives of the men's organisation (the Amalgamated Society of Tramway and Vehicle Workers), Mr. Askwith, K.C., of the Board of Trade proceeded to Leeds on August 3 to act as conciliator between the parties. Mr. Askwith, who was accompanied by Mr. D. C. Cummings of the Board of Trade, met representatives of the parties, and subsequently presided at a joint meeting, at which an agreement was arrived at.

For purposes of comparison with the terms of employment on the tramways of other powers we set out the agreement which was made on Aug. 4, 1911, between the Corporation of Leeds and the Amalgamated Association of Tramway and Vehicle Workers (Leeds Branch):—

1. That the working hours of conductors and motormen shall be as nearly as possible an average of 54 hours per week of six days.

2. That the following scale of wages be paid to conductors and motormen upon the understanding that payments for bonus, meal reliefs, and long spreads be discontinued, except as hereinafter stated.

Conductors.	Hour.		Week.
For first six months of satisfactory service .	5¼d.	...	24s. 9d.
For next twelve months	5⅝d.	...	25s. 10½d.
For next twelve months	6d.	...	27s. 0d.
Thereafter, if not appointed as motormen ...	6¼d.	...	29s. 3d.

Motormen.	Hour.		Week.
For the first six months	7d.	...	31s. 6d.
For the next twelve months	7¼d.	...	32s. 7½d.
Thereafter	7½d.	...	33s. 9d.

On all duties when the spread-over does not exceed 12 hours a margin of three hours be agreed to with no deduction for meal time; on all duties exceeding a 12-hour spread, and up to 15 hours, a margin of two hours be allowed. On all duties exceeding a 15-hour spread a margin of one hour be allowed. When a duty exceeds 12 hours a half-hour shall be deducted for meal time.

3. That upon the expiration of seven years' satisfactory service by

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conductors or motormen a merit stripe and 1s. a week extra wages be allowed as at present.

4. That spare conductors and motormen be guaranteed five and a half days' work per week of six days.

5. That where a conductor who is qualified as a motorman is so employed he shall be paid at motorman rates, and such time shall aggregate towards his next advance in wages.

6. That all time worked by motormen and conductors over 58 hours per week of six days be paid at the rate of time and a quarter.

7. That the wages of car cleaners (night staff) shall be 6d. for the first twelve months, 6½d. for the next three years, and 6¼d. after four years' service, previous service to count.

8. That the wages of labourers to car repairers and motor-overhaulers, as in clause 9, sandmen and greasers be for the first six months 22s. per week, for the second six months 23s. 6d. per week, after further twelve months 25s. per week, thereafter 26s. 6d. per week.

9. That the scale of wages for car repairers (night staff) and overhaulers (day staff) be as follows:—

	Per Week.
On appointment and for first six months	27s.
For next twelve months	28s.
For next twelve months	30s.
Thereafter	31s. 6d.

10. That the scale of wages for controller and trolley attendants (night staff) be as follows:—

	Per Week.
On appointment at age of 18	15s.
Second year, at age of 19	17s.
Third year, at age of 20	19s.
Fourth year, at age of 21	21s.
Fifth year, at age of 22	23s.
Sixth year, at age of 23	24s.

11. That overtime at the rate of time and a quarter for the first two hours and time and a half afterwards be paid to the shed staff engaged on night duty.

12. The Corporation guarantee that the percentage of spread-overs shall not increase in future, but, so far as possible, shall be decreased.

13. This agreement shall be subject to six months' notice on either side, but no notice shall be given before Feb. 4, 1914.

The London County Council tramway employés, who are agitating for an increase of wages, have formulated their demands as under:—

1. Minimum wage for adult labourers to be 30s. per week.

2. Rates of pay to be 5s. per day on entering the service and for the first four months, 5s. 6d. per day for the second four months, 6s. per day after eight months, and 6s. 6d. per day after 12 months.

3. Hours of labour to be eight per day—48 per week.

4. Rates of pay for all public holidays to be time and a half, with the exception of Christmas Day, which shall be paid at the rate of double time, or in lieu thereof three days' holiday per man per annum.

5. All men called upon to work upon their recognised weekly rest day to be paid at the rate of time and a quarter.

6. All overtime—that is to say, all time worked over schedule time (as per time-board)—to be paid for at the rate of time and a quarter.

7. All men promoted to positions as inspectors, &c., whilst on probation to be paid at the rate of 7s. per day, the period of probation not to exceed one month.

8. Court of appeal to be established to deal with cases of dismissal from the services of the Council.

The Aberdeen Tramways Committee is considering a request by the motormen and conductors for an increase of wages.

Motormen and conductors for ordinary week-day duty demand 5d. an hour on appointment, 6d. on completion of one year's service, 6½d. on completion of two years' service and 7d. on completion of three years' service. Members of the staff with more than two and three years' service to be granted an immediate increase in accordance with these rates. The rate of pay for Sunday work (motormen, conductors, cleaners and repairers) is to be increased from 8d. to 9d. per hour; and payment for work on week days over and above regular duty must be made at rate of time and quarter.

PARLIAMENTARY INTELLIGENCE.

GOVERNMENT CONTRACTORS AND FAIR WAGES.

In the House of Commons on Friday Mr. LANSBURY asked the Postmaster-General whether the Peel-Conner Telephone Works (Ltd.) were carrying out work for his department at a new telephone exchange in London; if so, whether they were employing telephone wiremen at 7d. per hour, although the rate for men of that trade was 9½d. per hour.

Mr. H. SAMUEL said he had made inquiries into the case, and his information was that the rate of 9½d. per hour to which the hon. member referred did not apply to telephone wiremen, and that no infringement of the fair-wages clause had taken place in the case of the Peel-Conner Co.

Mr. BOWERMAN asked if it was customary to recognise as fair a firm which on every other class of work pays unfair wages.

Mr. H. SAMUEL said no. The President of the Board of Trade a year or two ago said that if a firm was notoriously a bad employer it would not be retained on the list of Government contractors, even though the wages paid on Government contracts were strictly in accordance with the fair-wages clause. But he had no information that the particular firm was in that class.

Mr. POINTER inquired if the department could adopt the same attitude as corporations, and insist on trade-union wages for the whole of the employés.

Mr. H. SAMUEL said the attitude of the Government was declared on the occasion of the debate. He did not think they should be justified if they had a very small contract with some large firm in investigating all the conditions of employment throughout that firm's factories and insisting on trade-union rates being paid for all work.

GLASGOW TELEPHONE OPERATORS.

In the House of Commons last week Mr. MACCALLUM SCOTT asked the Postmaster-General whether, while National Telephone Co. operators with five years' company service, on being taken over by the Post Office, would be entitled to the full period of annual leave in 1912, the ex-Corporation (Glasgow) operators, who had already completed five years' Post Office service apart from previous company and Corporation service, would not receive the full period of leave until 1913.

Mr. H. SAMUEL said that, although in some respects the staff of Glasgow Corporation telephone department would have been less favourably treated than the staff of the National Telephone Co. on transfer to the Post Office, the conditions of transfer, taken as a whole, were more favourable to the former than to the latter.

Mr. MACCALLUM SCOTT asked the Postmaster-General why the transfer conditions comprised in the memorandum of 1905, relative to the staff of the National Telephone Co. were not applied to the staff of the Glasgow Corporation telephone department on its transfer to the Post Office, in view of the fact that the memorandum was issued previous to the transfer of the Corporation undertaking; and whether he was aware that it produced discontent in the public service that such discrimination should be made on the transfer of different staffs engaged on exactly similar work.

Mr. SAMUEL said the memorandum was drafted to give effect to the recommendations of the Select Committee of the House which sat in 1905 to consider the provisions of the agreement of Feb. 2, 1905, between the Postmaster-General and the National Telephone Co. The case of the Glasgow Corporation staff did not come within the purview of the Select Committee's report or of the memorandum. The Glasgow Corporation staff had benefited by comparison with the National Telephone Co. staff in that after a comparatively short period of employment under the Corporation they were taken into the service of the State more than five years earlier.

ELECTRICITY SUPPLY WORKS AND STRIKES.

In the House of Commons on Monday, Mr. LANSBURY asked the Home Secretary by whose authority soldiers were sent to occupy the Poplar electricity works last week, how long they stayed and at whose request and for what reason they were removed.

In reply, Mr. CHURCHILL said he did not know to which of the electrical stations in Popular the hon. member referred, but he might say that before troops were brought to London a list was prepared by the police and military authorities of the places to be specially guarded, because of the serious injury to the public which would ensue if damage were done by rioters. The chief electrical stations were on the list, and pickets were sent to them accordingly. He could not speak as to the actual circumstances that occurred inside any particular station. But the rule undoubtedly which they had usually followed had been that soldiers should be sent in aid of the civil power when thay had been advised by the local authority. In the present situation the military authorities had been charged with general duties for protecting the property of the railways and for securing law and order in the maintenance of traffic. For the purpose of discharging that duty it had been necessary to employ a large number of troops, and those troops had been placed under the orders of different generals who were responsible for certain areas in the country. Those officers in the discharge of their duties had been given and would continue to enjoy full discretionary power to move troops along the lines of railway to such points as might enable them to safeguard as far as possible the ordinary working of all necessary traffic.

New Acts of Parliament.—On Aug. 18 Royal Assent was given to the following Acts:—

Telephone Transfer, Expiring Laws Continuance, Dunfermline & District Tramways Order Confirmation, Edinburgh Suburban Electric Tramways, Paisley District Tramways Order Confirmation, Electric Lighting Orders Confirmation (Nos. 1 to 5), Tramways Orders Confirmation, Paignton U.D. Council, South Lancashire Tramways, London, Brighton & S. Coast Railway, Northampton Corporation, Winchester Corporation (Electric Supply), Sidmouth Gas & Electricity, Liverpool Overhead Railway, Metropolitan Railway, Bristol Tramways, Central London Railway, Nottinghamshire and Derbyshire Tramways, Middlesbrough, Stockton and Thornaby Tramways, Metropolitan Electric Tramways, London, Tilbury & Southend Railway, Rhondda U. D. Council, L.C.C. (Tramways and Improvements), Aberdare U. D. Council, Brighton, Hove and District Rail-less Traction, East Kent Electric Power, Halifax Corporation, Rotherham Corporation, Newcastle Corporation and Corporation of London (Bridges).

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COMMERCIAL AND INDUSTRIAL SECTION.

MUNICIPAL, FOREIGN & GENERAL NOTES.

BRITISH NOTES.

Abercarn.—The Council have adopted a scheme for the construction of electric tramways in the Western Valleys.

Arnside (Lancs.)—Public electric lighting is about to be introduced. Current will be supplied by Mr. Thos. Wilkinson, who has put down generating plant at his residence.

Burnham.—The Council have asked Mr. W. H. Trentham to report upon the proposal to erect electricity works in the district.

Cotton Mill Driving.—Albert Mill, Accrington, is running several looms by electric power supplied by the Corporation. It is stated that so far as the running is concerned the new power is all that could be desired, but it works out about 1½d. per loom more than the old method.

Customs Duties.—It has been decided that, under the Australian Commonwealth import tariff, the duty on electric bells, automatic arc lamp couplings, lampholders, ceiling roses, rosettes, wall plugs and Morse telegraph instruments is 17½ per cent. ad val. (10 per cent. for British goods). Rosettes and wall plugs suitable only for telephones can be imported free. The duty on shade galleries for electric lamps is 25 per cent. (British 15 per cent.) and on "Meggers" 5 per cent. (British free).

It has been decided that under the French import tariff the dynamo of small ventilating apparatus "consisting of a dynamo with metal wings" is liable to duty as a "dynamo-electric machine" and the wings of such apparatus are subject to duty as "detached parts of machines (other than electric)," or "manufactures of nickel, other" or "nickelled manufactures"—according to kind. Large ventilating apparatus, without electric equipment to be worked (by transmission band) by an electric motor is included under 512bis as "Ventilators, according to size," and large ventilating apparatus provided with coils and electrical attachments under 524bis, "electrical apparatus, according to kind." In the case of electric cranes, the motor, rheostat, crane and wagon or truck are subject to duty separately (under 524, 524bis, 525bis and 614, respectively.)

Carwen.—An inquiry was held here on Aug. 22 into the application of the Corporation for permission to borrow £7,600 for extensions of the electricity supply undertaking. It was reported that the demand for energy for power and lighting was increasing, and it was necessary to put down additional plant to meet the demand.

Fire.—A fire broke out at the Gillingham electricity supply stores on 15th inst., causing damage estimated at about £2,000. The supply of electric current for public and private lighting was not interfered with.

Glasgow.—At the meeting of the Corporation yesterday (Thursday) the Tramway Committee reported on the recent strike of the Corporation tramway employés.

At a meeting of the Committee on 14th inst. it was resolved to leave the settlement of the dispute in the hands of the General Manager, although an attempt was made to refer the subject matter of the dispute to an arbitrator of the Board of Trade, whose decision should be binding on the parties for three years.

Holmfirth.—The Council have adjourned for six months the question of obtaining electricity supply powers, but a plebiscite of the ratepayers will probably be taken on the subject. It is suggested that the Council should take current in bulk from the Yorkshire Electric Power Co.

Hospital Lighting.—Settle Council have decided to put in an electric lighting installation at the local hospital at a cost of £200.

Killeshandra (Ireland).—A L.G. Board inquiry was recently held into the application of Cavan Council for powers of an urban sanitary authority with respect to the electric lighting of Killeshandra and to fix the area, charges, &c.

Launceston.—The Council have approved the plans of the proposed electricity works which the Launceston & District Electric Supply Co. proposes to erect on land adjoining the L. & S.W. Railway station.

Light Railways.—The Southend-on-Sea Light Railways (Extensions) Order has been submitted to the Board of Trade for confirmation. Objections to the Board of Trade by Sept. 14.

Liverpool.—The supply of electrical energy was interfered with to some extent on Thursday and Friday last, by the calling out by the local Strike Committee of the staff of the electric supply department.

A number of young men of good standing and position in the city, however, came forward and assisted in the running of the generating stations. With this help it was found possible to run the public and private lighting each evening and also very largely to restore the supply for the tramways.

In regard to the latter the bulk of the men remained loyal to the Tramways Committee throughout the strike, and a good service of cars was run except on Thursday, Friday and Saturday last, when the service was seriously curtailed owing to lack of current. At the time of going to press the position, however, is somewhat complicated by the fact that the Tramways Committee refuse to reinstate the 250 tramway men who went out on strike, this refusal resulting in a threat by the Strike Committee to bring about another general transport strike. The 1,500 tramway men who remained loyal have threatened to cease work if the strikers are reinstated, whilst the difficulty is further increased by the fact that the positions vacated by the disloyal men have in the meantime been filled.

As we go to press we learn that the Tramways Committee have decided to reinstate, as and when required, the 250 men who are out on strike.

Macclesfield.—The total expenditure on the tramways to March 31 was £69,575.

The annual revenue was £11,717, including £11,270 traffic receipts. The total costs were £6,944, leaving a gross profit of £4,773. After paying interest and sinking fund there was a surplus of £545 on the year's working, against £25 in 1910. 2,439,536 passengers were carried and 282,026 car-miles run; 372,379 units of electrical energy were consumed.

Maidstone.—At the meeting of the Council last week Mr. Foster Clark moved that, in consequence of the continued heavy annual loss on the light-railway undertaking, it was desirable that the Light Railways Committee should be increased so as to include the whole of the members of the Council.

Ald. VAUGHAN said he still held the view that Mr. Clark's motion was a vote of censure on the present committee. If everyone was responsible it meant that no one was responsible. The tramways were such a great benefit to the town that he did not think the ratepayers cared very much about the extra money they had to pay in rates on account of the loss involved. It was true the loss last year was about £2,600, but £2,000 of that amount went towards buying the undertaking. Was not that a good investment? For the first 19 weeks of the current year the increase of revenue from the trams, compared with last year, was £311, while there had been a saving in wages of £67. 7s. 11d. and a saving in current of £84. 10s. 4d., making a total difference of £463.

The resolution was withdrawn.

Newport (Mon.)—On Tuesday the Electricity and Tramways Committee commenced the investigation of various matters affecting the management of the undertaking, but the enquiry has been postponed until the 18th prox.

Presentation.—The staff of the Hastings Tramway Co. has presented a clock to Mr. F. B. Holliday, overhead and permanent-way engineer, on his departure from the town.

Provisional Orders Extension.—The Board of Trade have deferred the revocation of Whitworth Council's electric lighting order for three months. The Hindley electric lighting order is not to be revoked for 12 months.

Radcliffe.—The Lancashire Electric Power Co. have notified the Council of their intention to apply for a provisional order.

Royal Metal Trades Pension Society.—It is announced that the annual ball and supper of this society will take place at the Portman Rooms, London, on Feb. 1 next, the chairman on the occasion being Mr. J. Coote Garnham, of 132, Upper Thames-street, E.C. The society does an immense amount of good all over the country, and is really the only charity society in the metal and hardware trades. Mr. Garnham and the stewards invite subscriptions and donations for this special occasion.

Swansea.—Last week the Corporation adopted the agreement with the local tramways company, by which the Corporation acquires the right to purchase in 31 years' time the whole of the tramways system at construction value.

The company will work the whole of the tramways till 1942, and will pay the Corporation 2 per cent. per annum on the gross profit earned. Under the new lease the yearly rent will, after April, 1919, be £1,118. 2s., equal to 7 per cent. per annum on the aggregate expenditure of the Corporation on the section of the tramways. Artisans, mechanics and dock

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labourers are to be carried on the tramways throughout the day (Sundays, Christmas Days, Good Fridays and Bank Holidays excepted) at fares not exceeding ½d. per mile or fraction of a mile, with a minimum fare of 1d. The Corporation will obtain statutory powers to construct and work certain extensions of the existing system.

Wireless Telegraph Notes.—It is announced that the negotiations which have been proceeding for some time past between the Egyptian Government and the Corporation of Lloyd's have resulted in the latter obtaining a concession for a monopoly of wireless telegraphy in Egypt. A powerful station is to be erected forthwith at Port Said, by means of which it will be possible, it is anticipated, to send messages as far westward as Malta and eastward to the Red Sea towards Aden, by October next.

COLONIAL AND FOREIGN NOTES.

Argentina.—The "Review of the River Plate" states that A company has been formed for the construction of a tramway in the district of San Isidro, joining up the lines of the Central Argentine and Central Cordoba. The capital is $500,000 m/n in shares of $100 m/n.

The Anglo-Argentine Electricity Co. have acquired the undertaking of the Franco-Argentine Electricity Co. The latter company recently acquired a controlling interest in the Anglo-Argentine Co. and now is to be absorbed by that company. More working capital is required and an early issue of shares will be made. The Anglo-Argentine Co. owns six generating stations and the Franco-Argentine four.

Australasia.—The Royal Commission on fares, &c., on the Melbourne tramways have presented their report:—

The Commission recommend that fares be revised, but, as an alternative recommendation, they suggest that the Government enter into negotiations for the purchase of all the rights up to 1916 of the Melbourne Tramway & Omnibus Co.; to constitute a tramway authority for the whole of the metropolitan area, independent of the claims or interests of any particular municipality. There would, the report continues, be little or no profit for the first year or possibly the second year, and the interest upon buildings, rolling stock, &c., might have to be capitalised until 1913 or 1914, but as the interest and sinking fund on the Tramway Trust indebtedness would cease in 1914, and £123,750 per annum would then be available for interest and sinking fund, this sum could be appropriated to the liquidation of the purchase money. The immediate purchase of the company's business is necessitated not only by reason of the desirableness of introducing sectional fares at once, but on account of the tramways extensions to the more distant suburbs, which are at present in contemplation.

Electricity Supply in Turkey.—The "Morgenpost" (Berlin) reports that negotiations for the formation of a trust company of electrical concerns in Turkey, with participation of German capital (including the Orient Bank), have almost been concluded. The amount involved is about 50,000,000 marks (about £2,500,000).

It will be remembered that some time ago Messrs. Ganz & Co., of Budapest, obtained the concession for the erection of electricity supply works in Constantinople, and a subsidiary company was formed for carrying out the work. The concession for the electrification of the tramways was obtained by the Société des Tramways de Constantinople, and in order to unite these two groups it is proposed to form a syndicate by a number of German, French, Belgian and Hungarian banks. The cost of the acquisition and construction is estimated at 36,000,000f. The concern is also contemplating the acquisition of the lighting concession from the Belgian-Hungarian group for 18,000,000f. Finally, the syndicate will acquire the rights for the execution of the project for an underground railway at Constantinople, now in the possession of the group of the Deutsche Bank, the construction of which is estimated at 36,000,000f. As soon as the licence of the latter enterprise has been granted a Belgian company will be formed which will represent at the Ottoman capital an international committee of tramway, underground railway and lighting enterprises.

Italy.—The "Gazzetta Ufficiale" has recently published a decree authorising the communal authorities of Turin to construct about 3 miles of additional electric tramway in the city; and also decrees authorising (1) the Soc. Anon. Elettrica Tramviaria Litoranea Viareggio–Versilia–Provincia di Massa Carrara, of Viareggio, to construct an electric tramway in Viareggio; (2) the communal authorities of Padua to construct an electric tramway from Padua to Abano; (3) the Elettrovie Colli Euganei to construct an electric tramway from Abano to Torreglia, passing by way of Monteortone to Tramonte.

La Paz (Bolivia).—The local electricity supply and water works were inaugurated on July 16.

Light Railways in Japan.—In a report on the trade of Japan in 1910 the acting Commercial Attaché (Mr. R. Boulter) states that the number of new proposals for light railways and electric lighting companies has continued to increase.

In August, 1910, a light railway law was put in operation in order to enforce proper control over the promotion of schemes for constructing light railways, and also to encourage the construction of such lines in order to connect minor centres of trade and production with the existing lines of railway. The nationalisation of the railways has had the effect of checking private enterprise in this direction, while the State is unable to spare funds sufficient to meet the demands for railway extension. It is hoped that this law will attract private capital to the construction of light railways. A more powerful fillip, however, to this industry was given by the bill of the 1911 session, granting subsidies to light railways. The date of the coming into force of this law is not yet determined.

It is pointed out by Mr. Boulter that, on account of the financial standing of some of the new undertakings, it is advisable for British merchants to do business with them only through firms or representatives in Japan, as the latter are in a position to ascertain whether contracts can safely be accepted.

Most of the light railways use electricity for motive power and also undertake the supply of electric current for lighting, &c. During the year a number of orders have been received for the erection of small gas-driven plants for the generation of electrical energy.

Lombardy.—In a report on the trade of Lombardy for 1910 Mr. Consul Towsey states that electrical undertakings were only slightly affected by the local depression.

The large companies that installed new plant deferred utilising some, and those whose plant was not completed delayed work so that their production should not exceed possible demands during the abnormal conditions of the market. During the year 21 new electric companies were formed with a share capital of 14,000,000 lire (about £510,000), two of them with capital of 3,000,000 and 2,000,000 lire respectively, four of 1,500,000 lire each, six with a capital varying from 250,000 to 600,000 lire, and nine with less; 32 existing companies increased their capital. Only four companies with a capital of barely 3,000,000 lire went into liquidation, and four others reduced their capital, but the companies which dissolved or liquidated were taken over or joined others. On the whole an additional sum of 50,000,000 lire was invested in electrical industries. Of the 118 companies engaged in these industries, 50 paid no dividends, but they were mostly of recent formation; nearly all the other companies declared the same dividends as in previous years, and a few increased them.

Of the 22 companies producing or selling electrical material, 11 paid no dividends, but some of these are branches of foreign firms. Of the 11 telephone companies, five paid no dividends, but some of them did not pay any in preceding years.

Spain.—The "Gaceta de Madrid" of 6th inst., contains a notice issued by the Ministry of Fomento, granting to the Soc. Anon. Iberia Concesionario de Bilbao a concession for constructing an electric railway from Porriño to Vigo.

Submarine Cable Communication with German Colonies.—It is announced by the Brunswick "Landeszeitung" that the establishment of direct cable communication between Germany and her colonies is to be hastened.

Toronto (Canada).—It is stated that the Toronto Board of Control will call for tenders (in September) from British contractors for the construction of an underground railway in the city. The cost of the line will, it is estimated, be about £800,000.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Ealing.—The accounts of the electric supply department and the report of the borough electrical engineer (Mr. J. D. Knight) for the year ended March 31 have been issued.

The output during the year increased by 55,209 units; for public lighting the supply was 1,839 units less, but the increase in private lighting was 57,048 units. The total income was £27,046 (increase £629), and there was an increase of nearly £247 in the collections from slot meters. The latter source of revenue accounts for over 5 per cent. of the gross receipts. Income from meter rents was £1,208, or £89 more. On capital account, £5,048 was spent, £8,130 was set aside out of revenue for repayment of capital, making the total repaid to date £63,912. Interest absorbed £5,153. Deducting cost of maintenance and management and charges for rent, rates and taxes, the gross profit was £15,041 14s. 2d., or 7¼ per cent. on the capital. After paying interest and sinking fund charges, audit fees and sums contributed to loans redemption fund and bad debt reserve, the net profit was £1,665. 11s. With the balance of £3,351 from last year the available balance is £5,017. Other payments bring this figure to £4,275. The reserve fund amounts to £9,955, or 4 per cent. of capital expenditure. Coal costs increased slightly. Cost of management went up by about 6 per cent., but there were 379 more consumers. The total cost per unit sold was 3·974d., compared with 3·948d. The total increase in the meters on circuit was 298, and the number of 8 c.p. lamps reached 150,507, an increase of 10,592. The total number of consumers is 4,569, or 379 more than last year, a net increase of 9 per cent. This is the largest number added in any one year since 1904. Last year there were sold to each consumer an average of 282 units, this year only 271, a decrease of 11 units per consumer. In 1906 each consumer took 359 units, so that the decrease in five years has been 88 units, or nearly 25 per cent.

Cooking by electricity having been greatly improved of late, both as regards first cost of apparatus and economy in working, it was deemed advisable to tap this large field at the earliest possible moment. "Tricity" cookers, in sizes to meet the requirements of any house, are now hired out to consumers.

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Greenock.—It was reported at the last meeting of the Council that the net profit on the electricity department for the year ended May 15 was £5,520, against £3,247 in 1910.

Mr. J. C. W. Bailey, who presented the accounts, said that the power output was responsible for the largest part of the increase, but at the same time there was an increase of 21 per cent. for lighting and 13 per cent. for traction. Their policy had been shown to be a correct one, to attract large power consumers instead of allowing them to put in power plant of their own. They proposed to place £1,500 to reserve and £4,020 remained for allocation, which would be dealt with at the next meeting.

Mr. Alex. Williamson said that was the largest increase recorded in any year, and the department was now in a sound financial position. The average price of electricity to all consumers was only 1½d. per unit.

Halifax.—The income of the electricity department for the year ended March 31 was £20,952 from private consumers, £17,577 from Corporation trading departments and £1,804 from public lighting, a total of £40,333, less £1,093 for discount. With motor hire and meter rent, &c., the total receipts were £40,784.

The total expenses were £20,900, leaving a gross profit of £19,884. Interest and sinking fund charges came to £14,561, so that the net profit was £5,323. After paying part of the cost of economiser (£307) and of rotary converter (£650), and paying £693 in aid of local rate, the balance (£3,673) was placed to renewals fund. The capital expended is £260,160, an increase of £1,901 during the year. 5,964,665 units were sold (against 5,477,369), of which 2,231,182 were sold for private lighting and power, 3,668,569 for traction and 64,914 for public lighting. There are 70 street arc lamps, against 63; the maximum supply demanded was 2,900 kw., against 2,870 kw.; there are 2,000 consumers (against 1,855), with an equivalent of 188,848 8-c.p. connected (against 174,984 8-c.p.).

TRADE NOTES AND NOTICES.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1911 Edition of the Big Blue Book is READY, price 15s., post free in the United Kingdom, 15s. 9d. The volume brings a great mass of very valuable statistical and technical data quite up to date, and the Directorial Division has been thoroughly revised and amplified up to February 24th.

All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters receive every attention in the new volume, which aggregates more than 2,000 pages. The Directory Division is complete and thoroughly accurate, and has been completely revised. The Big Blue Book contains more names of live electrical firms and persons than any other Directory published, and this notwithstanding that all mere lists of members of Societies and Institutions (so easily and cheaply available) are excluded, as unreliable and of little value for Manufacturers' and Dealers' purposes. The full set of valuable Statistical and Engineering Tables, &c., have been very carefully revised and extended, and are now issued in a handy form. These are included in the 1911 Big Blue Book, making it the most complete work of the kind ever published.

TENDERS INVITED.

The Electricity Supply Committee of DUBLIN Corporation invite ders for supply of 750 a.c. meters (single phase) and 200 a.c. ree phase) meters. Specification, conditions and form of tender m the city electrical engineer (Mr. Mark Ruddle), Fleet-street, blin. Tenders to the Chairman of the Committee, 3, Cork-hill, blin, by noon Thursday, Sept. 7. See also an advertisement.

Tenders are invited (up to Oct. 3) for the supply of 42 miles of phone cable to the Postmaster-General's department in Vic- ia. Tender forms, &c., from the Commonwealth offices, 72, toria-street, London, S.W. See an advertisement.

Tenders are invited up to Oct. 18 for the supply of 20 coin-in-the- attachments to the Postmaster-General's Department in STERN AUSTRALIA. Specifications, forms of tender, &c., may be ained at the Commonwealth Office, 72, Victoria-street, London, . See advertisement.

The WESTMINSTER ELECTRIC SUPPLY CORPORATION invite tenders supply, delivery and erection at their Davies-street station of ery boosters and switchboards. Copies of specification, with ring and general conditions can be obtained from the Secretary the Corporation, Eccleston-place, Belgravia, S.W., to whom tenders should be sent by 10 a.m. of Sept. 12. Specification can be seen at (but not obtained from) the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster, S.W.

CLEETHORPES-WITH-THRUNSCOE Urban District Council invite tenders for the supply, delivery and laying down of a system of vulcanised bitumen distribution and feeder cables on the low-pressure three-wire d.c. system. Specification, conditions of contract and form of tender from the clerk of the Council, Mr. B. Greaves, Council offices, Cleethorpes, to whom tenders must be sent by noon of Saturday, Sept. 2.

The Council of the County Borough of WEST HAM invite tenders for (*a*) water tube boilers, (*b*) coal handling and discharging plant, (*c*) 5,000 kw. turbo-alternator, with condensing plant, (*d*) river service pipe-work, (*e*) centrifugal pumps, (*f*) 750 kw. converter (two-phase to d.c.). Specification, form of tender, &c., from Mr. H. H. Couzens, engineer and manager, 84, Romford-road, Stratford. Tenders to the town clerk, Mr. Fred E. Hilleary, Town Hall, Stratford, E., by 10 a.m. Aug. 31.

WARRINGTON Education Committee invite tenders (by noon Sept. 1) for wiring Evelyn-street Council school. Specification from Mr. T. A. Buttery, Exchange-buildings, Morley.

WEST HAM Guardians invite tenders for 12 months' electrical stores. Tenders to chairman by 11 a.m. Aug. 31.

Tenders will be received until noon Monday, Sept., 18 for the supply of Swedish, Norwegian, Finland or Russian red fir telegraph poles, for the GENERAL POST OFFICE. Forms of tender from the Controller of Stores, Mr. G. Morgan, Stores Department, G.P.O., 17 and 19, Bedford-street, London, W.C.

Tenders are invited up to Sept. 5 for the supply of (*a*) 10,000 protectors and (*b*) sundries to the Postmaster-General's Department in VICTORIA and up to Sept. 26 for the supply of telephone material and 30 miles of telephone cable to the Postmaster-General's Department in VICTORIA. Tender forms and specifications at the Commonwealth Office, 72, Victoria-street, London, S.W.

The Metropolitan Water and Sewerage Board, Albert-street, BRISBANE, Queensland, want tenders by noon Jan. 30 next for supply and erection, of one, two or three complete units, each consisting of power generating plant and pump or pumps to lift not less than 6,000,000 gallons per day. Particulars from the Secretary, and forms from the Agent-General for Queensland.

Tenders will be received on Sept. 2 at the Prussian State Railway Offices, BRESLAU, for supply of three 1½-ton electric coal-loading cranes, two (20-ton and 30-ton) transfer cranes and a fixed 3-ton revolving crane.

Tenders are invited by the Municipal Council of PELOTAS (Brazil) for a 40 years' concession for the supply of electricity for power and lighting and the establishment and working of electric tramways. Tenders to Senhor Luiz M. da S. Pennafiel, Intendencia Municipal, Pelotas, up to 1 p.m. Nov. 14. A deposit (about £300) is required with each tender, to be increased by the successful tenderer to 25,000 milreis (about £1,670). Further particulars (in Portuguese) can be seen by British contractors at 73, Basinghall-street, London, E.C.

The Municipal Council of BUDAPEST, Hungary, require tenders for the manufacture and supply of plant for a steam-driven electrical generating station, including two groups of three-phase turbo-generators (5,000 kw. each), 10,000 volts 50 cycles, boiler equipment for mechanical output of 5,000 kw. with reserve, pipeline, central switching and accessory equipments, travelling crane for engine room and coal-conveying plant. Specifications, &c., can be obtained at the Presidial Section of the Council, 9: IV., Városház-utca 16, II. 1, Budapest. Tenders by 11 a.m. Sept. 30.

Tenders will be received at the Town Hall, SYZRAN, Russia, on Oct. 14, for the construction of an electric tramway and the supply of electrical energy for lighting.

The Public Works Department, Madrid, will receive tenders on Sept. 20 for the concession for the construction of the RENTERIA electric tramway.

The time for the receipt of tenders by the Ministry of Public Works, Constantinople, for an electric power and tramway concession for JERUSALEM, is extended to Sept. 13. Specifications (in French) can be seen at 73, Basinghall-street, London, E.C.

The Municipal Commissioners of PENANG invite tenders for the supply and delivery, f.o.b. British port, of one 500 kw. steam dynamo engine or turbine with ejector condensing plant and switchgear. Specifications, general conditions and form of tender may be obtained from the consulting engineers, Messrs. Preece, Cardew & Snell, 8, Queen Anne's-gate, Westminster, S.W., to whom tenders (*in duplicate*) are to be sent by noon of Tuesday, Sept. 5.

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TENDERS RECEIVED AND ACCEPTED.

Melbourne (Victoria) Council have placed a contract for a battery of Tudor accumulators, regulating switches, switchboards, &c., with Messrs. Siemens Bros. Dynamo Works at £16,487. We understand the capacity of the battery is 4,000 amperes at one-hour rate of discharge.

Erdington Council received 15 tenders for the construction of the Slade-road tramway route, together with the laying down of wood block paving outside the tramway track. The tender of Herbert Holloway (at £24,909) has been accepted.

The work of electrical equipment has been left to the Corporation of the city of Birmingham to carry out at an estimated cost of £1,356.

Haslingden Guardians have accepted the tender of Simpson Bros. for telephone and bell installation at the infirmary at £42.

Blackburn Guardians have accepted the tender of J. W. Garsden & Co. for a fire-alarm and telephone installation at the local workhouse at £192. 10s.

Among recent orders for v.i.r. wires and cables received by the Indian offices of W. T. Henley's Telegraph Works Co. were the following:—

Main underground cables in connection with the electric lighting plant for the Delhi Durbar and the twin underground cable for telephone connections in the various camps; the wiring for the lighting of several of the principal camps; also for the special illumination of the Victoria Terminus at Bombay by the Great Indian Peninsular Railway Co. on the occasion of their Majesties' visit. Orders have also been received for all the v.i.r. cables for the new mills of the Central India Spinning, Weaving & Mfg. Co. at Nagpur.

Admiralty Contracts.—The Walsall Electrical Co. have been placed on the Admiralty list for supply of small switchboards suitable for torpedo boat destroyers, cranes, accumulators, charging switches up to 100 amperes rating, ammeters up to 1,500 amperes and voltmeters up to 260 volts.

Yorkshire Boilers.—The Yorkshire Boiler Co. has received an order from the Hull & Barnsley Railway Co. for two Yorkshire boilers, 17 ft. long by 6 ft. 6 in. in diameter.

The guaranteed hourly evaporation of the two boilers is 10,000 lb. The company is completing an installation of two of their 24 ft. by 7 ft. 6 in. boilers for the Edinburgh Roperie & Sailcloth Co., the guaranteed hourly evaporation being nearly 20,000 lb. A 24 ft. by 9 ft. 6 in. Yorkshire boiler fixed during the Whitsuntide holidays was tested a few days ago, and gave an hourly evaporation of 13,670 lb. The company is also fixing a Yorkshire boiler (18 ft. by 8 ft.) at Kendal Electricity Works, which will give an evaporation of between 7,000 lb. and 8,000 lb. of water per hour.

Indian Train Lighting.—"Indian Engineering" states that Messrs. Mather & Platt have obtained an order from the South Indian Railway Co. for supply of train-lighting dynamos; Messrs. J. Stone & Co. have got the order for supply of train lighting cells; and E.M.F. (Ltd.) the contract for supply of electric ventilating fans.

On Dec. 31 last the railway had eight coaches on the broad gauge section fitted for electric lighting on Stone's system, while 331 coaches were fitted for gas lighting on Pintsch's system, and 26 vehicles were not fitted with either. On the metre gauge section (the original South Indian Railway) gas lighting is not used, but 337 coaches were fitted with electric lighting on Stone's system and 827 vehicles remain to be fitted with electric lighting.

BUSINESS NOTICES.

We are informed that Mr. A. J. Greenly, who is well known in publicity circles in the electrical industry, has joined Mr. Marcus Heber Smith, 115, Fleet-street, London, E.C. We are informed that he has a large number of original ideas for advertisement designs and trade literature. Mr. Greenly will be pleased to place at the disposal of electrical manufacturers exceptional facilities for making their advertisement copy and trade publications both forceful and attractive.

We are asked to state that Mr. David Smith has severed his connection with the Foster Engineering Co. (Ltd.).

Agents Required.—A German dynamo manufacturing firm require a London firm to act as their representatives. See an advertisement.

Patent Development.—The proprietors of patent No. 4,927/07 for "Improvements in or relating to electric furnaces" desire to make arrangements for exploiting same in this country. Communications to Messrs. Haseltine, Lake & Co., patent agents, 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

The proprietor of patent No. 13,427/06 and 880/07, for "Improvements in Dynamo electric machines," desires to make arrangements for exploiting same in this country. Applications to Messrs. Haseltine, Lake & Co., patent agents and consulting engineers, 7 and 8, Southampton-buildings, Chancery-lane, W.C.

ELECTRICITY SUPPLY TABLES AND DATA.

This Valuable Set of Tables and Engineering Data relating to Electricity Supply and to Electric Traction on Railways and Tramways in the United Kingdom, the Colonies, and some important places abroad, is now ready, and can be obtained complete in handy book form, price 6s. 6d. post free, or on very hard paper for rough or constant use, price 8s. 6d. post free. A complete Index is included.

The Ten Republics.—This little work, which is intended to serve as an introduction to the projected series of volumes on the ten Republics of South America, by Mr. Robert P. Porter, has been recently published by Messrs. Geo. Routledge & Sons. In addition to a brief sketch of their early history, the present volume contains much interesting information regarding the economic and financial position of the various South American Republics. An interesting chapter on the Panama Canal is also included, and this is followed by separate chapters on each of the ten Republics. There are few persons better qualified to write on South America than the present author, and no doubt the projected group of volumes in Porter's Progress of Nations will contain much valuable information on the economic condition, natural resources and future development of South America, a portion of the world which should offer excellent opportunities for the employment of British capital and enterprise. The present work, which is published in paper covers at 1s., is well printed and contains 12 maps.

BANKRUPTCIES, LIQUIDATIONS, &c.

A meeting of creditors of the Havana Telephone Securities Co. (Ltd.) will be held at New Broad-street House, London, E.C., on Aug. 31.

The Canadian Electric Traction Co. (Ltd.) is being wound up voluntarily. Claims by Aug. 29 to Mr. E. H. R. Trenow, Balfour House, Finsbury Pavement, London, E.C.

The Simplex Acme Patent Fire Alarm Co. (Ltd.) is being wound up voluntarily, and Mr. W. Denton, 7, Sweeting-street, Liverpool, has been appointed liquidator.

The Fife Electric Power Co. (Ltd.) is to be wound up voluntarily. The liquidator is Mr. Jas. Watt, 28, Charlotte-square, Edinburgh, where a meeting of creditors will be held on Sept. 1.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

*NOTE.—The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application, an asterisk is affixed.*

June 27, 1911.

14,994 BINGHAM. Means and apparatus for duplex wireless telegraphy.
14,999 BACHE. Experimental apparatus for intuitive electric instruction.*
15,008 WATKINSON & PAYNE. Shade-holders for incandescent and electric lights and the like.
15,038 MIDGLEY & VANDERVELL. Dynamo-electric machines.
15,039 MIDGLEY & VANDERVELL. Automatic switches or cut-outs for use in charging secondary batteries from dynamo-electric machines.
15,052 RANSFORD. (Samuel P. Thrasher, U.S.) Electric signalling apparatus.*
15,054 DENISSEL. Electric heating apparatus.*

June 28, 1911.

15,072 BARRON & BARRON. Preparation or solution for the deposition of metals.
15,085 HEATH. Electrical switch fuses.
15,086 PERRY. Thermo-electric generators.
15,087 PERRY. Combined boiler and thermo-electric generator.
15,090 MURDOCH. Friction permeameter for testing magnetic materials.*
15,126 ASSOCIATION DES OUVRIERS EN INSTRUMENTS DE PRECISION. Recording [illegible] for telephonic conversations and similar purposes. (Convention date, [illegible] France.)*
15,128 SIEMENS & HALSKE AKT.-GES. Manufacture of manganese peroxide anodes. (Convention date, 29/6/10, Germany. Addition to 605/09.)*
15,129 SIEMENS BROS. & CO. (Siemens & Halske Akt.-Ges., Germany.) Recording circuits from automatic telephone exchanges.*
15,133 DERRIMAN. (Automatic Electric Co., U.S.) Telephone systems.*
15,149 BERDON. Electric current controlling device. (Convention date, 5/7/10, U.S.)*
15,157 SANDY. Telephone lock.

June 29, 1911.

15,165 WILLIAMS & MCCALLUM. Apparatus for indicating earth leakage in [illegible] current and or to cut-out a leaky circuit in an installation. (Addition to 11,270/11.)
15,169 PERRY. Electrical accumulators.
15,181 PERRET. Extraction of compounds of vanadium, molybdenum, [illegible] and similar metals. (Divided Application on 26,777/10. Nov. 17. Convention date, 24/11/09, France.)*
15,216 LANE. Electric traction.
15,217 JAMES. (Ges. fur Verwertung technischer Patente m.b.H., Germany.) Lamps with parallel electrodes.*

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15,225 B.T.-H. Co. (G.E. Co., U.S.) Electrical resistances and methods of making same.
15,231 Marks. (John Roberts, Natal.) Method of and means for regulating electrical heating apparatus.

June 30, 1911.

15,232 Bellamy. Electrically-driven percussive tools.
15,248 Thompson. (Soc. la Radio-Electricité, France.) Controlling electric arcs.*
15,249 Thompson. (Soc. la Radio-Electricité, France.)* Antennæ for the transmission and reception of Hertzian waves.*
15,302 Lofquist. Electric water-heating devices.*
15,318 Gwozdz. Telephones. (Convention date, 6/6/11, Germany.)*
15,320 Craft & Brown. Selective calling apparatus. (Convention date, 30/6/10, U.S.)*
15,321 Craft. Selective signalling system for party lines. (Convention date, 30/6/10, U.S.*)
15,322 B.T.-H. Co. (G.E. Co., U.S.) Electric motor control systems and apparatus therefor.
15,390 Priestley & Aldred. Apparatus for generating electricity.

July 3, 1911.

15,398 Thomas. Brakes for steam and electric travelling cranes.
15,431 Hein & Copp. Electric railway signalling systems.*
15,453 Oldham. Secondary storage batteries or electrical accumulators.
15,469 Woodford. Safety device for controllers for electric motors.*
15,474 General Composing Co. Ges. m.b.H. Arc lights. (Convention date, 4/7/10, Germany).*

July 4, 1911.

15,502 British Insulated & Helsby Cables & Redfern. Circuits for telephone instruments.
15,503 Aitken & British Insulated & Helsby Cables. Telephone exchange systems.
15,538 Brooks & Holt. Switches for controlling the electric lighting systems of automobiles.
15,512 Day. Carriers for electric lamp shades, globes, reflectors, galleries, or the like.
15,513 Weiss. Electrical signalling device.*
15,524 Swift & Baxter. Electrical headway clock.
15,531 Inrig & Inrig. Dynamo-electric generators.
15,559 Kinsley. Printing telegraphy.*
15,568 Western Electric Co. (Western Electric Co., U.S.) Belts for signalling purposes.*
15,585 B.T.-H. Co., Wedmore, Wallace & Hamlyn. Electric switches.
15,666 B.T.-H. Co. (G.E. Co., U.S.) Method of treating refractory metals.

July 5, 1911.

15,597 Doddell & Partridge. Auxiliary apparatus for electric traction.
15,599 Crust. Electric lampholders.
15,646 Kalimann. Electric safety fuses. (Divided application on 16,258/10/7/7.)*
15,664 Gerdes. Clock having electrical winding mechanism.*

July 6, 1911.

15,718 Erskine-Murray. Wireless signalling.
15,719 Mayes. Electric incandescent lamp-holder cap.
15,725 Killar. Telephones.
15,730 Ges. fur Maschinen und Metall Industrie m.b.H. Arc lamps. (Convention date, 6/7/10, Germany.)*
15,751 Harden. Electrical conductors.
15,770 B.T.-H. Co. (A.E.G., Germany.) Valve-operating mechanism.

July 7, 1911.

15,793 Schmahl, Atkinson & Globe Electric Co. Illumination of advertising signs and the like.
15,794 Cole & Wilson. Arc lamps.
15,798 Masks. (Spinnerei & Weberei Steinen Akt.-Ges., Germany.) Current distributors for power looms having electrical stopping and signalling devices.
15,804 Boerne. Electric alarm.
15,815 Popplestone. Tramway rails and the like.
15,816 Schwager. Pocket lamps. (Convention date, 8/7/10, Germany.)*
15,824 Harden & Electric Furnaces & Smelters. Production of metals from their ores.
15,841 B.T.-H. Co. (G.E. Co., U.S.) Electric motor control systems.

July 8, 1911.

15,859 Bradshaw. Attachments in telephone mouthpieces.
15,894 Enright & Plews. Telegraphy and telegraphic apparatus.
15,895 Nightingall. Automatically controlling heat in electric heating apparatus.*
15,899 Nightingall. Apparatus for electric cooking and heating.*
15,901 B.T.-H. Co. (G.E. Co., U.S.) Systems of electric motor control.

SPECIFICATIONS PUBLISHED.

1910 Specifications.

8,031 B.T.-H. Co. (G.E. Co.) Tungsten and the manufacture thereof.
12,194 Johnson. Electric switch.
13,274 Hamilton & Ferranti. Electrical time switches.
14,334 Mathieson. Automatic contact device for use in connection with the overhead equipment of electric tramway installations.
4,625 Electric and Ordnance Accessories Co. & Collins. Slow-motion devices for use in connection with electric controllers, starting switches, and the like.
4,766 Compagnie de l'Industrie Electrique et Mecanique. Combined speed and current regulators for dynamo-electric series machines. (19/5/10.)
4,851 Adams mfg. Co. (Cutler Hammer Mfg. Co.) Controllers for electric motors.
5,004 Thomson. Construction of small or pocket electric lamps.
5,134 Rehrup. Magneto-ignition devices for internal-combustion engines.
5,143 Klostermann. Arc lamps. (26/6/09.)
5,356 Thomas. Control of series wound dynamo-electric machines.
5,414 Christian. Trolley poles for electric traction on the overhead conductor system.
5,415 Akt.-Ges. Brown, Boveri et Cie. Voltage regulation of dynamo-electric alternating current machinery. (10/7/09.)
5,423 Newton. Dynamo-electric machines for producing constant voltage.
5,619 Lambot. Automatic electric recording devices.
5,695 White. Electrically-controlled ejector vacuum-cleaning apparatus.
6,711 Quint. Enclosed arc lamps of the inverted type.
6,724 Pechin. Couplings for arc lamps.
6,869 Cerbetani. Wireless-operated electrical signalling, indicating, or like means. (24/2/10.)
6,466 Paton. Interlocking switch box for electric lighting or power transmission cables.
6,559 Clarke, Chapman & Co., & Moysey. Electric transmission means for use as or in helm indicators or in telemotor arrangements for steering-gear and the like.
7,690 Ashworth. Trolley poles for electric tramways.
8,136 Veritys, Ltd., & Pipkin. Electrical heaters or stoves of the radiator kind.
8,217 Stevenson & Williams. Raising and lowering arc lamps or other fittings suspended in central carrier frames.
9,969 Higgins. (Higgins.) Electrolytic reduction of organic bodies.
10,182 Electric & Ordnance Accessories Co. & Collins. Electrical switches. (Addition to 24,373/09.)
10,522 Brooks & Alston. Electric contact breakers for use in connection with the ignition systems of internal-combustion engines.
11,729 John & Berry. Galvanic battery.
11,794 Kirkland. Power systems employing prime movers.
12,717 Milch. Speed regulation of induction motors. (1/10/09, addition to 12,326/08.)
12,777 Massip. Electric furnaces and the manufacture of steel. (2/10/09.)
13,506 Dibgdon. Device for protecting the cars and trolley-wire on electric railways and tramways. (Cognate application 25,462/10.)
13,238 Hirst & Archer. Electric heating apparatus.
14,421 Smith. (Huth.) Receiving method for wireless telegraphy
25,012 Sefton-Jones. (Oesterreichische Daimler-Motoren Ges.) Collectors for overhead conductor electric-traction systems.
25,634 Schmidt. Self-regulating arc lamps for projection.
26,045 Krannichfeldt. Producing electric incandescence bodies.
26,836 Field & Ferranti Limited. Electric heaters.
27,176 Apoznanski. Electric accumulator plates.
27,407 Rosculet & Constantinescu. Vapour incandescent lamps.
27,652 Alwies. Street or station indicators for electric trains, tramcars, and the like. (26/11/09.)
28,177 Juston & Bunzli. Magneto-electric current generators. (10/3/10.)
28,246 Gray. Governing or controlling devices for dynamos.
28,320 Ray. Guide-sheaves for ships' telegraphs and the like.
28,724 Frankenburg & Sons, Ltd., & Fleming. Electric lighting.
29,727 Crompton & Co., McFarlane, Burge & Williams. Controlling electrically-operated driving systems.
29,810 Wolff. Automatic distributor for electricity.
28,994 Frisby. Electric-current gauges or apparatus for measuring the strength of electric current.

1911 Specifications.

790 Sauerbrey. Ascertaining the position of the current distributor in electro-magnetic ignition devices for explosion engines. (12/1/10.)
1,848 Mowbray. Thermal electric fire alarms.
2,111 Reisz & Strauss. Relay for undulatory currents. (30/3/10.)
2,369 Schulz & Eyermann. Homopolar or acyclic dynamo-electric machines.
2,632 Bellini & Tosi. Antennæ of wireless telegraphy and telephony. (10/2/10.)
3,028 B.T.-H. Co. (G.E. Co.) Mounting of electric conductors more particularly filaments for incandescent electric lamps.
3,533 Schatzl. Electric furnaces.
5,806 Girdlestone & Thorkelin. Arc lamps.
3,859 Mazellier. Electric sparking plug. (17/2/10.)
3,891 Korting & Mathieson Akt.-Ges. Enclosed arc lamps. (21/2/10.)
3,949 Girardeau. Sender with direct excitation for radiotelegraphic plants. (30/7/10.)
4,008 Klupathy & Berger. Apparatus for generating sound-waves and like vibrations in water.
4,524 Pritchett. Electric accumulator boxes. (Addition to 15,425/10.)
5,521 Sumner. Current graduation devices or resistances applicable for electric lighting or heating.
5,813 Hultman. Apparatus for manufacturing conduits for underground cables. (9/4/10.)
6,736 and 6,737 Siemens Bros. & Co., & Riber. Fixing and insulating contact springs for electrical apparatus.
6,823 Siemens & Halske Akt.-Ges. Recording intervals of time between the passage of trains on a track and the speed of the trains. (30/4/10. Addition to 376/10.)
7,103 B.T.-H. Co. (G.E. Co.) Boron compounds and methods of producing the same.
7,511 Krannichfeldt. Insulating the twisted ends of electric wires.
7,668 Allgemeine Elektricitats Ges. Electric voltage regulators. (26/3/10.)
8,392 Siemens Bros. Dynamo Works & Koettgen. Ventilation of dynamo-electric machines.
8,484 Martyn. Bonding devices for electric cables and electric fittings. (Divided application on 9,121/10. 23/4/.)
9,941 Spezialfabrik fur Aluminium-Spulen-und Leitungen Ges. Production of electrically insulating layers or coatings on metal.
9,942 Allgemeine Elektricitats-Ges. Coinfreed mechanism. (23/4/10.)
10,113 Siemens Bros. Dynamo Works. (Siemens-Schuckertwerke Ges.) Non-interchangeable electric fuses.
10,238 Telephon Apparat Fabrik E. Zwictusch & Co. Ges. Method of connection of lines in automatic telephone exchanges.
10,816 Chamberlain & Hookham, Ltd., & James. Electricity motor meters.

COMPANIES' MEETINGS AND REPORTS.

ABERDEEN SUBURBAN TRAMWAYS CO.—The profit earned during the past half-year was £1,443, and the balance at credit of profit and loss account is £3,233. The directors propose to add £1,800 to renewals and depreciation account and to pay a dividend of 2½ per cent. for the past year (£780).

BRITISH CONTINENTAL ELECTRICITY CO. (LTD.)—The directors report for the year ended April 30 states that during the year 179 new installations have been connected, while the number of 8 c.p. lamps added during the period has been 1,545. Towards the end of the year a contract for the public lighting of the village of Poggio was entered into on favourable terms, as also a contract to supply power to San Remo Corporation. After writing off £162. 3s. 4d. depreciation in respect of furniture, tools, meters, &c., and £177. 1s. 4d. depreciation of plant and stock, the balance (including amount from last year) is £2,315. 19s. 8d., a sum sufficient to pay a substantial dividend on the ordinary shares after paying in full the preference dividends due to date. As, however, this balance has been temporarily absorbed by further capital expenditure, rendered necessary by the continued growth of the business, the directors recommend that it shall be again carried forward pending a further issue of capital; £171. 13s. 1d. has been carried to a suspense account pending arbitration in respect of a power contract entered into by the company, and the directors anticipate that they will eventually be able to credit revenue account with a substantial award; £804.6s.7d. has been spent on capital account during the year.

BROWN, BOVERI & CO., A.G. (BADEN).—The net profit for the past year amounted to 2,300,031 fr. (£92,003), against 2,142,122 fr. (about £85,684) in 1909-10, and it is proposed to pay a dividend of 7 per cent., against 8 per cent. The general conditions of the electrical engineering industry are stated to have been not entirely satisfactory, but the outlook is considered good, all departments being well supplied with orders. The technical problems with regard to railway electrification are considered to have been settled, but it is not thought that any great amount of business will result until some main electrical line shows good financial results in working. Brown, Boveri & Co., of Mannheim, paid a dividend of 4 per cent., the Compagnie Electro-Mécanique (Paris) 10 per cent., the Tecnomasio Italiano Brown, Boveri (Milan) 4 per cent., and the Aktiesels-kabet Norsk Elektrisk & Brown, Boveri (Christiania) 5 per cent. The parent company has now formed the Austrian Brown, Boveri Works

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Vienna, having a capital of 4½ million kronen, of which 1½ million kronen are held by the Swiss undertaking.

GREAT WESTERN RAILWAY CO.—At the recent meeting the chairman (Viscount Churchill) stated that powers had been granted to the London Electric Railway Co. for the extension of their Baker Street and Waterloo line from Edgware-road to Paddington Station, and arrangements were being made to put the work in hand at once, while the construction of the Ealing and Shepherd's Bush line would also be proceeded with without delay now that the Central London Co.'s bill for the construction of a short extension of line at Wood-lane to connect with the authorised Great Western line from Ealing to Shepherd's Bush only awaited Royal assent.

JANDUS ARC LAMP & ELECTRIC CO. (LTD.)—At the meeting last week the chairman (Mr. E. N. Galloway) moved the adoption of the report which recommended payment of a dividend for the past year of 10 per cent. and the transfer of £2,500 to reserve.

KALGOORLIE ELECTRIC TRAMWAYS (LTD.)—Gross receipts for 1910 amounted to £43,004, compared with £45,266 for the previous year, and the net profits were £15,199, against £16,575. The directors regret to report the decrease in traffic receipts and nett profits. The rush to the Bullfinch district, which took a large number of the mining population and considerable money from Kalgoorlie, had its effect on the general trade of the district and the tramway receipts suffered in consequence. The construction of the trans-continental railway is likely to be commenced next year, and it is hoped that the completion of this line will have a beneficial effect on the prosperity of Kalgoorlie by opening up the country to the east. Until improved conditions are brought about, either by the railway or by the discovery of new mines, no increase in traffics can be expected. In the meantime every possible effort is being used to reduce working expenses. During the year 624,790 car-miles were run, against 631,212 in 1909, and 2,793,216 passengers, against 2,936,411, were carried. The earnings per car-mile were 16·45d., against 17·16d. in 1909, while expenses per car-mile amounted to 10·13d., against 10·29d. The expenses per cent. of earnings were 61·57 per cent., against 59·99.

NORTH-EASTERN RAILWAY CO.—At the meeting last week the chairman announced that the question of the electrification of the Shields to Newcastle line was receiving attention.

PERTH (W. AUSTRALIA) ELECTRIC TRAMWAYS (LTD.)—Gross receipts for 1910 amounted to £68,799, compared with £74,649 for 1909; the profit was £26,702, against £30,161. This decrease was due to the strike of motormen and conductors in July and August. The strike was the result of an application to the Arbitration Court by the men, at the instance of professional agitators, who, when the award was obtained, put an interpretation upon it which induced the men to make unreasonable claims upon the company, which were resisted; the men again appealed to the Court, and not being satisfied with its decision, elected to strike.

The question of the purchase of the company's undertaking, either by the City Council or by the State, has been a matter of local discussion. The board, therefore, deemed it wise to fortify themselves with the best legal and technical advice on the concessions and agreements, with the result that they are satisfied that the position of the company is a strong one. The feeling in Perth is that the tramway undertaking should be acquired either by the City Council or by the State and the latter view appears to predominate. The directors have intimated to the Mayor that they would advise the shareholders to accept £500,000. From the shareholders' point of view it would be better if the company were allowed to work the tramways for the full period of 29 years, but in view of the pressure of public opinion, the directors have every reason to believe that a definite offer to purchase will be made in the near future. After paying debenture interest, &c., and adding £1,056 brought forward, £10,054 was available. The preference dividend absorbed £6,000, and the directors recommend payment of a dividend on ordinary shares at the rate of 2½ per cent., £2,500. £1,000 is placed to reserve and the balance (£554) carried forward.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

ARDROSSAN AND SALTCOATS ELECTRIC LIGHT AND POWER CO. (LTD.) (7,959)—Reg. in Edinburgh Aug. 11, capital of £20,000 in £1 shares, to carry on the business of an electric light, power and heat supply company. First directors: G. Balfour and A. H. Beatty. Reg. office: 63, Castle-street, Edinburgh.

SKELMORLIE ELECTRIC SUPPLY CO. (LTD.) (7,960)—Reg. in Edinburgh Aug. 11, capital £10,000 in £10 shares, to acquire the business of the Skelmorlie Electrical Supply Co. Private company.

THOMAS R. CARPENTER (LTD.) (117,300)—Reg. Aug. 17, capital £5,000 in £1 shares, to carry on in Birmingham or elsewhere the business of manufacturers of and dealers in chandeliers, electric light and gas fittings, &c. Private company. T. R. Carpenter is first director.

WHITFIELD FAN CO. (LTD.) (117,321)—Reg. Aug. 18, capital £2,000 in £1 shares, to carry on the business of electrical, ventilating, mechanical and heating engineers, manufacturers of electric and belt-driven fans, &c., to acquire the business carried on at Shipley (Yorks) as the Whitfield Fan Co. First directors: J. Whitfield, J. Bolton and J. Bailey.

STATUTORY RETURNS.

ANCHOR CABLE CO. (LTD.)—In return to June 6 capital is £250,000 in £10 shares. 6,500 shares taken up. £10 per share called up on 4,600 and £5 per share on 1,500. £53,500 paid. £4,000 considered as paid on 400. Mortgages and charges: £50,000.

BRITISH ELECTRIC AUTOMATIC MACHINES (LTD.)—Return to July 28 gives capital as £150,000 in 200,000 preference and 400,000 ordinary shares of 5s. each. 30,000 preference and 5,280 ordinary shares taken up. 5s. per share called up on 10,000 and 1s. per share on 20,000. £3,259 paid, leaving £241 in arrears. £1,320 considered as paid on 5,280 shares. Mortgages and charges: Nil.

ELECTRICITY SUPPLY CO. FOR SPAIN (LTD.)—According to return to July 4 capital is £105,000 in 20,000 preference shares of £5 each and 19,900 ordinary and 100 founders' shares of 5s. each. 17,330 preference, 19,900 ordinary and 100 founders' shares taken up. 5s. per share called up on 19,900 ordinary. £4,975 paid. £86,675 considered as paid on 17,330 preference and 100 founders'. Mortgages and charges: £131,400.

ELECTROMOTORS (LTD.)—According to return to June 1, capital is £50,000 in £1 shares. 42,370 shares taken up. £1 per share called up. £39,195. 4s. paid, leaving £3,174. 16s. in arrears. Mortgages and charges: Nil.

EUROPE AND AZORES TELEGRAPH CO. (LTD.)—According to return to July 12 the capital is £200,000 in £10 shares. All shares taken up. £10 per share called up on 14,432. £144,320 paid. £55,680 considered as paid on 5,568. Mortgages and charges: Nil.

HESWALL ELECTRIC LIGHT CO. (LTD.)—In return to May 31, 1911, capital is £1,500 in £1 shares. 1,225 shares taken up. £1 per share called up. £1,225 paid. Mortgages and charges: Nil.

GORSEINON ELECTRIC LIGHT CO. (LTD.)—Return to June 3 gives capital as £4,000 in £1 shares. 2,000 shares taken up. £1,998 paid. Mortgages and charges: £800.

MORTGAGES AND CHARGES.

DAWLISH ELECTRIC LIGHT AND POWER CO. (LTD.)—Debenture dated July 25, 1911, to secure £2,000, charged on company's undertaking and property, present and future, including uncalled capital. Holders: The Capital & Counties Bank.

CITY NOTES.

MEMORANDA (Aug. 24).—**Bank rate 3 per cent.** (March 9, 1911). **Price of silver,** 24⅝**d. per oz. Consols** 78⅛—78⅜ **for money and for accounts. Consols Pay Day, Sept. 1; Stock and Shares Continuation Days, Aug. 29 and Sept. 12; Ticket Days, Aug. 30 and Sept. 15; Pay Days, Aug. 31 and Sept. 14; Mining Shares Carry Over Days, Aug. 28 and Sept. 11.**

PRICES OF METALS (London).—*Copper*, cash, 56⅝; three months, 57. *Lead*, English, 14¾—14⅞; Foreign, cash, 14⅝; three months, 14¾. *Spelter*, 27½—28. *Tin*, English, 191—193; Foreign, cash, 189½; three months, 187. *Iron*, Cleveland, cash, 47/6, three months, 48/4.

BAHIA TRAMWAY, LIGHT AND POWER CO. & CIE. D'ECLAIRAGE DE BAHIA.—The earnings of these companies for July were £14,600 (increase £766). The aggregate from Jan. 1 is £91,533 (increase £14,004).

KALGOORLIE ELECTRIC TRAWWAYS (LTD.)—Traffic receipts for July were £3,320. Aggregate from Jan. 1 £23,784.

MACKAY COMPANIES.—The regular quarterly dividend of 1 per cent. on the preferred shares and the regular quarterly dividend of 1½ per cent. on the common shares in the Mackay Companies will be paid on Oct. 2 to shareholders of record as they appear at the close of business Sept. 9. The transfer books will not be closed.

MADRAS ELECTRIC TRAMWAYS, 1904 (LTD.)—Traffic receipts for the fortnight ended Aug. 15 were R.2,2619 (increase R.2,164). Aggregate from Jan. 1 R.330,565 (increase R.27,913).

STEWARTS & LLOYDS (LTD.)—The directors have declared interim dividends for the half-year ended June at the rate of 6 per cent. on the preference and 10 per cent. on the preferred ordinary shares.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee has ordered £200,000 5 per cent. first mortgage debentures of the *Birmingham Tramways Co. (Ltd.)* to be quoted in the official list. The Committee have been asked to grant quotations to a further issue of 37,900 £1 fully-paid ordinary and 227,011 £1 7 per cent. preference shares of *Marconi Wireless Telegraph Co. (Ltd.)*.

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ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
ardsea Corporation	Aug. 16	1,773	+ 93	11	18,421	+ 1,361
rlie	„ 11	224	— 1	32	6,918	+ 41
lo-Argentine	„ 19	47,720	+ 2,375	33	1,608,677	+ 152,997
ton-under-Lyne	..	..	..	..	..	..
Corporation	„ 19	551	+ 42	14	6,141	+ 35
ansley	„ 11	197	+ 20	32	5,778	+ 327
row	„ 11	614	+ 257	32	9,345	+ 771
Electric Trams, Ltd.	„ 16	1,051	+ 41	33	27,808	+ 1,081
ningham Corporation	..	..	..	..	..	..
ningham & Midland	„ 11	1,171	+ 350	32	28,682	+ 1,836
kpool & Fleetwood	..	..	..	..	..	..
kburn Corporation	„ 16	1,298	+ 154	†21	24,772	+ 2,085
n Corporation	„ 20	2,827	+ 414	21	53,345	+ 4,133
bay	July 21	2,823	+ 150	29	82,703	+ 4,919
emouth Corporation	Aug. 16	2,670	+ 241	20	37,941	— 1,838
ford Corporation	„ 19	6,331	+ 907	20	115,787	+ 9,772
ton Corporation	„ 20	1,409	+ 65	¶20	23,418	+ 1,566
l Trams & Carriage	„ 18	7,223	+ 871	20	147,966	+ 15,389
ey Corporation	„ 17	1,636	+ 305	20	20,820	+ 2,679
n Corporation	„ 20	298	+ 20	20	6,116	+ 589
Corporation	„ 20	1,594	+ 446	¶20	27,324	+ 2,862
tta Tramways Co.	„ 19	R57,574	+ R3,654	7	R408,616	+ R39,316
zance-Redruth	„ 19	138	+ 1	33	4,044	+ 35
f Corporation	..	..	..	..	..	..
l London Railway	„ 19	3,592	— 1,151	7	30,862	— 6,323
am & Dist. Lt. Rys.	..	..	..	..	..	..
South London Rly.	„ 20	2,506	— 473	7	21,199	— 349
f Birmingham	„ 11	1,305	— 1,310	32	83,231	— 7,620
lectric Trams Co.	„ 17	612	+ 72	33	16,518	+ 440
n	..	..	..	..	..	..
port & Dist. Trams	„ 11	747	+ 200	32	15,597	+ 2,211
Corporation	..	..	..	..	..	..
& Lucan Railway	„ 18	182	— 2	7	1,239	— 20
United	„ 18	6,620	+ 510	7	52,343	+ 9,970
-Stourbridge	„ 11	1,530	+ 580	32	27,057	+ 1,962
Corporation	„ 16	1,193	— 61	¶13	16,128	— 196
am Council	„ 19	1,069	— 34	20	22,519	+ 1,312
Corporation	„ 18	401	+ 20	20	7,436	+ 657
ad & Dist. Trams	„ 11	1,173	+ 156	32	33,130	+ 1,840
Corporation	„ 19	15,965	— 1,594	§11	212,824	+ 12,418
Trams	„ 19	152	+ 23	33	4,063	+ 292
ter Corpn.	„ 16	335	+ 15	7	2,462	+ 306
nd-Northfleet	„ 11	340	+ 114	32	6,779	+ 192
Northern & City Rly.	„ 19	1,246	— 22	7	9,502	+ 239
& Port Glasgow	„ 11	893	+ 94	32	22,752	+ 2,879
Corporation	„ 15	2,733	+ 426	†20	41,479	+ 4,356
ol Tramways	„ 11	453	+ 130	32	8,562	+ 755
Elec. Trams Co.	„ 21	1,770	+ 129	7	10,005	+ 55
ng	„ 19	$8,281	—$1,292	..	..	..
field Corpn.	„ 19	2,293	+ 333	20	40,397	+ 4,324
poration	„ 19	2,812	+ 58	20	57,813	+ 2,377
strict Council	..	..	..	..	..	..
District Council	„ 16	137	— 1	20	2,729	+ 126
Corporation	„ 19	563	+ 4	20	9,750	+ 598
anet Co.	„ 19	2,218	+ 56	46	27,835	+ 1,294
	„ 11	193	+ 52	32	4,219	+ 281
Corporation	..	..	..	..	..	..
ester & District	„ 11	362	+ 202	32	3,810	+ 257
ck Corporation	„ 19	165	+ 15	14	2,535	+ 291
ff Trams Co.	„ 17	1,549	+ 7	33	46,112	+ 509
e United	„ 16	1,601	+ 97	33	44,318	+ 1,357
on	„ 11	401	+ 224	32	5,595	+ 338
poration	„ 19	7,735	+ 657	20	155,042	+ 10,761
Corporation	„ 19	2,363	— 21	20	52,724	+ 4,822
poration	„ 19	713	+ 16	‡14	9,987	+ 853
poration	..	..	..	..	..	..
Corporation	„ 12	13,202	+ 2,136	32	370,420	+ 15,466
Overhead Rly.	„ 20	978	— 462	7	10,859	+ 285
dColwynBayRy.	„ 18	905	+ 105	§37	10,449	+ 414
unty Council	„ 9	45,789	+ 5,433	‡11	850,985	+ 58,517
lec. Ry. Co.	„ 19	9,540	— 730	7	82,995	+ 1,430
nited	„ 19	7,321	— 310	33	220,136	+ 9,476
Corporation	„ 19	557	+ 69	46	9,145	+ 501
r Corporation	„ 19	17,174	+ 1,691	21	232,403	+ 19,834
llway	„ 19	1,224	— 717	7	12,651	— 1,104
	„ 11	315	+ 100	32	6,689	+ 116
an Dist. Railway	„ 19	8,723	— 391	7	74,880	+ 3,615
an Elec. Trams	„ 11	11,231	+ 3,347	32	280,699	+ 44,770
	„ 11	399	+ 52	32	10,779	+ 726
poration	„ 19	227	+ 66	§20	3,814	+ 791
on-Tyne Corp.	„ 19	4,120	+ 250	20	87,643	+ 5,933
don.)	„ 19	702	+ 8	..	..	..
on Corporation	„ 18	570	+ 35	20	11,407	+ 1,100
ilton & Hyde	„ 11	625	+ 66	32	18,121	+ 558
poration	..	..	..	..	..	..
) Corporation	..	..	..	..	..	..
) Elec. Trams	„ 18	1,519	+ 1,519	33	53,117	+ 8,792
th	„ 11	185	+ 49	32	4,058	+ 405
Corporation	..	..	..	..	..	..
	„ 11	2,158	+ 661	32	61,746	+ 6,303
poration	„ 16	939	+ 171	20	16,083	+ 1,191
Corporation	„ 17	650	— 1	20	13,774	+ 1,251
	„ 11	725	+ 43	32	6,760	— 203
poration	„ 21	5,336	+ 781	§20	102,297	+ 5,931
	„ 16	$12,000	+$1,046	6	$73,000	+$6,942
	„ 11	94	+ 9	32	1,639	+ 59
poration	„ 20	6,219	+ 224	20	136,310	+ 9,470
rams	„ 19	$9,880	— $593	..	..	..
politan	„ 11	1,333	+ 314	32	27,672	+ 1,522
	„ 11	1,184	+ 358	32	28,745	+ 2,170
n	„ 16	1,471	+ 190	20	25,737	+ 3,372
rporation	„ 16	1,313	+ 244	20	15,336	+ 2,201
ramways	„ 11	517	+ 72	32	9,752	+ 326
gds.&c., Jt. Bd.	„ 19	924	+ 126	20	16,512	+ 1,500
Corporation	„ 20	1,418	+ 126	20	23,188	+ 3,755
District	„ 16	494	— 19	42	19,432	+ 1,431
ms	„ 11	1,777	+ 522	32	36,493	+ 2,246
poration	„ 16	205	+ 35	20	3,243	+ 390
	„ 11	77	+ 15	32	1,370	+ 29
and District	„ 11	763	+ 266	32	8,466	+ 287
ms Co.	„ 16	540	+ 20	7	3,898	+ 218
poration	„ 19	1,272	+ 160	§20	23,955	+ 3,876
oration	„ 19	538	— 51	32	18,427	+ 732
Corporation	..	..	..	..	..	..
rporation	„ 17	2,576	+ 85	20	55,874	+ 5,692
Mare	„ 11	812	+ 328	32	5,070	+ 496
ton Co.	„ 11	617	+ 219	32	14,259	+ 693
ton Corpn.	„ 16	953	— 45	20	20,594	+ 1,284
	„ 11	511	+ 178	32	9,435	+ 492
	„ 11	145	+ 47	32	3,200	+ 124
R Trams	„ 20	1,424	+ 63	34	43,885	+ 2,410
oollen District	„ 11	1,152	+ 146	32	33,535	+ 2,374

Comparisons are with the corresponding period last year. * Partly electrical.
‡ Minus 3 days. † Minus 2 days. § Plus 3 days. ¶ Plus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Shee	Last Dividend	Name.	Price Wed., Aug. 23.	*Rate per cent. Yielded.	Dividend Due.	Business Week to Aug. 23. Highest.	Lowest.
		Electricity Supply.		£ s. d.			
10	6/0	†Bournemouth & Poole Elec. Sup. Ord.	7⅞—8¼	4 10 0	Mar, Sep	8	—
10	4/6	†Do. 4½ per Cent. Cum. Pref.	8¼—9¼	4 17 3	Feb, Aug	..	..
10	6/0	†Do. 6 per Cent. Cum. Second Pref.	10 —10½	5 17 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101 —103	4 6 6	Jan, July	..	..
5	4/6	†Brompton & Kensington Elec. Sup. Ord.	7¾—8¼	6 5 0	March	7⅞	..
5	3/6	†Do. 7 per Cent. Pref.	7⅞—7¾	4 11 9	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Deb. Stock	98 —101	4 0 6	June, Dec	..	..
5	2/6	†Charing Cross (W. End & City) El. Sup. Co.	3¾—4¼	5 0 0	Feb, Aug	..	..
5	2/3	†Do. 4½ per Cent. Pref.	4½—5	4 12 3	Feb., Aug	4½	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	94 —98	4 3 3	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	100 —102	4 8 3	..	101½	..
5	2/3	Do. City Undertaking 4½% Cum. Pref.	3¾—4¼	5 10 6	Jan, July	..	..
5	3/0	Chelsea Electric Supply Ord.	4 —4½	5 11 0	March	4¼	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	98 —100	4 11 0	June, Dec	..	..
10	8/0	City of London Electric Lighting Ord.	12¼ —12¾	4 16 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	12 —13	4 16 0	Jan, July	..	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	119 —123	4 2 9	June, Dec	..	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	100 —103	4 8 6	Jan, July	102¼	..
St.	5%	County of Durham Elec. P. D. 5% 1st Mort. Deb. Stk.	89½—91½	5 10 6	Jan, July	..	..
10	4/0	County of London Elec. Supply Ord.	7⅛—7⅜	3 5 9	Feb, Aug	7⅛	—
10	6/0	Do. 6 per Cent. Cum. Pref.	11 —11½	5 6 6	Mar, Sept	11½	—
St.	4½%	Do. 4½ per Cent. Deb Stock (red.)	108 —110	4 2 6	Jan, July	..	..
St.	4½%	Do. Second Deb. Stock	103 —103	4 7 6	May, Nov	—	..
..	..	Edmundson's Elec. Corp. Ord.	⅛—¼	..	Jan, July	..	..
5	..	Do. 6 per Cent. Cum. Pref.	2¼—2½	..	May, Nov	..	..
St.	4½%	Do 4½ per cent. 1st Mort. Deb. (red.)	84 —87	5 3 4	July	..	..
5	4/0	Folkestone Electricity Supply Co. Ord.	4½—5	6 6 0	April, Oct	—	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4¾—5½	4 15 3	Mar, Sept	—	..
St.	4½%	Do. 4½ 1st Deb. Stock (red)	95 —98	4 13 3	Feb, Aug	—	..
5	5/0	Hove Electric Lighting Ord.	6¾—7½	6 8 6	April, Oct	..	..
St.	4½%	Isle of Wight E. L. & P. Co. Deb. Stk.	88 —91	4 19 0	..	..	..
5	4/0	Kensington & Knightsbridge Ord.	6¾—7⅛	6 18 6	Feb, Aug	—	..
5	6%	Do. 6 per Cent. 1st Pref.	5¾—6	5 0 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	91 —93	4 6 0	..	91½	..
St.	4%	Kensington & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	96 —99	4 1 0	April, Oct	—	—
St.	4½%	Kent Elec. Power Co. Irred Deb. Stk.	80 —84	5 10 0	Jan, July	..	..
3	1/2½	London Electric Supply Ord.	1⅝—2	3 8 0	Mar, Sept	..	..
5	3/0	Do. 6 per Cent. Pref.	4⅜—5	6 3 0	Mar, Sept	4⅜	4⅜
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	89 —92	4 8 0	Jan, July	..	..
5	2/0	†Metropolitan Electric Sup. Ord.	3¾—4¼	6 0 0	April, Oct	—	—
5	2/3	Do 4½ per Cent. Cum. Pref.	4¼—4½	4 17 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	100 —105	4 8 0	June, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	84½—87½	4 1 6	Jan, July	..	..
..	4½%	Midland Elec. Corp. for P.D. 4½ 1st Mort. Debs	96½—98½	4 12 6	..	..	..
5	2/0	Newcastle Elec. Supply Ord. (1-50,000 & 57,010-137,500)	3¾—3⅞	6 4 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non Cum. Pref.	3¾—4⅛	6 5 0	Feb, Aug	—	..
100	4½%	Do. 4½ per Cent. 1st Mort. Deb.	97 —99	4 12 0	Jan, July	..	..
100	5%	North Metro. Elec. Power Sup. 5 Morts.	101 —104	4 17 6	..	..	..
1	6%	Northampton Elec. Lt. & P. Ord.	1⅛—1⅜	4 11 6	Feb, Aug	..	..
1	5%	Do. 5% Pref.	1⅛—1⅜	4 6 0	Feb, Aug	..	..
St.	4%	Do. 4% Debs.	99 —101	3 19 0	June, Dec	..	..
10	6/0	Notting Hill Electric Ord.	..	5 17 6	March	..	..
5	4/3	Oxford Electric Ord.	6¼—5⅝	5 10 0	March	..	..
St.	4%	Do. 4% Deb. Stk.	91 —94	4 5 1	..	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	8¼—9⅛	5 11 0	Feb, Aug	..	..
5	3/6	Do. 7 per Cent. Pref.	6¾—7⅛	5 0 0	Feb, Aug	7	..
St.	3½%	Do 3½ per Cent. Deb. Stock (red.)	84½—86½	4 2 0	Jan, July	..	..
5	..	Smithfield Markets Electric Sup. Ord.	1⅛—1⅜	..	Feb.	..	..
5	4/0	South London Electric Supply Ord.	2⅝—3	6 5 6	April	..	..
St.	5%	Do, 5 % 1st Mort. Stock (red.)	98½—101½	5 0 6	..	..	..
1	0 8½	South Metrop'n Elec. Lt & Power 7% 1st Pref	1⅛—1⅜	5 18 0	Feb, Aug	..	..
1	0/7½	Do. 6 per Cent. 2nd Pref.	⅝—¾	6 17 0	Feb, Aug	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	97 —100	4 11 6	April, Oct	..	..
5	1/3	Urban Electric Supply Ord.	¾—1	..	April, Oct	..	..
5	1/3	Do. 5 per Cent. Cum. Pref.	2½—3	8 6 0	April, Oct	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	87 —89	5 2 3	April, Oct	89	..
5	5/0	†Westminster Elec. Sup. Ord.	7⅛—8	6 15 6	Mar, Sept	..	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	5 —5⅛	4 3 6	Jan, July	..	..
		Electric Railways and Tramways.					
1	..	Bath Elec. Trams Pref. Ord.	⅜—⅝	..	April	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	⅜—½	8 0 0	Jan, July	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	79 —83	5 8 6	April, Oct	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Deb. Stock	91 —93	4 17 9	Jan, July	92	..
10	4%	†Bristol Tramways & Carriage Ord.	5¾—6¼	6 13 6	Feb, Aug	—	..
10	4%	Do Cum. Pref.	7 —7½	5 10 0	..	..	..
St.	4%	Do. 4 per Cent. Debs.	100 —101	3 19 2	Feb, Aug	..	..
10	..	British Electric Traction Ord.	⅞—1⅛	..	June, Dec	1⅛	1⅛
10	..	Do. 6 per Cent. Cum. Pref.	3¼—4	..	Feb, Aug	3⅜	3⅜
St.	5%	Do. 5 per Cent. Perpetual Debs.	94 —97	5 4 6	April, Oct	..	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	75 —79	5 17 0	May, Nov	..	..
St.	3%	†Central London Ordinary Stock	67 —69	4 8 0	Feb, Aug	67½	67
St.	4%	†Do. 4 per Cent. Pref. Stock	85 —87	4 13 0	Feb, Aug	85½	..
..	6/4	Do. 4½% Pref. Scrip 50% pd	63 —65	..	..	..	..
St.	2%	Do. Deferred Stock	47 —51	4 0 0	Feb.	47½	47½
100	4%	Do. 4 per Cent. Debs.	102 —104	3 16 11	Jan, July	..	..
5	2/6	City of Birmingham Trams, 5 % Cum. Pref.	4¼—5⅛	4 19 6	April, Oct	..	..
100	4%	Do 4 per Cent. 1st Mort. Debs.	99 —102	3 18 9	April, Oct	..	..
St.	1½%	City & South London Rly. Con. Ord.	29½—30½	5 16 6	Feb, Aug	..	..
St.	5%	Do. 5 per cent. Perp. Pref. (1891)	103 —110	4 11 9	Feb, Aug	30½	29½
St.	5%	Do. (1896)	104 —106	4 16 0	Feb, Aug	..	..
St.	5%	Do. (1901)	103 —105	4 17 0	Feb, Aug	..	..
St.	5%	Do. (1903)	102 —104	4 16 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	102 —104	3 17 9	May, Nov	..	..
10	6/0	†Dublin United Trams, 6 per Cent. Pref.	12 —13	4 16 0	Feb, Aug	..	..
10	12/0	Gateshead and District Trams Ord.	8¼—8½	6 19 0	..	..	..
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	⅛—1⅛	..	Feb, Aug	..	..
5	..	Hastings & District Elec. Trams, 6% C. P.	..	..	Mar. Sept	..	..
St.	4½%	Do. 4½ Deb. Stock	75 —80	5 10 0	April, Oct	..	..
10	..	Imperial Tramways Ord.	3 —3⅛	..	Mar, Sept	..	..
10	..	‡Do. 6 per Cent. Pref.	4 —4½	..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Debs.	72 —74	6 3 6	Jan, July	..	..
..	2/0	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	2½—3	4 11 0	Mar, Sept.	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	77 —82	5 1 0	Jan, July	..	..
10	5/0	†Lanarkshire Tramways	9¾—10½	5 15 0	Feb, Aug	..	..
St.	5%	Lancs Utd. Trams, 5% Prior Lien Deb. Stk.	79 —82	6 4 0	Jan, July	..	..
St.	4%	London Electric 4% Deb. St.	96 —98	4 2 6	..	97½	97
St.	4%	†Do. 4% Pref.	82½—83½	4 16 6	..	83½	83
10	..	London United Trams, 5% Cum. Pref.	3⅛—3¼	..	Jan, July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	73 —76	5 7 6	Jan, July	..	..
St.	..	Mersey Con. Ord. Stock	6 —8	..	Feb, Aug	..	..
1	1/1½	Metropolitan Elec. Tramways Ord.	⅝—1⅛	6 0 0	..	..	..
1	..	Do. Deferred	⅝—1	..	April	..	..
1	0/6	†Do. 5 per Cent. Cum. Pref.	⅝—1	5 8 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	99 —101	4 10 0	Jan, July	100½	99
St.	5%	Do. 5 per Cent. Db. Stk	102½—104½	4 16 6	..	103½	..

* No allowance has been made for accrued interest or redemption.
† Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Sect.	Last Dividend	Name	Price Wed., Aug. 23.	*Rate per cent. Yielded.	Dividend Due.	Business Week to Aug. 23. Highest.	Business Week to Aug. 23. Lowest.
		Electric Railways and Tramways— *Continued.*		£ s. d.			
St.	2%	Metropolitan Railway Consolidated	45 —45½	4 3 6	Feb, Aug	46½	43½
St.	3%	Do. Surplus Land Stocks	65 —67	4 11 0	Feb, Aug	66½	..
St.	3½%	Do. 3½ per Cent. Preference	88 —90	3 18 6	Feb, Aug	89½	89
St.	3½%	Do. 3½ per Cent. "A" Preference	87 —89	3 19 6	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Convertible Pref.	92 —94	3 14 6	Jan, July	92	..
St.	3½%	Do. 3½ per Cent. Debenture Stock	91 —93	3 16 0	Jan, July	..	..
St.	3½%	Do. 3½ per Cent. "A" Deb. Stock	.. ..	.. ..	Feb, Aug	27½	25½
St.	..	Metropolitan District Railway Ord.	26½—26¾	.. ..	Feb, Aug	88	86½
St.	4½%	†Do. 4½% First Pref.	86 —88	5 3 6	Feb, Aug	..	..
St.	3½%	Do. Assented 1st Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	74 —76	4 13 6	Feb, Aug	75	74½
St.	3%	Do. 3 per Cent. Consoltd. Rent-charge	76 —78	3 18 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Midland Rent-charge	102 —104	3 17 9	Jan, July	..	..
St.	6%	Do. 6 per Cent. Perp. Deb. Stock	145 —147	4 2 0	Jan, July	145½	..
St.	4%	Do. 4 per Cent. Ditto	96 —98	4 2 6	Jan, July	..	..
1	4½d.	Potteries Electric Traction Ord.	⅞—1⅛	6 11 3	April, Oct	..	..
1	0/6	†Do. 5 per Cent. Cum. Pref.	1⅛—1⅜	8 9 6	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent, Deb. Stock	88 —91	5 0 0	May, Nov	..	..
1	1/2½	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	⅜—⅝	10 2 0	.. ..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	73 —78	5 6 0	Jan, July	..	..
100	5%	Sunderland Dist. Elec. Trms. 5% 1stMtDb.	.. ..	8 4 0	Jan, July	61	59
—	10/0	Undergd E. Rys. Lon. 6% In. bds with coup 7	60 —62	1 12 6	June, Dec	..	..
—	5%	Do. 5% Prior Lien Bonds	100½—101½	4 19 0	.. ..	99½	98
—	4½%	Do. 4½% Bonds with coup. 8	98 —100	4 11 0	.. ..	..	..
—	4%	Do. 4 per Cent. 1st Power Ho. Dbs.	101 —103	3 18 3	.. ..	..	..
5	..	Yorkshire (W.R.) Elec. Trams. Ord.	¼—⅜	.. ..	March ..	..	..
5	—	Do. 6 per Cent. Cum. Pref.	2⅛—2⅜	.. ..	.. ..	..	..
St.	4½	Do. 4½ per Cent. 1st Debs.	80 —85	5 9 6	Jan, July	..	..
		Electric Manufacturing, &c.					
St.	4½%	Anchor Cable Co. 4½ % Deb. Stock	99 —101	4 10 0	—	..	..
1	1/2½	Aron Electricity Meter Ord.	⅜—½	.. ..	.. ..	..	..
1	0/7½	Do. 6% Cum. Pf.	⅝—⅞	7 10 0	April, Oct	5⅝	5⅜
1	3/2½	Babcock & Wilcox Ord.	5½—5⅝	4 14 3	April, Oct	..	..
1	0/7½	Do. Pref.	1⅜—1⅝	4 0 0	.. ..	..	..
5	6/0	British Insulated & Helsby Cables Ord.	6¼—7⅛	6 15 6	July, Feb	7⅛	7
5	3/0	Do. 6 per Cent. Pref.	5⅛—5⅜	5 0 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	102 —104	4 7 0	Jan, July	103	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	96 —99	4 11 0	Mar, Sept	..	..
5	4½%	British Westinghouse 6 per Cent. Pref.	⅝—¾	.. ..	Feb, Aug	..	..
100	..	Do 6 per Cent. Prior Lien Dbs. (rd.)	102 —104	5 17 0	.. ..	..	..
St.	6%	Do 4 per Cent. Mort. Deb. Stock	59 —62	6 6 6	Jan, July	..	..
St.	4%	BrushE. Eng. Co. 4½% Perp. 1st Deb. Stock	58 —63	7 8 6	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	39 —44	10 10 0	Jan, July	..	..
5	4½%	Callender's Cable Con. Ord.	9½—9¾	7 10 0	Jan, July	9½	..
5	10/0	Do. 5 per Cent. Cum. Pref.	4½—5¼	4 17 6	Jan, July	..	..
St.	2/6	Do. 4½ per Cent. 1st Mort Debs. (red.)	101 —103	4 8 0	Nov, May	3⅞	3½
1	4½%	Gastner-Kellner Alkali Co.	3½—3⅝	5 4 3	May, Nov	..	..
St.	1/6	Do. 4½ per Cent. 1st Mort. Deb. (red.)	102 —105	4 7 0	Feb, Aug	..	..
1	4½%	Chadburn's (Ship) Telegraph Ord.	1⅜—1⅝	5 19 0	March ..	..	..
1	1/0	Consolidated Electrical Co.	⅛—¼	7 8 9	August ..	..	..
1	0/8½	Consolidated Signal Co.	⅜—½	8 7 6	April, Oct	..	..
1	0/6	Do. 6 per cent. Cum. Pref.	⅜—½	7 6 6	April, Oct	..	..
1	0/7½	Crompton & Co (Nos. 1 to 85,000)	⅜—½	.. ..	Jan, July	..	..
3	..	Do. 5 per Cent. 1st Mort. Debs. (red.)	57⅛—67⅛	8 0 0	Jan, July	..	..
100	5%	Dick, Kerr & Co. Ord.	⅝—¾	5 14 0	Sept ..	..	..
5	1/0	Do. 6 per Cent. Cum. Pref.	1⅛—1⅜	5 6 0	Sept ..	..	..
5	0/7½	Do. 4½ per Cent. Deb. Stock	95 —98	4 13 3	Jan, July	..	..
St.	4½%	Edison & Swan United ("A" Sh.) (£3 pd.)	⅞—⅞	.. ..	Feb, Aug	..	..
5	..	Do. (£5 paid)	1⅝—2⅛	9 3 0	Feb, Aug	..	..
..	..	Do. 4 per Cent. Mort. Deb. Stock (red.)	67 —71	5 16 0	June, Dec	..	..
St.	4%	Do. 5 per Cent. 2nd Deb. Stock	78 —81	6 3 6	Mar, Sept	..	..
St.	5%	Electric Construction Co.	⅝—⅞	6 3 0	Jan, July	..	..
2	2½%	Do. 7 per Cent. Cum. Pref.	1⅛—1⅜	7 4 6	July ..	..	..
2	2/9½	Do 4 per Cent. Perp. 1st Mort. Debs.	73 —78	5 6 0	Jan, July	75	..
St.	4%	General Electric (1900) 5% Cum. Pref.	8¼—9	5 14 0	June, Dec	..	..
10	5/0	Do. 4 per Cent. 1st Mort. Debs.	88 —93	4 8 6	Mar, Sept	..	..
St.	4%	Henley's Telegraph Works Ord.	12½—12¾	5 16 6	Feb, Aug	..	..
5	10/0	Do. 4½ per Cent. Pref.	4⅛—5⅛	4 9 0	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. 1st Mort. Deb. Stock	100⅛—103⅛	4 3 6	Mar, Sept	13½	..
St.	4½%	India Rubber, Gut. Per., &c., Works	12 —14	6 0 0	Feb, Aug	10½	..
10	15/0	Do 5 per Cent. Cum. Pref.	9½—10¾	4 19 0	.. ..	9½	..
10	5/0	Do. 4 per Cent. Debs. (red.)	94½—96½	4 4 0	April, Oct	..	..
100	4%	National Elec. Construction Co.	¼—⅜	.. ..	April ..	..	..
1	..	Richardsons, Westgarth & Co., Ltd. Ord.	⅝—¾	.. ..	Nov ..	..	..
1	..	Do. 6 per Cent. Cum. Pref.	⅞—1	.. ..	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. Perp. Deb. Stock	77 —80	5 14 6	Jan, July	..	..
5	..	Simplex Conduits 6 per Cent. Cum. Pref.	4⅝—5	.. ..	.. ..	34½	34
12	12/0	Telegraph Construction & Maintenance	34½—36½	6 9 9	Mar, July	..	..
100	4%	Do. 4 per Cent. Deb. Bonds (1909)	100 —102	3 19 3	Jan, July	2	1⅝
1	1/0	†Vickers, Sons & Maxim, Ltd., Ord.	1⅜—1⅝	4 13 0	.. ..	..	..
1	0/6	†Do. 5 per Cent. non-Cum. Preference	1⅜—1⅝	4 3 0	.. ..	1½	—
St.	5%	†Do. 5 per Cent. non-Cum. Preferred	107 —111	4 11 6	.. ..	103½	..
St.	4%	Do. 4 per Cent. 1st Mort. Db. Stk. (red.)	99½—101⅛	3 19 6	June, Dec	100½	100
100	4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.)	103 —105	4 6 6	June, Dec	..	..
100	5%	Do. 5 per Cent. 3rd Mort. Debs Scrip	103 —105	4 16 0	.. ..	104	103⅛
10	12%	J. G. White & Co. 6% Cum. Pref.	14½—15½	7 14 10	.. ..	..	..
1	..	Willans & Robinson Ord.	⅜—½	.. ..	Apr, Oct	..	..
5	..	Do. 6 per Cent. Cum. Pref.	⅛—¼	.. ..	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	55 —65	6 3 0	May, Nov	..	..
		Telegraphs.					
10	..	Amazon Telegraph	7⅛—7½	.. ..	June, Dec	..	..
100	5%	Do. 5 per Cent. Debs. (red.)	98½—100⅛	5 0 5	Jan, July	..	..
St.	15/0	Anglo-American	67 —69	4 8 0	F, My, Ag, N	67½	..
St.	30/0	Do. Preferred	111½—112½	5 19 0	F, My, Ag, N	112½	111⅛
St.	30/0	Do. Deferred	25⅛—25⅝	5 7 0	F, My, Ag, N	25⅛	25⅛
St.	4%	Commercial Cable 4 per Cent. Deb. Stk.	87⅛—89⅛	4 10 6	Jn, Ap, Jy, O	89	88
10	6/0	Cuba Submarine Ord.	10¾—11	5 13 0	Feb, Aug	10⅜	..
10	10/0	Do. Preference 10 per Cent.	17⅛—18⅛	5 13 0	Feb, Aug	..	..
5	2/0	Direct Spanish Ord.	3⅛—4	5 0 0	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	8⅛—8⅝	5 16 0	April, Oct	..	..
50	4½%	Do 4½ per Cent. Deb.	100 —102	4 9 0	Jan, July	..	..
10	3/0	Direct United States Cable	8 —8⅛	6 3 0	Ja, Ap, Jy, O	8⅛	8⅛
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	99 —101	4 10 0	June, Dec	..	..
St.	25/0	Eastern Ordinary	136 —139	5 2 0	Ja, My, Jy, O	138½	137
St.	12/6	Do. 3½ per Cent. Pref. Stock	84 —86	4 2 6	Ja, My, Jy, O	84½	84
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (red.)	102 —104	3 17 9	May, Nov	104	103½
St	2/6	Eastern Extension	13¼—14	5 2 0	Ja, Ap, Jy, O	13⅜	13⅛
10	4%	Do. 4 per Cent. Deb. Stock	100⅛—102⅛	3 19 0	Feb, Aug	..	..
25	4%	Eastern and S. Af., 4% Mauritius Sub. Debs	100 —102	3 19 0	May, Nov	..	..
10	5/0	G.N. (of Copenhagen), with Coupon 83	31 —32	5 14 3	Jan, July	..	..
25	52/6	Indo-European	56½—58½	5 6 6	May, Nov	58	..
100	5%	Mackay Companies Common	80 —88	5 15 0	Ja, Ap, Jy, O	..	..
100	4%	Do. Preference	74 —77	5 6 0	Ja, Ap, Jy, O	..	..
1	1/0	Marconi's Wireless Teleg. Co.	2⅛—2⅜	.. ..	April ..	2⅛	2⅛
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (red.)	99⅛—101⅛	3 19 9	June, Dec	..	..
2½	1/3	West Coast of America	1⅛—1⅜	5 0 0	May ..	..	..
100	4%	Do. 4 per Cent. Debs.	99 —100	4 1 0	Jan, July	..	..
10	1/6	West India & Panama	2⅛—2¼	4 13 0	May, Nov	2⅛	2⅛
10	6/0	Do. 6 per Cent. 1st Pref.	10⅛—10⅝	5 16 6	May, Nov	10⅛	10⅛
10	6/0	Do. 6% 2nd Pref.	9⅞—10⅛	6 0 0	May, Nov	..	..
10	6/0	Do. 5 per Cent. Debs.	101 —103	4 18 0	Jan, July	..	..
100	5%	Western Telegraph	13⅜—14⅛	5 1 1	Mr, Jn, O, D	13⅛	13⅛
10	3/0	Do. 4 per Cent. Deb. Stock (red.)	100⅛—102⅛	3 19 0	June, Dec	101	..
St.	4%	Western Union Telegraph, $1,000 4% Bds	107 —110	3 13 9			
—	4%	Do. $1,000 4½% Fdg. & Rl. Est. Gd. Bnds	101 —104	4 8 0			

Sect.	Last Dividend	Name	Price Wed., Aug. 23	*Rate per cent. Yielded.	Dividend Due.	Business Week to Aug. 23. Highest.	Business Week to Aug. 23. Lowest.
		Telephones.		£ s. d.			
St.	2$	Amer. Telephn. & Telegh. Cap. St.	137 —139	5 16 0	.. ..	..	..
St.	4%	Do. Coll. Trust $1,000 4 per Cent. Bds.	94 —96	4 4 0	Jan, July	..	..
St.	4%	†Do. 4% Cons. Bonds 1936	107 —109	3 14 0	.. ..	..	..
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101½—103½	4 17 6	Mar, Sept	..	..
5	4/0	Chili Telephone	6⅛—7⅜	4 5 9	August ..	..	..
1	0/7½	Monte Video Telephone Ord.	¾—1	6 0 0	Nov ..	..	..
1	0/6	Do. 5 per Cent. Pref.	¾—1	5 11 0	May, Nov	..	..
St.	6%	National Co. Pref. Stock	104 —106	5 14 0	Feb, Aug	..	..
St.	6%	Do. Def. Stock	117½—120½	5 1 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	10 —10⅛	5 11 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10 —10⅛	5 11 6	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.	5⅛—5⅜	4 11 3	June, Dec	..	..
St.	3½%	Do Deb. Stock 3½ per Cent. (red.)	98 —100	4 1 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	98 —100	4 1 0	.. ..	..	..
5	5/0	New York Telephone Co. 30 yr. Bnds.	102½—103½	4 7 6	.. ..	..	..
1	1/0	Oriental	1⅛—1⅜	4 18 0	April, Oct	..	..
1	0/7½	Do 6 per Cent. Cum. Pref.	1⅛—1⅜	4 16 0	April, Oct	..	..
St.	4½%	Do. 4 per Cent. Red. Deb. Stock	88 —90	4 10 0	Jan, July	..	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. (red.)	99 —101	4 10 0	Jan, July	..	..
5	5/0	United River Plate Ord.	7⅛—7⅛	5 5 0	July ..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅛—5⅜	4 13 0	June, Dec	..	..
St.	4½%	Do. 4½ Deb. St. Red.	102½—104½	4 7 0	Jan, July	..	..
		Financial, Investment, &c.					
—	..	Elec. & Gen. Investment 6% Cum. Pref.	4 —4½	7 1 0	Jan, July	..	..
5	3/0	Globe Telegraph & Trust	10⅛—11⅛	5 9 0	Sp, Dcbr'ju	..	..
10	6/0	Do 6 per Cent. Pref.	13 —13⅜	4 10 9	Sp, Dcbr'ju	..	..
10	3/0	Submarine Cables Trust (Cert.)	131½—134½	4 10 3	April, Oct	..	..
		Colonial and Foreign Electric Railways, Tramways, &c.					
5	2/9	Anglo-Argentine 5½% Cum. 1st Pref.	5⅛—5⅜	4 17 6	April, Oct	..	..
5	2/9	Do. 5½% Cum. 2nd Pref.	4¼—5	5 12 9	Jan, July	..	..
St.	4%	Do. 4% Deb. Stock	94 —96	4 3 4	June, Dec	..	..
St.	4½%	Do. 4½% Dsb. Stock	102½—102¾	4 9 0	.. ..	..	..
St.	5%	Do. 5% Deb. Stock	100 —102	4 19 0	.. ..	..	..
5	4/0	Auckland Elec. Trams. 5% Deb. (red.)	102 —105	4 16 6	Jan, July	..	..
St.	5%	Brisbane Electric Trams. Invest. Ord	6½—7	5 14 0	May ..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5⅛	4 17 6	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Certs.	102 —105	4 7 0	Jan, July	..	..
St.	4½%	British Columbia El. Ry. Df. Ord.	139 —143	5 13 6	Mar, Sept	..	..
St.	6%	Do. Pref. Ord. Stock	119 —123	4 17 9	May, Nov	..	..
St.	5%	Do. 5% Cum. Perp. Pref. Stock	106 —109	4 13 0	Jan, July	..	..
St.	4%	Do. 4½ per Cent. 1st Mort. Debs.	100 —103	4 7 6	April, Oct	..	..
40	4½%	Do. Vancouver Power Debs.	101 —104	4 3 3	Jan, July	..	..
100	4½%	Do. 4½% Perp. Con. Deb. St.	102½—104½	4 2 0	.. ..	..	..
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	98 —100	5 1 0	Mar, Sept	..	..
St.	6%	†Buenos Ayres Port & City Tram, 1st Mt. Deb. Stock	92 —96	6 8 0	Feb, Aug	..	..
1	..	Calcutta Tramways (1 to 137,610)	5⅛—6¼	4 19 6	Mar, Sept	..	..
St.	3/6	Do. 5 per Cent. Cum. Pref.	5 —5⅛	4 17 6	Jan, July	..	..
100	2/6	Do. 4½% 1st Deb. Stock (red)	102 —105	4 5 9	Jan, July	..	..
1	4½%	Cape Electric Tram Shares	⅛—¼	.. ..	.. ..	..	..
St.	1/3	†City of Buenos Ayres Trams Co. (1904) Sh.	5⅛—5⅜	4 8 0	F, My, A, N	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	94 —97	4 4 0	June, Dec	..	..
St.	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.	95 —100	5 2 6	May, Nov	..	..
1	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	100 —103	4 19 0	Feb, Aug	..	..
5	..	Hong Kong Tramways Co. 5 per Cent. 1st Mort. Debs.	77 —81	6 6 6	June, Dec	..	..
..	..	Kalgoorlie Elec. Trams Sh.	⅜—½	.. ..	.. ..	..	..
..	..	Do. 5 per Cent. "A" Deb. Stock	22½—23½	5 4 6	Jan, July	..	..
..	..	Do. 6 per Cent. "B" Ditto	63 —67	8 15 0	Jan, July	..	..
..	..	Lisbon Elec. Trams. Ord.	1 —1⅛	4 16 0	July ..	..	..
..	..	Do. 6 per Cent. Cum. Pref.	1 —1⅛	4 16 0	Jan, July	..	..
..	..	Do. 5 per Cent. Reg. Mort. Debs.	97 —101	5 1 0	Jan, July	..	..
..	..	Madras Elec. Trams. 5% Deb. Stk.	95 —98	5 3 6	Jan, July	..	..
..	..	Manaos Trams and Lt. Co. 5% Debs	89 —92	5 10 3	.. ..	..	..
..	..	†Manila Elec. Ry. $1,000 Gold Bonds	97½—99½	5 1 0	Feb, Aug	..	..
..	..	Mexico Trams Co. Com. St.	120 —122	5 15 6	.. ..	..	..
..	..	Do. Gen. Con. 1st Mort. 5% Gold Bds.	99½—100⅛	5 0 0	.. ..	..	..
..	..	Do. 6% 50 yr. Mort. Bds.	99 —101	6 1 3	.. ..	..	..
..	..	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922) (Nos. 601 to 2,000)	100 —102	4 9 0	Feb, Aug	..	..
..	..	Do. do. (Nos. 1 to 4,600)	102 —104	4 7 6	May ..	..	..
..	..	Perth Elec. Trams Ord.	⅜—½	2 7 2	.. ..	..	..
..	..	Do 1st Mt. Db. Stock	101½—103½	4 17 6	Jan, July	..	..
..	..	Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	5⅛—5⅜	5 8 0	.. ..	..	..
..	..	Do. 4½% 1st Mort. Deb. Stk.	98 —101	4 10 6	.. ..	..	..
..	..	Rio Janeiro Tram, Lt. & P. Co.	115 —116	4 6 6	.. ..	..	..
..	..	Do. 30 yr. Gold Bnds.	101½—102½	4 18 3	.. ..	..	..
..	..	Do. 50 yr. Mt. Bnds	97½—98½	5 2 0	.. ..	..	..
..	..	Sao Paulo Tramway, Light & Power Co. $100 Stock	178 —181	5 11 6	.. ..	..	..
..	..	Do. 5 per Cent. 1st Mt. $500 Db.	103 —105	4 15 3	June, Dec	..	..
..	..	Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	99 —101	4 10 0	Feb, Aug	..	..
		Colonial and Foreign Electricity Supply, &c.					
..	..	Adelaide Elec. S'ply Co. 6% Cu. Pr.	5⅛—5⅜	5 8 0	Mar, Sept	..	..
..	..	Bombay E.S. & T. 6% Cm. Pf.	10⅛—11⅛	5 9 0	.. ..	..	..
..	..	Do. 4½ per Cent. Deb. Stk. (red).	96½—98½	4 12 0	Jan, July	..	..
..	..	Do 5 per Cent. 2nd Mort. Deb. Stock	97 —99	5 2 0	.. ..	..	..
..	..	Calcutta Elec. Supply Ord.	6⅛—7⅛	5 19 6	April, Oct	..	..
..	..	Do. 5% Cum. Pref	⅝—⅞	4 13 0	.. ..	..	..
..	..	Calgary Power Co. 5% 1st Mort. Bnds.	96 —99	5 2 0	.. ..	..	..
..	..	Canadian Gen. Elec. Co. Com. St.	109 —114	6 5 6	.. ..	..	..
..	..	Do. 7% Cm. Pf. Stock	121 —125	5 14 0	.. ..	..	..
..	..	Castner Electrolytic Alkali Co (of U.S.A.) 1st Mort. Stl. Debs.	94 —97	5 3 6	Jan, July	..	..
..	..	Elect. Development Co. of Ontario	81 —90	5 12 0	.. ..	..	..
..	..	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	84½—87½	5 4 0	Jan, July	..	..
..	..	Indian Elec. Sup. & Trac. Co.	1 —1⅛	.. ..	.. ..	..	..
..	..	Kalgoorlie Elec. Power & Ltg. Ord.	⅛—⅜	8 6 6	April, Oct	..	..
..	..	Do. 6 per Cent. Cum. Pref.	⅛—⅜	.. ..	.. ..	..	..
..	..	Kaministiquia Power Co. 5% Gold Bnds.	101 —103	4 18 0	.. ..	..	..
..	..	Madras E. S. Corp. Ord.	2½—3⅛	.. ..	.. ..	..	..
..	..	Melbourne E. S. Co. Cons. Ord. St.	3⅜—4⅛	.. ..	.. ..	..	..
..	..	Do. 5% 1st Mortg Deb. Stock	95 —97	5 4 0	.. ..	..	..
..	..	Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	89 —90	5 12 0	.. ..	..	..
..	..	Mexican Lt. & Power Co. Com. St.	83 —90	4 10 0	.. ..	..	..
..	..	Do. 7% Cum. Pref. St.	110 —112	6 6 0	.. ..	..	..
..	..	Do 5% 1st Mort. Gold Bnds.	96 —98	5 3 0	.. ..	..	..
..	..	Monterey Ry. L. & P. Co. 1st Mort. Db. Stk.	83 —91	5 11 0	F, My, A, N	..	..
..	..	†Montreal Lt. Ht. & Power Co. Cap. St.	165 —170	5 18 6	.. ..	..	..
..	..	Northern Lt. Power & Coal 5% Gd. Bds	40 —42	6 2 0	April ..	..	..
..	..	River Plate Electricity Co. Ord. Stk.	218 —228	4 7 9	May ..	..	..
..	..	Do. 6 per Cent. non-Cum. Pref. Stk.	107 —114	5 5 0	Jan, July	..	..
..	..	Do. 5 per Cent. Deb. Stock	101½—103½	4 17 6	.. ..	..	..
..	..	Shawinigan Water & Power Co. Cap.	115 —118	4 6 0	.. ..	..	..
..	..	Do. 5 per Cent. Bds.	107 —109	4 12 6	Jan, July	..	..
..	..	Do. 4½ Per Cen. Mt. Db. St.	102 —105	4 6 0	.. ..	..	..
..	..	Toronto Power Co. 4½% Db. St.	100 —101	4 8 0	.. ..	..	..
..	..	Victoria Falls Power Co. Ord.	11·85	.. ..	.. ..	..	..

* No allowance has been made for accrued interest or redemption. † Ex Dividend. ‡ The London Stock Exchange Committee

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NOTES.

The British Association.

ONCE more the members of the British Association are gathered together, and this time the meeting takes place at Portsmouth. Sir WILLIAM RAMSAY in his Presidential Address on Wednesday evening dwelt, among other matters, on the husbanding of our coal supply. The prominence given in the daily Press to his Address should certainly result in greater attention being devoted to this important subject. Yesterday the various sections met to hear their respective Chairmen's addresses. The number of members of all classes attending this year's meeting is returned as 1,200, and if only by reason of the proximity of the dockyards and Southsea the occasion will certainly be enjoyable. Of late years there has been a falling-off in the quality of Papers read and the reasons are not far to seek, but it is to be hoped that this year will see a welcome revival.

IN his address to Section A, Prof. H. H. TURNER pleads for the amateur, but his conception of the amateur is not that generally held by the man in the street. As a rule the amateur is a person of whom it may be said that "a little learning is a dangerous thing." By the professional he is regarded with something akin to contempt, and because of the old rule that a thing which costs nothing is not worth having, his advice is seldom sought and still more seldom taken. Amateur engineers, doctors, lawyers, and even sailors and soldiers, we always have with us, but generally they are not to be compared with the professional. Prof. TURNER'S amateur is, however, quite a different creature. His amateur is the man who, with no pay and often with no hope of reward, gives up his time and means to the prosecution of research. If this is the true meaning of the word, then it can only be said that there would be little progress if it were not for the amateur, and that everything possible should be done to encourage him.

Supply Stations and Strikes.

ATTENTION was called in our Notes last week to the necessity for legislation in connection with breaches of contract by workmen engaged in electricity supply and kindred industries, and although something will undoubtedly be done in this direction, yet time must necessarily elapse before any proposals can be embodied in an Act of Parliament. In the meantime the danger remains, and no one will dispute that it is very real. Since, moreover, legislative precautions for dealing with such an emergency are, according to present indications, not likely to prove a complete solution of the problem, it behoves electric supply authorities, and particularly municipalities, to take steps whereby continuity of supply shall be maintained in the event of a sudden stoppage of work by employés.

THE citizens of Liverpool, profiting by experience, have enrolled a number of volunteers who are prepared to come forward in an emergency and take up various duties in much the same way as was done by certain public-spirited persons during the recent strike. This example is commended to the notice of supply authorities, who, by

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following it, would thus be in a position to fulfil their obligations to the public, for a time at all events, and incidentally would place themselves in a much stronger position than they have ever held before. Since, also, the supply of fuel is liable to be seriously interfered with, even at 24 hours' notice, as in the recent railway strike, greater attention will doubtless be paid in future to maintaining a larger storage of coal. If reports in the daily Press are correct, many electric supply stations would have been in difficulties if the dislocation of railway traffic had occurred during the winter months.

Electricity Supply at Glasgow.

In analysing last week the accounts of the Glasgow Corporation Tramway Department we set out in detail the various items in the total cost of generating the electrical energy supplied to the cars. It is interesting to compare these figures with those contained in our analysis, on another page of this issue, of the accounts of the Corporation's electric supply undertaking for the year ended May 31st last. These accounts show that the undertaking is making excellent progress, nearly 1,700 new consumers having been obtained during the past 12 months, whilst the sales of energy to private consumers have increased by 4¼ million units. The low charges for current have, doubtless, done much to popularise the use of electricity and to bring about the above result, and in this connection domestic consumers, who for some time have obtained current for lighting at 3d. per unit, can now have energy for cooking, heating, &c., at 1d. per unit without the inconvenience of separate wiring. This scheme was only introduced last October, but by May of the present year it had been adopted by 300 consumers. Another feature of the supply is that no less than 7 million units, out of a total of 39 million sold to private consumers, were supplied at ½d. per unit.

In regard to the cost of generation, it will be noticed that salaries and wages are 0·09d. per unit sold and per unit sent out respectively in the case of the electric supply and the electric tramway power stations; whilst the cost of oil, waste, water, &c., is 0·01d. as against 0·02d. in the two cases. It is also interesting to observe that the cost of fuel is 0·19d. with a 19·8 per cent. load factor in the case of the electricity undertaking, and 0·13d. with a 39·7 per cent. load factor in the tramway power station; whilst the interest on the capital outlay is, per unit, approximately inversely proportional to the load factors, as might be expected. The tramway report states that the total cost of the tramway supply, including depreciation, is 1·17d. per unit sent out to sub-stations; so that, in view of the above figures, advocates of separate power stations would have difficulty in proving any economy from that arrangement, although local circumstances might sometimes point to its desirability.

The Education of Engineers.

If there was one thing that the recent Education Conference made clear it was the extraordinary diversity of opinion that exists between teachers and engineers as to the best method of training men for the profession of engineering. It is unfortunate that this should be so, for it must lead to uncertainty in the minds of parents who desire that their sons shall become engineers. In this connection we publish on another page of this issue a short account of the courses provided at Faraday House. These courses possess three great advantages: they are not designed to prepare the student for a particular degree, but rather to teach him the general principles of engineering; they provide an equal mixture of sound theoretical and practical training; and they give good promise of employment, as soon as he leaves the institution, to a student who has passed through them meritoriously. The training given appears to be eminently suited to the end it is desired to attain, and it is refreshing to know that such an institution can be successful, even though it does not indulge in the fascinating pastime of degree-hunting.

"Elektrotechnische Zeitschrift."—The offices of this journal have been moved to Berlin W. 9., Linkstrasse 23/24.

Electric Traction in Norway.—A recently issued report of the Committee on the electrification of Norwegian Railways states that a large amount of money can be saved by applying electric traction to the new lines which are being constructed. The only actual railway project imminent is the conversion of the Christiania–Drammen railway, but several private lines are already electrified. The general report of the Committee is in favour of a complete investigation into the whole question of converting the Norwegian lines. In view of the conversion of the railways, a large international combination of water-power installations in Scandinavia has recently taken place, with a capital of £2,000,000, in which three well-known German electric manufacturing firms are interested.

The Danger of Imperfect Earth Connections.—While the importance of earthing secondary circuits in order to render them safe against the possibility of accidental connection with high-tension wires is fairly understood, there is perhaps an insufficient appreciation of the necessity for having earth connections in perfect condition. A poor earth connection is worse than none at all on account of the sense of false security which it inspires. Whenever there is a connection between high-tension lines and ordinary lamp circuits there is a dangerous condition, owing to the possibility of some person's body completing the connection between the high-tension lines and earth. The possibility of such accidents is increased when in addition to the accessible lamp cords and switches there is added an earth wire running down a pole to an imperfect earth, the wire being exposed so that it is possible for persons or animals to come in contact with it. The "Electrical World" points out that earth rods or plates in dry, sandy or rocky soil are of very uncertain value and should not be depended upon. Wherever possible, earth connections to water-pipes should be secured. The ineffectiveness of earth connections in dry sandy, rocky soil has been many times tested, and a most deplorable practical test of the poor quality of such connection was recently made on a system operating in northern Michigan. The company earthed its secondary wires to a guy wire, the anchor of which was thought to be buried in the ground far enough for a good earth connection to be secured. An accidental connection between high-tension and low-tension wires occurred, thereby rendering the guy-wire earth connection alive, owing to there being insufficient contact with moist earth to cause the fuses on the high-tension line to open. A calf was killed by coming in contact with the guy wire, a veterinary surgeon coming along later to investigate the cause of the calf leaned against the guy wire and was also killed.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair
Assab—Perim	July 8, 1909 ...	—
Latakia—Palura	May 26, 1910 ...	—
Zanzibar—Mombasa	July 11, 1911 ...	—
Sabang—Koetaradja	Aug. 18, 1911 ...	—
Kotonou—Grand Bassam	Aug. 23, 1911 ...	—
Saigon–Pontianak.....	Aug. 23, 1911 ...	Aug. 24, 1911

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Wireless Telegraphy and Storm Warnings.—The sixth annual report of the Meteorological Committee of the Treasury, which was issued recently, states that during the year ending March last, 3,955 wireless reports were received from Atlantic liners, and were of great assistance to the forecaster. On January 28 a message which came to hand about noon showed that at 7 a.m. on that day a deep depression was in existence at some distance to the west of Ireland. Storm warnings were issued immediately to the west coast of Ireland, and in the course of the evening or night strong gales were experienced there.

The Hygienic Aspects of Lighting.—In a recent issue of the French official gazette "L'Officiel," it is announced that a committee dealing with the hygienic aspects of illumination has been appointed by the Minister of the Interior in France. The objects of the committee cover a wide ground, including the general effects of illumination on health, the framing of simple rules as to the best means of applying customary systems of lighting to various industrial operations, the nature and causes of short sight and impairment of vision, and their connection with defective living conditions, the study of methods of measuring illumination, &c. In investigating these different questions conjointly the committee should accomplish much valuable work. In the past the difficulty has sometimes been that recommendations on lighting were made by those interested primarily in physiological and hygienic questions, but without an adequate knowledge of the measurement of illumination, or vice versa. It is therefore satisfactory to observe that this committee receives the support of a number of prominent authorities on hygienic matters, gas and electrical engineers, inspectors of factories and others interested in various aspects of industrial lighting.

Current Topics.

Subjects of current interest dealt with in this issue include the following:—

Mr. D. Owen contributes an article on "The Pressure of Radiation."

The British Association meeting at Portsmouth opened on Wednesday evening when Sir Wm. Ramsay delivered his presidential address. Abstracts of this address, of the address of Prof. H. H. Turner to Section A (mathematical and physical sciences), and that of Prof. J. Walker to Section B (chemical) are given in this issue.

Standard tables for bare copper cables have been issued by the Bureau of Standards, Washington.

We give an account of the electrical work carried out at the Physikalisch-Technische Reichsanstalt during the past year.

We describe the Corcovado electric railway, in the neighbourhood of Rio de Janeiro.

The Faraday Lecture of the Chemical Society was delivered by Prof. T. W. Richards, the subject being "The Fundamental Properties of the Elements."

We analyse the accounts of the Glasgow Corporation Electricity Department for the year ended May 31st last.

The report on another page of the meeting of Liverpool Electricity Committee is of special interest, and throws a strong light upon the action of the tramway men as well as of the electricity department employés during the recent troubles in that city.

An abstract of the Census of Production for the year 1907 is given in another column.

A report of the proceedings at the meeting of the Association of Chambers of Commerce appears in another column.

OBITUARY.

L. E. Eschbæcher.—We regret to record the death, at Basle, on the 11th ult., of M. Louis Emile Eschbæcher, a former vice-director of the Bureau International des Telegraphes, at the age of 79. M. Eschbæcher was born at Hochfelden in Alsace on August 25, 1832, and entered the French Telegraph Service in the fifties. He spent several years in Algeria in the sixties, supervising the establishment of the telegraph system in that country, and joined the French Military Telegraph Service during the Franco-German War. He gained the cross of the Legion of Honour on the Battlefield of St-Privat, near Metz. After the war he became Inspector of Telegraphs at Besançon and later become Chef de Bureau at the Central Telegraph Administration in Paris. He was French delegate to the International Telegraph Conference of London (1879). He was appointed Secretary to the International Telegraph Bureau at Berne in 1885, and took a prominent part, as Secretary General, in the International Telegraph Conferences of Berlin (1885), Paris (1890), Budapest (1896), and London (1903). He was appointed Vice-Director of the International Bureau in 1897 and retired in 1905.

A. E. Preddle.—Mr. Albert E. Preddle, son of Mr. F. T. Preddle, Secretary of the Direct Spanish Telegraph Company, died at the Eastern Telegraph Company's station at Carcavellos, Lisbon, on Sunday, Aug. 27, of typhoid fever. The funeral took place at the English cemetery at Lisbon on Aug. 29, the family being represented by the Marquis of Villalobar, K.C.V.O., Minister Plenipotentiary to H.M. The King of Spain. The deceased was 23 years of age, had been at Carcavellos three years, and was greatly esteemed by all who knew him for his bright and amiable disposition.

We wish to be associated with the condolences to Mr. and Mrs. Preddle and the family.

PERSONAL NOTES.

Sir William Crookes, O.M., F.R.S., begs his friends to accept his grateful thanks for kind inquiries during his serious illness, and hopes before long to reply personally to their letters, which are too numerous to admit of immediate attention.

Mr. Wm. G. Hunter notifies us that he has resigned his position as advertising manager of the incandescent lamp department of the British Thomson-Houston Co., and is at liberty to enter into negotiations with any electrical firm, preferably an undertaking marketing an electrical incandescent lamp.

APPOINTMENTS VACANT AND FILLED.

An electrical engineer is wanted familiar with electrical and mechanical design of d.c. motors. Applicants must be technical graduates and read and speak English. See an advertisement.

One or two draughtsmen are wanted by a large electrical firm. Must be used to switchgear design, &c. See an advertisement.

An instructor is wanted for classes in telegraphy and telephony (City and Guilds syllabus) for the Wimbledon Technical Institute. Applications to the Principal, Gladstone-road, Wimbledon. See advertisement.

A competent battery mechanic, used to erecting and maintaining Tudor type secondary batteries, is wanted for South Africa. Commencing salary £30 per month, with three years' agreement. Applications to the Victoria Falls and Transvaal Power Co., 2, London Wall-buildings, London, E.C. See also an advertisement.

Test room assistants are wanted for adjusting and calibrating a.c. and d.c. ammeters, voltmeters and wattmeters. See advertisement.

A shift engineer is required for the electricity works of the Public Works Department of Southern Nigeria for two tours each of 12 months' residential service, with possible extension. Salary £250, rising to £300 per annum. Applications at once to the Crown Agents for the Colonies, 4, Whitehall-gardens, London, S.W. Further particulars are given in an advertisement.

An assistant lecturer and demonstrator on physics is required at the Battersea (London) Polytechnic. Commencing salary £120 per annum. Particulars from the Secretary.

Mr. F. Swarbrick, of Leigh, has been appointed engineer and manager of the Galway Electric Co.

Mr. C. W. Jackson has been appointed chief assistant engineer at the Urban Electric Supply Co.'s Grantham electricity works, in place of Mr. F. H. Brandreth, who has been appointed as resident manager of the same company's electricity supply undertaking at Stamford.

Mr. W. J. Carter, senior charge engineer at Oldham Corporation electricity works, has been appointed chief assistant electrical engineer at Batley electricity works.

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EDUCATIONAL NOTICES.

University of St. Andrews.—The 500th anniversary of the foundation of this University, which will occur this month, will be celebrated by the conferring of a number of honorary degrees. The degree of Doctor of Laws will be conferred among others upon the following :—Dr. E. W. Hobson, F.R.S., of Cambridge ; Prof. H. Lamb, F.R.S., of Manchester ; Prof. J. J. Larmor, Sec. R.S., of Cambridge ; Major P. A. MacMahon, F.R.S., of London ; Prof. R. Meldola, F.R.S., of London ; Prof. W. H. Perkin, F.R.S., of Manchester ; Prof. W. J. Pope, F.R.S., of Cambridge ; Dr. A. Schuster, F.R.S.; Sir J. J. Thomson, F.R.S., of Cambridge ; and Prof. W. Voigt, of Gottingen.

University College of North Wales.—At this college a systematic course of instruction in electrical measurements and practical electricity is provided for students proposing to enter the electrical engineering profession. The physical laboratory is well equipped for practical work and the fee for the ordinary course is £17. 1s. per session. The next session commences in October.

University of Manchester.—Prospectuses giving particulars of the lectures and laboratory courses in physics, preparing for both the ordinary and honours degrees, will be forwarded on application to the Registrar. Prof. Rutherford will meet intending students on Oct. 3.

University College, Nottingham.—The engineering department of the college provides thorough courses of instruction for the London University B.Sc. degree examinations and for college and other diplomas in engineering and mining. The session begins Oct. 2. Prospectus from the Registrar.

University of Durham.—Armstrong College, Newcastle-upon-Tyne.—The 1911-12 session commences Sept. 25. There are departments of mechanical, marine, civil and electrical engineering, naval architecture, mining, metallurgy, agriculture, pure science, arts and letters. Particulars may be obtained from the secretary, Mr. F. H. Pruen, M.A.

University of Bristol.—Prospectuses and particulars of the faculties of arts, science, medicine and engineering (civil, mechanical, electrical and motor car) and of the secondary training department, day training colleges, evening classes, halls of residence, scholarships and bursaries will be sent on application to the registrar, Mr. James Rafter. The session in the faculty of engineering commences Sept. 15 and in faculties of arts, science and medicine on Oct. 2.

University of London, University College.—The new session commences on Monday, Oct. 2. There are complete courses of study, extending over three years, in mechanical, electrical, civil and municipal engineering. Students desirous of entering the faculty of engineering, with the view of taking a full degree or diploma course, must have passed the matriculation examination, or some other examination accepted in its stead. There are also special diploma courses, and provision is made for post-graduate work and research. Intending students should communicate with the Provost as soon as possible, and full particulars may be obtained on application to the secretary, Mr. Walter W. Seton, M.A., Gower-street, W.C.

University of London, King's College.—Complete courses of study, extending over three or four years, are provided by this college in civil, mechanical and electrical engineering for engineering degrees of the University of London, and for the diploma and certificate of the college. The four years' course provides, in addition to the academic training, opportunity for practical training in works. Full information may be obtained from the Dean or the Secretary, King's College, Strand, London, W.C.

City and Guilds Technical College.—This college provides a scientific training for students preparing to become electrical and mechanical engineers or chemists, and for engineering pupils who desire to supplement their practical training by a two years' course of instruction in the principles of engineering science. There are also arrangements for three-year courses in engineering. Particulars at the college, Leonard-street, City-road, London, E.C., or from the City and Guilds of London Institute, Gresham College, Basinghall-street, London, E.C.

Glasgow and West of Scotland Technical College.—The diploma of the college is granted in the departments of civil, electrical and mechanical engineering, mining, naval architecture, chemistry, metallurgy, mathematics and physics, building and textile manufactures. The courses of study usually extend over three sessions, and holders of the diploma are eligible for the degree of B.Sc. in engineering of the University of Glasgow, after attendance for at least one session at prescribed university classes. The laboratories are well equipped, and facilities for research are afforded in the departments of physics, electrical engineering, chemistry, metallurgy, mechanics, &c. The preliminary examination begins on Sept. 18, and names of candidates must be sent in by Sept. 1. The day classes begin Sept. 26 and the evening classes Sept. 21. Calendar (by post 1s. 4d.) and prospectuses (gratis) will be sent on application to the Director.

The calendar for the 116th session (1911-2) has just been issued, and shows how complete are the arrangements made for day and evening instruction at this college. There are full courses in mathematics, natural philosophy, the principles of engineering, chemistry, and various science and commercial subjects, &c. The calendar gives particulars of fees, bursaries and scholarships, examinations, &c., as well as interesting information regarding the history and development of the college, which has done much for technical education in Scotland.

City of Bradford Technical College.—At this college there are full day courses qualifying for the college diploma in civil, mechanical and electrical engineering. The next session commences Sept. 18. The new power house, especially arranged for experimental and educational work, will be opened during the session, and the equipment of the electrical engineering laboratories and machine room has also been considerably extended and brought up to date. Calendar, containing particulars of all courses, on application to the director of education, Mr. A. C. Coffin.

Northampton Polytechnic Institute, Clerkenwell, London.—The full day courses in the theory and practice of mechanical and electrical engineering, and in electro-chemistry will commence on Oct. 2, and entrance examinations will take place on Sept. 27 and 28, at which five entrance scholarships will be offered. The courses for mechanical and electrical engineering include periods spent in commercial workshops, and extend over four years, and they also prepare for the degree of B.Sc. in engineering of the University of London. There are also full and partial day courses in technical optics. Particulars from the Principal, Dr. R. Mullineux Walmsley.

South-Western Polytechnic Institute.—This institute provides a complete three-years' course, leading to a diploma or university degree, in electrical engineering. A four-years' course is held in the evening. Separate courses of lectures and practical work are given in elementary, intermediate and advanced electrical engineering, electrical design, a.c. and polyphase currents, wiring and fitting, &c. Particulars from the Secretary, Manresa-road, Chelsea, S.W.

Goldsmith's College (University of London).—At this college complete evening courses of instruction are provided in mechanical, electrical and constructional engineering, land surveying, fitting and machining, pattern-making and smithing. Students are prepared for the London University degree of B.Sc. in engineering, for the examinations of the Institution of Civil Engineers, Board of Education, and City and Guilds of London Institute, &c. Particulars from the Warden of the College, New Cross, S.E. The new session commences on Monday, Sept. 25, and enrolling will begin on the 18th inst.

Sunderland Municipal Technical College.—We have received a prospectus of the day classes at this college and also pamphlets giving particulars of the evening courses in electrical and mechanical engineering, naval architecture, building construction, mathematics and physics, chemistry, &c. The courses of instruction cover three years and prepare for the B.Sc. degree in engineering.

Merchant Venturers' Technical College, Bristol.—We have received a copy of the new calendar for this College, and note that the Faculty of Engineering of the University of Bristol (which is provided and maintained in the College) has arranged with the Institution of Civil Engineers for the recognition of the degrees in civil and mechanical engineering as exempting from the examinations of the Institution for its associateship, provided that the matriculation examination has been passed in the subjects prescribed by the Institution.

ARRANGEMENTS FOR THE WEEK.

BRITISH ASSOCIATION.

Friday, September 1st (To-day) to Tuesday, September 5th.
Meeting at Portsmouth.

THE LONDON ELECTRICAL ENGINEERS.

Officer Commanding, Col. H. M. Leaf.

The following orders have been issued :—
Head-quarters will be closed for instruction, but will be open for office work as under until further orders :—
Monday to Friday, 10 a.m. to 4 p.m.
Saturday, 10 a.m. to 12 noon.

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GLASGOW CORPORATION ELECTRICITY SUPPLY ACCOUNTS.

Although the Glasgow Corporation electricity supply undertaking does not hand over for the relief of the rates large sums of money, as in the case of the Corporation's tramway undertaking (the accounts of which we analysed in our last issue), it is, nevertheless, in a prosperous condition, and is able to put aside a satisfactory sum to provide for depreciation. For the year ended May 31st last this contribution amounted to £44,552, or 0·26d. per unit, and the total amount set aside for this purpose during the last 10 years is no less than £393,821.

From our analysis below of the last year's expenditure it will be seen that several economies have been effected, as will also be gathered from the fact that, whilst the revenue has increased by £14,566, compared with last year's figure, the working expenses, including management and distribution costs, have only risen by £4,109. The excellence of this record will be appreciated when it is known that the number of units generated increased by 5,826,409. It will be noticed that the total cost per unit sold is now 1·23d., as against 1·33d. a year ago—that is, it has been reduced by $\frac{1}{10}$d.

Little need be said about the individual items in the cost set out below, but we should like to draw attention to the amount of rates and taxes. This was £22,198, or practically double the total cost of management; the charge of 0·13d. per unit sold is obviously a serious handicap on the undertaking, and under these circumstances it is very gratifying to notice that it has been found possible to supply no less than 7,021,142 units at ½d. per unit.

The total output during the 12 months under consideration was 40,823,090 units. Of this, 1,565,895 units were employed for public lighting, 193,655 units were sold by contract, and 39,063,540 units were sold to private consumers—an increase of 4,320,687 units. These 39,063,540 units were sold at the following prices :—

Lighting—			
Shops, warehouses, offices, theatres, halls, &c.		7,939,094 at	3½d.
" " " " "		3,822,279 at	¾d.
Domestic consumers, churches and public schools..		1,777,151 at	3d.
Special lighting		1,674,260 at	1½d.
" "		40,435 at	2d.
" "		382 at	1d.
		15,253,601	
Power and heating	6,206,398	at	1½d.
" "	9,172,412	at	¾d.
" "	1,409,987	at	1d.
" "	7,021,142	at	½d.
	23,809,939		
	39,063,540		

The following analysis of private consumers' accounts for the past year should prove of interest, particularly in connection with the figures for the number of consumers of each class a year ago. These latter figures are given in brackets :—

	No.		Consumption Units.
Consumers under 1 hour of max. demand	3,716	(3,537) ...	778,538
" " 2 hours " "	2,962	(2,919) ...	2,504,041
" " 3 " " "	1,661	(1,545) ...	2,187,929
" " 4 " " "	791	(695) ...	1,476,868
" " 5 " " "	348	(305) ...	1,203,799
" over 5 " " "	396	(375) ...	2,484,040
Theatres, halls and schools	308	(289) ...	1,246,228
Special	124	(102) ...	1,714,695
Domestic consumers and churches	6,895	(6,417) ...	1,657,463
Power	2,936	(2,630) ...	23,523,863
Heating	583	(340) ...	286,076
	20,720	(19,154)	39,063,540

It will be noticed that a considerable increase is shown in the number of consumers employing electricity for heating purposes. This is probably due to the scheme, which came into operation in October last, whereby domestic consumers can obtain a supply of energy for cooking, heating, &c., at 1d. per unit without separate wiring. The Electricity Committee state that this scheme has been adopted with favourable results. The number of consumers already benefiting by this scheme is 300.

The total number of consumers at May 31, 1911, was 21,166, compared with 19,489 at May 31, 1910, an increase of 1,677 consumers, or 8·6 per cent. during the year. More consumers have indeed been connected than for several years past.

As to the power load, 5,375 motors, of a total horse-power of 36,831, are now connected to the mains, 524 of these motors having been connected during the past 12 months.

The maximum demand upon the generating stations last winter amounted to 23,524 kw., compared with 21,719 kw. in the previous year, the corresponding load factors being 19·8 and 19·2 per cent. respectively. The Electricity Committee mention in their annual report that the fuel account shows that the use made of apparatus for ensuring the efficient and economical combustion of fuel has been fully justified. For the year 1909-10, 4·15 lb. of coal were used per unit generated; this year the figure is 3·47 lb., which represents a saving equivalent to 14,910 tons.

49,071,933 units were generated, 2,314,116 units being used on the works, and 5,934,727, or 12·1 per cent., being expended in distribution or otherwise not accounted for. Of the above total output, 32,356,818 units were generated at Port Dundas station, which transmits power at extra high pressure to all sub-stations as well as to Pollokshaws-road generating station. This latter station generated 16,162,267 units, Kelvinside station supplying the remaining 552,848 units.

We give below an analysis of the expenditure and revenue during the year ended May 31, 1911, together with the cost per unit sold of each item, the latter figures being also given for the preceding year :—

		Per unit sold. 1910-11.	1909-10.
Generating Costs.			
Fuel	£32,512	... 0·19d.	... 0·21d.
Oil, waste, water, &c.	2,333	... 0·01d.	... 0·02d.
Salaries and wages at station	14,900	... 0·09d.	... 0·10d.
Repairs and maintenance	9,511	... 0·06d.	... 0·05d.
Total Generating Costs	£59,256	0·35d.	0·38d.
Distribution Costs.			
Wages	£3,422	... 0·02d.	... 0·02d.
Repairs and maintenance of cables, &c.	5,469	... 0·03d.	... 0·03d.
Repairs and maintenance of meters, &c.	4,038	... 0·02d.	... 0·02d.
Total Distribution Costs	£12,929	0·07d.	0·07d.
Management Costs.			
Salaries	£6,471	... 0·04d.	... 0·04d.
Stationery, printing, &c.	1,200	... 0·01d.	... 0·01d.
General establishment charges	3,821	... 0·02d.	... 0·03d.
Total Management Costs	£11,492	0·07d.	0·08d.
Rents, rates and taxes	£22,198	... 0·13d.	... 0·14d.
Attending and repairing public and private lamps	£3,672	... 0·02d.	... 0·02d.
TOTAL COSTS (*ex.* capital charges)	**£109,547**	**... 0·64d.**	**... 0·69d.**
Capital Charges.			
Interest	£58,605	... 0·35d.	... 0·38d.
Sinking fund	41,142	... 0·24d.	... 0·26d.
Total Capital Charges	£99,747	0·59d.	0·64d.
TOTAL COSTS (*inc.* capital charges)	**£209,294**	**... 1·23d.**	**... 1·33d.**
Provision for depreciation	£44,552	... 0·26d.	... 0·28d.
Revenue.			
Sale of current per meter	£248,764	... 1·46d.	... 1·54d.
Public lighting	11,752	... 0·07d.	... 0·08d.
Rents of property	10	... 0·00d.	... 0·00d.
TOTAL REVENUE	**£260,526**	**1·53d.**	**1·62d.**
Balance	£6,680	... 0·04d.	... 0·01d.

This balance is placed to the credit of the reserve fund, which at May 31, 1911, stood at £27,468.

During the past year the capital expenditure amounted to £80,833, and the total capital expenditure at May 31, 1911, less depreciation written off, stood at £1,889,715.

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SIR WM. RAMSAY'S ADDRESS TO THE BRITISH ASSOCIATION.*

The world has greatly changed since 1831, the year in which the British Association was founded; the spread of railways and the equipment of numerous lines of steamships have contributed to the peopling of countries at that time practically uninhabited. Moreover, not merely has travelling been made almost infinitely easier, but communication by post has been enormously expedited and cheapened; and the telegraph, the telephone and wireless telegraphy have simplified as well as complicated human existence. Furthermore, the art of engineering has made such strides that the question "Can it be done?" hardly arises, but rather "Will it pay to do it?" In a word, the human race has been familiarised with the applications of science; and men are ready to believe almost anything, if brought forward in its name.

Education, too, in the rudiments of science has been introduced into almost all schools; young children are taught the elements of physics and chemistry. The institution of a Section for Education in our Association (L) has had for its object the organising of such instruction, and much useful advice has been proffered. The problem is, indeed, largely an educational one; it is being solved abroad in various ways—in Germany and in most European States by elaborate Governmental schemes dealing with elementary and advanced instruction, literary, scientific and technical; and in the United States and in Canada by the farsightedness of the people: both employers and employés recognise the value of training and of originality, and on both sides sacrifices are made to ensure efficiency.

In England we have made technical education a local, not an Imperial question; instead of half-a-dozen first-rate institutions of University rank, we have a hundred in which the institutions are necessarily understaffed, in which the staffs are mostly overworked and underpaid; and the training given is that not for captains of industry but for workmen and foremen. "Efficient captains cannot be replaced by a large number of fairly good corporals." Moreover, to induce scholars to enter these institutions, they are bribed by scholarships, a form of pauperisation practically unknown in every country but our own; and to crown the edifice, we test results by examinations of a kind not adapted to gauge originality and character (if, indeed, these can ever be tested by examination), instead of, as on the Continent and in America, trusting the teachers to form an honest estimate of the capacity and ability of each student, and awarding honours accordingly.

The remedy lies in our own hands. Let me suggest that we exact from all gainers of University scholarships an undertaking that, if and when circumstances permit, they will repay the sum which they have received as a scholarship, bursary or fellowship. It would then be possible for an insurance company to advance a sum representing the capital value—viz., £7,464,931—of the scholarships, reserving, say, 20 per cent. for non-payment, the result of mishap or death. In this way a sum of over six million pounds, of which the interest is now expended on scholarships, would be available for University purposes. This is about one-fourth of the sum of 24 millions stated by Sir Norman Lockyer at the Southport meeting as necessary to place our university education on a satisfactory basis. A large part of the income of this sum should be spent in increasing the emoluments of the chairs; for, unless the income of a professor is made in some degree commensurate with the earnings of a professional man who has succeeded in his profession, it is idle to suppose that the best brains will be attracted to the teaching profession. And it follows that unless the teachers occupy the first rank, the pupils will not be stimulated as they ought to be.

Again, having made the profession of a teacher so lucrative as to tempt the best intellects in the country to enter it, it is clear that such men are alone capable of testing their pupils. The modern system of "external examinations," known only in this country, and answerable for much of its lethargy, would disappear; schools of thought would arise in all subjects, and the intellectual as well as the industrial prosperity of our nation would be assured. As things are, can we wonder that as a nation we are not scientific? Let me recommend those of my hearers who are interested in the matter to read a recent report on technical education by the Science Guild.

I venture to think that, in spite of the remarkable progress of science and of its applications, there never was a time when missionary effort was more needed. Although most people have some knowledge of the results of scientific inquiry, few, very few, have entered into its spirit. We all live in hope that the world will grow better as the years roll on. Are we taking steps to secure the improvement of the race? I plead for recognition of the fact that progress in science does not only consist in accumulating information which may be put to practical use, but in developing a spirit of prevision, in taking thought for the morrow; in attempting to forecast the future, not by vague surmise, but by orderly marshalling of facts, and by deducing from them their logical outcome; and chiefly in endeavouring to control conditions which may be utilised for the lasting good of our people. We must cultivate a belief in the "application of trained intelligence to all forms of national activity."

The question has often been debated whether the present method of conducting our proceedings is the one best adapted to gain our ends. We exist professedly "to give a stronger impulse and a more systematic direction to scientific inquiry." The Council has had under consideration various plans framed with the object of facilitating our work, and the result of its deliberations will be brought under your attention at a later date. To my mind, the greatest benefit bestowed on science by our meetings is the opportunity which they offer for friendly and unrestrained intercourse, not merely between those following different branches of science, but also with persons, who, though not following science professionally, are interested in its problems. Our meetings also afford an opportunity for younger men to make the acquaintance of older men. I am afraid that we, who are no longer in the spring of our lifetime, perhaps from modesty, perhaps through carelessness, often do not sufficiently realise how stimulating to a young worker a little sympathy can be; a few words of encouragement go a long way. I have in my mind words which encouraged me as a young man, words spoken by the leaders of Associations, now long past—by Playfair, by Williamson, by Frankland, by Kelvin, by Stokes, by Francis Galton, by Fitzgerald and many others. Let me suggest to my older scientific colleagues that they should not let such pleasant opportunities slip.

After referring by name to distinguished members of the Association who had died since the last address was delivered, the President proceeded to give an account of ancient and modern views regarding the chemical elements. He dealt with the theories held by the Greeks, by Boyle, by Stahl and his phlogiston theory, by Lavoiser, Dalton and Davy. Indeed, in those days the ancient idea of the unitary nature of matter was held to be highly probable, and much work on this hypothesis was done by Liebeg, Redtenbacher, Dunn, Döbereiner and Newlands, and at a later date by Meyer and Mendeléeff. By this time it might have been supposed that our knowledge of the elements was practically complete, but the discovery of radio-activity by Becquerel, and the work of the Curies, Rutherford and Soddy have indicated the existence of no fewer than 26 elements hitherto unknown, and of these radium is found to be unstable. Now, stability was believed to be the essential characteristic of an element. Radium disintegrates and gives off radium emanation and helium. The former in its turn disintegrates much more rapidly than radium, with the evolution of helium, and what is left goes through a series of changes until it finally becomes radium F or polonium, which itself disintegrates into an unknown metal, possibly lead.

For the first time we have accurate knowledge as to the descent of some of the elements. Supposing the atomic weight of uranium to be certainly 239, it may be taken as proved that in losing three atoms of helium, radium is produced, and, if the change consists solely in the loss of the three atoms of helium, the atomic weight of radium must necessarily be 227. But it is known that β-rays, or electrons, are also parted with during this change; and electrons have weight. How many electrons are lost is unknown; therefore, although the weight of an electron is approximately known, it is impossible to say how much to allow for in estimating the atomic weight of radium. But it is possible to solve this question indirectly by determining exactly the atomic weights of radium and of uranium; the difference between the atomic weight of radium *plus* 12, *i.e.*, plus the weight of three atoms of helium, and that of uranium, will give the weight of the number of electrons which escape. Taking the most probable numbers available—viz., 239·4 for uranium and 226·8 for radium—and adding 12 to the latter, the weight of the escaping electrons would be 0·6.

The correct solution of this problem would in great measure clear up the mystery of the irregularities in the periodic table, and would account for the deviations from Prout's Law, that the atomic weights are multiples of some common factor or factors. I also venture to suggest that it would throw light on allotropy, which in some cases at least may very well be due to the loss or gain of electrons, accompanied by a positive or negative heat-change. Incidentally, this suggestion would afford places in the periodic table for the somewhat overwhelming number of pseudo-elements, the existence of which is made practically certain by the disintegration hypothesis. Of the 26 elements derived from uranium, thorium and actinium, 10, which are formed by the emission of electrons alone, may be regarded as allotropes or pseudo-elements; this leaves 16, for which 16 or 17

* Abstract of the Presidential Address delivered by Prof. Sir William Ramsay, K.C.B., D.Sc., F.R.S., to the British Association on Wednesday last.

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gaps would appear to be available in the periodic table, provided the reasonable supposition be made that a second change in the length of the periods has taken place. It is above all things certain that it would be a fatal mistake to regard the existence of such elements as irreconcilable with the periodic arrangement, which has rendered to systematic chemistry such signal service in the past.

Attention has repeatedly been drawn to the enormous quantity of energy stored up in radium and its descendants. That in its emanation, niton, is such that if what it parts with as heat during its disintegration were available, it would be equal to three and a half million times the energy available by the explosion of an equal volume of detonating gas—a mixture of one volume of oxygen with two volumes of hydrogen. The major part of this energy comes, apparently, from the expulsion of particles (that is, of atoms of helium) with enormous velocity. It is easy to convey an idea of this magnitude in a form more realisable by giving it a mechanical turn. Suppose that the energy in a ton of radium could be utilised in 30 years, instead of being evolved at its invariable slow rate of 1,760 years for half-disintegration, it would suffice to propel a ship of 15,000 tons, with engines of 15,000 H.P., at the rate of 15 knots, for 30 years—practically the *lifetime* of the ship. To do this actually requires a million and a half tons of coal.

It is easily seen that the virtue of the energy of the radium consists in the small weight in which it is contained; in other words, the radium-energy is in an enormously concentrated form. I have attempted to apply the energy contained in niton to various purposes; it decomposes water, ammonia, hydrogen chloride and carbon dioxide, each into its constituents; further experiments on its action on salts of copper appeared to show that the metal copper was converted partially into lithium, a metal of the sodium column; and similar experiments, of which there is not time to speak, indicate that thorium, zirconium, titanium and silicon are degraded into carbon; for solutions of compounds of these, mixed with niton, invariably generated carbon dioxide; while cerium, silver, mercury and some other metals gave none. One can imagine the very atoms themselves, exposed to bombardment by enormously quickly moving helium atoms, failing to withstand the impacts. Indeed, the argument *a priori* is a strong one; if we know for certain that radium and its descendants decompose spontaneously, evolving energy, why should not other more stable elements decompose when subjected to enormous strains?

This leads to the speculation whether, if elements are capable of disintegration, the world may not have at its disposal a hitherto unsuspected source of energy. If radium were to evolve its stored-up energy at the same rate that gun-cotton does, we should have an undreamt-of explosive; could we control the rate we should have a useful and potent source of energy, provided always that a sufficient supply of radium were forthcoming. But the supply is certainly a very limited one; and it can be safely affirmed that the production will never surpass half-an-ounce a year. If, however, the elements which we have been used to consider as permanent are capable of changing with evolution of energy; if some form of catalyser could be discovered which would usefully increase their almost inconceivably slow rate of change, then it is not too much to say that the whole nature of our race would be altered.

The whole progress of the human race has indeed been due to individual members discovering means of concentrating energy, and transforming one form into another. Great progress has been made during the past century in effecting the conversion of one form of energy into others, with as little useless expenditure as possible. The middle of the nineteenth century will always be noted as the beginning of the golden age of science; the epoch when great generalisations were made, of the highest importance on all sides, philosophical, economic and scientific. Carnot, Clausius, Helmholtz, Julius Robert Mayer abroad, and the Thomsons, Lord Kelvin and his brother James, Rankine, Tait, Joule, Clerk Maxwell and many others at home, laid the foundations on which the splendid structure has been erected. That the latent energy of fuel can be converted into energy of motion by means of the steam engine is what we owe to Newcomen and Watt; that the kinetic energy of the flywheel can be transformed into electrical energy was due to Faraday, and to him, we are indebted for the re-conversion of electrical energy into mechanical work; and it is this power of work which gives us leisure, which enables a small country like ours to support the population which inhabits it.

We have in this world of ours only a limited supply of stored-up energy; in the British Isles a very limited one—namely, our coal-supply. The rate at which this supply is being exhausted has been increasing very steadily for the last 40 years, as anyone can prove by plotting the data given on p. 27, table D, of the General Report of the Royal Commission on Coal Supplies (1906). In 1870 110 million tons were mined in Great Britain, and ever since the amount has increased by three and a third million tons a year. The available quantity of coal in the proved coalfields is very nearly 100,000 million tons; it is easy to calculate that if the rate of working increases as it is doing, our coal will be completely exhausted in 175 years. But, it will be replied, the rate of increase will slow down. Why? It has shown no sign whatever of slackening during the last 40 years. Later, of course, it must slow down, when coal grows dearer owing to approaching exhaustion.

This consumption is still proceeding at an accelerated rate. Between 1905 and 1907 the amount of coal raised in the United Kingdom increased from 236 to 268 million tons, equal to six tons per head of the population, against 3½ tons in Belgium, 2½ tons in Germany and 1 ton in France. Our commercial supremacy and our power of competing with other European nations are obviously governed, so so far as we can see, by the relative price of coal; and when our prices rise, owing to the approaching exhaustion of our supplies, we may look forward to the near approach of famine and misery.

Having been struck some years ago with the optimism of my non-scientific friends as regards our future, I suggested that a committee of the British Science Guild should be formed to investigate our available sources of energy. The Science Guild has enlisted the services of a number of men, each eminent in his own department, and each has now reported on the particular source of energy of which he has special knowledge. Besides concerning the uses of coal and its products, and how they may be more economically employed, in which branches the Hon. Sir Charles Parsons, Mr. Dugald Clerk, Sir Boverton Redwood, Dr. Beilby, Dr. Hele-Shaw, Prof. Vivian Lewes and others have furnished reports, the following sources of energy have been brought under review: The possibility of utilising the tides; the internal heat of the earth; the winds; solar heat; water-power; the extension of forests, and the use of wood and peat as fuels; and, lastly, the possibility of controlling the undoubted but almost infinitely slow disintegration of the elements, with the view of utilising their stored-up energy.

However interesting a detailed discussion of these possible sources of energy might be, time prevents my dwelling on them. Suffice it to say that the Hon. R. J. Strutt has shown that in this country at least it would be impracticable to attempt to utilise terrestrial heat from bore-holes; others have deduced that from the tides, the winds and water-power small supplies of energy are no doubt obtainable, but that, in comparison with that derived from the combustion of coal, they are negligible; nothing is to be hoped for from the direct utilisation of solar heat in this temperate and uncertain climate; and it would be folly to consider seriously a possible supply of energy in a conceivable acceleration of the liberation of energy by atomic change. It looks utterly improbable, too, that we shall ever be able to utilise the energy due to the revolution of the earth on her axis, or to her proper motion round the sun.

Attention should undoubtedly be paid to forestry, and to the utilisation of our stores of peat. On the Continent, the forests are largely the property of the State; it is unreasonable, especially in these latter days of uncertain tenure of property, to expect any private owner of land to invest money in schemes which would at best only benefit his descendants, but which, under our present trend of legislation, do not promise even that remote return. Our neighbours and rivals, Germany and France, spend annually £2,200,000 on the conservation and utilisation of their forests; the net return is £6,000,000. There is no doubt that we could imitate them with advantage. Moreover, an increase in our forests would bring with it an increase in our water-power; for without forest land rain rapidly reaches the sea, instead of distributing itself, so as to keep the supply of water regular, and so more easily utilised. Various schemes have been proposed for utilising our deposits of peat: I believe that in Germany the peat industry is moderately profitable; but our humid climate does not lend itself to natural evaporation of most of the large amount of water contained in peat, without which processes of distillation prove barely remunerative.

We must therefore rely chiefly on our coal reserve for our supply of energy, and for the means of supporting our population; and it is to the more economical use of coal that we must look, in order that our life as a nation may be prolonged. We can economise in many ways: By the substitution of turbine engines for reciprocating engines, thereby reducing the coal required per horse-power from 4 lb. to 5 lb. to 1½ lb. or 2 lb.; by the further replacement of turbines by gas engines, raising the economy to 30 per cent. of the total energy available in the coal—that is, lowering the coal consumption per horse-power to 1 lb. or 1¼ lb.; by creating the power at the pit-mouth, and distributing it electrically, as is already done in the Tyne district. Economy can also be effected in replacing "beehive" coke ovens by recovery ovens; this is rapidly being done; and Dr. Beilby calculates that in 1909 nearly six million tons of coal, out of a total of 16 to 18 millions, were coked in recovery ovens, thus effecting

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a saving of two to three million tons of fuel annually. Progress is also being made in substituting gas for coal or coke in metallurgical, chemical, and other works. But it must be remembered that for economic use, gaseous fuel must not be charged with the heavy costs of piping and distribution.

The domestic fire problem is also one which claims our instant attention. It is best grappled with from the point of view of smoke. Although the actual loss of thermal energy in the form of smoke is small—at most less than ½ per cent. of the fuel consumed—still the presence of smoke is a sign of waste of fuel and careless stoking. In works, mechanical stokers which ensure regularity of firing and complete combustion of fuel are more and more widely replacing hand-firing. But we are still utterly wasteful in our consumption of fuel in domestic fires. There is probably no single remedy applicable; but the introduction of central heating, of gas fires, and of grates which permit of better utilisation of fuel will all play a part in economising our coal. It is open to argument whether it might not be wise to hasten the time when smoke is no more by imposing a sixpenny fine for each offence; an instantaneous photograph could easily prove the offence to have been committed; and the imposition of the fine might be delayed until three warnings had been given by the police.

Now, I think that what I wish to convey will be best expressed by an allegory. A man of mature years who has surmounted the troubles of childhood and adolescence without much disturbance to his physical and mental state gradually becomes aware that he is suffering from loss of blood; his system is being drained of this essential to life and strength. What does he do? If he is sensible, he calls in a doctor, or perhaps several, in consultation; they ascertain the state of the disease, and diagnose the cause. They point out that while consumption of blood is necessary for healthy life, it will lead to a premature end if the constantly increasing drain is not stopped. They suggest certain precautionary measures; and if he adopts them, he has a good chance of living at least as long as his contemporaries; if he neglects them, his days are numbered. That is our condition as a nation. We have had our consultation in 1903; the doctors were the members of the Coal Commission. They showed the gravity of our case, but we have turned a deaf ear.

It is true that the self-interest of coal consumers is slowly leading them to adopt more economical means of turning coal into energy. But I have noticed and frequently publicly announced a fact which cannot but strike even the most unobservant. It is this: When trade is good, as it appears to be at present, manufacturers are making money; they are overwhelmed with orders, and have no inclination to adopt economies which do not appear to them to be essential, and the introduction of which would take thought and time, and which would withdraw the attention of their employés from the chief object of the business—how to make the most of the present opportunities. Hence improvements are postponed. When bad times come, then there is no money to spend on improvements; they are again postponed until better times arrive. What can be done? I would answer: Do as other nations have done and are doing; take stock annually. The Americans have a permanent Commission, initiated by Mr. Roosevelt, consisting of three representatives from each State, the sole object of which is to keep abreast with the diminution of the stores of natural energy, and to take steps to lessen its rate. This is a non-political undertaking, and one worthy of being initiated by the ruler of a great country. If the example is followed here the question will become a national one.

Two courses are open to us; first, the *laissez-faire* plan of leaving to self-interested competition the combating of waste; or, second, initiating legislation which, in the interest of the whole nation, will endeavour to lessen the squandering of our national resources. This legislation may be of two kinds: penal, that is, imposing a penalty on wasteful expenditure of energy-supplies; and helpful, that is, imparting information as to what can be done, advancing loans at an easy rate of interest to enable reforms to be carried out, and insisting on the greater prosperity which would result from the use of more efficient appliances.

This is not the place, nor is there the time, to enter into detail; the subject is a complicated one, and it will demand the combined efforts of experts and legislators for a generation; but if it be not considered with the definite intention of immediate action, we shall be held up to the deserved execration of our not very remote descendants.

The two great principles which I have alluded to in an earlier part of this address must not, however, be lost sight of; they should guide all our efforts to use energy economically. Concentration of energy in the form of electric current at high potential makes it possible to convey it for long distances through thin and therefore comparatively inexpensive wires; and the economic coefficient of the conversion of mechanical into electrical, and of electrical into mechanical energy is a high one; the useless expenditure does not much exceed one-twentieth part of the energy which can be utilised. These considerations would point to the conversion at the pit-mouth of the energy of the fuel into electrical energy, using as an intermediary, turbines, or preferably gas engines; and distributing the electrical energy to where it is wanted. The use of gas engines may, if desired, be accompanied by the production of half-distilled coal, a fuel which burns nearly without smoke, and one which is suitable for domestic fires, if it is found too difficult to displace them and to induce our population to adopt the more efficient and economical systems of domestic heating which are used in America and on the Continent. The increasing use of gas for factory, metallurgical and chemical purposes points to the gradual concentration of works near the coal mines, in order that the laying-down of expensive piping may be avoided.

An invention which would enable us to convert the energy of coal directly into electrical energy would revolutionise our ideas and methods, yet it is not unthinkable. The nearest practical approach to this is the Mond gas-battery, which, however, has not succeeded, owing to the imperfection of the machine.

In conclusion, I would put in a plea for the study of pure science, without regard to its applications. The discovery of radium and similar radio-active substances has widened the bounds of thought. While themselves, in all probability, incapable of industrial application, save in the domain of medicine, their study has shown us to what enormous advances in the concentration of energy it is permissible to look forward, with the hope of applying the knowledge thereby gained to the betterment of the whole human race. As charity begins at home, however, and as I am speaking to the *British* Association for the Advancement of Science, I would urge that our first duty is to strive for all which makes for the permanence of the British Commonweal, and which will enable us to transmit to our posterity a heritage not unworthy to be added to that which we have received from those who have gone before.

AMERICAN STANDARD TABLES FOR BARE COPPER CABLES.*

The appended tables give data on bare concentric cables of standard annealed copper. A "concentric cable" is a conductor made up of a straight central wire surrounded by one or more layers of wires, the alternate layers having a twist in opposite directions. In the first layer about the central wire, six wires of the same diameter are used; in the next layer 12, then 18, 24, &c. The number of layers thus determines the number of individual wires in the cable. There are many other more complicated forms of cables, but these are not considered here. The size of the individual wires or "strands"† may be taken to be a definite gauge number, but it is the more usual practice to start with a specified total cross-section for the cable and from that calculate the diameter of the strands. In these tables, the column "diameter of wires" was calculated from the total cross-section.

The various sizes of cables are designated in commercial practice by a statement of the total cross-section in "circular mils" (the cross-section in circular mils of a single wire is the square of its diameter in mils). It is believed that these tables contain the more usual sizes which are made and used in the United States. The practices of manufacturers vary, and the "number of wires" given in the table for each value of "circular mils" may not represent the practices of all manufacturers. For some purposes a more flexible cable is wanted than in other cases, and this end is attained by using finer wire and increasing the number of layers and of wires. The list of sizes and "number of wires" used in these tables are those given as representing average American practice in a report by Mr. H. W. Fisher to the Standards Committee of the American Institute of Electrical Engineers, in January, 1911. Accordingly these tables do not present an arbitrary set of data on cables, especially since it will be shown below that the table involves no selection of values for the "lay" or pitch.

* We are enabled to publish these tables, &c., by the courtesy of Dr. S. W. Stratton, Director of the Bureau of Standards, Washington.

† A "strand" is any component part of a cable. In the case of a concentric cable, therefore, the meaning of the term is definitely limited to the individual wire of the cable.

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The "outside diameter in mils" or "outside diameter in millimetres" is the diameter of the circle circumscribing the cable, and is calculated very simply. Thus, for a cable of seven wires the "outside diameter" is three times the diameter of one wire; for a cable of 19 wires it is five times the diameter of one wire, &c. The values given for the resistance are based on the "annealed copper standard,"* an average for the present-day copper used in electrical work, determined by the Bureau of Standards, and accepted by the American Institute of Electrical Engineers. The density used in calculating the mass is 8·89 grammes per cubic centimetre, or 0·32117 lb. per cubic inch. The effect of the twisting of the strands on the resistance and mass per unit length is discussed in the following paragraphs.

Different authors and different cable companies do not agree in their methods of calculating the resistance of cables. It is usually stated that on account of the stranding the lengths of the individual wires are increased, and hence the resistance of the cable is *greater* than the resistance of an "equivalent solid rod"—*i.e.*, a solid wire or rod of the same length and of cross-section equal to the total cross-section of the cable (taking the cross-section of each wire perpendicular to the axis of the wire). However, there is always some contact area between the wires of a cable, which has the effect of increasing the cross-section and decreasing the resistance; and some authors have gone so far as to state that the resistance of a cable is *less* than that of the equivalent solid rod. The Bureau of Standards has made inquiries to ascertain the experience of cable manufacturers and others on this point. It is practically unanimously agreed that the resistance of a cable is actually *greater* than the resistance of an equivalent solid rod. It is shown mathematically in the appendix below that the percentage increase of resistance of a cable with all the wires perfectly insulated from one another, over the resistance of the equivalent solid rod, is exactly equal to the percentage decrease of resistance of a cable in which each strand makes perfect contact with a neighbouring strand at all points of its surface. That is, the resistance of the equivalent solid rod is the arithmetical mean of these two extreme cases. Since the resistance of the cable must necessarily lie between these two extremes, the resistance of the equivalent solid rod is not greatly different from the resistance of the actual cable; the difference must be less than the difference between the mean and either extreme.

Accordingly, in the tables the values of "ohms per 1,000 ft." and "ohms per kilometre" are calculated for a solid wire or rod of the same length and total cross-section as the cable. As stated above, experience has shown that the actual resistance of a cable is greater than this. This is due, no doubt, to the fact that the wires are not distorted much from their circular shape, and hence are very far from making perfect contact with each other. But the actual departure of the resistance of a cable from these tabulated values depends further upon the "lay" or "pitch" on the tension under which the strands are wound, the age of the cable, the variations of the resistivity of the wires, variations of temperature, &c., so that it is very doubtful whether any correction should ever be made to the tabulated values.

The actual *mass* per unit length of a cable cannot be calculated without a knowledge of the pitch or lay; and this varies greatly for different sizes of cable and different manufacturers. Although unsatisfactory it is therefore necessary to calculate "pounds per 1,000 ft." and "kilogrammes per kilometre" on the assumption that the wires of the cable are not twisted—*i.e.*, that the mass of the cable is the same as the mass of the "equivalent solid rod" of the same length and total cross-section. In actual use, therefore, a correction must be *added* to the values in the tables, the amount of the correction depending on the amount of twist. The correction is smaller the more gradual the twist. The effect of "lay" and the magnitude of the correction are discussed in the following appendix.

* THE ELECTRICIAN, Vol. LXVI., p. 906, March 17, 1911. "Bulletin" of the Bureau of Standards, VII., p. 103, 1910.

Table I.—*Bare Concentric Cables of Standard Annealed Copper. English Units.*

A.W.G.	Circular mils.	Outside diam., in mils.	No. of wires.	Diam. of the wires in mils.	Ohms per 1,000 ft. 25°C. (=77°F.)	Ohms per 1,000 ft. 65°C. (=149°F.)	Pounds per 1,000 ft.
...	2,000,000	1,631	127	125·5	0·00528	0·00610	6,050
...	1,900,000	1,590	127	122·3	0·00556	0·00642	5,750
...	1,800,000	1,548	127	119·1	0·00587	0·00678	5,450
...	1,700,000	1,504	127	115·7	0·00621	0·00718	5,150
...	1,600,000	1,459	127	112·2	0·00660	0·00762	4,840
...	1,500,000	1,413	127	108·7	0·00704	0·00813	4,540
Less common.	1,400,000	1,365	127	105·0	0·00754	0·00871	4,240
	1,300,000	1,315	127	101·2	0·00812	0·00938	3,940
	1,200,000	1,264	127	97·2	0·00880	0·0102	3,630
	1,100,000	1,210	127	93·1	0·00960	0·0111	3,330
	1,000,000	1,154	127	88·7	0·0106	0·0122	3,030
	2,000,000	1,631	91	148·2	0·00528	0·00610	6,050
	1,900,000	1,589	91	144·5	0·00556	0·00642	5,750
	1,800,000	1,547	91	140·6	0·00587	0·00678	5,450
	1,700,000	1,503	91	136·7	0·00621	0·00718	5,150
	1,600,000	1,459	91	132·6	0·00660	0·00762	4,840
	1,500,000	1,412	91	128·4	0·00704	0·00813	4,540
...	1,400,000	1,364	91	124·0	0·00754	0·00871	4,240
...	1,300,000	1,315	91	119·5	0·00812	0·00938	3,940
...	1,200,000	1,263	91	114·8	0·00880	0·0102	3,630
...	1,100,000	1,209	91	109·9	0·00960	0·0111	3,330
...	1,000,000	1,153	91	104·8	0·0106	0·0122	3,030
...	1,000,000	1,152	61	128·0	0·0106	0·0122	3,030
...	950,000	1,123	61	124·8	0·0111	0·0128	2,880
...	900,000	1,093	61	121·5	0·0117	0·0136	2,720
...	850,000	1,062	61	118·0	0·0124	0·0144	2,570
...	800,000	1,031	61	114·5	0·0132	0·0152	2,420
...	750,000	993	61	110·9	0·0141	0·0163	2,270
...	700,000	964	61	107·1	0·0151	0·0174	2,120
...	650,000	929	61	103·2	0·0162	0·0188	1,970
...	600,000	893	61	99·2	0·0176	0·0203	1,820
...	550,000	855	61	95·0	0·0192	0·0222	1,660
...	500,000	815	61	90·5	0·0211	0·0244	1,510
...	500,000	814	37	116·2	0·0211	0·0244	1,510
...	450,000	772	37	110·3	0·0235	0·0271	1,360
...	400,000	728	37	104·0	0·0264	0·0305	1,210
...	350,000	681	37	97·3	0·0302	0·0349	1,060
...	300,000	630	37	90·0	0·0352	0·0407	908
...	250,000	575	37	82·2	0·0422	0·0488	757
0000	212,000	528	19	105·5	0·0499	0·0576	641
000	168,000	470	19	94·0	0·0629	0·0727	508
00	133,000	418	19	83·7	0·0793	0·0917	403
0	106,000	373	19	74·5	0·100	0·116	319
1	83,700	332	19	66·4	0·126	0·146	253
2	66,400	292	7	97·4	0·159	0·184	201
3	52,600	260	7	86·7	0·201	0·232	159
4	41,700	232	7	77·2	0·253	0·292	126
5	33,100	206	7	68·8	0·319	0·368	100
6	26,300	184	7	61·2	0·402	0·465	79
7	20,800	164	7	54·5	0·507	0·586	63
8	16,500	146	7	48·6	0·640	0·739	59

NOTE 1.—The *fundamental resistivity* used in calculating the table is the annealed copper standard—viz., 0·153022 ohm per metre-gramme at 20°C. The *temperature coefficient* for this particular resistivity is $\alpha_{20}=0{\cdot}00394$, or $\alpha_0=0{\cdot}00423$. However, the temperature coefficient is proportional to the conductivity, and hence the change of *resistivity* per degree Centigrade is a constant, 0·000598 ohm per metre-gramme. The "constant mass" temperature coefficient of any sample is

$$\alpha_t = \frac{0{\cdot}000598 + 0{\cdot}000005}{\text{resistivity in ohms per metre-gramme at } t°\text{C.}}$$

The *density* is 8·89 grammes per cubic centimetre.

NOTE 2.—"Ohms per 1,000 ft." and "Pounds per 1,000 ft." are calculated for a solid rod of the same length and of cross-section equal to the total cross-section of the wires of the cable. The resistance of an actual cable is likely to be somewhat greater than the value given by the table, but not much greater. However, the *mass* per unit length of an actual cable is necessarily increased by the stranding, and hence a *correction must be added* whose amount depends on the "lay" of the cable. The value of the correction relative to the whole mass is $\left(\frac{4{\cdot}9}{n^2}\right)$, where the lay is "1 in n." For any lay more gradual than about 1 in 20, the correction is less than 1 per cent.

APPENDIX.

CALCULATION OF THE RESISTANCE AND MASS PER UNIT LENGTH OF CABLES.

In the first place, it is proposed to show that the percentage increase of resistance of a cable with all the wires perfectly insulated from one another over the resistance of the "equivalent solid rod" is exactly equal to the percentage decrease of

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Table II.—*Bare Concentric Cables of Standard Annealed Copper. Metric Units.*

	Circular mils (or gauge No.).	Total cross-section in mm².	Outside diam. in mm.	No. of wires.	Diam. of wires in mm.	Ohms per kilometre 25°C.	Ohms per kilometre 65°C.	Kgms. per kilometre.
...	2,000,000	1,013	41·4	127	3·19	0·0173	0·0200	9,010
...	1,900,000	963	40·4	127	3·11	0·0182	0·0211	8,560
...	1,800,000	912	39·3	127	3·02	0·0192	0·0222	8,110
...	1,700,000	861	38·2	127	2·94	0·0204	0·0235	7,660
...	1,600,000	811	37·1	127	2·85	0·0217	0·0250	7,210
...	1 500 000	760	35·9	127	2·76	0·0231	0·0267	6,760
Less common.	1,400,000	709	34·7	127	2·67	0·0247	0·0286	6,310
	1,300,000	659	33·4	127	2·57	0·0266	0·0308	5,860
	1,200,000	608	32·1	127	2·47	0·0289	0·0333	5,410
	1,100,000	557	30·7	127	2·36	0·0315	0·0364	4,960
	1,000,000	507	29·3	127	2·25	0·0346	0·0400	4,500
	2,000,000	1,013	41·4	91	3·77	0·0173	0·0200	9,010
	1,900,000	963	40·4	91	3·67	0·0182	0·0211	8,560
	1,800,000	912	39·3	91	3·57	0·0192	0·0222	8,110
	1,700,000	861	38·2	91	3·47	0·0204	0·0235	7,660
	1,600,000	811	37·0	91	3·37	0·0217	0·0250	7,210
	1,500,000	760	35·9	91	3·26	0·0231	0·2670	6,760
...	1,400,000	709	34·7	91	3·15	0·0247	0·0286	6,310
...	1,300,000	659	33·4	91	3·04	0·0266	0·0308	5,860
...	1,200,000	608	32·1	91	2·92	0·0289	0·0333	5,410
...	1,100,000	557	30·7	91	2·79	0·0315	0·0364	4,960
...	1,000,000	507	29·3	91	2·66	0·0346	0·0400	4,500
...	1,000,000	507	29·3	61	3·25	0·0346	0·0400	4,500
...	950,000	481	28·5	61	3·17	0·0365	0·0421	4,280
...	900,000	456	27·8	61	3·09	0·0385	0·0445	4,050
...	850,000	431	27·0	61	3·00	0·0408	0·0471	3,830
...	800,000	405	26·2	61	2·91	0·0433	0·0500	3,600
...	750,000	380	25·3	61	2·82	0·0462	0·0534	3,380
...	700,000	355	24·5	61	2·72	0·0495	0·0572	3,150
...	650,000	329	23·6	61	2·62	0·0533	0·0616	2,930
...	600,000	304	22·7	61	2·52	0·0577	0·0667	2,700
...	550,000	279	21·7	61	2·41	0·0630	0·0728	2,480
...	500,000	253	20·7	61	2·30	0·0693	0·0800	2,250
...	500,000	253	20·7	37	2·95	0·0693	0·0800	2,250
...	450,000	228	19·6	37	2·80	0·0770	0·0889	2,030
...	400,000	203	18·5	37	2·64	0·0866	0·100	1,800
...	350,000	177	17·3	37	2·47	0·0990	0·114	1,580
...	300,000	152	16·0	37	2·29	0·115	0·133	1,350
...	250,000	127	14·6	37	2·09	0·139	0·160	1,130
	A.W.G.							
...	0000	107	13·4	19	2·68	0·164	0·189	953
...	000	85·0	11·9	19	2·39	0·206	0·238	756
...	00	67·4	10·6	19	2·13	0·260	0·301	599
...	0	53·5	9·46	19	1·89	0·328	0·379	475
...	1	42·4	8·43	19	1·69	0·414	0·478	377
...	2	33·6	7·42	7	2·47	0·522	0·603	299
...	3	26·7	6·61	7	2·20	0·658	0·760	237
...	4	21·2	5·88	7	1·96	0·830	0·959	188
...	5	16·8	5·24	7	1·75	1·05	1·21	149
...	6	13·3	4·67	7	1·56	1·32	1·52	118
...	7	10·5	4·16	7	1·39	1·66	1·92	94
...	8	8·4	3·70	7	1·23	2·10	2·42	74

NOTES.—The fundamental resistivity, temperature coefficient and density are given in Note 1 of the preceding table. Note 2 explains the calculations of ohms per unit length and mass per unit length.

resistance of a cable in which each strand makes perfect contact with a neighbouring strand at all points of its surface. That is, if R_s = resistance of a solid wire or rod of the same length and of cross-section equal to the total cross-section of the cable (taking the cross-section of each wire perpendicular to the axis of the wire), R_1 = resistance of a cable with the individual wires perfectly insulated from one another, R_2 = resistance of a hypothetical cable with the wires distorted into such shape that they make perfect contact at all points of their surfaces (the layers all being twisted in the same direction), then

$$R_s = \frac{R_1 + R_2}{2}.$$

$R_1 > R_s$, because on account of the stranding the path of the current is longer than it would be if parallel to the axis of the cable. $R_2 < R_s$, because the path of the current is in this case parallel to the axis of the cable, which path has a greater cross-section than the sum of the cross-sections of each wire taken perpendicular to the axis of the wire.

$$\therefore R_1 > R_s > R_2.$$

In showing that R_s is just half-way between R_1 and R_2, we use the symbols :—

ρ = volume resistivity.

l = length along axis of cable, or length of "equivalent solid rod."

s = total cross-section of the wires of the cable, taken perpendicular to axis of wire, or cross-section of "equivalent solid rod."

$\triangle l$ = increase of length of strand due to twisting.

$\triangle s$ = increase of cross-section perpendicular to axis of cable due to twisting.

We have

$$R_s = \frac{\rho l}{s} \quad \ldots\ldots\ldots (1)$$

$$R_1 = \frac{\rho(l + \triangle l)}{s} \quad \ldots\ldots\ldots (2)$$

$$R_2 = \frac{\rho l}{s + \triangle s}. \quad \ldots\ldots\ldots (3)$$

The following diagram (Fig. 1) shows a side view of one strand of a cable. In the diagram only one dimension of the

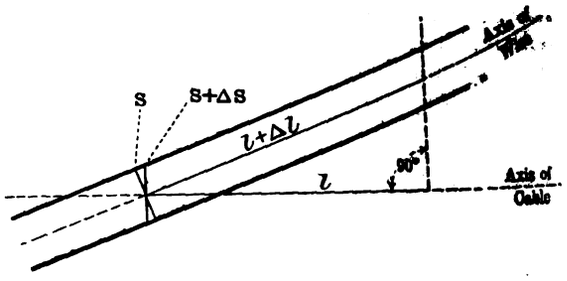

FIG. 1.

cross-section s is shown ; the dimension perpendicular to this is unchanged by the twisting, and hence s is proportional to the dimension shown.

By similar triangles,

$$\frac{s + \triangle s}{s} = \frac{l + \triangle l}{l},$$

$$s + \triangle s = s\left(1 + \frac{\triangle l}{l}\right). \quad \ldots\ldots (4)$$

$$\therefore R_2 = \frac{\rho l}{s\left(1 + \frac{\triangle l}{l}\right)} = \frac{\rho l}{s}\left(1 - \frac{\triangle l}{l}\right), \text{ since } \frac{\triangle l}{l} \text{ is small.} \quad (5)$$

From (2),

$$R_1 = \frac{\rho l}{s}\left(1 + \frac{\triangle l}{l}\right). \quad \ldots\ldots (6)$$

$$\therefore R_1 + R_2 = \frac{2\rho l}{s}. \quad \ldots\ldots\ldots (7)$$

From (1) and (7),

$$R_s = \frac{R_1 + R_2}{2}. \qquad \text{Q.E.D.}$$

The resistance of an actual cable must be between R_1 and R_2. Although the case represented by R_2 is highly hypothetical, still the effect of contact between the wires is not negligible. This is shown by the fact that the resistance of cables increases with age, which may be considered to be due to contamination of the wire surfaces. Hence, while the resistance of a cable may not exactly equal R_s, it is greater than R_s by an amount less than $(R_1 - R_s)$. By equations (1) and (6),

$$\frac{R_1 - R_s}{R_s} = \frac{\triangle l}{l}$$

The resistance of a cable is then greater than R_s by a fractional amount less than $\triangle l/l$.

The *mass* of a cable is greater than the mass of the "equivalent solid rod" by a fractional amount exactly equal to $\triangle l/l$. This is readily seen, and may be considered to be due either to increase of length or to increase of cross-section. Since the mass per unit length in the tables is calculated for the "equiva-

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lent solid rod," they should strictly be corrected in use by the factor $(1+\Delta l/l)$. The method of computing this factor from the "lay" of the cable is given herewith.

Let d=diameter of the helical path of one strand.

L=length along axis of cable for one complete revolution of strand about axis.

$n=\frac{L}{d}$=number of times the diameter, d, is contained in the length L.

"Lay"=$d/L=1/n$=ratio of the diameter d to the length L. The lay is usually expressed as $1/n$ or "1 in n"; thus we may speak of a lay of 1/20, or 1 in 20.

Consider a strand of length $(L+\Delta L)$, developed in a plane containing the axis of the cable of length L. The developed

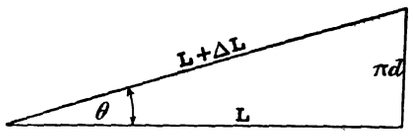

FIG. 2.

strand and the axis make with each other the angle θ, in Fig. 2. The third side of the triangle equals in length the circumference of the helical path of the strand.

$$\tan\theta=\frac{\pi d}{L}=\frac{\pi}{n}.$$

$$\frac{L+\Delta L}{L}=\sec\theta=\sqrt{1+\tan^2\theta},$$

$$=\sqrt{1+\frac{\pi^2}{n^2}}$$

$$=1+\frac{1}{2}\left(\frac{\pi^2}{n^2}\right)-\frac{1}{8}\left(\frac{\pi^2}{n^2}\right)^2+\ldots\ldots$$

All terms of higher order than the first are negligible for the purpose in hand, hence the correction factor to be applied to the tabulated values of mass per unit length is

$$\left(1+\frac{\Delta l}{l}\right)=\left(1+\frac{\Delta L}{L}\right)=1+\frac{1}{2}\left(\frac{\pi^2}{n^2}\right).$$

For example, if the lay is 1 in 40, $n=40$, and the correction factor is $(1+\frac{1}{2}\frac{9{\cdot}87}{1{,}600}=(1+0{\cdot}30$ per cent.).

If the lay is 1 in 20, the correction factor is (1+1·2 per cent).

If the lay is 1 in 10, the correction factor is (1+4·9 per cent.).

This correction factor must be computed separately for each layer of the strands when the lay is different for different layers of the cable. If L is the same for each layer of the cable the lay varies because of the change of d. It should not be forgotten that the central wire is untwisted.

Bureau of Standards, U.S.A., July 29, 1911.

THE FUNDAMENTAL PROPERTIES OF THE ELEMENTS.*

BY PROF. T. W. RICHARDS.

The mystery that enshrouds the ultimate nature of the physical universe has always stimulated the curiosity of thinking man. Of old, philosophers sought to solve the cosmic problem by abstract reasoning, but to-day we agree that the only hope of penetrating into the closely guarded secret lies in the precise estimation of that which is tangible and visible. Knowledge of the actual behaviour of material and of energy provides the only safe basis for logical inference as to the real essence of things. Faraday was deeply imbued with this conviction; and it is widely recognised as the basis of all modern experimental science. The subject of my lecture to-night concerns the methods and general results of several extended series of investigations, planned with the hope of adding a little to the foundations of human knowledge by means of careful experiment.

*Abstract of the Faraday Lecture delivered before the Chemical Society.

What, now, are the most important precautions to be taken in such work? These are worthy of brief notice, because the value of the results inevitably depends upon them. Obvious although they may be, they are often disregarded. In the first place, each portion of substance to be weighed must be free from the suspicion of containing unheeded impurities; otherwise its weight will mean little. This is an end not easily attained, for liquids often attack their containing vessels and absorb gases, crystals include and occlude solvents, precipitates carry down polluting impurities, dried substances cling to water, and solids, even at high temperatures, often fail to discharge their imprisoned contaminations. In the next place, after an analysis has once begun, every trace of each substance to be weighed must be collected and find its way in due course to the scale pan. The trouble here lies in the difficulty in estimating, or even detecting, minute traces of substances remaining in solution, or minute losses by vaporisation at high temperatures.

In brief, "the whole truth and nothing but the truth" is the aim. The chemical side of the question is far more intricate and uncertain than the physical operation of weighing. For this reason it is neither necessary nor advisable to use extraordinarily large amounts of material; from 5 to 20 grammes in each experiment is usually enough. The exclamation, "What wonderfully fine scales you must have to weigh atoms," simply indicates ignorance; the real difficulties precede the introduction of the substance into the balance case. Every substance must be assumed to be impure, every reaction must be assumed to be incomplete, every measurement must be assumed to contain error, until proof to the contrary can be obtained. Only by means of the utmost care, applied with ever-watchful judgment, may the unexpected snares which always lurk in complicated processes be detected and rendered powerless for evil. Among all the possibilities of error, the unsuspected presence of water is perhaps the most frequent and most insidious. The two errors—namely, the presence of residual water and the loss of traces of precipitate respectively—have perhaps ruined more previous investigations than any other two causes, unless the inclusion of foreign substances by precipitates may be ranked as an equal vitiating effect. But these are merely details; the scope and method of the recent work on this subject at Harvard (in the course of which 30 atomic weights have been re-determined) may be seen in their full bearing only in the original Papers.*

That the atomic weights may be connected by precise mathematical equations seems highly probable; but although many interesting attempts have been made to solve the problem, the exact nature of such relationships has not yet been discovered. No attempt which takes liberties with the more certain of the observed values is worthy of much respect. It seems to me that the discovery of the ultimate generalisation is not likely to occur until many atomic weights have been determined with the greatest accuracy. No trouble being too great to attain this end, the Harvard work will be continued indefinitely, and attempts will be made to improve its quality, for the discovery of an exact mathematical relationship between atomic weights would afford us an immeasurably precious insight into the ultimate nature of things.

But weight is only one of the fundamental properties of an element. Volume is almost, if not quite, as important in its own way, although far more variable and confusing. All gases, indeed, approach closely to a simple relationship of volumes, defined by the law of Gay Lussac and the rule of Avogadro. In the liquid and solid state, however, great irregularities are manifest, and very little system as regards volume is generally recognised.

About 12 years ago the study of such small irregularities as exist among gases led me to the suspicion of a possible cause for the greater irregularities in liquids and solids. The next step in the train of thought is perhaps equally obvious. If changes in the bulk of molecules are to be inferred even from gases, may not the expansion and contraction of solids and liquids afford a much better clue to the relative expansion and contraction of these molecules?

Most physical chemists refer all changes in volume to changes in the extent of the *empty space* between the molecules. But are there, after all, any such empty spaces in solids and liquids? Solids do not behave as if the atoms were far apart within them; porosity is often conspicuous by its absence. Take, for instance, the case of glass; the careful experiments of Landolt on the conservation of weight show that glass is highly impermeable to oxygen, nitrogen and water for long periods. Such porosity as occurs in rigid, com-

*An important part in these researches has been taken by G. P. Baxter, and many able students also have assisted the author in the work. A complete bibliography is given in "Publ. Carnegie Inst. of Washington," 1910, No. 125, 91. Most of the Papers are reprinted in full in a volume entitled "Experimentelle Untersuchungen über Atomgewichte," by the author and his collaborators (Hamburg, 1909). The Carnegie Institution of Washington has generously subsidised the work in recent years.

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pact solids usually permits the passage only of substances which enter into the chemical structure of the solids themselves. In these cases, as in so many others, the so-called "sphere of influence" of the atom is the actual boundary by which we know the atom and measure its behaviour. Why not call this the actual bulk of the atom?

From another point of view, the ordinary conception of a solid has always seemed to me little short of an absurdity. A gas may very properly be imagined with moving particles far apart, but what could give the rigidity of steel to such an unstable structure? The most reasonable conclusion, from all the evidence taken together, seems to be that the interstices between atoms in solids and liquids must usually be small even in proportion to the size of the atoms themselves, if, indeed, there are any interstices at all.

Very direct and convincing evidence of another sort is at hand. The idea that atoms may be compressible receives striking confirmation from a recent interesting investigation of Grüneisen* concerning the small effect of low temperatures on the compressibility of metals. The average compressibility of aluminium, iron, copper, silver and platinum falls off only 7 per cent. between the temperature of the room and that of liquid air. Extrapolation of the curves indicates that at the absolute zero very little further diminution should occur. As far as we can guess, therefore, the hard metals are almost as compressible at the absolute zero as at room temperatures. But at the absolute zero all heat vibration is supposed to stop; hence this remaining compressibility must needs be ascribed to the atoms themselves. If the atoms are compressible, all mathematical reasoning which assumes them to be incompressible rests upon a false basis. The kinetic theory of *gases* remains unmolested by these considerations, except as they indicate the changeability of b in the equation of van der Waals, but the new views affect seriously the application of this equation to solids and liquids.

Let us proceed to trace a few of the outcomes of our hypothesis. If atoms may really be packed closely together, the volumes of solids and liquids should afford valuable knowledge concerning the relative spaces occupied by the atoms themselves under varying conditions. The densities of solids and liquids then assume a significance far more interesting to the chemical philosopher than before, because they have a more definite connection with the fundamental nature of things. An apparent objection at once suggests itself; if the particles in condensed material are really touching one another, how can we account for heat within the material? Would such closely packed atoms be able to vibrate? The theory of compressible atoms supplies as one of its own corollaries the immediate answer to this question. If atoms are compressible throughout their whole substance, they may contract and expand, or vibrate within themselves, even when their surfaces are prevented from moving by being closely packed together. It is thus possible to conceive of a vibrational effect, even in contiguous atoms, provided we can conceive of these atoms as being elastic throughout all their substance. Agitation sufficient to produce even the Brownian movement might easily exist in such a system.

Clearly there is nothing impossible or obviously contradictory to experimental knowledge in the notion that atoms are compressible; indeed, the old idea of small, hard particles far apart is really more arbitrary and hypothetical than the new conception. The obvious simplicity of the latter is rather in its favour than otherwise, as in Dalton's atomic theory. In general, the more simply a hypothesist interprets the phenomena of Nature the more useful the hypothesis is likely to be, provided, of course, that the interpretation is adequate. The modern philosophy of pragmatism is a good guide in such matters; a theory not obviously illogical should be judged by its usefulness. Let us, then, test the new hypothesis by applying it to other aspects of physical chemistry.

If pressure produces a change in the sizes of the atoms and molecules themselves, may not the actual volumes of liquids and solids be used as a guide to the unknown internal pressures within them? Cannot we thus discover whether or not chemical affinity exerts pressure in its action? To follow this clue the simplest possible case was chosen at first—namely, the comparison of the contractions taking place on combining several elements in succession with a single very compressible one. The changes of volume occurring during the formation of oxides were first computed; later, chlorides and bromides were studied. According to the theory of compressible atoms, we should expect to find greater contraction in cases of greater affinity. A glance at a diagram (Fig. 1) depicting typical data concerning certain nearly related chlorides strongly supports this inference—that is to say, reactions evolving much heat manifest great contraction. Evidently the change of volume in any case must depend not only on the intensity of the pressure exerted by the affinity, but also, among other things, on the compressibility of the substances concerned. The greater the compressibility the greater should be the change of volume caused by a given pressure of affinity. Before any definite conclusion can be drawn the differences in compressibility must be taken into account.

These thoughts led to the measuring of the compressibilities of a large number of elements and simple compounds. The compressibilities of 35 elements and many single compounds were studied with sufficient care to leave no doubt as to their relative values. It became at once manifest that the formation of a compound of a compressible element was attended with greater decrease of volume than the formation of a similar compound of a less compressible element, other things being equal. This is just what the theory leads us to expect, and is a fact inexplicable by any other hypothesis as yet known to me.

Another essential aspect of the theory of compressible atoms is that which concerns cohesion. If the pressure of chemical affinity causes atomic compression, may not the pressure of cohesive affinity also have the same effect? The bulk of evidence strongly indicates that cohesiveness as well as chemical affinity exerts pressure in its action, and hence that each plays a part in determining the volumes occupied by molecules.

Thus the computation of the space occupied by either a solid or a liquid becomes a very complex matter. Not only must the various chemical affinities at work be taken into account, but also the cohesive attraction of both factors and products, and the compressibilities over a very wide range of all the substances concerned. Discoverable parallelism in volume changes is to be expected only when one alone of these forces is the chief variable.

Carried through to its logical conclusion, the idea that atoms are compressible gives one quite a new conception of the molecular

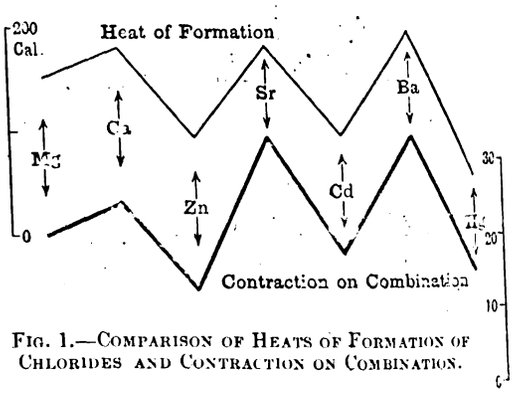

FIG. 1.—COMPARISON OF HEATS OF FORMATION OF CHLORIDES AND CONTRACTION ON COMBINATION.

mechanics of the universe. The influence of atomic compressibilities may be perceived everywhere, and in most cases each fact seems to fit easily and without constraint into its place in the hypothesis. Even apparent exceptions, such as the abnormal bulk of ice, may be ascribed in a reasonable fashion to superposed effects.

Many physico-chemical phenomena assume a new aspect when viewed from the standpoint of this idea. New notions of the mechanism of the critical phenomena, surface tension, ductility, malleability, tenacity and coefficient of expansion are gained. The peculiar relations of material and light, such as magnetic rotation, fluorescence, partial absorption, and so forth, may be referred to the modified vibrations of distorted atoms. The deviations from the exact fulfilment of many older generalisations concerning volume (such as the equation of Van der Waals already cited, the comparative volumes of aqueous solutions, especially of electrolytically dissociated substances, and the variations in the crystal forms of isomorphous substances) are seen to be a foregone conclusion. Moreover, the theory, although not necessarily dependent on the modern belief that atoms are built up of numbers of much smaller corpuscles, is consistent with that belief, for would not such an entity be compressible?

The relation between heat of reaction and change of volume stimulates interest in chemical thermodynamics and curiosity as to the mechanism of the output of energy during chemical change. A search for accurate data wherewith to reason about this question soon revealed the uncertain nature of many of the figures. Here, in the domain of thermo-chemistry, as in those of atomic weights and compressibilities, new methods were needed in order to attain precise results. In thermo-chemical reasoning particularly accurate data possess a significance wholly denied to cruder results. The relations between the heat of formation of organic substances, if determined accurately enough, may be hoped to throw light on

* E. Grüneisen, "Ann. Physik," 1910 (iv.), 33, 1239. The relative values for the compressibilities recorded in this investigation are doubtless trustworthy, although the absolute magnitudes are somewhat uncertain, because they depend on the rather inadequate theory of elasticity.

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organic structure and the nature of valence. Approximate values are of no use at all for such a purpose. Enough has been done already to suggest relations of a highly interesting sort between heats of combustion, heats of evaporation, compressibility and many other properties; and to add support to the theory of compressible atoms. Moreover, taken in connection with more precise knowledge of the free energy of chemical changes, the new results will permit the evaluation of bound energy, and give results which may decide whether or not bound energy is really a simple function of change of heat capacity, as has been more than once intimated.

A first step towards the collation of all the varying properties, so as to show their many-sided relationships, is clearly to find the way in which each property varies in relation to every other. With this in mind, let us appeal to the irregular system of the periodic classification, which formed the subject of the Faraday Lecture by Mendeléeff 22 years ago. This mysterious index of uncharted tendencies must hide within itself guiding ideas capable of pointing us onward. Clearly each property must receive, not merely qualitative, but strictly quantitative, treatment. With this in mind, let us compare our various facts by plotting atomic weight in one direction and all the other properties in another. Then, by noting the parallelism or antiparallelism of the wavy lines, many relationships may be traced.

In the diagram (Fig. 2) are plotted a number of properties with relation to the atomic weights. Prominent among the lines is the atomic volume curve; below it is plotted the almost parallel line depicting the compressibilities of the solid elements. These are

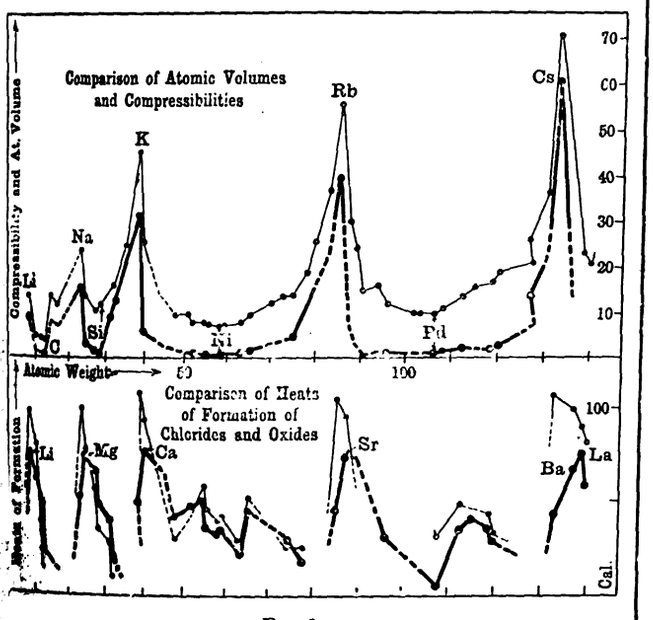

FIG. 2.

seen to be, like the atomic volumes, periodic functions of the atomic weights. The parallelism cannot but suggest that atomic volume and compressibility are fundamentally connected. Another set of waves shows the heat of formation of several compounds plotted with relation to the atomic weights, and a third curve gives the heats of combination of chlorine with other elements, and below it a heavy line depicts the heats of the combination of oxygen with these elements.

The attempt to fathom the nature of these fundamental tendencies leads beyond one's depth into an ocean of speculation. In the blindness of our submerged state we cannot distinguish between cause and effect. The well-known definite relations of the spectrum lines suggest that at least one of the essential requirements for the existence of an atom may be susceptibility to certain definite harmonic vibrations; those compressible atoms capable of vibrating in certain rhythms may be permanent, whilst other aggregations may be unstable. The gap in the periodic system where *ekaiodine* and *ekacæsium* should be, and the amazing instability of the elements immediately following, supports the notion. But here we have a cosmic puzzle for future solution. To-day we lack adequate data, we are blocked at every turn by our ignorance; therefore, the immediate problem is to discover and test each step as carefully as possible. When the facts have been ascertained, man will have a solid basis upon which to build his future superstructure of theoretical interpretation. The quest is not dictated by mere curiosity alone. All organic life is actuated by chemical energy, and exists in a mechanism and environment composed of chemical substances; and the effort to understand these essential conditions of human existence constitutes one of the most important objects of human endeavour. Superficial observation of the complex phenomena of life can do but little; patient study of the fundamental laws of the physical universe alone can help to unravel the interwoven threads. Health, well-being and a profound philosophic outlook are alike dependent upon the result. No one can predict how far we shall be enabled by means of our limited intelligence to penetrate into the mysteries of a universe immeasurably vast and wonderful; nevertheless, each step in advance is certain to bring new blessing to humanity and new inspiration to greater endeavour.

CORCOVADO ELECTRIC RAILWAY.

One of the most recent electric railways installed in South America is the new Corcovado line, which ascends to the summit of Mount Corcovado, in the neighbourhood of Rio de Janeiro. A steam operated line had previously been in operation, and was well patronised by tourists on account of the wide panorama overlooking the city and the bay which could be enjoyed from the summit. Quite recently the line was purchased by the local power company which is concerned with lighting and tramway enterprises in Rio de Janeiro, and the road was equipped with electric traction on the Oerlikon system, following to some extent the method used on the Jungfrau railway.

The electric line starts near the city at a 130 ft. altitude and rises to 2,100 ft., reaching a point near the summit of the mountain. The

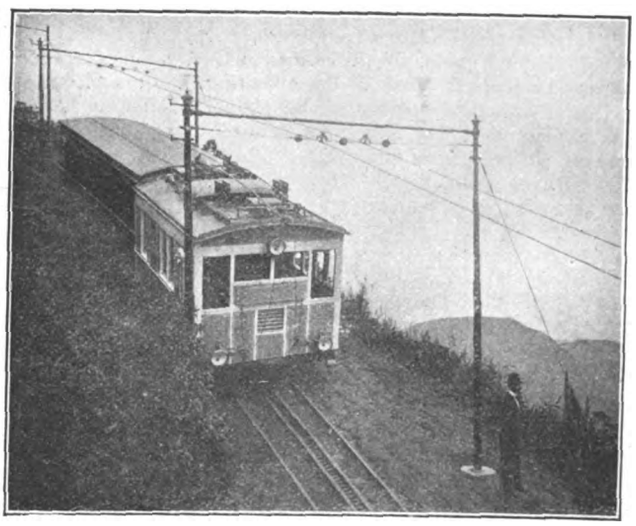

FIG. 1.—CORCOVADO ELECTRIC RAILWAY.

total length is 2·3 miles, of which 68 per cent. comprises curves. Owing to the heavy gradients it is necessary to use the rack-rail on the whole of the line, and the Riggenbach system is adopted. The track gauge is one metre, and between the rails are fixed two channel irons between which are riveted the teeth of the rack.

Three-phase current is employed, and a specially-designed locomotive, which is illustrated in Figs. 1 and 2, was built by the Oerlikon Company. On the roof is a double trolley which takes current from a 750-volt overhead line at a frequency of 50 cycles. Such frequency was already adopted in the local power plant, and even though it is somewhat high for traction work, it was used without any difficulty by properly designing the motors.

Some departure was made from the methods employed on the Jungfrau line. The locomotive is at the rear and pushes the car up the track, but owing to the heavy gradients it was found advisable to keep the locomotive independent of the car, and it does not support any of the weight of the latter, as on the Swiss line. In designing the locomotive, the centre of gravity is brought down as near the rail as possible, and a safety grip is used under the rack rail.

The truck of the locomotive carries two separate pinions which engage with the rack. For each pinion there is mounted a similar set of apparatus consisting of a three-phase motor driving a countershaft by means of reduction gears. The speed reduction is from 11·3 to 1. Each of the motors is bolted down to the top framing of the truck, so that it lies above the inside floor of the locomotive and is quite accessible. The motors have 8 poles, and normally run at

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730 revs. per min. In the armature circuit of each motor is placed a rheostat for regulating the speed. Both rheostats are coupled together mechanically so as to be operated by a single movement of the controller handle. The two motors are always operated in parallel. Above them is mounted a sheet-iron box of large size in order to contain the resistance coils, and a good air draught for cooling the coils is provided by a motor-driven fan placed in the rear.

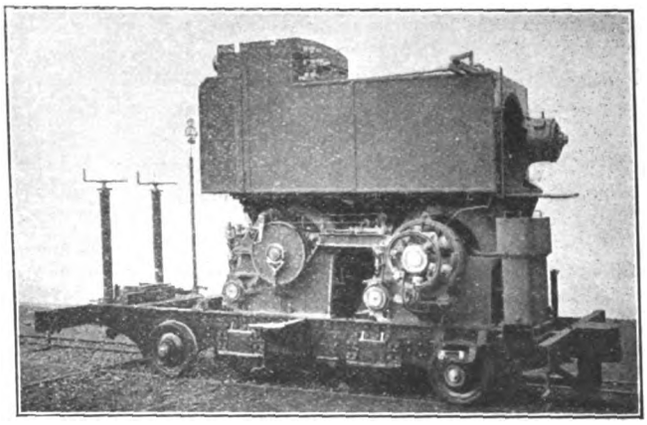

FIG. 2.—VIEW SHOWING CONSTRUCTION OF CORCOVADO ELECTRIC LOCOMOTIVE.

Such air escapes at the front by a vertical flue, which runs up through the roof of the locomotive. On the front of the box are mounted various instruments and control levers.

The resistance coils also serve to absorb the energy when the car is run on the down grade, and the motors are used as generators in order to provide an electric brake. For operating the three-phase motors in this way, there is mounted a small six-pole exciter on the shaft of the rear motor (*see* Fig. 2) in order to furnish direct current. When running under these conditions a double-throw switch disconnects the field winding of both motors from the overhead line, and inserts the fields in the direct current circuit of the exciter. In this way the three-phase motors are made to work as generators upon the resistance coil. A rheostat regulates the amount of direct current in the fields, and accordingly the amount of electric braking. Means are also provided to allow the motors to work as generators upon the line itself, in order to return energy in the usual way, but as the cost of current is quite low in the present case, this point is not one which has as much importance as on some lines. It is found that 40 to 45 per cent. of the energy can thus be regenerated. When descending, the motors can furnish the current needed on the locomotive for the fan motor and also for the lighting.

The company is now operating a 50,000 H.P. hydraulic plant in the region of Rio de Janeiro, using a 44,000-volt three-phase power line. The line ends in a large sub-station in the suburbs of the town, and the present electric road takes its supply from this source. A special sub-station has been installed on the mountain, which sub-station receives 6,300-volt current from the main plant, and reduces the pressure to 750 volts for use on the double-trolley line.

Turkish Telegraphs.—The office of posts, telegraphs and telephones of the Ottoman Empire has been elevated to the rank of a Ministry, and His Excellency Agap Effendi Stamboulian has been appointed Minister.

FARADAY HOUSE AS A TRAINING INSTITUTION.

This is a time of year of great anxiety to parents whose boys have just left school. Some have doubtless decided to make their sons doctors or lawyers, and others, perhaps taking into account the mechanical aptitude displayed by the particular youth considered, have sanctioned his desire to be an electrical engineer. In the case of a lawyer or a doctor, very definite courses of training are laid down and the parent cannot go far wrong; but in the case of the engineer it is different. The parent will find that his son may *apparently* reach his goal in a bewildering variety of ways, and that a decision (by the uninitiated) as to which is the best is difficult, if not almost impossible.

If the parent consults the "Proceedings" of the recent Education Conference for advice he will not be much better off. There he will find almost as many solutions as there were speakers, though if he goes somewhat more deeply into the matter he will discover that it is generally conceded that practical training is essential, and that it is best for the student to combine this in some way or other with his theoretical work.

Such a combination is provided by the Electrical Standardising, Testing and Training Institution in Southampton Row, better known as "Faraday House." The length of the course is four years, although a shorter course can be arranged. The first year is occupied with lectures on electrical and mechanical engineering, combined with practical work in the laboratories, workshops and drawing office. The second year is devoted to the shops and is spent with one of the mechanical engineering firms that are affiliated to Faraday House. During the third year the student once more finds himself back in Southampton Row, and he is now in a position to take full advantage of the advanced course of instruction provided for the third-year students. In his fourth year he is again engaged in practical work, this time with electrical manufacturers, or in a power house. It should be pointed out in this connection that the parent is relieved from all the responsibility of finding a place for his son in works. All arrangements of this kind are made by the Faraday House authorities, and the delay which usually arises at this period is avoided. In fact, by the time the student has finished his first year's course arrangements have been made as to which of the affiliated works he is to attend during his second year. Another important point is that while in works the student remains *in statu pupillari*. Mr. Ernest A. Nash, the secretary,

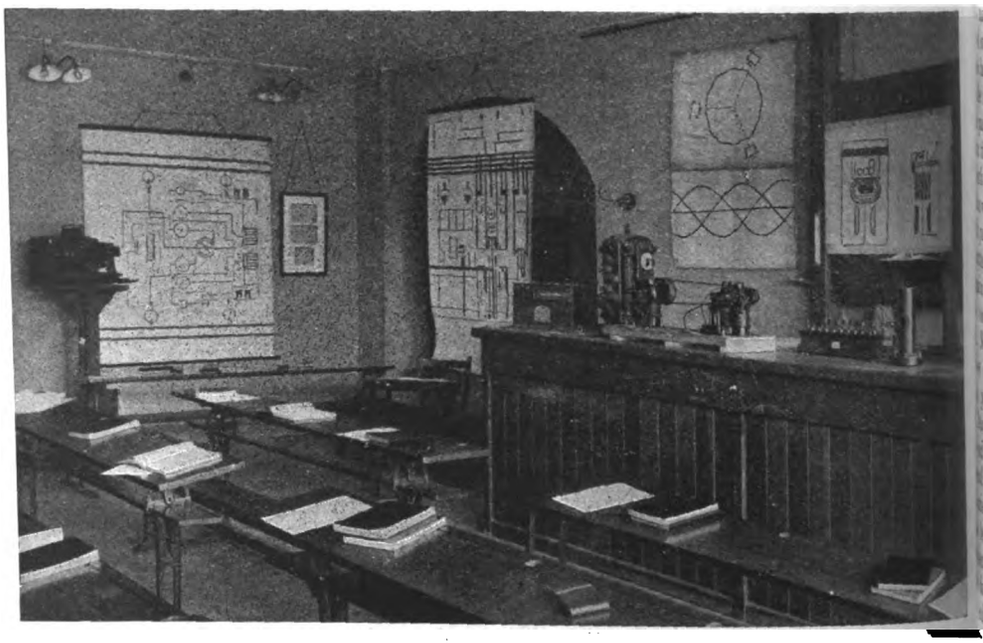

FIG. 1.—ONE OF THE LECTURE ROOMS.

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of Faraday House, not only receives monthly reports but constantly pays visits to all the affiliated works, and personally satisfies himself as to how each pupil is progressing, both mentally and physically. A third important point to parents is the fact that the fourth or last year of the course is spent in works. The student is therefore right in the way of any

FIG. 2.—THE DRAWING OFFICE.

appointments that may be going. In fact, Mr. Nash informs us that many firms take into their employ these fourth-year affiliated students, being naturally prepossessed in favour of men who have been trained in their own methods.

But the ultimate test of the suitability of any course both from the parent's and the student's point of view is the influence it has on the after-life of the pupil, both as regards technical knowledge and the facility it provides for obtaining further employment. Here again Faraday House can be confidently recommended. Not only do the authorities do their best to obtain a position for each student leaving the college at the end of a complete course—and we are informed that a satisfactory appointment has been obtained for every student who completed his course during last year—but they endeavour to keep constantly in touch both with employers and employés. In this way not only is the properly qualified student reasonably sure of a position, but also, through the help of Faraday House, he is often enabled to obtain an important appointment many years after he has left the college. This valuable feature of the institution is not unlikely to become more valuable in the future. For an increasing number of "Old Faradians" are by this time at or reaching the top of the tree, and they naturally are not averse to applying to their old college to help them to find suitable men. As regards keeping in touch with old students, mention may be made of that excellent publication "The Faraday House Journal." In it are chronicled the appointments obtained by old pupils in a way which must foster the spirit of emulation in those still at the college. There are besides a number of excellent technical articles, all from the pens of old Faradians.

We give examples in the accompanying illustrations of the accommodation provided at Faraday House for the theoretical training of students. On the ground floor and basement are the carpentry, fitting and machine shops and engine room. The second floor contains the physical and chemical laboratories, the battery room and the common room of the junior students. On the third floor are three lecture rooms and two more common rooms, and on the fourth floor is the drawing office. All the rooms are light and airy, desirable features where mental work has to be done, while the whole building is heated by a low-pressure hot-water system.

The basement workshop and engine room has a floor area of about 2,000 sq. ft. and is well lighted by two large skylights fitted with a special glass rendering artificial light unnecessary. Indeed, although it is entirely underground, the light is as good as in some of the upper rooms which get their light direct. At the north end are the lathes, seven in all, including five screw-cutting lathes, also drilling, shaping and milling machines, all electrically driven from shafting attached to a steel frame erected independently of the main fabric, so as to avoid vibration. Running the whole length of the shop under the main

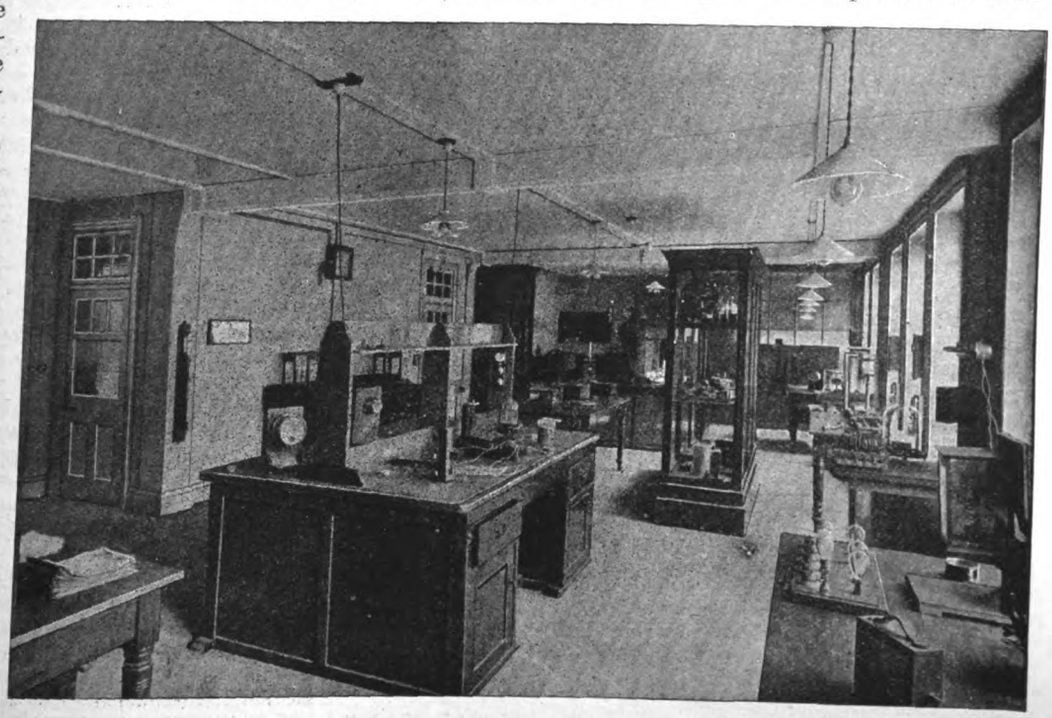

FIG. 3.—THE ELECTRICAL LABORATORY.

skylight is the fitting bench, 55 ft. long. At the south end is the forge, a boiler, steam engine, condenser and pump, a new type of Crossley gas engine with magnetic ignition, four electrical generators, and a De Laval turbo-generator. The upper or carpenter's shop has an area of about 1,200 sq. ft. The main

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bench, running nearly the whole length of the shop, is 42 ft. long and is fitted with Parkinson vices. The lathes, saw bench, and other appliances for carpentry are here. There is also at the south end an unusual type of motor generator constructed for testing work. It is a special form of alternator direct-coupled to a continuous-current motor having a double commutator. By means of connecting pieces it is possible to obtain either single, two, or three-phase current of any practical frequency, the regulating device of the motor allowing a very wide range of speed. Outside the chemical laboratory, on the flat at the back, is the battery room, containing about 54 large Pritchett cells and about 200 smaller accumulators. The connections allow of a wide range of combination, so that almost any voltage or current can be obtained. The lecture rooms, three in number, are on the third floor; two have a floor area of over 600 sq. ft., the smallest being about 22 ft. by 20 ft. The usual fitted lecturers' benches are provided and all the rooms can with little difficulty be made into one room. It may be of interest to state that when each room is filled with the maximum number of students provided for, the supply of air per pupil is ample owing to the excellent ventilation. The drawing office which is on the fourth floor, is 60 ft. long, the total floor area being at present over 2,000 sq. ft. It is splendidly lighted both back and front, and is provided with accommodation for 70 students. The benches are of a special pattern, having slopes for the drawing boards and lockers underneath that close with a spring catch, so that each student can immediately put away his board, with T-square and instruments, at the end of the lesson, and yet keep it free from dust. Round the room are hung many samples of the materials and parts used in dynamo manufacture.

The physical laboratory is on the second floor and runs the whole width of the building, 60ft., and has an area of 1,600 sq. ft., being well lighted back and front. It is fitted with all the necessary apparatus for making physical and electrical measurements. At the north end, protected by a strong barricade, are two motor generator sets and one rotary converter for experimental demonstrations. An independent system of wiring runs all round the room to provide the current required for testing purposes, whether from the institution generators or from the street mains which supply the building with alternating current at 200 and 100 volts, and direct-current at 530, 200 and 100 volts.

Finally, as a guarantee of the value of the course given, we may mention that Dr. Alex. Russell, M.A., D.Sc., M.I.E.E., is the principal of Faraday House, and that he personally gives lectures to the advanced students both in mathematics and electrical engineering. The regular staff, too, is supplemented by engineers who deliver lectures on subjects in which they are experts, and amongst those who have given regular courses of lectures to the students we may mention, Mr. James Swinburne, F.R.S., Mr. Robert Hammond, M.Inst. C.E., Prof. Carus Wilson, Mr. H. M. Hobart, M.Inst.C.E., Mr. W. R. Cooper, Dr. W. H. Eccles, Mr. John Rennie and Mr. Wallis Jones, M.Inst.C.E.

In connection with Faraday House there is a very flourishing Old Students' Association of which Mr. C. P. Sparks, M.Inst. C.E., and Mr. G. W. Partridge, M.Inst.C.E., are the two senior past-presidents.

PROF. TURNER'S ADDRESS TO SECTION "A" OF THE BRITISH ASSOCIATION.*

THE CHARACTERISTICS OF THE OBSERVATIONAL SCIENCES.

It will doubtless startle my audience to hear that this section has only once in its history been addressed by an astronomical president upon an astronomical topic. The addresses of Sir George Darwin (in 1886) and of Prof. Love (in 1907) on the past history of our earth certainly have an astronomical bearing, but if we distinguish between the classical astronomy and its modern expansions they would be assigned to the latter rather than to the former; and so would the few astronomical allusions in Prof. Schuster's address at Edinburgh in 1892. Even if we include, instead of excluding, all doubtful cases, there will still appear a curious neglect of astronomy by section A in the last half-century, all the more curious when it is remarked that the neglect does not extend to the Association itself, seeing that there have been three astronomical presidents of the Association who had not been previously chosen to fill this chair. The neglect is not confined to astronomy, but extends, as some of us recently pointed out, to the other sciences of observation; and we thought that, as a corollary, it would be better for the section to divide, in order that these sciences might not continue the struggle for existence in an atmosphere to which they were apparently ill-suited. But the section decided against the suggestion, and I have no intention of appealing against the decision. This explicit statement will, I trust, suffice to prevent misunderstanding if I proceed to examine the possible causes of neglect—for I cannot but regard the record as significant of some cause which it will be well to recognise even if we cannot remove it.

Let me begin by quoting from the admirable address—none the less admirable because it was only one-quarter of the length to which we have become accustomed—delivered by my late Oxford colleague, the Rev. B. Price, at Oxford in 1860, wherein he referred to the constitution of this section as follows:—"The area of scientific research which this section covers is very large, larger perhaps than that of any other; and its subjects vary so much that while to some of those who frequent this room certain papers may appear dull, yet to others they will be full of interest. Some of them possess, probably in the highest degree attainable by the human intellect, the characteristics of perfect and necessary science; while others are at present little more than a conglomeration of observations, made indeed with infinite skill and perseverance, and of the greatest value: capable probably in time of greater perfection, nay, perhaps of the most perfect forms, but as yet in their infancy, scarcely indicating the process by which that maturity will be arrived at and containing hardly the barest outline of their ultimate laws." A little later in the address Prof. Price made it quite clear which were the sciences "in their infancy." "And finally we come to the facts of meteorology and its kindred subjects, many of which are scarcely yet brought within any law at all."

There is here much that will command ready and universal assent; but is there not also a rather unnecessary social scale? The science of planetary movement had not yet been "brought within any law at all" (as we now use the term) in Tycho Brahé's time; but was the astronomy of Tycho Brahé socially inferior to that of Kepler? I ask whether there is of necessity any drop whatever from the plane of Kepler, who realised the laws, to that of Tycho, who never reached any suspicion of the true laws, but had nevertheless such faith in their existence that he cheerfully devoted his life to labours of which he never reaped the fruits? Is it not a dangerous doctrine that the work done previous to the formulation of a law is in any way inferior? Consider the case of M. Teisserene de Bort, when he began sending up his balloons. "Show me your laws," cries the mathematician. "But they are just what I hope to find," replies M. de Bort. "Yes, but surely you have formulated some law you wish to test?" pursues the invigilator. "How can I to give you proper scientific rank unless you can produce at least a tentative law?" "On the other hand I wish to keep a perfectly open mind," maintains M. de Bort. "Then I fear I cannot admit you to our class at present; you must join the infants' class, and I can only give you my best wishes that you may reach maturity some day." Unperturbed, M. de Bort continues to send up his balloons, and almost immediately discovers the great fact about the isothermal region which will be a permanent factor in the meteorology of the future. The mathematician is now ready to admit him, as a worthy person who has found a law about the constitution of the atmosphere. But was not the merit in sending up the balloons whatever came of it? Is it not sometimes more courageous to take risks of failure? The mathematician, safe in his stronghold which possesses "probably in the highest degree attainable by the human intellect the characteristics of perfect and necessary science" is like a man who has inherited a good old-established business, and he has a distaste for the methods of those who have to try new ventures. No doubt many who make such trials fail; but on the other hand, great fortunes have been made in that way.

I also take the opening words of Sir G. H. Darwin's address to the section at Birmingham in 1886. "A mere catalogue of facts, however well arranged, has never led to any important scientific generalisation. For in any subjects the facts are so numerous and many-sided that they only lead us to a conclusion when they are marshalled by the light of some leading idea. A theory is then a necessity for the advance of science, and we may regard it as the branch of a living tree, of which facts are the nourishment."

With the utmost respect I wish to question whether the criterion indicated goes deep enough. Often have we had ocular demonstra

*Abstract of the Address delivered by Prof. H. H. Turner, D.Sc., D.C.L., F.R.S., at Portsmouth, yesterday.

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tion of the value of a theory in stimulating the advance of science, but is advance wholly dependent on the existence of a theory? I have tried to indicate already a deeper motive power by such instances as the work of Tycho, who had no theory, but who perceived the need of observation. And I will now definitely formulate the view that the perception of the need for observations, the faith that something will come of them, and the skill and energy to act on that faith—that these qualities, all of which are possessed by any observer worthy the name, have at least as much to do with the advance of science as the formulation of a theory, even of a correct theory. The president in support of his assertion then described the observations made by Mr. Campbell at the Lick Observatory which, when catalogued in an obvious order, had led to an important scientific generalisation.

Even if the like has never happened before, *this* scientific advance is at any rate due to little more than the accumulation of facts which arranged themselves, as Bacon hoped would naturally happen. But does it detract from the merits of this fine piece of observational work that it was suggested by no leading theory? And I will ask even further: Would its merits have been less if no such immediate induction had presented itself? To this second question I can scarcely expect a general answer in the affirmative; it is so natural to judge by results, and so difficult to look beyond them to the merits of the work itself that I shall not easily carry others with me in claiming that the merits of the observer shall be assessed independently of his results. And yet I affirm unhesitatingly that until this attitude is reached, we cannot do justice to the observer. I believe it will be reached in the future, and I shall endeavour to give reasons for this forecast; but I admit frankly that our habit of judging by results will be hard to break. It extends even to the observer himself, and leads to the withholding of his observations from publication, so that he may himself extract the results from them. In the pure interests of the advance of knowledge, it would be far better to publish the material, so that many brains rather than one might work upon it. But the observer knows that by this course he risks losing almost the whole value of his patient work, which would pass as unearned increment to the particular person who was lucky enough to make the induction.

The illustration will suffice to remind us that the work of the observer is far from being merely mechanical: it demands also skill and judgment—skill in defeating systematic error, and a fine judgment, born of experience, of the success attained. All this is independent of the generalisations which may or may not be arrived at. I venture to think that the great brilliance of Newton has dazzled our vision so that we do not see some things quite clearly. "Had it not been for Newton (writes De Morgan in his 'Budget of Paradoxes,' p. 56) the whole dynasty of Greenwich astronomers, from Flamsteed of happy memory, to Airy, whom Heaven preserve, might have worked away at nightly observation and daily reduction without any remarkable result: looking forward, as to a millennium, to the time when any man of moderate intelligence was to see the whole explanation. What are large collections of fact for? To make theories *from*, says Bacon; to try ready-made theories *by*, says the history of discovery; it's all the same, says the idolater; nonsense, say we!" But nothing of this will fit in with what we know of Bradley's work; he discovered aberration, not by any help fom Newton, but by accumulating a mass of observations. He had no ready-made hypothesis, or rather he had a wrong one, *viz.*, that the stars would show displacement due to parallax; and after this was proved wrong, as it was at the very outset, he had nothing in the way of a theory to guide him, and found great difficulty in devising one *after* he had collected his facts, which spoke for themselves so far as to reveal plainly the essential features of the phenomenon in question.

De Morgan was a mathematician, and I have noticed that mathematicians are apt to be crisp in their statements: but he is a bold man who says "nothing will ever come of it." Perhaps an equally crisp statement on the other side may be pardoned. I adventure the remark that if nothing has hitherto come of such observations, it is because observers have been misled by the very teaching of De Morgan and others who share his views: they have been told that they will do no good without a theory until they have come to believe it; whereas the truth probably lies in a quite different direction. To present my reasons for this proposition I must ask you first to consider in some detail the method of discussing meteorological observations suggested some years ago by Prof. Schuster.

He considers the record of any meteorological element such as temperature or rainfall. When these records are put in the form of a diagram in the familiar way we get a wavy line, which has much in common with that traced by a gramophone needle on a smaller scale. The sight of the complexities is almost paralysing, especially when those who would otherwise attack the problem are deterred by the emphatic assertion that it is useless to do so without the equipment of some guiding hypothesis. Most of the obvious hypotheses have of course already been tried, and the majority of them have failed. It is to Prof. Schuster that we owe the vitally important advice to disregard hypotheses and make a complete analysis of the record. Of course the labour is great, but the genuine observer is not afraid of labour. And in practice the work always resolves itself into a series of finite steps, owing to the finite extent of the observations. This method has been applied to the consideration of spectra, sun spots and other astronomical data.

The method of Prof. Schuster is not the only one that has been recently proposed for dealing with large masses of observations. We have also the methods of Prof. Karl Pearson. These have been far more widely adopted for use than the periodogram, and they have also been more adversely criticised. As regards criticism, I think it is fair to say that it has chiefly been directed towards the nature of the material on which Prof. Pearson has used his process than on the process itself, and at present we need not be concerned with it. The processes themselves are sound enough; one of them, for instance, is much the same as the old method of least squares in a simple form. But if the same criticism is made as has been made on the method of the periodogram—viz., that it is not new—we can reply in almost the same words in the two cases: the mathematical calculus may not be new, the novelty is the insistence on the application of it, and the application to all possible cases. Prof. Pearson ceases to look for one principal factor only, and examines all possible factors, just as Prof. Schuster examines all possible frequencies.

Let us admit frankly that there is an appearance of brutality about such methods. Is our method of search to be merely the old and prosaic one of leaving no stone unturned? We have been led to believe that there should be more of inspiration in it; that a true man of science should have some of the qualities of that fascinating hero of fiction, Mr. Sherlock Holmes, who picks up his clue and follows it unerringly to the triumphant conclusion. Such qualities will do the man of science no possible harm: indeed they will be of the utmost value to him. The point to which I am now calling attention is the chance in nature of the opportunities for using them, which are becoming every day more confused. Dr. Conan Doyle, in the exercise of his art, keeps our attention fixed on a single trail: he conceals from us by mere omission the numerous trails which cross it. We admire the skill of the Indian who pursues an enemy through the trackless forest: but his success depends on the simplicity brought by this very tracklessness, and would be imperilled if there were numerous tracks. It may be remarked, however, that there is a still higher sagacity—that of a hound who even among a number of tracks can pick out the right one by scent. Let us imagine for a moment that the scientific man can be endowed in the future, by training or by some new invention, with a faculty of this kind, so that he may unerringly pursue a single trail even when it is crossed and re-crossed by others. Then in the terms of this metaphor I draw attention to the fact that he has still to determine which is the right trail; and that in general he can only do so by pursuing each in turn to the end. To take an example from recent scientific anecdote: I relate the story as I was told it, and even if incorrect in detail it will serve its purpose as a parable. The Röntgen rays were discovered originally by their photographic action, but afterwards it was found that they would render a screen of calcium tungstate phosphorescent. I was told that this discovery had been made in this wise: Mr. Edison had a large collection of different chemicals, and a number of assistants: he set his assistants busily to work to try each substance in turn until the right one was found. Now this is not only a genuine scientific process, but it is the fundamental process. Let it be frankly admitted that our instincts are against it. We should much prefer to hear that some hypothis had pointed the way, even a false hypothesis such as actually led to the discovery of the possibility of achromatism in lenses. Or if memory had played a part: The other day Prof. Fowler identified the spectrum of a comet's tail with one taken in his laboratory, of which he had some recollection, and our human sympathies fasten at once on this idea of recollection as a praiseworthy element in the discovery. Nay, even mere accident appeals to us more than brutal industry: if Mr. Edison had wandered into his laboratory, picked up a bottle at random, and found it answer his purpose, I venture to say that we should have instinctively awarded him more merit: there would have been just a chance that he was inspired. Let us by all means welcome hypothesis, memory, inspiration, and accident whenever and wherever they will help us: but they may fail, and then our only resource is to help ourselves by the unfailing method of examining all possibilities. The aid of the others is adventitious and comes, like that of the gods, most readily to those who help themselves.

The maxim of "leaving no stone unturned" was enunciated from a rather different point of view some dozen years ago by an American geologist, Prof. T. C. Chamberlin, of Chicago, in a short Paper for

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students entitled: "The Method of Multiple Working Hypotheses."* After recalling how much the march of science in early days was retarded by the tyranny of a theory formulated too hastily, and how in later times attempts have been made to remedy this evil by holding the theory, provisionally only, as a working hypothesis, Prof. Chamberlin points out that even the working hypothesis has serious disadvantages:—"Instinctively there is a special searching-out of phenomena that support it, for the mind is led by its desires. . . . From an unduly favoured child it readily grows to be a master and leads its author whithersoever it will. . . . Unless the theory happens perchance to be the true one, all hope of the best results is gone. To be sure, truth may be brought forth by an investigator dominated by a false ruling idea. His very errors may indeed stimulate investigation on the part of others. But the condition is scarcely the less unfortunate. . . . To avoid this grave danger the method of multiple working hypotheses is urged. It differs from the simple working hypothesis in that it distributes the effort and divides the affections. . . . In developing the multiple hypotheses, the effort is to bring up into view every rational explanation of the phenomenon in hand and to develop every tenable hypothesis as to its nature, cause or origin, and to give all of these as impartially as possible a working form and a due place in the investigation. The investigator thus becomes the parent of a family of hypotheses: and by his parental relations to all is morally forbidden to fasten his affections unduly upon any one. In the very nature of the case, the chief danger that springs from affection is counteracted." For the further elucidation of Prof. Chamberlin's proposals I must refer my audience to his original Paper, which is well worthy of careful attention. He does not shirk consideration of the drawbacks—"No good thing is without its drawbacks," he writes. And it may be added that no good thing is entirely new, or entirely old. Perhaps it is better to say that it is generally both new and old. The "Method of Multiple Hypotheses" is new because it is still necessary to remind scientific workers of all kinds that so long as they restrict themselves to the examination of one hypothesis only they can never reach complete logical proof: they can only attain a high measure of probability. What is often called verification is not complete proof, but only increase in probability: for complete proof it is necessary to show that no other hypothesis will suit the facts equally well, and thus we are bound to consider other possible hypotheses even in the direct establishment of one.

But the method is also old in that it has long been adopted in practice, however partially and unconsciously, by scientific workers of all kinds. When a boy at school I began to make physical measurements under Mr. J. G. McGregor (now Professor of Physics at Edinburgh) I learnt from him one golden rule: "Reverse everything that can be reversed." The crisp form of the rule may be new to many who have long used it in their work: and its use is simply that of "multiple hypotheses." For when the current in a wire is reversed, the hypothesis is tacitly made that the effect observed may be due to the direction of the current: and when a measured spectrum photograph is turned round and re-measured, it is an admission of the hypothesis that the direction of measurement may be partly responsible for the observed displacements of the spectrum lines. By the various reversals we endeavour in Prof. Chamberlin's words, "to bring up into view every rational explanation of the phenomenon in hand" which can be brought up into view in this way. But truly "no good thing is without its drawbacks," and one drawback to the recognition of this principle is that, by a process of mental confusion, it seems sometimes to be regarded as a distinct merit in a piece of apparatus that it can be reversed in a large number of ways. It must be remembered that the hypotheses thus examined and ruled out are chiefly instrumental ones superadded to those of Nature: and the latter are already sufficiently numerous, without our ingenious additions.

The view which I have endeavoured to put before you of the inevitable course of scientific work is that it will depend more and more on the patient process of "leaving no stone unturned." It may not be an inspiring view, but it should be at least encouraging, for it follows that no good honest work is thrown away. And it is just this encouragement of which the observer, as opposed to the worker in the laboratory and the mathematician, stands sometimes in sore need. The worker in the laboratory can often clear away his hypotheses on the spot, he can reverse his current then and there; but this is often impossible for the observer, who can and does reverse his spectrum plate for measurement, but to reverse the motion of the earth which affected the lines must wait six months, and to reverse also the motion of the star may have to wait six years, or 60, or 60,000. In many cases he must leave the reversal to others, and thus not only can he not test all his hypotheses, but he may not even be able to formulate them. His aim cannot therefore be to establish within his lifetime some new law, and his work is not therefore to be appreciated or condemned by his success or failure in this respect. There are truer aims and surer methods of judgment. Something is inevitably lost when we endeavour to express these aims in the concrete; but for the sake of illustration we may say that the true observer is always endeavouring to reach the next decimal place, and is ever on the alert for some new event. Of the pursuit of the next decimal place it is needless to say more: the aim is as familiar in the laboratory as in the observatory. But I often think that the recognition of new events is scarcely given its proper place in the annals of science, if we have due regard to the consequences. I have protested that in much of his work the observer cannot be judged by the fruits of his labour, though there is an instinctive tendency to judge in this way; but here is a case where he might well be content to be so judged, and yet the consistent award is withheld. Think for a moment of the very considerable additions to our knowledge which have accrued from the discovery by Prof. W. H. Pickering of an eighth satellite to Saturn. The discovery led directly to the recognition of the retrograde motion, and to explain this we were led to revise completely our views of the past history of the solar system. Incidentally it stimulated the search for other new satellites, resulting in the discovery of a curious pair to Jupiter, and next of the extraordinary eighth satellite; while it was the investigation of the orbit of this curiosity which suggested an eminently successful method of work on cometary orbits. If we judge scientific work by its results we must take into account all this subsequent history in our appreciation of Prof. Pickering's achievement. But whether we do so or not is probably a matter of indifference to him, for the true observer is above all things an amateur, using the word in that splendid sense to which Prof. Hale recently introduced us. There have been many attempts to define an amateur. One was given by Prof. Schuster in his eloquent address to this section at Edinburgh in 1892:—"We may perhaps best define an amateur as one who learns his science as he wants it and when he wants it. I should call Faraday an amateur." We need not quarrel with his definition and certainly not with the noble instance with which he points it. But after all I prefer the definition of Prof. Hale:*—"According to my view, the amateur is the man who works in astronomy because he cannot help it, because he would rather do such work than anything else in the world, and who therefore cares little for hampering traditions or for difficulties of any kind."

The wholly satisfactory nature of this view is that it provides not only a definition, but an ambition, and a criterion. We feel at once the ambition to become amateurs, for I deny stoutly that the distinction is conferred at birth: it comes with work of the right kind. And we may know what is work of the right kind by this if by nothing else, that by diligently performing it we shall become amateurs who find it impossible to stop, "who work in astronomy because we cannot help it." Before an army of such men even the vast hordes of dusky possibilities of which we are beginning to catch glimpses must yield. The fight may seem, and no doubt is, without end; and the opportunities for glorious deeds by which outlying whole troops of the enemy are demolished at once are becoming rarer. We are confronted with the necessity of attacking each possibility singly, which threatens the stopping of the conflict through sheer weariness. Clearly the army of amateurs is the right one for the work; weariness cannot touch them, they will go on fighting automatically because "they cannot help it."

* University of Chicago Press, 1897.

THE ELECTRICAL WORK OF THE PHYSIKALISCH-TECHNISCHE REICHSANSTALT IN 1910.†

The electrical work at the Reichsanstalt during 1910 may as usual be divided into two parts, the purely routine tests on instruments and apparatus, and the researches undertaken with a view to improving the present methods of measurement or to increasing the present state of our knowledge of the physical properties of the materials employed in electrical work. We give below some details of the researches made in the latter division.

The joint work carried on in the National Physical Laboratories of Germany, England and the United States under the *ægis* of the International Commission for Electrical Units and Standards was begun at the Reichsanstalt in 1910 under the direction of Dr. Jaeger. The most important part of this work was the determination of the E.M.F. of the Weston standard cell to within 1/10,000th part of the value given by the International Ohm and Ampere as fundamental standards. As a result of measurements with the silver voltameter undertaken at Washington, the delegates found that the com-

* "Monthly Notices, R.A.S." LXVIII., p. 64.

† The information given in this article is taken from the official report of the Reichsanstalt, published in the "Zeitschrift für Instrumentenkunde."

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ponding value for the E.M.F. of the Weston cell was 1·0183 international volts to within 1/10,000th part. It was therefore agreed that from January 1, 1911, the value of the Weston cell should in all international laboratories be considered as 1·0183 volts at 20°C. This required an alteration of 0·0003 volts in the standard German value, the value formerly being 1·0186 volts. This alteration is due to the fact that the mercurous sulphate in the new cells has a somewhat lower electromotive force than that hitherto used at the Reichsanstalt.

During 1911 a sum of 283,400 marks (£14,170) was granted for the erection of a new "heavy-current" electrical laboratory, and of 111,500 marks (£5,575) for the erection of a telegraph laboratory, which is to be free from magnetic disturbances, at Potsdam.

The experiments on the variation of standard Weston cells which were carried out in conjunction with the National Physical Laboratory and the Bureau of Standards have been continued during the past year. Similar researches have been conducted on the silver voltameter.

The four manganin resistances which have been employed for some years past as secondary standards were during 1910 frequently compared with each other and with other resistances; and appeared to have remained constant within the limits of observational error. The 1 ohm manganin resistances were during July 1909 placed in an atmosphere of 50 per cent. humidity from which they were only removed for measurements to be made on them. Arrangements have now been made for these resistances to be tested while they are actually in the humidifiers. As is well known, moisture has a certain effect on the resistance of wire resistances, though with those whose value is of the order of 1 ohm it is not considerable (under 1/100,000th of an ohm). The influence of damp upon the secondary standards cannot be determined with any accuracy as the variations are so small.

In February, 1910, seven mercury rectifiers were installed for charging a 120-volt battery off a three-phase circuit. The maximum capacity of each rectifier is 10 amps. To maintain the current at this value two iron wire variators in parallel are placed in the cathode circuit. These variators have a choking effect so that while the voltage varies from 10 to 40 volts, the current remains constant at 5 amps. In this way it is possible to operate several rectifiers in parallel for charging the same battery. The rectifiers are divided into two groups of three and four respectively, so that it is possible to charge two batteries at the same time at different voltages. In general, however, all seven rectifiers are connected in parallel. Charging can thus go on both day and night without any attendance being necessary, and the cost of the energy used in the variators is therefore more than set off by the saving in attendants' wages. Further, so long as the batteries were charged off rotary machines there were never sufficient batteries for the work in hand, but since rectifiers have been installed, by the employment of which charging can go on all night, the number of batteries has been quite sufficient for all purposes.

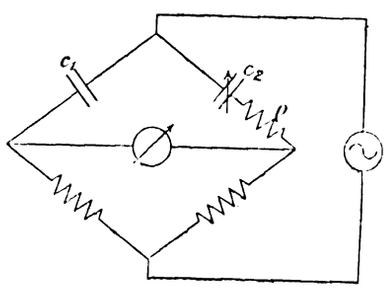
Tests have also been carried out to determine the most suitable arrangements for testing transformer oils. Spheres of 10 mm. and 15 mm. diameter were used as electrodes as well as pin points. With very dry and clean oil the breakdown voltage between the points was somewhat lower than with spheres. The difference, however, disappeared as the distance between the electrodes became greater. As the distances were increased in damp oil a higher breakdown variation was noticed between points than between spheres, but the values were often very irregular. Probably in this case the strong electric field at the end of the points played some considerable part. It was noticed that when a high voltage had been impressed between electrodes placed a long distance apart for a considerable time, the breakdown voltage for a specific distance apart of the electrodes was considerably higher than when a previous high-voltage stress had not been impressed. With the 10 mm. sphere electrodes the measurement of distances was easier and more accurate than with points. These researches are being continued.

Up to the present, certain difficulties have been experienced in making arrangements for testing the breakdown voltages on substances, such as bitumen, which are used for covering in cables. If a mass of the substance is poured on to a smooth metal surface considerable sparking takes place round the edges of the mass, resulting in heating and premature breakdown occurring. An apparatus was therefore devised so as to imitate as nearly as possible the conditions which exist in actual practice. For this purpose an iron tube, 15 mm. in diameter and 10 cm. long, was used, the ends of which were widened out cylindrically. A 40 cm. cardboard tube was then slipped over this arrangement so that the iron pipe was wholly enclosed in the cardboard. A 9 mm. brass rod was next fixed into this arrangement by means of two corks, so that the brass rod was concentric with the iron tube, the two being protected by the cardboard. The iron tube was then filled with the material for testing through an opening in the upper cork. In this way a mass of insulating material about 3 mm. thick was obtained between the brass rod and the iron tube. The cardboard prevented sparking from the iron pipe to the brass rod through the air, the iron and the brass forming the two electrodes for testing. Tests made on this arrangement agreed pretty well amongst themselves.

A series of tests was also carried out on plates of insulating material to determine the energy losses in dielectrics. About ten such plates were interspersed with copper foil, the whole making up a condenser, C_1, with a capacity of from 0·004 to 0·07 mfd. This was connected in a Wheatstone bridge, as shown in the accompanying diagram, C_2 being a variable air condenser which was connected in series with an adjustable resistance. From the value of the condenser, C_2, of the resistance, P, and the frequency, the angle by which the voltage and current in the condenser, C_1, differed from 90 deg. could be determined. Tests were carried out on this arrangement for frequencies between 9 and 2,000, and it was found that the variation in capacity in the case of some substances was only dependent to a slight extent on the frequency, while in other cases the variation was considerable. Sometimes the phase difference also depended on the voltage used, but not always. These researches are being continued.

For measurements such as those mentioned above, resistances free from capacity and self-induction are very desirable. For this reason researches were undertaken on various types of liquid resistances. Numerous solutions were tested and some were found which gave satisfactory results.

Earlier tests which were undertaken on the increase of resistance of single layer coils with the frequency were extended during the year to coils with two and more layers. The interdependence of resistance on the frequency was determined and the results of tests have already been published. During 1910, for the first time, an ammeter was made for measuring high-frequency currents up to 40 amps. A hot wire air thermometer was used for its standardisation and some tests on the optical method of current measurement similar to those of Orlich were made with glowing platinum foil. The agreement was satisfactory enough for the purpose.



It has been ascertained as a result of conductivity tests on copper which have extended over a number of years that there is proportionality between the temperature coefficent and electrical conductivity. For example, an approximate formula is $a_{15} \cdot c_{15} =$ a constant, a_{15} being the temperature coefficent, and c_{15} the specific resistance in ohms per mm. cube at 15°C. The mean value for the constant for all types of copper tested at the Reichsanstalt since 1905 is $6{\cdot}7_8 \times 10^{-5}$. The same relations also apply to aluminium and iron, the constant being different in each case.

Some experiments were made to determine the amount of water absorbed by certain insulating oils and in the course of these researches it was found that the product termed commercially "transformer oil" absorbs but slightly more water than petroleum. The absorption of water at 18°C is for paraffin oil 0·003 per cent., for petroleum 0·005 per cent., and for benzol 0·05 per cent.

As a continuation of the experiments on fuses mentioned in last year's report, researches were made on the influence of high-voltage and the filling material. Silver wires 0·1 mm. in diameter and 150 mm. long were stretched through 15 mm. glass tubes and 200 mm. long, the tubes being filled with dry sand. A current density of 4 amps. per sq. in. was used, the mean temperature of the wire being then 230°C. A number of these fuses were tested with a current of 4 amps. and others with 2 amps. the frequency being 50 in each case. Tinfoil was pasted round the glass tube and an alternating-current pressure of 4,800 volts was applied between the tinfoil and the fuse wire. In these two cases an increase of resistance of the fuse was noticed, the increase being very rapid in the case of the higher currents and amounting to as much as twice the original amount. These wires fused in 10 days. In the case of a current of 2 amps. increase and fusion were less rapid. This increase is attributed to the powdering of the wire. In the case of fuses tested at a pressure of 600 volts with a current of 4 amps., the resistance increased from 10 to 20 per cent. in eight months and fusion did not occur. Overloading fuse wires causes less corrosion when they are enclosed than when free to the atmosphere. In the latter case the convection seems to cause oxidation.

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SOME OF THE EFFECTS OF COMPETITION.

In the days when the so-called Manchester School of politics flourished, ideas which now seem a little crude found ready acceptance. The pure and undiluted doctrine, as then preached, has almost passed into oblivion, and is now generally associated with rather elderly people of a somewhat philosophic turn of mind. In saying this, we do not mean to pour contempt upon it; it had its virtues and could be supported by many arguments, which were often a little embarrassing to the controversialist, but none the less it represented at best a partial view of things, no longer compassing the whole field of a more highly evolved state of commercial activity.

Perhaps one of its most cogent arguments was directed to prove that under conditions of unfettered competition everything would be for the best. Much that has lately happened, quite apart from acute political controversy, seems to show that it is now recognised that competition without compromise is neither in the interest of buyer nor seller, of consumer nor producer. A case in point may be found in the cessation of cut-throat rivalry between the various agencies competing for the traffic of London, a commercial interest which seems likely to be profitable to all concerned if due regard is had to the public weal in any scheme that may be evolved for the purpose of suppressing useless competition. The same policy is being followed by the railway companies of the kingdom, with results which seem likely to be beneficial.

In the electrical world complaints are frequently heard that there are too many in the business, but no remedy has

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been propounded, and none seems likely, short of the survival of the fittest. Still it is not with this phase of the problem that we are at the moment proposing to deal. Quite apart from this there has been some acute and bitter controversy between electrical and gas engineers. We hope we have at no time done anything to embitter the relations between us and them; they have undoubtedly as much right to conduct their business in their own way as we have to conduct ours.

Still it is pleasant to be told that the effect of this competition between the gas and electrical interests is all for our good. In making this seemingly paradoxical assertion, we are going on the assumption that the state of affairs in Germany is similar to that in this country. The electrical fraternity in Germany owes a debt to Herr DETTMAR, who contributes from time to time to the technical Press a review of the state of progress that is being made in that country. His articles are not altogether suitable for reproduction in our columns, seeing that they appeal to facts, details and statistics that do not apply to Great Britain. It seems unfortunate that we cannot produce somebody who could do the same for us, and devote a certain amount of leisure time to a painstaking analysis of the masses of figures that are to be found in official and technical publications and that might form the raw material for much edifying discourse on the progress that is being actually made, its causes and effects, together with useful hints that might help to encourage the optimist and confound the pessimist.

Herr DETTMAR's latest thesis seems to be to the effect hat greater development of electricity supply has taken lace in those towns in which there is competition from the as works than in those in which no gas is supplied. This ems at first a rather startling assertion. None the less, he alyses facts by subdividing the towns in Germany cording to these two categories, and, further, according to eir populations. Undoubtedly the towns in which there no gas supply but which have an electricity supply are the whole small, but there appear to be nearly 100 of ese in all. The comparison is made on the basis of watts r head of the population, and the state of affairs in 1900 contrasted with that in 1909. It seems that in these all places, none of which has a population exceeding 000, a good start had been made in 1900 on the watt-sis, all the stations included in the statistics having been work for at least two years (this proviso being made to clude mere chance growths of a few weeks). The progress ich was made between 1900 and 1909 was gratifying, the its per head of the population having nearly doubled on average. On the other hand, in the towns in which works already existed, amounting in all as far as central tions are concerned to 72, a much less hopeful start s made on the watt-basis, especially in the bigger towns h populations over 50,000. But here the progress has n on a much larger scale, and in the towns with a popula- of more than 100,000 the output per head of the popu- on has increased more than four-fold. This does not, ourse, necessarily mean that the output per head is at ent much greater in the one case than in the other; in fact, the figures in the two cases are very similar; but the differential coefficient, so to speak, or in other words, the rate of progress, differs, and this leads us to think that it will continue to vary, probably in a way that should be encouraging to the electrical engineer. Herr DETTMAR is unable to give any very precise answer to those who ask what has been the effect of electrical competition on the gas interests. He says that their statistics are often vague and lacking in precision; but on the whole there seems reason to think that their output may in some cases have increased slightly, if estimated on the same basis; but in others there has probably been a small loss. In so far as our own interests are concerned, it is not perhaps difficult to understand some of the causes that have contributed to electrical progress in the larger towns, where gas is already in the field. And the absence of these causes in the smaller towns, such as greater competition with one's neighbour and perhaps a higher standard of comfort, may explain why in the country districts progress is slower, though the start promises better things. Undoubtedly, other reasons besides the mere existence of gasworks in a place could be adduced to show why a larger field is likely to be more profitable than a more confined sphere. But probably sufficient has been said to enable us to see that the pioneer work which was done by the gas engineers in ousting paraffin lamps and candles has not been without its beneficial effects on electricity supply.

REVIEWS.

(Copies of the undermentioned works can be had from THE ELECTRICIAN Office, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.)

Dynamo Electric Machinery. DIRECT CURRENT MACHINES. 8th edition. By S. SHELDON and E. HAUSMANN. (London: Crosby Lockwood & Son.) Pp. ix. + 328. 12s. net.

The later editions of many works consist simply of reprints of the earlier editions with a few alterations and additions. As a result much matter is still included which deals with practices rendered obsolete, and which would probably not be included in an entirely new work. This failing is only too often noticeable with text books on dynamo-electric machinery, the examples and illustrations of machines being frequently anything but up to date.

It is, therefore, very pleasing to note that the authors have revised their book in a most thorough manner. With the exception of the first two chapters—devoted to electrical and magnetic laws and facts—the book has been entirely rewritten, and practically the whole of the illustrations are new.

In the previous editions chapters were devoted to the design and testing of machines. These have now been omitted. We agree with the authors that the subject of the design of continuous-current machines is too vast to be adequately treated in a book of this type, but think that a small chapter on testing should have been retained, dealing with the more ordinary tests in common use.

The subject matter is divided into nine chapters, the first two of which contain a concise *résumé* of general electrical and magnetic principles, and the electrical and magnetic properties of materials. The third chapter deals with the rotating portion of continuous-current machines, both from the theoretical and practical point of view. The authors have contented themselves with describing modern practice, with the result that ring windings and smooth core armatures are barely mentioned. The fourth chapter is devoted to the field system and the calculations connected therewith. The following chapter deals with armature reaction and commutation. The

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theory of commutation is gone into at very great length. We are surprised to find that the use of auxiliary poles is stated as rather to reduce armature reaction than definitely to assist commutation. As a matter of fact, it can hardly be claimed that the effect of the interpole is materially to reduce armature reaction, for its action is confined to a very small portion of the armature midway between the main poles. The true function of the commutating pole is to provide a correct commutating field in the armature coils undergoing short-circuit. To effect this the M.M.F. on the commutating pole must be such as more than to counterbalance the armature M.M.F. acting at the geometric neutral position.

The two next chapters deal with generators and motors respectively, and contain much up-to-date information. The generator speeds for direct-coupled machines are low compared with English practice. The remaining chapters deal with motor generators, boosters and storage batteries and central station equipment, and call for no especial comment.

The book is to be recommended as a very good text book on continuous-current machines. The information given is reliable and typical of modern practice, and the purely theoretical parts are put forward clearly. Inch units are used, which causes the magnetic calculations to appear unfamiliar to those of us who use the C.G.S. system. A. E. C.

Electricity in the Service of Man. By R. Mullineux Walmsley, D.Sc. Vol. I.—"The History and Principles of Electrical Science." (London: Cassell & Co.) Pp. xv.+828. 7s. 6d. nett.

One hardly knows what to expect on opening a book with such a title. Twenty or thirty years ago the practical applications of electrical science were few, and there existed an enormous field of electrical phenomena and theory, which seemed to have no prospect of practical application or public utility. To-day this is all changed; the pretty-coloured Geissler tubes have developed into the X-ray apparatus, the electromagnetic waves, which appeared to be little more than an elaborate toy for mathematicians, are now among the commonplaces of our everyday life. To whichever branch of electrical science we turn, it can very properly be described as "Electricity in the Service of Man." It is useless trying to give anyone a reasonable idea of the many applications of electrical science without a certain amount of grounding in the fundamental principles involved. The title "Electricity in the Service of Man" is, therefore, broad enough to include practically anything which the author cares to put into it, so that we are not surprised to find that the volume under review deals with almost everything electrical, including lightning, which can hardly yet be said to have been impressed into "the service of man."

The book is, of course, a new edition of an old and well-known work. It has been very largely rewritten to bring it into line with our present knowledge of the subject. This has increased the bulk so greatly that it has been found necessary to divide the book into two volumes, of which that under review is the first. It deals with the history and principles of electrical science while Volume II. will deal with practical applications and their technical details. The present volume contains over 800 pages and 800 illustrations. After a brief historical survey of the subject down to the beginning of the last century, the first chapter deals with the elementary principles of magnetism and then, somewhat fully, with terrestrial magnetism. Then follows electrostatics, including influence machines, electrophori, Leyden jars, &c. The succeeding chapters deal with primary batteries, thermo-couples, Ohm's law, electrolytic action, secondary cells, heating effects of the current, glow lamps, arc lamps, magnetic properties of iron, electromagnets, instruments and simple measurements, telegraphy and telephony, transformers and induction coils, dynamos, motors, alternators, converters (under the somewhat unusual name of kinetic transformers), sparks, vacuum tubes, and their applications. The book concludes with a chapter on more advanced measurements and instruments. We are pleased to see that the chapters on such subjects as lamps and magnetic properties of iron are quite up to date, and give the reader a good idea of the recent advances made in these branches. One is surprised not to find among the applications of the electromagnet a description and illustration of the lifting magnets so much used in iron works at the present day, but this is probably reserved for the second volume.

One could hardly expect a book of this nature and size to be entirely free from imperfections. We notice that the description of the single-pivot galvanometer on page 721 seems to refer to a figure which is not reproduced, as the reference letters are not to be found on the figures given. All curves should have clearly marked on them the units in which the quantities are plotted. On page 756 is a sheet of curves giving the resistances of different metals at various temperatures. It is pretty obvious that the temperatures are in degrees centigrade, and a reference to the letterpress confirms this. No clue is given to the units in which the resistance is measured, but by referring to copper we find that at 0°C. its specific resistance is 1,500, from which one concludes that it is given in absolute units. This should be marked on the curve and not left to calculation or inference.

For the book as a whole, however, we have nothing but praise. It is a storehouse of well-arranged and clearly expressed information and can be confidently recommended.

G. W. O. Howe.

L'Établissement des Lignes Aériennes de Transport d'Énergie Électrique. By Octave Cahen. (Paris: H. Dunod & E. Pinat.) Pp. 308. Fr. 9.

This book deals with the preliminary matters inseparable from all transmission schemes with aerial conductors. Naturally the interpretation of the legal enactments in this province come in for the greatest attention, but the technical requirements are also carefully treated. Indeed, this is the only part of the book likely to be of immediate interest to English readers, unless they are inclined, in a spirit of sympathy, to examine the voluminous restrictions that hedge about the transmission problem in France. The original laws, with their subsequent modifications and supplementary decrees, dating from 1888-1910, make a very formidable list, and their detailed recital takes up nearly 200 pages of an appendix.

Legislation affecting electric lines in France is mainly concerned with those transmitting power in bulk at high pressures, the others being more leniently dealt with. The author assumes that the pressure and system, number of conductors, &c., have already been settled, and that, until constructional work is actually commenced, the engineer will be engaged in co-ordinating the legal and engineering conditions so as to secure the best results.

The author very properly insists on the importance of the preliminary setting out or "piquetage" of the line, so as to avoid contravention of any of the State or local regulations, and to ensure that when completed it will be a success as regards its capital cost, working and maintenance. The engineer who has charge of the survey of a line of any length must be familiar with the materials and construction necessary, the laws controlling national and other roads and the procedure to be followed when the line crosses private property. "Piquetage" being, as the author says, the corner stone of the transmission problem, it is essential to apply in its service an expert knowledge of law and engineering and the gift of tact.

The technical side of the survey, dealing with alignments, curves, angles, crossings of railways and telegraph lines, lopping of trees, &c., is a subject of considerable interest, and furnishes some guidance to practice elsewhere than in France. The book as a whole, however, is scarcely one to be bought by an English engineer, unless he is of distinctly altruistic temperament in his professional outlook. J. R. D.

Beanspruchung und Durchhang von Freileitungen. By Roger Weil. (Berlin, 1910: Julius Springer.) Pp. 106. M. 4.

This work is a very instructive and able mathematical treatise on the calculation of the strains and sags of aerial conductors, and will be found of great use by all who have anything to do with overhead line construction. It contains 12 chapters. In the first the author discusses the governing factors of the problem and shows that the starting-point for all calculations is the consideration of the maximum strain in relation to its

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change and that of the sag with temperature and extraneous loads, such as ice, snow and wind pressure. The fundamental equations are given in Chapter II.; the most important laws on maximum strain and maximum sag are investigated in Chapter III., and in Chapter IV. the fundamental equations and their practical application are carefully discussed and explained.

In this chapter, on page 18, we note what is evidently a slip, or printer's error, in the mathematical investigation of the existence of a point of inflection in the curve given by equation (9') on page 14. The equation on page 18 reads

$$fu''(f \pm n) = 2a_9 - \frac{2b_9}{(f \pm n)^3} = 2a_9\left[1 - \frac{b_9}{a_5 f^3 + 3fn^2 \pm (3f_x^2 + n^3)}\right].$$

The coefficient a_5 in the denominator of the fraction in the right-hand of the equation should be a_9—not a_5—and should multiply all the other terms of this fraction, thus:

$$= 2a_9\left[1 - \frac{b_9}{a_9[(f^3 + 3fn^2) \pm (3f^2n + n^3)]}\right].$$

In Chapter V. numerical examples are completely worked out by the aid of the formulæ given in the preceding chapters. It contains some very interesting results which are also embodied in curves.

The author shows in Chapter VI. how to determine the maximum sags for the most important conductors for spans up to 300 metres (328 ft.) An important case is then considered separately in Chapter VII., namely, the maximum sag of a steel wire or rope from which a cable is suspended.

A simple graphical method of solution of the general problem is next given in Chapter VIII., and the application of this graphical method to hard copper wires is given in Chapter IX. which also includes several instructive curves. The influence of the points of support at different heights are considered in Chapter X., and the case of wires suspended between flexible points of support are investigated in Chapter XI. In the final chapter the numerical and graphical methods are then compared. Two tables of curves are also given at the end of the book. Table I. gives the maximum sags for copper and aluminium wires for all spans up to 300 metres, based upon the rules (Normalien) of the Verein deutscher Ingenieure, while Table II., to which is attached a so-called "cover" table on tracing paper, enables the values of the strain and sag for any particular temperature without accessory load to be ascertained for a copper wire, and the method of using this table is explained by means of an example.

The book contains a large amount of useful information, and the author has carried out his investigations into the problem with considerable skill and success. It deserves close study.

H. G. S.

The Slide Rule. A Practical Manual. By C. M. Pickworth. 12th edition. (London: Whittaker & Co.) Pp. 118. 2s. net.

In this edition of the "Slide Rule" six pages have been added in an appendix on new slide rules, but otherwise the book remains the same as before; so that the new edition is practically a reprint. The book may be recommended to students and others who are anxious for help in using the slide rule and wish to know more of its possibilities. It evidently meets a demand, judging by the large number of editions which seem necessary.

RECENT PHYSICAL RESEARCH.

IX.—THE PRESSURE OF RADIATION.

BY D. OWEN, B.A., B.SC.

§1. When, early in the seventeenth century, Kepler pointed to the pressure of sunlight as the possible cause of the deflection of cometary tails away from the sun, he offered a suggestion that was quite reasonable on the corpuscular theory of light, which was then in vogue. Many efforts were made to put the corpuscular theory on a better footing by establishing experimentally the existence of a force of repulsion by light. De Mairan, the famous observer of the phenomena of auroras, for example, tried such experiments in or about 1754, but without success. Later, the failure of such efforts did duty as an argument against an "emission" theory.

In 1873 Maxwell pointed out, as a deduction from his electromagnetic theory, that light waves should exert a pressure upon objects on which they fall, in amount equal to the energy density, or radiant energy in unit volume. A few years later Bartoli deduced from entirely new considerations the existence of such a pressure, and started an idea which has proved very fruitful in the province of thermodynamic theory. However, many years were permitted to elapse before experimental proof of the reality of such forces was secured. Crooke's researches on the radiometer between 1873 and 1877 had revealed the play of considerable forces, but, as Tait and others showed, these are only indirectly caused by the incident light, being the result of molecular bombardment by the surrounding gas on unequally heated surfaces. This molecular action may be thousands of times in excess of the pressure of the impinging light as calculated from the energy density. The radiometer effect and the influence of convection currents together constitute a gas action which in the earlier experiments effectually barred the way to any demonstration of a light pressure. In 1900 Prof. Lebedew, of Moscow, announced that he had succeeded in isolating and measuring this force. Nichols and Hull, in America, quickly followed, securing a remarkable degree of agreement of observation with theory. Prof. Poynting, in this country, has conducted a series of beautiful experiments on the tangential forces due to oblique radiation. The existence of a radiation pressure has thus been firmly established.

It would now appear that this result may be generalised: that in wave motion of every description there is a pressure normal to the wave-front equal in value to the energy density. In the case of sound waves, Altberg, working in Lebedew's laboratory, has quantitatively verified this; and Prof. R. W. Wood has constructed a "wind-mill" driven by sound waves.

To return to ether waves. The phenomenon under consideration has opened up several avenues of progress. It is the foundation of a new and important branch of thermodynamic theory—*the thermodynamics of radiation*—with which are associated the names of Bartoli, Boltzmann, Wien and others. It has formed the basis of some very interesting astronomical applications, mainly at the hands of Arrhenius and Poynting. It leads to some considerations on the interaction of matter and ether which are of interest at the present moment, when the foundations of the Newtonian mechanics are in question and the principle of relativity is bidding for the scientific ear.

Interpretation of Radiation Pressure.

§2. The existence of a pressure is an obvious consequence of an emission (or corpuscular) method of propagation of energy. It is of interest to see how the pressure arises in wave propagation.

(i) *Light*, *heat* and *electrical waves* are, on Maxwell's electromagnetic theory, all of the same type. In the plane of the wave-front are tubes of electric and of magnetic force. Such tubes behave as though in a state of longitudinal tension, whilst they exert a lateral repulsion on adjacent tubes of the same sign. These lateral pressures are represented, in terms of the magnetic force H and the electric force F, by the well-known expression $\mu H^2/8\pi$ and $KF^2/8\pi$. They combine to form a resultant pressure which is equal to the energy density in the medium. Maxwell ("Electricity and Magnetism," Vol. II.) deduces his pressure from these considerations, and proceeds to a calculation of the pressure on a square foot of the earth's surface due to strong sunlight, the pressure assigned being the energy in 1 cubic ft. of sunlight.

Sir J. J. Thomson regards the force, when the light is incident on a reflecting surface, in terms of the induced electric currents in the surface. A perfect reflector is a perfect conductor. The alternations of magnetic force cause induced currents confined to the surface layer of the conductor. These currents are in direction perpendicular to the tubes of magnetic force in the incident wave-front. The usual laws of mechanical force on a conductor

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carrying a current in a magnetic field will apply and the conducting surface will be repelled. When the medium transmits the light the force is reversed after passage over half a wave-length. Integrated over a distance of many wave-lengths, the resultant effect would be zero. The force will thus be a maximum for infinite conductivity, dying down as the conductivity, and therefore reflecting power of the medium falls off.

(ii) *Sound Waves.*—If we consider a mass of air contained in a cylinder in which a piston fits, it is easy to see that the confined air behaves very differently from an ordinary spiral spring. Even if the changes are at constant temperature, the application of Boyle's law shows that the increase of pressure for a given displacement of the piston inwards is appreciably greater than the decrease due to the same movement outwards. Still more must this be the case when the action is adiabatic, when motion inwards causes a rise, motion outwards a fall, of temperature. Thus, in a sound wave in a gas, since the gas pressure rises a little more above the normal in the compression half-period than it falls below in the rarefaction half, there is clearly an average pressure forwards on any surface on which the sound falls. Strictly speaking, the assumption of simple harmonic particle motion here made is not quite justifiable; Lord Rayleigh has shown, however, that in the case of isothermal change the forward pressure does exist in amount equal to the energy density in the wave.

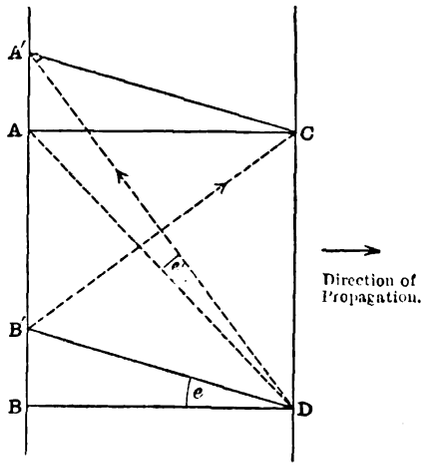

Fig. 1.—Pressure arising in Shear Waves.

(iii) *Transverse Waves in an Elastic Solid.*—Prof. Poynting has indicated a method of interpreting the forward pressure in the case where, for example, energy is being propagated along rotating steel shafting. During shear there is a force of compression along one axis of the shear and an equal force of tension along the second axis, which is perpendicular to the first. But these axes do not make equal angles on either side of the perpendicular to the planes of shear—*i.e.*, with the direction of propagation of the shear. If e denotes the angle of shear, one shear axis, that of compression, is turned by the amount $e/2$ nearer the normal; the other along which there is tension is turned by the same amount away from the normal. The effect is evidently to destroy the exact balance of these forces, yielding a slight excess of forward push over backward pull; and this difference works out to be equal to the energy-density in the shafting. In the diagram (Fig. 1) ABCD represents a section parallel to the direction of propagation. Particles at A and B are displaced to A′ and B′ in the plane of shear, whilst the disturbance is passing over the length AC. The compression axis CB′ makes with CA the angle $\left(45°-\frac{e}{2}\right)$, while the axis of tension DA′ makes the angle $\left(45°+\frac{e}{2}\right)$ with DB. Clearly the resultant is a pressure in the plane through CD in the direction of propagation. Its magnitude proves to be of the value required.

(iv) *Interpretation from the Energy Point of View.*—Larmor has applied the principle of the conservation of energy to the problem, thereby deriving very simply the magnitude of the radiation pressure. This proof, as Poynting has observed, holds for any type of radiation in which the energy density for a given amplitude is proportional to the square of the frequency. This simple law, of course, holds in the case of a single particle of matter moving with simple harmonic motion.

The simplest case to examine is that of a plane-radiating surface emitting plane waves. The surface will experience a pressure of recoil of value equal to the energy density. This may be seen by supposing the surface to move with velocity denoted by v in the direction of propagation of the radiation. Let V denote the wave velocity. The effect of the motion of the source is, in accordance with Doppler's principle, to raise the frequency of the emitted vibrations in the proportion $V/(V-v)$. If, then, E denote the energy density when the source is at rest, the measure of this quantity when the source is moving will be $E \cdot V^2/(V-v)^2$. In one second the source will have moved forward a distance v, and the energy emitted per second per unit area will, therefore, be crowded into the volume $(V-v)$ of the medium, the amount present being thus

$$E \cdot \frac{V^2}{(V-v)^2}(V-v) = E \cdot \frac{V^2}{(V-v)}.$$

When the source is at rest the energy emitted per second is EV. The source thus emits more energy per second when moving than if it were at rest. This implies a back pressure, p, against the source, and we may write

$$p = E \cdot \frac{V^2}{V-v} - EV = E \cdot \frac{Vv}{V-v},$$

which, when $v = 0$ becomes $p = E$.

Experimental Work.

§ 3. Great as the influence of the existence of a light pressure is in extending theory, the order of magnitude of these forces is not such as to make them of sensible importance in terrestrial mechanics. The steps taken by the physicists already named in disentangling these forces from insistent disturbing effects, and submitting them to accurate measurement, are of a high order of interest.

In the case of radiation falling normally on a surface which absorbs it completely, the pressure is equal to the energy per unit volume of the incident radiation. When the surface is totally reflecting, the energy density is doubled by the superposition of the reflected beam upon the incident one, and the pressure is correspondingly doubled. In the former case the pressure caused by full sunlight at the earth's surface amounts to 0·59 milligrams per square metre (or $0·58 \times 10^{-3}$ C.G.S.); for a total reflector it therefore exceeds 1 milligram per square metre. By means of the arc an intensity of perhaps 20 or 40 times that of sunlight can be applied. Such is the order of the forces to be measured.

The methods adopted in the three series of measurements referred to agree in that the light forces were made to act upon delicate vanes set at the end of a horizontal arm, producing a couple which was opposed by the torsional control of a fine suspending fibre.

The arrangements adopted by Lebedew are represented in Figs. 2, 3 and 4.

Two pairs of circular discs of platinum 5 mm. in diameter were mounted, as shown in Fig. 2 (elevation), at the ends of two light rods, these rods being attached perpendicularly to the vertical glass rod HH. The system was suspended by a glass fibre, T, in a glass globe about 20 cm. in diameter. The discs P_1, Q_1 have a thickness of 0·1 mm., and the lower pair, P_2, Q_2, a thickness of 0·02 mm. P_1 and P_2 are polished on both sides, whilst Q_1 and Q_2 are electrolytically coated with platinum black, the depositing current being maintained for times in proportion to the thickness of the plates. M is a mirror used in conjunction with a telescope and scale. The method of illumination of the discs is shown in Fig. 3. Radiation from an electric arc at S falls on a lens, and by the mirrors M and a second lens may be made to converge on either side of the disc A at will, the mirror M being capable of movement to a second position, M′, indicated by the dotted outline.

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In addition to the light pressure on the disc there are the two forces constituting the gas action—namely, the radiometer effect and that arising from convection currents. By the use of very thin discs of metal the radiometer action was very much reduced, since it depends on a difference of temperature between the two faces of the disc. It is always in the same direction as the light pressure; but by comparison of the deflections obtained successively with the thick and thin discs it may be eliminated in the final calculations.

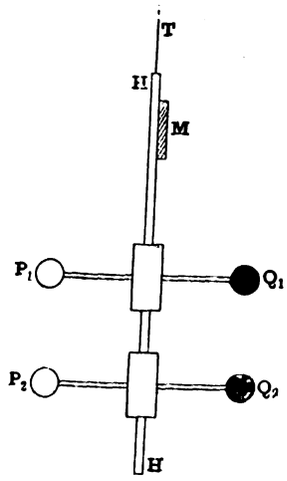

FIG. 2.—SUSPENDED SYSTEM (Lebedew).

The effect of convection was but very small, since the globe was exhausted of air to the utmost extent possible with a Sprengel mercury pump. The direction of the disturbing couple due to convection is, moreover, independent of the side of the disc on to which the beam is directed, the difference of temperature of the two faces being in this respect negligible. The mean of deflections taken with the light, first on one face, then on the other, is thus free from the convection effect.

It is to be observed that the light pressure effect should, according to theory, be practically twice as great for the polished as for the black disc; whilst the rise of temperature in the case of the black disc will be greater than for the polished

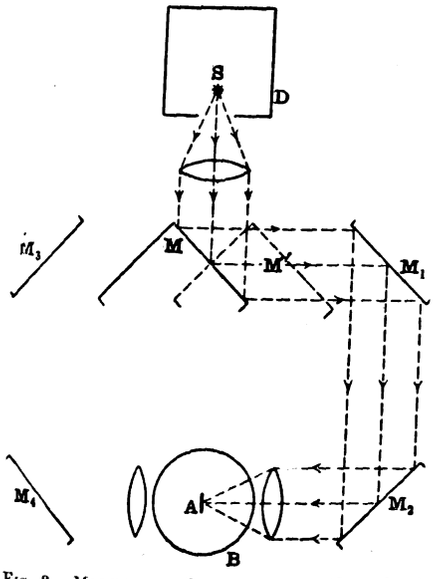

FIG. 3.—METHOD OF ILLUMINATION (Lebedew).

one, and consequently the gas action greater. That the radiometer action was sufficiently annulled was judged from the fact that a polished disc was repelled more strongly than the corresponding blackened one.

The deflections obtained were reduced to the equivalent couples in the usual way, by observation of the times of vibration of the suspended system before and after the addition of a known moment of inertia.

The absolute measure of the intensity of radiation employed was obtained by a simple calorimetric apparatus (*see* Fig. 4). A plate, D, containing an aperture of area equal to that of the discs, was placed in the globe so that the aperture coincided precisely with the position previously occupied by a disc. Behind it is a small copper cube weighing 30 grammes, with one face, C, blackened. In a hole drilled in the cube is embedded the bulb of a thermometer, T, a little mercury being used to ensure conducting contact. The rise of temperature in a given time is obtained when the light is directed on to the cube under the conditions of the main experiments. A simple calculation leads to the required datum. Lebedew was finally able to announce the discovery of a pressure equal, within the limits of error of experiment, to that predicted by Maxwell.

Nichols and Hull's researches involved an exhaustive examination of the nature of gas action. Experiments were made at various pressures of the air surrounding the suspended system. Whilst, as exhaustion proceeds, radiometer action becomes more pronounced, the effect of convection currents is reduced. It is thus possible to pit these disturbing effects against one another. In the apparatus employed by Nichols and Hull a zero resultant effect was found to be most nearly secured when the pressure was about 16 mm. of mercury.

The vanes on which the radiation was received were circular discs of thin glass silvered on one side, the silver film being polished on its exposed side.

The gas action is independent of the face of the disc on which the radiation first falls. The incident rays have already been sifted by the glass walls of the containing vessel, so that in the case where the radiation falls on the unsilvered face of the disc it is transmitted entirely by the glass, and falling on the silver film raises its temperature to the same extent as when the beam is directed first on the silvered face. Thus, when the incident beam meets the silvered face first, the light pressure and the slight outstanding gas action are in the same direction; when the beam falls first on the unsilvered face the light pressure and the gas action are opposed.

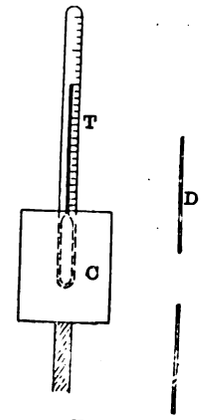

FIG. 4. CALORIMETER (Lebedew).

Furthermore, in order to reduce the gas action to a minimum, the observations were "semi-ballistic." The radiation was allowed to fall upon the vanes for a time (some six seconds) equal to one quarter the period of oscillation of the suspended system, and the throw was observed. The gas action takes a few minutes to develop fully, hence the above procedure.

The authors appear to have secured agreement to within 1 per cent. between the light pressure measured and that deduced from the energy measurements.

A very simple method was subsequently proposed, and carried out by Hull, with the object of eliminating the gas action. It consists in enclosing the vanes within airtight thin-walled glass cells, vane and cell being in rigid connection (*see* Fig. 5). The thin glass walls of the enclosure are practically at the same temperature as the surrounding gas, since,

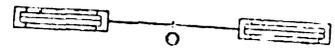

FIG. 5.—HULL'S SUSPENSION.

as already explained, they do not absorb any of the incident radiation. Forces on the vanes are attended by equal reactions on the walls of the containing cells, so that the couple on the suspended system is nil. This device proved highly successful. The light repulsion was measurable at practically any pressure from that of the atmosphere downwards in the containing vessel. Gas action was reduced to 2 per cent. of the light pressure. With this arrangement the pressure due to light may be comparatively easily demonstrated.

Prof. Poynting has initiated a series of experiments suggested by a fresh point of view of the radiation pressure—namely, that in which the radiation is regarded as a stream of

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momentum. Not only is *energy* carried by the undulating medium, but also momentum, the amount of the latter in unit volume being obtained by dividing the energy density by the velocity of propagation. When light is incident on matter, whatever momentum the light loses the matter gains, and *vice versâ*. A simple analysis on the basis of the principle of the conservation of momentum shows that at total reflection, and at refraction, the light forces are normal to the surface for all angles of incidence. At reflection the surface is urged in the direction of the incident light, at refraction the force is in the opposite direction—a pull instead of a push—in the case of passage of the light into a denser medium. When absorption takes place the tangential component of the light stream, as well as the normal component, is destroyed; wherefore the surface experiences a tangential force in addition to the normal one.

These consequences have been verified by Prof. Poynting and Dr. Barlow. Two experiments due to them will be adduced. In the first, two discs of glass, one silvered (S) and the other blackened (B), were fixed vertically at the ends of a

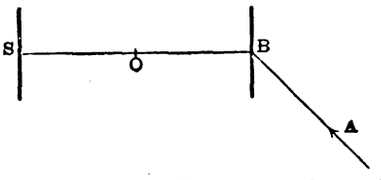

Fig. 6.—Demonstration of Tangential Force (Poynting).

thin horizontal glass rod, the system being hung by a quartz fibre attached at O, as shown in the diagram of Fig. 6. A beam, A, from a Nernst lamp was allowed to fall at an angle of 45 deg. on first one disc then the other. The arrangement is such that normal forces acting uniformly over the discs produce no couple on the system. Radiometric action is thus eliminated—a noteworthy advantage of this disposition of the discs. Any torque observed is, therefore, a measure of the tangential forces present.

The deflection when the stream was directed on B was very much greater than when directed on S. In a particular experiment the torque observed in the former case was 21×10^{-6} cm. dyne, whilst the value calculated from the energy was 22×10^{-6} cm. dyne.

A second experiment, showing the effects at refraction, is indicated in the diagram (in plan) of Fig. 7. Two glass prisms, with refracting angle 34 deg., were mounted at opposite ends of a glass arm 3 cm. long, the system being then hung from a

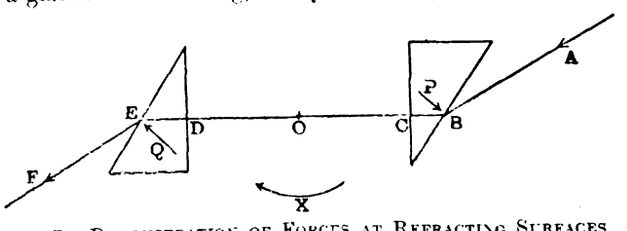

Fig. 7.—Demonstration of Forces at Refracting Surfaces (Poynting).

quartz fibre attached at O. A beam of light, ABCDEF, entered one prism at B, emerging at E from the second prism. The system turned in the direction shown by the arrow X. The forces acting have their points of application at B and E, being normal to the surfaces, and of sign represented by the arrows P and Q. The order of magnitude of the deflections observed was as expected.

Further additions to the list of beautiful experiments on the forces due to light might be made. Simple mention must suffice of a wonderful demonstration by Prof. Lebedew of the pressure on an absorbing gas, a consummation which could hardly have been thought possible in view of the small absorbing power which gases possess.

In a succeeding article it is hoped to put forward an account of the three lines of inquiry which take their origin in the fact of the radiation pressure.

CORRESPONDENCE.

PERMANENT MAGNETS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I have been much interested in reading the article on "Some Alloys for Permanent Magnets" in your issue of Aug. 18. Such information is very badly wanted, because those manufacturers who supply permanent magnet steel (and most of it comes from Germany) keep the processes a close trade secret.

It really is surprising what a long time properly made permanent magnets will retain their magnetism. For example, at the South Head lighthouse, Sydney, New South Wales, there are two De Meritens alternators with permanent magnets. They have been in constant use for over 20 years, and, although I made every inquiry possible, I could not find that the magnets had shown any falling-off during that time, and there was certainly no record of their having been changed.

The discovery of self-excitation sets permanent magnets back, but with the advent of internal-combustion engines, especially petrol engines for motor cars, motor cycles, motor boats and for aviation, the demand for magneto-generators has increased enormously. From being more or less a toy, the magneto is now a most important link in the two most modern methods of rapid transit, and that, if nothing else, shows its reliability.

The demand for permanent steel has grown to such an extent, and the prices asked for it are so high, that it is to be hoped that some of the Sheffield people will soon produce a steel equal to, if not better than, Remy and at a much lower price.

One use for which permanent magnets are suited is for small electric motors. We have now arrived at the point when electricity should be exploited for the "million" and not for the luxurious "few"; but so far as small motors are concerned it will never be done at the present ruling prices. One has only to consider what a sovereign or two will buy in the way of a sewing machine, a bicycle or rifle and compare it with what one gets in the way of a motor and starter.

One of the principal items of expense in small motors, and the part which is likely to break down, is the field winding. The wire is very small and at the best is only thinly insulated whilst the number of turns, especially at the higher voltages, is very high. Then, again, if regulation is attempted by means of a shunt resistance the thing is far from robust.

By using permanent magnets the field coil difficulty disappears at once and speed regulation can be effected by merely shunting more or less of the lines of force through an iron keeper. The writer's Patent Specification, No. 24,023 of 1909 ("Improvements in Direct-Current Motors") may be of interest to those who wish to go into the matter further.

It may be said that permanent magnets will not give the required magnetic flux and will not retain it. This is where the researches by Messrs. Burgess & Aston are so useful, for they show that quite high values of magnetic flux can be obtained. Even when field coils are fitted on small motors, the possible magnetic flux is very much lower than what is customarily used in dynamos and large motors. The magnet poles and yoke, &c., are all so near together on quite small motors that there is excessive leakage if the magnetic flux is forced up to much above what is possible with permanent magnets.

Again, as to permanence of the magnetism, the above-mentioned investigations have shown that a few per cent. of some alloy make a remarkable difference to the coercive force. Besides, as I have already mentioned, permanent magnets made over 20 years ago are still doing duty. In any case it is not likely that any small motor will be subjected to a fraction of the vibrations that a magneto has to put up with on a motor car.

I think there is a field for the small output permanent magnet motor, made by the thousand as are magnetos and sewing machines, &c. As for appearance, cast steel

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permanent magnets should be possible, and possibly it may be found that chilled cast iron may give a sufficiently high flux for the smallest sizes. Such chilled cast-iron can be made into very good permanent magnets. The whole matter strikes me as well worth further investigation.—I am, &c.

Bromley, Aug. 24. E. KILBURN SCOTT.

EFFECT OF ALTERNATING CURRENT ON DRAWN TUNGSTEN WIRE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have noted with interest the editorial in your issue of August 25th on the "Progress of the Metal Filament Lamp," and the abstract of an article by Dr. Monasch on the same subject. In this article and editorial it is stated that "drawn tungsten wires behave with alternating current in the same way as the tantalum filament; the molecular structure changes, and, for practical purposes, with alternating current, this is a very grave defect."

I desire to advise you that this statement is in error so far as it concerns the drawn-wire employed by the British Thomson-Houston Co. in their new drawn-wire Mazda lamps, a description of which appears in the same issue of your paper. This wire is absolutely free from any "off-setting" with alternating current, which is such a characteristic feature of tantalum wire, so that the drawn-wire Mazda lamp gives equally as good life on alternating current as it does on direct current.

We shall be much obliged if you will publish this correction of the statement of Dr. Monasch and your editorial.—We are, &c.,

THE BRITISH THOMSON-HOUSTON CO. (LTD.)

London, Aug. 29. F. W. Willcox.

A NEW HIGH-FREQUENCY GENERATOR.*

BY PROF. A. LARSEN.

Summary.—A method of generating small high-frequency currents is described, a telephone receiver being connected to a microphone by adjustable air-tubes. The periodicity can be varied from 600 to 1,100 per second.

It is a well-known fact that a telephone will emit a sound when it is connected to a microphone through a transformer, as shown in Fig. 1. The vibration is, however, rather unstable; a slight change

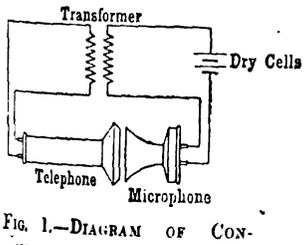

FIG. 1.—DIAGRAM OF CONNECTIONS BETWEEN THE TELEPHONE AND MICROPHONE.

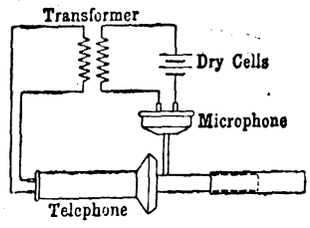

FIG. 2.—DIAGRAM OF A.C. GENERATOR WITH ADJUSTABLE TUBE FOR REGULATING THE FREQUENCY.

in the relative positions alters the pitch of the note considerably. The author had occasion to carry out certain tests with regard to the vibration of the membrane of a telephone receiver, and was surprised to find that these vibrations depend on the columns of air which are set in motion. The idea, therefore, suggested itself that the above-mentioned humming telephone might be controlled by adjusting the volume of air that was set in vibration, and that in this way a simple and cheap form of generator might be made for purposes of measurement. The first form of the apparatus, which was the outcome of this idea, is shown diagrammatically in Fig. 2. An open brass tube is screwed to the mouth of the receiver, and another tube is arranged to slide over the first. A narrow side tube leads, as shown, to the microphone. The microphone is in series with two dry batteries, and acts on the telephone through the medium of an ordinary microphone-transformer. If the open tube is drawn out to a suitable distance, the system is set in vibration, and the frequency can be adjusted within wide limits by altering the length of the tube.

When the frequency was considered as a function of the tube length, and plotted out in the form of a curve, certain peculiarities showed themselves. The curve fell suddenly when the tube length approached a certain definite amount, and then resumed its regular course. This irregularity was at first ascribed to some property of the membranes of the telephone or microphone. Rather thicker membranes were, therefore, substituted for them; the frequency was thereby affected, but the irregularity remained as before, and corresponded to about the same tube lengths as before. The only possible explanation was, therefore, to be found in the action of the air in the hollow space behind the membrane of the telephone. This was found to be the case, for the irregularity disappeared as soon as the space was filled with paraffin oil, and the apparatus in this form was found to be suitable for frequencies of over 1,000 per second. It became evident at once that the air behind the membrane might also be utilised in the working of the apparatus, and this gave rise to the second form of the apparatus shown in Fig. 3. Here on both sides of the receiver sliding tubes of equal lengths are connected up, and the frequency can in this case be varied steadily from 600 to 1,100 per second.

In order to maintain the state of vibration, the forces, exercised through the microphone, and alternately attracting and repelling the membrane of the telephone, must be adjusted to a certain phase. This force is best arranged so that it is one-quarter of a period in front or three-quarters of a period behind the phase of motion of the membrane. Suppose its phase to be other than this. It can then be resolved into two components, of which the one has a phase displacement of a quarter period, and the other has the same phase as the vibration (or it may be the opposite phase). This last component will act as though the air pressure on the membrane had been increased, and in this way the frequency will be somewhat affected.

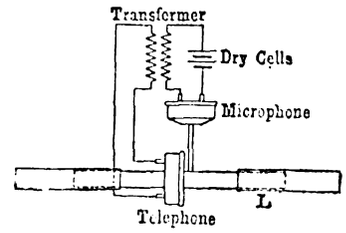

FIG. 3.—A.C. GENERATOR WITH TWO ADJUSTABLE TUBES FOR REGULATING THE FREQUENCY.

The apparatus is intended to be used in connection with the author's "complex compensator," already described in THE ELECTRICIAN. (*See* THE ELECTRICIAN, Vol. LXVI., p. 736.) It is being put on the market by the A.-G. Dansk Telegrafonfabrik of Copenhagen; and while it is cheap, it works well as a generator of small high-frequency currents with frequencies between the limits of 600 and 1,000 per second. The current is best taken from the secondary terminals of the transformer, and then passed through another transformer so as to be reduced to a suitable voltage for measurement purposes. The frequency may at first vary by as much as 1 per cent., but after that it will remain almost entirely constant with small variations amounting to 0·2 per cent. The small sudden variations, which occur quite unavoidably with ordinary high-frequency machines driven by a motor, are quite absent. For measurements on telephone cables the constancy of the frequency, when once adjusted, is of considerable importance; and for all measurements which have to be made outside a laboratory it is very convenient to be able to dispense with the use of accumulators; in the present case it is only necessary to take two dry cells for use in connection with the microphone. The output is, of course, very small, but it is fully sufficient for the purposes in view.

* Abstract of an article in the "Elektrotechnische Zeitschrift."

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from *The Electrician* office, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published under 2s., and 5 per cent. for books published nett. Add 10 per cent. for abroad or for foreign books.]

"Proceedings of the Physical Society of London." Vol. XXIII., Part V. (London, 1911: "The Electrician" Printing & Publishing Co.) 4s. net.

"Cantor Lectures on the Applications of Electric Heating." By Prof. J. A. Fleming, F.R.S. (London, 1911: Royal Society of Arts.) 1s.

"Journal of the Institution of Electrical Engineers," Vol. XLVII. No. 208. (London, 1911: E. & F. N. Spon.) 5s.

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PROF. WALKER'S ADDRESS TO SECTION "B" OF THE BRITISH ASSOCIATION.*

THEORIES OF SOLUTIONS.

Twenty-one years ago the Chemistry Section of the British Association at its meeting in Leeds was the scene of a great discussion on the nature of solutions. To-day, speaking from the honourable position of President of the Section, I conceive I can do no better than indicate the position of the question at the present time. And this appears to me the more appropriate as our science has had this year to mourn the departure of van 't Hoff, the founder of the modern theory of solution, whose name will remain one of the greatest in theoretical chemistry—in time to come, it will, I think, be considered almost the greatest. His ideas are part and parcel of the chemical equipment of every one of us, and we know that whatever form the fundamental conceptions of chemistry may assume, the quantitative idea of osmotic pressure will be to the theory of solution what the quantitative idea of the atom is to chemical composition and properties. For I must emphasise the fact that chemistry is essentially a quantitative science, and no chemical theory, no partial chemical theory even, can be successful unless its character is quantitative.

A general theory of solutions must be applicable to all solutions—to those in which solvent and solute exist in practically mere intermixture, as well to those in which solute and solvent are bound together in what we cannot sharply distinguish from ordinary chemical union. Between these extremes all grades of binding between solvent and solute exist. Herein lies the importance of van 't Hoff's osmotic pressure theory. It applies equally to mixtures of gases, to mixtures of inert liquids, and to mixtures such as those of sulphuric acid and water; and it has the further advantage that so long as the solutions considered are dilute there are simple relations connecting the osmotic pressure with other easily measurable properties of the solutions. It has been unfortunately the custom to oppose the osmotic pressure theory of solution to the hydrate, or more generally the solvate, theory, in which combination between solute and solvent is assumed. The solvate theory is, in the first place, not a general theory, and in the second place it is perfectly compatible with the osmotic pressure theory. It is, in fact, with regard to a general theory of solutions on the same plane as the electrolytic dissociation theory of Arrhenius. This theory of ionisation applies to a certain class of solutions, those, namely, which conduct electricity, and is a welcome and necessary adjunct in accounting for the numerical values of the osmotic pressure found in such solutions. Similarly, the hydrate, or more generally the solvate, theory is applicable only to those solutions in which combination between solvent and solute occurs, and will no doubt in time afford valuable information with regard to the osmotic pressure, especially of concentrated solutions in which the affinity between solvent and solute is most evident. It can tell us nothing about solutions in which one, or both, components is inactive, just as the electrolytic dissociation theory can tell us nothing about solutions which do not conduct electricity.

The great practical advantage bequeathed to chemists by the genius of van 't Hoff is the assimilation of substances in dilute solution to substances in the gaseous state. Here all substances obey the same physical laws, and a secure basis is offered for calculation connecting measurable physical magnitudes, irrespective of the chemical nature of the substances and of the solvents in which they are dissolved, provided only that the solutions are non-electrolytes. If the solutions are electrolytes, the dissociation theory of Arrhenius, developed independently of the osmotic pressure theory of van 't Hoff, gives the necessary complement, and for aqueous solutions offers a simple basis for calculation. Van 't Hoff has given to science the numerically definable conception of osmotic pressure; Arrhenius has contributed the numerically definable conception of coefficient of activity of electrolytes in aqueous solution, or what is now called the degree of ionisation.

Of late there has been a tendency in some thermodynamical quarters to belittle the importance of the conception of osmotic pressure. It is quite true that from the mathematical thermodynamical point of view it may be relegated to a second place, and even dispensed with altogether, for it is thermodynamically related to other magnitudes which can be substituted for it. But it may be questioned if without the conception the cultivators of the thermodynamic method would ever have arrived at the results obtained by van 't Hoff through osmotic pressure. Van 't Hoff was only an amateur of thermodynamics, but the results achieved by him in that field are of lasting importance, and his work and the conception of osmotic pressure have given a great stimulus to the cultivation of thermodynamics to chemistry.

The outstanding practical problem in the domain of electrolytic solutions is to show why the strong electrolytes are not subservient to the same laws as govern weak electrolytes. If we apply the general mass-action law of chemistry to the electrically active and inactive parts of a dissolved substance (the ions and un-ionised molecules) as deduced from the conductivities by the rule of Arrhenius, we find that for a binary substance a certain formula connecting concentration and ionisation should be followed, a formula which we know by the name of Ostwald's dilution law. This law seems to be strictly applicable to solutions of feeble electrolytes, but to solutions of strong electrolytes it is altogether without application. Wherein lies the fundamental difference between these two classes of solutions? Two kinds of explanation may be put forward. First, the ionised proportion may not be given accurately for strong electrolytes by the rule of Arrhenius; or, second, the strong electrolytes do not obey the otherwise general law of active mass, which states that the activity of a substance is proportional to its concentration. The first mode of explanation has been practically abandoned, for other methods of determining ionisation give values for strong electrolytes in sufficient agreement with the values obtained by the method of Arrhenius. The other explanation is that for some reason the law of active mass is, apparently or in reality, not obeyed by some or all of the substances in a solution of a strong electrolyte. An apparent disobedience to the law of mass-action would, for example, be caused by the formation of complexes such as Na_2Cl_2, or Na_2Cl^+ or $NaCl_2^-$ in a solution of sodium chloride. Mere hydration, *e.g.*, the formation of a complex $NaCl, 2H_2O$, would not affect the mass-action law in dilute solution, and the electrolyte would obey the dilution law in solutions of the concentration usually considered. A somewhat similar explanation, which takes into account the properties of the solvent, is that the ionising power of the solvent water undergoes a noticeable change when the concentration of the ions in it increases beyond a certain limit.

I should wish now to draw attention to a point of view which has not, so far as I am aware, been fully considered. To begin with we may put to ourselves the question: Is it the ions in the solution which are abnormal or is it the non-ionised substance? A simple consideration would point at once to it being the non-ionised portion. We have, for example, in acetic acid a substance which behaves normally, so that the ions H^+ and Ac^- as well as the undissociated molecule HAc are normal. Similarly, in ammonium hydroxide the ions NH_4^+ and OH^- as well as the non-ionised NH_3 and NH_4OH all behave normally. When we mix the two solutions there is produced a substance, ammonium acetate, which behaves abnormally. Now, on the assumption that the equilibrium we are dealing with is

$$NH_4^+ + Ac^- \rightleftarrows NH_4Ac,$$

which of these molecular species is abnormal in the relation between its concentration and its activity? Probably not the ions NH_4^+ and Ac^-, because these were found to act normally in the solutions of acetic acid and ammonia. The presumption is rather that the abnormal substance is the undissociated ammonium acetate, for this occurs only in the abnormal acetate solution, and not in the normal acetic acid and ammonia. This view, that it is the non-ionised portion of the electrolyte which exhibits abnormal behaviour and not the ions, has been reached on other grounds by Noyes and others, and I hope in what follows to deduce reasons in its support.

One is apt, because the ions are in general the active constituents of an electrolyte, to lay too much stress on their behaviour in considering the equilibrium in an electrolytic solution. We are justified in attributing the fact that acetic acid is a weak acid, whilst trichloracetic acid is a powerful one, rather to the properties of the un-ionised substances than to the properties of the ions. The divergence of trichloracetic acid from the simple dilution law may similarly be due to an inherent property of the un-ionised acid, a single cause being not improbably at the bottom of both the great tendency to split into ions in water and also the abnormal behaviour towards dilution. However that may be, reasoning goes far to show that the non-ionised portion of the electrolyte is that which is primarily abnormal in its behaviour, the ions acting in every way as normal. The dilution formulæ of Ostwald or of van 't Hoff is essentially equilibrium formulæ. One side of the equilibrium represents the interaction of the ions to form the non-ionised substance, the other side represents the splitting up of the non-ionised substance into ions. To put the whole matter briefly, in the equilibrium between electrolytes agreement will be obtained between theory and experiment whether we use the mass-action law, or an empirical law such as van 't Hoff's dilution formula, provided only that we attribute the abnormality to the non-ionised portion of the electrolyte. Thus

* Abstract of the Address delivered by Prof. J. Walker, D.Sc., F.R.S., at Portsmouth yesterday.

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we can deduce the ordinary formulæ for hydrolysis or for isohydric solutions as readily for abnormal as for normal electrolytes, and find the most satisfactory agreement with experiment in both cases. By this one simple assumption, then, it is possible to find a basis for calculation with abnormal electrolytes. The problem of *why* certain electrolytes should be normal and others abnormal is, of course, in no way touched by this assumption. That is a matter for further investigation and research.

Another great desideratum of the theory of solutions is to find a general basis for the calculation of hydrates. The present position of the theory of hydrates in solution may perhaps most aptly be compared with the theory of electrolytic dissociation for solvents other than water. That hydrates exist in some aqueous solutions is undoubted, but no general rule or method exists for determining what the hydrates are and in what proportions they exist. Similarly, the theory of electrolytic dissociation applied to other than aqueous solutions affords no general means of determining what the ions are and how great is the degree of ionisation. It is only for aqueous solutions that Arrhenius was able to give a practically realisable definition of degree of ionisation, and it is on this definition that the whole effective work on aqueous electrolytes is based; and until some general practically applicable principle of a similar character is attained for hydrates, the work done on that subject, however interesting and important it may be in itself, must necessarily be of an isolated character.

Arrhenius did not originate the doctrine of electrolytic dissociation or free ions: that was enunciated in 1857 by Clausius, and remained relatively barren. What he did was to introduce measurable quantities into the doctrine and to show its simple quantitative applicability to aqueous solutions; immediately it became fertile. And as soon as a simple quantitative principle is developed for hydrates in solution, that doctrine will become fertile also.

It is surely now time that all the irrelevant and intemperate things that have been said and written by supporters of the osmotic pressure and electrolytic dissociation theories on the one hand, and by those of the hydrate theory on the other, should be forgotten. Far from being irreconcilable, the theories are complementary, and workers may, each according to his proclivity, pursue a useful course in following either. One type of mind finds satisfaction in using a handy tool to obtain practical results; another delights only in probing the ultimate nature of the material with which he works. For the progress of science both types are necessary- the man who determines exact atomic weights as well as the man who speculates upon the nature of the atoms. That the want of knowledge as to what the exact nature and mechanism of osmotic pressure is, should prevent accurate experimental work being done on it, or interfere with its use in theoretical reasoning, is equally ridiculous with the proposition that because in the theory of osmotic pressure we have a good quantitative tool for the investigation of solutions, therefore we should abandon altogether the problem of its nature.

The fundamental ideas of a science are the gift to that science of the few great masters; the many journeymen investigators may be trusted to utilise them according to their abilities. Having once given his great principles to the world, van 't Hoff remained practically a spectator of their development; but by his single act he provided generations of chemists with useful and profitable fields for their labour.

THE OSRAM LAMP AND ITS APPLICATIONS.*

BY H. REMANÉ.

My object in this Paper will be to call your attention to several directions in which the Osram lamp can be used with special advantage, to explain these directions and the results which have been obtained in them. I wish also to explain one or two points which are not quite clear regarding the uses and possible uses of the Osram lamp. You must not forget that we manufacturers set great value on the experience obtained in practice with our lamps, as we cannot get the same variety of the conditions during test as is obtained in practice.

In order to get some reliable information on this question, the Deutsche Gasgluhlicht A.G. sent inquiries to about 1,600 electricity supply authorities in towns and villages, asking whether Osram lamps were used for street lighting, and what were their candle-powers. At the time that the material for this lecture was got together 450 replies † had come to hand, which showed that 185 towns were using Osrams for street lighting. In these places 15,180 Osram lamps are used with a total of 743,000 c.p., of which 67 per cent. are for 220 volts. Lamps used for street lighting are tabulated according to candle-power as follows:—

C.P. ...	16	25	32	40	50	70	100	200	300	400	600	1,000
No.	636	3,319	6,615	695	20,325	285	1,379	135	81	113	56	5
Per cent.	1·9	10·0	20·0	2·1	60·0	0·8	4·0	0·4	0·2	0·3	0·1	—

In the following table the Osram lamps used in street lighting are tabulated according to candle-power:—

C.P. ...	16	25	32	40	50	70	100	200	300	400	600	1,000
No. ...	305	1,714	2,213	639	9,354	285	486	57	36	78	15	1
Per cent.	2·0	11·3	14·6	4·2	61·5	1·9	3·2	0·3	0·2	0·5	0·1	—

The majority of Osram lamps (61·5 per cent.) are 50 c.p., and it is satisfactory to note that very few, actually only 2 per cent. of the Osrams used in street lighting, are of 16 c.p. These are evidently lamps in unimportant streets or emergency lights. It might have been expected that a large number of 100 c.p. lamps would be used for street lighting. That this is not the case may be due to several causes, the first and principal one undoubtedly being that the former 16 c.p. glow lamps were simply replaced by Osrams of the same candle-power so that the lighting system should not be any further loaded up. Secondly, incandescent gas lighting is still predominant in the larger towns. It is well known that in Germany at least many of the smaller towns have for years owned their own gasworks, and that with the advent of the gas mantle many other gasworks were laid out in very small towns.

The streets in such towns are generally lighted by gas from the town gasworks. From this we see that the largest towns mostly use gas lighting, and that only small and medium-sized towns and especially small villages have electric street lighting. It is, of course, clear that the demand for light in small villages is not great. In such villages 50 c.p. lamps are used, but greatly improved lighting could be obtained by using lamps of a higher candle-power. The outlook for electric lighting in future is more favourable, especially in connection with the suburbs of rapidly growing towns.

Of the towns which use a large number of Osrams in addition to their gas lighting, Dortmund, with 1,000 Osrams of 50 c.p., and Strassburg, with 3,000 lamps of 32 c.p. and 50 c.p., may be mentioned. In large towns sometimes special conditions cause extensions of the street lighting. For example, in Breslau the boulevards, which are 15 km. (10 miles) in length, are lighted with Osram lamps because the leakage from the gas pipes interferes with the flowers and shrubs. In Breslau 285 70 c.p. and two 200 c.p. lamps are used for boulevard lighting.

Looking at the lamp from the commercial point of view, it is assumed that in a street-lighting scheme carbon filament lamps of 16 c.p. and 25 c.p. have been hitherto used costing 35 pf. (4d.) each. The life of these lamps is taken at 1,000 hours, and the current at 12 pf. (1·2d.) per lamp of 4-watts per candle-power. Taking the efficiency of the 110-volt Osram at 1·1 watt per candle-power and the 220-volt at 1·25 per candle-power, and taking the life of the Osram lamp at the rather low figure of 1,000 hours, and the nett price for the 110-volt lamp at M.1·40 (1s. 5d.), and that of the 220-volt at M.2·30 (2s. 4d.), the following figures for a 2,000 hours run will be obtained:

1. 10 Osrams, 16 c.p.,	Current...	M.42·24	£2	2	3
	Renewals	M.28·00	1	8	0
		M.70·24	£3	10	3
2. 10 Carbon Filament, 16 c.p.,	Current...	M.124·80	£6	4	10
	Renewals	M.7·00	0	7	0
		M.131·80	£6	11	10
3. 10 Osrams, 25 c.p. 220 volts,	Current...	M.74·40	£3	14	5
	Renewals	M.46·00	2	6	0
		M.120·40	£6	0	5
4. 10 Carbon Filament 25 c.p.	Current ...	M.192·00	£9	12	0
	Renewals	M.7·00	0	7	0
		M.199·00	£9	19	0

From the above figures it will be seen that Osram lamps cost so much less than carbon filament lamps that a saving can be made even when carbon filament lamps are replaced by Osrams of double the candle power. For lighting large squares and streets the Osram does not, of course, enter into competition with carbon filament lamps, but Osrams from 100 c.p. to 1,000 c.p. compete with small and medium sized arc lamps.

When I gave a lecture at a conference of German electrical engineers in Erfurt two years ago on the possibility of replacing arc lamps with high candle-power Osram lamps, doubts were expressed whether high candle-power Osrams were really as economical as my figures represented them to be, and it was contended that high candle metal

* Abstract of a Paper read before the Schweizerische Elektrotechnische Verein.

† Up to the time of printing 1,290 replies were received, showing that Osrams are employed in 484 localities. The total number in use is 33,643, with a total of 1,640,000 H.K., about 50 per cent. of the lamps working on 220 volts.

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filament lamps could never replace arc lamps. Time has proved that these doubts were not justified, and were I to give you figures of the number of high candle-power lamps which have been used since that time you would be astonished. For business reasons it is, however, out of the question for me to give such figures.

In order to give some idea of the results obtained by replacing arc lamps by high candle-power Osrams, I have taken railway installations as examples, owing to the fact that such installations are very compact and suitable for obtaining such data. The Prussian Railway department, which generally wires its own premises, has changed the lighting of many of its railway stations, and whenever it has been considered suitable or likely to be a change for the better has replaced arc lamps. The railway department hold that, apart from the question of economy, better distribution of light can be obtained than with arc lamps, and that as the number of points is greater when Osrams are used, great differences of light and shade such as exist with arc lamps are avoided.

In addition to this, the switches can be arranged in such a manner that lamps can be turned on or off as required. With arc lighting this is not the case, as railway stations are generally lighted with a relatively small number of arc lamps whose candle-power and current consumption are large.

I will give a few data on railway station installations, and especially on the lighting of the Stadtbahnhof Charlottenburg and the Erfurt main line stations.

At the Charlottenburg station the entrances and platforms were lighted by 36 12-ampere alternating-current arc lamps. These were replaced by 86 100 c.p. Osram and four 200 c.p. Osram lamps, the latter high candle-power lamps being erected outside the station and in the booking office. Owing to the larger number of points at which Osrams are installed, the distribution of light shows an enormous improvement.

In order to do away with the carbon filament lamps in front of the train indicator board the two Osrams nearest the indicator are brought about a yard out of line with the other lamps. This secures better lighting of the boards. The saving in current amounts to five units per hour, in addition to which the costs of carbons, maintenance, repairs and attendance are also saved, so that a total saving of M.3,000 (£150) per year has been effected in this railway station. Owing to the fact that there is traffic through the station until a very late hour, it is not possible to make very much use of the advantage of extinguishing part of the lights.

The lamps in this station have lasted very well, and no lamp has become defective due to shaking or other mechanical influence. Lamps under the platforms are hung on cords 1 metre (3·3 ft.) long. They carry no outer globe, but are furnished with enamelled reflectors, and are hung at a height of 4 metres (13·2 ft.). The working pressure is 120 volts, and the installation is connected with the alternating-current network of the Charlottenburg electricity works. The average life of the lamps is 2,000 hours.

At the Erfurt railway station a total of 192 arc lamps were installed, of which the 91 that lighted the main entrance platforms, stores, generating station, goods department and engine shops have been replaced by Osram lamps. The arc lamps which were replaced had the following current consumptions: 3 at 10 amps., 84 at 6 amps., 4 at 4 amps. The lamps were connected in 22 separate series circuits of 23 and four lamps, and had a total consumption of 32·12 kw. The 91 arc lamps in question were replaced by Osrams as below: 89 at 50 c.p., 70 at 100 c.p., 20 at 200 c.p., 1 at 400 c.p. All these lamps are for 220 volts and consume a total of 16 kw. The saving effected was, therefore, 16·12 kw., or about 50 per cent. The total candle-power of the arc lamps was about 28,000, while that of the Osram is only 15,850. One would imagine from these figures that the illumination was considerably less and not so good as before. Actually quite the contrary is the case, as owing to the larger number of points and to the fact that it was possible to hang the lamps lower than would have been possible with arc lamps a much more even distribution of light has been obtained.

The switches controlling the different lamps on the platforms, staircases, &c., are all fixed on a central control board in charge of an attendant who operates them according to the instructions he receives. When a platform is empty a large proportion of the lamps is turned out, and before the platform gates are opened to the public the attendant again switches the lamps on, extinguishing them after the departure of the train. On the platforms and in the sheds the lamps are installed as in the Charlottenburg station. For lighting the goods department lamps are hung on span wires fastened to poles. The current carrying wires are arranged at the sides of the span wire.

That Osram lamps are suitable for use in places where there is vibration is also demonstrated by the experience gained in the Grafin Laura Colliery, near Konigshütte. In the machine rooms and surface workings 32 c.p., 50 c.p., and 100 c.p. 100-volt Osrams are in use. In the underground workings where the lamps hang low small transformers are connected with the main power cables. These transformers formerly each fed 10 carbon filament lamps of 16 c.p., the pressure being 130 volts. These lamps have been replaced by 30 Osrams of 16 c.p. at 70 volts. These lamps are similar to the 25 c.p. 110-volt or the 32 c.p. 220-volt types. About 400 of these lamps are in use altogether, and in spite of the fact that many of them are wilfully smashed an average life of 1,700 hours is obtained. Lives of 3,000 or 4,000 hours are by no means rare with the 100 c.p. lamps. Lately 16 c.p. 135-volt lamps have been successfully used the life of which averages 1,200 hours. When one takes into account the enormous amount of vibration to which lamps are exposed in colliery work and in places which are exposed, it is clear that the extreme sensitiveness which is attributed to one-watt lamps in general has very little effect upon their life.

THE TREATMENT OF SULPHATED STORAGE CELLS.*

BY G. A. PERLEY.

A few very unsatisfactory methods of removing the sulphate have been suggested, including scraping with a wire brush, prolonged charging at a low rate which, though ultimately successful, is very expensive, and charging at a high rate which decreases the capacity of the cell.

The author made a number of tests of chemical methods on 12 badly sulphated cells with five plates per cell, and a rated capacity of forty ampere-hours. They had hastily been put out of commission, the acid not being washed out of the pores of the plates. The general methods employed were chemical reduction, electrolytic deposition and reduction, and solvent action. In the first different mixtures of ferrous oxide and caustic soda both hot and cold were tried without success. Bourtraeger's zinc and hydrochloric acid method was next studied. Using 25 per cent. hydrochloric acid it was found complete reduction took place, but weaker acid down to a 10 per cent. solution gave splendid results, though under the best conditions this method only partially cures the sulphating of a spongy lead plate.

Under the second heading lead was deposited under varying conditions from plumbite, fluosilicate, acetate and perchlorate solutions. The deposition was always accompanied by great shedding of the lead sulphate, and the method was therefore ruled out as unsatisfactory.

In the third heading solvents for the lead sulphate such as sodium acetate and sodium tartrate were used without satisfactory results. But during some experiments with ferrous hydroxide in which an excess of sodium hydroxide was used, it was noticed that where the sodium hydroxide came in simultaneous contact with lead and lead sulphate crystals of lead were deposited. One of the sulphated grids was immersed in a solution containing 500 gms. of caustic soda per litre. The sulphate completely disappeared, lead being deposited after an intermediate formation of yellow salt. A concentration of 65 gms. of caustic soda per litre was found to be best.

Since sodium hydroxide has such an effect on lead sulphate when the latter is in contact with metallic lead, attempts were accordingly made to apply this economically in the case of the sulphated storage cell. If a sodium sulphate solution is electrolysed between two sulphated lead grids, the action of the current would tend to form caustic soda at the cathode. The cathode would then react with the caustic soda just as in the experiments previously described. In fact, the reduction of the lead sulphate should be extremely efficient, because the caustic soda would be formed just where it was needed, in the pores of the grid.

At the anode we should expect to get a more efficient oxidation of the lead sulphate to lead peroxide with a sodium sulphate solution than with a sulphuric acid solution. The potential of oxidising agents is higher in a strongly acid solution than in a neutral or alkaline one, and consequently it is easier to oxidise a substance to a higher stage of oxidation, other things being equal, in an alkaline or slightly acid solution than in a strongly acid one. It ought therefore to be possible to regenerate both plates of the battery simultaneously.

Varying concentrations of sodium sulphate were tried and it was found that the best results were obtained with a concentration of 45 gms. per litre.

Before applying these results in the final tests, some experiments were made with caustic soda and sodium carbonate solutions. The electrolysis of a sodium hydroxide solution should give the maximum

* Abstract of an article in the "Journal of Physical Chemistry."

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reduction at the cathode and maximum oxidation at the anode. The difficulty is that it is too efficient. Varying concentrations of sodium hydroxide were tried but the reduction is usually so rapid that grids were formed which began to shed after a little service. The manipulation or control of this solution is not easy unless one has had a great deal of practice. While a sodium hydroxide solution can be made to give good results, it is not so satisfactory as a sodium sulphate solution. Varying concentrations of sodium carbonate were also tested. The results are similar to those with the caustic solutions and for the same reasons.

The experiments with the home-made grids indicated that a concentration of about 45 gms. anhydrous sodium sulphate per litre should be the best; but the difference between temporary grids and the commercial ones was so great that it was not felt at all certain that it was safe to reason from one to the other. Some actual runs were therefore made at various concentrations. In order to obtain a comparison, one cell was charged and discharged a great many times at the normal rate with sulphuric acid as the electrolyte.

While it might be considered rather a feat to bring the cell from zero capacity to nearly 70 per cent. of its initial capacity, the run was not really satisfactory. The cell was in very poor condition after this treatment, as the active material began to disintegrate and to shed. Another cell of the same type was filled with sodium sulphate solution and charged at the normal rate until the reduction was complete. This took about 60 hours. Two lead dummies were placed in the container so that the end plates should be reduced rapidly.

A similar run was made with sodium carbonate as electrolyte instead of sodium sulphate. The reduction required about one-third the number of the ampere-hours that the sodium sulphate solution did, but this apparent advantage is much more than counterbalanced by the deposit being too dense and by the excessive shedding. Only about 53 per cent. of the normal capacity could be obtained. To test the effect of concentration of sodium sulphate, runs were made with a saturated solution and with a solution containing about 91 gms. hydrated sodium sulphate (equivalent to 40 gms. anhydrous salt) per litre.

These cells have been giving these high percentage capacities even since then, so there is no chance for error in regard to the facts. It is of course impossible to say whether these two cells were originally better than the other two cells of the same lot or whether there was some difference in the amount that they were used before they were allowed to spoil. All the plates in all the cells were covered with an apparently uniform shell of white sulphate, and the important thing is that they can be brought back into such good condition. It would not be safe to conclude from the two experiments that the dilute sodium sulphate worked any better than the concentrated solution. About 30 per cent. more ampere-hours were necessary to produce complete reduction in the dilute solution than in the concentrated one and this difference is unquestionably a real one. So far as can be judged, the concentration of the solution is important only to the extent that the reduction takes place more rapidily in the concentrated solution than in the dilute one. The tests so far had all been on cells which had become sulphated under rather unusual conditions. The authors have therefore tested two other wrecks on which they were able to lay their hands. The first was an old and badly buckled cell which was rescued literally from the scrap heap.

This condemned cell was restored so as to give 80 per cent. of its original capacity. Considering the condition it was in, this was as much as anybody could hope for. Another cell was only partially sulphated over the surface but had been allowed to stand discharged for a long time.

Although this cell was apparently in poor condition, it was restored practically to its original state. These illustrations suffice to show the general applicability of the method. When one starts with a battery in commission, the acid should be siphoned off and the solution of sodium sulphate run in. It is desirable, but not necessary, to place dummy plates outside the end plates. The cell can then be charged at the normal rate until the sulphate is entirely reduced. This can be determined by the eye; but if that is inconvenient a charge of 60 hours will probably be satisfactory. The sodium sulphate should then be siphoned off and the grids washed once with water. The amount of sodium sulphate remaining in the plates will have a beneficial rather than a deleterious effect. If the water is then drawn off and the normal battery acid run in, the battery should be as good as new, always supposing that the only damage is due to sulphating. In the authors' tests the current efficiency was only about 80 per cent. which is probably lower than it was when the cell was new, though they have no data on that point.

The cost of restoring a cell is low. For the small 40 ampere-hour cells which have been studied, it has taken less than a kilowatt-hour to bring them back to good condition. That means not more than 5d. per cell for electrical energy. Sodium sulphate is cheap and can of course be used over and over again. While good results can be obtained with almost any concentration of sodium sulphate, the time necessary for reduction is increased when the solution is relatively dilute. On the other hand a saturated solution is objectionable owing to the possible crystallisation. An arbitrary concentration of 200 gms. $Na_2SO_4 \cdot 10\,H_2O$ per litre is therefore recommended. The process as outlined is very efficient and has the further advantage that it introduces no deleterious substances into the cell. Of course, it is absolutely essential that the sodium sulphate shall be pure. The ordinary sodium sulphate always contains chloride. With chlorine in the cell the destruction of the plates is only a matter of time and not of very long time at that.

If the time involved is excessive, as it is likely to be in the case of badly sulphated cells, the cost of time and of electrical energy will exceed the cost of handling. It would be a mistake to make any hard-and-fast rule as to which method to employ; but it seems probable that a prolonged over-charge at half rate in the regular battery acid will suffice for cells which are not badly sulphated. For extreme cases of sulphating the sodium-sulphate method is unquestionably the only one which can be used. A special series of tests would be necessary to determine the relative merits of the two methods for intermediate cases. The general results of this paper are as follows: (1) A badly sulphated cell can be restored by charging at the normal rate in a sodium-sulphate solution. (2) It is desirable, but not necessary, to use leaf dummies outside the end plates. (3) A concentration of about 200 gms. $Na_2SO_4 \cdot 10\,H_2O$ per litre is recommended but the concentration can be varied within very wide limits. (4) It is essential to the life of the cell that the sodium sulphate should meet the requirements as to purity which are laid down for battery acid. (5) A very badly sulphated cell can be restored by about 60 hours charge at normal rate. (6) The cost of electrical energy to restore a 40 ampere-hour cell should not exceed 5d. (7) Since sodium sulphate is not deleterious to the cell, it is not necessary that the sulphate solution should be washed completely out of the pores of the plates. (8) It has been stated by others that a cell can be restored by charging a half of the normal rate for a long time in the regular battery acid. It seems probable that the time and electrical energy required would be excessive in the case of very badly sulphated cells.

THE MAGICIAN DYNAMO FOR CAR LIGHTING.

The problem of securing a satisfactory system of motor-car lighting is by no means a new one, and various devices have been introduced from time to time in order to deal with it. One of the chief difficulties to be overcome is the inevitable speed variation of the engine and, therefore, of the dynamo. Of course, the simplest electrical method is to refrain from using a dynamo at all and merely to put in accumulators which can be charged at intervals. The drawbacks of this method are obvious, and the suggestion is hardly practical, at all events so far as vehicles such as the taxi-cab are concerned; for anything above a low efficiency a dynamo must be used.

An ingenious method of overcoming the speed variation difficulty has been adopted in the "Magician" dynamo. The machine consists of a shunt-wound generator whose armature can be driven by the car engine by any convenient method. The special feature of the machine is that its field magnets are capable of rotation through a fraction of a whole revolution. Moreover, the brushes are attached to the field magnets so that they also rotate at the same time. The commutator is L-shaped in section, the brushes being in contact with the horizontal portion. Pressing against the vertical portion is a third brush which is connected to one end of the shunt winding, the other end being connected to one of the first-mentioned brushes. It is obvious that the E.M.F. generated by the dynamo will now depend not only on the speed but also on the position of what may be called the third brush with relation to the others, since the magnitude of the exciting current depends on this position. Attached to the fixed framework is a C spring of ribbon steel (*a* in Fig. 1). This carries a copper contact piece of Δ section and about an inch long (*b*). Attached to the framework of the field magnets is a grooved roller (*c*), whose two halves are, however, insulated from each other in a direction perpendicular to their axes. Hence, when the field magnets move so as to bring the roller into contact with the Δ-shaped copper the two halves are connected together electrically, and the device, therefore, acts as an automatic switch. This switch is in series with the main circuit. If the machine is at rest, the lamps are supplied by the accumulators alone, because normally the automatic switch is open. Directly it is started the fields are excited, and there exists a tendency for them to be dragged round with the armature owing to the magnetic torque. They are, however, prevented from moving at once by a spring. Ultimately, the torque exceeds the tension of

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the spring, and the magnets move round through a small angle, closing the automatic switch. It will be observed that the instant when this occurs depends upon the value of the torque; this latter depends upon the strength of the magnetic field, and consequently upon the position of the third brush. Hence, by adjusting the position of this brush the speed and E.M.F. at which the dynamo shall be cut in or out can be nicely determined. The third brush, it may be mentioned, is carried on a clamping sheave. If, now, the speed increases, the tendency is for the E.M.F. to rise; this increases the field current, and thereby raises the torque. The result is that the field magnets move a little further round, thus altering the relative posi-

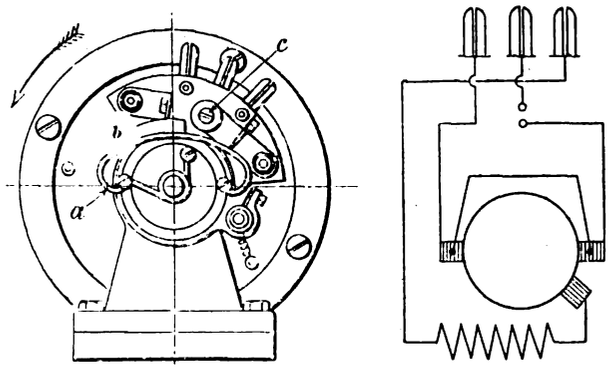

FIG. 1.—GENERAL ARRANGEMENT OF DYNAMO.

tions of the two field brushes, thereby decreasing the difference of potential across the field, reducing the excitation and bringing the E.M.F. back again to its original value. In this way the E.M.F. can be kept constant over a very large speed range. In an actual demonstration which we witnessed the dynamo cut in at 800 revs. per min., and from that speed to 2,100 revs. per min. there was not more than a 5 per cent. variation as indicated by the voltmeter, the lamps and accumulators being in parallel. Directly the speed fell to 800 revolutions again the dynamo cut out automatically, thus avoiding any discharge from the cells through the armature fields.

The behaviour of the machine when short-circuited, or when con-

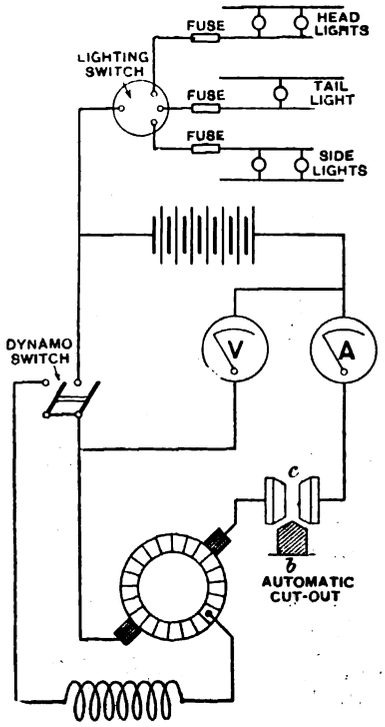

FIG. 2.—DIAGRAM OF CONNECTIONS.

nected up to the cells the wrong way, is particularly interesting. When short-circuited the fields are rocked back by the spring and the automatic cut-out opened; this allows the field to build up again, the magnets are once more dragged round and the dynamo cut in. If the short-circuit still exists this operation is repeated. The result is a violent knocking noise as the magnets oscillate backwards and forwards, and however ignorant a man might be he could not remain unaware that something was wrong.

If the dynamo is connected wrongly to the cells the magnets rock back, and thereby cut the dynamo out. Almost immediately, however, the direction of the E.M.F. in the armature is reversed, the field builds up and the machine is cut in again, this time, of course, with opposite polarity. It would, therefore, seem that the system is not only self-regulating, but also foolproof. Fig. 2 is a diagram of connections.

The "Magician" dynamo is supplied by United Motor Industries (Ltd.), 45-46, Poland-street, London, W.

THE SCIENCE AND OTHER SECTIONS AT SHEPHERD'S BUSH EXHIBITION.

The Science Section, to which we referred in our issue of May 19th, in connection with the opening of the Coronation Exhibition at Shepherd's Bush, we regret to find has not come up to expectations. Demonstrations of electrical apparatus are being given three times daily, at noon, 3 p.m. and 6 p.m., but do not attract a great deal of attention, being of too technical a nature to be understood by the average audience. We must confess, also, that the exhibits of apparatus are somewhat disappointing.

As regards the demonstrations, three methods of ascertaining the temperature in a furnace are shown, viz., a thermo-junction in the furnace, Féry's spiral pyrometer, and the ordinary radiation pyrometer. The stroboscopic method of ascertaining the speed of a revolving shaft by means of a vibrating tuning fork is also demonstrated, whilst Dr. Herbert Smith's refractometer and some apparatus for showing induced reflected waves in a conductor complete the list of apparatus shown in operation. Other experimental apparatus had been promised, but is not now likely to arrive.

The two Marconi stations, one equipped with typical land apparatus and the other for marine work, have aroused much interest, as visitors can witness the process of sending messages between the two stations, which are situated at the ends of one of the halls in the gallery from Uxbridge-road to Wood-lane.

Mention was made in our previous article of some of the electrical apparatus that is to be seen, and little need be added to what we then said. It may, however, be of interest to draw attention to the historic apparatus which has been loaned by King's College. This comprises lodestone used by Faraday, experimental coils of Henry, Wheatstone's rotating mirrors for measuring the velocity of electric waves along conductors, his electromagnetic chronograph and one of his resistance boxes, the original Wheatstone bridge, Dr. John Hopkinson's earliest form of electricity supply meter, one of Clerk Maxwell's models, and the original battery of Daniell.

Messrs. A. C. Cossor exhibit a number of vacuum tubes to illustrate the evolution of the present heavy-discharge X-ray tube from a Crooke's tube; whilst apparatus to illustrate the development of electric valves for rectifying high-tension alternating currents is shown by Sir Oliver Lodge, F.R.S.

Adjacent to the Science Section, the London County Council exhibit one of their electric cars and a section of the conduit. A model is also shown of the slot grip brake used on the Highgate Hill section of the tramway system; in this brake two blocks operate respectively downwards and upwards against the upper and lower surfaces of the special conduit slot rails. The blocks are operated by a helical cam. We also noticed various types of American ploughs.

Attention may be called to the large display which the Gas Companies' Joint Exhibition Committee are making. Much more space has been taken than in previous years, and prominence is given to the various domestic and commercial uses of gas. Visitors, however, are not able to ascertain the effects of a number of gas burners on the atmosphere of a room, since the stand was not enclosed by walls. We noticed that portable gas fittings on the tables, &c., are much in evidence, whilst a special feature is also being made of switches for controlling the lights from a distance. The "Telephos" system (in which a dry cell is used for ignition purposes) and a pneumatic system (in which a special pipe of small bore is installed and the control is by air pressure) are shown. The attempt in the latter system to imitate the popular tumbler switch of electric lighting is proof that gas consumers appreciate the convenience of an electrical installation. Gas fires and gas cookers are, of course, to the fore.

The gas people also have a large display to illustrate the industrial uses of gas. Thus, laundry operations provide an opportunity for bringing gas irons to the notice of the public. A placard near a gas engine which drives some shafting states that gas is the cheapest power for generating electricity for country houses, business premises, theatres, hotels, &c. This is perhaps an admission that the gas industry is giving up hope of ousting electricity.

We regret that the electric supply industry have not a counter-blast to the gas companies' display, but perhaps the electric supply authorities are reserving their energies for the forthcoming Olympia Exhibition.

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COMMERCIAL AND INDUSTRIAL SECTION.

MUNICIPAL, FOREIGN & GENERAL NOTES.

BRITISH NOTES.

Bacup.—The Municipal electricity supply undertaking was inaugurated last week. Electric current in bulk is obtained from Rawtenstall Corporation.

Bangor.—An unopposed inquiry was held last week into the Council's application for sanction to a loan of £2,000 for additional generating plant and mains extensions.

The town clerk (Mr. H. W. Rowland) and the borough electrical engineer (Mr. Price F. White) gave evidence in support of the application. Mr. White supplied details of the capacity of the existing machinery and of the growing demand for current in the town.

Buxton.—Application has been made for sanction to borrow £1,000 for mains, &c.

Census of Production.—The Board of Trade have issued a Blue Book dealing with the census of production for 1907.

The gross output (selling value, or value of work done) in the United Kingdom during 1907 was £1,757,000,000, cost of materials used £1,019,000,000, and work given out (amount paid to other firms) £26,000,000. The net output was £712,000,000, and the average number of persons employed (excluding outworkers) was 6,936,000. In addition there were about 100,000 outworkers, and the total number of persons employed on the work covered by the census amounts to about 7,000,000. The following table gives the details for several industries :—

	Output. Gross.	Net.	No. of employés.
Building trades	£87,967,000	£42,954,000	513,961
Gas undertakings (public authorities)	10,769,000	5,732,000	28,585
Gas companies	20,838,000	11,546,000	54,946
Electricity undertakings (public authorities)	5,721,000	3,572,000	14,119
Electricity supply companies	3,182,000	1,996,000	8,499

The total gross output of these industries (including slate, limestone and iron quarries, waterworks, and miscellaneous factories and workshops) was £156,615,000; cost of material used was £63,236,000; work given out to other firms £6,498,000, leaving net output £86,881,000. The total number of persons employed in such industries was 780,747. £26,451,657 represents the gross and £14,356,397 the net output of local authorities in the British Isles, canal, dock, &c., companies, tramway and light railway companies, several Government departments, and the National Telephone Co., which together employed 219,361 persons. The net output of the Post Office telegraph and telephone undertakings was £954,819, and of the National Telephone Co. £510,229, which employed respectively 10,171 and 7,028 persons.

Mr. G. R. Askwith points out in the preface to the Census, that "not only does this, the first census under the Census of Production Act, 1906, show for the first time the relative and absolute mangitudes of all the various industries coming within its scope, but that, when subsequent censuses have been taken, the results of the series will afford the means for measuring the development of the manufacturing and extractive industries of the United Kingdom."

The total quantity of electricity generated by companies and public authorities (exclusive of that generated for their own use by industrial and commercial establishments and by railway and tramway companies) amounted to 1,430,069,000 units. Further, 174,607,000 units were generated by railway companies and 54,743,000 units by tramway and light railway companies for their own purposes.

Association of Chambers of Commerce.—The autumn meeting of this Association is being held in Dublin this week, and many commercial and industrial subjects were dealt with.

Strikes.—A resolution on strikes and intimidation by workers was submitted by the Leeds Chamber on Tuesday. The Hon. R. Beckett, who moved the resolution, said they could concede to anybody the right to strike, but where they quarrelled with him was as to the methods, once a strike was in progress, which led to violence, intimidation and a general breaking of the law. Acts were perpetrated under sec. 2 of the Trades Disputes Act of 1906 which that clause never contemplated. They had there a machinery under which licence and riot had stalked unchecked through the land, and that was a strong indictment against any measure. Therefore they would be only doing their duty as peaceful citizens of this Empire in asking for a Special Commission to consider the re-casting of that Act. Under clause 4 of the Act trade unions were relieved in a large measure from responsibility for their acts, and when they found trade unions in a more favourable position as regarded the common law than other sections of the community it made one fear for the future of the community. He submitted that the railway strike had been rendered largely possible by the readiness of the unions to disregard their own rules. The fact that trade unions occupied a favoured position as regarded the law of the land was in itself a bait to attract many men to join the unions. That coercion had been effective lately, but when once the unions were recognised up and down the land was it not to be expected that peaceful persuasion would go on to coerce the free labourer to come into the union? He wanted to see equal justice to all. He moved "That in view of the intimidation and violence which had been openly carried on during the recent railway and other strikes, and of the serious interference, not only with the supply of food and other necessaries of life to the people, but also with the home and foreign trade of the kingdom, this meeting of representatives of Chambers of Commerce of the United Kingdom hereby calls upon the Government to appoint at once a Special Commission to inquire into the working of the Trades Disputes Act of 1906, which in the opinion of this meeting has, by authorising peaceful picketing and relieving trade unions from responsibility for their acts, made possible much intimidation, violence and interference; and that copies of this resolution be forwarded to the Prime Minister, the Chancellor of the Exchequer, the Home Secretary, the President of the Board of Trade and the Leader of the Opposition."

After discussion the resolution was carried unanimously.

National Insurance Bill.—On the motion of Mr. Hobson (Sheffield), a resolution was unanimously passed urging the postponement of the National Insurance Bill, and pledging the meeting in that case to appoint a special committee of the association to put forward the detailed views of the commercial community, with the object of a workable measure being passed which will be acceptable to both employers and employed.

Workmen's Compensation.—A resolution calling upon the Government to appoint a Committee to inquire into the working of the Workmen's Compensation Acts was also passed.

Cleethorpes.—The Council have been authorised to borrow £4,000 for electricity supply works.

Dock Lighting.—Among the improvements that are being made at Methil Dock, N.B., is the installation of plant for the generation of electrical energy for power and lighting.

Dungiveen (Ireland).—Electricity supply for public and private lighting was available for the first time on Aug. 18.

Electric current is supplied at 220 volts from a gas-driven station of Mr. Alex. Semple, J.P. Overhead cables are employed and metal filament lamps of 50 c.p. each are used for street lighting. The contractor was Jas. E. M'Laughlin, and Mr. May was consulting engineer.

Exhibitions.—The North of England Exhibition, which it is proposed to hold in the Queen's Rink, West Hartlepool, from Nov. 13 to Dec. 9, inclusive, is being organised for the display of engineering appliances, motors, &c., together with colliery mining, electrical and horticultural machinery. The general manager of the exhibition is Mr. Geo. Scott, 7, Victoria-road, West Hartlepool.

On Monday afternoon the Mayoress of Ilkeston (Mrs. Shaw) opened an electrical exhibition in the Town Hall of electric cooking, lighting, heating and power apparatus, &c.

A number of prominent firms, including Siemen Bros. & Co., the Osram Electric Lamp Works, the Jandus Arc Lamp & Electric Co., Ferranti Limited, the Union Electric Co., the British Westinghouse Co., &c., had exhibits on show, and demonstrations of cooking, heating, lighting, &c., are given daily from 3 to 10 p.m. The exhibition, which remains open until to-morrow (Saturday) evening, has been organised by the borough electrical engineer and tramways manager (Mr. H. P. Stokes), and has aroused considerable local interest.

Glasgow.—Acting on a report of the general manager of the tramways (Mr. J. Dalrymple) the Tramways sub-committee have unanimously agreed to apply for powers to construct lines to Milngavie, Coatbridge and Clarkston from the present tramway termini.

Huddersfield.—The new tramway route from Holly Bond-road, Edgerton, to the borough boundary at Birchencliffe was opened for traffic on Tuesday.

Negotiations have taken place for the extension of the Huddersfield municipal tramways into Elland. Huddersfield Corporation are willing to extend the lines to the top of the Ainleys, and to apply for the necessary Parliamentary authority.

Liverpool.—As announced in our last issue, the threatened general strike in consequence of the dispute between the Tramways Committee and a section of the tramway employés, was averted at the last moment by the Committee undertaking to reinstate the men out on strike "as and when required."

During the week these men have been reinstated in batches and the last batch was re-started on Monday. The dock and other strikers have also resumed work and things have now assumed almost their normal condition at Liverpool.

On Monday morning the general manager of the tramways (Mr. C. W. Mallins) had a gratifying experience when the last batch (60) of the

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uniformed men resumed work. The men assembled in the large hall at the Hatton-garden buildings, where an interview was held with the general manager. In the course of a brief address, Mr. MALLINS said that everything possible would be done for the men, so that they might be able to resume work as speedily as possible. He believed that in a day or two the last vestige of the strike would have disappeared, and that all the men would be reinstated and comfortable once more.

Driver WILLIAMS *proposed* a vote of thanks to Mr. Mallins for the highly sympathetic way in which he had received the men, adding that they were exceedingly pleased with the concessions which Mr. Mallins had made while the strike lasted. It was added that the men had been misled, and the general manager could rest assured that they would never take part in another strike, if one, unfortunately, should occur.

Last week a deputation, representing those who had been voluntarily assisting in running the electric power station during the strike, met the chairmen of the Committee (Sir Charles Petrie) at the City Electrical Engineer's Office, Hatton-garden. The deputation handed to Sir Charles a list containing the names of nearly 500 voluntary workers, and suggested that the list might form the basis of a permanent association of citizens willing to help the administration in any similar emergency.

Sir CHARLES PETRIE, in heartily welcoming the proposal, said that he would be glad to give facilities for for any who might desire it to become more intimately acquainted with the practical details of the working of the stations. He expressed on behalf of the Tramways Committee and himself (as chairman) the highest appreciation of the spirit shown by the voluntary helpers, without whose assistance it would have been impossible to continue the electric supply service. He considered that the city generally owed a debt of gratitude to the gentlemen who at great sacrifice of personal comfort and convenience had stepped forward to prevent the city being plunged in sudden darkness, the effect of which in the present disturbed state of affairs might have had most disastrous consequences. He trusted that the deputation would be good enough to convey his appreciation for their patriotic assistance to every member of the band of voluntary assistants.

At a meeting of the men at the power station who went out on strike on 24th inst., Mr. Ross (local secretary of the men's union) spoke.

Mr. Ross said their relations with the electrical engineer (Mr. A. Clough) and the consulting engineer (Mr. A. Bromley-Holmes) were as nice that day as ever they were. Those gentlemen were naturally sore at the men being drawn out without giving the Committee longer notice than they did. He had assured those officials that there had not been the slightest malicious intent on the part of the men, nor any intention of placing the city in darkness, which would have been a very serious thing. The only reason they came out when they did was one of tactics pure and simple. He had given a pledge to the officials that if ever a similar trouble arose again they would give the Committee reasonable notice before they left work. Complaint was made that three men had gone back to work during the night, which was contrary to the instructions of the strike leaders. He said a pledge had been given to the officials at Lister-drive station that as soon as the reinstatement of the uniformed men had taken place the power men would all go back.

L.C.C. Tramway Employés.—On Friday there was a special meeting of the Highways Committee of London County Council to consider certain demands of the men for higher wages, &c.

At the conclusion of the meeting, Sir Laurence Gomme, clerk of the Council, made an official statement to the effect that the Highways Committee had unanimously agreed to arrange for a meeting of the Conciliation Board during the first week of the meetings of the committees of the Council in October next. The Highways Committee also requested the chairman (Mr. F. Hall, M.P.) and the vice-chairman (Mr. Squires) to meet a deputation, which was in attendance, from the Amalgamated Association of Tramway and Vehicle Workers, to ascertain and deal with their grievances in matters not referable to the Conciliation Board. The chairman and vice-chairman would have power to deal with all matters which did not involve further expenditure by the Council.

Mr. Hall and Mr. Squires saw the deputation after the meeting, and the men subsequently met Mr. Fell, the chief tramway officer, in order to discuss matters.

Maldens and Coombe.—As Wimbledon Corporation have now obtained sanction to extend their electricity supply mains to this area the work will be taken in hand at once and a supply of current will be available before the winter sets in.

Metal Lamp Patents.—In regard to the announcement on this subject made in our issue of the 18th ult. (p. 757), the managers of the "Z" Electric Lamp Mfg. Co. (Messrs. Kilburn, Brown & Co.) write as follows:—

Our attention has been called to a statement under the above heading appearing in your journal of the 18th Aug. addressed to you by the Osram Lamp Works (Ltd.), to which is appended a notice of an order made in reference to an action brought by that company against the British Tungsten Lamp Co. (Ltd.). As one of the various manufacturers referred to in that letter against whom litigation has been commenced, we desire to call your attention to the fact that the order referred to was made with the consent of the defendants, who took no steps to defend the action. The business of the British Tungsten Lamp Co. was in the hands of a receiver for the debenture holders, who did not feel justified in contesting the proceedings. The point is material, as your correspondent's letter might convey the impression that the order was the outcome of an investigation by the court. We may add that the proceedings instituted against us are being defended, and we are content to await the decision of the court.

ELECTRICITY SUPPLY TABLES AND DATA.

This Valuable Set of Tables and Engineering Data relating to Electricity Supply and to Electric Traction on Railways and Tramways in the United Kingdom, the Colonies, and some important places abroad, is now ready, and can be obtained complete in handy book form, price 6s. 6d. post free, or on very hard paper for rough or constant use, price 8s. 6d. post free. A complete Index is included.

Moseley.—The City of Birmingham electric supply department have decided to lay electricity supply mains in this district.

Pittington.—The local Co-operative Society recently installed at their premises electric lighting and power plant, including a 16 B.H.P. Tangye gas engine and dynamo, and a battery of 27 storage cells.

Rural Telephones.—The Postmaster-General (Mr. H. Samuel) referred at a meeting of the Cleveland Agricultural Society last week to the transfer of the telephone undertaking and said that the Post Office were making an effort to serve the agricultural interests of the country in relation to telephones.

Wages in the Metal, Engineering and Shipbuilding Trades.—The Board of Trade have issued a report for 1906 on the earnings of workpeople engaged in the metal, engineering and shipbuilding.

The return puts the workpeople employed in those industries in 1906, at 1,500,000. The return relates to 744,557 workpeople, of whom 67·5 per cent. were time workers and 32·5 per cent. piece workers. Their average earnings for a full week were 27s. 4d. The average for engineering and boilermaking was 35s. 11d. and 39s. 1d. in iron and steel manufacture, 34s. 4d. in pig iron manufacture, 30s. 9d. in railway carriage and waggon building, and 31s. 4d. in manufacture of light iron castings, &c.

The following summary shows the average annual earnings (approximately) per head:—

	£ s. d.
Pig iron	79 0
Iron and steel	82 0
Tinplate	74 10
Engineering and boilermaking	69 0
Ship, &c., building and repairing	70 10
Railway carriage and waggon	66 10
Light iron castings	59 0
Average for all metal trades	68 10

The average number of hours constituting a full week were:—Pig iron, 55·2; iron and steel, 54·4; tinplate, 47·8; engineering and boilermaking, 53·1; ship, &c., building and repairing, 52·9; railway carriage and waggon 53·6; and light iron castings, 53·8. For all the trades included, the hours averaged 53·2 per week.

In engineering and boilermaking the earnings are classified into 14 districts. For the whole country the average earnings for the census week (end September, 1906) of adult males who worked full time were 32s. 5d., and for all men, including those who worked more or less than full time, 31s. 11d. The figures include labourers. The average earnings of men working full time in engineering and boiler making was:—

	s.	d.		s.	d.
London	38	0	Southern & South-Western Counties	31	8
Tyne, Wear & Tees	35	8	Remainder of Lancashire & Cheshire	31	4
Mersey & Barrow	35	5	North & West Midland Counties	31	4
Clyde	33	6	Remainder of Yorkshire	30	4
Sheffield	33	0	Remainder of Scotland	30	2
Manchester	33	0	Leeds	29	10
11 Lancashire Towns	31	8	Remainder of United Kingdom	29	3

In the electrical engineering industry, telegraph apparatus manufacture &c., the average was 34s. 7d.; wire drawing and working, 35s. 7d.; brass and allied metal wares, 31s. 9d.

Wireless Telegraph Notes.—In the "Australian Mining Standard" for July 27 there appeared a lengthy note on the effect of the recent judgment of Mr. Justice Parker in the action of the Marconi Company against the British Radiotelegraph Co. The purpose of the note is to set out certain differences of opinion which have arisen over Mr. Justice Parker's judgment. The opinions expressed on the subject editorially in THE ELECTRICIAN come under review.

The "Manchester Guardian's" London correspondent understands that a committee has been formed to consider and recommend what steps should be taken to establish a chain of British State-owned wireless stations within the Empire.

The committee (the correspondent continues) consists of representatives of the home Government and of the Governments of Australia and New Zealand. A preliminary meeting has already been held. A beginning is to be made with a chain of six stations in England, Cyprus, Aden, Bombay, Straits Settlements, and Australia. From Western Australia the messages will be carried over the land-lines to Sydney, and thence to New Zealand. The cost of the stations in England and Cyprus will be borne by the home Government, those at Aden and Bombay by the Government of India, those in Australia and New Zealand by the Governments, while the cost of the station at Singapore will be shared by all the Governments concerned except Australia. The selection of sites for the several wireless stations on the route will be taken in hand at once.

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COLONIAL AND FOREIGN NOTES.

Argentina.—The tramways in the City of Corrientes, owned by Senor Dodero, are to be converted to electric traction.

A telephone network to connect the various departments in Corrientes province with the capital is to be erected.

An electricity supply company has been formed at Carmen de Areco with a capital of $100,000. Mr. R. Pearson Hale is chairman.

An electric lighting and tramway company with £250,000 capital, and with Mr. V. Jauregui as chairman has been formed in Lujan (Buenos Ayres Province).

The plant at the power house of the Cia Alemana Transatlantica de Electricidad at Avellaneda, Buenos Ayres, is to be increased to 50,000 H.P., several new sub-stations are to be built and others will be enlarged.

Australasia.—The Premier of Western Australia (the Hon. F. Wilson) has announced that it is the intention of the Government to proceed with the nationalisation of the Perth tramways, provided that the company is willing to sell its undertaking at a reasonable figure.

Negotiations for the supply of electrical energy by the Bellambi Coal Co. to the Bulli (N.S.W.) Shire Council for public lighting have been renewed.

Sydney Council have entered into agreements to supply electricity to the local authorities of Glebe, Woollahra, St. Peters, Darlington, Randwick, Erskineville, Botany and Alexandria.

Sydney Council recently decided to appoint an assistant installation inspector at £187 per annum.

The directors of the Tallangatta (Victoria) butter factory recently visited the electricity works of other towns with a view to making recommendations as to establishing similar works at Tallangatta.

In evidence before the (Melbourne) Metropolitan Traffic Commission, Mr. T. B. Malomby, superintendent of the Victorian passenger train service, said he was in favour of electrical power, and was sure it would give better results than steam. Mr. J. M. Jolly, manager of the Australian Metal Co.'s electrical department, said he was in favour of the overhead system and the big type of car for the Melbourne tramways. If the electrification were to extend more than 10 miles from the city, modern practice recommended the use of alternating current, but if restricted to the suburbs direct current would have advantages.

The special committee appointed to deal with the acquisition by Hobart (Tasmania) Council of the undertaking of the Hobart Tramway Co. have expressed the view that the limit to which the Council should go in purchasing the company's rights and powers is £150,000, which would mean an annual payment of £7,500 for interest and sinking fund. The company ask for a much larger price.

Launceston (Tasmania) Council have been considering the question of putting in auxiliary generating plant, and it is regarded as certain that steam-driven plant of about 1,000 H.P. will be decided upon.

Mr. Vaughan, the South Australian Treasurer, recently stated in the Legislative Assembly that the Government had advanced £1,323,483 to the Municipal Tramway Trust for the purchase of the old lines and the construction of the new system.

The Victorian Electrical Installation Board is to consist of Messrs. W. Cumming, E. Bridger and H. Rowe, representing the employers, and C. S. Willers, W. R. Stewart and Wm. R. Thomson, representing the employés.

In future the Australian Postmaster-General's department will present an annual report to Parliament, as do the various State departments.

A report recently presented to the Victorian Parliament shows that in 1910 ten applications for Orders in Council were made under the Electric Light and Power Act, and the following eight were granted: Melbourne Electric Supply Co. (for Brighton and Camberwell), South Gippsland Butter Factory Co. (for Yarram), Defence Department (for portions of Braybrook and Footscray), Tatura Butter Factory Co. (for Tatura), Upper Yarra Shire Council (for Warburton), Charlton Electric Light & Power Co. (for portions of town and shire of Charlton), Footscray Council (for Footscray). The Footscray and cordite factory supplies will be obtained from Melbourne City Council, and that for Warburton from the Signs Publishing Co. The Prahran and Malvern Tramways Trust has been empowered to use and supply electricity. Preliminary enquiries were made with the view of obtaining orders for Birchip, Euroa, Numurkah, Daylesford, Rainbow, Dandenong, Yea, Ararat and Woodend.

Austria-Hungary.—Innsbruck municipality are acquiring the Achensee, with certain buildings, at a cost of about £167,000, with the view of establishing hydro-electric works.

A scheme for developing 7,500 H.P. of electrical energy for steel works to be erected between Kitzbühel and Oberndorf, by means of water-power from the Aschaver Ache, is to be carried out by Salzburg electrical engineers with the assistance of the Länderbank.

The communal authorities of Kgl. Weinberge are about to construct electric tramways, and Vienna Town Council have also decided to lay down tramways.

Brazil.—Imports at the port of Santos in 1910 included electrical appliances valued at £216,518 (compared with £77,087 in 1908 and £102,606 in 1909), industrial machines £188,478 (against £186,330 and £173,127), "water engines," £41,489 (against £46,690 and £29,142) and sundry machines and implements, other than agricultural, £390,373 (against £286,919 and £242,245).

A by-law has recently been passed by the Municipal Council of Salvador, the capital of the State of Bahia, instructing their superintending engineer to cancel the concession granted to the Companhia d'Eclairage de Bahia, subject to compensation, and to invite tenders for the supply of current for public and private lighting and for power purposes in the city for a term of 60 years.

Canada.—Though little more than a year old, the town of New Waterford, in a newly discovered coalfield in Cape Breton County, Nova Scotia, has a population of 5,000, and is lighted electrically.

India.—"Indian Industries and Power" states that a licence has been granted by the Municipal Commissioners of Chittagong to the agents of the A.E.G. for the supply of electricity to the town.

The Municipality have decided to light the main streets electrically. The preliminary scheme is being drafted by Mr. H. R. Speyer, who will be responsible for the engineering portion of the undertaking, and Messrs. Turner, Morrison & Co. are representing the commercial interests of the A.E.G. at Chittagong.

Japan.—The British Acting Commercial Attaché for Japan states that the capital embarked in new engineering and transport enterprises in the years 1907, 1908, 1909 and 1910 was as follows:—

	1907.	1908.	1909.	1910.
Electrical	£5,778,000	£1,549,000	£840,000	£9,349,000
Mining	5,354,000	495,000	876,000	2,266,000
Railway	6,663,000	1,137,000	1,409,000	9,285,000
Manufacturing	20,038,000	3,230,000	3,167,000	14,215,000
Transport	3,935,000	1,108,000	306,000	860,000

A factory for making incandescent electric lamps has been established and experiments in that direction are being carried out in Osaka.

During the year steady progress was made in the direction of extending the use of hydro-electric power. In October the Kinugawa Hydro-Electric Power Co. was formed with a capital of 13,500,000 yen (£1,378,000) to supply Tokio with electricity generated by the waters of the Kinu River.

In April a Government commission was appointed to examine and make a record of the water-power resources of the country. The hydro-electric works, for which charters have been granted, will have an ultimate capacity of 592,000 kw. A number of these power stations are in course of erection or in contemplation.

Russia.—Amongst projected and authorised railways in Russia is the Oranienbaum electric railway, the two sections of which will total 41 miles.

United States.—Exports of electrical goods from the U.S.A. for the 12 months ended June 30 last include heavy machinery to the value of $8,024,028, against $6,048,263 in the previous year, and instruments and apparatus $10,702,827 ($8,694,132). More than a fourth of these exports ($4,912,189) were sent to Canada (against $3,557,954), while the value of those sent to Japan was $2,215,173, Mexico $2,468,888, and Brazil $2,446,041.

Uruguay.—The Oficina Técnica Hércules has been authorised to make surveys for an electric railway to the port of La Paloma y Rocha.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Bury St. Edmunds.—In a report on the past year's working of the electricity undertaking, the borough electrical engineer (Mr. Sydney E. Day) states that the year's results could not be considered other than satisfactory, and the all-round expansion of the business was most marked.

Mr. Day states that the number of new consumers connected during the year had been well maintained, and there was an increase of over 20,600 in the units sold, representing about £450. There was also an increase in the works cost, for which the coal bill was mainly responsible, and the inefficiency of the condensing plant and its inability to deal satisfactorily with the heavy winter loads was in no small measure responsible for the increased coal consumption. The removal of the condensing plant and the thorough overhauling of the plant, which was now in hand, would practically overcome the difficulty and a marked economy in fuel consumption should result. Advantage had been taken of the arc lamp hire scheme introduced in the early part of the year, there being about 14 lamps on hire at present. Much satisfaction was being obtained from these lamps. The popularity of the prepayment meter was growing.

Cardiff.—The accounts of the electricity supply department for the year ended March show capital expenditure £272,250 (increase £3,820.)

Revenue was £45,455 and working and general expenses were £27,638, leaving gross profit £17,817, and net surplus of £909 (compared with £94) after meeting capital charges, &c. Units generated were 5,952,502, supplied to public lamps 1,214,650, minimum 3,401, private consumers by meter 3,630,824. There are 618 arcs and 178 incandescents for public lighting. The total maximum demand was 2,694 kw. The report of the city electrical engineer, Mr. Arthur Ellis, states that the department has suffered as a result of the introduction of metal filament lamps, but he thinks it has now begun to reap the benefits accruing from the metal filament lamp which has reduced the cost of electric light so as to bring it within the reach of a larger body of people. There is ample evidence

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that builders prefer electric light when erecting new property, as it enables them to sell the property more readily. The number of consumers increased by 247 making a total of 2,106. Of the 4,848,875 units sold (compared with 4,561,682 in previous year), 1,416,182 were for power purposes. There are 546 motors connected = 3,688 H.P.

Wellington (N. Z.) -The accounts of the electric lighting department for the year ended March 31 last show capital expenditure £224,304 (increase £6,344) and revenue contribution to capital outlay was £23,910 (against £19,961 in previous year.)

Revenue was £45,587 (against £44,814), working expenses were £23,609 (against £25,933) and the net surplus, after meeting capital charges and placing £6,986 (£6,361) to depreciation, was £4,345 (£2,228). Units generated were 3,251,549 (against 2,770,379), and units sold were 2,056,617 (2,018,526). There are 5,368 (4,501) consumers, the lamps connected are equivalent to 193,692 (170,627) 8 c.p. lamps, and the total horse-power of motors connected is 1,252 (1,187).

The capital expenditure on the tramways department is £619,865 (including £39,530 for power supply and public lighting), compared with £595,781 at March, 1910. The total revenue (tramway and power supply) was £142,788 (£139,460) working expenses were £95,965 (£92,946), and after meeting capital charges and placing £14,408 (£14,202) to depreciation, the net surplus is £6,226 (£6,123). The passengers carried (on the city lines) were 22,604,235 (21,932,507) and car-miles run (on all lines) were 2,250,291 (2,203,666).

TRADE NOTES AND NOTICES.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1911 Edition of the Big Blue Book is READY, price 15s., post free in the United Kingdom, 15s. 9d. The volume brings a great mass of very valuable statistical and technical data quite up to date, and the Directorial Division has been thoroughly revised and amplified up to February 24th.

All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters receive every attention in the new volume, which aggregates more than 2,000 pages. The Directory Division is complete and thoroughly accurate, and has been completely revised. The Big Blue Book contains more names of live electrical firms and persons than any other Directory published, and this notwithstanding that all mere lists of members of Societies and Institutions (so easily and cheaply available) are excluded, as unreliable and of little value for Manufacturers' and Dealers' purposes. The full set of valuable Statistical and Engineering Tables, &c., have been very carefully revised and extended, and are now issued in a handy form. These are included in the 1911 Big Blue Book, making it the most complete work of the kind ever published.

TENDERS INVITED.

Tenders are invited up to Oct. 18 for the supply of 20 coin-in-the-slot attachments to the Postmaster-General's Department in WESTERN AUSTRALIA. Specifications, forms of tender, &c., may be obtained at the Commonwealth Office, 72, Victoria-street, London, S.W. See advertisement.

The Postmaster-General's Department in SOUTH AUSTRALIA require tenders up to Oct. 25 for supply of cable and paper sleeves. Tender forms and specifications may be obtained from the Commonwealth Office, 72, Victoria-street, London, S.W. See also an advertisement.

The Postmaster-General's Department in TASMANIA want tenders by Oct. 2 for supply of 10,000 porcelain insulators. Tender forms and specifications from the Commonwealth Office, 72, Victoria-street, London, S.W. See also an advertisement.

The WESTMINSTER ELECTRIC SUPPLY CORPORATION invite tenders for supply, delivery and erection at their Davies-street station of battery boosters and switchboards. Copies of specification, with drawing and general conditions can be obtained from the Secretary of the Corporation, Eccleston-place, Belgravia, S.W., to whom tenders should be sent by 10 a.m. of Sept. 12. Specification can be seen at (but not obtained from) the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster, S.W.

Tenders will be received until noon Monday, Sept. 18, for the supply of Swedish, Norwegian, Finland or Russian red fir telegraph poles, for the GENERAL POST OFFICE. Forms of tender from the Controller of Stores, Mr. G. Morgan, Stores Department, G.P.O., 17 and 19, Bedford-street, London, W.C.

ECCLES Electricity Supply Committee require tenders by noon, Sept. 12, for supply and erection of h.t. single phase a.c. switchboard. Specification, &c., from the Borough Electrical Engineer.

HASLINGDEN Council require tenders by noon Sept. 9 for the electric lighting of various buildings owned by the Corporation. Specifications, &c., from the Electrical Engineer, John-street, Haslingden.

PONTYPRIDD Council want tenders by noon Sept. 12 for supply and erection of water tube boiler and Foster superheater. Specification, &c., from Mr. J. E. Teasdel, Electricity Works, Treforest.

The Electricity Supply Committee of DUBLIN Corporation invite tenders for supply of 750 a.c. meters (single phase) and 200 a.c. (three phase) meters. Tenders to the Chairman of the Committee, 3, Cork-hill, Dublin, by noon Thursday, Sept. 7.

Tenders are invited up to Sept. 26 for supply of telephone material and 30 miles of telephone cable, and up to Oct. 3 for the supply of 42 miles of telephone cable to the Postmaster-General's department in VICTORIA. Tender forms and specifications at the Commonwealth Office, 72, Victoria-street, London, S.W.

The Metropolitan Water and Sewerage Board, Albert-street, BRISBANE, Queensland, want tenders by noon Jan. 30 next for supply and erection of one, two or three complete units, each consisting of power generating plant and pump or pumps to lift not less than 6,000,000 gallons per day. Particulars from the Secretary, and forms from the Agent-General for Queensland.

Tenders are invited by the Municipal Council of PELOTAS (Brazil) for a 40 years' concession for the supply of electricity for power and lighting and the establishment and working of electric tramways. Tenders to Senhor Luiz M. da S. Pennafiel, Intendencia Municipal, Pelotas, up to 1 p.m. Nov. 14. A deposit (about £300) is required with each tender, to be increased by the successful tenderer to 25,000 milreis (about £1,670). Further particulars (in Portuguese) can be seen by British contractors at 73, Basinghall-street, London, E.C.

The Municipal Council of BUDAPEST, Hungary, require tenders for the manufacture and supply of plant for a steam-driven electrical generating station, including two groups of three-phase turbo-generators (5,000 kw. each), 10,000 volts 50 cycles, boiler equipment for mechanical output of 5,000 kw. with reserve, pipeline, central switching and accessory equipments, travelling crane for engine room and coal-conveying plant. Specifications, &c., can be obtained at the Presidial Section of the Council, 9: IV., Városház-utca 16, II. 1, Budapest. Tenders by 11 a.m. Sept. 30.

Tenders will be received at the Town Hall, SYZRAN, Russia, on Oct. 14, for the construction of an electric tramway and the supply of electrical energy for lighting.

The Public Works Department, Madrid, will receive tenders on Sept. 20 for the concession for the construction of the RENTERIA electric tramway.

The Municipal Commissioners of PENANG invite tenders for the supply and delivery, f.o.b. British port, of one 500 kw. steam dynamo engine or turbine with ejector condensing plant and switchgear. Specifications from the consulting engineers, Messrs. Preece, Cardew & Snell, 8, Queen Anne's-gate, Westminster, S.W., to whom tenders (in duplicate) by noon of Tuesday, Sept. 5.

Tenders will be received at the Prefecture, CANEA (Crete), until Aug. 30 for supply of 5,500 kilogs (about 5½ tons) of telegraph wire.

The Danish State Railways Administration, COPENHAGEN, require tenders by 1 p.m. Sept. 4 for supply of 936 accumulators for train lighting. Specification (in Danish) may be seen at 73, Basinghall-street, London, E.C.

TENDERS RECEIVED AND ACCEPTED.

Among recent contracts secured by the Electrical Power Storage Co., 4, Great Winchester-street, London, E.C., are the following:—

Devonport Corporation, renewing 261 cells of lighting battery, having a capacity of 670 ampere-hours, also renewing part of traction battery, each cell having a capacity of 2,000 ampere-hours, at £1,[illegible] and maintenance of same for 10 years.

Birkenhead Corporation, supplying new battery of 260 cells, 1,350 ampere-hours capacity, at £1,771, and maintenance for 10 years.

Bispham Council have accepted the following contracts in connection with their electricity undertaking: National Gas Engine Co., engines and dynamos; Kelvin & James White, switchboard, balancers and boosters; Premier Accumulator Co., storage battery; British Insulated & Helsby Cables, mains; Chadwick Bros., erection of station buildings; Smith Bros., cable trenches, &c.

Sydney (N.S.W.) Council recently accepted the tender of the Australian General Electric Co. for supply of switchgear and transformers at £3,500, and purchased electric cooking apparatus from

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Wm. Adams & Co. at £25 and single-phase meters for large motors from the A.E.G. at £95.

Auckland (N.Z.) Council have received the following tenders for plant for their generating station :—

Engine-room Plant.—Greenshields & Co., £42,592; General Electric Co., £50,181, £41,768 and £38,419; Turnbull & Jones, £37,841 and £40,310; George Fraser, £37,946. 10s.; Belliss & Morcom, £40,570, £41,360, £41,990 and £40,070; A. & T. Burt, £37,360 and £23,105; National Electric Co., £38,596, £38,126, £31,066 and £37,881; Brush Co., £32,410; Grey Thorpe, £39,028; Wm. Adams, £34,795.

Boiler-house Equipment.—J. Chambers, £21,844; J. Howden & Co., £15,800. The tenders were referred to the Electricity Committee and the City Electrical Engineer.

The Government Electric Supply Department at Montevideo has accepted the tender of Cooper & Sons, on behalf of Colson, Brookhouse & Pyne, for supply of 200 km. (124 miles) of insulated aerial conductors, manufactured by British Insulated & Helsby Cables. Seventeen tenders were received, the accepted tender being the lowest.

Commonwealth Contracts.—The Postmaster-General's department in Victoria have accepted the tenders of British Insulated & Helsby Cables for telephone cables (£10,990) and 3,500 copper binders (£3. 5s. per 1,000); Western Electric Co. for telephone cables (£19,879. 14s.); R. Johnson, Clapham & Morris for 3,500 tapes (£1. 16s. 6d. per 1,000); T. Zwicker & Co. for 7,000 insulators (5d. each); and Gibbs, Bright & Co. for 11 tons h.d. copper wire (£68. 10s. per ton).

BUSINESS NOTICES.

The telegraphic address of the publishing department of the British Westinghouse Co. will be in future, "Westinghouse Manchester," and not "Unappalled Manchester."

The Standard Cable Mfg. Co. (Ltd.) have opened a contract office at 98a, St. Vincent-street, Glasgow.

A. A. Kerridge and H. Sloman (trading as the Starlight Electric Co.), 38, Alexandra-road, Southend-on-Sea, have dissolved partnership. Debts by Mr. Kerridge, who continues.

Patents Development.—The proprietor of patents No. 13,427/06 and 880/07, for "Improvements in dynamo electric machines," desires to make arrangements for exploiting same in this country. Applications to Messrs. Haseltine, Lake & Co., patent agents and consulting engineers, 7 and 8, Southampton-buildings, Chancery-lane, W.C.

The owners of patents No. 23,501/99, relating to "Improvements in vacuum tube lighting," and No. 12,582/02, relating to "An improved system of electric lighting," also desire to negotiate with electrical engineers with the view of granting licences. Applications to Messrs. Lloyd Wise & Co., patent agents, 46, Lincoln's Inn Fields, W.C.

BANKRUPTCIES, LIQUIDATIONS, &c.

The Havana Telephone Securities Co. (Ltd.) is being wound up voluntarily, and Mr. Geo. Banks, New Broad-street House, London, E.C., is liquidator.

Broadstone (Ltd.) (which formerly owned the Fleetwood electricity works) is being wound up voluntarily. Mr. G. E. Conolly, Bank-chambers, Woolwich, is liquidator. Meeting of creditors Sept. 8 at Messrs. Whale & Wates', 107, Cannon-street, London, E.C.

A meeting of creditors of the Simplex Acme Patent Fire Alarm Co. (Ltd.) at 7, Sweeting-street, Liverpool, on Sept. 4.

The liquidator (Mr. S. P. Child, 8, Frederick's-place, Old Jewry, London, E.C.) of the Phosphor Bronze Co. (Ltd.) has been released.

A dividend is to be paid to creditors of W. H. Ridpath (trading as Ridpath & Wells), electrical engineer, 20, Bath-street, Ilkeston. Claims to Mr. E. W. Humphreys, 5, Victoria-buildings, Derby, by Sept. 9.

The examination of Fredk. Vickers, electrical engineer, took place at Manchester on Friday last. It was stated that debtor commenced business in November, 1908, without capital. He did electrical installation work. One creditor gave him credit to the amount of £250. After removing 18 months ago to 286, Oxford-road, Manchester, he lost money on contracts for which his foreman had given estimates which were too low. Unsecured liabilities were £... and assets £58. The examination was closed.

COMPANIES STRUCK OFF THE REGISTER.—The following were struck off the register of Joint Stock Companies on Aug. 29 :—
Aberdare Electric Lighting Co., Albion Battery Co., Buenos Ayres Electric Light Co., Heswall District Power Co., Private Wire & Telephone Installation Co.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application, an asterisk is affixed.*

July 10, 1911.

15,933 WALKER & WAYGOOD & Co. Control of electrically-operated lifts, elevators and the like. (Divided application on 20,118/10. Aug. 29.)
15,959 LOWY & MULLER. Production of electro-deposits. (Convention date, 1/6/11, Austria.)*
15,998 B.T.-H. Co. (G.E. Co., U.S.) Means for handling freight and apparatus therefor.
16,007 GRAFTON & PRIOR. Automatic control of dynamo-electric machines in direct-current distributing and consumption systems.*

July 11, 1911.

16,026 VAUGHAN. Sparking-plugs.
16,068 ELECTRIC & ORDNANCE ACCESSORIES CO., ETCHELLS & PRICE. Variable-speed dynamos.
16,074 BROWN. Sending mechanism for party-line signalling. (Convention date, 11/7/10, United States.)*
16,075 WESTERN ELECTRIC CO. (Western Electric Co., U.S.)* Telephone Exchange Systems.
16,081 PRICE. Electric plug connection.
16,088 ARON. Systems for electrically controlling or operating clocks or the like.
16,093 WARWICK MACHINERY CO. (1908). (A.E.G., Germany.) Speed-regulating devices.

July 12, 1911.

16,095 MOORE, GAMBRELL & GAMBRELL. Dynamometers, wattmeters, watthourmeters and the like.
16,096 ELFORD. Contact-breakers for induction coils and other purposes.
16,143 BASTIAN. Envelopes or supports for the resistances in electric-heating apparatus.
16,163 B.T.-H. CO. (G.E. Co., U.S.) Electric lamps.

July 13, 1911.

16,187 ANDERSON & BURNSIDE. Mercury or other vapour electric apparatus.*
16,195 SCHALLER. Electric incandescent lamp. (Convention date, 13/7/10, Germany.)*
16,228 GRAHAM. Fuses for electric circuits.*
16,230 BLOCH. Method of and apparatus for regenerating burnt out carbon and metal filament electric lamps.*
16,234 Creighton. Protective devices of the type known as lightning arresters. (Convention date, 5/7/10, U.S.)*

July 14, 1911.

16,271 HEWITT. Light transforming reflectors. (Convention date, 23/7/10, U.S.)*
16,298 BOWRON. Electric oscillographs.

July 15, 1911.

16,318 WILSON & WARREN. Type of electric lamp holder.
16,343 ELECTROMOTORS (LTD.) & GREENHALGH. Controlling the speed of electro-motors.
16,352 MITCHELL. Telephone call apparatus and the like.
16,355 FRASER. Direct-current transformers and the like.
16,361 BARBOUR. Control of alternating-current electric motors.
16,367 OGILVY-WEBB & REINECKE. Arc lamps.
16,372 SUBMARINE SIGNAL CO. & EVANS. Submarine signalling-apparatus.
16,374 LAKE. (David Leonard Lindquist, U.S.) Traction electromagnets.*

July 17, 1911.

16,426 ELEKTROCHEMISCHE WERKE G.M.B.H. Process for the electrolytic production of ammonium nitrate from hydrated nitric acid. (Convention date, 16/7/10, Germany.)*
16,437, 16,438 MACKENZIE. (Champion Ignition Co., U.S.) Spark plugs.*
16,440 ANSCHUTZ & CO. Electrical Contacts. (Convention date, 26/11/10, Germany.)*
16,456 KAISER. Electrical driving devices for sound reproducing machines.*
16,456 LEGRAND & ARMEL. Electrically-operated apparatus for locking railway carriage and other doors. (Convention date, 27/7/10, France.)*
16,469 STROUDE & JOSEPHS. Electrical measuring instruments.

July 18, 1911.

16,488 WOODHOUSE. Terminal and like boxes for use with conduits or casings for electric conductors.
16,489 WOODHOUSE. Conduits or casings for electric conductors.
16,498 DAVIS. Electrical conducting cables and the like.
16,514 LUNDBERG, LUNDBERG & LUNDBERG. Electrical terminals.*
16,523 DARE. Portable field-telephoning apparatus.
16,528 SIEMENS BROS. & CO. (Siemens & Halske Akt.-Ges., Germany.) Safety devices for locking appliances. (Addition to 20,779/07.)*
16,532 SCOTT. Electric lifts.
16,533 MULLER. Protecting insulated conductors against fire. (Convention date, 3/8/10, Austria.)*
16,542 SMITH & SHUTER. Covering of electric conductors with plastic material and apparatus therefor.*
16,547 DENNY. Electric fuses or cut-outs.
16,553 CHAPMAN & GRIMSLEY. Apparatus for recording telephone calls.
16,554 DEARLOVE & BROWN. Manufacture of electrical condensers and similar apparatus.

July 19, 1911.

16,584 ADAMS. Electrical combined switch and fuses.
16,602 LOFQUIST. Device for heating running water or other liquid by electricity.*
16,604 BENZ & CO. RHEINISCHE GASMOTOREN FABRIK AKT.-GES. Ignition devices for internal combustion engines operated by heavy hydrocarbons. (Convention date, 19/7/10, Germany.)*
16,644 GASNIER. Electro-mechanical change-speed and reversing device. (Convention date, 19/7/10, France.)*

July 20, 1911.

16,667 MARTIN & CAMPBELL. Controlling and operating electric locomotives, electric trains, electric tramcars and other electric traction machinery.
16,678, 16,679 ENGINEERING & ARC LAMPS and DOWDELL. Arc lamps.
16,694 KINLEYSIDE. Insulating supports for electric conductors.
16,707 KAHN. Telephone and other suitable sound receivers.
16,721 MOORE. Transmitting telegraph keys.
16,727 NATIONAL CASH REGISTER CO. (National Cash Register Co., U.S.) Cash registering machines and electrical control means for same.*
16,737 B.T.-H. CO. (A.E.G., Germany.) Compensation of polyphase commutating dynamo-electric machines.
16,738 B.T.-H. CO. (A.E.G., Germany.) Regulating devices for driving motors of spinning machines.

July 21, 1911.

16,796 HUMPHRYS. Means for connecting electric cables to junction, bifurcating, trifurcating terminal boxes and the like.

July 22, 1911.

16,828 LONGFORD & CLARK. Terminals for ignition plugs.
16,841 RAILING & KRAUSE. Regulators for dynamo-electric machines.
16,859 BAYER & HUBBARD. Electrical secondary or storage batteries.*
16,867 MCBERTY. Automatic telephone exchange selector. (Convention date, 23/7/10, U.S.)*
16,868 WESTERN ELECTRIC CO. (Western Electric Co., U.S.)* Wiring contacts of telephone switches.
16,869 MCBERTY. Semi-automatic telephone systems. (Convention date, 23/7/10, U.S.)*
16,870 WEST & CO. & MOGGRIDGE. Drum-type controllers for the shunt control of electric motors.*
16,871 WEST & CO. & MOGGRIDGE. Liquid electric controllers.*

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SPECIFICATIONS PUBLISHED.

1910 SPECIFICATIONS.

9,191 BOOKER, OGILVY-WEBB & REINECKE. Arc lamps. Cognate application, 24,041/10.)
9,580 ARNO. Alternating-current power measurement and instruments for the same.
13,716 CRAWFORD & SCOTT. Tools or machines operated by a reciprocating element and means for driving them electrically.
14,042 JOHNSON & LOXLEY & Co. Electrical ceiling roses, junction boxes, fuses and the like.
14,126 HOLDEN. Electric clocks. (Patent of addition not granted.)
16,258 KALLMANN. Electric safety fuses.
16,552 BOLTINKOFF. Incandescent vapour lamps.
16,653 MAVOR & MAVOR & COULSON. Power installations.
16,763 KLEIN. Alternating current and alternating and direct current machines.
16,904 LICHTENFELD. Switch devices for electric circuits.
17,010 ROSENBERG & PECK. Braking induction motors.
17,107 ADAMS MFG. Co. (Cutler Hammer Mfg. Co.) Control systems for electric motors.
17,172 BONHOMME. Wireless signalling apparatus. (19/7/09.)
17,222 SUMPTER. Controlling a reversing variable-speed motor for driving reciprocating tools, planing and rifling machines, cranes and the like.
17,236 WATKINS. Grinding the contact surfaces of carbon brushes for dynamos, or other purposes.
17,247 JAMES. Electrically driving machines at variable speeds.
17,469 EISNER. Manufacture of filaments for incandescing electric lamps.
17,523 JUDD & HARDIE. Telegraph relays.
17,684 VENNER. Resistance for electric heating apparatus.
18,295 ANDERSON. Manufacturing spark plugs.
18,794 SMITH & MUIRHEAD & Co. Ignition apparatus.
20,900 TUCKER. Electrical switches. (Cognate application, 22,163/10.)
21,206 HARDEN & ELECTRIC FURNACES & SMELTERS. Production of metals from their ores by reduction.
21,235 ROGLER. Motor, more especially designed for use in driving blowers, rolling mills, and electric generators for smelting works.
21,848 CUNNINGTON. Electrical heating radiators.
22,198 PRESSER & GES. FUR ELEKTROTECHNISCHE INDUSTRIE. Automatic regulators for electric circuits.
22,239 WHITE. Intercommunication telephone systems
24,347 PEROTTI. Process and device for transmitting and registering verbal communications by means of the telephone.
24,489 SAMAIA. Apparatus for actuating conduit covers and collector ploughs of electric conduit tramways. (Addition to 8,852/10.)
27,240 BACCI. Incandescent electric lamp.
28,588 WESTINGHOUSE BRAKE Co. (Taylor.) Electric relay apparatus.
28,783 BARBER. Wooden propellers for aeroplanes and the like with an electrically-deposited metal coating.
29,489 ANDERSON. Sparking plugs.
29,802 MURPHY. Producing high-tension electric discharges and electric oscillations.
30,297 COMPAGNIE POUR LA FABRICATION DES COMPTEURS ET MATERIEL D'USINES A GAZ. Electricity motor meters of the mercury type. (2/5/10.)

1911 SPECIFICATIONS.

177 B.T.-H. Co. (G.E. Co.) Systems of electric motor control.
559 COMPAGNIE POUR LA FABRICATION DES COMPTEURS ET MATERIEL D'USINES A GAZ. Electricity motor meters of the mercury type. (Addition to 30,297/10.)
1,100 STROUDE & JOSEPHS. Thermo-electric temperature measuring apparatus.
1,251 WILSON. Incandescent lamp.
2,226 GAUTSCH. Method and apparatus for extinguishing fires in electric cables and electric circuits especially, in telegraph, telephone and similar installations.
2,501 GRAHAM. Water-tight telephonic apparatus.
3,086 CARDWELL. Transmitting electric impulses.
3,422 CAMPBELL & SHAW. Line circuits for the transmission of electrical signals. (12/2/10.)
3,423 SHAW. Line circuits for the transmission of electrical signals. (12/2/10.)
5,267 WESTON. Electrical measuring instruments. (Divided application on 17,091, 18/7/10.)
5,596 SIEMENS BROS & Co. (Siemens & Halske Akt.-Ges.) Railway signalling apparatus. (Addition to 19,558/07.)

COMPANIES' MEETINGS AND REPORTS.

BLACKPOOL & FLEETWOOD TRAMROAD CO.—At the meeting last week the chairman (Mr. Geo. Richardson) said there was an increase of £594 in the profits for the past half-year and the expenditure was less by £25. They had taken from the reserve fund £3,020 for renewals, repairs, &c., but had added £1,750 to that account. They received 6½ per cent. as dividend for the year. The directors were anxious to make the dividend equal but could not legally do so under present conditions. They were to get permission to make up the accounts yearly and for the declaration of an interim dividend. The receipts for the current half-year showed an increase of £750.

KALGOORLIE ELECTRIC TRAMWAYS (LTD.)—At the meeting on Tuesday the chairman (Mr. A. H. P. Stoneham) said that the result of the past year's working was not so good as the previous year's, as the mining industry was not now in a flourishing state. They took their power from the Kalgoorlie Power Co., and that company from time to time had made propositions to them to work the tramways for them under an agreement at so much per mile. There was also a possibility that the State Government would nationalise the Perth tramways The tendency all through Australia was to nationalise all means of locomotion. Whether the State would acquire the Kalgoorlie tramways he could not say.

PERTH ELECTRIC TRAMWAYS (LTD.)—At the meeting on Tuesday the chairman (Mr. A. H. P. Stoneham) said that for eight months of the current year the returns were £10,300 ahead of those of last year, but last year the returns were affected by the strike of motormen and conductors. They had been occupied during the last three months in negotiations for the disposal of the tramways. The people of Perth had come to the conclusion that they ought to own the tramways. When the concession was granted it was granted for 17 miles and the company was now operating over 30 miles of track. The company said they did not want to sell, but if there was to be dissatisfaction among the public, then, rather than have any trouble, they would recommend the shareholders to sell, if a fair price was given. The State were also making inquiries as to the purchase of the lines. The company had an offer of £50,000 new capital on fair terms in case they decided to go on as at present.

NEW COMPANIES, RECEIVERSHIPS, &c.

NEW COMPANIES.

CURTIS & CO. (LTD.) (117,400.)—Reg. Aug. 25, capital £2,000 in £1 shares (1,000 preference), to take over the business of an electrical engineer and medical electrician, &c., carried on by W. Curtis. Private company. First directors: W. Curtis and Elma Curtis. Reg. office: 101, Leadenhall-street, London, E.C.

DARNELL ACOUSTIC CO. (LTD.) (117,382.)—Reg. Aug. 24, capital £100 in £1 shares, to carry on the business of manufacturers of and dealers in electrical and other instruments for deafness, medical or surgical appliances, &c. Private company. Mrs. G. Hincks is permanent governing director. Reg. office: 383, Mansion House, Chambers, London, E.C.

WEAVERHAM ELECTRICITY SUPPLY CO. (LTD.) (117,358.)—Reg. Aug. 22, capital £5.000 in £5 shares, to carry on the business of electrical engineers, electricians, manufacturers of and dealers in electrical apparatus, suppliers of electricity, &c., in Weaverham and district. First directors: J. W. Smith, W. H. Burgess, G. H. Dean, R. Howarth and R. N. Gandy.

RECEIVERSHIP.

THOMAS BRITTAN (LTD.)—Notice of appointment of J. W. Vincent, 6, Holborn Viaduct, E.C., as receiver, by order of Court dated Aug. 16, has been filed.

CITY NOTES.

MEMORANDA (Aug. 31).—**Bank rate 3 per cent.** (since March 9, 1911.) **Price of silver,** 24⅛d. **per oz. Consols** 78¼—78⅜ **for money;** 78⅜—78½ **for account. Consols Pay Day,** Sept. 1; **Stock and Shares Continuation Days,** Sept. 12 and 26; **Ticket Days,** Sept. 13 and 27; **Pay Days,** Sept. 14 and 28; **Mining Shares Carry Over Day,** Sept. 11.

PRICES OF METALS (London).—***Copper*, cash,** 56; **three months,** 56⅛. ***Lead*, English,** 14⅛—14⅛; **Foreign, cash,** 14⅛—14⅜; **three months,** 14½—14⅝. ***Spelter*,** 27⅝—27¾. ***Tin*, English,** 191—192; **Foreign, cash,** 189½; **three months,** 186½. ***Iron*, Cleveland, cash,** 47/1½, **three months,** 47/7½.

ARGENTINE TRAMWAYS.—The "Review of the River Plate" states that the shareholders of the Cia de Electricidad de la Provincia de Buenos Ayres recently approved a proposal by an English syndicate to acquire all the $100 shares of the company for $100 cash and one $100 share in the new company to be formed to carry on the undertaking. The capital of the new company will be £1,000,000 in ordinary shares and £900,000 in 5 per cent. debentures.

The tramways in Buenos Ayres, in the half-year ended June 30 last, carried 28 253,543 passengers (compared with 25,732,154 and 20,005,937 in the corresponding half years of 1910 and 1909 respectively). Receipts were $17,368,928 (m.n.) (against $15,391,072 and $14.385,537), of which the Anglo-Argentine Co.'s system accounted for $14,506.036 (against $13,043,699 and $12,622,035) and the Lacroze Co. for $2,392,827 (against $1,965,132 and $1,481,982). The Rosario electric tramways carried 12,352,731 passengers in the same period (against 10,837,143 in the first half of 1910). The output of the Compania Alemana Transatlantica de Electricidad, Buenos Ayres, in the same period was 19,903,981 units for lighting (against 20,010,006 and 14,401,767 in the corresponding half years of 1910 and 1909 respectively), 8,319,006 for power (against 7,595,579 and 5,731,920) and 30,957,038 for traction (against 28,049,270 and 24,304,990).

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—The transfer books and register of members of this company will be closed from 1st to 15th inst., inclusive.

LIVERPOOL DISTRICT LIGHTING CO. (LTD.)—The directors have declared an interim dividend at rate of 4 per cent. for half-year to June 30.

RANGOON ELECTRIC TRAMWAY & SUPPLY (CO.)—This company's gross earnings in July were £7,637. Aggregate from Jan. 1, £58,150.

RIO DE JANEIRO TRAMWAY, LIGHT & POWER CO. (LTD.)—This company's gross earnings in July were £235.457 (increase £34,027. Aggregate from Jan. 1, £1,237,619 (increase £252,871).

SAO PAULO TRAMWAY, LIGHT & POWER CO. (LTD.) (CANADA).—A quarterly dividend of 2½ per cent. on the capital stock, payable on Oct. 2, has been declared.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed Sept. 6 a special settling day in and have granted a quotation to £240,000 4½ per cent. debenture stock of the *Welshach Light Co. (Ltd.)*, and have also granted a quotation to £200,000 5 per cent. mortgage debenture stock of *British Insulated & Helsby Cables (Ltd.)*. The Committee have been asked to grant quotations to £268,235 10s., fully paid, ordinary shares and 80,000 £1, fully paid, 6 per cent. cumulative preference shares (partly in lieu of £5 preference shares now quoted, of the *Hastings & District Electric Tramway Co.*

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ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
ardeen Corporation	Aug. 23	1,563	— 28	12	19,984	+ 1,332
rle	,, 18	230	+ 8	33	7,149	+ 48
gio-Argentine	,, 26	46,860	+ 2,873	34	1,655,537	+ 155,870
nton-under-Lyne	,, 26	521	+ 105	22	9,435	+ 770
r Corporation	,, 26	399	— 8	15	6,541	+ 26
nsley	,, 18	229	+ 19	33	6,007	+ 346
row	,, 18	515	+ 197	33	9,860	+ 969
h Electric Trams, Ltd.	,, 23	1,063	+ 109	34	28,871	+ 1,190
ningham Corporation	,, 19	8,393	+ 1,798	20	159,896	+ 23,563
ningham & Midland	,, 18	857	— 26	33	29,740	+ 1,810
ckpool & Fleetwood	,, 26	1,727	+ 84	..	..	..
kburn Corporation	,, 23	1,304	+ 302	‡22	26,076	+ 2,392
ton Corporation	,, 27	2,449	+ 153	22	55,794	+ 4,186
abay	July 28	2,737	+ 218	30	85,440	+ 5,137
rnemouth Corporation	Aug. 23	2,432	+ 20	21	40,373	— 1,818
dford Corporation	,, 26	5,503	+ 415	21	121,290	+ 10,187
ghton Corporation	,, 27	1,383	+ 128	¶21	24,801	+ 1,694
tol Trams & Carriage	,, 25	7,585	+ 1,422	21	155,551	+ 16,811
dley Corporation	,, 26	1,445	+ 185	21	22,265	+ 2,864
ton Corporation	,, 27	292	— 81	21	6,409	+ 558
r Corporation	,, 27	1,353	+ 173	¶21	28,678	+ 3,036
utta Tramways Co.	,, 26	R56,332	+ R4,428	8	R464,948	+ R43,746
borne-Redruth	,, 26	125	— 2	34	4,169	+ 33
iff Corporation	,, 19	2,513	+ 70	20	52,132	+ 5,047
ral London Railway	,, 26	3,746	— 998	8	34,608	— 7,321
ham & Dist. Lt. Rys.	..	..	..	..	..	..
& South London Rly.	,, 27	2,939	— 148	8	24,138	— 496
of Birmingham	,, 19	1,041	— 1,767	33	84,271	— 9,378
Electric Trams Co.	,, 24	563	+ 42	34	17,081	+ 482
don	,, 18	1,853	+ 92	..	..	..
nport & Dist. Trams	,, 18	627	+ 159	33	16,224	+ 2,371
r Corporation	,, 19	385	— 32	20	5,652	+ 860
n & Lucan Railway	,, 25	180	— 3	8	1,419	— 23
n United	,, 25	6,987	+ 1	8	59,330	+ 10,153
ey-Stourbridge	,, 18	994	+ 68	33	28,051	+ 2,030
ne Corporation	,, 23	1,177	— 70	¶14	17,304	— 267
ham Council	,, 26	1,046	— 16	21	23,564	+ 1,296
r Corporation	,, 25	381	+ 2	21	7,817	+ 660
head & Dist. Trams	,, 18	1,072	+ 38	33	34,202	+ 1,879
ge Corporation	,, 26	18,747	+ 1,780	‡12	231,572	+ 14,177
ip Trams	,, 26	161	+ 32	34	4,224	+ 324
ester Corpn.	,, 23	320	+ 3	8	2,782	+ 309
mond-Northfleet	,, 18	245	+ 10	33	7,025	+ 202
t Northern & City Rly.	,, 26	1,271	— 40	8	10,773	+ 249
ock & Port Glasgow	,, 18	919	+ 123	33	23,672	+ 3,003
ax Corporation	,, 22	2,457	+ 624	‡21	43,937	+ 4,981
rpool Tramways	,, 18	317	— 50	33	8,879	+ 705
ngs Elec. Trams Co.	,, 24	1,542	— 56	8	11,547	— 1
Kong	,, 26	$9,808	— $892	..	..	..
ansfield Corpn.	,, 26	1,948	+ 242	21	42,345	+ 4,566
Corporation	,, 26	2,844	+ 72	21	60,658	+ 2,950
District Council	,, 26	528	— 5	22	12,117	+ 506
on District Council	,, 23	137	— 2	21	2,867	+ 125
h Corporation	,, 26	560	+ 18	21	10,310	+ 623
Thanet Co.	,, 26	2,014	+ 83	47	29,850	+ 1,377
r	,, 18	151	— 3	33	4,370	+ 280
ley Corporation	..	..	..	..	..	..
rmuister & District	,, 18	161	+ 22	33	3,972	+ 279
mock Corporation	,, 26	150	+ 6	15	2,691	+ 297
shire Trams Co.	,, 24	1,560	+ 164	34	47,672	+ 673
shire United	..	..	..	..	..	..
ington	,, 18	224	— 20	33	5,819	+ 318
Corporation	,, 26	7,775	+ 704	21	162,817	+ 11,584
ter Corporation	,, 26	2,389	+ 10	21	55,113	+ 4,832
Corporation	,, 26	671	+ 90	‡15	10,658	+ 942
n Corporation	..	..	..	..	..	..
ool Corporation	..	..	..	..	..	..
ool Overhead Rly.	,, 27	1,199	— 231	8	12,058	+ 55
nion & Colwyn Bay Ry.	,, 25	697	— 37	§39	11,146	+ 377
n County Council	,, 16	41,907	+ 534	‡12	892,891	+ 59,010
n Elec. Ry. Co.	,, 26	10,285	— 150	8	93,280	+ 1,280
n United	,, 26	6,974	+ 25	34	227,110	+ 9,502
oft Corporation	,, 26	525	+ 82	47	9,672	+ 584
ester Corporation	,, 26	16,437	+ 1,339	21	348,845	+ 21,319
Railway	,, 26	1,478	— 412	8	14,129	— 1,516
r	,, 18	250	+ 40	33	6,939	+ 156
olitan Dist. Railway	,, 26	9,289	+ 104	8	84,169	+ 3,719
olitan Elec. Trams	,, 18	9,090	+ 1,032	33	289,789	+ 45,802
ton	,, 18	456	+ 65	33	11,235	+ 792
Corporation	,, 26	508	+ 65	§21	4,022	+ 856
dleton-Tyne Corp.	,, 26	4,346	+ 6,576	21	91,989	+ 12,509
rt (Mon.)	,, 26	680	— 25	21	15,720	+ 917
mpton Corporation	,, 25	529	— 2	21	11,934	+ 1,098
, Ashton & Hyde	,, 18	670	+ 57	33	18,791	+ 616
n Corporation	..	..	..	..	..	..
N.B.) Corporation	..	..	..	..	..	..
W.A.) Elec. Trams	..	..	..	..	..	..
rough	,, 25	1,524	+ 1,524	34	51,641	+ 10,316
outh Corporation	,, 18	157	+ 16	33	4,216	+ 423
es	,, 26	2,668	— 35	21	53,046	+ 5,446
n Corporation	,, 18	1,626	— 40	33	63,372	+ 6,263
ham Corporation	..	..	..	..	..	..
ay	,, 24	729	+ 80	21	14,504	+ 1,401
Corporation	,, 18	769	+ 190	33	7,529	— 22
es	,, 28	4,557	+ 80	§21	106,855	+ 6,007
	,, 23	$12,500	+ $1,325	7	$85,500	+ $8,267
	,, 18	82	+ 10	33	1,722	+ 69
d Corporation	,, 27	6,063	+ 225	21	142,374	+ 9,673
re Trams	,, 25	$9,175	— $740	..	..	..
etropolitan	,, 18	1,231	+ 89	33	28,906	+ 1,610
Staffs	,, 18	861	..	33	29,607	+ 2,169
mpton	,, 23	1,397	+ 156	21	27,134	+ 2,543
od Corporation	,, 23	1,152	+ 104	21	16,459	+ 2,306
ort Tramways	,, 18	490	+ 101	33	10,242	+ 427
dge, Hyde, &c., Jt. Bd.	,, 25	1,036	+ 202	21	17,548	+ 1,833
land Corporation	,, 27	1,323	+ 132	21	29,511	+ 3,887
land District	,, 23	623	+ 178	43	20,061	+ 1,610
a Trams	,, 18	1,342	+ 150	33	37,835	+ 2,395
n Corporation	,, 23	173	+ 18	21	3,416	+ 408
outh and District	,, 18	51	+ 2	33	1,420	+ 30
in Trams Co.	,, 18	503	— 12	33	8,968	+ 275
y Corporation	,, 23	820	+ 356	8	4,717	+ 574
Corporation	,, 26	1,130	+ 107	§21	25,087	+ 3,983
pton Corporation	,, 26	585	+ 44	33	19,012	+ 777
am Corporation	,, 21	389	+ 4	21	8,433	+ 223
-super-Mare	,, 24	2,733	+ 281	21	59,607	+ 5,973
hampton Co.	,, 18	587	+ 137	33	5,655	+ 633
hampton Corpn.	,, 18	443	+ 1	33	14,703	+ 694
ter	,, 23	986	+ 70	21	21,580	+ 1,354
on	,, 18	312	— 22	33	9,777	+ 479
re W.R. Trams	,, 18	124	+ 20	33	3,324	+ 144
re Woollen District	,, 18	1,197	+ 6	35	45,082	+ 2,416
	,, 18	1,180	+ 102	33	34,715	+ 2,476

ese comparisons are with the corresponding period last year. * Partly electrical.
† Minus 3 days. ‡ Minus 2 days. § Plus 7 days. ¶ Plus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Last Dividend		NAME.	Price Wed., Aug. 30.	*Rate per cent. Yielded. £ s. d.	Dividend Due.	Business Week to Aug. 30. Highest.	Lowest.
		Electricity Supply.					
10	5/0	†Bournemouth & Poole Elec. Sup. Ord.	7⅞—8¼	7 10 0	Mar, Sep	..	..
10	4/6	†Do. 4½ per Cent. Cum. Pref.	8¾—9¼	4 17 3	Feb, Aug	..	..
10	6/0	†Do. 6 per Cent. Cum. Second Pref.	10 —10½	5 17 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101 —103	4 6 6	Jan, July	..	..
5	4/6	†Brompton & Kensington Elec. Sup. Ord.	7⅛—8¼	6 5 0	March	7⅛	..
5	3/6	†Do. 7 per Cent. Pref.	7⅛—7¾	4 11 9	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Deb. Stock	98 —101	4 0 6	June, Dec	101	..
5	2/6	†Charing Cross (W. End & City) El. Sup. Co.	3¾—4¼	5 0 0	Feb, Aug	..	..
5	2/3	†Do. 4½ per Cent. Pref.	4¼—5	4 12 3	Feb., Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	94 —98	4 3 3	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	100 —102	4 8 3	..	101½	..
5	2/3	Do. City Undertaking 4½% Cum. Pref.	3⅞—4¼	5 10 6	Jan, July	..	..
5	3/0	Chelsea Electric Supply Ord.	4 —4¼	5 11 0	March ..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	98 —100	4 11 0	June, Dec	..	..
10	8/0	City of London Electric Lighting Ord.	12½—12¾	4 16 0	Feb, Aug	12½	12⅛
10	6/0	Do. 6 per Cent. Cum. Pref.	12 —13	4 16 0	Jan, July	..	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	119 —123	4 2 9	June, Dec	..	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	100 —103	4 8 6	Jan, July	102¼	..
St.	5%	County of Durham Elec. P. D. 5% 1st Mort. Deb. Stk.	89½—91½	5 10 6	Jan, July	..	..
10	4/0	County of London Elec. Supply Ord.	7⅛—7½	3 5 9	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11 —11½	5 6 6	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Deb Stock (red.)	108 —110	4 2 6	Jan, July	..	..
St.	4½%	Do. Second Deb. Stock	100 —103	4 7 6	May, Nov	..	..
..	..	Edmundson's Elec. Corp. Ord.	⅛—¼	..	Jan, July	..	..
5	..	Do. 6 per Cent. Cum. Pref.	2¼—2½	..	May, Nov	..	..
St.	4½%	Do 4½ per cent. 1st Mort. Deb. (red.)	83 —86	5 6 6	July	..	..
5	4/0	Folkestone Electricity Supply Co. Ord.	4½—5	6 6 0	April, Oct	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4¾—5¼	4 15 3	Mar, Sept	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red)	95 —98	4 13 3	Feb, Aug	..	..
5	5/0	Hove Electric Lighting Ord.	6⅞—7⅛	6 4 0	April, Oct	..	..
St.	4½%	Isle of Wight E. L. & P. Co. Deb. Stk.	88 —91	4 19 0	..	..	..
5	4/0	Kensington & Knightsbridge Ord.	6¾—7⅛	6 18 6	Feb, Aug	..	..
5	6%	Do. 6 per Cent. 1st Pref.	5¾—6	5 0 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	91 —93	4 6 0	..	91½	91½
St.	4%	Kensington & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	96 —99	4 1 0	April, Oct	..	..
St.	4½%	Kent Elec. Power Co. Irred Deb. Stk.	80 —84	5 10 0	Jan, July	..	..
3	1/2½	London Electric Supply Ord.	1⅛—2	3 8 0	Mar, Sept	..	..
5	3/0	Do. 6 per Cent. Pref.	4¼—5	6 3 0	Mar, Sept	4⅛	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb	89 —92	4 8 0	Jan, July	91½	89½
5	2/0	†Metropolitan Electric Sup. Ord.	3¾—4¼	6 0 0	April, Oct	..	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	4¼—4¾	4 17 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	100 —105	4 8 0	June, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	84½—87½	4 1 6	Jan, July	..	..
..	4½%	Midland Elec. Corp. for P.D. 4½ 1st Mort. Debs	96½—98½	4 12 6	..	..	..
5	2/0	Newcastle Elec. Supply Ord. (1-50,000 & 57,010-137,500)	3¼—4	6 0 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non Cum. Pref.	4 —4½	5 17 6	Feb, Aug	..	..
100	4½%	Do. 4½ per Cent. 1st Mort. Deb.	97 —99	4 12 0	Jan, July	..	..
100	5%	North Metro. Elec. Power Sup. 5 Morts.	101 —104	4 17 6	..	..	..
1	6%	Northampton Elec. Lt. & P. Ord.	1¼—1⅜	4 11 6	Feb, Aug	..	..
1	5%	Do. 5% Pref.	1⅛—1¼	4 6 0	Feb, Aug	..	..
St.	4%	Do. 4% Debs.	99 —101	3 19 0	June, Dec	..	..
10	6/0	Notting Hill Electric Ord.	..	5 17 6	March	..	..
8	4/3	Oxford Electric Ord.	6¼—5⅞	5 10 0	March	..	..
St.	4%	Do. 4% Deb. Stk.	91 —94	4 5 1	..	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	8¼—9¼	5 11 0	Feb, Aug	8¼	..
5	3/6	Do. 7 per Cent. Pref.	6¾—7¼	5 0 0	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	85 —87	4 1 6	Jan, July	85¼	..
5	..	Smithfield Markets Electric Sup. Ord.	1⅛—1⅞	..	Feb.	..	..
5	4/0	South London Electric Supply Ord.	2¾—3	6 5 6	April	..	..
St.	5%	Do. 5% 1st Mort. Stock (red.)	98½—101½	5 0 6	..	..	..
1	0 8/3	South Metrop'n Elec. Lt & Power 7% 1st Pref	1⅜—1¾	5 18 0	Feb, Aug	..	..
1	0/7½	Do. 6 per Cent. 2nd Pref.	⅞—1	6 17 0	Feb, Aug	..	..
1	4½%	Do. 4½ 1st Deb. Stock (red.)	97 —100	4 11 6	April, Oct	99½	..
St.	1/3	Urban Electric Supply Ord.	¾—1	..	April, Oct	..	..
5	1/3	Do. 5 per Cent. Cum. Pref.	2¼—2½	10 0 0	April, Oct	..	..
5	4½%	Do. 4½ per Cent. 1st Mort. Deb.	87½—89½	5 1 9	April, Oct	89	..
5	5/0	†Westminster Elec. Sup. Ord.	7⅛—8	6 15 6	Mar, Sept	7⅛	7⅛
5	2/3	Do. 4½ per Cent. Cum. Pref.	5 —5⅛	4 3 6	Jan, July	5	..
		Electric Railways and Tramways.					
1	..	Bath Elec. Trams Pref. Ord.	⅞—1	..	April	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	¾—⅞	8 0 0	Jan, July	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	79 —83	5 8 6	April, Oct	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Deb. Stock.	91 —93	4 17 9	Jan, July	..	..
10	4%	†Bristol Tramways & Carriage Ord.	5¾—6¼	6 13 6	Feb, Aug	..	..
10	4%	Do. Cum. Pref.	7 —7½	5 10 0	..	..	..
St.	4%	Do. 4 per Cent. Debs.	100 —101	3 19 2	Feb, Aug	..	..
10	..	British Electric Traction Ord.	¾—1⅛	..	June, Dec	..	..
10	..	Do. 6 per Cent. Cum. Pref.	3¾—4	..	Feb, Aug	3⅜	3⅛
St.	5%	Do. 5 per Cent. Perpetual Debs.	94 —97	5 4 6	April, Oct	94	..
St.	4½%	Do. 4½ per Cent 2nd Deb. Stock	75 —79	5 17 0	May, Nov	..	..
St.	3%	†Central London Ordinary Stock	67 —69	4 8 0	Feb, Aug	67	..
St.	4%	†Do. 4 per Cent. Pref. Stock	85 —87	4 13 0	Feb, Aug	85½	..
..	6/4	Do. 4½% Pref. Scrip 50% pd	63 —65	..	..	..	..
St.	2%	Do. Deferred Stock	49 —51	4 0 0	Feb.	49	..
100	4%	Do. 4 per Cent. Debs.	102 —104	3 16 11	Jan, July	..	..
5	2/6	City of Birmingham Trams, 5% Cum. Pref.	4⅞—5⅛	4 19 6	April, Oct	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 18 9	April, Oct	..	..
St.	1½%	City & South London Rly. Con. Ord.	29 —30	5 19. 0	Feb, Aug	30½	29½
St.	5%	Do. 5 per cent. Perp. Pref. (1891)	108 —110	4 11 9	Feb, Aug	..	..
St.	5%	Do. (1896)	104 —106	4 16 0	Feb, Aug	..	..
St.	5%	Do. (1901)	103 —105	4 17 0	Feb, Aug	104½	..
St.	5%	Do. (1903)	102 —104	4 16 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	102 —104	3 17 9	May, Nov	104	..
10	6/0	†Dublin United Trams, 6 per Cent. Pref.	11½—12½	5 0 0	Feb, Aug	..	..
10	12/0	Gateshead and District Trams Ord.	8½—8¾	6 19 0	..	..	..
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	¾—1⅛	..	Feb, Aug	..	..
5	..	Hastings & District Elec. Trams, 6% C. P.	..	..	Mar, Sept	..	..
St.	4½%	Do. 4½ Deb. Stock	75 —80	5 10 0	April, Oct	..	..
10	..	Imperial Tramways Ord.	3 —3½	..	Mar, Sept	..	..
10	..	‡Do. 6 per Cent. Pref.	4 —4¼	..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Debs.	72 —74	6 3 6	Jan, July	..	..
..	2/0	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	2½—3	4 11 0	Mar, Sept.	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	77 —82	5 1 0	Jan, July	..	..
10	5/6	†Lanarkshire Tramways	9¾—10½	5 15 0	Feb, Aug	..	..
St.	5%	Lancs Utd. Trams, 5% Prior Lien Deb. Stk.	79 —82	6 4 0	Jan, July	..	..
St.	4%	London Electric 4% Deb. St.	96 —98	4 2 6	..	97½	97½
St.	4%	†Do. 4% Pref.	82½—83½	4 16 6	..	83½	82½
10	..	London United Trams, 5% Cum. Pref.	3½—3¾	..	Jan, July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	73 —76	5 7 6	Jan, July	..	..
St.	..	Mersey Con. Ord. Stock	6 —8	..	Feb, Aug	..	..
1	1/1½	*Metropolitan Elec. Tramways Ord.	¾—1⅛	6 0 0	..	..	..
1	..	Do. Deferred	⅞—1	..	April	..	..
1	0/6	†Do. 5 per Cent. Cum. Pref.	¾—1	5 8 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	99 —101	4 10 0	Jan, July	100	99½
St.	5%	Do. 5 per Cent. Db. Stk	102½—104½	4 16 6	..	103½	..

* No allowance has been made for accrued interest or redemption.
† Ex Dividend ‡ The London Stock Exchange Committee have declined to quote this.

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ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Class	Last Dividend	NAME.	Price Wed., Aug. 30.	*Rate per cent. Yielded. £ s. d.	Dividend Due.	Business Week to Aug. 30. High-est.	Low-est.
		Electric Railways and Tramways—*Continued.*					
St.	2%	Metropolitan Railway Consolidated	43½–43¾	4 12 0	Feb, Aug	45	43
St.	3%	Do. Surplus Lands Stocks	65 –67	4 11 0	Feb, Aug	66½	65½
St.	3½%	Do. 3½ per Cent. Preference	88 –90	3 18 6	Feb, Aug	88½	..
St.	3½%	Do. 3½ per Cent. "A" Preference	87 –89	3 19 6	Feb, Aug	87½	87½
St.	3½%	Do. 3½ per Cent. Convertible Pref.	87 –89	3 19 6	Feb, Aug	88	..
St.	3½%	Do. 3½ per Cent. Debenture Stock	92 –94	3 14 6	Jan, July	92½	..
St.	3½%	Do. 3½ per Cent. "A" Deb. Stock	91 –93	3 16 0	Jan, July	..	..
St.	..	Metropolitan District Railway Ord.	24 –24½	..	Feb, Aug	26½	23½
St.	4½%	†Do. 4½% First Pref.	86 –88	5 3 6	Feb, Aug	87	86½
St.	3½%	Do. Assented 1st Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	74 –76	4 13 6	Feb, Aug	75	..
St.	3%	Do. 3 per Cent. Consoltd. Rent-charge	76 –78	3 18 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Midland Rent-charge	102 –104	3 17 9	Jan, July	146	145½
St.	6%	Do. 6 per Cent. Perp. Deb. Stock	145 –147	4 2 0	Jan, July	197½	196½
1	4%	Do. 4 per Cent. Ditto	96 –98	4 2 6	Jan, July	..	..
1	4½d.	Potteries Electric Traction Ord.	⅞–1⅛	6 11 3	April, Oct	..	..
St.	0/6	† Do. 5 per Cent. Cum. Pref.	1⅛–1⅜	8 9 6	Feb, Aug	..	..
1	4½%	Do. 4½ per Cent, Deb. Stock	88 –91	5 0 0	May, Nov	..	..
St.	1/2½	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	1⅜–1⅝	10 2 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	73 –78	5 6 0	Jan, July	..	..
100	5%	Sunderland Dist. Elec. Trms. 5% 1stMtDb.	..	8 4 0	Jan, July	..	..
—	10/0	Undergd E. Rys. Lon. 6% 1n. bds with coup 7	60 –62	1 12 6	June, Dec	61½	60½
—	5%	Do. 5% Prior Lien Bonds	100½–101¼	4 19 0	..	99½	99
1	4½%	Do. 4½% Bonds with coup. 8	98 –100	4 11 0	..	..	..
1	4%	Do. 4 per Cent. 1st Power Ho. Dbs.	101 –103	3 18 3	..	..	..
5	—	Yorkshire (W.R.) Elec. Trams. Ord.	¼–½	..	March ..	..	..
5	—	Do. 6 per Cent. Cum. Pref.	2½–2¾	..	..	..	..
St.	4½	Do. 4½ per Cent. 1st Debs.	80 –85	5 9 6	Jan, July	..	..
		Electric Manufacturing, &c.					
St.	4½%	Anchor Cable Co. 4½ % Deb. Stock	99 –101	4 10 0	..	..	..
1	1/2½	Aron Electricity Meter Ord.	⅛–¼	..	..	..	..
1	0/7½	Do. 6% Cum. Pf.	⅛–⅜	7 10 0	April, Oct	5⅛	5⅛
1	3/2½	Babcock & Wilcox Ord.	5⅛–5⅜	4 14 6	April, Oct	..	..
1	0/7½	Do. Pref.	1⅜–1⅝	4 0 0	..	..	..
5	6/0	British Insulated & Helsby Cables Ord.	6½–7⅛	6 15 6	July, Feb	7	..
5	3/0	Do. 6 per Cent. Pref.	5⅛–6½	5 0 0	Jan, July	6⅛	6
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	102 –104	4 7 0	Jan, July	103½	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt.Db.	96 –99	4 11 0	Jan, July	..	..
5	..	British Westinghouse 6 per Cent. Pref.	⅛–¼	..	Mar, Sept	..	..
100	6%	Do 6 per Cent. Prior Lien Dbs. (rd.)	102 –104	5 17 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	59 –62	6 6 6	..	60½	..
St.	4½%	Brush E. Eng. Co. 4½% Perp. 1st Deb. Stock	58 –63	7 8 6	Jan, July	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	39 –44	10 10 0	Mar, Sept	..	..
5	10/0	Callender's Cable Con. Ord.	9⅛–9½	7 10 0	Jan, July	9⅛	..
5	2/6	Callender's Cable Con. Pref.	4⅛–5⅛	4 19 0	Jan, July	5⅛	..
St.	4½%	Do. 4½ per Cent. 1st Mort Debs. (red.)	101 –103	4 8 0	Jan, July	104	..
1	1/6	Castner-Kellner Alkali Co.	3⅛–3⅜	5 4 3	Nov, May	3⅛	3⅛
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	102 –105	4 7 0	May, Nov	..	..
1	1/0	Chadburn's (Ship) Telegraph Ord.	1⅛–1⅜	5 19 0	Feb. Aug	..	..
1	0/8½	Consolidated Electrical Co.	⅛–¼	7 8 9	March ..	..	..
1	0/6	Consolidated Signal Co.	⅛–¼	8 7 6	August ..	..	..
1	0/7½	Do. 6 per cent. Cum. Pref.	⅛–¼	7 6 6	April, Oct	..	..
3	..	Crompton & Co (Nos. 1 to 85,000)	⅛–¼	..	April, Oct	..	..
100	5%	Do. 5 per Cent. 1st Mort. Debs. (red.)	57⅛–67⅛	8 0 0	Jan, July	..	..
5	1/0	Dick, Kerr & Co. Ord.	⅛–¼	5 14 0	Jan, July	..	..
5	0/7½	Do. 6 per Cent. Cum. Pref.	⅛–1½	5 6 0	Sept ..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	95 –98	4 13 3	Sept ..	..	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	⅛–¼	..	Jan, July	..	..
		Do. (£5 paid)	1½–2⅛	9 3 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (red.)	67 –71	5 16 0	June, Dec	70½	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	78 –81	6 3 6	Mar, Sept	..	..
2	2½%	Electric Construction Co.	⅞–1	6 3 0	Jan, July	..	..
2	2/9½	Do. 7 per Cent. Cum. Pref.	1⅛–1⅜	7 4 6	July ..	..	..
St.	4%	Do 4 per Cent. Perp. 1st Mort. Debs.	75 –76	5 6 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	8½–9	5 14 0	June, Dec	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	88 –93	4 8 6	Mar, Sept	..	..
5	10/0	Henley's Telegraph Works Ord.	12½–12¾	5 16 6	Feb, Aug	..	..
St.	2/3	Do. 4½ per Cent. Pref.	5 –5½	4 8 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	105½–108½	4 3 6	Mar, Sept	13½	..
10	15/0	India Rubber, Gut. Per., &c., Works	12 –14	6 0 0	Feb, Aug	..	..
10	5/0	Do 5 per Cent. Cum. Pref.	9½–10½	4 19 0	..	..	..
100	4%	Do 4 per Cent. Debs. (red.)	95 –97	4 3 3	April. Oct	..	..
1	..	National Elec. Construction Co.	⅛–¼	..	April	..	..
1	..	Richardsons, Westgarth & Co., Ltd. Ord.	⅞–1	..	Nov	..	..
1	..	Do. 6 per Cent. Cum. Pref.	⅛–¼	..	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. Perp. Deb. Stock	77 –80	5 14 6	Jan, July	..	..
5	..	Simplex Conduits 6 per Cent. Cum. Pref.	4½–5	..	..	..	..
12	12/0	Telegraph Construction & Maintenance	34½–36½	6 9 9	Mar, July	..	..
100	4%	Do. 4 per Cent. Deb. Bonds (1909)	100 –102	3 19 3	Jan, July	..	..
1	1/0	†Vickers, Sons & Maxim, Ltd., Ord.	1⅜–2⅛	5 0 0	..	2⅛	1⅝
1	0/6	†Do. 5 per Cent. non-Cum. Preference	1⅛–1⅜	4 3 0	..	..	..
St.	5%	†Do. 5 per Cent. non-Cum. Preferred	107 –111	4 11 6	..	110½	..
St.	4%	Do. 4 per Cent. 1st Mort. Db. Stk. (red)	99½–101½	3 19 6	June, Dec	100½	99
100	4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.)	103 –105	4 6 6	June, Dec	..	..
100	5%	Do. 5 per Cent. 3rd Mort. Debs Scrip.	103 –105	4 16 0	..	104½	..
10	12%	J. G. White & Co. 6% Cum. Pref.	14½–15½	7 14 10	..	15⅜	..
1	..	Willans & Robinson Ord.	⅜–⅝	..	Apr, Oct	..	..
5	..	Do. 6 per Cent. Cum. Pref.	⅞–1	..	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	55 –65	6 3 0	May, Nov	..	..
		Telegraphs.					
10	..	Amazon Telegraph	7⅛–7½	..	June, Dec	..	..
100	5%	Do. 5 per Cent. Debs. (red.)	98½–100½	5 0 5	Jan, July	..	..
St.	15/0	Anglo-American	67½–69½	4 8 3	F,My,Ag,N	..	..
St.	30/0	Do Preferred	111½–112½	5 7 0	F,My,Ag,N	112½	111½
St.	30/0	Do. Deferred	25½–25⅞	5 7 0	F,My,Ag,N	25½	25⅛
St.	4%	Commercial Cable 4 per Cent. Deb. Stk.	87½–89½	4 10 6	Jn,Ap,Jy,O	89	86½
10	6/0	Cuba Submarine Ord.	10½–11	5 13 0	Feb, Aug	10⅜	..
10	10/0	Do. Preference 10 per Cent.	17½–18½	5 13 0	Feb, Aug	..	..
½	2/0	Direct Spanish Ord.	3½–4	5 0 0	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	8½–8¾	5 16 0	April, Oct	..	..
50	4½%	Do 4½ per Cent. Deb.	100 –102	4 9 0	Jan, July	..	..
10	3/0	Direct United States Cable	7⅞–8½	6 3 0	Ja,Ap,Jy,O	8½	8
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	99 –101	4 10 0	June, Dec	..	..
St.	25/0	Eastern Ordinary	136 –139	5 2 0	Ja,My,Jy,O	138½	136½
St.	17/6	Do. 3½ per Cent. Pref. Stock	84 –86	4 2 6	Ja,My,Jy,O	85½	84
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (red.)	102 –104	3 17 9	May, Nov	103½	103
St	2/6	Eastern Extension	13¾–14	5 2 0	Ja, Ap, Jy, O	13⅜	13½
10	4%	Do. 4 per Cent. Deb. Stock	103½–102½	3 19 0	Feb, Aug	101½	101½
25	4%	Eastern and S.Af., 4% Mauritius Sub. Debs	100 –102	3 19 0	May, Nov	..	..
10	5/0	G.N (of Copenhagen), with Coupon 83	31 –32	5 14 3	Jan, July	31	..
25	52/6	Indo-European	56½–58½	5 5 6	May, Nov	58	..
100	5%	Mackay Companies Common	86 –88	5 15 0	Ja,Ap,Jy,O	..	..
100	4%	Do. Preference	76 –78	5 4 0	Ja,Ap,Jy,O	..	..
1	1/0	Marconi's Wireless Teleg. Co.	2⅛–2⅜	..	April	2½	2½
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (red.)	99½–101½	3 19 9	June, Dec	..	..
2½	1/3	West Coast of America	1⅛–1⅜	5 0 0	May	..	..
100	4%	Do. 4 per Cent. Debs.	98 –100	4 1 0	Jan, July	..	..
10	1/6	West India & Panama	2⅜–2½	4 11 0	May, Nov	2½	2½
10	6/0	Do. 6 per Cent. 1st Pref.	10⅛–10⅝	5 16 6	May, Nov	..	..
10	6/0	Do. 6% 2nd Pref.	9⅛–10⅛	6 0 0	May, Nov	..	..
100	5%	Do. 5 per Cent. Debs.	101 –103	4 18 0	Jan, July	..	..
10	3/0	Western Telegraph	13¼–14	5 2 0	Mr,Jn,O,D	13⅜	13⅛
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	100 –103	3 19 0	June, Dec	101½	..
—	4%	Western Union Telegraph, $1,000 4% Bds	107 –110	3 13 9	..	..	..
—	4½%	Do. $1,000 4½% Fdg. & Rl. Est. Gd. Bnds	101 –104	4 8 0	..	..	..
		Telephones.					
		Amer. Telephn. & Telegh. Cap. St.	135 –137	5 18 0	..	..	..
		Do. Coll. Trust $1,000 4 per Cent. Bds.	94 –96	4 4 0	Jan, July	..	..
		†Do. 4% Cons. Bonds 1936	106 –108	3 14 9	..	..	..
		Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101½–103½	4 17 6	Mar, Sept	..	..
		Chili Telephone	6⅛–7⅛	4 5 9	August ..	..	..
		Monte Video Telephone Ord.	⅛–1	6 0 0	Nov	..	..
		Do. 5 per Cent. Pref.	⅛–¼	5 11 0	May, Nov.	..	..
		National Co. Pref. Stock	104 –106	5 14 0	Feb, Aug	106	104
		Do. Def. Stock	117½–120½	5 1 0	Feb, Aug	119½	..
		Do. 6 per Cent. Cum. 1st Pref.	10 –10½	5 11 6	Feb, Aug	..	..
		Do. 6 per Cent. Cum. 2nd Pref.	10 –10½	5 11 6	Feb, Aug	..	..
		Do. 5 per Cent. non-Cum. 3rd Pref.	9⅜–5⅝	4 11 0	..	..	..
		Do Deb. Stock 3½ per Cent. (red.)	98½–100½	4 0 6	June, Dec	..	..
		Do. 4 per Cent. Deb. Stock (red.)	98½–100½	4 0 6	Jan, July	..	..
		New York Telephone Co. 30 yr. Bnds.	102½–103½	4 7 6	..	..	..
		Oriental	1⅛–1⅜	4 18 0	April, Oct	..	..
		Do 6 per Cent. Cum. Pref.	1⅜–1⅝	4 16 0	April, Oct	..	..
		Do. 4 per Cent. Red. Deb. Stock	88 –90	4 10 0	Jan, July	..	..
		Telephone Co. of Egypt 4½% Db. Stk. (red.)	99 –101	4 10 0	Jan, July	..	..
		United River Plate Ord.	7⅛–7½	5 8 5	July	..	..
		Do. 5 per Cent. Cum. Pref.	5⅛–5⅜	4 13 0	June, Dec	..	..
		Do. 4½ Deb. St. Red.	102½–104½	4 7 0	Jan, July	..	..
		Financial, Investment, &c.					
		Elec. & Gen. Investment 6% Cum. Pref.	4 –4½	7 1 0	Jan, July	..	..
		Globe Telegraph & Trust	10⅜–11½	5 10 3	Sp,Dcbr,Ju	..	..
		Do. 6 per Cent. Pref.	13 –13½	4 10 9	Sp,Dcbr,Ju	..	..
		Submarine Cables Trust (Cert.)	132 –135	4 10 0	April, Oct	..	..
		Colonial and Foreign Electric Railways, Tramways, &c.					
		Anglo-Argentine 5½% Cum. 1st Pref.	5⅛–5⅜	4 17 6	April, Oct	..	..
		Do. 5½% Cum. 2nd Pref.	4¾–5	5 12 9	Jan, July	..	..
		Do. 4% Deb. Stock	94 –96	4 3 4	June, Dec	..	..
		Do. 4½% Deb. Stock	101 –103	4 8 3	..	..	..
		Do. 5% Deb Stock	101 –103	4 18 0	..	..	..
		Auckland Elec. Trams. 5% Deb. (red.)	102 –105	4 16 6	Jan, July	..	..
		Brisbane Electric Trams. Invest. Ord	6⅜–7⅛	5 16 3	May	..	..
		Do. 5 per Cent. Cum. Pref.	5 –5⅜	4 17 6	May, Nov	..	..
		Do. 4½ per Cent. Db. Prov. Certs.	102 –105	4 7 0	Jan, July	..	..
		British Columbia El. Rly. Df. Ord.	139 –143	5 13 6	Mar, Sept	..	..
		Do. Pref. Ord. Stock	119 –123	4 19 9	May, Nov	..	..
		Do. 5% Cum. Perp. Pref. Stock	106 –109	4 13 0	Jan, July	..	..
		Do. 4½ per Cent. 1st Mort. Debs.	100 –103	4 7 6	April, Oct	..	..
		Do. Vancouver Power Debs.	101 –104	4 3 3	Jan, July	..	..
		Do. 4½% Perp. Con. Deb. St.	103 –105	4 1 6	..	..	..
		†Buenos Ayres Lacroze Trams 1st Mt. Db.	98 –100	5 1 0	Mar, Sept	..	..
		Buenos Ayres Port & City Tram, 1st Mt. Deb. Stock	92 –96	6 8 0	Feb, Aug	..	..
		Calcutta Tramways (1 to 137,610)	5⅜–6⅛	4 19 6	Mar, Sept	..	..
		Do. 5 per Cent. Cum. Pref.	5 –5⅛	4 17 6	Jan, July	..	..
		Do. 4½% 1st Deb. Stock (red)	102 –105	4 5 9	Jan, July	..	..
		Cape Electric Tram Shares	⅜–½	..	..	..	..
		†City of Buenos Ayres Trams Co. (1904) Sh.	5⅛–5⅜	4 8 0	F,My,A,N	..	..
		Do. 4 per Cent. Deb. Stock	94 –97	4 4 0	June, Dec	..	..
		Colombo Tr. & Ltg. 5% 1st Mt. Db.	95 –100	5 2 6	May, Nov	..	..
		Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	100 –103	4 19 0	Feb, Aug	..	..
		Hong Kong Tramways Co. 5 per Cent. 1st Mort. Debs.	77 –81	6 6 6	June, Dec	..	..
		Kalgoorlie Elec. Trams Sh.	⅛–¼	..	..	..	..
		Do. 5 per Cent. "A" Deb. Stock	92½–95⅛	5 4 6	Jan, July	..	..
		Do. 6 per Cent. "B" Ditto	63 –67	8 15 0	July	..	..
		Lisbon Elec. Trams. Ord.	1 –1⅛	4 16 0	Jan, July	..	..
		Do. 6 per Cent. Cum. Pref.	1 –1⅛	4 16 0	Jan, July	..	..
		Do. 5 per Cent. Reg. Mort. Debs.	97 –101	5 1 0	Jan, July	..	..
		Madras Elec. Trams. 5% Deb. Stk.	95 –98	5 3 6	..	..	..
		Manaos Trams and Lt. Co. 5% Debs	88 –91	5 12 0	..	..	..
		†Manila Elec. Ry. $1,000 Gold Bonds	97½–99½	5 1 0	Feb, Aug	..	..
		Mexico Trams Co. Com. St.	119 –121	5 15 9	..	..	..
		Do. Gen. Con. 1st Mort. 5% Gold Bds.	99½–100½	5 0 0	..	..	..
		Do. 6% 50 yr. Mort. Bds.	98½–100½	6 0 6	..	..	..
		Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922) (Nos. 601 to 2,000)	100 –102	4 9 0	Feb, Aug	..	..
		Do. do. (Nos. 1 to 4,600)	102 –104	4 7 6	..	..	..
		Perth Elec. Trams Ord.	⅛–1⅛	2 10 0	May	..	..
		Do. 1st Mt. Db. Stock	101½–103½	4 17 6	Jan, July	..	..
		Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	5⅛–5⅜	5 8 0	—	..	..
		Do. 4½% 1st Mort. Deb. Stk.	98 –101	4 10 6	—	..	..
		Rio Janeiro Tram, Lt. & P. Co.	115⅛–116⅛	4 6 0	—	..	..
		Do. 30 yr. Gold Bnds.	101½–102½	4 18 3	—	..	..
		Do. 50 yr. Mt. Bnds	97⅛–98⅛	5 2 0	—	..	..
		Sao Paulo Tramway, Light & Power Co. $100 Stock	178 –181	5 11 6	..	..	..
		Do. 5 per Cent. 1st Mt. $500 Db.	103 –105	4 15 3	June, Dec	..	..
		Toronto Ry. Co 1st Mt. 4½% Ster. Bonds	99 –101	4 10 0	Feb, Aug	..	..
		Colonial and Foreign Electricity Supply, &c.					
		Adelaide Elec. Sply Co. 6% Cu. Pr.	5⅛–5⅜	5 8 0	Mar, Sept	..	..
		Bombay E.S. & T. 6% Cm. Pf.	10⅜–11⅛	5 9 0	..	..	..
		Do. 4½ per Cent. Deb. Stk. (rsd)	96½–98½	4 12 0	Jan, July	..	..
		Do. 5 per Cent. 2nd Mort. Deb. Stock	97 –99	5 2 0	..	..	..
		Calcutta Elec. Supply Ord.	6⅜–7⅛	5 19 6	April, Oct	..	..
		Do. 5% Cum. Pref	4⅛–5⅜	4 13 0	..	..	..
		Calgary Power Co. 5% 1st Mort. Bnds.	96 –98	5 2 0	..	..	..
		Canadian Gen. Elec. Co. Com. St.	107 –112	6 8 0	..	..	..
		Do. 7% Cm. Pf. Stock	121 –125	5 14 0	..	..	..
		Castner Electrolytic Alkali Co (of U.S.A.) 1st Mort. Stl. Debs.	94 –99	5 3 6	Jan, July	..	..
		Elect. Development Co. of Ontario	83 –90	5 12 0	..	..	..
		Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	84½–87½	5 4 0	Jan, July	..	..
		Indian Elec. Sup. & Trac. Co.	1 –1⅛	..	..	..	..
		Kalgoorlie Elec. Power & Ltg. Ord.	⅛–¼	..	..	..	..
		Do. 6 per Cent. Cum. Pref.	⅛–¼	8 6 6	April, Oct	..	..
		Kaministiquia Power Co. 5% Gold Bnds.	101 –103	4 18 0	..	..	..
		Madras E. S. Corp. Ord.	2⅛–3⅛	..	..	..	..
		Melbourne E. S. Co. Cons. Ord. St.	37 –42	..	..	..	..
		Do. 5% 1st Mortg Deb. Stock	95 –97	5 4 0	..	..	..
		Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	88½–89½	5 10 9	..	..	..
		Mexican Lt. & Power Co. Com. St.	87 –89	4 11 0	..	..	..
		Do. 7% Cum. Pref. St.	107½–109½	6 9 0	..	..	..
		Do 5% 1st Mort. Gold Bnds.	95½–97½	5 3 6	..	..	..
		Montreal Lt. Ht. & P. Co., 1st Mort. Db. Sk.	89 –91	5 11 6	F,My,A,N	..	..
		Montreal Lt. Ht. & Power Co. Cap. St.	165 –170	5 18 6	..	..	..
		Northern Lt. Power & Coal 5% Gd. Bds	39 –41	6 5 0	April	..	..
		River Plate Electricity Co. Ord. Stk.	218 –228	4 7 9	May	..	..
		Do. 6 per Cent. non-Cum. Pref. Stk.	107 –114	5 5 0	Jan, July	..	..
		Do. 5 per Cent. Deb. Stock	101½–103½	4 17 6	..	..	..
		Shawinigan Water & Power Co. Cs.	114 –116	4 7 0	Jan, July	..	..
		Do. 5 per Cent. Bds.	107 –109	4 12 6	..	..	..
		Do. 4½ Per Con. Mt. Db. St.	103 –105	4 6 0	..	..	..
		Toronto Power Co. 4½% Db. St.	99 –101	4 8 0	July	..	..
		Victoria Falls Power Co. Pref.	11·85				

* No allowance has been made for accrued interest or redemption. † Ex Dividend. ‡ The London Stock Exchange Co...

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NOTES.

An Alarming Suggestion.

IT appears that the London County Council are accepting the idea, without any substantial reason for doing so, that some of the recent large fires in the Metropolis were caused by defective wiring; and it is stated that the Council are considering the desirability of making a regulation to the effect that electric wires in all buildings where hotel or sleeping accommodation is available for the public shall be encased in steel tubing throughout. This seems to be another case of legislation by those who are not well acquainted with the technical points involved. Steel tubing is no doubt excellent in many ways, but in some respects wood casing is equally good, so that it is very doubtful if anything is to be gained by stipulating any particular system in general. As a matter of fact, any risk is not as a rule associated with the system used, but is due to details and to those parts of the wiring where the work is not carried out in as thorough a manner as it should be. It would be much more to the point if the Council were to insist upon proper inspection of the work in places of this kind, rather than to make a bye-law which would inflict a deal of hardship without necessarily doing any good.

Gas Progress.

COMPETITION between the electrical and gas industries has been very keen in the past, but it is likely that the future will see even a still more desperate attempt by the latter not only to retain the lighting load which they now possess, but to recapture some of the consumers who have been won over by the advantages of electric lighting. Electrical engineers would therefore be well advised to follow closely any developments, such as new gas lamps of higher efficiency, so that they may be fully informed as to how electrical apparatus compares from the point of view of economy as well as convenience, cleanliness and reliability. A new Nico inverted gas lamp is one of the most recent and, if reports are correct, will shortly be one of the strongest weapons in the hands of the gas industry. This is a low pressure lamp which, it is claimed, gives 42 c.p. per cub. ft. of gas per hour. This figure is stated (by the "Journal of Gas Lighting") to be that of an independent "gas tester." Our contemporary also mentions that the principles of the lamp are not for description at the present stage, but the lamp is already made in sizes of 500 c.p., 750 c.p. and 1,000 c.p., and doubtless it will soon be seen in use. Although the above-mentioned efficiency may have been obtained in a laboratory, and is scarcely likely to be maintained in street or outside illumination, the lamp will apparently prove a strong competitor of electric lamps during the coming lighting season wherever large lighting units are required. The high candle-power metal lamp, however, is likely to hold its own and to become increasingly popular, since its light does not appreciably diminish even after 1,000 hours' use, and no attention whatever is necessary to ensure that the lamp will maintain its rated candle-power.

Tramway Accidents.

THE safety of railway travelling in this country is proverbial, and although slight tramway accidents are of somewhat frequent occurrence there have been but few in the last year or two that have resulted in loss of life. It is, therefore, noteworthy that two serious tramway accidents occurred last Saturday afternoon. The one at Glasgow, due to the illness of a motorman, is, however

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quite overshadowed by the disaster on the London County Council's system. These tramways, considering their size and the exceptional traffic difficulties, have been comparatively free from serious accidents, but that which occurred last week proved exceptionally disastrous. For the present the cause of the car leaving the rails is shrouded in mystery, and owing to the conflicting evidence as to the state of the rails it is likely to remain so. It is noticeable that the large majority of serious tramway accidents occur at more or less sharp curves in the track; and as the lay-out of such curves necessitates the negotiation of them by the cars at very low speeds it would seem desirable for all curves to be inspected by some authority with a view to possible alteration. Since tramcars have to compete with motor traffic, any reduction in speed would now be a serious handicap; but if present speeds are to be maintained it is essential that great attention should be paid to the maintenance of the track in a clean and good condition.

Production of Light.

THE production of light is one of the most fascinating of subjects, partly because we know so little of the ultimate phenomena underlying some of the processes of production, and partly because of the enormous possibilities that are yet open to the patient investigator. The present methods of producing light are extraordinarily inefficient, and yet during the last few years great advances have been made. The metal filament lamp, the flame arc lamp, the vacuum tube, operated either as a mercury arc or by an electric discharge, all indicate a movement in the right direction. A very great deal, however, yet remains to be done if we are to approach the efficiency of Nature, though certainly the station engineer does not wish this efficiency to be approached too closely. But we do not doubt that there are many investigators who are keenly anxious to produce a truly cold light, either by means of the electric discharge or by means of fluorescence, and thus to emulate the hitherto unrivalled efficiency of the firefly. The engineer wishing to approach this subject from the more theoretical standpoint finds himself at a disadvantage in that the subject in some respects is by no means simple, and further the literature on the subject is more or less scattered, so that it is not easy to find what has been done without spending a good deal of time in looking up various publications. We therefore think that our readers will welcome the series of articles, the first of which appears in our present issue, by Dr. R. A. HOUSTOUN, as they present the subject, although briefly, from many points of view.

The "Telefunken Zeitung."—We have received from Berlin a copy of the first number of this periodical, which is edited by Mr. H. Bredow, and is devoted to the interests of the Gesellschaft für Drahtlose Telegraphie. The present issue contains a photograph commemorative of the visit of the Emperor William to the Nauen station. There is also an historical article on the progress of the Telefunken Co. and other matters of current wireless interest.

Cable Interruptions.	Date of Interruption.
Assab—Perim	July 8, 1909
Latakia—Palura	May 26, 1910
Zanzibar—Mombasa	July 11, 1911
Sabang—Koetaradja	Aug. 18, 1911
Kotonou—Grand Bassam	Aug. 23, 1911
San Thiago—Bathurst	Sept. 4, 1911
Bathurst—Sierra Leone	Sept. 4, 1911

Electric Lighting of Westminster Abbey.—Westminster Abbey, which has been closed since March 31st on account of the Coronation, was opened on Tuesday last for the usual services. The lighting of the nave is now effected by electricity instead of by gas.

Telegraph Union Monument.—"The Times" announces that the International jury have chosen the design submitted by Signor Giuseppe Romagnoli, of Bologna, for the International Telegraph Union monument. The design represents Helvetia seated and having on either side figures representing Trade, Labour and the various professions.

London Electricity Supply Works Survey.—The Chief Commissioner of Metropolitan Police (Sir E. R. Henry) is having a survey made of the electricity supply works, power stations, gas works, &c., within the Metropolitan Police area, with the view of collecting information for the guidance of the police in future industrial disputes.

New Director of the Science Museum.—It is announced that Mr. F. C. Ogilvie, C.B., has been appointed Director of the Science Museum, and will hold this position in addition to his present office of Secretary for the Science Museum and Geological Survey and Museum. Mr. Ogilvie was educated at Aberdeen University and for a time held the position of Assistant Professor of Natural Philosophy, both at that University and at Edinburgh. He was director of the Edinburgh Museum of Science and Art from 1900 to 1903, and principal assistant secretary (Technology and Higher Education in Science and Art) of the Board of Education from 1903 to 1910.

"The Central."—The article of greatest interest in the current issue of this magazine is the first. It is devoted to an account of the life of Prof. Henrici, and is partly autobiographical and partly written by Mr. G. C. Turner. It is illustrated by three excellent photographs of Prof. Henrici at various times of his life, and of the Mechanics Laboratory which he founded at the "Central." A report is given of the complimentary dinner to Prof. Armstrong which was held on May 13th last, and there are also articles on "Lifeboat Launching Slipways"; on "The Training of Alluvial Rivers," by Mr. C. G. Smith, and "Notes upon Modern Simple Span Truss Bridge Construction," by Mr. R. O. Beit.

Deterioration of Insulation on Traction Motors.—The "Engineer" remarks that a tramway or railway motor is usually selected with reference to the work it has to do in propelling the car, with little regard to the extra work which is thrown upon it when braking. It is, therefore, often urged that, since a motor usually operates at a fairly high temperature under normal conditions, the extra load thrown upon it by electric braking is certain to produce more or less rapid deterioration of the insulation. With the latest type of track magnet, however, the current taken from the motors is a very small percentage of that required for rheostatic braking, and the increased heating due to braking with this type of magnet is practically nil. If, in addition, the motor fields are provided with solenoid operated shunts, excessive voltage rises cannot occur, and the usual objections to the use of the motors for electric braking are removed.

Smelting of Pig Iron by Electricity.—An official report on the experiments in the electric smelting of iron ore at Trollhätten has now been published by the Iron Institute of Sweden, which, in conjunction with the Government, provided the money to carry out the experiments on a commercial scale. On the basis of the selling price for the output of the furnace, agreed upon by the committee in charge of the operations, the experimental business was self-supporting, even for the short period of its duration, five months. It is stated that the results obtained warrant the opinion that the question of the economical smelting of iron in the electric furnace has been solved, and that perfection of the methods for handling the gases to secure a more effective circulation, if not their utilisation, will greatly enhance the results already obtained. It is hoped to reach the preliminary estimate of 3 tons of pig-iron per horse-power-year, although the results so far give only

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2·7 tons. Trials have proved that the product of the electric furnace is as well adapted to the manufacture of steel as is the ordinary Swedish pig-iron.

The Need for Reform in our System of Chemical Training.—In an article on this subject in a recent issue of "Chemical Engineering and the Works' Chemist," the author remarks that too much time is at present given to the acquisition of detail, while too little regard is paid to the real object of scientific education, which is to develop the reasoning powers. Students should be taught chemistry so that they may be able to apply their knowledge intelligently in after-life. To think and to originate are infinitely more important for the man of science than simply to be a master of detail. Some of the cures proposed for this evil are worse than the disease. More attention should be paid to the value of scientific application and less to the results of "cramming." Graduation by research should be made the rule and not the exception, as this method would differentiate between the student who can simply cram facts and one who is capable of applying what he knows to useful purposes. What is above all things necessary, the author concludes, is proper instruction in applied chemistry and encouragement of students to take up applied chemical research. It must be borne in mind, too, that it is not possible to study technical chemistry in a college alone, and that a student should pass a period in works in order that he may gain the all-important experience of the conditions which obtain on a large scale.

Royal Engineer Cadets (2nd London Division).—We are informed that recruits are wanted for this Corps, and great efforts are being put forth to bring it up to its establishment. The Company at present in existence is a Fortress Company, but if the right kind of recruit is forthcoming in sufficient numbers, it is proposed to form a Communication Company. Youths between the ages of 13 and 18 years having a knowledge of electricity or telegraphy should therefore send in their names. The cadets are instructed in all branches of military engineering, and the training and instruction are of a very interesting character for any lad desirous of serving his country.

Cadets transferring to the Territorial Force from their Cadet Corps are excused their recruit drills, and service in a Cadet Unit after the age of 15 counts towards the Territorial Efficiency Medal. Recruits are enrolled between the ages of 13 and 18, and should apply at the Duke of York's Headquarters, Chelsea, S.W., on Monday and Friday evenings between 7:30 and 9 p.m. Full particulars can be obtained from Sergt.-Major G. D. Elms, R.E. (T.), 37, Langthorne-street, Bishop's Park, S.W. Col. Sir Howland Roberts, Bt., V.D., is the honorary Commanding Officer, and the officer in command of the Corps is Capt. Beeman, R.E. The Corps attended the annual training and camp this year with the Royal Engineers, 2nd London Division, at Shorncliffe, from the 7th to the 19th August, and worked with the sappers in building a redoubt and in constructing a trestle and double-lock bridge. The cost of uniform and equipment amounts to about 15s., and there is an entrance fee of 1s. Rifles, bayonets and brown Slade-Wallace equipment are supplied, and remain the property of the Corps.

The Noise of Motor Cars.—During the past few months correspondence has been taking place in several of our daily contemporaries regarding the noise made by drivers of motor vehicles, especially at night. As a result of this agitation, which from our own experience seems to be especially well-founded, the Commissioner of Police of the Metropolis has, with the concurrence of the Local Government Board, issued a circular dealing with the matter. He points out that while it is necessary for all motor drivers to give audible warning of their approach when there is possibility of danger, where the only danger is attributable to reckless speed the practice quickly develops into an avoidable nuisance. Attention is also called to the practice of using a "cut-out" and the employment of siren or multiple horns worked from the exhaust. It is quite certain, he points out, that unless some alteration is brought about by motorists of their own impulse there will be an insistent demand for repressive legislation. In these circumstances the Commissioner of Police thinks it advisable to call upon all owners and drivers of motor vehicles to do what is in their power to reduce the annoyance caused, especially at night, by the excessive use of the horn, or by the use of unsuitable devices, such as those above mentioned, for unnecessarily varying the timbre or intensifying the sound emitted. He feels sure that much may be done by concerted action on the part of owners and drivers of private cars to diminish the nuisance which is now so much complained of. From this circular it is evident that if this plain hint is not sufficient the Commissioner will use his powers to make a bye-law on the subject. The nuisance is of course primarily due to drivers of taxi-cabs and chauffeurs who are freed from the influence of their employers. Since, too, a silent motor-'bus is an assured fact, attention might also be paid to the excessive noise at present made by many of these vehicles.

Current Topics.

Subjects of current interest dealt with in this issue include the following:—

Dr. R. Beattie contributes an article on "An Extension of Fischer-Hinnen's Method of Harmonic Analysis."

Dr. R. A. Houstoun contributes the first of a series of articles on "Studies in Light Production."

Our special correspondent gives an account of the Papers and discussions at the meeting of the British Association at Portsmouth. Abstracts of the following Papers which were presented at the meetings of the various Sections will be found elsewhere in this issue: "Electric Drives for Screw Propellers," by Mr. H. A. Mavor; "The Origin and Production of Corrugation of Tramway Rails," by Mr. Worby Beaumont; "Recent Developments in Radio-telegraphy," by Prof. G. W. O. Howe. The presidential address of Sir William Ramsay (of which an abstract appeared in our last issue) is discussed in our Leading Article.

The Trades' Union Congress has been held during the week at Newcastle-on-Tyne, and the president, Mr. W. Mullin, referred to the course adopted by the unions when legislation affecting the working classes is in preparation. He remarked that discussions between members of the Cabinet and accredited representatives of the unions had become a part of the regular programme. (We wonder is the same practical course adopted towards the masters). Mr. Mullin referred particularly to the Insurance Bill in this connection. He also referred to the recent series of so-called "strikes."

Shoreditch (London) Council have decided to adopt incandescent electric lighting in place of gas in the portion of their area north of Old-street.

Salford Corporation are recommended to carry out extensions and to effect improvements of their electricity supply undertaking at an estimated cost of £85,350.

The Port of London Authority have decided to provide four electric ambulances for the docks under their control.

An interesting report on methods of charging for electric current at Brighton has been prepared by the engineer and manager, Mr. John Christie. The report recommends the abolition of meter rents and the adoption of a flat rate of charge for all current supplied.

OBITUARY.

T. H. Riches.—We regret to record the death of Mr. Thomas Hurry Riches, locomotive superintendent to the Taff Vale Railway, which occurred at Cardiff on Monday last at the age of 65. Mr. Riches was a past-president of the Institution of Mechanical Engineers and for three successive years was also president of the South Wales Institute of Engineers. He served as chairman of the mechanical engineering section of the Franco-British Exhibition.

H. O. Wills.—We also regret to record the death of Mr. Henry Overton Wills, chancellor of the University of Bristol, which occurred at Kelston Knoll, Weston, near Bath, on Monday last. Mr. Wills took great interest in the formation of the university in Bristol, and went so far in practical sympathy as to subscribe £100,000 towards the project. When the charter was eventually granted Mr. Wills became the first chancellor of the new university.

PERSONAL NOTE.

On Monday Mr. W. Aitken left Liverpool by the s.s. "Megantic" for New York. Mr. Aitken will be absent from England for some time on business and pleasure.

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ment small and propeller efficiency as good as is attainable and the quantity of fuel carried small relative to the weight of the machinery, the possible economy in fuel may be insufficient to warrant any increase in the weight of machinery; or, to put the case otherwise, it is advisable to sacrifice economy in fuel to keep down the weight of the equipment—*e.g.*, a vessel running one-day voyages, and burning 50 tons of coal, could not possibly submit to an increase in weight of machinery in excess of the coal-saving, because such increase would increase the displacement, and therefore the power necessary to drive the vessel.

If, on the other hand, the vessel make a 10-day voyage, and the saving in fuel carried amount to 10 tons per day, a considerable increase in weight of machinery might be associated with decreased displacement and a substantial all-round economy.

Various methods of making the required adaptation of generator to propeller are at present under trial. For this, mechanical gearing by toothed wheels or hydraulic transmission may be considered serious competitors with electric transmission, but for large powers it seems reasonable to expect that electric transmission, which is already developed for this very purpose on land, is likely to find an equally useful field where the conditions are such as to require an intermediate device at sea. The cost, weight and efficiency of electric transmission compare favourably in the examples which have been examined with either of the two competing methods.

are attainable in a reciprocating steam engine connected direct to the propeller, and the electric motor is applicable to powers for which there is no possibility of using anything in the nature of reversing gears or clutches.

The property of combining the power of more than one engine for application to one or more propellers is the special feature of the author's inventions as distinguished from the ordinary methods of electrical engineering. Engines of different types, sizes and rates of revolution can have their powers combined without interconnection of their electric circuits, and without risk of mistake or error. An oil engine at 100 revs. per min. may be running the vessel at low speed, and a steam turbine running at 20 times the speed may be jointly applied to the propellers without any complication of the electric equipment. Each unit does its own work independently.

The advantage of such an equipment in vessels which are required to operate under varying load conditions is evident. Without subdivision of the power units the whole of the main machinery must be in motion while the ship is in motion.

At speeds reduced below its normal rate of revolution the turbine is even less economical than the steam engine. Subdivision into high-pressure, low-pressure and intermediate elements has been carried out in certain steam equipments, but this results in a somewhat complicated and inconvenient system of piping, because the steam has to be led from one part of the system to the other across the

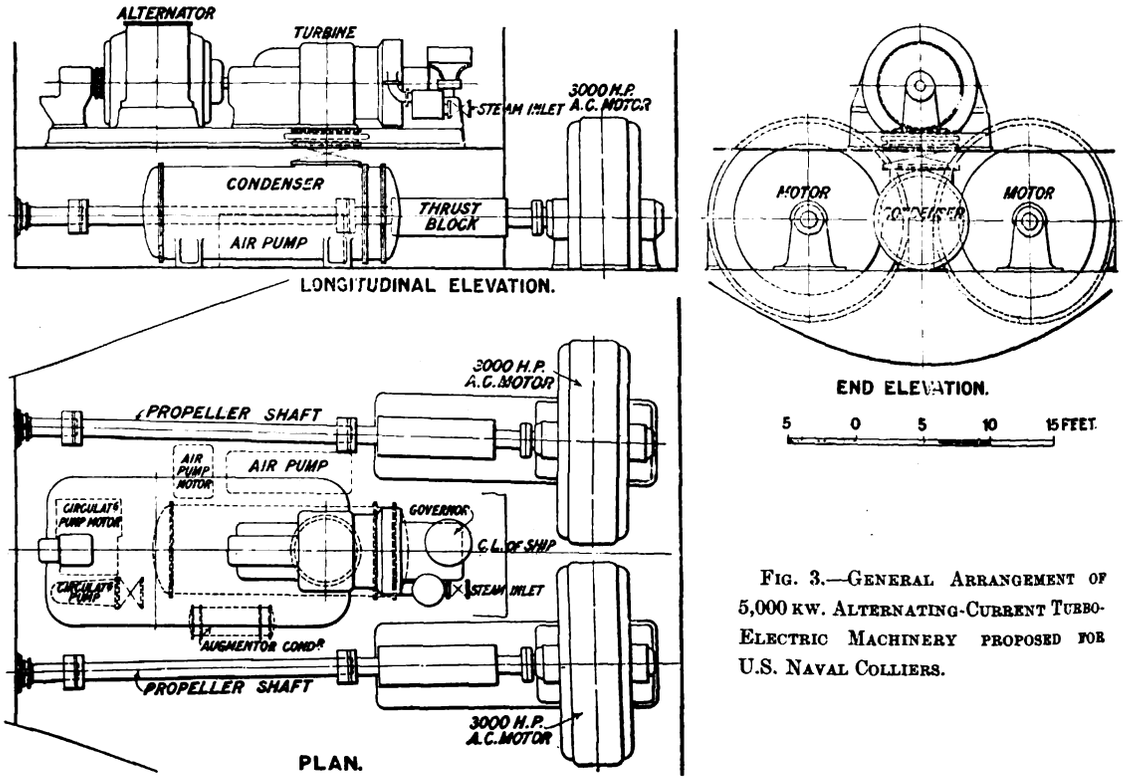

FIG. 3.—GENERAL ARRANGEMENT OF 5,000 KW. ALTERNATING-CURRENT TURBO-ELECTRIC MACHINERY PROPOSED FOR U.S. NAVAL COLLIERS.

There are other important qualifications of electric transmission in which it stands altogether unrivalled. The most important of these qualifications are:—

It provides a ready means of reversing the direction of rotation of the propeller without changing the direction of rotation of the power generator.

The electric transmission also provides means for changing the speed ratio between generator and propeller, so as to permit of the power of the generator being developed under the most favourable conditions at all speeds of the ship.

Lastly, it provides means for applying the power of one or more engines to one or more propellers, so that the power generating units may be so disposed as to give the highest efficiency, and when they are not required they can be stopped. These properties of the electric transmission supply exactly what is required to render steam turbines, and also internal-combustion engines, completely adaptable to the purpose required.

Power generators give their best efficiency when full speed of rotation is maintained, even when running below full power. It is therefore advantageous to keep the engine revolutions within the range of governor control while the required speed change is accomplished by electric combinations.

The properties of the electric motor lend themselves well to the requirements of manœuvring. The rate of reversal is under perfect control. The possibilities of rapid and certain action are more than

vessel. In the electric system each unit can be self-contained, and disposed in the manner best suited to a convenient arrangement of the engine room. The size of the individual units can be adjusted to suit the powers required at the different working speeds, or they may be duplicate and interchangeable.

A few examples of application of the system are here presented, together with a description of a small vessel built to demonstrate and illustrate the principles of operation and to provide experience in the use of the plant. In all cases alternating three-phase currents are used and interlocking devices connect mechanically the main reversing switches with the exciting switches so that no change can take place in the connections while they are passing currents.

DESCRIPTION OF THE TURBO-ELECTRIC STEAMSHIP "FRIEDA" (FOR AMERICAN OWNERS).

This vessel has been specially designed for the transport of bulk freights between the Gulf of Mexico and New York City. The vessel is to be 300 ft. long and will carry a dead weight of, approximately, 5,000 tons at a mean loaded speed of 12 knots at sea.

The propelling machinery is aft, and consists of a turbo-electric outfit for three-phase 50 cycles when running at 3,000 revs. per min. The turbine is supplied with steam at a pressure of 200 lb. per square inch at the stop valve.

This electric generating plant is arranged on foundations on a platform deck in the engine room and the condensing plant in the engine-

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room hold. The condenser is fitted with a vacuum augmentor, and is suitable for dealing with the full load quantity of steam from the turbine. The vacuum obtained will be 28½ in., with cooling water about 85°F. The condensing plant consists of a vacuum condenser, three-throw air pumps and centrifugal pumps with electric motor drives.

The current is led to a three-phase motor, which is keyed direct to the main propeller shaft, and is capable of developing 1,900 B.H.P. at a speed of about 84 revs. per min. The steam is generated in two Scotch boilers, with Howden's forced draught and liquid fuel burners.

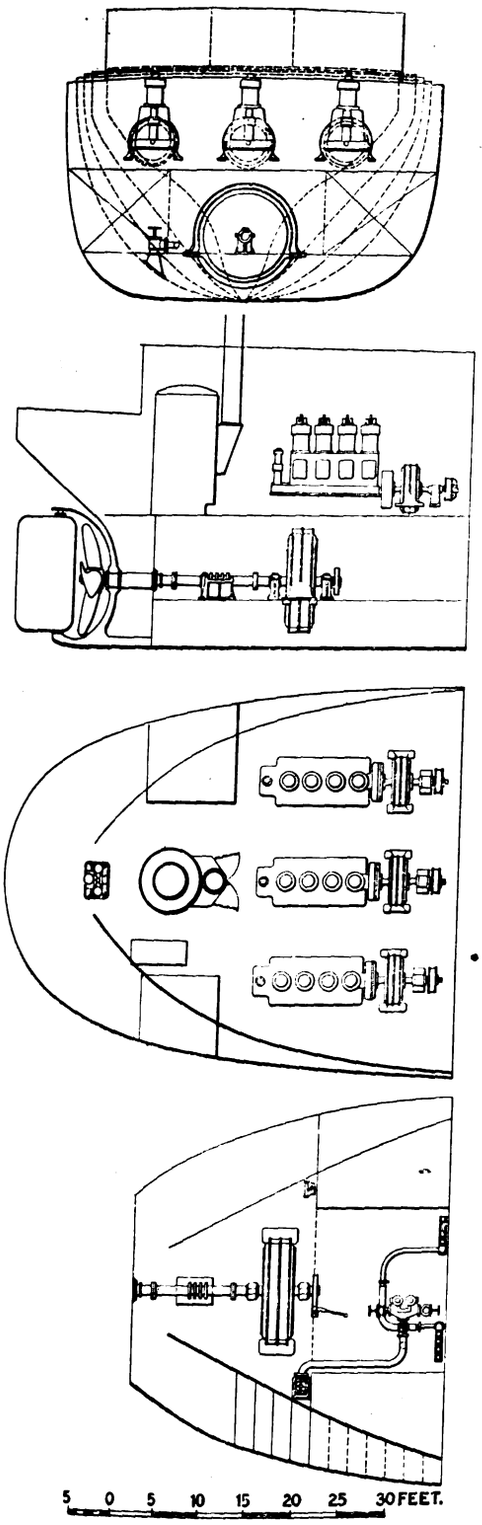

FIG. 4.—PROPOSED ARRANGEMENT OF OIL-ELECTRIC PROPULSION FOR LAKE STEAMER, 250 FT. BY 42 FT. 6 IN. BY 19 FT.

This installation costs and weighs less than the normal equipment. The coal-saving is over 10 tons per day.

The design of the ship itself presents many novel features not germane to the subject under review. This design was prepared by John Reid & Co., 17, Battery-place, New York.

OIL ELECTRIC TANK BARGE FOR CANADIAN SERVICE.

Fig. 4 shows the application of the system to the propulsion of a 245 ft. Canadian canal type tank barge.

The equipment consists of three separate units of Diesel non-reversible oil engines, each capable of developing 200 shaft H.P., and directly connected to an alternating-current generator. The currents from one or all of the units are respectively led to the separate windings of a three-phase motor keyed to the main propelling shaft and operating a single slow-turning screw.

The great advantage and economy of this system consists in being able to run at full power or at one-third power using one or three engines at full-load economy at will, thus providing for an economical operation impossible with any other propulsive system. The fact that non-reversible oil engines are used, running under governor control, greatly simplifies the maintenance and operation.

The control is operated by a low-tension interlocking switch, operated by an ordinary engine-room telegraph stand located in the pilot house, so that the manœuvring of the vessel is at all times in the hands of the navigating officer. This equipment increases the cost of the ship about 10 per cent. above the normal, but the carrying capacity is very largely increased.

MARINE TURBO-ELECTRIC INSTALLATION PROPOSED FOR U.S. NAVY COLLIERS.

The installation illustrated in Fig. 3 shows a marine turbo-electric installation submitted to the U.S. Navy Department for adoption in one of the four large colliers recently given out to contract.

It consists of a steam turbo-alternator of 5,000 kw. capacity with condensing plant; the current is led to two motors, one being keyed to each propeller shaft. The machinery is right aft in the vessel; the steam is generated by Scotch boilers.

The vessels in which it is proposed to instal this machinery are 525 ft. long, and will carry a dead weight of 12,500 tons of coal, at a speed of 14 knots at sea. Here again the cost, weight and economy are better than can be shown with the normal reciprocating-engine equipment.

AN EXTENSION OF FISCHER-HINNEN'S METHOD OF HARMONIC ANALYSIS.

BY R. BEATTIE, D.SC.

Amongst methods of determining the several coefficients in Fourier's expression

$$y = A_0 + A_1 \sin\theta + A_2 \sin 2\theta + A_3 \sin 3\theta + \ldots + B_1 \cos\theta + B_2 \cos 2\theta + B_3 \cos 3\theta + \ldots \quad (1)$$

for a single-valued periodic curve, one of the most useful is Fischer-Hinnen's development of the old principle of selected ordinates.* In order to find the coefficient of a harmonic of the nth order by Fischer-Hinnen's method, $2n$ equi-distant ordinates, spaced a distance π/n apart, are erected, the initial ordinate being at a distance $\pi/2n$ from the origin, or at the origin itself, according as a sine coefficient or a cosine coefficient is desired. The ordinates thus drawn are added together, the signs of all the ordinates of even number being reversed and the mean is taken. Calling S_n the mean of the sine-spaced ordinates, and C_n the mean of the cosine-spaced ordinates, then

$$S_n = A_n - A_{3n} + A_{5n} - A_{7n} + \&c. \quad (2)$$

$$C_n = B_n + B_{3n} + B_{5n} + B_{7n} + \&c. \quad (3)$$

The truth of this result for a particular case is readily apparent from Fig. 1. This figure shows Fischer-Hinnen's construction for determining the coefficients A_3 and B_3 of the curve represented, the sine-spaced ordinates y_1, y_2, y_3, &c., being erected at distances 30, 90, 150, 210, 270 and 330 deg. respectively from the origin, and the cosine-spaced ordinates

* Fischer-Hinnen, "E.T.Z.," Vol. XXII., p. 396, 1901; "Elektrotechnik u. Maschinenbau," Vol. XXVII., p. 335, 1909. For references to earlier work on similar lines *see* Burkhardt, "Encyklopädie der Mathematischen Wissenschaften," Band II., Theil 1, p. 642; also Darwin, "Engineering," July 14, 1911, p. 81. [Since the foregoing was written, a Paper by Prof. S. P. Thompson has appeared, which should be consulted ("Proc." Phys. Soc., Aug., 1911, p. 334). This Paper, although entitled "A New Method of Harmonic Analysis," is really nothing more than an account of Fischer-Hinnen's method and contains no new developments.]

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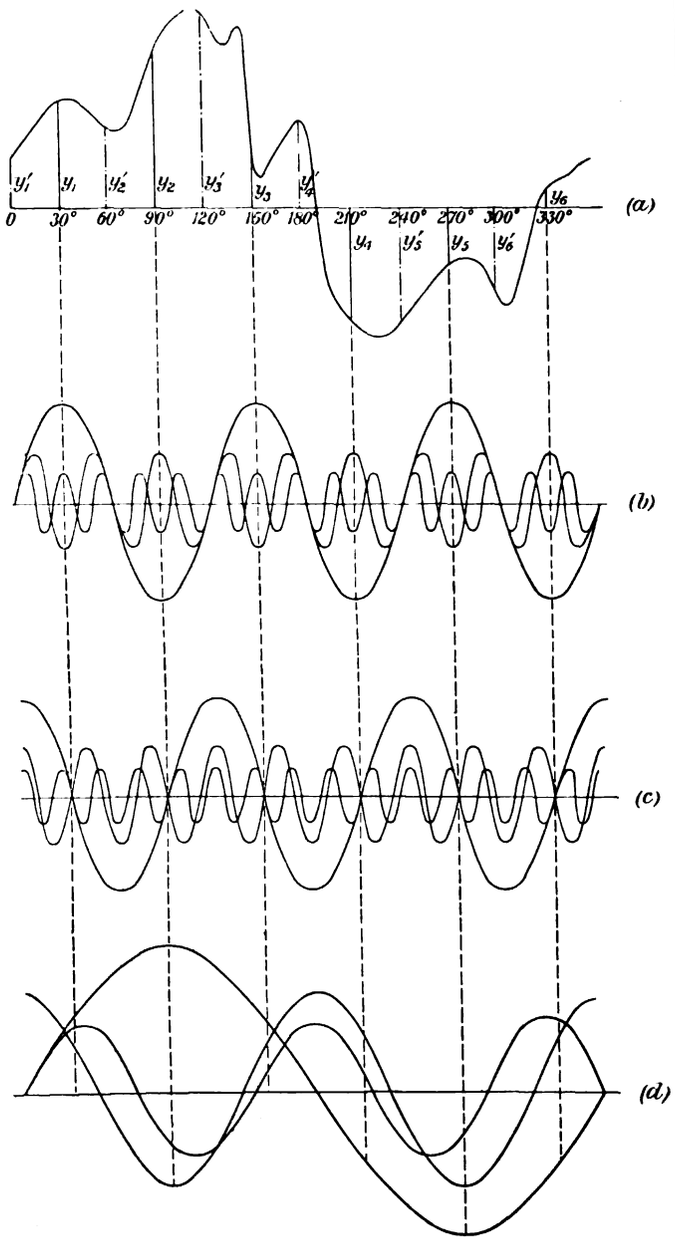
y'_1, y'_2, y'_3, &c., at distances 0, 60, 120, 180, 240 and 300 deg. respectively. It is seen that the successive sine-spaced ordinates cut the 3rd, 9th, 15th, &c., sine harmonics at their crest values, which are, of course, alternately positive and negative, whereas they cut the 3rd, 9th, 15th, &c., cosine harmonics at their zero values. Further, the sum of the intercepts of the sine-spaced ordinates with all the remaining harmonics, even or odd, sine or cosine, when taken over a whole period with alternate signs reversed, vanishes. Hence the average value of y_1, y_2, y_3, &c., with alternate signs reversed is equal to $A_3-A_9+A_{15}-$ &c. Similarly, the average value of the cosine-spaced ordinates y'_1, y'_2, y'_3, &c., with alternate signs reversed, is equal to $B_3+B_9+B_{15}+$ &c.



(*a*) Original Curve. (*b*) 3rd, 9th, 15th, &c., sine components. (*c*) 3rd, 9th, 15th, &c., cosine components. (*d*) All the even and all the remaining odd sine and cosine components including the constant term.

FIG. 1.—ILLUSTRATING HARMONIC ANALYSIS OF CURVE BY FISCHER-HINNEN'S 2*n*-ORDINATE METHOD.

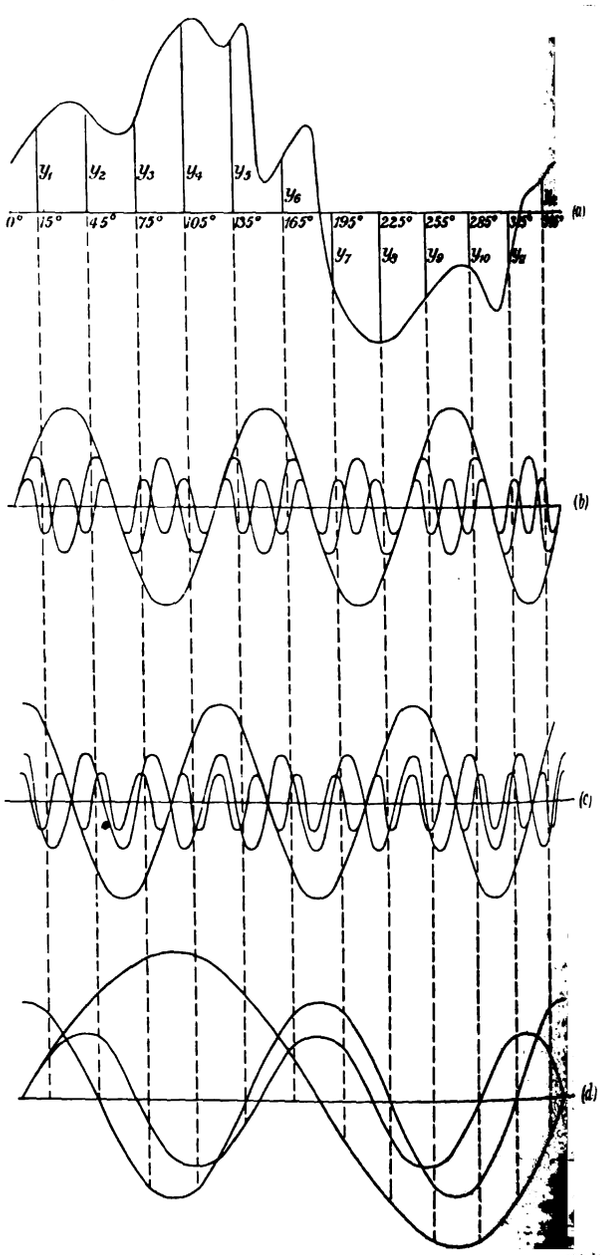
A disadvantage inseparable from Fischer-Hinnen's method is that it does not directly give the value of the harmonic sought, except in the special case where all the odd multiples of that particular harmonic are either absent or negligibly small. In practice, when evaluating higher harmonics, we are often certain, or can safely assume, that this is so, and the method is then specially serviceable. When evaluating lower harmonics, however, the absence of odd multiple harmonics cannot be taken for granted, and a process of elimination must therefore be resorted to. Thus suppose we know that, as in alternating-current wave-forms for instance, there are only odd harmonics present, and also that all harmonics of higher order than, say, the 15th are absent or negligible. We can then write

$$\left.\begin{aligned} &S_{15}=A_{15},\ S_{13}=A_{13},\ S_{11}=A_{11},\ S_9=A_9,\ S_7=A_7,\\ &S_5=A_5-A_{15},\ S_3=A_3-A_9+A_{15},\\ &S_1=A_1-A_3+A_5-A_7+A_9-A_{11}+A_{13}-A_{15} \end{aligned}\right\} \quad . \quad . \quad . \quad (4)$$

from which we readily deduce

$$\left.\begin{aligned} &A_{15}=S_{15},\ A_{13}=S_{13},\ A_{11}=S_{11},\ A_9=S_9,\ A_7=S_7,\\ &A_5=S_5+A_{15},\ A_3=S_3+A_9-A_{15},\\ &A_1=S_1+A_3-A_5+A_7-A_9+A_{11}-A_{13}+A_{15} \end{aligned}\right\} \quad . \quad . \quad . \quad (5)$$

A similar scheme of elimination can be drawn up for the cosine terms.



(*a*) Original Curve. (*b*) 3rd, 9th, 15th, &c., sine components. (*c*) 3rd 9th, 15th, &c. cosine components. (*d*) All the even and all the remaining odd sine and cosine components including the constant term.

FIG. 2.—ILLUSTRATING HARMONIC ANALYSIS OF CURVE BY 4*n*-ORDINATE METHOD.

When there is no certainty that all harmonics above a certain order are either absent or diminish very rapidly in value, Fischer-Hinnen's method, while still applicable, becomes laborious and comparatively useless. Even in these circumstances, however, the scope of the method can, by a simple development, be considerably extended and its accuracy appreciably increased without departing from the general principle involved.

A Modified or 4n-Ordinate Method.—Improvements on Fischer-Hinnen's method may aim at (i) reducing the errors

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due to accidental irregularities in the curve to be analysed, (ii) reducing the number of included higher harmonics. Both these ends can be attained by increasing the number of ordinates employed. The extent to which the number of ordinates can be increased is limited by the condition that multiplications or divisions must not be introduced further than what is required in averaging ordinates. It is, however, possible to double or even treble the number of ordinates without sensibly departing from this condition.*

Suppose, for example, that we wish to find the coefficient of the nth sine harmonic. Instead of erecting $2n$ equi-distant ordinates, as in Fischer-Hinnen's method, we erect $4n$ ordinates spacing them a distance $\pi/2n$ apart, the initial ordinate of the series being at a distance $\pi/4n$ from the origin. These ordinates we add together, taking them in pairs, and reversing the signs of alternate pairs. That is to say, the signs of the 1st and 2nd, 5th and 6th, 9th and 10th, &c., ordinates are left unchanged, those of the 3rd and 4th, 7th and 8th, 11th and 12th, &c., ordinates are reversed, the scheme of reversal being indicated by $++--++--$&c. The average ordinate obtained in this way when multiplied by $\sqrt{2}$ gives a quantity which we shall denote by S'_n. It is then easy to show that

$$S'_n=A_n+A_{3n}-A_{5n}-A_{7n}+A_{9n}+A_{11n}-A_{13n}-\&c. \quad . \quad (6)$$

To get the corresponding cosine term the ordinates are drawn precisely as for the sine term, with the initial ordinate at a distance $\pi/4n$ from the origin. The only difference lies in the way the ordinates are added up. In doing this the signs of the first and last, 4th and 5th, 8th and 9th, &c., ordinates are left unchanged, whilst the signs of the 2nd and 3rd, 6th and 7th, 10th and 11th, &c., ordinates are reversed, the scheme of reversal being therefore indicated by $+--++--$&c. The average ordinate thus obtained when multiplied by $\sqrt{2}$ we shall denote by C'_n. We then have

$$C'_n=B_n-B_{3n}-B_{5n}+B_{7n}+B_{9n}-B_{11n}-B_{13n}+\&c. \quad . \quad (7)$$

In proof of (6) and (7) it will suffice to take the particular case represented in Fig. 2. Here the ordinates are drawn according to the modified method for determining the 3rd sine component of the curve shown, the ordinates, 12 in number, being spaced 30 deg. apart, with the initial ordinate 15 deg. from the origin. It is seen that these ordinates cut the 3rd sine harmonic and all odd multiples of the 3rd sine harmonic in the same relative position—viz, 45 deg. from the maximum, the 45 deg. being reckoned on the scale of the harmonic considered. It is likewise seen that the sum of the intercepts with these harmonics, taken with signs reversed in pairs according to the scheme $++--++--$&c., is equal to $\frac{12}{\sqrt{2}}(A_3+A_9-A_{15}-A_{21}+A_{27}+A_{33}-\&c.)$. At the same time the sum of the intercepts with all the remaining harmonics, of whatever order or denomination, when taken over a complete period with signs reversed in pairs, is seen to vanish. It follows that $\sqrt{2}$-times the average value of the ordinates y_1, y_2, y_3, &c., with signs reversed in pairs, must equal $A_3+A-A_{15}-A_{21}+A_{27}+A_{33}-\&c$. From this the general result of (6) can readily be inferred, as also, by similar reasoning, that of (7).

It will be observed that the result obtained by averaging ordinates on the above plan still contains all harmonics which are odd multiples of the harmonic sought. These included harmonics have, therefore, to be eliminated by proceeding as in the schemes (4) and (5) already outlined for Fischer-Hinnen's $2n$-ordinate method. Thus, taking the previously chosen case of a curve containing odd harmonics only and none higher than the 15th, we have

$$\left.\begin{array}{l} A_{15}=S'_{15},\ A_{13}=S'_{13},\ A_{11}=S'_{11},\ A_9=S'_9, \\ A_7=S'_7,\quad A_5=S'_5-A_{15},\quad A_3=S'_3-A_9+A_{15}, \\ A_1=S'_1-A_3+A_5+A_7-A_9-A_{11}+A_{13}+A_{15} \end{array}\right\} \quad . \quad . \quad . \quad (8)$$

with a similar scheme for the cosine coefficients.

A Combined or 6n-Ordinate Method.—Taken by itself, the modification of Fischer-Hinnen's method just described has certain minor advantages. These arise in part from the increased number of ordinates employed, which helps to eliminate errors due to accidental irregularities, and in part from the fact that the same ordinates serve both for the sine and cosine components. In practice, however, it does not always lead to results that are conspicuously superior to those obtained by Fischer-Hinnen's $2n$-ordinate method. The improvement hinted at in an earlier paragraph is the outcome of combining the results of the $2n$ and $4n$-ordinate methods.

As has been pointed out, the result obtained in attempting to evaluate a given coefficient, say A_n, by Fischer-Hinnen's $2n$-ordinate method includes the coefficients A_{3n}, A_{5n}, A_{7n}, &c. The result obtained in attempting to estimate the coefficient A_n by the modified method also includes the same coefficients A_{3n}, A_{5n}, A_{7n}, &c., only they enter into the result in a different way. Thus we have

$$S_n=A_n-A_{3n}+A_{5n}-A_{7n}+A_{9n}-\&c.,$$

by the $2n$-ordinate method, and

$$S'_n=A_n+A_{3n}-A_{5n}-A_{7n}+A_{9n}+\&c.,$$

by the $4n$-ordinate method. Hence, by taking the mean of the results of the two methods we can eliminate a large number of the higher included harmonics, and thus obtain a more

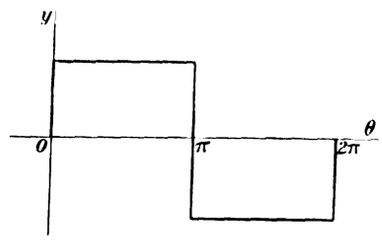

FIG. 3.—RECTANGULAR WAVE SHAPE.

accurate result. Calling the mean of the results for the nth sine coefficient S''_n, where $S''_n=(S_n+S'_n)/2$, we have, in fact,

$$S''_n=A_n-A_{7n}+A_{9n}-A_{15n}+A_{17n}-\&c. \quad . \quad . \quad . \quad . \quad (9)$$

Similarly, if we call C''_n the mean of the results for the nth cosine coefficient, where $C''_n=(C_n+C'_n)/2$, then

$$C''_n=B_n+B_{7n}+B_{9n}+B_{15}+B_{17n}+\&c. \quad . \quad . \quad . \quad (10)$$

Obviously this process (which may be described as a $6n$-ordinate method, since it involves the measurement of $6n$ separate ordinates) gives directly a close approximation to the true value of any harmonic other than the fundamental, since no component of an order lower than seven times that of the harmonic sought is included in the result. To eliminate the few included harmonics that do remain we proceed as before. Thus for a curve containing odd harmonics only, of which the 21st and higher harmonics are assumed to be absent, we have

$$\left.\begin{array}{l} A_{17}=S''_{17},\ A_{15}=S''_{15},\ A_{13}=S''_{13},\ A_{11}=S''_{11}, \\ A_9=S''_9,\quad A_7=S''_7,\quad A_5=S''_5,\quad A_3=S''_3, \\ A_1=S''_1+A_7-A_9+A_{15}-A_{17} \end{array}\right\} \quad . \quad . \quad (11)$$

with a similar scheme for the cosine coefficients.

To illustrate the superiority of the $6n$-ordinate method we may apply it to analyse the rectangular wave-shaped curve of Fig. 3. This curve is known to possess a large number of sine components of odd orders and no cosine components. The amplitude of the components, moreover, decreases very slowly, and the curve therefore affords a severe test of the accuracy of any method of harmonic analysis. Representing the crest value of the curve by 1, its equation as a Fourier series is

$$y=\frac{4}{\pi}(\sin\theta+\tfrac{1}{3}\sin 3\theta+\tfrac{1}{5}\sin 5\theta+\tfrac{1}{7}\sin 7\theta+\&c.).$$

* Fischer-Hinnen's and similar methods of harmonic analysis are examples of approximate integration by averaging a finite number of ordinates. This method of integration and its limitations are discussed by Bruns in his book "Grundlinien des Wissenschaftlichen Rechnens" (Leipzig: B. G. Teubner, 1903). Amongst other examples he considers the evaluation of Fourier's coefficients and (Chapter VII., §§ 85 and 86) gives rules applicable to the general case in which the number of ordinates is made equal to $4m$, where m is any integer. The special advantage of choosing a number of ordinates divisible by 4 is pointed out by Bruns, and much of what follows in the present article might be deduced from his rules by putting m equal to the order of the harmonic sought, or to twice that order.

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If we analyse the curve by the $2n$-ordinate method we get

$$y=\sin\theta+\tfrac{1}{3}\sin 3\theta+\tfrac{1}{5}\sin 5\theta+\tfrac{1}{7}\sin 7\theta+\text{ &c.},$$

and by the $4n$-ordinate method

$$y=1{\cdot}41(\sin\theta+\tfrac{1}{3}\sin 3\theta+\tfrac{1}{5}\sin 5\theta+\tfrac{1}{7}\sin 7\theta+\text{&c.}).$$

Both these results, which are obtained without having recourse to elimination, are seen to be hopelessly wrong, and equally so for the higher harmonics as for the lower. If, however, we take the mean we get

$$y=1{\cdot}21(\sin\theta+\tfrac{1}{3}\sin 3\theta+\tfrac{1}{5}\sin 5\theta+\tfrac{1}{7}\sin 7\theta+\text{&c.})$$

which for many practical purposes may be accepted as sufficiently correct.

Diagrams for Use with Fischer-Hinnen's Method.—Fischer-Hinnen's method and its modifications have the merit that they can be carried out by the direct addition of ordinates as measured on the curve itself without the use of tables or adventitious aids of any kind. The application of the methods is greatly facilitated, however, by the use of specially prepared diagrams of suitably graduated scales similar to those described by the writer in THE ELECTRICIAN for June 9, 1911.

In the case of Fischer-Hinnen's $2n$-ordinate method, for instance, the diagram for determining an nth sine coefficient would consist of $4n$ equi-spaced vertical scales erected at successive distances of $\pi/2n$, π/n, $3\pi/2n$, $2\pi/n$, $5\pi/2n$ . . . &c., measured from one end of a common base-line. The units of the successive scales would be made equal in length to ± 1, ∞, ∓ 1, ∞, ± 1, ∞, &c., where the upper signs refer to the scales above the base-line and the lower scales to those below. The even-numbered scales are clearly "dummy" ones, and are introduced for the purpose of bringing the diagrams into line with the others.

In the case of the $4n$-ordinate method, the diagram for an nth sine harmonic would, similarly, consist of $4n$ equi-spaced vertical scales erected at distances $\pi/4n$, $3\pi/4n$, $5\pi/4n$ . . . &c., respectively from the end of the base-line. The unit of each scale would be made equal in length to $\sqrt{2}$, the successive scales being marked $++--++$ &c., above the base-line, and $--++--$ &c., below.

In like manner the diagram for determining an nth sine coefficient by the $6n$-ordinate method (which may be regarded as an $8n$-ordinate method with the 4th, 8th, 12th, &c., ordinates omitted) would consist of $8n$ equi-spaced vertical scales erected at the respective distances $\pi/4n$, $2\pi/4n$, $3\pi/4n$, &c., from the end of the base-line. The units of the successive scales would be made equal in length to $\pm\sqrt{2}$, ± 1, $\pm\sqrt{2}$, ∞, $\mp\sqrt{2}$, ∓ 1, $\mp\sqrt{2}$, ∞, $\pm\sqrt{2}$, ± 1, &c., where the upper signs relate to the scales above the base-line and the lower signs to those below.

The investigation of the character of the corresponding diagrams for cosine coefficients may safely be left to the reader.

Twice the average ordinate of a periodic curve, as read on one of the above sine diagrams, would give S_n, S'_n or S''_n according to the type of diagram employed. Diagrams of this kind adapted to Fischer-Hinnen's method or its modifications will, on comparison, be seen to be but particular cases of the general "reciprocal-sine" and "reciprocal-cosine" diagrams described in THE ELECTRICIAN article just referred to. The general diagram passes into the particular whenever the number of scales which it contains is made some fixed multiple (such as 4 or 8) of the order of the harmonic for which the diagram is constructed. Thus the diagram for a $2n$-ordinate Fischer-Hinnen method is a $4n$-ordinate reciprocal-sine diagram constructed by dividing the base-line into $4n$ equal parts and erecting scales at the several points of division. If instead of erecting scales at the points of division we erect them midway between the points of division, we get a diagram for the $4n$-ordinate modification of Fischer-Hinnen's method. So, also, a diagram for the $6n$-ordinate modification of Fischer-Hinnen's method is a reciprocal-sine diagram constructed by dividing the base-line into $8n$ equal parts and erecting scales at the points of division.

It must not be forgotten that reciprocal-sine diagrams with a fixed number of scales occasionally assume the special forms indicated above. Thus, in applying a 24-ordinate reciprocal-sine diagram to determine a 3rd harmonic we are actually using an $8n$-ordinate diagram (or what we have elsewhere called a $6n$-ordinate method of the Fischer-Hinnen type), and therefore the 21st, 27th, &c., harmonics are included in the result which is thus inaccurate to that extent. Again, in applying a diagram with the same number of ordinates to evaluate a 6th harmonic, we are, in fact, using a $4n$-ordinate Fischer-Hinnen method, and the result must contain the 18th, 30th, &c., harmonics. In the practical application of fixed ordinate methods the risk of error from this cause can be largely minimised by employing a sufficient number of ordinates.

Alternative Methods.—The preceding discussion does not pretend to be exhaustive, and certain alternatives to the methods described are possible. Thus we might devise an alternative to the $4n$-ordinate method by erecting ordinates y_1, y_2, y_3, &c., at the respective distances $\pi/6n$, $5\pi/6n$, $7\pi/6n$, $11\pi/6n$, $13\pi/6n$, &c., from the origin. Twice the average of these ordinates with signs reversed in pairs according to the scheme $++--++$&c., gives $A_n+2A_{3n}+A_{5n}-A_{7n}-2A_{9n}-A_{11n}+A_{13n}+$ &c. By taking the arithmetical mean between this result and that given by Fischer-Hinnen's $2n$-ordinate method (thus utilising $6n$ separate ordinates), we obtain $A_n+\frac{1}{2}A_{3n}+A_{5n}-A_{7n}-\frac{1}{2}A_{9n}-A_{11n}+A_{13n}+$&c. To get the corresponding cosine terms a new set of ordinates y'_1, y'_2, y'_3, &c., must be erected at successive distances $\pi/3n$, $2\pi/3n$, $4\pi/3n$, $5\pi/3n$, $7\pi/3n$, &c., from the origin. Twice the average of these ordinates with signs reversed in pairs according to the scheme $+--++--$&c., gives $B_n-2B_{3n}+B_{5n}+B_{7n}-2B_{9n}+B_{11n}+$ &c., and by combining this with the corresponding result obtained by the $2n$-ordinate method we have $B_n-\frac{1}{2}B_{3n}+B_{5n}+B_{7n}-\frac{1}{2}B_{9n}+B_{11n}+$ &c.

Another way of treating the ordinates drawn as indicated in the last paragraph is to average y'_1, y'_2, y'_3, &c., with signs reversed in pairs according to the scheme $++--++$ &c. This average, when multiplied by $2/\sqrt{3}$, gives $A_n-A_{5n}+A_{7n}-A_{11n}+A_{13n}-$&c., or, combined with the $2n$-ordinate method so as to utilise $6n$ separate ordinates, $A_n-\frac{1}{2}A_{3n}+\frac{1}{2}A_{9n}-A_{11n}+A_{13n}-$&c. Similarly, $2/\sqrt{3}$ times the average of y_1, y_2, y_3, &c., with signs reversed in pairs according to the scheme $+--++--$&c., gives $B_n-B_{5n}-B_{7n}+B_{11n}+B_{13n}-$&c., or, combined with the $2n$-ordinate method, $B_n+\frac{1}{2}B_{3n}+\frac{1}{2}B_{9n}+B_{11n}+B_{13n}+$&c.

Evidently both of the "combined" or $6n$-ordinate methods thus obtained are inferior to the $6n$-ordinate method previously described, since the results they give contain a larger number of included harmonics. In this respect the second of the alternative $4n$-ordinate methods is, however, superior to the $4n$-ordinate method referred to in an earlier part of the article, as also to Fischer-Hinnen's $2n$-ordinate method. Thus the ascending order of accuracy as estimated by the number of included higher harmonics is (i) Fischer-Hinnen's $2n$-ordinate method, (ii) the second of the alternative $4n$-ordinate methods, (iii) the $6n$-ordinate method first described.

THE ORIGIN AND PRODUCTION OF "CORRUGATION" OF TRAMWAY RAILS.*

BY W. WORBY BEAUMONT.

Summary.—The author calls attention to the various stresses which are set up in free flat bars of iron and steel when subjected to rolling or hammering, and that this originates on the upper surface of the rail a condition of intense compressive stress, tending to produce a modification of form. The results of tests made on the L.C.C. tramways and other systems are given.

Few of the phenomena of the behaviour of materials employed in tramway construction have given rise to so much enquiry, speculation and diversity of opinion in the last few years as the phenomenon known as "corrugation" of tramway rails.

The rapid spread of its occurrence in nearly all towns with heavy tramway service has directed anxious attention to the discovery

* Paper read before Section G (Engineering) of the British Association at Portsmouth.

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of its cause, and much has been written concerning it, and some experimental investigations have been made. Unfortunately, the indoor experiments have seldom been conducted with apparatus or under conditions which simulate those of the tramway itself.

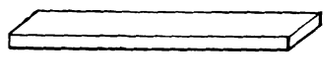
On the other hand, the observations which have been made by many on the rails themselves have led to every possible variety of interpretation of the cause of corrugation, largely because of the apparent contrariety of its occurrence and non-occurrence.

The author had commenced the preparation of an index to the Papers and articles which have appeared in this and other countries during the past five years, but it was soon found that this would be of intolerable length, and after all of but little service. The "Proceedings" of the Institution of Civil Engineers provide abstracts of Papers too numerous to mention; the Institution of Electrical Engineers has dealt with the subject; the Municipal Tramway Association and the Tramway Congress hardly ever meet without dealing with the subject; the Tramways and Light Railways Association Official Circular and "Journal" for some years has been crowded with corrugation inequalities and vagaries, and lately a Joint Committee of the two Associations—the Municipal Tramways Association and the Tramways and Light Railways Association—has been working on the subject. To the proceedings of this Committee the author has contributed, and had previously dealt with the subject elsewhere. Foreign authors have contributed largely, and a report by a Committee consisting of the managers of nine Continental tramway systems, one British professor of engineering and the secretary, was discussed at the International Tramway Congress held in Brussels in 1910.

One of the recent and most useful reports on the subject (although some judicious analysis of the facts presented is required) has been prepared as a provisional report by a Committee of the technical department for railway construction and exploitation of Amsterdam, including Messrs. J. Schrooder van der Kolk, M.P., Mass Geesteranne and T. E. van Putten. And more recently a Paper by Herr Von Borries, of much merit, has been published.

Having given some attention to all this literature of this particular

FIG. 1.



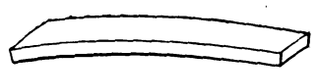


FIG. 2.

engineering ailment, and being aware of the indecision that still exists in the minds of many upon it, the author now ventures, at more length and with the object of greater precision, the explanation he has on previous occasions attempted to convey.

The subject has hitherto been treated mainly from the general point of view suggested by the practical experience of the tramway manager and engineer, and has seldom attracted or received the considered reasoning conjointly of the mechanic and the physicist. It is, however, one which in a marked degree demands the patient application of the attributes of both, and in this Paper I may repeat the words of Mr. H. R. A. Mallock,* and say "it is often useful to have a simple, even if incomplete, theoretical treatment of a subject provided that the theory is correct as far as it goes, and is kept within bounds by comparison with actual observations."

In a surface of a homogeneous solid under compressive stress in orthogonal directions in the plane of the surface, every particle tends to cause every particle surrounding it to recede in every direction.

If one surface of a free flat bar of steel or iron, as Fig. 1, be rolled or hammered, the material of that surface is subjected to a compressive stress. Of this stress it is relieved in the direction of length of the bar so far as the stress is no greater than that which is necessary to bend the bar, and cause it to keep the bent form of Fig. 2.

If of wrought iron, the molecular surface stress will in part be relieved by flow of the material or detrusion along the edges of the hammered surface, and the longitudinal bending be less than if the bar be of rail steel, in which the detrusion will be less.

If of cast iron, the surface compressive stress will accumulate and the bar will be bent by it; but the accumulation of stress reaches an early limit, as it sooner exceeds the limit of cohesion between the surface and subjacent material. The result is that, with cast iron, surface crumbling occurs and limits stress accumulation. It does, however, become sufficient to permit its use as a means of straightening cast-iron coping plates and the like if slightly curved when taken out of the sand.

If when a bar has been bent by surface compression of one side, it be forcibly straightened, the compressive stress will be increased, and a tensile stress impressed on the opposite side sufficient to eliminate the difference of dimension of the two sides caused by the compression. To remove the difference permanently the stress on the uncompressed side must reach the character of strain, equally distributed throughout the whole length of the bar. At the same time an increase is made in the compressive stress on the rolled or hammered surface. This cannot be relieved by a single pucker or extrusion of the surface about the centre of length of the bar, as the stress is uniformly distributed. Hence, at distances apart (or pitch), depending on the elastic and cohesive properties of the material, there will result incipient surface crumblings or corrugations, as shown exaggerated in Fig. 3.

The bearing of this fact on the tramway or railway rail will appear hereafter, but here it may be observed that the stresses in a bar which is bent by compression of one side and caused to retain the bent form by that resident molecular stress, is not in the same condition as to stress throughout its structure as a similar bar bent and maintained in a bent form by mechanically imposed distributed load.

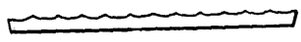


FIG. 3.

In the bar bent by compression of the material on one side there is molecular tensile stress immediately below the hammered surface. The compression differentiates in intensity from the surface to a zone or couche under tensile stress resulting from the molecular cohesion which has prevented the compressed and extended surface from separating itself by shear. Below this, tensile stress differentiates into a neutral zone and therefrom into the compressive stress which remains resident in the bar so long as it is bent by these internal forces.

In a surface such as that of an ironplate which has been rolled or hammered on that surface only, the particles of the hammered surface are, as previously mentioned, restrained by cohesion of and with the subjacent particles, which are less and less under compression as they are remote from the compressed surface film.

If any two points, a, b, or a', b', Fig. 4, be taken in such a surface film, it will be seen that all the particles round each point press towards it with forces proportional to some function of their respective distances from such points. In a line drawn from a to b, or a' b', there are, therefore, equal and opposite forces tending to separate those points, and when their amount exceeds the elastic resistance of the material, deformation or crushing or crumpling

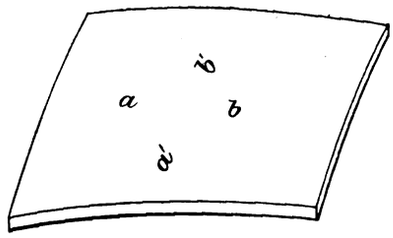


FIG. 4.

must occur, if change of form of that of which the surface is a part be restrained. If the surface be that of a deformable plate, then the forces are in part relieved by bending the plate in orthogonal directions. It is not necessary here to determine the distance between a and b at which any given material will reach the yielding point, or at which the accumulated forces will be sufficient to cause either the bending of a plate or give rise to destructive stresses in any other form of which the compressed surface is part.

To this a return may be made later, but here it is sufficient to repeat that it will be dependent upon the relation between the elastic resistance of the material to compression and its elastic tensile strength and its hardness.

In dealing with these stresses as occurring in practice, and in such forms as those of a railway or tramway rail, it will be seen from the foregoing that the values of the stresses in orthogonal directions soon reach inequality, because while they become cumulative in the direction of length of the rail, the distance transversely separating the points a and b earlier reach the limits of dimensions at which the forces can arise, because relief of the stresses is found in lateral deformation or detrusion at the rail edges, as in Fig. 5.

There is a further view of the physical conditions to be considered, which under the mechanical conditions of the rolling of a wheel on

* "Proc." Inst. Civ. Eng., Vol. CLXXVIII., 1909.

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the plane surface of a rail under pressure greater than or approaching its elastic resistance gives rise to that which results in what is known as corrugation.

A loaded circular surface, as of a roller or wheel resting upon a deformable straight plane surface, has but a line contact with that surface until either or both the circular and flat surfaces of contact are so deformed by loading the roller as to increase the area of contact. The deformation will continue until the resistance to deformation equals the force producing it. If the materials of the two surfaces be equally resistant, the circular surface will be flattened and the flat surface will be depressed or indented. If the roller be of the more resistant material, the deformation may be chiefly in the material of the flat surface. If the roller be made to roll along the surface which it can so deform it presses before it a wave of deformation. The depression giving rise to this wave may (as in the case of the tramcar wheels and rails) approach or exceed the limit of elastic deformation of the material of the rail. When this is the case, continuation of the movement of the roller upon the surface demands

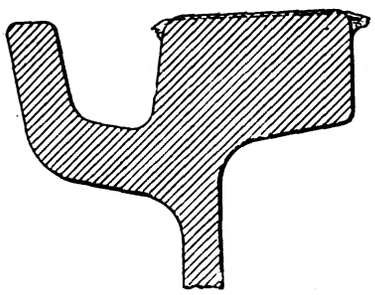

FIG. 5.

the translation of the crest of the wave, and this would involve the destruction of the cohesion between the rolled compressed surface wave crest and the material supporting it and of which it is a part. The result, therefore, is that tensile stress arises *pari passu* with the wave formation between the wave particle and the subjacent particle of the material supporting it, and the point is reached at which the tensile resistance to the increase of the wave height prevents further increase. The roller then must rise upon the minute crest, and in doing this with its heavy load upon the extremely small area compresses it to extreme hardness.

The roller (wheel) in its continued progress repeats the process and continuously adds to the rearward dimensions of the hardened spot.

The foregoing then shows that the rolling and hammering of the upper surfaces of a rail originate a condition of intense compressive stress, the elimination of which produces, or tends to produce, modification of form. It also shows that areas of maximum compression are originated at points separated by distances which are determined mainly by the relation between compression resistance and elastic strength of the material rolled, but in part by the relative hardness of the roller and rail and by the mechanical conditions which affect the area of the roller and rail contact.

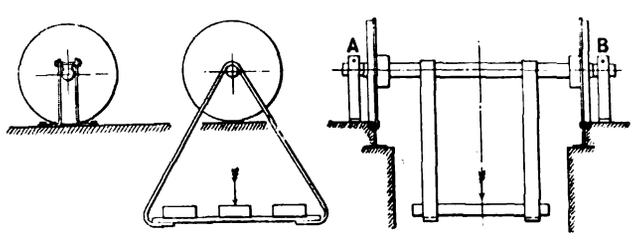

FIG. 6.—AREA OF CONTACT OF TRAMCAR WHEELS ON RAILS.
(Experimental Apparatus.)

The area of contact of hard tyre tramway wheels on steel rails is very small—is less than on ordinary railway wheels. On the latter it has been found to vary, with wheels 4 ft. 6 in. to 5 ft. in diameter, and carrying a steadily applied static load of from 12,000 lb. to 14,000 lb. per wheel, from 66,000 lb. to 48,000 lb. per square inch of contact area. The minimum and maximum areas of a larger number of observations gave loads per square inch of contact area of from 26,607 lb. to 85,961 lb. This, however, was the minimum pressure, as it was taken with engines standing on a level rail and the wheel gently lowered on to it. With an engine moving at speed and heeling over as on curves, this pressure would be much greater. It must further be noted that the central part of the area of contact would be much more severely pressed than the borders of the area.

By the courtesy of Mr. A. L. C. Fell, M.I.E.E., the author has been enabled to give measurements made at his request of the pressure of the wheels of a standing car on rails of standard type. These measurements were made by loading the axles of the larger and the smaller wheels of the bogie of one of the large standard London County Council double-bogie trucks.

For the purpose of the experiments, a sling was made as shown in the diagram Fig. 6. This consisted of flat bars to which were bolted three pieces of timber on which the load was placed. The rails were carefully cleaned and the wheels turned to the correct standard taper, but with a finer cut than that usually adopted in practice.

The load used was as follows in each case :—

Driving wheels, 31 in. diameter, 6 tons.
Pony wheels, 21·56 in. diameter, 3·25 tons.

These weights approximate closely to the actual weights on a standard bogie car when loaded.

The wheel on the side marked A, *see* Fig. 6, was on the rail where it was continuously supported. On the side marked B the wheel rested immediately above the centre of a pier 14 in. wide, where the rail was not quite so rigidly carried. The diagrams obtained, marked 1 in Fig. 7, were slightly larger on this side.

The rails showed very little sign of wear, and the experiments were made at the end of a shop which has not been very much used. At each end of the axle a guide bracket was fixed to the ground, as shown in Fig. 6; between these brackets and the axle journal boxes pieces of wood were fixed to prevent lateral movement.

The axle was lifted at the extreme end by means of a jack, and lowered carefully on a piece of tissue paper on thin carbon paper placed on the rail under the wheel. The impressions made are shown by the diagrams herewith (*see* Fig. 7).

The rails were of British standard hardness, and the tyres were manufactured to specification, for the following extract from which the author is indebted to Mr. Fell.

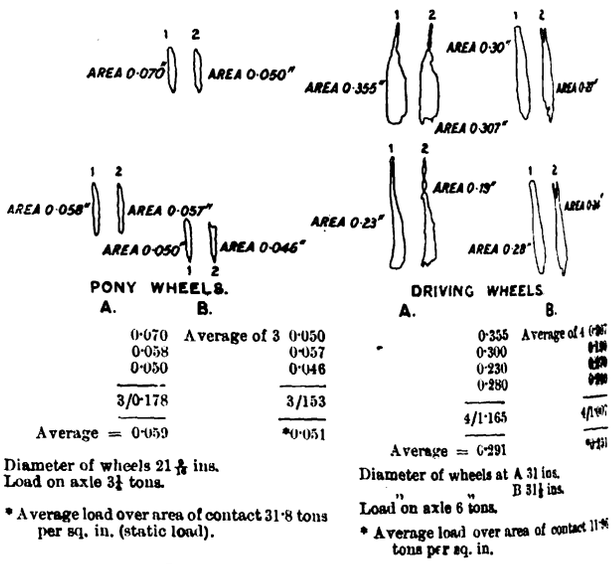

FIG. 7.—DIAGRAMS OF CONTACT AREAS.

Tensile strength not less than 55 and not more than 70 tons per square inch, minimum elongation of 11 to 8 per cent. in 2 in., and of the following composition :—

Carbon	0·65 to 0·75 per cent.
Silicon	0·32 "
Manganese	0·6 to 0·8 "
Sulphur	0·035 "
Phosphorus	0·035 "

The tyres are thus of harder material than the rails, which have 0·40 to 0·55 per cent. carbon.

The areas of contact carefully measured from these diagrams are given on the drawings accompanying this Paper, the areas and pressures given being those obtained from the smaller diagrams marked 2 measured on the inner edge of the black lines made by the carbon paper. The loads given per square inch are the average loads over the whole area of the diagram when the tyre had pressed into the rail, and the tyre itself also microscopically deformed until the area of support given was obtained. The pressure per unit of area in the centre of the area of support would, of course, enormously exceed this average, and I estimate the maximum static pressure to be not less than 35 tons per square inch under this driving wheel. When the car is running at ordinary speeds the pressure would rise to not less than double this as impact pressure, and when the car runs at speed round curves, and the greater part of the load with the heeling over of the car is visited on the wheels on one side, the pressure might easily reach at least 100 tons per square inch.

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On the pony wheels the average pressure of the whole area of contact under static loads reached 31·8 tons per square inch. The maximum pressure in the centre of area of contact was probably not less than 50 tons. This, with the car running at ordinary speeds, would probably reach 90 tons per square inch, and when running at speed round curves and the car heeling over so that the greater part of the load rested on the wheels on one side, the maximum pressure would probably reach 120 tons per square inch.

It is clear, then, that the pressure per unit of area much exceeds the limit of elastic compression of the material of the average rail, and that flow or deformation would occur were it not that the area pressed is supported by the surrounding material and held *encastrée*, so that flow cannot occur. One result of this is the detrusion of one or of both the rail edges, as shown by Fig. 5, by which cumulative

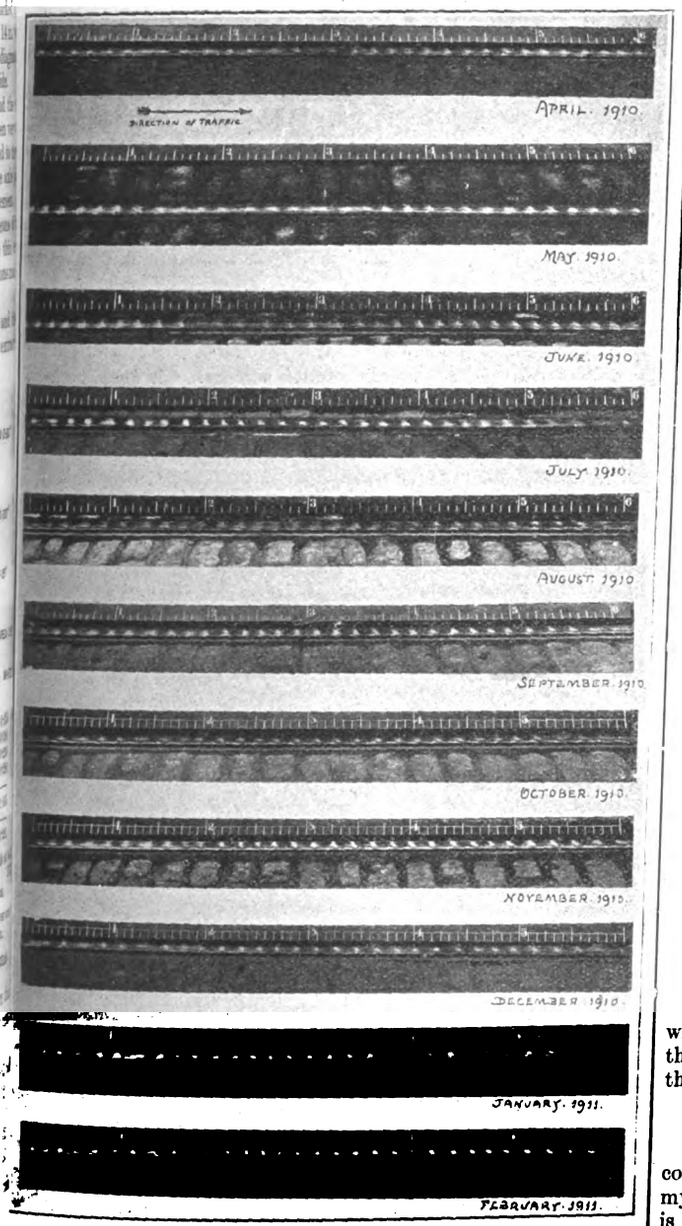

FIG. 8.—LEEDS CITY TRAMWAYS.—PARK LANE.
38 ft. 6 in. past pole 20. Outgoing track. Outer rail. Straight track. Down gradient 1 in 70. Pitch of corrugations, 2 in. In use 10 years. Section No. 6, L.S.W.

disruptive forces are in part dissipated and the extruded material on the groove edge of the tread is removed by the car wheel flanges. Another result is corrugation, and a third is the minute crumbling and pitting of the rolled surface.

Under some circumstances and conditions corrugations may decrease as the raised hardened surfaces approach by lengthening; and as corrugation and the surface become more uniform by the removal of surface material by crumbling or minute flaking, especially of the harder rails with up to 0·66 of carbon, which best resist the causes of corrugation. The removal of corrugations, however, by grinding only prepares the rail surface for quick recommencement of corrugation or for lengthening the hardened part of the corrugations.

If the preceding be accepted as the origin and production of corrugation, then the question remains, What are the remedies? The mechanical originating conditions being the weight on the wheels and the increase of that weight, more especially on outside curves by car heeling at the higher speeds, then :—

The first and most effective remedy is the reduction of the great destructive weight on the wheels of the modern car.

The second is the use of larger wheels than can be used with the present design of car.

The third is the maintenance of moderate speeds; of much lower speeds than are common on curves even those of large radius, and moderate speeds on lines that may be classed as straight, but which have such departure from straightness as will encourage boxing or wandering of the cars from side to side.

Fourthly, the use of harder rails than the hardest at present employed.

The reduction of weight is possible, the reduction of speed is possible, the use of larger wheels is possible with future cars, and the use of harder or more resistant rail materials may be possible, but they would have to be produced by methods more costly than those now adopted. The remedies will involve modifications in the views at present prevalent as to the place, purpose and working of tramway services; but even the most ardent advocates of tramway ubiquity

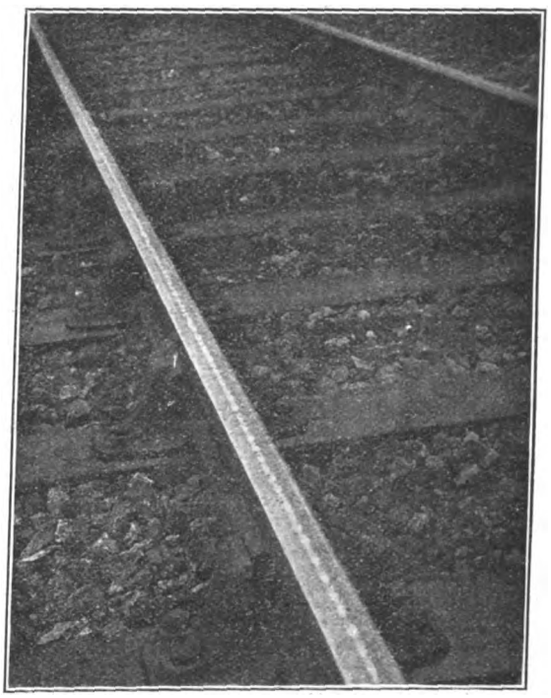

FIG. 9.—ON MIDLAND RAILWAY.—SHEFFIELD.
Straight track. Falling gradient of 1 in 100.

will ultimately be constrained to admit that tramways, like all other things that have and offer desirable ends and convenience, have also their economic and expediency limits.

ADDENDUM.

The occurrence of corrugation of electric tramway rails, as recorded by many tramway engineers and managers, and as found by my own observations extending over some years at home and abroad, is everywhere associated with the following broad generalisations of facts :—

1. That it occurs on straight lines and on curves.
2. That it is most prevalent and generally commences on curves of large radius—flat curves.
3. That it never or rarely occurs on curves of small radius—*e.g.*, from 40 ft. to 80 ft.
4. That on hills, and especially on slight gradients, it is most prevalent on the down line.
5. That its occurrence as to date or length of time after laying the rails varies broadly with (*a*) the position of the rail on straight or flat curve or down gradient, (*b*) the frequency of the service, (*c*) the mechanical properties and composition of the rails, as shown by more or less outer edge detrusion.
6. That it occurs with all types of truck.
7. That it is most prevalent where the speeds are highest.

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The general appearance of corrugated rails is known to all who are interested in the subject, and photographs showing corrugations in various stages of growth in many towns might be shown. The author is enabled, by the courtesy of Mr. J. B. Hamilton, general manager of the Leeds tramways, to show photographs of three sets of 33 rails in that city. These photographs show rails which have been in use from 4 to 13 years on straight track. Those which have been in use 13 years are on the level, those of 10 years (*see* Fig. 8) are on a gradient of 1 in 70, and those which have been in use four years are on a gradient of 1 in 50.

A small photograph, Fig. 9, is exhibited of a rail in a straight piece of track on the Midland Railway, Sheffield, on a falling gradient of 1 in 100. This shows a much worn rail, with the bright hard spots about the centre of the tread, and shows that what is called corrugation is not confined as to nature of origin or production to street tramway rails, although it is necessarily much more general and severe on tramways and other rails where heavy vehicles with small wheels and high speeds are used, as, for example, on some of our tube lines and the Metropolitan of Paris.

RECENT DEVELOPMENTS IN RADIO-TELEGRAPHY.*

BY G. W. O. HOWE, M.SC.

Summary.—The author first discusses the difficulties experienced in wireless transmission due to interferences, atmospheric disturbances, &c. He then considers recent developments for minimising such interference and improving the conditions, dealing firstly with the transmitting apparatus, and secondly with the receiving apparatus.

During the last two or three years the number of radio-telegraphic installations has increased enormously both on land and sea. This increase has not been due so much to any new discovery or striking improvement as to several instances in which radio-telegraphy prevented what might otherwise have been terrible calamities at sea.

The total number of ships of the mercantile marine fitted with Marconi apparatus at the end of 1907, that is, after seven years of development, was 140; at the end of 1908 the number was 220; at the end of 1909 it was 330, while at the close of last year it had risen to 510. In addition to the mercantile marine, practically every ship in the British navy has been fitted with Marconi apparatus.

The Telefunken Company, of Berlin, carried out 106 installations last year, bringing the total number of stations using their apparatus up to nearly 1,000. About 500 of these are warships, principally German and Russian, while 100 are portable military sets. Excluding German boats, only 13 ships of the mercantile marine are fitted with Telefunken apparatus.

Marconi's earliest experiments were made in 1895–1896 and now, after 15 years, every passenger ship of any magnitude has its wireless installation as a matter of course. There is every indication that very soon practically every ship will be so equipped. Some of the trawlers of the North Sea fishing fleet have recently been fitted with Telefunken apparatus with a range of about 100 miles. These boats receive the weather reports sent out daily from the coast stations and are thus able to warn the fleet of approaching storms.

As was recently pointed out by Mr. Bradfield of the Marconi Company the increase in the number of installations will probably be cumulative, since each installation on land or sea increases the value of the service to every ship making use of it. There is, however, another aspect to which attention should be drawn, and that is, that the troubles due to interference between stations working simultaneously will also increase cumulatively. These troubles promise to become of the gravest importance in the immediate future.

Before one can appreciate the recent developments in the apparatus, one must know something of the difficulties experienced in carrying on radio-telegraphic communication. The nature of the telegraphic service which may be required of a station is very varied. A station may have to work with only one other station and never send to, or receive from, any other. This is practically the case with the trans-Atlantic stations. A station may correspond with a limited number of stations with definite and well-known characteristics as in the case of the mail-boats running between England and the Continent. On the other hand, a station may have to work with all comers.

One can easily see that apparatus which might be eminently suitable in one case would be very unsuitable in the other. Stations in the first category can use uncommon wave-lengths and thus free themselves, to a large extent, from interference from other stations, besides being able to use a large amount of power without causing interference. The Marconi trans-Atlantic stations in Ireland and Nova Scotia use a wave-length of over 6,000 metres (50,000 c. per second) and are thus free from disturbance from ships which generally use 300 to 600 metres.

Stations of the third class, on the other hand, should be able to call, or be called up by, ships or land stations, fitted with any make of apparatus covering a wide range of frequency.

To appreciate the difficulties due to interferences one has only to consider a station on the Kentish coast, with half-a-dozen ships within range all wishing to communicate with the coast station. They can only communicate one at a time, and each operator naturally tries to "catch the speaker's eye," which in this case is the coast operator's ear, by calling often and loudly, notwithstanding any regulations to the contrary. The same thing may be going on at other coast stations on both sides of the Channel. In addition to this we have English and French warships and dockyards working at the same time. If every station or every ship had a different wave-length it might be possible to tune the others out to a certain extent, but for the sake of uniformity and convenience in working, the majority of stations have about the same wave-length, so that when one is tuned to the desired station, one is also tuned to the disturbing stations. The result is that one station tries to shout the other down and the successful working of all the stations is greatly hindered. At the City and Guilds College in South Kensington one of the aerials is a single wire 260 ft. high and with this one can sometimes hear half-a-dozen stations sending simultaneously at approximately the same wave-length, making it absolutely impossible to read any one of them.

Apart from all this, there are the atmospheric disturbances, which vary very much from time to time. One station receiving from another a thousand miles away will certainly hear every lightning flash over a large part of the earth's surface. These atmospheric disturbances are often strong enough to make working impossible over any but very short distances, even when the weather conditions locally look ideal.

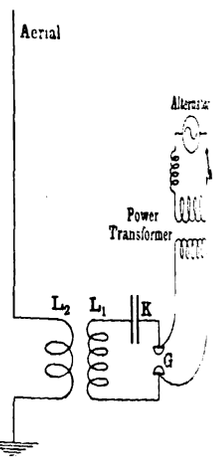

FIG. 1.

Whether one can receive or not in spite of these atmospheric disturbances depends on the loudness and nature of the signals, so that one can become more and more independent of the atmospheric conditions by increasing the power employed and by making the signals easily distinguishable from the sounds caused by the disturbances.

Recent developments in the sending apparatus have been largely directed towards obtaining freedom from interference. This has been sought in two ways: Firstly, by sending out well-sustained trains of waves of one definite frequency, giving sharper tuning, and secondly, by giving the signals a high musical pitch, easily distinguished from the crackling noises caused by atmospheric disturbances and also from other stations having notes of a different pitch. The spark-gap must be so designed that these characteristics are retained when very large powers are employed. A spark-gap may work excellently when the power is small, but fail entirely when the power is increased. Absolute reliability and constancy are of far greater importance than efficiency, although any improvement in the latter is to be welcomed, not so much for the saving of power as for the reduction in size and cost of the apparatus.

Fig. 1 may be taken to represent diagrammatically the sending apparatus of almost every system, by whatever name it may be called. In all except the smallest installations, the sparking coil with hammer or mercury break has been replaced by an ordinary power transformer supplied with alternating current, as shown in the figure. The coils L_1, L_2 constitute an air-core Tesla transformer of few turns. It is sometimes connected as an auto-transformer, *i.e.*, with a single winding tapped off at different points, but this alters nothing so far as the principle is concerned. If coil L_2 is far removed from coil L_1, each discharge of the condenser K across the gap G will cause a damped oscillation in the primary circuit GKL_1, as shown in Fig. 2. The rapid damping is mainly due to the dissipation of energy in the spark-gap. The time, T, of a complete oscillation depends only on K and L_1 and is usually about 1/500,000 second, corresponding to a wave-length in space of 600 metres. All the energy stored in the condenser at the moment of breakdown is dissipated as heat in the gap and in the remainder of the oscillatory circuit. It is seen that the oscillatory disturbance caused by one spark lasts about 1/50,000 second. Nothing further happens until the condenser is charged up

* Paper read before Section G of the British Association at Portsmouth.

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to the same potential difference as before. If the gap is made so long that the spark can only just jump it, the next spark may not occur until several half-cycles of the alternating supply have passed, the voltage across the secondary of the power transformer gradually building up due to resonance. This resonance is obtained by adjusting the speed of the alternating-current generator. The result will be that, with an alternating-current supply of 50 cycles per second, the sparks may occur at intervals of 1/20 to 1/30 second (Fig. 2). This is the method which was largely used two or three years ago and which is still used by the Eiffel Tower and many other stations.

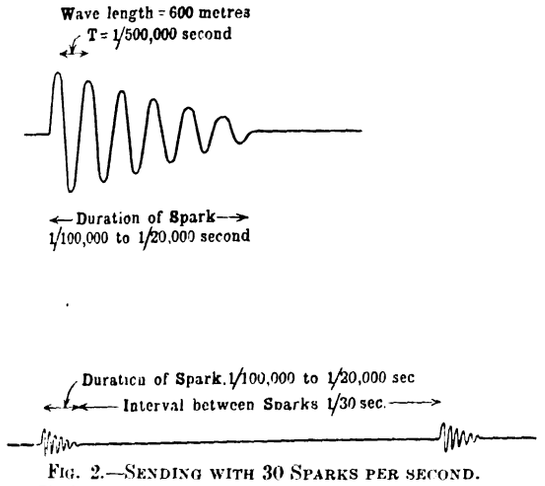

FIG. 2.—SENDING WITH 30 SPARKS PER SECOND.
The duration of a Morse dot is about one-twentieth of a second.

If the coil L_2, which with the aerial constitutes an oscillatory circuit of the same frequency as the circuit GKL_1, is loosely coupled with the coil L_1 so that about 5 per cent. of the magnetic flux of L_1 links L_2, a part of the oscillating energy will be transferred to the aerial and there partly radiated out into space and partly dissipated in the aerial, coil, and earth connection. The oscillogram (Fig. 3) shows the nature of the primary and aerial currents accompanying each spark. Owing to the loose coupling between L_1 and L_2 the transference of energy is very slow and the major portion is still dissipated in the spark-gap. From experiments made at the City and Guilds College it has been found that under the most favourable circumstances 30 per cent. of the primary energy can be transferred to the aerial. If the transfer of primary energy to the aerial is hastened by increasing the mutual inductance between L_1 and L_2, the energy surges backwards and forwards between the two circuits and gives us the phenomenon of beats. The oscillograms (Figs. 4 and 5) show the nature of the primary and aerial currents as the coupling is increased. Instead of a wave of one definite length, say 600 metres, a pulsating oscillation is sent out, which may be looked upon as made up of two ordinary damped waves with lengths of, say, 500 and 700 metres. This will be received almost equally well on the receiving aerial whether it be tuned to 400, 600 or 800 metres or any other intermediate wave-length.

In Figs. 9 and 10 are plotted the currents in the receiving apparatus as its natural frequency is varied. The two figures refer to different installations; in each case a series of curves is given for different degrees of coupling between the coils L_1 and L_2. With the ordinary spark-gap it is obviously impossible to increase the coupling much above 7 or 8 per cent. without sacrificing sharpness of tuning and thus causing undue interference with stations working at other wave-lengths. Apart from the question of interference, there is little increase of efficiency to be obtained by increasing the coupling beyond this value.

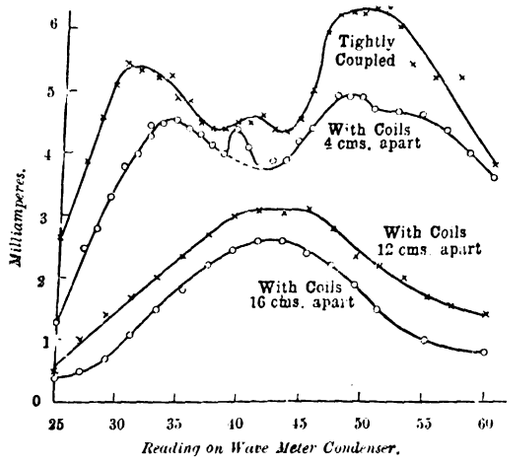

FIG 9.—SENDING ON FIVE-WIRE AERIAL, USING SMALL SPARK COIL AND PLAIN GAP WITHOUT AIR BLAST.

These are the conditions under which the majority of stations are working at the present time, but during the last three or four years a great amount of research work has been done with the object of improving these conditions.

In Fig. 10 it will be noticed that when the coupling is tight, the aerial oscillation contains waves of three different frequencies, one high and one low, corresponding to the constituents of the beats, and one of the natural frequency of the aerial alone. This shows that during a part of the time the aerial oscillated freely, uncoupled from the primary circuit. The reason for this can be seen from the oscillogram, Fig. 6. In the experiment to which Fig. 10 refers, the spark-gap was exposed to an air-blast, so that whenever the amplitude of the current in the primary oscillating circuit was small, there was a tendency for the air-blast to remove the column of hot air and metallic vapour and thus to extinguish the spark. This will obviously occur at a moment when all the energy is oscillating in the aerial and will prevent it surging back into the primary circuit. The aerial will now continue to oscillate at its natural frequency until the energy is all radiated or dissipated. In Fig. 10 not only was there an air-blast

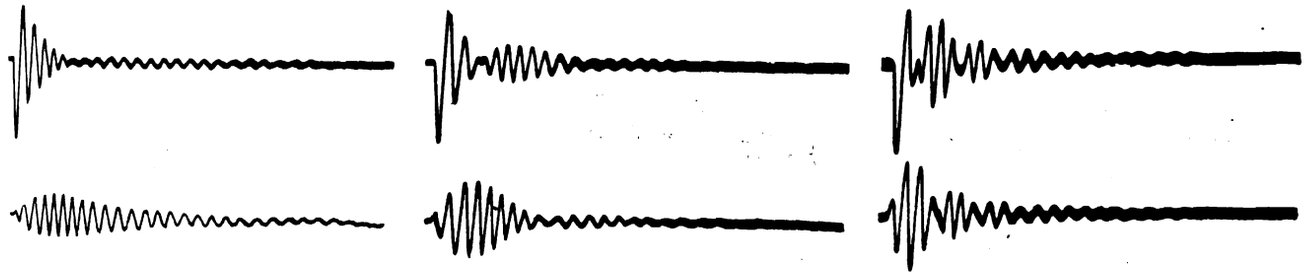

FIG. 3.

FIG. 4.

FIG. 5.

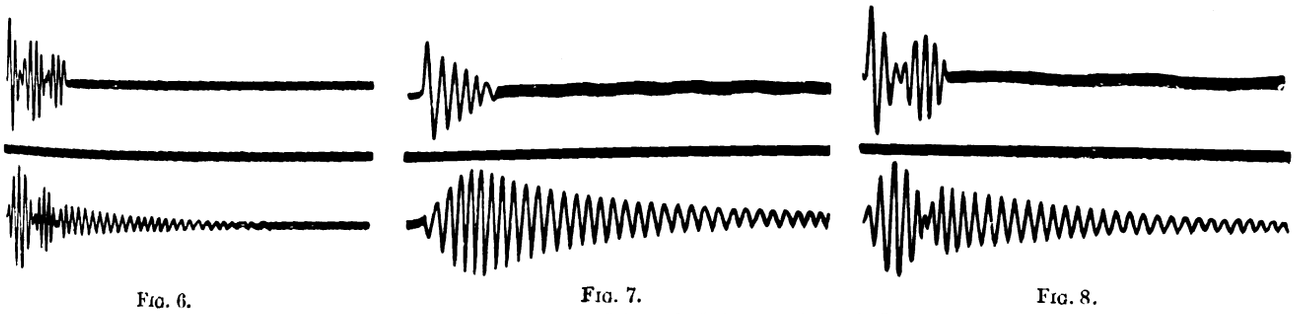

FIG. 6.

FIG. 7.

FIG. 8.

In all the Oscillograms the Upper Curve refers to the Current in the Primary Oscillating Circuit and the Lower Curve to that in the Aerial.

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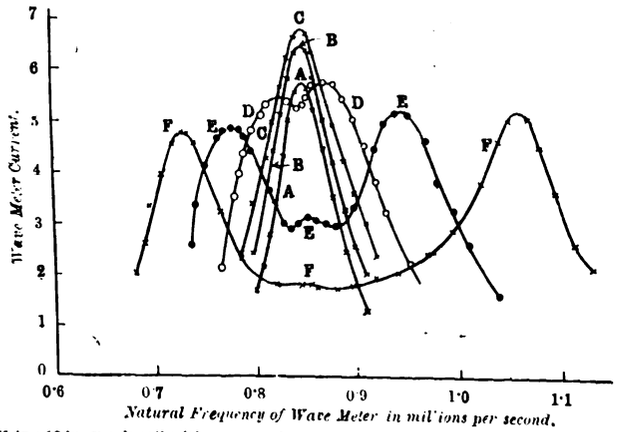
but the electrodes were comparatively large and the spark-gap short, so that no part of the spark was far removed from the large mass of cold metal tending to condense the metallic vapour and thus lower the conductivity of the spark.

This quenching of the spark was discovered in 1906 by Prof. Max Wien and was afterwards taken up by the Telefunken Company, who have evolved a form of spark-gap in which the quenching is very effective. With this gap the primary and aerial currents will be as shown in the oscillogram, Fig. 7. The gap acts as a very quick-acting minimum-current cut-out, and opens the primary oscillating circuit at the first opportunity, viz., when all the energy has been transferred to the aerial. The time during which the two circuits are coupled is very short, the energy wasted in the spark-gap is reduced, and the major portion of the energy oscillates freely in the aerial and is radiated as a damped train of waves at its natural frequency. In this way it is claimed that 75 per cent. of the output of the alternator is transferred to the aerial.

It is obviously advantageous to shorten the duration of the spark as much as possible by tightening the coupling between the coils L_1 and L_2, and thus hastening the transfer of energy to the aerial. If this be overdone, however, the gap will fail to quench at the first minimum and we may get the conditions shown in Fig. 8, or even Fig. 6, with a great loss both in efficiency and sharpness of tuning.

Wien first obtained quenching by the use of very short spark-gaps, and this is the method which the Telefunken Company has adopted, although other methods have since been discovered. The spark is made to occur between the parallel faces of discs of copper or silver placed about 1/100 in. apart, the discs being separated by thin annular rings of mica which also serve to shut the sparking spaces off from the air. The number of these discs in series depends on the voltage and power required. This form of gap is undoubtedly complicated and expensive, not only in first cost but also in subsequent up-keep.



Using 10 in. spark coil with mercury break. Length of spark gap 1·2 mm. with air-blast.
Primary capacity, 0·00567 microfarad. Secondary capacity, 0·00198 microfarad.
Resistance in secondary, 6·36 ohms.

A coupling = 2·9 per cent.	C coupling = 7·8 per cent.	E coupling = 21·4 per cent.
B " = 4·75 "	D " = 12·55 "	F " = 36·3 "

FIG 10.

Those who have picked up the time signals and weather reports sent out daily from Norddeich near Bremerhaven will have noticed that although the signals are very clear and easily distinguished from extraneous sounds, they often decrease in loudness after working for some time, and have been known to fail altogether for a few seconds in spite of the efforts of the operator. This may have been due, of course, to some exceptional cause not connected with the gap, but it is almost what one would expect when using such minute gaps as 1/100 of an inch. It seems therefore, at present, that the increased efficiency due to the quenched spark is obtained by the sacrifice, to a certain extent, of reliability and simplicity.

Turning now to the receiving apparatus, we find that the filings coherer has practically disappeared. The reception of the signals is now always aural. The detectors now employed in conjunction with a telephone receiver are not only much more sensitive than the filings coherer operating a Morse inker, but enable the operator to discriminate between the signals being sent to him and the various disturbances picked up by the aerial, which, as we have already seen, is a matter of ever-increasing importance.

The magnetic detector used by the Marconi Company is ideal in its simplicity and reliability, but is not so sensitive as the electrolytic or the mineral contact detector. The Telefunken Company have recently given up the electrolytic detector in favour of a detector of the latter type. Another type of detector used to a certain extent is the Fleming valve, which combines extreme sensitiveness with comparative simplicity and reliability.

Although there are many ways of arranging the receiver connections, Fig. 11 may be taken as typical of the usual arrangements when using a mineral contact detector. The high-frequency oscillation picked up by the aerial is transferred by means of the oscillation transformer L_3 L_4 to the tuned oscillatory circuit KL_4. Shunted across the condenser is the detector—consisting simply of a piece of zincite in contact with a piece of pyrites—together with the telephone receiver of several thousand ohms resistance. The telephone is shunted with a condenser, which must have such a capacity that it acts as a conductor to the high-frequency oscillations enabling them to pass through the detector without passing through the highly inductive telephone receiver, but as an insulator to currents of telephonic frequency, thus forcing them to pass through the telephone.

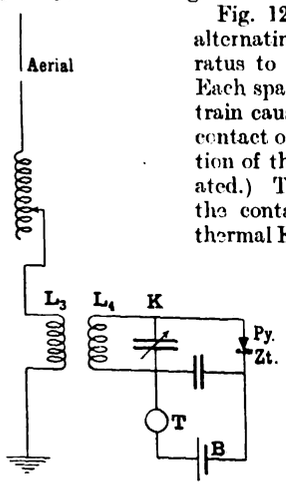


FIG. 11.

Fig. 12 explains the various stages from the alternating-current supply of the sending apparatus to the currents in the telephone receiver. Each spark causes a wave-train, and each wave-train causes a momentary heating of the point of contact of the detector. (In the figure the duration of the wave-train has been greatly exaggerated.) This will cause a momentary variation in the contact resistance and will also produce a thermal E.M.F., with the result that a momentary current passes through the telephone or, if, as is sometimes found advantageous, a steady current is maintained through the telephone by means of the cell B, this steady current will suffer a momentary variation.

Thus each spark gives an impulse to the telephone diaphragm and the pitch and nature of the note heard in the telephone receiver will depend entirely on the frequency and regularity of the sparks. It is here that one of the greatest improvements has taken place. Until recently the sparks followed one another so slowly or so irregularly that the sound heard in the telephone could not be called a note but was merely a crackling noise. A great number of stations are still working in this way, and the signals they send out are very difficult to distinguish from atmospheric disturbances and other extraneous noises. It is now realised, however, that by giving the signals a pure musical note of high pitch, they can be readily heard and distinguished above comparatively loud atmospheric disturbances and in spite of interference from other stations, unless these stations happen to be working with a note of the same pitch.

Another very important point in this connection is the great increase in the sensitiveness of the telephone receiver as the pitch of the note is increased.

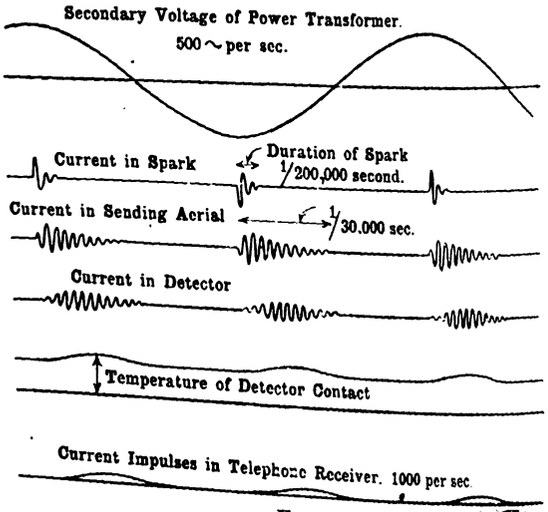


FIG. 12.

Wave length = 600 metres. A.C. supply from 500 ~ alternator.

To produce a musical note of high pitch it is necessary to make the sparks follow one another rapidly and with regularity. When sending at a speed of 20 words per minute the dot will be about 1/20 of a second, so that with a frequency of 30 per second the dot will consist of one, or at most a few sparks, whereas with a spark frequency of 1,000 per second, the dot will consist of 50 sparks. The former was quite enough to actuate a filings coherer, but would merely cause a blow on the telephone diaphragm, whereas the latter would give a short piping note in the receiver.

By increasing the alternating supply voltage or by shortening the spark-gap, a large number of sparks can be made to occur during each

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half-cycle, but they will occur too irregularly to produce a musical note unless steps are taken to make the sparks occur at regular intervals. This can be done by replacing the stationary gap by two discs revolving at high speed, the rims of the discs being provided with projecting knobs between which the sparks jump.

The simplest way of obtaining 1,000 sparks per second with great regularity is to use an alternator giving 500 cycles per second and to adjust the voltage until the gap breaks down once every half-cycle as shown in Fig. 12. To ensure regularity the gap must be kept cool and the after-effects of each spark quickly removed. With the ordinary stationary gap this can be done by means of an air-blast, but with the Marconi revolving discs the air-blast will hardly be necessary. In the new Telefunken gap the quenching action, which we have already considered, has to extinguish the spark 1/200,000 second after it has jumped, so that after 1/1,000 second the gap should have lost all traces of the spark. The quenching action has thus to play a double part, the first affecting the nature of each spark and the resultant oscillation, and the second affecting the regular succession of sparks.

One of the most recent developments, although hardly yet beyond the experimental stage, is the introduction of the telephone relay. By placing one of the telephone relays, recently invented by Mr. S. G. Brown, between the detector and the telephone receiver, signals which are otherwise quite inaudible can be easily read. The Telefunken Company has recently experimented with an apparatus somewhat similar in principle and known as a tone augmenter.

The distances over which communication can be maintained with a given supply of power depends on the height and size of the aerial, on the nature of the intervening country and on the type of detector employed.

A safe guarantee under very unfavourable conditions is about 50 miles per kilowatt of alternator output but with favourable conditions and sensitive apparatus, distances of over 500 miles per kilowatt have been covered.

Practically all the radio-telegraphic apparatus working commercially or being installed at the present time is based on the principles which we have considered. With the exception of the spark-gap and the detector employed, the differences are non-essential. No mention has been made of the generation of undamped waves by means of arcs, as this system has not yet made the revolutionary changes in radio-telegraphy which many anticipated.

A NEW TREATMENT FOR PREVENTING SCALE IN BOILERS.*

BY T. R. DUGGAN.

It is not quite known why, in the generation of steam, certain salts of calcium and magnesium form hard crusts or scale. All engineers try to minimise this evil, knowing that $\frac{1}{8}$ in. thickness of scale means a loss of about 20 per cent., $\frac{1}{4}$ in. equals a loss of 40 per cent., and $\frac{3}{8}$ in. of scale a loss of about 50 per cent. of heat.

After many trials, Brandes has discovered an apparatus—"The Luminator"—which so changes water allowed to flow over it that when used in steam boilers little scale is deposited, old scale is softened and detached from the plates, and the precipitable salts are deposited as powder. I should hesitate to offer this for serious consideration were there not men of repute and integrity who have proved it in practice, as well as several plants working successfully in this country.

The treatment consists in allowing water to run down an aluminium plate of special dimensions, with corrugations of a particular size, according to the character of the water to be treated. It is only necessary to brush the channels well to keep them clean.

Storage tanks and mains, if far from the boiler, must be coated with a non-conducting composition—any bituminous varnish will do—and the water must reach the boiler as soon after treatment as possible. In any case, to get the maximum effect, the water must be used within seven days of its treatment.

The theory of the action of the "Luminator" is that, by the passage of water over the metal channels at certain speeds a current of electricity is induced, the water being negative and plates positive, and a kind of ionisation of the salts takes place, which makes them fall out in an amorphous form; at the same time aluminium is by friction and electrical action abraded from the surface as colloidal aluminium, which after a time is changed in the water. The best results are obtained when the "Luminator" is facing either north or south and exposed to direct light; in the dark the apparatus almost ceases to work.

The action within a steam generator is somewhat obscure, but in all probability the colloidal aluminium acts as a series of nuclei or active centres for the evolution of carbon dioxide and the crystallisation of salts, while the aluminium particles also combine with the dissolved oxygen of the water, and so deoxidise it. As corrosion of boiler plates is supposed to be caused by the presence of free oxygen in the water, this action should diminish the corrosion of boilers; such is found in practice to be the case. For instance, a boiler which was usually red with ferric oxide at the steam and water line, a belt of about 12 in. wide became purple black like new plates after using water treated by this process. This action is not confined to the steam and water junction, but goes on all over the boiler until it becomes coated with a smooth adherent semi-metallic coating of magnetic oxide of iron, which seems to prevent centres of crystallisation upon the plates and precipitates the salts as a powder.

* Abstract, from the "Journal" of the Society of Chemical Industry, of Paper read at the Chemists' Club, New York.

DISCUSSION.

Mr. W. A. CONVERSE said that it seemed to be generally agreed that the change effected by the "Luminator" was physical and not chemical. The water, before and after treatment, showed no difference upon analysis, but, upon boiling, was said to show considerable difference in precipitation. He had himself examined samples before and after treatment and could not find any difference.

Mr. F. B. HERRESHOF said that an experiment was tried with a feed water heater made in Boston some 15 or 20 years ago. It had a coil with a large surface exposed, so that the temperature of the feed was brought up to nearly 300° F. It was assumed that sulphate of lime would separate out at about 300° F., and it was claimed by the makers that all the carbonate would separate out. There were about 5 grains to the gallon of carbonate, as well as sulphate, and analysis showed that none of the carbonate was separated. Thus, at even that high temperature, the presence of carbonic acid which could not get away kept the calcium carbonate in solution; but calcium sulphate, if present in large enough amount, separated out. In a steam boiler the conditions were different, because the steam evolved swept away the carbonic acid as fast as it was disengaged from the bicarbonate; and the insoluble carbonate of lime, probably at first a fine powder, began to crystallise and form scale on parts of the boiler. Calcium sulphate was soluble in 400 parts of cold water; but at high temperatures, such as 300° F., it probably became dehydrated to a certain extent—at any rate it deposited on the tubes and parts of the boiler that became heated. The flues and crowns of boilers were hotter than the water, and it was there that calcium sulphate became attached as a very hard scale. How was this electric influence on a small scale to prevent calcium bicarbonate from decomposing at that temperature; or the carbonic acid from being swept out by the steam? How could it prevent calcium sulphate from decomposing when heated to a high temperature and forming scale?

Mr. JEROME ALEXANDER said that the fact that metals dissolved in water in the colloidal condition had long been known. In this particular case, aluminium and its compounds, whatever they might be, acted substantially as protective colloids. The various reactions described by Mr. Herreshof actually did occur; but in the presence of the aluminium or alumina compounds, the insoluble products separated as colloids and remained in suspension so that they passed out of the boiler when the boiler was blown off. He had never heard of a metal acting as a protective colloid, and he doubted if the metal aluminium could so act. Possibly aluminium oxide might, and so prevent precipitation. There appeared to be no doubt as to the facts stated by Mr. Duggan, and therefore one could only search for the most reasonable explanation of them. It looked as if the aluminium compounds, of whatever nature they might be, did act as protective colloidal substances.

Dr. FERRIS said that it was a common practice in the west to put zinc slugs in boilers, particularly tubular ones, where the heat was principally in the flues, to prevent the formation of scale. The precipitate remained in powder form and could be blown out very easily. But the zinc slugs in time dissolved. In an 80 H.P. boiler two or three zinc slugs of 25 lb. each would disappear in a month.

Mr. T. R. DUGGAN, in reply, said that a litre of water was run through the "Luminator" apparatus 10 times, and another litre of the same water was run over an enamelled plate the same number of times. Both samples were then heated to 80° C. for 10 or 15 minutes. The experiment showed a loss of 20 per cent. of temporary hardness in the water run through the "Luminator," while the other lost about 3 per cent. Aeration had nothing to do with it. There was no limit to the hardness which could be treated in the apparatus, but for such hard waters as reached, say, 80 grains per gallon on Clark's scale, an apparatus some 20 ft. long would be needed. The loss in weight of the aluminium was impossible to measure, it was so infinitesimal. A boiler using the "Luminator" should be blown off frequently, more especially in the first stages of its use, because old scale came off so rapidly that it accumulated at the bottom, and if permitted to remain there might result in burning the boiler. It was extraordinary what an effect the treatment had upon foaming. In every case where these machines had been used, foaming practically ceased. Waters containing ferrous sulphate could be treated, but ferrous carbonate would deposit on the aluminium plates, so they had to be continually cleaned, making it almost impossible to treat such waters. Milk, when passed through the apparatus, was found to keep an extraordinarily long time; whereas the same milk, not passed through it coagulated and became sour quickly. The corrugations had no function except to increase the surface of the plate. Zinc slugs were used in Great Britain many years ago, in marine boilers particularly, but for some unknown reason had been abandoned within the last 10 years.

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SIR WILLIAM RAMSAY'S ADDRESS TO THE BRITISH ASSOCIATION.

Of all the tasks that fall to the lot of a distinguished man of letters or science, that of composing a Presidential Address to the British Association is by no means the least difficult. At the best he can please only a small percentage of his hearers, for some will understand and disagree, while many will not understand and will be correspondingly discontented. Sir WILLIAM RAMSAY, on the present occasion, has committed himself to nothing very deeply, but has touched on a variety of subjects calculated to interest that section of the general public which attends the British Association. Some of his points are, however, worthy of careful consideration, and not the least of these is to be found under the head of education: we refer to the evil of the present-day examination system. Unfortunately, it must be admitted that examinations of some kind are a necessity; there is at present nothing that could fill the gap which would remain if examinations were abolished. Bad as the system is, however, it is, nevertheless, susceptible of easy improvement. The trouble is that examiners, and even teachers, attach too much importance to examinations, and very often the tests themselves are conducted by the wrong persons. Perhaps the most glaring example of how not to do it is found in what is called the "external examination." A syllabus is laid down by an examining body, and students are carefully crammed in the subject-matter thereof for several months on end. At the conclusion of this period there is a final furbishing up with a text book at the very threshold of the examination room; then a paper of per-

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haps ten questions, set with a view to ascertaining not how much a student has digested, but whether he has retained certain particular points. It is no exaggeration to say that a student who has been well taught may stand less chance of success in such a test than one who has been crammed on the bare syllabus. It must be evident that a teacher, who has had a student working under him for two or three years, knows far more about his man than the most distinguished examiner can find out in a couple of hours; yet the latter is the one to decide the fate of the unfortunate student. If Sir WILLIAM RAMSAY will only take some steps towards abolishing this iniquitous system we feel sure he will not lack support. That the importance of the matter is being realised will be apparent from the discussion which took place in Section L on Friday, when it was suggested that application should be made for the appointment of a Royal Commission to consider it.

The next point of interest in the Address relates to the positions of radium and its descendants in the periodic table, in which it is suggested that allotropy may be due to gain or loss of electrons, accompanied by positive or negative heat change. Taking as his text the disintegration of radium, Sir WILLIAM proceeds to descant upon the waste of coal which goes on. He calls attention to the enormous amount of energy contained in a minute quantity of radium, and illustrates it by striking figures. Unfortunately, however, the rate of liberation is far too slow to be of practical use, and, even if some means of accelerating it were discovered, then the quantity of radium available is much too small to have any effect on the rate at which our remaining coal store is being used up. Sir WILLIAM refers to the idea of obtaining energy from the tides, from the wind and from the sun, and, although this could be done, yet the amount would be insignificant, and, what is equally important, it would not pay—at all events, at present. Hence, until the happy day comes when some new store of energy is discovered, the best thing the nation can do is to take care of the coal it has left. It is calculated that England has enough coal remaining to last her 175 years; unless, therefore, some substitute is found the prospect is not a very cheerful one, for the nation can no more live without coal than a man can live without food. The right note is struck when Sir WILLIAM RAMSAY advocates the adoption of economical methods in the use of coal. Since the store must be exhausted, let it be exhausted as slowly as possible; if a method can be found of doing as much with a ton of coal as was formerly done with a ton and a quarter, let that method be adopted without delay. As a matter of fact, this is exactly what has been going on for a great many years, and the "*laissez-faire* plan of leaving to self-interested competition the combating of waste" is not so "*laissez-faire*" as the President might think. Strenuous endeavours are being made by engineers all over the country to reduce coal consumption, not perhaps from a purely altruistic motive, but because it pays. His suggestion that electricity should be generated at the pit's mouth and distributed at high pressure is a somewhat belated one; it has already been done, and in all probability the method will be extended as time goes on. It must be recognised, however, that a point is soon reached when this plan no longer becomes commercially possible. Presumably, this is the point at which Sir WILLIAM suggests State aid in the form of "loans at an easy rate of interest." We fear it will be a long time before any Chancellor of the Exchequer is bold enough to attempt the inclusion in his Finance Bill of a clause to transfer a portion of the national revenue to an electricity supply undertaking with the object of securing coal to posterity. It is a magnificent idea, but we fear it is a long, long way off realisation.

Sad as it may be, it seems that the saving of coal must, for very many years, be left to the efforts of engineers, who will use their wits, not in the interests of humanity, but with a view to diminishing that magical item "coal costs." Of course, if the State took over the electric supply industry, the matter would be on an entirely different footing; but we imagine that this also is not likely to take place in the immediate future.

Sir WILLIAM RAMSAY has done the country a real service in re-calling attention to this subject, and we can only hope that his Address will be read with the attention it deserves. At all events, his warning is a timely one, and he has discharged his duty by stating the case in such a way that there can be no mistake about it.

REVIEWS.

(Copies of the undermentioned works can be had from THE ELECTRICIAN Office, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.)

The Elements of Telephony. By ARTHUR CROTCH. (London, 1910: E. & F. N. Spon.) Pp. 90. 1s. 6d. net.

Within the limits of a modest volume of 90 pages the author has outlined the main features of a present-day telephone system in a way which should enable a reader who has some little knowledge to start with to obtain a clear and intelligent understanding of the inner workings of a modern exchange.

The general arrangement of the book is excellent. After a discussion of first principles in the introductory chapter, the reader is led by easy stages from the simple magnetic telephone of Bell up to the intricacies of the large common battery exchange. The text is plentifully illustrated by circuit diagrams and photographs of apparatus. The former, although of necessity rather small, are nevertheless very clear and show evidence of considerable care having been taken in their selection and preparation.

In a book of this kind one does not look for detailed descriptions of the thousand-and-one types of apparatus now in use, but rather for an explanation of the salient features of a few of the more important ones, with a view to bringing out the underlying principles upon which their action depends and the conditions they are designed to meet. In this respect the author is particularly successful and his book can be recommended as eminently suitable to place in the hands of the elementary student to form a foundation for the more detailed knowledge he will afterwards acquire. H. S. T.

William Thomson, Lord Kelvin—His Way of Teaching Natural Philosophy. By D. WILSON. (Glasgow, 1910: J. Smith & Son.) Pp. 56. 2s. nett, cloth; 1s. nett, paper.

In this book the author gives his recollections of certain scenes in the natural philosophy class at Glasgow University in the early eighties, and his own personal ideas about Lord Kelvin's method of teaching. The images presented seem to us very distorted, the author and his friends forming a very conspicuous group in the centre. They seem to have belonged

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to that class of student which is always on the look-out to "show off," not infrequently with disastrous results. The first chapter, on the "metric system," purports to portray a scene in the class-room and illustrates the difficulties of teaching "raw material" in bulk. In the next chapter several happy prophecies made by Kelvin in 1884 are given. They illustrate how clearly he saw the lines on which progress in electric lighting and traction would be made. The author does not throw much light as to what Kelvin meant by the "vital principle," but he airs his knowledge of Oriental religions, and thinks that Kelvin must have been actuated by the *Golden Rules*.

In the last chapter the author describes how, in a degree examination on natural philosophy, he answered the last question in a way which, although correct, was more fitted for the pages of "Punch" than for examiners' reading. The examiners being Scotch, and consequently being able to appreciate a joke without loss of dignity, decided that justice would be satisfied if the culprit had a personal interview with Sir William. The interview shows Sir William in a very pleasant light, but we are doubtful, notwithstanding the statement to the contrary, whether he really succeeded in making the author see the principle of the conservation of energy. "Conservation of energy was seen to be a verbal symbol of one aspect of what Carlyle called the 'fact of facts,' the living universe, whose 'energy' includes, as an insignificant item, the whole human race from the beginning of time, and can no more be measured by us than the ocean can be bottled in our laboratories." Personally, the reviewer thought that the conservation of energy was something quite different, but still, if philosophers are willing to accept it in the form set forth by Mr. Wilson it seems a pity to try and upset their faith.

Elektrische Winke für Architekten und Hausbesitzer By Dr. L. Block and R. Zandy. (Berlin, 1911; Julius Springer.) Pp. iv. + 151. M.2.80.

Messrs. Block and Zandy have written a very interesting little work on electric installations generally which undoubtedly fulfils the title they have given it, as it certainly does contain a large number of useful wrinkles which should appeal not only to architects and householders for whom it has been mainly written but also to electric-lighting engineers in general. Of course, there are many points of difference between English and Continental installation practice which must be considered in using the book. Although, as pointed out by the authors in their introduction, the architect with a knowledge of electrical installation practice and requirements has it in his power by making from the start suitable provision for the cable runs, &c., of cheapening and facilitating the arrangement and installation of electrical wires in new buildings—of special importance in the case of buildings with ferro-concrete walls and floors—this should be done by the architect under the guidance of a responsible electrical engineer, not by the architect alone. It is impossible for the architect to gain all the necessary knowledge and experience, however well the facts are put together and condensed, in a single volume. The electrical engineer is either not consulted at all in far too many cases or is called in too late.

Chapter I. contains remarks on the installation generally—position of the connections to the supply, main runs, rising mains, distributing centres, &c. It also points out the advisability of making the necessary provision for fixing and running the wires in the case of concrete floors and gives methods of carrying this out. Chapter II. is on electric illumination. It deals with all the various types of incandescent and arc lamps in a brief but satisfactory manner. The candle-power and watt consumption are given in a very clear tabular form, especially those for arc lamps. The paragraphs on the selection of lamps, the number and candle-power, are very good, and the table for calculating the number of lamps required for different classes of rooms will also be found very instructive; it is, of course, in Hefner candle-power per square metre. The illustrations in this chapter of examples of interior illumination, both direct and indirect, are also very good. Staircase and shop-window illumination are, further, separately considered.

Chapter III. is on electric cooking and heating. Many useful data will be found in it as regards the watt consumption of various cooking utensils. Electric power in dwellings is explained in Chapter IV. It includes information and illustrations of lifts (push-button system), ventilating fans, vacuum cleaners, water pumps, small charging outfits for charging batteries for electric automobiles, electrically-driven refrigerators, &c. Chapter V. sets forth the advantages of electrically driven contractors' plant and gives excellent illustrations showing how electric power can be utilised by the contractor in building operations in numberless ways to expedite the work of excavating, removal of rubbish, &c., elevating, and so on.

The book is well and clearly written and well illustrated, and contains a number of useful hints; it reflects considerable credit upon the authors who have succeeded in setting forth the advantages of electric lighting and power in a simple and decisive manner.

STUDIES IN LIGHT PRODUCTION.*

BY R. A. HOUSTOUN, M.A., PH.D., D.SC.

(Lecturer in Physical Optics in the University of Glasgow.)

Summary.—In these studies the author deals with the theory of light production, the scope being briefly indicated by the following contents: (1) The distribution of the energy in the spectrum and the measuring of efficiency. (2) The importance of "black body" radiation and the experimental realisation of the black body. Comparison of the energy curves of a black body and of platinum, and the variation of the position of maximum energy with temperature. (3) Mechanism of flame, and the temperature, energy and efficiency of flames. (4) The Welsbach mantle and selective radiation. (5) Radiation and efficiency of the carbon glow lamp. (6) Physical properties and temperature of the arc. (7) Temperature and energy curves of the Nernst glower. (8) Efficiency of the metal filament. (9) The mercury arc and its difficulties. (10) The light of the future and the possibility of obtaining "cold light."

No. 1.—The Energy Spectrum.

It is a commonplace that our means of producing artificial light are all very inefficient. What the efficiency is in each case and the circumstances on which it depends are not generally known. The information lies scattered in a number of different periodicals. In these studies the most important facts have been collected and arranged both for the sake of reference and for information as to the lines future progress is most likely to take.

Light waves carry energy with them. Every source of light is radiating energy, and this energy is being absorbed and converted into heat by the objects on which the rays strike.

If a ray of white light fall upon a prism a spectrum is produced. Part of the energy of the original ray is reflected at the surfaces of the prism, part is absorbed in the prism and the rest is spread over the different colours of the spectrum. Suppose that the spectrum is received on a screen and we fix our attention upon that portion of it bounded by the wave-lengths λ and $\lambda + d\lambda$. The rays, the wave-lengths of which lie between λ and $\lambda + d\lambda$, bring every second a certain amount of energy to the screen; let this amount of energy be denoted by $E_\lambda d\lambda$. E_λ is a function of λ. The total energy arriving per second on the screen is $\int E_\lambda d\lambda$, the integration being carried out over the whole spectrum.

This function E_λ is very important in the theory of the efficiency of light sources, and it is necessary to consider how the variation of E_λ with λ can be determined experimentally. The brightness of the different parts of the spectrum as estimated by the eye is of no use, for the sensitiveness of the eye to different colours is by no means the same. The light energy of the different colours must be turned into heat and the quantity of heat measured. Four different instruments may be used for this purpose—the thermopile, the bolometer, the radiometer and the radiomicrometer. These instruments and the methods of working with them are fully described in

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Kayser's "Spectroscopie," Vol. I., Chapters V. and VI., and in Baly's "Spectroscopy," Chapter VIII. There is also an extremely important article in the publications of the Bureau of Standards ("Instruments and Methods of Radiometry," W. W. Coblentz, Bull. Bureau of Standards, 4, p. 391, 1908) in which the relative advantages of the four methods are discussed both from the literature of the subject and as a result of tests made by the author. The radiometer has been used chiefly by E. L. Nichols and his pupils in America. It and the radiomicrometer possess the advantage that they do not require galvanometers and the disadvantage that they cannot be moved during the set of observations. Here I shall mention only a few points about the thermopile and radiomicrometer, of which instruments good types are on the market in this country. (Cambridge Scientific Instrument Co.; Keiser & Schmidt, Berlin-Charlottenburg.)

The Rubens linear thermopile is made of iron and constantan wire of diameter 0·1 mm. to 0·15 mm. It has a resistance of about 4 ohms. Constantan is an alloy consisting of 60 per cent. Cu and 40 per cent. Ni. There are 20 junctions arranged on a length of 2 cm. for receiving the light, and, of course, another 20 unexposed junctions. The junctions are soldered with beads of silver, which are flattened into discs of about 1 mm. diameter, so as to present a large surface to the rays. For mapping energy curves the thermopile is mounted in the telescope of a spectroscope, just behind the focal plane of the latter, and there are shutters in that plane for regulating the width of spectrum that is to be admitted to the thermopile. Wires lead from the thermopile to the galvanometer. When plotting an energy curve—*i.e.*, determining the function E_λ—the source of light is focussed on the slit and a screen placed before the latter. The screen is then removed and the galvanometer deflection noted. The operation is then repeated for other points in the spectrum. The galvanometer deflections do not give E_λ directly; the "slit width" correction must first of all be made. Owing to the fact that the dispersion of the prism is not normal, the range of wave-lengths falling on the thermopile at different points in the spectrum—*i.e.*, $d\lambda$—is not always the same. As the deflections are proportional to $E_\lambda d\lambda$, in order to obtain the variation of E_λ we must allow for the variation of $d\lambda$. To do this we draw the calibration curve of the spectroscope—that is, plot s, the telescope reading in angular measure in terms of λ. If we then determine $\frac{ds}{d\lambda}$ and multiply the deflections by $\frac{ds}{d\lambda}$, the result will be proportional to E_λ.

Another correction must be made before the energy curve is obtained. The absorption of light in the instrument must be corrected for. Glass absorbs all wave-lengths greater than 3μ; but if a glass prism and glass lenses be used, the deflections are influenced by the absorption of the glass from 2μ on. An energy curve cannot be plotted beyond 3μ with a glass prism and lenses, and if the region $2\mu-3\mu$ is to be determined, the absorption of the glass must be allowed for. Quartz transmits much further into the infra-red and ultra-violet than glass does; but for the infra-red region rock salt and fluorite are the most suitable materials for the prism and lenses. The absorption of the aqueous vapour and carbon dioxide in the atmosphere must be allowed for; at certain wave-lengths it influences the deflections appreciably. It is better to use mirrors in the spectroscope than lenses; all metals reflect infra-red rays well, and the focal length of a mirror being independent of the wave-length, there is no trouble in focussing the thermo-pile.

In the radiomicrometer we have both thermopile and galvanometer combined. It consists of a single loop of wire with a thermo-junction at one end suspended between the poles of a magnet by a quartz fibre. In comparison with the thermopile it has a very steady zero, but its sensitiveness is distinctly less than that of the latter when connected with a low resistance Du Bois Rubens galvanometer, which has a resistance of 10 ohms and a sensitiveness of 3×10^{-10} amperes/$\frac{1}{2}$ mm. at metre distance for a period of 5 seconds. As the radiomicrometer cannot be moved, the spectroscope telescope used with it must remain fixed.

Of course, it is only the strongest sources of light, of which the energy curves can be determined directly with a thermopile or similar instrument. The light radiation from the brightest sodium flame produced by a bunsen burner would not produce a readable deflection. If the energy curve of a weak source is required, the latter must be compared with a strong source by a spectrophotometer in the visible spectrum, and by a photographic method in the ultra-violet, and the energy curve may thus be determined indirectly. There is no means of determining it in the infra-red.

The most satisfactory way of determining the wave-length in the infra-red is to calculate it from the index of refraction of the quartz or fluorite prism, or to place a very thin film of water before the slit and use its absorption bands as reference points. The positions of the latter have been accurately determined. The methods described in the text books—auxiliary gratings and interference bands—are expensive, or much more troublesome.

Suppose, now, that a number proportional to E_λ is plotted as a function of λ from end to end of the spectrum. If we wish to find what proportion of the total energy radiated is light, what we have to do is to erect ordinates at $0{\cdot}410\mu$ and $0{\cdot}760\mu$, the commonly accepted ends of the visible spectrum, and find the ratio of the area included between these ordinates to the area of the whole curve. E. L. Nichols has named this ratio the radiant efficiency of the source. At the same time he has introduced another quantity, the luminous efficiency of the light source. This is defined to be the ratio of the total energy radiated per second as light to the total energy consumed per second by the source.

Let Q = total electrical energy consumed per second, R the total energy radiated per second and L the total luminous energy radiated per second; then

$$L/Q = \text{luminous efficiency}$$

and

$$L/R = \text{radiant efficiency}$$

of the lamp.

In the case of an electric glow lamp the total energy consumed per second can be easily found from the current and the difference of potential between the terminals of the lamp. In the case of a gas flame we require to know the total quantity of gas consumed per second and the amount of chemical energy liberated by the combustion of unit mass of gas. The luminous efficiency is always less than the radiant efficiency. If the energy not radiated were zero—that is, if there were no conduction and convection losses—they would have the same value. Both quantities are extremely useful in the discussion of the performance of a light source.

A glass cell 1 cm. thick filled with water stops all wave-lengths greater than $1{\cdot}4\mu$ entirely, and absorbs the infra-red between $1{\cdot}4\mu$ and the visible spectrum considerably, but does not absorb the visible spectrum appreciably. The energy in the ultra-violet of the common light sources is very small indeed, and may be neglected in comparison with the light energy. Hence, in order to separate the light from the dark heat, it used to be the practice to pass the rays through a water filter or through a solution of alum. But a water filter transmits much dark heat as well as light, and if we attempt to determine the radiant efficiency by taking the deflections of a thermopile with and without a water filter before it the value we obtain is much too high. Some experimenters have attempted to correct for the dark heat transmitted by the water by means of solutions of iodine in carbon disulphide, which were supposed to absorb all the light and nothing but the light. The utter untrustworthiness of this correction has, however, been demonstrated by E. L. Nichols and W. W. Coblentz. ("On Methods of Measuring Radiant Efficiencies," Phys. Rev., XVII., 1903, p. 267.) Even if we use the correction the values of the radiant efficiency are still too high. Aqueous solutions of ferrous ammonium sulphate have recently been suggested as a means of separating the light from the dark heat. But it has been shown (R. A. Houstoun and J. Logie, Phys. Zs., 11, p. 672) that though they are considerably better in this respect than water filters, yet they are not good enough to afford us a satisfactory method of determining the radiant

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efficiency. It should be noted that, in spite of the widespread opinion to the contrary, alum solutions do not absorb dark heat any better than water does.

Almost all the accurate determinations of radiant efficiency yet made have been carried out by a method introduced by K. Angström, which will be described later. I have recently determined ("The Efficiency of Metallic Filament Lamps," Proc. Roy. Soc., Edin., Vol. XXX., p. 555, 1910) the radiant efficiency of some metallic filament lamps by a method which, to me at least, seems preferable. The radiation was first measured in the usual way by a thermopile and galvanometer with and without a 1 cm. thick water filter, and the fraction of the total radiation transmitted through the filter determined (F). The light was then focussed on the slit of a spectroscope through the same water filter and an energy curve taken. The deflections were plotted against the scale readings and an ordinate set up at 0·76μ. The area on the side of shorter wave-lengths divided by the whole area then gave the ratio (f) of light transmitted by the filter to the total radiation transmitted. It was then only necessary to find what fraction of the incident light was transmitted by the water cell. This was done with a spectrophotometer for four different points in the spectrum and the value found, 0·84, was the same for each point. The radiant efficiency was then F/0·84.

The determination of luminous efficiency is much more difficult. It was the luminous efficiency that was aimed at by the old calorimetric method of measuring the efficiency of a glow lamp. The lamp was placed in a glass calorimeter and then in a similar copper one, and from the rise of temperature in the two cases, with various corrections, the ratio of the energy radiated as light to the whole energy supplied could be calculated. The heat lost by convection and conduction went to raise the temperature in both cases. But the method is in principle bad; the whole energy and the dark heat are measured and the light is obtained as the difference of two much larger quantities, both subject to considerable error of observation. Also, as has been already mentioned, water does not absorb all the dark heat, and hence some escapes from the glass calorimeter. If we wish to determine the luminous efficiency we must first of all determine the radiant efficiency; we must then find the total rate at which energy is being consumed by the source, and we must finally determine the total energy radiated per second. The neatest way of finding the energy radiated per second in any one direction is by some such instrument as Angström's pyrheliometer. To find the total energy radiated per second it is necessary to find the energy radiated in different directions and to integrate over the sphere.

So far we have considered light solely from the objective standpoint. It is now necessary to consider it in relation to the eye. The same quantity of energy in different parts of the spectrum does not produce the same intensity of sensation in the eye. The well-known curve shown in Fig. 1, taken by Sir Wm. Abney, illustrates this. The brightness of the different colours of the spectrum of the crater of the arc was compared in turn with the brightness of a white light, which could be varied by a rotating sector. The ordinates of the curve are obtained in this way, and are proportional to the brightness or luminosity of the part of the spectrum in question as seen by a normal eye. If we took an energy curve of the arc crater with the same prism and lenses, plotted it on the same diagram and divided the ordinates of the energy curve by the ordinates of the luminosity curve, the quotient would be proportional to the quantity of energy necessary to produce the same luminosity at different points in the spectrum. It varies widely throughout the spectrum, having a minimum at 510 $\mu\mu$ for low intensities, and increasing rapidly on both sides of this minimum. At 410 $\mu\mu$ it has then a value roughly 50 times the minimum value, and at 610 $\mu\mu$ one roughly 40 times the minimum value. According to P. G. Nutting ("The Luminous Equivalent of Radiation," Bull. Bureau of Standards, 5, p. 273, 1908), who refers to the reciprocal of this quotient as the visibility of the colour, the quotient for low intensities has the form $e^{\kappa(\lambda-\lambda_m)^2}$ for the normal eye, λ_m being the wave-length of the minimum measured in 10^{-5} cm., and κ being equal to 4·5.

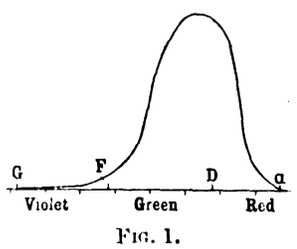

Fig. 1.

For higher intensities the maximum of visibility moves towards the yellow, and the visibility in the neighbourhood of the maximum does not vary so much with colour. At low intensities vision seems to be performed by the retinal rods alone, and at higher intensities mainly by the cones. The transition from rod to cone vision is very gradual; they are about equally in play at ordinary working intensities. It is the transition from rod to cone vision that displaces the maximum of visibility with increase of intensity.

As the brightness of the light produced depends not only on the energy of the radiation, but also on its colour, luminous efficiency, as we have defined it, has no direct connection with efficiency as ordinarily understood in connection with artificial illuminants. One source which radiates more energy between 410 $\mu\mu$ and 760 $\mu\mu$ than another may have that radiation distributed so disadvantageously over the spectrum that it gives less light than the other. C. E. Guillaume has, therefore, proposed to specify the efficiency by multiplying E_λ for every wave-length by the "visibility" for that wave-length, taking the maximum visibility in the spectrum as unity, and by dividing the quantity thus formed by the total power supplied. It may be urged against this proposal that the visibility of different colours is not very well known yet, and that in watts per candle or in candles per watt we have already a term that conveys Guillaume's meaning. Also the relative visibility of the different colours varies with their intensity. And the ordinary method of testing lamps on the photometric bench is certainly a much shorter and more accurate method for getting their watts per candle than the one suggested in Guillaume's definition. It seems to me, therefore, better to retain the old way of specifying luminous efficiency. It has, in addition, the merit of simplicity.

Various observers at different times have attempted to determine what has been called the mechanical equivalent of light—namely, how much energy is it necessary for a source to radiate per second in order to produce 1 c.p. of light. From the foregoing it is obvious that the mechanical equivalent of light must vary with the nature of the source. As a result of a recent determination, C. V. Drysdale "On Luminous Efficiency and the Mechanical Equivalent of Light," Proc. Roy. Soc. A, 80, 1907-08, p. 19), using glow lamps, obtained 16·7 candles per watt for yellow-green light.

The visibility is greatest for green light. This, consequently, is the cheapest kind of light; but, being monochromatic, it is of no use for the purpose of discriminating colour. The ideal illuminant must make all colours appear the same at night as by day. It might be possible to make a creditable white light by combining two monochromatic sources, but for making all colours appear the same by night as by day the illuminant must have all the colours of the spectrum in the same proportion as average sunlight. Consequently, we arrive at the specification of the energy curve of the perfect artificial illuminant after which technology is striving. *Throughout the visible spectrum it will have an energy curve like that of average sunlight; the energy curve will cease at the limits of the visible spectrum.*

(To be continued.)

Simmer Pan Power Station.—The June "Translations" of the South African Institute of Electrical Engineers, which have only recently come to hand, contain a brief description of this power station, the members of the Institute having paid an official visit to the station on July 15th last. The party was received by the chief engineer, Mr. Bernard Price, who is vice-president of the Institute.

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THE BRITISH ASSOCIATION AT PORTSMOUTH.

(From Our Special Correspondent.)

Wednesday, August 30th.

The eighty-first meeting of the British Association commenced this evening at Portsmouth, when Sir William Ramsay, K.C.B., F.R.S., delivered his Presidential Address in the Town Hall. In requesting Sir William to take the chair, Prof. Bonney, the outgoing President, referred to his great work in radio-activity, and said that he might be said to have brought down helium from the sun to earth by showing that it was all the while lurking in various terrestrial substances.

Since the new President's address has already been published in The Electrician, there is no necessity to refer further to it here except to say that it was warmly received by an appreciative audience. The Mayor of Portsmouth moved a vote of thanks to Sir William Ramsay, and at the same time extended a hearty welcome to the British Association on the occasion of its first visit to Portsmouth. Prof. Dixon seconded the motion, which was carried with acclamation.

Thursday, August 31st.

Work commenced in real earnest this morning when the respective Presidents of Sections opened the proceedings by reading their addresses. Reference has been made already to Prof. H. H. Turner's address to Section A, and there is nothing of electrical interest in Prof. J. H. Biles's address to Section G.

After a vote of thanks to Prof. Biles had been proposed by Sir William Ramsay, seconded by Mr. Alexander Siemens, and carried unanimously, Mr. Worby Beaumont read his Paper on "The Origin and Production of Corrugation of Tramway Rails." The author contended, as will be seen by the Paper which we publish on another page, that the primary cause of corrugation is really a triple one: (*a*) The great weight of the cars, (*b*) the small diameter of the wheels employed, (*c*) the high speeds at which cars are run. These three factors together, he maintained, are such as to render it impossible to procure any material which will not be deformed under the stresses put upon it. As a result of experiments, conducted at the request of Mr. Fell, on certain London County Council equipment, he came to the conclusion that the pressure between wheel and rail, in the case of driving wheels, rose as high as 100 tons per square inch when the car was rounding curves, and in the case of pony wheels it was even 120 tons. Hence, it is evident that the pressure per unit area exceeds the limit of elastic compression of the material of the ordinary rail, and that flow or deformation would occur if it were not that the area pressed is supported by the surrounding material and held *encastree*, so that flow cannot occur. The result is detrusion of both edges of the rail, but, of course, the inner is ground down by the flange of the rail. Another result is that the material of the rail moves forward with the advancing wheel until it becomes so compressed and hardened that the wheel mounts it, making it harder still, and then begins to make another depression on the other side. A third result is the minute crumbling and pitting of the rolled surface. Mr. Beaumont put forward four suggestions for dealing with the difficulty. The first was to reduce the weight of the car; this would have the effect of reducing the pressure between the tyre and the rail. He did not observe, nor did any speaker in the discussion which ensued, that decreasing the weight of the car would have the effect of decreasing the area of contact, and, therefore, to some extent, defeating its own object, since pressure is equal to force divided by area. His second suggestion was that larger wheels should be used; this, of course, would increase the contact area and therefore reduce the pressure. Speed reduction was his third point, and the use of harder material for the rails his fourth. With regard to this latter, however, he admitted that harder rails would necessitate the employment of methods more costly than those now in use. Mr. Alexander Siemens opened the discussion, and said he could scarcely imagine that Mr. Beaumont believed his conclusions to be possible—viz., that the speed of cars should be reduced and the wheels made larger. He thought Mr. Beaumont was quite wrong to suggest harder rails; his own opinion was that they should be softer or, at all events, more elastic. This would secure a much larger area of contact by permitting the wheel to sink in as it were. Directly the wheel moved on the nature of the rail material would cause the depression to disappear. He suggested that rails should be made of hard material with a tread of soft or elastic material on the top. Sir William White said that corrugation was experienced on gun-beds due to the motion on recoil; this, however, had been overcome after lengthy experiments had been carried out, but he did not divulge the nature of the experiments. He did not agree with Mr. Siemens that the rails should be made of softer material. After one or two other speakers had interpolated remarks, Mr. Beaumont replied to the discussion. He asserted, with due respect to the President of the Institution of Civil Engineers, that Mr. Siemens had devoted very little study to the use of tramway materials if he could advocate the employment of soft rails, and in reply to a protest from Mr. Siemens he (Mr. Beaumont) said he thought Mr. Siemens meant ductility when he said elasticity. The question of speed reduction was a very difficult one, and would remain so owing to the fact that a tramcar was bound to keep to the rails. The consequence was that a high speed had to be attained whenever a clear course was available in order that the average speed could be kept up to the desired magnitude. He thought it would be quite possible to employ larger wheels, but at the same time he recognised that this would lead to a considerable modification in the design of cars. Corrugation was becoming a very serious matter, for it raised the cost of repairs and renewals to such a figure as to make some tramway systems financially impossible without aid from the rates. Moreover, the noise and vibration were becoming almost unbearable. He did not think it possible to do anything with the wheels or tyres so as to make the latter elastic, and thereby increase the area of contact with the rails.

The next Paper on the list was on the "Anschutz Gyro Compass," by Mr. G. K. B. Elphinstone. This device, as its name implies, is a gyroscope, carried on a float which rests in an annular vessel of mercury, the centre of mass of the whole arrangement being brought about 4 in. below the surface of support. Its action is entirely independent of the earth's magnetic field or of the presence of magnets or iron in the neighbourhood. The rotating element is electrically driven, and the air current set in motion by it is employed for damping purposes. The combined action of gravity and the earth's rotation is such as to cause the gyroscope always to point to the geographical north. Mr. Elphinstone showed a model compass, while in an adjoining room several instruments were exhibited. There was no discussion on the Paper, as time had slipped away, and it was one o'clock when the author finished.

In the afternoon a visit was paid to the Dockyard, and the visitors were shown over H.M.S. "St. Vincent." This visit was the occasion of a good deal of grumbling among members of the Association at the lack of organisation apparent. Association officials seemed to be conspicuous by their absence, and this may have accounted for the fact that very little of interest was seen. Our attention was directed to the wireless aerial, but we were informed that no one could be allowed to look inside the operator's cabin. Only by persistent efforts did a chosen few manage to get down to the engine room. This is divided into two distinct portions and it is necessary to go up to the main deck in order to get from one to the other. The ship is driven entirely by turbines of the Parsons type, the condensers being of the surface type. When running at full speed, the coal consumption works out at about 1·5 lb. per horse-power-hour, but when running at half speed the coal consumption goes up to about 3·5 lb. It appears that, by an Admiralty order, the turbines may not be opened up within five years from

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their installation. The gun-laying is carried out by hydraulic power and ammunition hoists, &c., are similarly worked; electric motors are, however, employed for ventilating.

In the evening a reception was given by the Mayor and Mayoress on the South Parade Pier.

Friday, September 1st.

After a discussion on the principle of relativity, Section A divided into two portions, one of which proceeded to listen to Papers on Mathematics and the other on General Physics. The first Paper in the latter category was "On the Radiation producing Aurora Borealis" by Mr. L. Vegard. Starting from the view advocated by Birkeland that auroræ are caused by electric solar radiations, the author treated the problem of determining their physical properties. From the form and structure of the luminosity a method is found of examining the way in which the solar rays are absorbed by matter, and he arrived at the conclusion that the law of absorption of the solar rays is essentially the same as that of α-rays. This coincidence with regard to law of absorption led the author to draw further consequences of the hypothesis that certain auroral forms are caused by α-rays. The author finds that the α-ray hypothesis, as far as our present knowledge goes, explains in a satisfactory way the properties of the definite auroral forms, while the assumption of a radiation of the β-ray type meets with serious difficulties.

The next Paper was entitled "A Friction Permeameter," by Mr. W. H. F. Murdoch. This we hope to publish in next week's issue of THE ELECTRICIAN.

Section G opened with a Paper on "Electrical Drives for Screw Propellers," by Mr. H. A. Mavor; the Paper is dealt with elsewhere in this issue. The author advocated the employment of three-phase working, and gave details of several installations in actual operation. It seems that high-speed propellers give very poor results on low-speed vessels, and hence a difficulty arises if it is desired to employ economical high-speed engines. In the case of turbines the problem resolves itself into a choice between mechanical gearing and what may be regarded as electrical gearing. Mr. Mavor described systems in which engines were employed for driving three-phase generators, the motors being connected directly to the propeller shafts. By this means very large speed reductions could be obtained with a trifling loss of power. Opening the discussion, Prof. W. E. Dalby asked for efficiency figures at full and half loads. He also inquired whether there were not serious flywheel effects obtained by connecting a motor of some 12 ft. in diameter to the propeller. Prof. Petavel suggested that the high efficiency obtained might compensate for the losses in transmission. At the same time he could not help thinking that additional liability to breakdown was introduced by the presence of the dynamo, motor, &c., as well as the engine, which had to be there in any case. Dr. J. Morrow said he thought that the electric drive might be very suitable for low-speed ships, but he was not convinced that it could be applied with advantage to high-speed vessels. He also suggested that the U.S. Navy authorities were discarding turbines in favour of reciprocating engines, but Sir William White at once explained that only in in the case of one slow-speed vessel, now building, were they putting in a reciprocating engine, and, therefore, Dr. Morrow's statement was hardly accurate. The chairman, Prof. Biles, asked whether short-circuiting would take place if the motor were flooded, and if so what would happen. In his reply, Mr. Mavor said that the full load efficiency was about 96 per cent., but that, as a rule, he preferred to work with large air-gaps and amply proportioned machines, the result being that the efficiency worked out at about 90 per cent. Although he had had considerable experience with large motors directly connected to propellers he had detected no trouble due to flywheel action, as suggested by Prof. Dalby. He quite agreed that it was useless to talk of electric driving if the propeller could be driven by the engine, but the fact remained that a low-speed ship could not be driven by a high-speed propeller. If electric driving were adopted there was nothing to prevent the use of an engine running at 3,000 revs. per min. in a low-speed ship. In a particular instance he had obtained an estimate from makers of mechanical gear, and it turned out to have practically the same weight, price and efficiency as the electrical gear. There was no additional danger of breakdown because there was practically no additional complication. Nothing could be simpler than a squirrel-cage rotor, and he called attention to the fact that the energy was generated in the stationary portion of the machine, it was transmitted by cables that did not move, and it was utilised in the stator of the motor. It was sometimes more economical to employ two or three small generating sets, rather than one large one, as they were frequently more efficient. Moreover, each machine could be connected to its own coils of the motor, and was, therefore, completely independent of the others. Complicated switchgear was avoided, and since the motor coils were mutually non-inductive there was no fear of current being generated back into a machine which happened to be at rest. With regard to the chairman's suggestion of short-circuits, he pointed out that even if a short-circuit did occur it could have *no* serious consequences. The power of the engine was limited, and the only effect would be the production of a current two or three times greater than the normal, with a corresponding drop in voltage. This would produce nothing like the disastrous results associated with short-circuits on street mains designed for comparatively small currents, when there was practically unlimited power at the generating station. So far as he could gather, flooding of the motor did not make the least difference. Some time ago he made an experiment on an old continuous-current motor, which, of course, possessed the additional disadvantage of a commutator; this machine he put under water, and it ran quite sweetly all day. In reply to Sir William White, Mr. Mavor said that the voltage he employed was 2,000, but the pressure was quite immaterial.

The next Paper on the list was on "Electrical Steering," by Mr. B. P. Haigh. The problem is a difficult one because two very different conditions have to be fulfilled. On the one hand it is necessary to have a system capable of dealing with the power necessary to put the helm hard over in emergency in the shortest possible time, and, on the other, it must possess sufficient sensitiveness to enable an accurate course to be kept by moving the rudder promptly through small angles. So far as sensitiveness is concerned, it appears that electrical gears are an improvement on steam gears, partly owing to the rapid wearing of valves and the loss of economy when large sensitive valves are employed. In the author's system the motor is kept running and is provided with two magnetic clutches, one at each end of the shaft. Three slip-rings are provided on the motor shaft, one being common to both clutches and the others distinct. Current is carried from the slip-rings to the clutches by means of leads passing through a hole in the shaft. These leads are quite small, the magnetising current being only about ½ ampere. The actual friction surfaces in the clutches consist of steel and red fibre.

The discussion was opened by Mr. Worby Beaumont, who thought that there would be considerable inequality of performance of the fibre employed in the clutch; he also thought it undesirable to carry leads in the motor shaft. Sir William White expressed himself strongly in favour of electrical steering. He had recently designed a yacht in which everything was done by electricity. He rather thought that great sensitiveness of steering gear was sometimes a positive disadvantage, for it tempted a steersman to manipulate it much too frequently; indeed, it might even be a source of danger in the hands of a nervous person. For this reason, he strongly advised the installation of a helm indicator in every case, so that a steersman could see the immediate result of his movements. He would abolish all hunting gear, and give all orders from amidships. So far as sensitiveness and ease of control were concerned, the superiority of electric gear was undoubted. Prof. Dalby, who spoke next, said that the principal feature of Mr. Haigh's device was the clutch. He would like to know what was the coefficient of friction between the steel and fibre, and what was the pressure per square inch

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In the course of his reply, Mr. Haigh said fibre was the best substance he had tried. The difficulty with wood was that it soon charred, and then made an intolerable squeaking noise. Fibre, of course, was very hygroscopic, and on this account would prove unreliable when the clearance was small, the clearance on his clutch being $\frac{1}{16}$ in. He had, however, got over the difficulty by boiling the fibre in oil, which effectually prevented any absorption of moisture. There was no appreciable slipping even when oil was present. He had purposely poured oil into the clutch and then closed it; for about a dozen revolutions it slipped, then the oil was squeezed out between the fibre segments, and it held quite well. He had not noticed any falling off of friction with temperature, nor was there any variation when the rudder was hard over. The power demanded by the motor was not sufficient to affect the lighting circuit. He did not think there was any danger incurred by putting the leads in the shaft of the motor. Very sensitive gear was never put on low-speed ships. In reply to Prof. Dalby, the author stated that the coefficient of friction of steel on fibre was about one-sixth, and the pressure he employed did not exceed 100 lb. per square inch.

Mr. T. F. Wall next read a Paper on "The Single-phase Repulsion Motor," but as it was of a type seldom heard at a British Association meeting, there was no discussion. It will be given in full in future issues of THE ELECTRICIAN.

Next came a Paper entitled "Some Preliminary Notes on a Study as to Human Susceptibility to Vibration," by Mr. W. Pollard Digby and Capt. A. Riall Sankey. The Paper described the results undertaken with a view to ascertaining what amount of vibration can be said to constitute a nuisance. The audience treated the matter as something in the nature of a joke, and some additional "standards of degree of vibration" were suggested informally. Apparently, certain members seemed to think that "excessive" was not a sufficiently violent adjective to describe some forms of nuisance, and although they did not put them forward at the meeting there is no doubt that many would be prepared to offer suggestions to the authors with a view to adding to the different degrees. Prof. Dalby said he thought no subject should be treated who had not just completed three months' holiday. Sir William White thought there must be some scientific standard of vibration; the human element varied so greatly as to make it quite hopeless otherwise. Prof. Petavel called attention to the effect of sound, which made observers think a vibration very much more serious than it really was.

The chairman then announced that Prof. E. Wilson had asked for his Paper on "Some New Aluminium Alloys" to be taken as read, and this concluded the business of the day. (This paper will be given in next week's issue of THE ELECTRICIAN.)

Monday, September 4th.

Sections A and G had a joint meeting this morning for the purpose of discussing "Aeronautics," and then split up again. The first Paper on the programme for Section G was by Prof. H. W. O. Howe, on "Recent Developments in Radio-telegraphy," and it attracted a large audience. The author gave an excellent, though brief, account of the modern practice of wireless telegraphy, and succeeded in making some difficult points quite clear by means of diagrams. Moreover, he had erected up an aerial from the Town Hall to the roof of the Municipal Technical College, in which the meeting was held, and was able to receive—among other things—the Paris and Norddeich time signals. By means of a telephone relay of the pattern designed by Mr. S. G. Brown and conical trumpets these signals were made audible to almost everyone in the room. Prof. Howe's Paper is published in full in the present issue of THE ELECTRICIAN, and we will, therefore, refer to it no further here.

Next on the list came a Paper by Capt. H. Riall Sankey, entitled "Portable Equipment for Wireless Telegraphy." However, instead of reading a Paper Capt. Sankey contented himself with showing a number of quite interesting slides relating to portable sets for use by troops in the field. The first set was intended for cavalry, the various parts being carried on the backs of horses. For example, one horse carried the petrol engine and alternator, another the sending and receiving apparatus, while a third carried the mast and aerial. The capacity of the alternator was 0·4 kw., and the range was 20 miles over mountainous country and 100 over water. Each animal's equipment was securely fastened to a saddle of special design, and in no case did the total weight exceed 180 lb. When fully extended the mast had a length of 60 ft., but as a directive aerial was employed it was necessary to carry two masts, the effective length of aerial being 350 ft. between masts. In order to preserve the insulation of the high-tension transmitting apparatus the latter was completely enclosed in a metal case. On taking this case from the horse's back, a double lid is opened, one serving as a writing desk and the other as a protection against rain, &c. Capt. Sankey mentioned that the time occupied in getting a station set up and working was only nine minutes, while the time occupied in taking it down and packing it up again was six minutes.

At the conclusion of Capt. Sankey's remarks there was only about a quarter of an hour available for discussion of both Papers, owing to a fixture having been arranged for 2 p.m., but even this proved more than sufficient. In reply to questions from Prof. Dalby, Prof. Howe stated that the Marconi trans-Atlantic work was carried on with a wave-length of 6,000 metres. He had ascertained this from his own observations. The minimum that he knew of was 300 metres, and he believed that the Admiralty kept all wave-lengths between 600 and 1,600 metres for themselves. The sharp tuning of the receiving station depended on the tuning of the transmitting station, for if the coupling were too tight, harmonics came in; it was impossible to tune to an explosion. This concluded the work of the Section for the day.

In the afternoon a most interesting display was provided by the Admiralty, by arrangement of the Commander-in-Chief, Admiral Sir A. W. Moore, G.C.B. Members of the Association were taken on board H.M.S. "Revenge" at the Dockyard and sailed out to sea some miles from the coast. An attack was then made on the vessel by about a dozen torpedo boats. These boats advanced on the "Revenge" at full speed, discharging torpedoes at her as they passed alongside. Next, four submarines advanced in line ahead, the first passing with conning tower out of water and driven by her petrol engines. The second advanced and dived just as she came alongside, this vessel and the remainder being driven by electric motors. The third dived gradually as she passed, and reappeared after passing. Finally, the fourth boat, which could be seen rather more than a mile away, dived and advanced on the "Revenge" with only her periscope showing. When she got within striking distance she fired a torpedo which gave the onlookers a decided thrill, as it struck the vessel with a plainly perceptible "bump." Still advancing, she fired a second, and then dived so that even her periscope disappeared. In a few seconds she reappeared, and her commander, who presently emerged from the conning tower, was greeted with a storm of applause. The "Revenge" then returned to the Dockyard, and members were unanimous in describing the display as quite the feature of the Portsmouth Meeting.

Tuesday, September 5th.

Some very interesting work was done in Section G this morning, when the respective merits of steam, suction gas and Diesel engines were discussed. Mr. W. T. Marshall commenced with a Paper on "Economical and Reliable Power Generation by Over-type Superheated Steam Engines." He remarked that owing to the introduction of internal combustion engines, steam-engine builders had been stimulated to produce steam plants having a fuel cost quite on a par with that of internal combustion plants, and possessing additional advantages in the nature of superior reliability, flexibility and over-load capacity. The so-called "over-type superheated steam engine" is a distinct reversion to the old portable type, and consists of a compound engine fixed on top of a tubular boiler, with a superheater in the smoke box. Air pump, feed

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quite overshadowed by the disaster on the London County Council's system. These tramways, considering their size and the exceptional traffic difficulties, have been comparatively free from serious accidents, but that which occurred last week proved exceptionally disastrous. For the present the cause of the car leaving the rails is shrouded in mystery, and owing to the conflicting evidence as to the state of the rails it is likely to remain so. It is noticeable that the large majority of serious tramway accidents occur at more or less sharp curves in the track; and as the lay-out of such curves necessitates the negotiation of them by the cars at very low speeds it would seem desirable for all curves to be inspected by some authority with a view to possible alteration. Since tramcars have to compete with motor traffic, any reduction in speed would now be a serious handicap; but if present speeds are to be maintained it is essential that great attention should be paid to the maintenance of the track in a clean and good condition.

Production of Light.

THE production of light is one of the most fascinating of subjects, partly because we know so little of the ultimate phenomena underlying some of the processes of production, and partly because of the enormous possibilities that are yet open to the patient investigator. The present methods of producing light are extraordinarily inefficient, and yet during the last few years great advances have been made. The metal filament lamp, the flame arc lamp, the vacuum tube, operated either as a mercury arc or by an electric discharge, all indicate a movement in the right direction. A very great deal, however, yet remains to be done if we are to approach the efficiency of Nature, though certainly the station engineer does not wish this efficiency to be approached too closely. But we do not doubt that there are many investigators who are keenly anxious to produce a truly cold light, either by means of the electric discharge or by means of fluorescence, and thus to emulate the hitherto unrivalled efficiency of the firefly. The engineer wishing to approach this subject from the more theoretical standpoint finds himself at a disadvantage in that the subject in some respects is by no means simple, and further the literature on the subject is more or less scattered, so that it is not easy to find what has been done without spending a good deal of time in looking up various publications. We therefore think that our readers will welcome the series of articles, the first of which appears in our present issue, by Dr. R. A. HOUSTOUN, as they present the subject, although briefly, from many points of view.

The "Telefunken Zeitung."—We have received from Berlin a copy of the first number of this periodical, which is edited by Mr. H. Bredow, and is devoted to the interests of the Gesellschaft für Drahtlose Telegraphie. The present issue contains a photograph commemorative of the visit of the Emperor William to the Nauen station. There is also an historical article on the progress of the Telefunken Co. and other matters of current wireless interest.

Cable Interruptions.	Date of Interruption.
Assab—Perim	July 8, 1909
Latakia—Palura	May 26, 1910
Zanzibar—Mombasa	July 11, 1911
Sabang—Koetaradja	Aug. 18, 1911
Kotonou—Grand Bassam	Aug. 23, 1911
San Thiago—Bathurst	Sept. 4, 1911
Bathurst-Sierra Leone	Sept. 4, 1911

Electric Lighting of Westminster Abbey.—Westminster Abbey, which has been closed since March 31st on account of the Coronation, was opened on Tuesday last for the usual services. The lighting of the nave is now effected by electricity instead of by gas.

Telegraph Union Monument.—"The Times" announces that the International jury have chosen the design submitted by Signor Giuseppe Romagnoli, of Bologna, for the International Telegraph Union monument. The design represents Helvetia seated and having on either side figures representing Trade, Labour and the various professions.

London Electricity Supply Works Survey.—The Chief Commissioner of Metropolitan Police (Sir E. R. Henry) is having a survey made of the electricity supply works, power stations, gas works, &c., within the Metropolitan Police area, with the view of collecting information for the guidance of the police in future industrial disputes.

New Director of the Science Museum.—It is announced that Mr. F. C. Ogilvie, C.B., has been appointed Director of the Science Museum, and will hold this position in addition to his present office of Secretary for the Science Museum and Geological Survey and Museum. Mr. Ogilvie was educated at Aberdeen University and for a time held the position of Assistant Professor of Natural Philosophy, both at that University and at Edinburgh. He was director of the Edinburgh Museum of Science and Art from 1900 to 1903, and principal assistant secretary (Technology and Higher Education in Science and Art) of the Board of Education from 1903 to 1910.

"The Central."—The article of greatest interest in the current issue of this magazine is the first. It is devoted to an account of the life of Prof. Henrici, and is partly autobiographical and partly written by Mr. G. C. Turner. It is illustrated by three excellent photographs of Prof. Henrici at various times of his life, and of the Mechanics Laboratory which he founded at the "Central." A report is given of the complimentary dinner to Prof. Armstrong which was held on May 13th last, and there are also articles on "Lifeboat Launching Slipways"; on "The Training of Alluvial Rivers," by Mr. C. G. Smith, and "Notes upon Modern Simple Span Truss Bridge Construction," by Mr. R. O. Beit.

Deterioration of Insulation on Traction Motors.—The "Engineer" remarks that a tramway or railway motor is usually selected with reference to the work it has to do in propelling the car, with little regard to the extra work which is thrown upon it when braking. It is, therefore, often urged that, since a motor usually operates at a fairly high temperature under normal conditions, the extra load thrown upon it by electric braking is certain to produce more or less rapid deterioration of the insulation. With the latest type of track magnet, however, the current taken from the motors is a very small percentage of that required for rheostatic braking, and the increased heating due to braking with this type of magnet is practically nil. If, in addition, the motor fields are provided with solenoid operated shunts, excessive voltage rises cannot occur, and the usual objections to the use of the motors for electric braking are removed.

Smelting of Pig Iron by Electricity.—An official report on the experiments in the electric smelting of iron ore at Trollhätten has now been published by the Iron Institute of Sweden, which, in conjunction with the Government, provided the money to carry out the experiments on a commercial scale. On the basis of the selling price for the output of the furnace, agreed upon by the committee in charge of the operations, the experimental business was self-supporting, even for the short period of its duration, five months. It is stated that the results obtained warrant the opinion that the question of the economical smelting of iron in the electric furnace has been solved, and that perfection of the methods for handling the gases to secure a more effective circulation, if not their utilisation, will greatly enhance the results already obtained. It is hoped to reach the preliminary estimate of 3 tons of pig-iron per horse-power-year, although the results so far give only

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2·7 tons. Trials have proved that the product of the electric furnace is as well adapted to the manufacture of steel as is the ordinary Swedish pig-iron.

The Need for Reform in our System of Chemical Training.—In an article on this subject in a recent issue of "Chemical Engineering and the Works' Chemist," the author remarks that too much time is at present given to the acquisition of detail, while too little regard is paid to the real object of scientific education, which is to develop the reasoning powers. Students should be taught chemistry so that they may be able to apply their knowledge intelligently in after-life. To think and to originate are infinitely more important for the man of science than simply to be a master of detail. Some of the cures proposed for this evil are worse than the disease. More attention should be paid to the value of scientific application and less to the results of "cramming." Graduation by research should be made the rule and not the exception, as this method would differentiate between the student who can simply cram facts and one who is capable of applying what he knows to useful purposes. What is above all things necessary, the author concludes, is proper instruction in applied chemistry and encouragement of students to take up applied chemical research. It must be borne in mind, too, that it is not possible to study technical chemistry in a college alone, and that a student should pass a period in works in order that he may gain the all-important experience of the conditions which obtain on a large scale.

Royal Engineer Cadets (2nd London Division).—We are informed that recruits are wanted for this Corps, and great efforts are being put forth to bring it up to its establishment. The Company at present in existence is a Fortress Company, but if the right kind of recruit is forthcoming in sufficient numbers, it is proposed to form a Communication Company. Youths between the ages of 13 and 18 years having a knowledge of electricity or telegraphy should therefore send in their names. The cadets are instructed in all branches of military engineering, and the training and instruction are of a very interesting character for any lad desirous of serving his country.

Cadets transferring to the Territorial Force from their Cadet Corps are excused their recruit drills, and service in a Cadet Unit after the age of 15 counts towards the Territorial Efficiency Medal. Recruits are enrolled between the ages of 13 and 18, and should apply at the Duke of York's Headquarters, Chelsea, S.W., on Monday and Friday evenings between 7:30 and 9 p.m. Full particulars can be obtained from Sergt.-Major G. D. Elms, R.E. (T.), 37, Langthorne-street, Bishop's Park, S.W. Col. Sir Howland Roberts, Bt., V.D., is the honorary Commanding Officer, and the officer in command of the Corps is Capt. Beeman, R.E. The Corps attended the annual training and camp this year with the Royal Engineers, 2nd London Division, at Shorncliffe, from the 7th to the 19th August, and worked with the sappers in building a redoubt and in constructing a trestle and double-lock bridge. The cost of uniform and equipment amounts to about 15s., and there is an entrance fee of 1s. Rifles, bayonets and brown Slade-Wallace equipment are supplied, and remain the property of the Corps.

The Noise of Motor Cars.—During the past few months correspondence has been taking place in several of our daily contemporaries regarding the noise made by drivers of motor vehicles, especially at night. As a result of this agitation, which from our own experience seems to be especially well-founded, the Commissioner of Police of the Metropolis has, with the concurrence of the Local Government Board, issued a circular dealing with the matter. He points out that while it is necessary for all motor drivers to give audible warning of their approach when there is possibility of danger, where the only danger is attributable to reckless speed the practice quickly develops into an avoidable nuisance. Attention is also called to the practice of using a "cut-out" and the employment of siren or multiple horns worked from the exhaust. It is quite certain, he points out, that unless some alteration is brought about by motorists of their own impulse there will be an insistent demand for repressive legislation. In these circumstances the Commissioner of Police thinks it advisable to call upon all owners and drivers of motor vehicles to do what is in their power to reduce the annoyance caused, especially at night, by the excessive use of the horn, or by the use of unsuitable devices, such as those above mentioned, for unnecessarily varying the timbre or intensifying the sound emitted. He feels sure that much may be done by concerted action on the part of owners and drivers of private cars to diminish the nuisance which is now so much complained of. From this circular it is evident that if this plain hint is not sufficient the Commissioner will use his powers to make a bye-law on the subject. The nuisance is of course primarily due to drivers of taxi-cabs and chauffeurs who are freed from the influence of their employers. Since, too, a silent motor-'bus is an assured fact, attention might also be paid to the excessive noise at present made by many of these vehicles.

Current Topics.

Subjects of current interest dealt with in this issue include the following:—

Dr. R. Beattie contributes an article on "An Extension of Fischer-Hinnen's Method of Harmonic Analysis."

Dr. R. A. Houstoun contributes the first of a series of articles on "Studies in Light Production."

Our special correspondent gives an account of the Papers and discussions at the meeting of the British Association at Portsmouth. Abstracts of the following Papers which were presented at the meetings of the various Sections will be found elsewhere in this issue: "Electric Drives for Screw Propellers," by Mr. H. A. Mavor; "The Origin and Production of Corrugation of Tramway Rails," by Mr. Worby Beaumont; "Recent Developments in Radio-telegraphy," by Prof. G. W. O. Howe. The presidential address of Sir William Ramsay (of which an abstract appeared in our last issue) is discussed in our Leading Article.

The Trades' Union Congress has been held during the week at Newcastle-on-Tyne, and the president, Mr. W. Mullin, referred to the course adopted by the unions when legislation affecting the working classes is in preparation. He remarked that discussions between members of the Cabinet and accredited representatives of the unions had become a part of the regular programme. (We wonder is the same practical course adopted towards the masters). Mr. Mullin referred particularly to the Insurance Bill in this connection. He also referred to the recent series of so-called "strikes."

Shoreditch (London) Council have decided to adopt incandescent electric lighting in place of gas in the portion of their area north of Old-street.

Salford Corporation are recommended to carry out extensions and to effect improvements of their electricity supply undertaking at an estimated cost of £85,350.

The Port of London Authority have decided to provide four electric ambulances for the docks under their control.

An interesting report on methods of charging for electric current at Brighton has been prepared by the engineer and manager, Mr. John Christie. The report recommends the abolition of meter rents and the adoption of a flat rate of charge for all current supplied.

OBITUARY.

T. H. Riches.—We regret to record the death of Mr. Thomas Hurry Riches, locomotive superintendent to the Taff Vale Railway, which occurred at Cardiff on Monday last at the age of 65. Mr. Riches was a past-president of the Institution of Mechanical Engineers and for three successive years was also president of the South Wales Institute of Engineers. He served as chairman of the mechanical engineering section of the Franco-British Exhibition.

H. O. Wills.—We also regret to record the death of Mr. Henry Overton Wills, chancellor of the University of Bristol, which occurred at Kelston Knoll, Weston, near Bath, on Monday last. Mr. Wills took great interest in the formation of the university in Bristol, and went so far in practical sympathy as to subscribe £100,000 towards the project. When the charter was eventually granted Mr. Wills became the first chancellor of the new university.

PERSONAL NOTE.

On Monday Mr. W. Aitken left Liverpool by the s.s. "Megantic" for New York. Mr. Aitken will be absent from England for some time on business and pleasure.

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APPOINTMENTS VACANT AND FILLED.

An Atlantic steamship company advertises for an assistant foreman electrician.

An assistant electrician is wanted for works in South Wales. Must be good wireman and able to take charge of installation during absence of electrician. See an advertisement.

INSTITUTIONS AND SOCIETIES.

Municipal Tramways Association.—The tenth annual conference of this Association will be held at Glasgow on Sept. 27, 28 and 29, under the presidency of Mr. James Dalrymple. The following preliminary programme has been arranged: On Wednesday, Sept. 27, there will be a reception in the City Chambers, and the Presidential Address will be delivered by Mr. Dalrymple. Papers will be read by Mr. W. Nelson and by Ald. J. H. Rodgers, the latter on "The Present Position of Municipal Tramways." In the evening the delegates will be the guests of the Corporation at dinner. On Thursday, Sept. 28, Papers will be read on "Car Meters" by Messrs. R. G. & J. G. Cunliffe, and on "Tramway Track—Methods of Construction and Maintenance," by representatives of the Glasgow, Manchester and Leeds Corporation Tramways. In the evening the Association dinner will be held. Friday, Sept. 29, will be devoted to excursions. The Executive Committee, it is announced, have acceded to the wish expressed by several tramway manufacturers to arrange for exhibits in connection with the meeting. For this purpose it is proposed to set apart a portion of the Newlands tramway depot of the Corporation tramways in Kilmarnock-road, in order that manufacturers and inventors may have an opportunity of exhibiting anything of interest. No charge will be made for the space allotted. Communications should be addressed to Mr. James Dalrymple, general manager, Glasgow Corporation tramways. The headquarters of the Association during the Conference will be at the Grand Hotel, Charing Cross, Glasgow.

EDUCATIONAL NOTICES.

University of London, University College.—The new session commences on Monday, Oct. 2. There are complete courses of study, extending over three years, in mechanical, electrical, civil and municipal engineering. Students desirous of entering the faculty of engineering, with the view of taking a full degree or diploma course, must have passed the matriculation examination, or some other examination accepted in its stead. There are also special diploma courses, and provision is made for post-graduate work and research. Intending students should communicate with the Provost as soon as possible, and full particulars may be obtained on application to the secretary, Mr. Walter W. Seton, M.A., Gower-street, W.C.

University of Manchester.—In the faculty of science complete courses of study extending over three years are arranged for the University degrees in civil, mechanical and electrical engineering. The equipment of the civil and mechanical engineering laboratories was completed last session, and the new electrical engineering laboratory will be opened next month. Prospectus, containing full particulars of the courses will be forwarded on application to the Registrar. The session commences on Oct. 2.

University of Edinburgh.—The next session opens on Oct. 10. The University provides complete courses in civil, mechanical and electrical engineering, qualifying for the degree of B.Sc. in engineering, and extending over a period of three years. Particulars of the entrance examination, scholarships, fees, &c., can be obtained from the Matriculation Office, The University, Edinburgh.

University of Bristol.—Prospectuses and particulars of the faculties of arts, science, medicine and engineering (civil, mechanical, electrical and motor car) and of the secondary training department, day training colleges, evening classes, halls of residence, scholarships and bursaries will be sent on application to the registrar, Mr. James Rafter. The session in the faculty of engineering commences Sept. 15 and in faculties of arts, science and medicine on Oct. 2.

Goldsmith's College (University of London).—At this college complete evening courses of instruction are provided in mechanical, electrical and constructional engineering, land surveying, fitting and machining, pattern-making and smithing. Students are prepared for the London University degree of B.Sc. in engineering, for the examinations of the Institution of Civil Engineers, Board of Education, and City and Guilds of London Institute, &c. Particulars from the Warden of the College, New Cross, S.E. The new session commences on Monday, Sept. 25, and enrolling will begin on the 18th inst.

University of Durham.—Armstrong College, Newcastle-upon-Tyne.—The 1911-12 session commences Sept. 25. There are departments of mechanical, marine, civil and electrical engineering, naval architecture, mining, metallurgy, agriculture, pure science, arts and letters. Particulars may be obtained from the secretary, Mr. F. H. Pruen, M.A.

University College of North Wales.—At this college a systematic course of instruction in electrical measurements and practical electricity is provided for students proposing to enter the electrical engineering profession. The physical laboratory is well equipped for practical work and the fee for the ordinary course is £17. 1s. per session. The next session commences in October.

Northampton Polytechnic Institute, Clerkenwell, London.—The full day courses in the theory and practice of mechanical and electrical engineering, and in electro-chemistry will commence on Oct. 2, and entrance examinations will take place on Sept. 27 and 28, at which five entrance scholarships will be offered. The courses for mechanical and electrical engineering include periods spent in commercial workshops, and extend over four years, and they also prepare for the degree of B.Sc. in engineering of the University of London. There are also full and partial day courses in technical optics. Particulars from the Principal, Dr. R. Mullineux Walmsley.

Sir John Cass Technical Institute.—Evening classes in physics and mathematics, chemistry and metallurgy are held at this Institute, and are designed to meet the requirements of those engaged in the electrical, chemical and metallurgical industries and in trades associated therewith. Facilities are also afforded for special and advanced practical work in well-equipped laboratories, both in the afternoon and evening. The classes in physics and mathematics prepare for the final B.Sc. examination of the University of London, and there are also special courses on general physics and electricity and magnetism for the Honours B.Sc., and on conduction in gases, radio-activity and colloids for science students. The new session begins on Monday, Sept. 25. Particulars of classes may be obtained at the offices of the Institute, Jewry-street, Aldgate, London, E.C., or on application by letter to the Principal.

Battersea Polytechnic (London, S.W.).—The new session commences on Monday, 25th inst. There are complete day college courses in civil, mechanical and electrical engineering, extending over three or four years. These courses are suitable for preparing for the B.Sc. (Eng.) of the University of London, the Associateship examination of the Institution of Civil Engineers, &c. There are also evening classes in electrical technology, electrical design and power distribution, theory of machines, hydraulics, heat engines, strength of materials, &c. Further particulars can be obtained from the Secretary.

Borough Polytechnic Institute.—A four years' course of instruction in electrotechnics is provided at this Institute. There are also classes in electric wiremen's work, and elementary and advanced courses in electrical design and workshop drawing. The head of the department is Dr. John Henderson, D.Sc., F.R.S.E., A.M.I.E.E. Prospectuses, containing further particulars and detailed syllabus, from the Principal, Mr. C. T. Millis, Borough-road, S.E. The session begins on 25th inst.

Electrical Standardising, Testing and Training Institution.—This institution has two departments—a training department and a standardising and testing department. The training department provides students with a thorough course of instruction (theoretical and practical) in electrical and mechanical engineering. The full course occupies four years, and is so arranged that the first and third years are spent at Faraday House, the second at engine manufacturers, and the fourth year at electrical manufacturers or a power house. The principal is Mr. Alex. Russell, M.A., D.Sc., M.I.E.E., and he is assisted by a capable staff of lecturers. There are well equipped laboratories for practical work. The Michaelmas term begins on the 25th inst. Prospectuses containing particulars of fees, &c., from the Secretary, Faraday House, Southampton-row, W.C.

ARRANGEMENTS FOR THE WEEK.

THE LONDON ELECTRICAL ENGINEERS.
Officer Commanding, Col. H. M. Leaf.

The following orders have been issued:—

Head-quarters will be closed for instruction, but will be open for office work as under until further orders:—

Monday to Friday, 10 a.m. to 4 p.m.
Saturday, 10 a.m. to 12 noon.

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ELECTRIC DRIVES FOR SCREW PROPELLERS.*

BY H. A. MAVOR.

Summary.—The author first discusses the difficulties in the application of steam turbines and internal combustion engines to screw propellers, and he considers that electric transmission is eminently suitable for adapting these prime movers to the propeller. After referring briefly to his system of electric propulsion, he gives several examples of vessels to which it has been proposed to be applied.

The problems of marine engineering have until recent years been solved exclusively by the application of various forms of the reciprocating steam engine, and the power, speed, form and general arrangement of power-driven vessels have been developed in connection with this means of propulsion.

The advent of other appliances has opened up new lines of development, and in certain departments there is evidence of need for intermediate devices between the power-producing and the power-absorbing elements. The necessity for these devices arises when the properties of the propeller in respect of rate of revolution are incompatible with those of the power generator.

This incompatibility is most conspicuous in vessels which have to operate at relatively low speeds. An examination of the conditions which have emerged in the development of marine propulsion soon shows that the incompatibility is not accidental, or due to imperfections in the design, construction or use of the propelling equipment, but that it is associated with the essential properties of the substances and appliances with which we have to deal.

It may be said in general terms that high efficiency is associated with low rate of revolution of the propeller, while in the steam turbine high rates of revolution are essential to the most economical use of the steam. Internal-combustion engines have speeds more nearly approximating those of reciprocating steam engines, but here also there is a tendency to speeds higher than are convenient or economical from the propeller standpoint.

In addition to those fundamental incompatibilities arising from causes out of the reach of direct accommodation, there are other conditions which limit the direct application of engine to propeller.

The draught, beam and form of the vessel limit the area of the propeller. The traffic for which the vessel is designed influences the determination whether one, two or more propellers are to be used, and the speed, size and form of the vessel determine limits to the designer's choice. All these considerations taken together frequently fix the diameter, pitch and thrust of the propeller, and, within very narrow limits, also the rate of revolution.

Now this rate of revolution is not always the most favourable for the power generator, and the designer is in such cases compelled to resort to new expedients if he is to attain the standard of efficiency in power generation which has been set by results attained on land. At the present moment the economy of power production in the best practice on land is considerably in advance of what has been done at sea. The principal reason for the better economy of the land work is the higher rate of revolution of the power generator when untrammelled by propeller conditions.

There are cases where the special limitations in respect of dimensions and weights permissible for the machinery are such as to preclude the use of any intermediate mechanism between the prime mover and the propeller.

In the ship whose voyage is short, whose speed is high, displace-

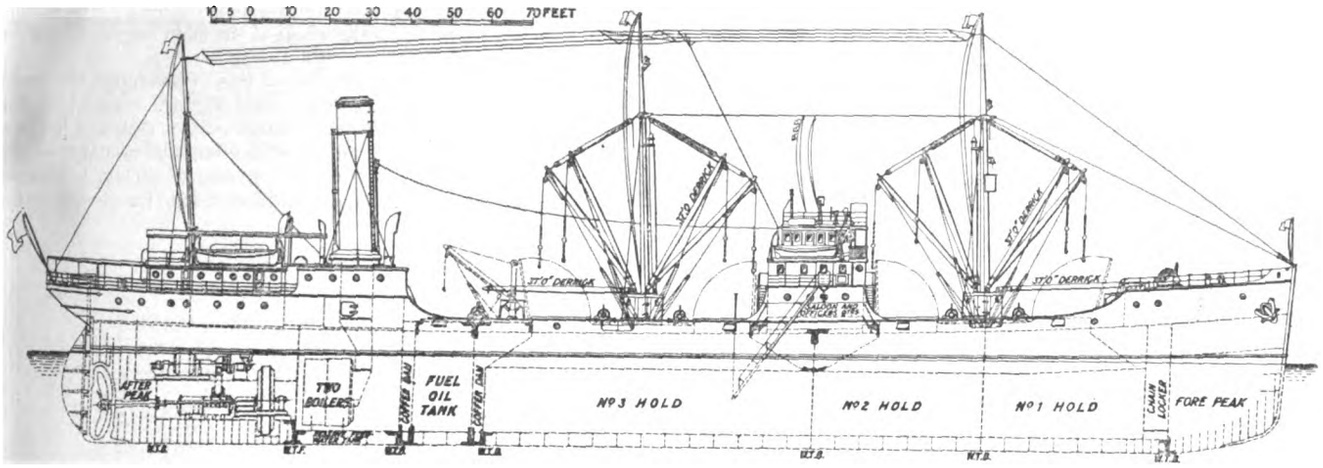

FIG. 1.—OUTBOARD PROFILE OF ELECTRIC S.S. "FRIEDA."

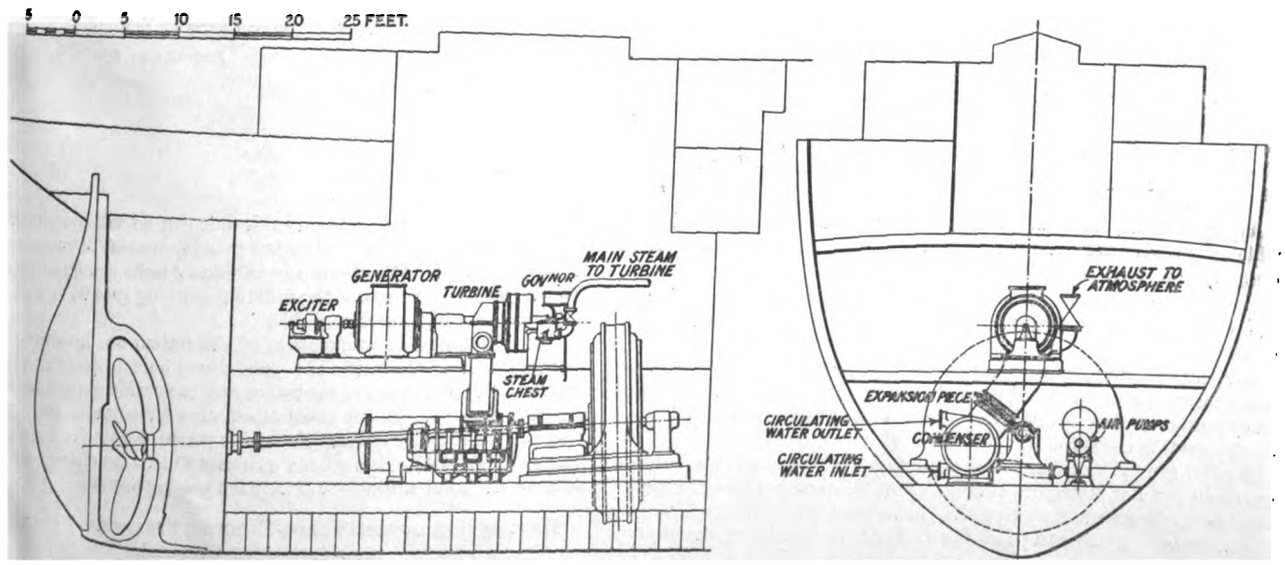

FIG. 2.—GENERAL ARRANGEMENT OF PROPOSED 1,500 KW. ALTERNATING-CURRENT TURBO-ELECTRIC MACHINERY FOR BULK FREIGHT S.S. "FRIEDA."

* Paper read before Section G of the British Association at Portsmouth.

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ment small and propeller efficiency as good as is attainable and the quantity of fuel carried small relative to the weight of the machinery, the possible economy in fuel may be insufficient to warrant any increase in the weight of machinery; or, to put the case otherwise, it is advisable to sacrifice economy in fuel to keep down the weight of the equipment—*e.g.*, a vessel running one-day voyages, and burning 50 tons of coal, could not possibly submit to an increase in weight of machinery in excess of the coal-saving, because such increase would increase the displacement, and therefore the power necessary to drive the vessel.

If, on the other hand, the vessel make a 10-day voyage, and the saving in fuel carried amount to 10 tons per day, a considerable increase in weight of machinery might be associated with decreased displacement and a substantial all-round economy.

Various methods of making the required adaptation of generator to propeller are at present under trial. For this, mechanical gearing by toothed wheels or hydraulic transmission may be considered serious competitors with electric transmission, but for large powers it seems reasonable to expect that electric transmission, which is already developed for this very purpose on land, is likely to find an equally useful field where the conditions are such as to require an intermediate device at sea. The cost, weight and efficiency of electric transmission compare favourably in the examples which have been examined with either of the two competing methods.

are attainable in a reciprocating steam engine connected direct to the propeller, and the electric motor is applicable to powers for which there is no possibility of using anything in the nature of reversing gears or clutches.

The property of combining the power of more than one engine for application to one or more propellers is the special feature of the author's inventions as distinguished from the ordinary methods of electrical engineering. Engines of different types, sizes and rates of revolution can have their powers combined without interconnection of their electric circuits, and without risk of mistake or error. An oil engine at 100 revs. per min. may be running the vessel at low speed, and a steam turbine running at 20 times the speed may be jointly applied to the propellers without any complication of the electric equipment. Each unit does its own work independently.

The advantage of such an equipment in vessels which are required to operate under varying load conditions is evident. Without subdivision of the power units the whole of the main machinery must be in motion while the ship is in motion.

At speeds reduced below its normal rate of revolution the turbine is even less economical than the steam engine. Subdivision into high-pressure, low-pressure and intermediate elements has been carried out in certain steam equipments, but this results in a somewhat complicated and inconvenient system of piping, because the steam has to be led from one part of the system to the other across the

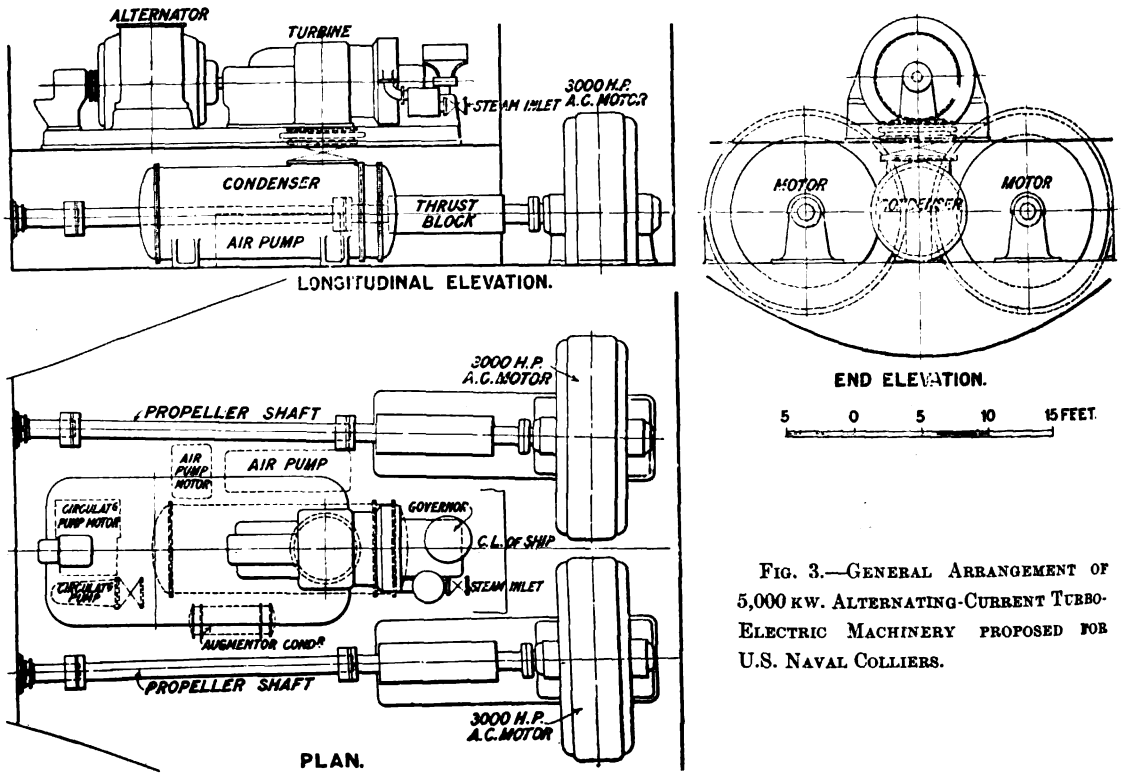

FIG. 3.—GENERAL ARRANGEMENT OF 5,000 KW. ALTERNATING-CURRENT TURBO-ELECTRIC MACHINERY PROPOSED FOR U.S. NAVAL COLLIERS.

There are other important qualifications of electric transmission in which it stands altogether unrivalled. The most important of these qualifications are:—

It provides a ready means of reversing the direction of rotation of the propeller without changing the direction of rotation of the power generator.

The electric transmission also provides means for changing the speed ratio between generator and propeller, so as to permit of the power of the generator being developed under the most favourable conditions at all speeds of the ship.

Lastly, it provides means for applying the power of one or more engines to one or more propellers, so that the power generating units may be so disposed as to give the highest efficiency, and when they are not required they can be stopped. These properties of the electric transmission supply exactly what is required to render steam turbines, and also internal-combustion engines, completely adaptable to the purpose required.

Power generators give their best efficiency when full speed of rotation is maintained, even when running below full power. It is therefore advantageous to keep the engine revolutions within the range of governor control while the required speed change is accomplished by electric combinations.

The properties of the electric motor lend themselves well to the requirements of manœuvring. The rate of reversal is under perfect control. The possibilities of rapid and certain action are more than

vessel. In the electric system each unit can be self-contained, and disposed in the manner best suited to a convenient arrangement of the engine room. The size of the individual units can be adjusted to suit the powers required at the different working speeds, or they may be duplicate and interchangeable.

A few examples of application of the system are here presented, together with a description of a small vessel built to demonstrate and illustrate the principles of operation and to provide experience in the use of the plant. In all cases alternating three-phase currents are used and interlocking devices connect mechanically the main reversing switches with the exciting switches so that no change can take place in the connections while they are passing currents.

DESCRIPTION OF THE TURBO-ELECTRIC STEAMSHIP "FRIEDA" (FOR AMERICAN OWNERS).

This vessel has been specially designed for the transport of bulk freights between the Gulf of Mexico and New York City. The vessel is to be 300 ft. long and will carry a dead weight of, approximately, 5,000 tons at a mean loaded speed of 12 knots at sea.

The propelling machinery is aft, and consists of a turbo-electric outfit for three-phase 50 cycles when running at 3,000 revs. per min. The turbine is supplied with steam at a pressure of 200 lb. per square inch at the stop valve.

This electric generating plant is arranged on foundations on a platform deck in the engine room and the condensing plant in the engine-

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room hold. The condenser is fitted with a vacuum augmentor, and is suitable for dealing with the full load quantity of steam from the turbine. The vacuum obtained will be 28½ in., with cooling water about 85°F. The condensing plant consists of a vacuum condenser, three-throw air pumps and centrifugal pumps with electric motor drives.

The current is led to a three-phase motor, which is keyed direct to the main propeller shaft, and is capable of developing 1,900 B.H.P. at a speed of about 84 revs. per min. The steam is generated in two Scotch boilers, with Howden's forced draught and liquid fuel burners.

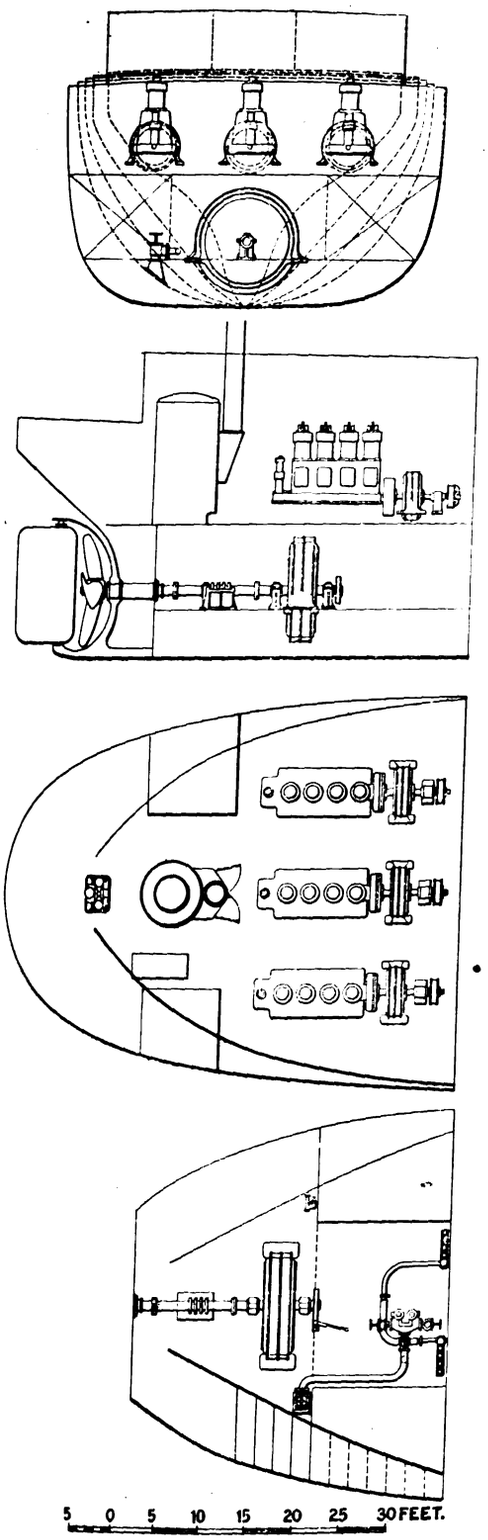

FIG. 4.—PROPOSED ARRANGEMENT OF OIL-ELECTRIC PROPULSION FOR LAKE STEAMER, 250 FT. BY 42 FT. 6 IN. BY 19 FT.

This installation costs and weighs less than the normal equipment. The coal-saving is over 10 tons per day.

The design of the ship itself presents many novel features not germane to the subject under review. This design was prepared by John Reid & Co., 17, Battery-place, New York.

OIL ELECTRIC TANK BARGE FOR CANADIAN SERVICE.

Fig. 4 shows the application of the system to the propulsion of a 245 ft. Canadian canal type tank barge.

The equipment consists of three separate units of Diesel non-reversible oil engines, each capable of developing 200 shaft H.P., and directly connected to an alternating-current generator. The currents from one or all of the units are respectively led to the separate windings of a three-phase motor keyed to the main propelling shaft and operating a single slow-turning screw.

The great advantage and economy of this system consists in being able to run at full power or at one-third power using one or three engines at full-load economy at will, thus providing for an economical operation impossible with any other propulsive system. The fact that non-reversible oil engines are used, running under governor control, greatly simplifies the maintenance and operation.

The control is operated by a low-tension interlocking switch, operated by an ordinary engine-room telegraph stand located in the pilot house, so that the manœuvring of the vessel is at all times in the hands of the navigating officer. This equipment increases the cost of the ship about 10 per cent. above the normal, but the carrying capacity is very largely increased.

MARINE TURBO-ELECTRIC INSTALLATION PROPOSED FOR U.S. NAVY COLLIERS.

The installation illustrated in Fig. 3 shows a marine turbo-electric installation submitted to the U.S. Navy Department for adoption in one of the four large colliers recently given out to contract.

It consists of a steam turbo-alternator of 5,000 kw. capacity with condensing plant; the current is led to two motors, one being keyed to each propeller shaft. The machinery is right aft in the vessel; the steam is generated by Scotch boilers.

The vessels in which it is proposed to instal this machinery are 525 ft. long, and will carry a dead weight of 12,500 tons of coal, at a speed of 14 knots at sea. Here again the cost, weight and economy are better than can be shown with the normal reciprocating-engine equipment.

AN EXTENSION OF FISCHER-HINNEN'S METHOD OF HARMONIC ANALYSIS.

BY R. BEATTIE, D.SC.

Amongst methods of determining the several coefficients in Fourier's expression

$$y = A_0 + A_1 \sin\theta + A_2 \sin 2\theta + A_3 \sin 3\theta + \ldots + B_1 \cos\theta + B_2 \cos 2\theta + B_3 \cos 3\theta + \ldots \quad (1)$$

for a single-valued periodic curve, one of the most useful is Fischer-Hinnen's development of the old principle of selected ordinates.* In order to find the coefficient of a harmonic of the nth order by Fischer-Hinnen's method, $2n$ equi-distant ordinates, spaced a distance π/n apart, are erected, the initial ordinate being at a distance $\pi/2n$ from the origin, or at the origin itself, according as a sine coefficient or a cosine coefficient is desired. The ordinates thus drawn are added together, the signs of all the ordinates of even number being reversed and the mean is taken. Calling S_n the mean of the sine-spaced ordinates, and C_n the mean of the cosine-spaced ordinates, then

$$S_n = A_n - A_{3n} + A_{5n} - A_{7n} + \&c. \quad (2)$$
$$C_n = B_n + B_{3n} + B_{5n} + B_{7n} + \&c. \quad (3)$$

The truth of this result for a particular case is readily apparent from Fig. 1. This figure shows Fischer-Hinnen's construction for determining the coefficients A_3 and B_3 of the curve represented, the sine-spaced ordinates y_1, y_2, y_3, &c., being erected at distances 30, 90, 150, 210, 270 and 330 deg. respectively from the origin, and the cosine-spaced ordinates

* Fischer-Hinnen, "E.T.Z.," Vol. XXII., p. 396, 1901; "Elektrotechnik u. Maschinenbau," Vol. XXVII., p. 335, 1909. For references to earlier work on similar lines *see* Burkhardt, "Encyklopädie der Mathematischen Wissenschaften," Band II., Theil 1, p. 642; also Darwin, "Engineering," July 14, 1911, p. 81. [Since the foregoing was written, a Paper by Prof. S. P. Thompson has appeared, which should be consulted ("Proc." Phys. Soc., Aug., 1911, p. 334). This Paper, although entitled "A New Method of Harmonic Analysis," is really nothing more than an account of Fischer-Hinnen's method and contains no new developments.]

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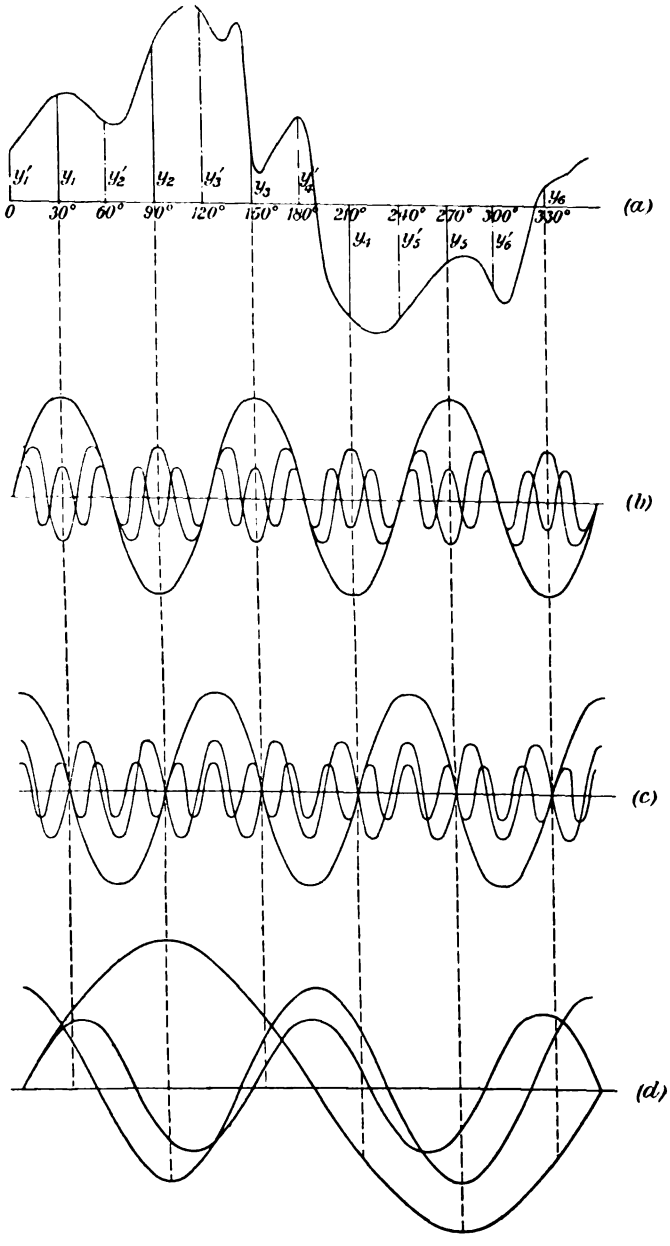
y'_1, y'_2, y'_3, &c., at distances 0, 60, 120, 180, 240 and 300 deg. respectively. It is seen that the successive sine-spaced ordinates cut the 3rd, 9th, 15th, &c., sine harmonics at their crest values, which are, of course, alternately positive and negative, whereas they cut the 3rd, 9th, 15th, &c., cosine harmonics at their zero values. Further, the sum of the intercepts of the sine-spaced ordinates with all the remaining harmonics, even or odd, sine or cosine, when taken over a whole period with alternate signs reversed, vanishes. Hence the average value of y_1, y_2, y_3, &c., with alternate signs reversed is equal to $A_3-A_9+A_{15}-$ &c. Similarly, the average value of the cosine-spaced ordinates y'_1, y'_2, y'_3, &c., with alternate signs reversed, is equal to $B_3+B_9+B_{15}+$ &c.



(*a*) Original Curve. (*b*) 3rd, 9th, 15th, &c., sine components. (*c*) 3rd, 9th, 15th, &c., cosine components. (*d*) All the even and all the remaining odd sine and cosine components including the constant term.

FIG. 1.—ILLUSTRATING HARMONIC ANALYSIS OF CURVE BY FISCHER-HINNEN'S 2*n*-ORDINATE METHOD.

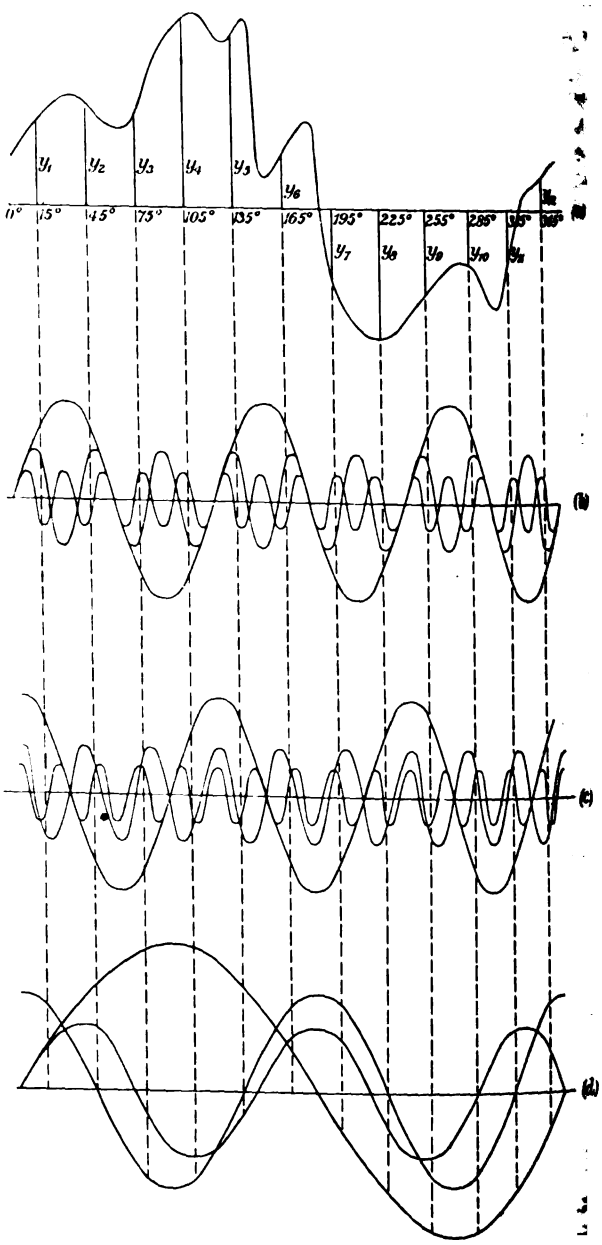
A disadvantage inseparable from Fischer-Hinnen's method is that it does not directly give the value of the harmonic sought, except in the special case where all the odd multiples of that particular harmonic are either absent or negligibly small. In practice, when evaluating higher harmonics, we are often certain, or can safely assume, that this is so, and the method is then specially serviceable. When evaluating lower harmonics, however, the absence of odd multiple harmonics cannot be taken for granted, and a process of elimination must therefore be resorted to. Thus suppose we know that, as in alternating-current wave-forms for instance, there are only odd harmonics present, and also that all harmonics of higher order than, say, the 15th are absent or negligible. We can then write

$$\left.\begin{aligned} &S_{15}=A_{15},\ S_{13}=A_{13},\ S_{11}=A_{11},\ S_9=A_9,\ S_7=A_7,\\ &S_5=A_5-A_{15},\ S_3=A_3-A_9+A_{15},\\ &S_1=A_1-A_3+A_5-A_7+A_9-A_{11}+A_{13}-A_{15} \end{aligned}\right\} \quad \ldots \quad (4)$$

from which we readily deduce

$$\left.\begin{aligned} &A_{15}=S_{15},\ A_{13}=S_{13},\ A_{11}=S_{11},\ A_9=S_9,\ A_7=S_7,\\ &A_5=S_5+A_{15},\ A_3=S_3+A_9-A_{15},\\ &A_1=S_1+A_3-A_5+A_7-A_9+A_{11}-A_{13}+A_{15} \end{aligned}\right\} \quad \ldots \quad (5)$$

A similar scheme of elimination can be drawn up for the cosine terms.



(*a*) Original Curve. (*b*) 3rd, 9th, 15th, &c., sine components. (*c*) 3rd 9th, 15th &c. cosine components. (*d*) All the even and all the remaining odd sine and cosine components including the constant term.

FIG. 2.—ILLUSTRATING HARMONIC ANALYSIS OF CURVE BY 4*n*-ORDINATE METHOD.

When there is no certainty that all harmonics above a certain order are either absent or diminish very rapidly in value, Fischer-Hinnen's method, while still applicable, becomes laborious and comparatively useless. Even in these circumstances, however, the scope of the method can, by a simple development, be considerably extended and its accuracy appreciably increased without departing from the general principle involved.

A Modified or 4n-Ordinate Method.—Improvements on Fischer-Hinnen's method may aim at (i) reducing the errors

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due to accidental irregularities in the curve to be analysed, (ii) reducing the number of included higher harmonics. Both these ends can be attained by increasing the number of ordinates employed. The extent to which the number of ordinates can be increased is limited by the condition that multiplications or divisions must not be introduced further than what is required in averaging ordinates. It is, however, possible to double or even treble the number of ordinates without sensibly departing from this condition.*

Suppose, for example, that we wish to find the coefficient of the nth sine harmonic. Instead of erecting $2n$ equi-distant ordinates, as in Fischer-Hinnen's method, we erect $4n$ ordinates spacing them a distance $\pi/2n$ apart, the initial ordinate of the series being at a distance $\pi/4n$ from the origin. These ordinates we add together, taking them in pairs, and reversing the signs of alternate pairs. That is to say, the signs of the 1st and 2nd, 5th and 6th, 9th and 10th, &c., ordinates are left unchanged, those of the 3rd and 4th, 7th and 8th, 11th and 12th, &c., ordinates are reversed, the scheme of reversal being indicated by $++--++--$&c. The average ordinate obtained in this way when multiplied by $\sqrt{2}$ gives a quantity which we shall denote by S'_n. It is then easy to show that

$$S'_n = A_n + A_{3n} - A_{5n} - A_{7n} + A_{9n} + A_{11n} - A_{13n} - \&c. \quad . \quad (6)$$

To get the corresponding cosine term the ordinates are drawn precisely as for the sine term, with the initial ordinate at a distance $\pi/4n$ from the origin. The only difference lies in the way the ordinates are added up. In doing this the signs of the first and last, 4th and 5th, 8th and 9th, &c., ordinates are left unchanged, whilst the signs of the 2nd and 3rd, 6th and 7th, 10th and 11th, &c., ordinates are reversed, the scheme of reversal being therefore indicated by $+--++--$&c. The average ordinate thus obtained when multiplied by $\sqrt{2}$ we shall denote by C'_n. We then have

$$C'_n = B_n - B_{3n} - B_{5n} + B_{7n} + B_{9n} - B_{11n} - B_{13n} + \&c. \quad . \quad (7)$$

In proof of (6) and (7) it will suffice to take the particular case represented in Fig. 2. Here the ordinates are drawn according to the modified method for determining the 3rd sine component of the curve shown, the ordinates, 12 in number, being spaced 30 deg. apart, with the initial ordinate 15 deg. from the origin. It is seen that these ordinates cut the 3rd sine harmonic and all odd multiples of the 3rd sine harmonic in the same relative position—viz, 45 deg. from the maximum, the 45 deg. being reckoned on the scale of the harmonic considered. It is likewise seen that the sum of the intercepts with these harmonics, taken with signs reversed in pairs according to the scheme $++--++--$&c., is equal to $\frac{12}{\sqrt{2}}(A_3 + A_9 - A_{15} - A_{21} + A_{27} + A_{33} - \&c.)$. At the same time the sum of the intercepts with all the remaining harmonics, of whatever order or denomination, when taken over a complete period with signs reversed in pairs, is seen to vanish. It follows that $\sqrt{2}$-times the average value of the ordinates y_1, y_2, y_3, &c., with signs reversed in pairs, must equal $A_3 + A - A_{15} - A_{21} + A_{27} + A_{33} - \&c$. From this the general result of (6) can readily be inferred, as also, by similar reasoning, that of (7).

It will be observed that the result obtained by averaging ordinates on the above plan still contains all harmonics which are odd multiples of the harmonic sought. These included harmonics have, therefore, to be eliminated by proceeding as in the schemes (4) and (5) already outlined for Fischer-Hinnen's $2n$-ordinate method. Thus, taking the previously chosen case of a curve containing odd harmonics only and none higher than the 15th, we have

$$\left.\begin{array}{l} A_{15} = S'_{15},\ A_{13} = S'_{13},\ A_{11} = S'_{11},\ A_9 = S'_9, \\ A_7 = S'_7,\quad A_5 = S'_5 - A_{15},\ A_3 = S'_3 - A_9 + A_{15}, \\ A_1 = S'_1 - A_3 + A_5 + A_7 - A_9 - A_{11} + A_{13} + A_{15} \end{array}\right\} \quad . \quad . \quad . \quad (8)$$

with a similar scheme for the cosine coefficients.

A Combined or 6n-Ordinate Method.—Taken by itself, the modification of Fischer-Hinnen's method just described has certain minor advantages. These arise in part from the increased number of ordinates employed, which helps to eliminate errors due to accidental irregularities, and in part from the fact that the same ordinates serve both for the sine and cosine components. In practice, however, it does not always lead to results that are conspicuously superior to those obtained by Fischer-Hinnen's $2n$-ordinate method. The improvement hinted at in an earlier paragraph is the outcome of combining the results of the $2n$ and $4n$-ordinate methods.

As has been pointed out, the result obtained in attempting to evaluate a given coefficient, say A_n, by Fischer-Hinnen's $2n$-ordinate method includes the coefficients A_{3n}, A_{5n}, A_{7n}, &c. The result obtained in attempting to estimate the coefficient A_n by the modified method also includes the same coefficients A_{3n}, A_{5n}, A_{7n}, &c., only they enter into the result in a different way. Thus we have

$$S_n = A_n - A_{3n} + A_{5n} - A_{7n} + A_{9n} - \&c.,$$

by the $2n$-ordinate method, and

$$S'_n = A_n + A_{3n} - A_{5n} - A_{7n} + A_{9n} + \&c.,$$

by the $4n$-ordinate method. Hence, by taking the mean of the results of the two methods we can eliminate a large number of the higher included harmonics, and thus obtain a more

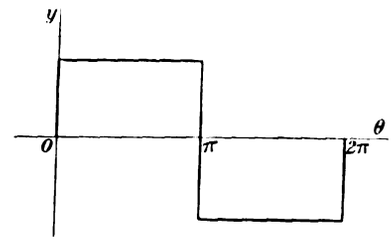

FIG. 3.—RECTANGULAR WAVE SHAPE.

accurate result. Calling the mean of the results for the nth sine coefficient S''_n, where $S''_n = (S_n + S'_n)/2$, we have, in fact,

$$S''_n = A_n - A_{7n} + A_{9n} - A_{15n} + A_{17n} - \&c. \quad . \quad . \quad . \quad . \quad (9)$$

Similarly, if we call C_n'' the mean of the results for the nth cosine coefficient, where $C''_n = (C_n + C'_n)/2$, then

$$C''_n = B_n + B_{7n} + B_{9n} + B_{15} + B_{17n} + \&c. \quad . \quad . \quad . \quad (10)$$

Obviously this process (which may be described as a $6n$-ordinate method, since it involves the measurement of $6n$ separate ordinates) gives directly a close approximation to the true value of any harmonic other than the fundamental, since no component of an order lower than seven times that of the harmonic sought is included in the result. To eliminate the few included harmonics that do remain we proceed as before. Thus for a curve containing odd harmonics only, of which the 21st and higher harmonics are assumed to be absent, we have

$$\left.\begin{array}{l} A_{17} = S''_{17},\ A_{15} = S''_{15},\ A_{13} = S''_{13},\ A_{11} = S''_{11}, \\ A_9 = S''_9,\quad A_7 = S''_7,\quad A_5 = S''_5,\quad A_3 = S''_3, \\ A_1 = S''_1 + A_7 - A_9 + A_{15} - A_{17} \end{array}\right\} \quad . \quad . \quad (11)$$

with a similar scheme for the cosine coefficients.

To illustrate the superiority of the $6n$-ordinate method we may apply it to analyse the rectangular wave-shaped curve of Fig. 3. This curve is known to possess a large number of sine components of odd orders and no cosine components. The amplitude of the components, moreover, decreases very slowly, and the curve therefore affords a severe test of the accuracy of any method of harmonic analysis. Representing the crest value of the curve by 1, its equation as a Fourier series is

$$y = \frac{4}{\pi}(\sin\theta + \tfrac{1}{3}\sin 3\theta + \tfrac{1}{5}\sin 5\theta + \tfrac{1}{7}\sin 7\theta + \&c.).$$

* Fischer-Hinnen's and similar methods of harmonic analysis are examples of approximate integration by averaging a finite number of ordinates. This method of integration and its limitations are discussed by Bruns in his book "Grundlinien des Wissenschaftlichen Rechnens" (Leipzig: B. G. Teubner, 1903). Amongst other examples he considers the evaluation of Fourier's coefficients and (Chapter VII., §§ 85 and 86) gives rules applicable to the general case in which the number of ordinates is made equal to $4m$, where m is any integer. The special advantage of choosing a number of ordinates divisible by 4 is pointed out by Bruns, and much of what follows in the present article might be deduced from his rules by putting m equal to the order of the harmonic sought, or to twice that order.

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If we analyse the curve by the $2n$-ordinate method we get

$$y=\sin\theta+\tfrac{1}{3}\sin 3\theta+\tfrac{1}{5}\sin 5\theta+\tfrac{1}{7}\sin 7\theta+\text{ \&c.},$$

and by the $4n$-ordinate method

$$y=1{\cdot}41(\sin\theta+\tfrac{1}{3}\sin 3\theta+\tfrac{1}{5}\sin 5\theta+\tfrac{1}{7}\sin 7\theta+\text{\&c.}).$$

Both these results, which are obtained without having recourse to elimination, are seen to be hopelessly wrong, and equally so for the higher harmonics as for the lower. If, however, we take the mean we get

$$y=1{\cdot}21(\sin\theta+\tfrac{1}{3}\sin 3\theta+\tfrac{1}{5}\sin 5\theta+\tfrac{1}{7}\sin 7\theta+\text{\&c.})$$

which for many practical purposes may be accepted as sufficiently correct.

Diagrams for Use with Fischer-Hinnen's Method.—Fischer-Hinnen's method and its modifications have the merit that they can be carried out by the direct addition of ordinates as measured on the curve itself without the use of tables or adventitious aids of any kind. The application of the methods is greatly facilitated, however, by the use of specially prepared diagrams of suitably graduated scales similar to those described by the writer in THE ELECTRICIAN for June 9, 1911.

In the case of Fischer-Hinnen's $2n$-ordinate method, for instance, the diagram for determining an nth sine coefficient would consist of $4n$ equi-spaced vertical scales erected at successive distances of $\pi/2n$, π/n, $3\pi/2n$, $2\pi/n$, $5\pi/2n$ . . . &c., measured from one end of a common base-line. The units of the successive scales would be made equal in length to ± 1, ∞, ∓ 1, ∞, ± 1, ∞, &c., where the upper signs refer to the scales above the base-line and the lower scales to those below. The even-numbered scales are clearly "dummy" ones, and are introduced for the purpose of bringing the diagrams into line with the others.

In the case of the $4n$-ordinate method, the diagram for an nth sine harmonic would, similarly, consist of $4n$ equi-spaced vertical scales erected at distances $\pi/4n$, $3\pi/4n$, $5\pi/4n$ . . . &c., respectively from the end of the base-line. The unit of each scale would be made equal in length to $\sqrt{2}$, the successive scales being marked $++--++$ &c., above the base-line, and $--++--$ &c., below.

In like manner the diagram for determining an nth sine coefficient by the $6n$-ordinate method (which may be regarded as an $8n$-ordinate method with the 4th, 8th, 12th, &c., ordinates omitted) would consist of $8n$ equi-spaced vertical scales erected at the respective distances $\pi/4n$, $2\pi/4n$, $3\pi/4n$, &c., from the end of the base-line. The units of the successive scales would be made equal in length to $\pm\sqrt{2}$, ± 1, $\pm\sqrt{2}$, ∞, $\mp\sqrt{2}$, ∓ 1, $\mp\sqrt{2}$, ∞, $\pm\sqrt{2}$, ± 1, &c., where the upper signs relate to the scales above the base-line and the lower signs to those below.

The investigation of the character of the corresponding diagrams for cosine coefficients may safely be left to the reader.

Twice the average ordinate of a periodic curve, as read on one of the above sine diagrams, would give S_n, S'_n or S''_n according to the type of diagram employed. Diagrams of this kind adapted to Fischer-Hinnen's method or its modifications will, on comparison, be seen to be but particular cases of the general "reciprocal-sine" and "reciprocal-cosine" diagrams described in THE ELECTRICIAN article just referred to. The general diagram passes into the particular whenever the number of scales which it contains is made some fixed multiple (such as 4 or 8) of the order of the harmonic for which the diagram is constructed. Thus the diagram for a $2n$-ordinate Fischer-Hinnen method is a $4n$-ordinate reciprocal-sine diagram constructed by dividing the base-line into $4n$ equal parts and erecting scales at the several points of division. If instead of erecting scales at the points of division we erect them midway between the points of division, we get a diagram for the $4n$-ordinate modification of Fischer-Hinnen's method. So, also, a diagram for the $6n$-ordinate modification of Fischer-Hinnen's method is a reciprocal-sine diagram constructed by dividing the base-line into $8n$ equal parts and erecting scales at the points of division.

It must not be forgotten that reciprocal-sine diagrams with a fixed number of scales occasionally assume the special forms indicated above. Thus, in applying a 24-ordinate reciprocal-sine diagram to determine a 3rd harmonic we are actually using an $8n$-ordinate diagram (or what we have elsewhere called a $6n$-ordinate method of the Fischer-Hinnen type), and therefore the 21st, 27th, &c., harmonics are included in the result which is thus inaccurate to that extent. Again, in applying a diagram with the same number of ordinates to evaluate a 6th harmonic, we are, in fact, using a $4n$-ordinate Fischer-Hinnen method, and the result must contain the 18th, 30th, &c., harmonics. In the practical application of fixed ordinate methods the risk of error from this cause can be largely minimised by employing a sufficient number of ordinates.

Alternative Methods.—The preceding discussion does not pretend to be exhaustive, and certain alternatives to the methods described are possible. Thus we might devise an alternative to the $4n$-ordinate method by erecting ordinates y_1, y_2, y_3, &c., at the respective distances $\pi/6n$, $5\pi/6n$, $7\pi/6n$, $11\pi/6n$, $13\pi/6n$, &c., from the origin. Twice the average of these ordinates with signs reversed in pairs according to the scheme $++--++$&c., gives $A_n+2A_{3n}+A_{5n}-A_{7n}-2A_{9n}-A_{11n}+A_{13n}+$ &c. By taking the arithmetical mean between this result and that given by Fischer-Hinnen's $2n$-ordinate method (thus utilising $6n$ separate ordinates), we obtain $A_n+\frac{1}{2}A_{3n}+A_{5n}-A_{7n}-\frac{1}{2}A_{9n}-A_{11n}+A_{13n}+$&c. To get the corresponding cosine terms a new set of ordinates y'_1, y'_2, y'_3, &c., must be erected at successive distances $\pi/3n$, $2\pi/3n$, $4\pi/3n$, $5\pi/3n$, $7\pi/3n$, &c., from the origin. Twice the average of these ordinates with signs reversed in pairs according to the scheme $+--++--$&c., gives $B_n-2B_{3n}+B_{5n}+B_{7n}-2B_{9n}+B_{11n}+$ &c., and by combining this with the corresponding result obtained by the $2n$-ordinate method we have $B_n-\frac{1}{2}B_{3n}+B_{5n}+B_{7n}-\frac{1}{2}B_{9n}+B_{11n}+$ &c.

Another way of treating the ordinates drawn as indicated in the last paragraph is to average y'_1, y'_2, y'_3, &c., with signs reversed in pairs according to the scheme $++--++$ &c. This average, when multiplied by $2/\sqrt{3}$, gives $A_n-A_{5n}+A_{7n}-A_{11n}+A_{13n}-$&c., or, combined with the $2n$-ordinate method so as to utilise $6n$ separate ordinates, $A_n-\frac{1}{2}A_{3n}+\frac{1}{2}A_{9n}-A_{11n}+A_{13n}-$&c. Similarly, $2/\sqrt{3}$ times the average of y_1, y_2, y_3, &c., with signs reversed in pairs according to the scheme $+--++--$&c., gives $B_n-B_{5n}-B_{7n}+B_{11n}+B_{13n}-$&c., or, combined with the $2n$-ordinate method, $B_n+\frac{1}{2}B_{3n}+\frac{1}{2}B_{9n}+B_{11n}+B_{13n}+$&c.

Evidently both of the "combined" or $6n$-ordinate methods thus obtained are inferior to the $6n$-ordinate method previously described, since the results they give contain a larger number of included harmonics. In this respect the second of the alternative $4n$-ordinate methods is, however, superior to the $4n$-ordinate method referred to in an earlier part of the article, as also to Fischer-Hinnen's $2n$-ordinate method. Thus the ascending order of accuracy as estimated by the number of included higher harmonics is (i) Fischer-Hinnen's $2n$-ordinate method, (ii) the second of the alternative $4n$-ordinate methods, (iii) the $6n$-ordinate method first described.

THE ORIGIN AND PRODUCTION OF "CORRUGATION" OF TRAMWAY RAILS.*

BY W. WORBY BEAUMONT.

Summary.—The author calls attention to the various stresses which are set up in free flat bars of iron and steel when subjected to rolling or hammering, and that this originates on the upper surface of the rail a condition of intense compressive stress, tending to produce a modification of form. The results of tests made on the L.C.C. tramways and other systems are given.

Few of the phenomena of the behaviour of materials employed in tramway construction have given rise to so much enquiry, speculation and diversity of opinion in the last few years as the phenomenon known as "corrugation" of tramway rails.

The rapid spread of its occurrence in nearly all towns with heavy tramway service has directed anxious attention to the discovery

* Paper read before Section G (Engineering) of the British Association at Portsmouth.

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of its cause, and much has been written concerning it, and some experimental investigations have been made. Unfortunately, the indoor experiments have seldom been conducted with apparatus or under conditions which simulate those of the tramway itself.

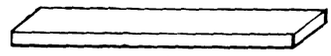
On the other hand, the observations which have been made by many on the rails themselves have led to every possible variety of interpretation of the cause of corrugation, largely because of the apparent contrariety of its occurrence and non-occurrence.

The author had commenced the preparation of an index to the Papers and articles which have appeared in this and other countries during the past five years, but it was soon found that this would be of intolerable length, and after all of but little service. The "Proceedings" of the Institution of Civil Engineers provide abstracts of Papers too numerous to mention; the Institution of Electrical Engineers has dealt with the subject; the Municipal Tramway Association and the Tramway Congress hardly ever meet without dealing with the subject; the Tramways and Light Railways Association Official Circular and "Journal" for some years has been crowded with corrugation inequalities and vagaries, and lately a Joint Committee of the two Associations—the Municipal Tramways Association and the Tramways and Light Railways Association—has been working on the subject. To the proceedings of this Committee the author has contributed, and had previously dealt with the subject elsewhere. Foreign authors have contributed largely, and a report by a Committee consisting of the managers of nine Continental tramway systems, one British professor of engineering and the secretary, was discussed at the International Tramway Congress held in Brussels in 1910.

One of the recent and most useful reports on the subject (although some judicious analysis of the facts presented is required) has been prepared as a provisional report by a Committee of the technical department for railway construction and exploitation of Amsterdam, including Messrs. J. Schrooder van der Kolk, M.P., Mass Geesteranne and T. E. van Putten. And more recently a Paper by Herr Von Borries, of much merit, has been published.

Having given some attention to all this literature of this particular

Fig. 1.



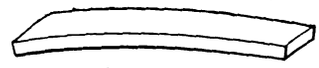


Fig. 2.

engineering ailment, and being aware of the indecision that still exists in the minds of many upon it, the author now ventures, at more length and with the object of greater precision, the explanation he has on previous occasions attempted to convey.

The subject has hitherto been treated mainly from the general point of view suggested by the practical experience of the tramway manager and engineer, and has seldom attracted or received the considered reasoning conjointly of the mechanic and the physicist. It is, however, one which in a marked degree demands the patient application of the attributes of both, and in this Paper I may repeat the words of Mr. H. R. A. Mallock,* and say "it is often useful to have a simple, even if incomplete, theoretical treatment of a subject provided that the theory is correct as far as it goes, and is kept within bounds by comparison with actual observations."

In a surface of a homogeneous solid under compressive stress in orthogonal directions in the plane of the surface, every particle tends to cause every particle surrounding it to recede in every direction.

If one surface of a free flat bar of steel or iron, as Fig. 1, be rolled or hammered, the material of that surface is subjected to a compressive stress. Of this stress it is relieved in the direction of length of the bar so far as the stress is no greater than that which is necessary to bend the bar, and cause it to keep the bent form of Fig. 2.

If of wrought iron, the molecular surface stress will in part be relieved by flow of the material or detrusion along the edges of the hammered surface, and the longitudinal bending be less than if the bar be of rail steel, in which the detrusion will be less.

If of cast iron, the surface compressive stress will accumulate and the bar will be bent by it; but the accumulation of stress reaches an early limit, as it sooner exceeds the limit of cohesion between the surface and subjacent material. The result is that, with cast iron, surface crumbling occurs and limits stress accumulation. It does, however, become sufficient to permit its use as a means of straightening cast-iron coping plates and the like if slightly curved when taken out of the sand.

If when a bar has been bent by surface compression of one side, it be forcibly straightened, the compressive stress will be increased, and a tensile stress impressed on the opposite side sufficient to eliminate the difference of dimension of the two sides caused by the compression. To remove the difference permanently the stress on the uncompressed side must reach the character of strain, equally distributed throughout the whole length of the bar. At the same time an increase is made in the compressive stress on the rolled or hammered surface. This cannot be relieved by a single pucker or extrusion of the surface about the centre of length of the bar, as the stress is uniformly distributed. Hence, at distances apart (or pitch), depending on the elastic and cohesive properties of the material, there will result incipient surface crumblings or corrugations, as shown exaggerated in Fig. 3.

The bearing of this fact on the tramway or railway rail will appear hereafter, but here it may be observed that the stresses in a bar which is bent by compression of one side and caused to retain the bent form by that resident molecular stress, is not in the same condition as to stress throughout its structure as a similar bar bent and maintained in a bent form by mechanically imposed distributed load.

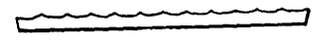


Fig. 3.

In the bar bent by compression of the material on one side there is molecular tensile stress immediately below the hammered surface. The compression differentiates in intensity from the surface to a zone or couche under tensile stress resulting from the molecular cohesion which has prevented the compressed and extended surface from separating itself by shear. Below this, tensile stress differentiates into a neutral zone and therefrom into the compressive stress which remains resident in the bar so long as it is bent by these internal forces.

In a surface such as that of an ironplate which has been rolled or hammered on that surface only, the particles of the hammered surface are, as previously mentioned, restrained by cohesion of and with the subjacent particles, which are less and less under compression as they are remote from the compressed surface film.

If any two points, *a*, *b*, or *a'*, *b'*, Fig. 4, be taken in such a surface film, it will be seen that all the particles round each point press towards it with forces proportional to some function of their respective distances from such points. In a line drawn from *a* to *b*, or *a' b'*, there are, therefore, equal and opposite forces tending to separate those points, and when their amount exceeds the elastic resistance of the material, deformation or crushing or crumpling

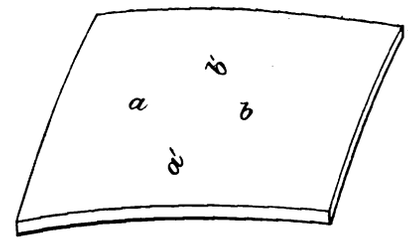


Fig. 4.

must occur, if change of form of that of which the surface is a part be restrained. If the surface be that of a deformable plate, then the forces are in part relieved by bending the plate in orthogonal directions. It is not necessary here to determine the distance between *a* and *b* at which any given material will reach the yielding point, or at which the accumulated forces will be sufficient to cause either the bending of a plate or give rise to destructive stresses in any other form of which the compressed surface is part.

To this a return may be made later, but here it is sufficient to repeat that it will be dependent upon the relation between the elastic resistance of the material to compression and its elastic tensile strength and its hardness.

In dealing with these stresses as occurring in practice, and in such forms as those of a railway or tramway rail, it will be seen from the foregoing that the values of the stresses in orthogonal directions soon reach inequality, because while they become cumulative in the direction of length of the rail, the distance transversely separating the points *a* and *b* earlier reach the limits of dimensions at which the forces can arise, because relief of the stresses is found in lateral deformation or detrusion at the rail edges, as in Fig. 5.

There is a further view of the physical conditions to be considered, which under the mechanical conditions of the rolling of a wheel on

* "Proc." Inst. Civ. Eng., Vol. CLXXVIII., 1909.

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the plane surface of a rail under pressure greater than or approaching its elastic resistance gives rise to that which results in what is known as corrugation.

A loaded circular surface, as of a roller or wheel resting upon a deformable straight plane surface, has but a line contact with that surface until either or both the circular and flat surfaces of contact are so deformed by loading the roller as to increase the area of contact. The deformation will continue until the resistance to deformation equals the force producing it. If the materials of the two surfaces be equally resistant, the circular surface will be flattened and the flat surface will be depressed or indented. If the roller be of the more resistant material, the deformation may be chiefly in the material of the flat surface. If the roller be made to roll along the surface which it can so deform it presses before it a wave of deformation. The depression giving rise to this wave may (as in the case of the tramcar wheels and rails) approach or exceed the limit of elastic deformation of the material of the rail. When this is the case, continuation of the movement of the roller upon the surface demands

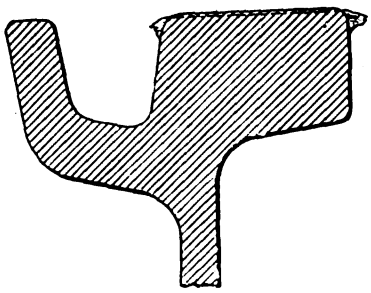


FIG. 5.

the translation of the crest of the wave, and this would involve the destruction of the cohesion between the rolled compressed surface wave crest and the material supporting it and of which it is a part. The result, therefore, is that tensile stress arises *pari passu* with the wave formation between the wave particle and the subjacent particle of the material supporting it, and the point is reached at which the tensile resistance to the increase of the wave height prevents further increase. The roller then must rise upon the minute crest, and in doing this with its heavy load upon the extremely small area compresses it to extreme hardness.

The roller (wheel) in its continued progress repeats the process and continuously adds to the rearward dimensions of the hardened spot.

The foregoing then shows that the rolling and hammering of the upper surfaces of a rail originate a condition of intense compressive stress, the elimination of which produces, or tends to produce, modification of form. It also shows that areas of maximum compression are originated at points separated by distances which are determined mainly by the relation between compression resistance and elastic strength of the material rolled, but in part by the relative hardness of the roller and rail and by the mechanical conditions which affect the area of the roller and rail contact.

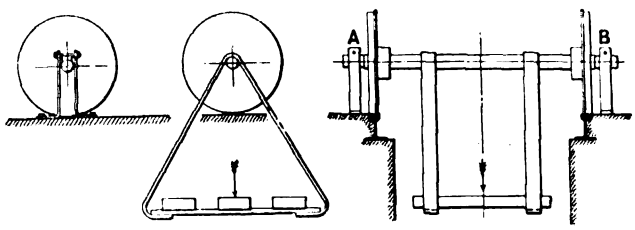


FIG. 6.—AREA OF CONTACT OF TRAMCAR WHEELS ON RAILS.
(Experimental Apparatus.)

The area of contact of hard tyre tramway wheels on steel rails is very small—is less than on ordinary railway wheels. On the latter it has been found to vary, with wheels 4 ft. 6 in. to 5 ft. in diameter, and carrying a steadily applied static load of from 12,000 lb. to 14,000 lb. per wheel, from 66,000 lb. to 48,000 lb. per square inch of contact area. The minimum and maximum areas of a larger number of observations gave loads per square inch of contact area of from 26,607 lb. to 85,961 lb. This, however, was the minimum pressure, as it was taken with engines standing on a level rail and the wheel gently lowered on to it. With an engine moving at speed and healing over as on curves, this pressure would be much greater. It must further be noted that the central part of the area of contact would be much more severely pressed than the borders of the area.

By the courtesy of Mr. A. L. C. Fell, M.I.E.E., the author has been enabled to give measurements made at his request of the pressure of the wheels of a standing car on rails of standard type. These measurements were made by loading the axles of the larger and the smaller wheels of the bogie of one of the large standard London County Council double-bogie trucks.

For the purpose of the experiments, a sling was made as shown in the diagram Fig. 6. This consisted of flat bars to which were bolted three pieces of timber on which the load was placed. The rails were carefully cleaned and the wheels turned to the correct standard taper, but with a finer cut than that usually adopted in practice.

The load used was as follows in each case :—

Driving wheels, 31 in. diameter, 6 tons.
Pony wheels, 21·56 in. diameter, 3·25 tons.

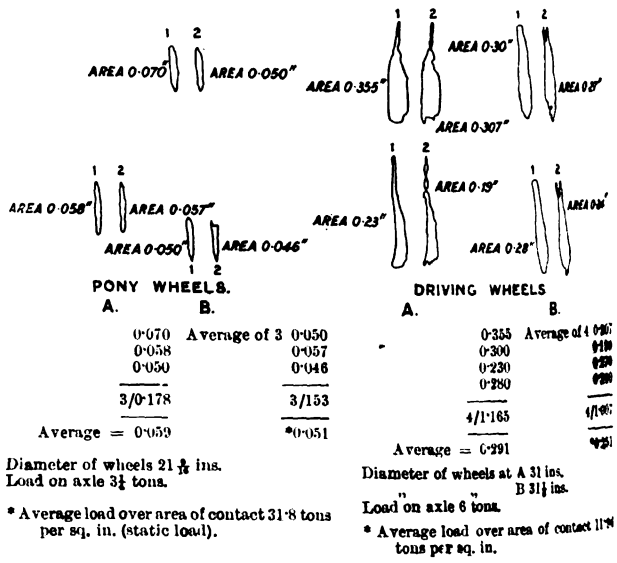
These weights approximate closely to the actual weights on a standard bogie car when loaded.

The wheel on the side marked A, *see* Fig. 6, was on the rail where it was continuously supported. On the side marked B the wheel rested immediately above the centre of a pier 14 in. wide, where the rail was not quite so rigidly carried. The diagrams obtained, marked 1 in Fig. 7, were slightly larger on this side.

The rails showed very little sign of wear, and the experiments were made at the end of a shop which has not been very much used. At each end of the axle a guide bracket was fixed to the ground, as shown in Fig. 6 ; between these brackets and the axle journal taper pieces of wood were fixed to prevent lateral movement.

The axle was lifted at the extreme end by means of a jack, and lowered carefully on a piece of tissue paper on thin carbon paper placed on the rail under the wheel. The impressions made are shown by the diagrams herewith (*see* Fig. 7).

The rails were of British standard hardness, and the tyres were manufactured to specification, for the following extract from which the author is indebted to Mr. Fell.



Diameter of wheels 21 $\frac{5}{16}$ ins.
Load on axle 3¼ tons.

* Average load over area of contact 31·8 tons per sq. in. (static load).

Diameter of wheels at A 31 ins.
" " B 31¼ ins.
Load on axle 6 tons.

* Average load over area of contact 11·8 tons per sq. in.

FIG. 7.—DIAGRAMS OF CONTACT AREAS.

Tensile strength not less than 55 and not more than 70 tons per square inch, minimum elongation of 11 to 8 per cent. in 2 in., and of the following composition :—

Carbon	0·65 to 0·75 per cent.
Silicon	0·32 "
Manganese	0·6 to 0·8 "
Sulphur	0·035 "
Phosphorus	0·035 "

The tyres are thus of harder material than the rails, which have 0·40 to 0·55 per cent. carbon.

The areas of contact carefully measured from these diagrams are given on the drawings accompanying this Paper, the areas and pressures given being those obtained from the smaller diagrams marked 2 measured on the inner edge of the black lines made by the carbon paper. The loads given per square inch are the average loads over the whole area of the diagram when the tyre had pressed into the rail, and the tyre itself also microscopically deformed until the area of support given was obtained. The pressure per unit of area in the centre of the area of support would, of course, enormously exceed this average, and I estimate the maximum static pressure to be not less than 35 tons per square inch under this driving wheel. When the car is running at ordinary speeds the pressure would rise to not less than double this as impact pressure, and when the car runs at speed round curves, and the greater part of the load with the heeling over of the car is visited on the wheels on one side, the pressure might easily reach at least 100 tons per square inch.

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On the pony wheels the average pressure of the whole area of contact under static loads reached 31·8 tons per square inch. The maximum pressure in the centre of area of contact was probably not less than 50 tons. This, with the car running at ordinary speeds, would probably reach 90 tons per square inch, and when running at speed round curves and the car heeling over so that the greater part of the load rested on the wheels on one side, the maximum pressure would probably reach 120 tons per square inch.

It is clear, then, that the pressure per unit of area much exceeds the limit of elastic compression of the material of the average rail, and that flow or deformation would occur were it not that the area pressed is supported by the surrounding material and held *encastrée*, so that flow cannot occur. One result of this is the detrusion of one or of both the rail edges, as shown by Fig. 5, by which cumulative

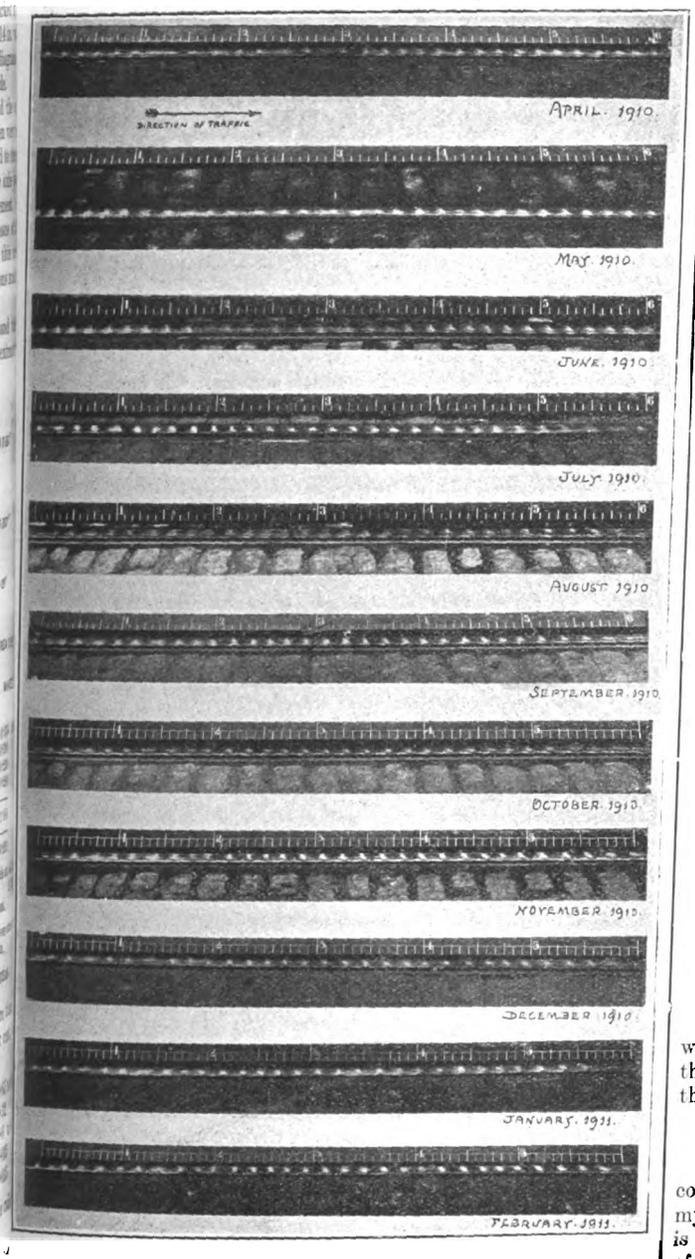

FIG. 8.—LEEDS CITY TRAMWAYS.—PARK LANE.
38 ft. 6 in. past pole 20. Outgoing track. Outer rail. Straight track. Down gradient 1 in 70. Pitch of corrugations, 2 in. In use 10 years. Section No. 6, L.S.W.

disruptive forces are in part dissipated and the extruded material on the groove edge of the tread is removed by the car wheel flanges. Another result is corrugation, and a third is the minute crumbling and pitting of the rolled surface.

Under some circumstances and conditions corrugations may decrease as the raised hardened surfaces approach by lengthening; and as corrugation and the surface become more uniform by the removal of surface material by crumbling or minute flaking, especially of the harder rails with up to 0·66 of carbon, which best resist the causes of corrugation. The removal of corrugations, however, by grinding only prepares the rail surface for quick recommencement of corrugation or for lengthening the hardened part of the corrugations.

If the preceding be accepted as the origin and production of corrugation, then the question remains, What are the remedies? The mechanical originating conditions being the weight on the wheels and the increase of that weight, more especially on outside curves by car heeling at the higher speeds, then:—

The first and most effective remedy is the reduction of the great destructive weight on the wheels of the modern car.

The second is the use of larger wheels than can be used with the present design of car.

The third is the maintenance of moderate speeds; of much lower speeds than are common on curves even those of large radius, and moderate speeds on lines that may be classed as straight, but which have such departure from straightness as will encourage boxing or wandering of the cars from side to side.

Fourthly, the use of harder rails than the hardest at present employed.

The reduction of weight is possible, the reduction of speed is possible, the use of larger wheels is possible with future cars, and the use of harder or more resistant rail materials may be possible, but they would have to be produced by methods more costly than those now adopted. The remedies will involve modifications in the views at present prevalent as to the place, purpose and working of tramway services; but even the most ardent advocates of tramway ubiquity

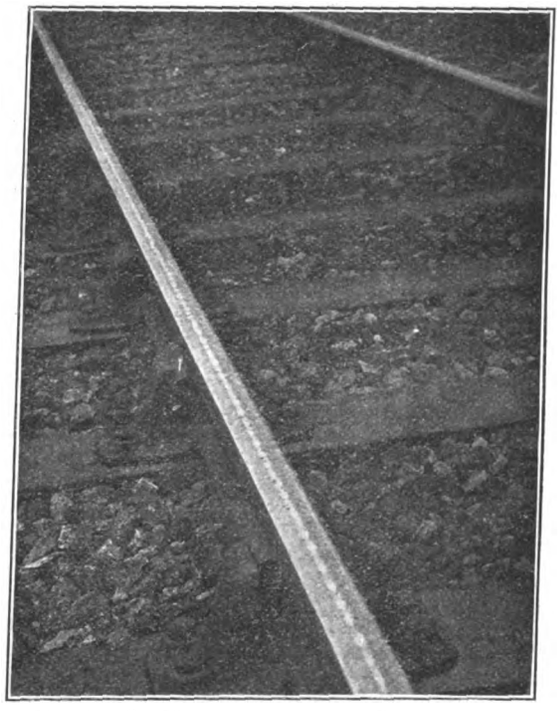

FIG. 9.—ON MIDLAND RAILWAY.—SHEFFIELD.
Straight track. Falling gradient of 1 in 100.

will ultimately be constrained to admit that tramways, like all other things that have and offer desirable ends and convenience, have also their economic and expediency limits.

ADDENDUM.

The occurrence of corrugation of electric tramway rails, as recorded by many tramway engineers and managers, and as found by my own observations extending over some years at home and abroad, is everywhere associated with the following broad generalisations of facts:—

1. That it occurs on straight lines and on curves.
2. That it is most prevalent and generally commences on curves of large radius—flat curves.
3. That it never or rarely occurs on curves of small radius—*e.g.*, from 40 ft. to 80 ft.
4. That on hills, and especially on slight gradients, it is most prevalent on the down line.
5. That its occurrence as to date or length of time after laying the rails varies broadly with (*a*) the position of the rail on straight or flat curve or down gradient, (*b*) the frequency of the service, (*c*) the mechanical properties and composition of the rails, as shown by more or less outer edge detrusion.
6. That it occurs with all types of truck.
7. That it is most prevalent where the speeds are highest.

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The general appearance of corrugated rails is known to all who are interested in the subject, and photographs showing corrugations in various stages of growth in many towns might be shown. The author is enabled, by the courtesy of Mr. J. B. Hamilton, general manager of the Leeds tramways, to show photographs of three sets of 33 rails in that city. These photographs show rails which have been in use from 4 to 13 years on straight track. Those which have been in use 13 years are on the level, those of 10 years (*see* Fig. 8) are on a gradient of 1 in 70, and those which have been in use four years are on a gradient of 1 in 50.

A small photograph, Fig. 9, is exhibited of a rail in a straight piece of track on the Midland Railway, Sheffield, on a falling gradient of 1 in 100. This shows a much worn rail, with the bright hard spots about the centre of the tread, and shows that what is called corrugation is not confined as to nature of origin or production to street tramway rails, although it is necessarily much more general and severe on tramways and other rails where heavy vehicles with small wheels and high speeds are used, as, for example, on some of our tube lines and the Metropolitan of Paris.

RECENT DEVELOPMENTS IN RADIO-TELEGRAPHY.*

BY G. W. O. HOWE, M.SC.

Summary.—The author first discusses the difficulties experienced in wireless transmission due to interferences, atmospheric disturbances, &c. He then considers recent developments for minimising such interference and improving the conditions, dealing firstly with the transmitting apparatus, and secondly with the receiving apparatus.

During the last two or three years the number of radio-telegraphic installations has increased enormously both on land and sea. This increase has not been due so much to any new discovery or striking improvement as to several instances in which radio-telegraphy prevented what might otherwise have been terrible calamities at sea.

The total number of ships of the mercantile marine fitted with Marconi apparatus at the end of 1907, that is, after seven years of development, was 140; at the end of 1908 the number was 220; at the end of 1909 it was 330, while at the close of last year it had risen to 510. In addition to the mercantile marine, practically every ship in the British navy has been fitted with Marconi apparatus.

The Telefunken Company, of Berlin, carried out 106 installations last year, bringing the total number of stations using their apparatus up to nearly 1,000. About 500 of these are warships, principally German and Russian, while 100 are portable military sets. Excluding German boats, only 13 ships of the mercantile marine are fitted with Telefunken apparatus.

Marconi's earliest experiments were made in 1895–1896 and now, after 15 years, every passenger ship of any magnitude has its wireless installation as a matter of course. There is every indication that very soon practically every ship will be so equipped. Some of the trawlers of the North Sea fishing fleet have recently been fitted with Telefunken apparatus with a range of about 100 miles. These boats receive the weather reports sent out daily from the coast stations and are thus able to warn the fleet of approaching storms.

As was recently pointed out by Mr. Bradfield of the Marconi Company the increase in the number of installations will probably be cumulative, since each installation on land or sea increases the value of the service to every ship making use of it. There is, however, another aspect to which attention should be drawn, and that is, that the troubles due to interference between stations working simultaneously will also increase cumulatively. These troubles promise to become of the gravest importance in the immediate future.

Before one can appreciate the recent developments in the apparatus, one must know something of the difficulties experienced in carrying on radio-telegraphic communication. The nature of the telegraphic service which may be required of a station is very varied. A station may have to work with only one other station and never send to, or receive from, any other. This is practically the case with the trans-Atlantic stations. A station may correspond with a limited number of stations with definite and well-known characteristics as in the case of the mail-boats running between England and the Continent. On the other hand, a station may have to work with all comers.

One can easily see that apparatus which might be eminently suitable in one case would be very unsuitable in the other. Stations in the first category can use uncommon wave-lengths and thus free themselves, to a large extent, from interference from other stations, besides being able to use a large amount of power without causing interference. The Marconi trans-Atlantic stations in Ireland and Nova Scotia use a wave-length of over 6,000 metres (50,000 ~ per second) and are thus free from disturbance from ships which generally use 300 to 600 metres.

Stations of the third class, on the other hand, should be able to call, or be called up by, ships or land stations, fitted with any make of apparatus covering a wide range of frequency.

To appreciate the difficulties due to interferences one has only to consider a station on the Kentish coast, with half-a-dozen ships within range all wishing to communicate with the coast station. They can only communicate one at a time, and each operator naturally tries to "catch the speaker's eye," which in this case is the coast operator's ear, by calling often and loudly, notwithstanding any regulations to the contrary. The same thing may be going on at other coast stations on both sides of the Channel. In addition to this we have English and French warships and dockyards working at the same time. If every station or every ship had a different wave-length it might be possible to tune the others out to a certain extent, but for the sake of uniformity and convenience in working, the majority of stations have about the same wave-length, so that when one is tuned to the desired station, one is also tuned to the disturbing stations. The result is that one station tries to shout the other down and the successful working of all the stations is greatly hindered. At the City and Guilds College in South Kensington one of the aerials is a single wire 260 ft. high and with this one can sometimes hear half-a-dozen stations sending simultaneously at approximately the same wave-length, making it absolutely impossible to read any one of them.

Apart from all this, there are the atmospheric disturbances, which vary very much from time to time. One station receiving from another a thousand miles away will certainly hear every lightning flash over a large part of the earth's surface. These atmospheric disturbances are often strong enough to make working impossible over any but very short distances, even when the weather conditions locally look ideal.

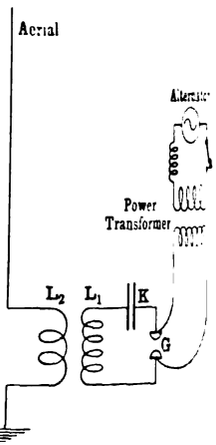

Fig. 1.

Whether one can receive or not in spite of these atmospheric disturbances depends on the loudness and nature of the signals, so that one can become more and more independent of the atmospheric conditions by increasing the power employed and by making the signals easily distinguishable from the sounds caused by the disturbances.

Recent developments in the sending apparatus have been largely directed towards obtaining freedom from interference. This has been sought in two ways: Firstly, by sending out well-sustained trains of waves of one definite frequency, giving sharper tuning, and secondly, by giving the signals a high musical pitch, easily distinguished from the crackling noises caused by atmospheric disturbances and also from other stations having notes of a different pitch. The spark-gap must be so designed that these characteristics are retained when very large powers are employed. A spark-gap may work excellently when the power is small, but fail entirely when the power is increased. Absolute reliability and constancy are of far greater importance than efficiency, although any improvement in the latter is to be welcomed, not so much for the saving of power as for the reduction in size and cost of the apparatus.

Fig. 1 may be taken to represent diagrammatically the sending apparatus of almost every system, by whatever name it may be called. In all except the smallest installations, the sparking coil with hammer or mercury break has been replaced by an ordinary power transformer supplied with alternating current, as shown in the figure. The coils L_1, L_2 constitute an air-core Tesla transformer of few turns. It is sometimes connected as an auto-transformer, *i.e.*, with a single winding tapped off at different points, but this alters nothing so far as the principle is concerned. If coil L_2 is far removed from coil L_1, each discharge of the condenser K across the gap G will cause a damped oscillation in the primary circuit GKL_1, as shown in Fig. 2. The rapid damping is mainly due to the dissipation of energy in the spark-gap. The time, T, of a complete oscillation depends only on K and L_1 and is usually about 1/500,000 second, corresponding to a wave-length in space of 600 metres. All the energy stored in the condenser at the moment of breakdown is dissipated as heat in the gap and in the remainder of the oscillatory circuit. It is seen that the oscillatory disturbance caused by one spark lasts about 1/50,000 second. Nothing further happens until the condenser is charged up

* Paper read before Section G of the British Association at Portsmouth.

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to the same potential difference as before. If the gap is made so long that the spark can only just jump it, the next spark may not occur until several half-cycles of the alternating supply have passed, the voltage across the secondary of the power transformer gradually building up due to resonance. This resonance is obtained by adjusting the speed of the alternating-current generator. The result will be that, with an alternating-current supply of 50 cycles per second, the sparks may occur at intervals of 1/20 to 1/30 second (Fig. 2). This is the method which was largely used two or three years ago and which is still used by the Eiffel Tower and many other stations.

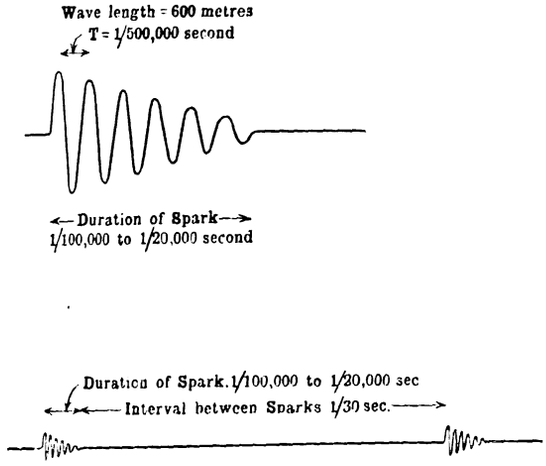

FIG. 2.—SENDING WITH 30 SPARKS PER SECOND.
The duration of a Morse dot is about one-twentieth of a second.

If the coil L_2, which with the aerial constitutes an oscillatory circuit of the same frequency as the circuit GKL_1, is loosely coupled with the coil L_1 so that about 5 per cent. of the magnetic flux of L_1 links L_2, a part of the oscillating energy will be transferred to the aerial and there partly radiated out into space and partly dissipated in the aerial, coil, and earth connection. The oscillogram (Fig. 3) shows the nature of the primary and aerial currents accompanying each spark. Owing to the loose coupling between L_1 and L_2 the transference of energy is very slow and the major portion is still dissipated in the spark-gap. From experiments made at the City and Guilds College it has been found that under the most favourable circumstances 30 per cent. of the primary energy can be transferred to the aerial. If the transfer of primary energy to the aerial is hastened by increasing the mutual inductance between L_1 and L_2, the energy surges backwards and forwards between the two circuits and gives us the phenomenon of beats. The oscillograms (Figs. 4 and 5) show the nature of the primary and aerial currents as the coupling is increased. Instead of a wave of one definite length, say 600 metres, a pulsating oscillation is sent out, which may be looked upon as made up of two ordinary damped waves with lengths of, say, 500 and 700 metres. This will be received almost equally well on the receiving aerial whether it be tuned to 400, 600 or 800 metres or any other intermediate wave-length.

In Figs. 9 and 10 are plotted the currents in the receiving apparatus as its natural frequency is varied. The two figures refer to different installations; in each case a series of curves is given for different degrees of coupling between the coils L_1 and L_2. With the ordinary spark-gap it is obviously impossible to increase the coupling much above 7 or 8 per cent. without sacrificing sharpness of tuning and thus causing undue interference with stations working at other wave-lengths. Apart from the question of interference, there is little increase of efficiency to be obtained by increasing the coupling beyond this value.

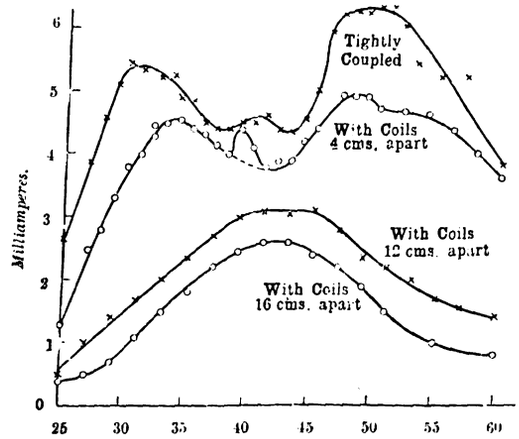

FIG 9.—SENDING ON FIVE-WIRE AERIAL, USING SMALL SPARK COIL AND PLAIN GAP WITHOUT AIR BLAST.

These are the conditions under which the majority of stations are working at the present time, but during the last three or four years a great amount of research work has been done with the object of improving these conditions.

In Fig. 10 it will be noticed that when the coupling is tight, the aerial oscillation contains waves of three different frequencies, one high and one low, corresponding to the constituents of the beats, and one of the natural frequency of the aerial alone. This shows that during a part of the time the aerial oscillated freely, uncoupled from the primary circuit. The reason for this can be seen from the oscillogram, Fig. 6. In the experiment to which Fig. 10 refers, the spark-gap was exposed to an air-blast, so that whenever the amplitude of the current in the primary oscillating circuit was small, there was a tendency for the air-blast to remove the column of hot air and metallic vapour and thus to extinguish the spark. This will obviously occur at a moment when all the energy is oscillating in the aerial and will prevent it surging back into the primary circuit. The aerial will now continue to oscillate at its natural frequency until the energy is all radiated or dissipated. In Fig. 10 not only was there an air-blast

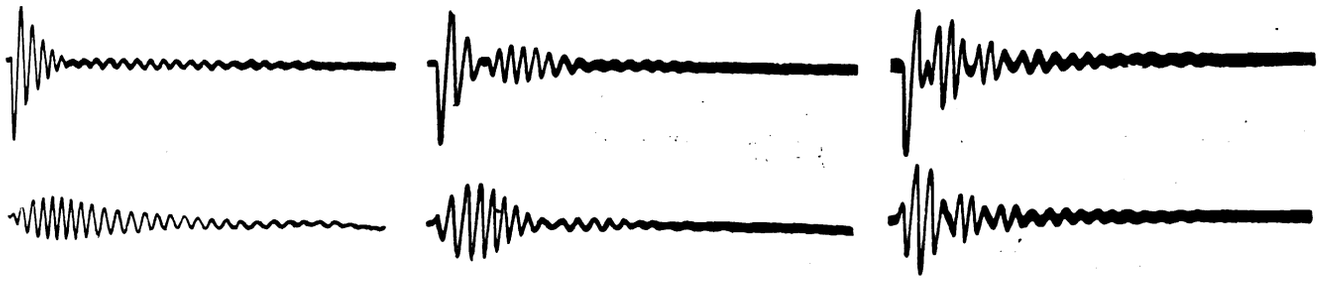

FIG. 3. FIG. 4. FIG. 5.

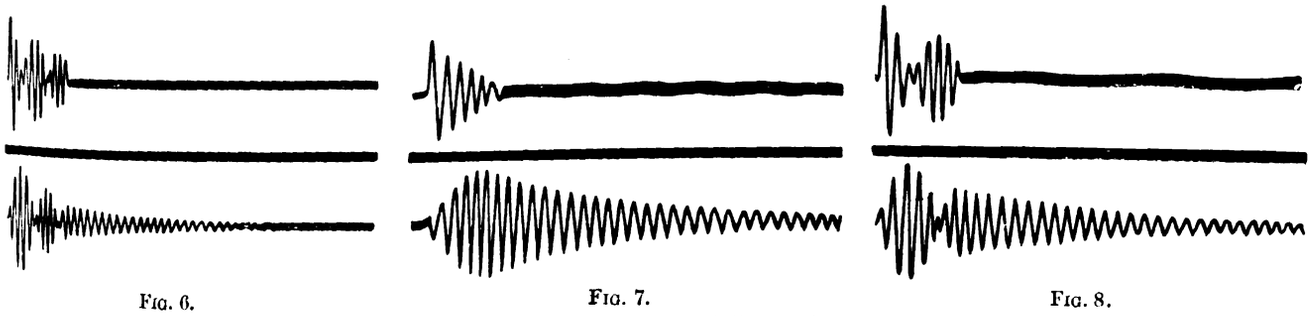

FIG. 6. FIG. 7. FIG. 8.

In all the Oscillograms the Upper Curve refers to the Current in the Primary Oscillating Circuit and the Lower Curve to that in the Aerial.

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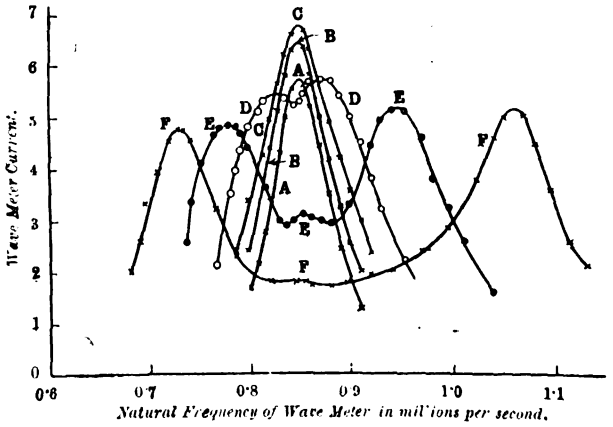
but the electrodes were comparatively large and the spark-gap short, so that no part of the spark was far removed from the large mass of cold metal tending to condense the metallic vapour and thus lower the conductivity of the spark.

This quenching of the spark was discovered in 1906 by Prof. Max Wien and was afterwards taken up by the Telefunken Company, who have evolved a form of spark-gap in which the quenching is very effective. With this gap the primary and aerial currents will be as shown in the oscillogram, Fig. 7. The gap acts as a very quick-acting minimum-current cut-out, and opens the primary oscillating circuit at the first opportunity, viz., when all the energy has been transferred to the aerial. The time during which the two circuits are coupled is very short, the energy wasted in the spark-gap is reduced, and the major portion of the energy oscillates freely in the aerial and is radiated as a damped train of waves at its natural frequency. In this way it is claimed that 75 per cent. of the output of the alternator is transferred to the aerial.

It is obviously advantageous to shorten the duration of the spark as much as possible by tightening the coupling between the coils L_1 and L_2, and thus hastening the transfer of energy to the aerial. If this be overdone, however, the gap will fail to quench at the first minimum and we may get the conditions shown in Fig. 8, or even Fig. 6, with a great loss both in efficiency and sharpness of tuning.

Wien first obtained quenching by the use of very short spark-gaps, and this is the method which the Telefunken Company has adopted, although other methods have since been discovered. The spark is made to occur between the parallel faces of discs of copper or silver placed about 1/100 in. apart, the discs being separated by thin annular rings of mica which also serve to shut the sparking spaces off from the air. The number of these discs in series depends on the voltage and power required. This form of gap is undoubtedly complicated and expensive, not only in first cost but also in subsequent up-keep.



Using 10 in. spark coil with mercury break. Length of spark gap 1·2 mm. with air-blast.
Primary capacity, 0·00567 microfarad. Secondary capacity, 0·00198 microfarad.
Resistance in secondary, 6·36 ohms.

A coupling = 2·9 per cent.	C coupling = 7·8 per cent.	E coupling = 21·4 per cent.
B " = 4·75 "	D " = 12·55 "	F " = 36·3 "

FIG 10.

Those who have picked up the time signals and weather reports sent out daily from Norddeich near Bremerhaven will have noticed that although the signals are very clear and easily distinguished from extraneous sounds, they often decrease in loudness after working for some time, and have been known to fail altogether for a few seconds in spite of the efforts of the operator. This may have been due, of course, to some exceptional cause not connected with the gap, but it is almost what one would expect when using such minute gaps as 1/100 of an inch. It seems therefore, at present, that the increased efficiency due to the quenched spark is obtained by the sacrifice, to a certain extent, of reliability and simplicity.

Turning now to the receiving apparatus, we find that the filings coherer has practically disappeared. The reception of the signals is now always aural. The detectors now employed in conjunction with a telephone receiver are not only much more sensitive than the filings coherer operating a Morse inker, but enable the operator to discriminate between the signals being sent to him and the various disturbances picked up by the aerial, which, as we have already seen, is a matter of ever-increasing importance.

The magnetic detector used by the Marconi Company is ideal in its simplicity and reliability, but is not so sensitive as the electrolytic or the mineral contact detector. The Telefunken Company have recently given up the electrolytic detector in favour of a detector of the latter type. Another type of detector used to a certain extent is the Fleming valve, which combines extreme sensitiveness with comparative simplicity and reliability.

Although there are many ways of arranging the receiver connections, Fig. 11 may be taken as typical of the usual arrangements when using a mineral contact detector. The high-frequency oscillation picked up by the aerial is transferred by means of the oscillation transformer L_3 L_4 to the tuned oscillatory circuit KL_4. Shunted across the condenser is the detector—consisting simply of a piece of zincite in contact with a piece of pyrites—together with the telephone receiver of several thousand ohms resistance. The telephone is shunted with a condenser, which must have such a capacity that it acts as a conductor to the high-frequency oscillations enabling them to pass through the detector without passing through the highly inductive telephone receiver, but as an insulator to currents of telephonic frequency, thus forcing them to pass through the telephone.

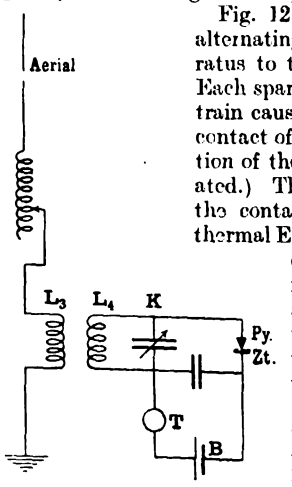
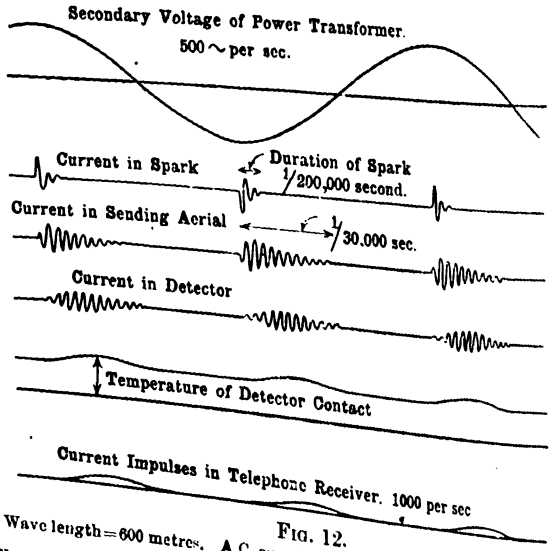


FIG. 11.

Fig. 12 explains the various stages from the alternating-current supply of the sending apparatus to the currents in the telephone receiver. Each spark causes a wave-train, and each wave-train causes a momentary heating of the point of contact of the detector. (In the figure the duration of the wave-train has been greatly exaggerated.) This will cause a momentary variation in the contact resistance and will also produce a thermal E.M.F., with the result that a momentary current passes through the telephone or, if, as is sometimes found advantageous, a steady current is maintained through the telephone by means of the cell B, this steady current will suffer a momentary variation.

Thus each spark gives an impulse to the telephone diaphragm and the pitch and nature of the note heard in the telephone receiver will depend entirely on the frequency and regularity of the sparks. It is here that one of the greatest improvements has taken place. Until recently the sparks followed one another so slowly or so irregularly that the sound heard in the telephone could not be called a note but was merely a crackling noise. A great number of stations are still working in this way, and the signals they send out are very difficult to distinguish from atmospheric disturbances and other extraneous noises. It is now realised, however, that by giving the signals a pure musical note of high pitch, they can be readily heard and distinguished above comparatively loud atmospheric disturbances and in spite of interference from other stations, unless these stations happen to be working with a note of the same pitch.

Another very important point in this connection is the great increase in the sensitiveness of the telephone receiver as the pitch of the note is increased.



Wave length = 600 metres. A.C. supply from 500 ~ alternator. Quenched spark.

FIG. 12.

To produce a musical note of high pitch it is necessary to make the sparks follow one another rapidly and with great regularity. When sending at a speed of 20 words per minute, the duration of a dot will be about 1/20 of a second, so that with a spark frequency of 30 per second the dot will consist of one, or at the most, two sparks, whereas with a spark frequency of 1,000 per second, the dot will consist of 50 sparks. The former was quite enough to actuate a filings coherer, but would merely cause a blow on the telephone diaphragm, whereas the latter would give a short piping note in the receiver.

By increasing the alternating supply voltage or by shortening the spark-gap, a large number of sparks can be made to occur during each

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half-cycle, but they will occur too irregularly to produce a musical note unless steps are taken to make the sparks occur at regular intervals. This can be done by replacing the stationary gap by two discs revolving at high speed, the rims of the discs being provided with projecting knobs between which the sparks jump.

The simplest way of obtaining 1,000 sparks per second with great regularity is to use an alternator giving 500 cycles per second and to adjust the voltage until the gap breaks down once every half-cycle as shown in Fig. 12. To ensure regularity the gap must be kept cool and the after-effects of each spark quickly removed. With the ordinary stationary gap this can be done by means of an air-blast, but with the Marconi revolving discs the air-blast will hardly be necessary. In the new Telefunken gap the quenching action, which we have already considered, has to extinguish the spark 1/200,000 second after it has jumped, so that after 1/1,000 second the gap should have lost all traces of the spark. The quenching action has thus to play a double part, the first affecting the nature of each spark and the resultant oscillation, and the second affecting the regular succession of sparks.

One of the most recent developments, although hardly yet beyond the experimental stage, is the introduction of the telephone relay. By placing one of the telephone relays, recently invented by Mr. S. G. Brown, between the detector and the telephone receiver, signals which are otherwise quite inaudible can be easily read. The Telefunken Company has recently experimented with an apparatus somewhat similar in principle and known as a tone augmenter.

The distances over which communication can be maintained with a given supply of power depends on the height and size of the aerial, on the nature of the intervening country and on the type of detector employed.

A safe guarantee under very unfavourable conditions is about 50 miles per kilowatt of alternator output but with favourable conditions and sensitive apparatus, distances of over 500 miles per kilowatt have been covered.

Practically all the radio-telegraphic apparatus working commercially or being installed at the present time is based on the principles which we have considered. With the exception of the spark-gap and the detector employed, the differences are non-essential. No mention has been made of the generation of undamped waves by means of arcs, as this system has not yet made the revolutionary changes in radio-telegraphy which many anticipated.

A NEW TREATMENT FOR PREVENTING SCALE IN BOILERS.*

BY T. R. DUGGAN.

It is not quite known why, in the generation of steam, certain salts of calcium and magnesium form hard crusts or scale. All engineers try to minimise this evil, knowing that $\frac{1}{8}$ in. thickness of scale means a loss of about 20 per cent., $\frac{1}{4}$ in. equals a loss of 40 per cent., and $\frac{3}{8}$ in. of scale a loss of about 50 per cent. of heat.

After many trials, Brandes has discovered an apparatus—"The Luminator"—which so changes water allowed to flow over it that when used in steam boilers little scale is deposited, old scale is softened and detached from the plates, and the precipitable salts are deposited as powder. I should hesitate to offer this for serious consideration were there not men of repute and integrity who have proved it in practice, as well as several plants working successfully in this country.

The treatment consists in allowing water to run down an aluminium plate of special dimensions, with corrugations of a particular size, according to the character of the water to be treated. It is only necessary to brush the channels well to keep them clean.

Storage tanks and mains, if far from the boiler, must be coated with a non-conducting composition—any bituminous varnish will do—and the water must reach the boiler as soon after treatment as possible. In any case, to get the maximum effect, the water must be used within seven days of its treatment.

The theory of the action of the "Luminator" is that, by the passage of water over the metal channels at certain speeds a current of electricity is induced, the water being negative and plates positive, and a kind of ionisation of the salts takes place, which makes them fall out in an amorphous form; at the same time aluminium is by friction and electrical action abraded from the surface as colloidal aluminium, which after a time is changed in the water. The best results are obtained when the "Luminator" is facing either north or south and exposed to direct light; in the dark the apparatus almost ceases to work.

The action within a steam generator is somewhat obscure, but in all probability the colloidal aluminium acts as a series of nuclei or active centres for the evolution of carbon dioxide and the crystallisation of salts, while the aluminium particles also combine with the dissolved oxygen of the water, and so deoxidise it. As corrosion of boiler plates is supposed to be caused by the presence of free oxygen in the water, this action should diminish the corrosion of boilers; such is found in practice to be the case. For instance, a boiler which was usually red with ferric oxide at the steam and water line, a belt of about 12 in. wide became purple black like new plates after using water treated by this process. This action is not confined to the steam and water junction, but goes on all over the boiler until it becomes coated with a smooth adherent semi-metallic coating of magnetic oxide of iron, which seems to prevent centres of crystallisation upon the plates and precipitates the salts as a powder.

* Abstract, from the "Journal" of the Society of Chemical Industry, of Paper read at the Chemists' Club, New York.

DISCUSSION.

Mr. W. A. CONVERSE said that it seemed to be generally agreed that the change effected by the "Luminator" was physical and not chemical. The water, before and after treatment, showed no difference upon analysis, but, upon boiling, was said to show considerable difference in precipitation. He had himself examined samples before and after treatment and could not find any difference.

Mr. F. B. HERRESHOF said that an experiment was tried with a feed water heater made in Boston some 15 or 20 years ago. It had a coil with a large surface exposed, so that the temperature of the feed was brought up to nearly 300°F. It was assumed that sulphate of lime would separate out at about 300°F., and it was claimed by the makers that all the carbonate would separate out. There were about 5 grains to the gallon of carbonate, as well as sulphate, and analysis showed that none of the carbonate was separated. Thus, at even that high temperature, the presence of carbonic acid which could not get away kept the calcium carbonate in solution; but calcium sulphate, if present in large enough amount, separated out. In a steam boiler the conditions were different, because the steam evolved swept away the carbonic acid as fast as it was disengaged from the bicarbonate; and the insoluble carbonate of lime, probably at first a fine powder, began to crystallise and form scale on parts of the boiler. Calcium sulphate was soluble in 400 parts of cold water; but at high temperatures, such as 300 F., it probably became dehydrated to a certain extent—at any rate it deposited on the tubes and parts of the boiler that became heated. The flues and crowns of boilers were hotter than the water, and it was there that calcium sulphate became attached as a very hard scale. How was this electric influence on a small scale to prevent calcium bicarbonate from decomposing at that temperature; or the carbonic acid from being swept out by the steam? How could it prevent calcium sulphate from decomposing when heated to a high temperature and forming scale?

Mr. JEROME ALEXANDER said that the fact that metals dissolved in water in the colloidal condition had long been known. In this particular case, aluminium and its compounds, whatever they might be, acted substantially as protective colloids. The various reactions described by Mr. Herreshof actually did occur; but in the presence of the aluminium or alumina compounds, the insoluble products separated as colloids and remained in suspension so that they passed out of the boiler when the boiler was blown off. He had never heard of a metal acting as a protective colloid, and he doubted if the metal aluminium could so act. Possibly aluminium oxide might, and so prevent precipitation. There appeared to be no doubt as to the facts stated by Mr. Duggan, and therefore one could only search for the most reasonable explanation of them. It looked as if the aluminium compounds, of whatever nature they might be, did act as protective colloidal substances.

Dr. FERRIS said that it was a common practice in the west to put zinc slugs in boilers, particularly tubular ones, where the heat was principally in the flues, to prevent the formation of scale. The precipitate remained in powder form and could be blown out very easily. But the zinc slugs in time dissolved. In an 80 H.P. boiler two or three zinc slugs of 25 lb. each would disappear in a month.

Mr. T. R. DUGGAN, in reply, said that a litre of water was run through the "Luminator" apparatus 10 times, and another litre of the same water was run over an enamelled plate the same number of times. Both samples were then heated to 80°C. for 10 or 15 minutes. The experiment showed a loss of 20 per cent. of temporary hardness in the water run through the "Luminator," while the other lost about 3 per cent. Aeration had nothing to do with it. There was no limit to the hardness which could be treated in the apparatus, but for such hard waters as reached, say, 80 grains per gallon on Clark's scale, an apparatus some 20 ft. long would be needed. The loss in weight of the aluminium was impossible to measure, it was so infinitesimal. A boiler using the "Luminator" should be blown off frequently, more especially in the first stages of its use, because old scale came off so rapidly that it accumulated at the bottom, and if permitted to remain there might result in burning the boiler. It was extraordinary what an effect the treatment had upon foaming. In every case where these machines had been used, foaming practically ceased. Waters containing ferrous sulphate could be treated, but ferrous carbonate would deposit on the aluminium plates, so they had to be continually cleaned, making it almost impossible to treat such waters. Milk, when passed through the apparatus, was found to keep an extraordinarily long time; whereas the same milk, not passed through it coagulated and became sour quickly. The corrugations had no function except to increase the surface of the plate. Zinc slugs were used in Great Britain many years ago, in marine boilers particularly, but for some unknown reason had been abandoned within the last 10 years.

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With "THE ELECTRICIAN" for Sept. 14, 1906, was issued the first of a series of "Industrial Supplements," to be published from time to time with "THE ELECTRICIAN." The fifty-third issue of the Supplement published (Gratis) with the number of "THE ELECTRICIAN" for September 23, 1910, was the last of the monthly issues. "THE COMMERCIAL AND INDUSTRIAL SUPPLEMENT" to "THE ELECTRICIAN" is now issued weekly (Gratis). It will be found towards the end of the present issue.

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SIR WILLIAM RAMSAY'S ADDRESS TO THE BRITISH ASSOCIATION.

Of all the tasks that fall to the lot of a distinguished man of letters or science, that of composing a Presidential Address to the British Association is by no means the least difficult. At the best he can please only a small percentage of his hearers, for some will understand and disagree, while many will not understand and will be correspondingly discontented. Sir WILLIAM RAMSAY, on the present occasion, has committed himself to nothing very deeply, but has touched on a variety of subjects calculated to interest that section of the general public which attends the British Association. Some of his points are, however, worthy of careful consideration, and not the least of these is to be found under the head of education: we refer to the evil of the present-day examination system. Unfortunately, it must be admitted that examinations of some kind are a necessity; there is at present nothing that could fill the gap which would remain if examinations were abolished. Bad as the system is, however, it is, nevertheless, susceptible of easy improvement. The trouble is that examiners, and even teachers, attach too much importance to examinations, and very often the tests themselves are conducted by the wrong persons. Perhaps the most glaring example of how not to do it is found in what is called the "external examination." A syllabus is laid down by an examining body, and students are carefully crammed in the subject-matter therein for several months on end. At the conclusion of this period there is a final furbishing up with a text book at the very threshold of the examination room; then a paper of per-

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haps ten questions, set with a view to ascertaining not how much a student has digested, but whether he has retained certain particular points. It is no exaggeration to say that a student who has been well taught may stand less chance of success in such a test than one who has been crammed on the bare syllabus. It must be evident that a teacher, who has had a student working under him for two or three years, knows far more about his man than the most distinguished examiner can find out in a couple of hours; yet the latter is the one to decide the fate of the unfortunate student. If Sir WILLIAM RAMSAY will only take some steps towards abolishing this iniquitous system we feel sure he will not lack support. That the importance of the matter is being realised will be apparent from the discussion which took place in Section L on Friday, when it was suggested that application should be made for the appointment of a Royal Commission to consider it.

The next point of interest in the Address relates to the positions of radium and its descendants in the periodic table, in which it is suggested that allotropy may be due to gain or loss of electrons, accompanied by positive or negative heat change. Taking as his text the disintegration of radium, Sir WILLIAM proceeds to descant upon the waste of coal which goes on. He calls attention to the enormous amount of energy contained in a minute quantity of radium, and illustrates it by striking figures. Unfortunately, however, the rate of liberation is far too slow to be of practical use, and, even if some means of accelerating it were discovered, then the quantity of radium available is much too small to have any effect on the rate at which our remaining coal store is being used up. Sir WILLIAM refers to the idea of obtaining energy from the tides, from the wind and from the sun, and, although this could be done, yet the amount would be insignificant, and, what is equally important, it would not pay—at all events, at present. Hence, until the happy day comes when some new store of energy is discovered, the best thing the nation can do is to take care of the coal it has left. It is calculated that England has enough coal remaining to last her 175 years; unless, therefore, some substitute is found the prospect is not a very cheerful one, for the nation can no more live without coal than a man can live without food. The right note is struck when Sir WILLIAM RAMSAY advocates the adoption of economical methods in the use of coal. Since the store must be exhausted, let it be exhausted as slowly as possible; if a method can be found of doing as much with a ton of coal as was formerly done with a ton and a quarter, let that method be adopted without delay. As a matter of fact, this is exactly what has been going on for a great many years, and the "*laissez-faire* plan of leaving to self-interested competition the combating of waste" is not so "*laissez-faire*" as the President might think. Strenuous endeavours are being made by engineers all over the country to reduce coal consumption, not perhaps from a purely altruistic motive, but because it pays. His suggestion that electricity should be generated at the pit's mouth and distributed at high pressure is a somewhat belated one; it has already been done, and in all probability the method will be extended as time goes on. It must be recognised, however, that a point is soon reached when this plan no longer becomes commercially possible. Presumably, this is the point at which Sir WILLIAM suggests State aid in the form of "loans at an easy rate of interest." We fear it will be a long time before any Chancellor of the Exchequer is bold enough to attempt the inclusion in his Finance Bill of a clause to transfer a portion of the national revenue to an electricity supply undertaking with the object of securing coal to posterity. It is a magnificent idea, but we fear it is a long, long way off realisation.

Sad as it may be, it seems that the saving of coal must, for very many years, be left to the efforts of engineers, who will use their wits, not in the interests of humanity, but with a view to diminishing that magical item "coal costs." Of course, if the State took over the electric supply industry, the matter would be on an entirely different footing; but we imagine that this also is not likely to take place in the immediate future.

Sir WILLIAM RAMSAY has done the country a real service in re-calling attention to this subject, and we can only hope that his Address will be read with the attention it deserves. At all events, his warning is a timely one, and he has discharged his duty by stating the case in such a way that there can be no mistake about it.

REVIEWS.

(Copies of the undermentioned works can be had from THE ELECTRICIAN Office, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.)

The Elements of Telephony. By ARTHUR CROTCH. (London, 1910: E. & F. N. Spon.) Pp. 90. 1s. 6d. net.

Within the limits of a modest volume of 90 pages the author has outlined the main features of a present-day telephone system in a way which should enable a reader who has some little knowledge to start with to obtain a clear and intelligent understanding of the inner workings of a modern exchange.

The general arrangement of the book is excellent. After a discussion of first principles in the introductory chapter, the reader is led by easy stages from the simple magnetic telephone of Bell up to the intricacies of the large common battery exchange. The text is plentifully illustrated by circuit diagrams and photographs of apparatus. The former, although of necessity rather small, are nevertheless very clear and show evidence of considerable care having been taken in their selection and preparation.

In a book of this kind one does not look for detailed descriptions of the thousand-and-one types of apparatus now in use, but rather for an explanation of the salient features of a few of the more important ones, with a view to bringing out the underlying principles upon which their action depends and the conditions they are designed to meet. In this respect the author is particularly successful and his book can be recommended as eminently suitable to place in the hands of the elementary student to form a foundation for the more detailed knowledge he will afterwards acquire. H. S. T.

William Thomson, Lord Kelvin—His Way of Teaching Natural Philosophy. By D. WILSON. (Glasgow, 1910: J. Smith & Son.) Pp. 56. 2s. nett, cloth; 1s. nett, paper.

In this book the author gives his recollections of certain scenes in the natural philosophy class at Glasgow University in the early eighties, and his own personal ideas about Lord Kelvin's method of teaching. The images presented seem to us very distorted, the author and his friends forming a very conspicuous group in the centre. They seem to have belonged

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to that class of student which is always on the look-out to "show off," not infrequently with disastrous results. The first chapter, on the "metric system," purports to portray a scene in the class-room and illustrates the difficulties of teaching "raw material" in bulk. In the next chapter several happy prophecies made by Kelvin in 1884 are given. They illustrate how clearly he saw the lines on which progress in electric lighting and traction would be made. The author does not throw much light as to what Kelvin meant by the "vital principle," but he airs his knowledge of Oriental religions, and thinks that Kelvin must have been actuated by the *Golden Rules*.

In the last chapter the author describes how, in a degree examination on natural philosophy, he answered the last question in a way which, although correct, was more fitted for the pages of "Punch" than for examiners' reading. The examiners being Scotch, and consequently being able to appreciate a joke without loss of dignity, decided that justice would be satisfied if the culprit had a personal interview with Sir William. The interview shows Sir William in a very pleasant light, but we are doubtful, notwithstanding the statement to the contrary, whether he really succeeded in making the author see the principle of the conservation of energy. "Conservation of energy was seen to be a verbal symbol of one aspect of what Carlyle called the 'fact of facts,' the living universe, whose 'energy' includes, as an insignificant item, the whole human race from the beginning of time, and can no more be measured by us than the ocean can be bottled in our laboratories." Personally, the reviewer thought that the conservation of energy was something quite different, but still, if philosophers are willing to accept it in the form set forth by Mr. Wilson it seems a pity to try and upset their faith.

Elektrische Winke für Architekten und Hausbesitzer By Dr. L. Block and R. Zandy. (Berlin, 1911; Julius Springer.) Pp. iv.+151. M.2.80.

Messrs. Block and Zandy have written a very interesting little work on electric installations generally which undoubtedly fulfils the title they have given it, as it certainly does contain a large number of useful wrinkles which should appeal not only to architects and householders for whom it has been mainly written but also to electric-lighting engineers in general. Of course, there are many points of difference between English and Continental installation practice which must be considered in using the book. Although, as pointed out by the authors in their introduction, the architect with a knowledge of electrical installation practice and requirements has it in his power by making from the start suitable provision for the cable runs, &c., of cheapening and facilitating the arrangement and installation of electrical wires in new buildings—of special importance in the case of buildings with ferro-concrete walls and floors—this should be done by the architect under the guidance of a responsible electrical engineer, not by the architect alone. It is impossible for the architect to gain all the necessary knowledge and experience, however well the facts are put together and condensed, in a single volume. The electrical engineer is either not consulted at all in far too many cases or is called in too late.

Chapter I. contains remarks on the installation generally—position of the connections to the supply, main runs, rising mains, distributing centres, &c. It also points out the advisability of making the necessary provision for fixing and running the wires in the case of concrete floors and gives methods of carrying this out. Chapter II. is on electric illumination. It deals with all the various types of incandescent and arc lamps in a brief but satisfactory manner. The candle-power and watt consumption are given in a very clear tabular form, especially those for arc lamps. The paragraphs on the selection of lamps, the number and candle-power, are very good, and the table for calculating the number of lamps required for different classes of rooms will also be found very instructive; it is, of course, in Hefner candle-power per square metre. The illustrations in this chapter of examples of interior illumination, both direct and indirect, are also very good. Staircase and shop-window illumination are, further, separately considered.

Chapter III. is on electric cooking and heating. Many useful data will be found in it as regards the watt consumption of various cooking utensils. Electric power in dwellings is explained in Chapter IV. It includes information and illustrations of lifts (push-button system), ventilating fans, vacuum cleaners, water pumps, small charging outfits for charging batteries for electric automobiles, electrically-driven refrigerators, &c. Chapter V. sets forth the advantages of electrically driven contractors' plant and gives excellent illustrations showing how electric power can be utilised by the contractor in building operations in numberless ways to expedite the work of excavating, removal of rubbish, &c., elevating, and so on.

The book is well and clearly written and well illustrated, and contains a number of useful hints; it reflects considerable credit upon the authors who have succeeded in setting forth the advantages of electric lighting and power in a simple and decisive manner.

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BY R. A. HOUSTOUN, M.A., PH.D., D.SC.

(Lecturer in Physical Optics in the University of Glasgow.)

Summary.—In these studies the author deals with the theory of light production, the scope being briefly indicated by the following contents: (1) The distribution of the energy in the spectrum and the measuring of efficiency. (2) The importance of "black body" radiation and the experimental realisation of the black body. Comparison of the energy curves of a black body and of platinum, and the variation of the position of maximum energy with temperature. (3) Mechanism of flame, and the temperature, energy and efficiency of flames. (4) The Welsbach mantle and selective radiation. (5) Radiation and efficiency of the carbon glow lamp. (6) Physical properties and temperature of the arc. (7) Temperature and energy curves of the Nernst glower. (8) Efficiency of the metal filament. (9) The mercury arc and its difficulties. (10) The light of the future and the possibility of obtaining "cold light."

No. 1.—The Energy Spectrum.

It is a commonplace that our means of producing artificial light are all very inefficient. What the efficiency is in each case and the circumstances on which it depends are not generally known. The information lies scattered in a number of different periodicals. In these studies the most important facts have been collected and arranged both for the sake of reference and for information as to the lines future progress is most likely to take.

Light waves carry energy with them. Every source of light is radiating energy, and this energy is being absorbed and converted into heat by the objects on which the rays strike.

If a ray of white light fall upon a prism a spectrum is produced. Part of the energy of the original ray is reflected at the surfaces of the prism, part is absorbed in the prism and the rest is spread over the different colours of the spectrum. Suppose that the spectrum is received on a screen and we fix our attention upon that portion of it bounded by the wave-lengths λ and $\lambda+d\lambda$. The rays, the wave-lengths of which lie between λ and $\lambda+d\lambda$, bring every second a certain amount of energy to the screen; let this amount of energy be denoted by $E_\lambda d\lambda$. E_λ is a function of λ. The total energy arriving per second on the screen is $\int E_\lambda d\lambda$, the integration being carried out over the whole spectrum.

This function E_λ is very important in the theory of the efficiency of light sources, and it is necessary to consider how the variation of E_λ with λ can be determined experimentally. The brightness of the different parts of the spectrum as estimated by the eye is of no use, for the sensitiveness of the eye to different colours is by no means the same. The light energy of the different colours must be turned into heat and the quantity of heat measured. Four different instruments may be used for this purpose—the thermopile, the bolometer, the radiometer and the radiomicrometer. These instruments and the methods of working with them are fully described in

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Kayser's "Spectroscopie," Vol. I., Chapters V. and VI., and in Baly's "Spectroscopy," Chapter VIII. There is also an extremely important article in the publications of the Bureau of Standards ("Instruments and Methods of Radiometry," W. W. Coblentz, Bull. Bureau of Standards, 4, p. 391, 1908) in which the relative advantages of the four methods are discussed both from the literature of the subject and as a result of tests made by the author. The radiometer has been used chiefly by E. L. Nichols and his pupils in America. It and the radiomicrometer possess the advantage that they do not require galvanometers and the disadvantage that they cannot be moved during the set of observations. Here I shall mention only a few points about the thermopile and radiomicrometer, of which instruments good types are on the market in this country. (Cambridge Scientific Instrument Co.; Keiser & Schmidt, Berlin-Charlottenburg.)

The Rubens linear thermopile is made of iron and constantan wire of diameter 0·1 mm. to 0·15 mm. It has a resistance of about 4 ohms. Constantan is an alloy consisting of 60 per cent. Cu and 40 per cent. Ni. There are 20 junctions arranged on a length of 2 cm. for receiving the light, and, of course, another 20 unexposed junctions. The junctions are soldered with beads of silver, which are flattened into discs of about 1 mm. diameter, so as to present a large surface to the rays. For mapping energy curves the thermopile is mounted in the telescope of a spectroscope, just behind the focal plane of the latter, and there are shutters in that plane for regulating the width of spectrum that is to be admitted to the thermopile. Wires lead from the thermopile to the galvanometer. When plotting an energy curve—*i.e.*, determining the function E_λ—the source of light is focussed on the slit and a screen placed before the latter. The screen is then removed and the galvanometer deflection noted. The operation is then repeated for other points in the spectrum. The galvanometer deflections do not give E_λ directly; the "slit width" correction must first of all be made. Owing to the fact that the dispersion of the prism is not normal, the range of wave-lengths falling on the thermopile at different points in the spectrum—*i.e.*, $d\lambda$—is not always the same. As the deflections are proportional to $E_\lambda d\lambda$, in order to obtain the variation of E_λ we must allow for the variation of $d\lambda$. To do this we draw the calibration curve of the spectroscope—that is, plot s, the telescope reading in angular measure in terms of λ. If we then determine $\frac{ds}{d\lambda}$ and multiply the deflections by $\frac{ds}{d\lambda}$, the result will be proportional to E_λ.

Another correction must be made before the energy curve is obtained. The absorption of light in the instrument must be corrected for. Glass absorbs all wave-lengths greater than 3μ; but if a glass prism and glass lenses be used, the deflections are influenced by the absorption of the glass from 2μ on. An energy curve cannot be plotted beyond 3μ with a glass prism and lenses, and if the region $2\mu-3\mu$ is to be determined, the absorption of the glass must be allowed for. Quartz transmits much further into the infra-red and ultra-violet than glass does; but for the infra-red region rock salt and fluorite are the most suitable materials for the prism and lenses. The absorption of the aqueous vapour and carbon dioxide in the atmosphere must be allowed for; at certain wave-lengths it influences the deflections appreciably. It is better to use mirrors in the spectroscope than lenses; all metals reflect infra-red rays well, and the focal length of a mirror being independent of the wave-length, there is no trouble in focussing the thermo-pile.

In the radiomicrometer we have both thermopile and galvanometer combined. It consists of a single loop of wire with a thermo-junction at one end suspended between the poles of a magnet by a quartz fibre. In comparison with the thermopile it has a very steady zero, but its sensitiveness is distinctly less than that of the latter when connected with a low resistance Du Bois Rubens galvanometer, which has a resistance of 10 ohms and a sensitiveness of 3×10^{-10} amperes/$\frac{1}{2}$ mm. at 1 metre distance for a period of 5 seconds. As the radiomicrometer cannot be moved, the spectroscope telescope used with it must remain fixed.

Of course, it is only the strongest sources of light, of which the energy curves can be determined directly with a thermopile or similar instrument. The light radiation from the brightest sodium flame produced by a bunsen burner would not produce a readable deflection. If the energy curve of a weak source is required, the latter must be compared with a strong source by a spectrophotometer in the visible spectrum, and by a photographic method in the ultra-violet, and the energy curve may thus be determined indirectly. There is no means of determining it in the infra-red.

The most satisfactory way of determining the wave-length in the infra-red is to calculate it from the index of refraction of the quartz or fluorite prism, or to place a very thin film of water before the slit and use its absorption bands as reference points. The positions of the latter have been accurately determined. The methods described in the text books—auxiliary gratings and interference bands—are expensive, or much more troublesome.

Suppose, now, that a number proportional to E_λ is plotted as a function of λ from end to end of the spectrum. If we wish to find what proportion of the total energy radiated is light, what we have to do is to erect ordinates at $0{\cdot}410\mu$ and $0{\cdot}760\mu$, the commonly accepted ends of the visible spectrum, and find the ratio of the area included between these ordinates to the area of the whole curve. E. L. Nichols has named this ratio the radiant efficiency of the source. At the same time he has introduced another quantity, the luminous efficiency of the light source. This is defined to be the ratio of the total energy radiated per second as light to the total energy consumed per second by the source.

Let Q = total electrical energy consumed per second, R the total energy radiated per second and L the total luminous energy radiated per second; then

$$L/Q = \text{luminous efficiency}$$

and

$$L/R = \text{radiant efficiency}$$

of the lamp.

In the case of an electric glow lamp the total energy consumed per second can be easily found from the current and the difference of potential between the terminals of the lamp. In the case of a gas flame we require to know the total quantity of gas consumed per second and the amount of chemical energy liberated by the combustion of unit mass of gas. The luminous efficiency is always less than the radiant efficiency. If the energy not radiated were zero—that is, if there were no conduction and convection losses—they would have the same value. Both quantities are extremely useful in the discussion of the performance of a light source.

A glass cell 1 cm. thick filled with water stops all wave-lengths greater than $1{\cdot}4\mu$ entirely, and absorbs the infra-red between $1{\cdot}4\mu$ and the visible spectrum considerably, but does not absorb the visible spectrum appreciably. The energy in the ultra-violet of the common light sources is very small indeed, and may be neglected in comparison with the light energy. Hence, in order to separate the light from the dark heat, it used to be the practice to pass the rays through a water filter or through a solution of alum. But a water filter transmits much dark heat as well as light, and if we attempt to determine the radiant efficiency by taking the deflections of a thermopile with and without a water filter before it the value we obtain is much too high. Some experimenters have attempted to correct for the dark heat transmitted by the water by means of solutions of iodine in carbon disulphide, which were supposed to absorb all the light and nothing but the light. The utter untrustworthiness of this correction has, however, been demonstrated by E. L. Nichols and W. W. Coblentz. ("On Methods of Measuring Radiant Efficiencies," Phys. Rev., XVII., 1903, p. 267.) Even if we use the correction the values of the radiant efficiency are still too high. Aqueous solutions of ferrous ammonium sulphate have recently been suggested as a means of separating the light from the dark heat. But it has been shown (R. A. Houstoun and J. Logie, Phys. Zs., 11, p. 672) that though they are considerably better in this respect than water filters, yet they are not good enough to afford us a satisfactory method of determining the radiant

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efficiency. It should be noted that, in spite of the widespread opinion to the contrary, alum solutions do not absorb dark heat any better than water does.

Almost all the accurate determinations of radiant efficiency yet made have been carried out by a method introduced by K. Angström, which will be described later. I have recently determined ("The Efficiency of Metallic Filament Lamps," Proc. Roy. Soc., Edin., Vol. XXX., p. 555, 1910) the radiant efficiency of some metallic filament lamps by a method which, to me at least, seems preferable. The radiation was first measured in the usual way by a thermopile and galvanometer with and without a 1 cm. thick water filter, and the fraction of the total radiation transmitted through the filter determined (F). The light was then focussed on the slit of a spectroscope through the same water filter and an energy curve taken. The deflections were plotted against the scale readings and an ordinate set up at $0{\cdot}76\mu$. The area on the side of shorter wave-lengths divided by the whole area then gave the ratio (f) of light transmitted by the filter to the total radiation transmitted. It was then only necessary to find what fraction of the incident light was transmitted by the water cell. This was done with a spectrophotometer for four different points in the spectrum and the value found, 0·84, was the same for each point. The radiant efficiency was then $F/0{\cdot}84$.

The determination of luminous efficiency is much more difficult. It was the luminous efficiency that was aimed at by the old calorimetric method of measuring the efficiency of a glow lamp. The lamp was placed in a glass calorimeter and then in a similar copper one, and from the rise of temperature in the two cases, with various corrections, the ratio of the energy radiated as light to the whole energy supplied could be calculated. The heat lost by convection and conduction went to raise the temperature in both cases. But the method is in principle bad; the whole energy and the dark heat are measured and the light is obtained as the difference of two much larger quantities, both subject to considerable error of observation. Also, as has been already mentioned, water does not absorb all the dark heat, and hence some escapes from the glass calorimeter. If we wish to determine the luminous efficiency we must first of all determine the radiant efficiency; we must then find the total rate at which energy is being consumed by the source, and we must finally determine the total energy radiated per second. The neatest way of finding the energy radiated per second in any one direction is by some such instrument as Angström's pyrheliometer. To find the total energy radiated per second it is necessary to find the energy radiated in different directions and to integrate over the sphere.

So far we have considered light solely from the objective standpoint. It is now necessary to consider it in relation to the eye. The same quantity of energy in different parts of the spectrum does not produce the same intensity of sensation in the eye. The well-known curve shown in Fig. 1, taken by Sir Wm. Abney, illustrates this. The brightness of the different colours of the spectrum of the crater of the arc was compared in turn with the brightness of a white light, which could be varied by a rotating sector. The ordinates of the curve are obtained in this way, and are proportional to the brightness or luminosity of the part of the spectrum in question as seen by a normal eye. If we took an energy curve of the arc crater with the same prism and lenses, plotted it on the same diagram and divided the ordinates of the energy curve by the ordinates of the luminosity curve, the quotient would be proportional to the quantity of energy necessary to produce the same luminosity at different points in the spectrum. It varies widely throughout the spectrum, having a minimum at 510 $\mu\mu$ for low intensities, and increasing rapidly on both sides of this minimum. At 410 $\mu\mu$ it has then a value roughly 50 times the minimum value, and at 610 $\mu\mu$ one roughly 40 times the minimum value. According to P. G. Nutting ("The Luminous Equivalent of Radiation," Bull. Bureau of Standards, 5, p. 273, 1908), who refers to the reciprocal of this quotient as the visibility of the colour, the quotient for low intensities has the form $e^{\kappa(\lambda-\lambda_m)^2}$ for the normal eye, λ_m being the wave-length of the minimum measured in 10^{-5} cm., and κ being equal to 4·5.

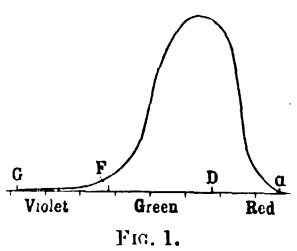

Fig. 1.

For higher intensities the maximum of visibility moves towards the yellow, and the visibility in the neighbourhood of the maximum does not vary so much with colour. At low intensities vision seems to be performed by the retinal rods alone, and at higher intensities mainly by the cones. The transition from rod to cone vision is very gradual; they are about equally in play at ordinary working intensities. It is the transition from rod to cone vision that displaces the maximum of visibility with increase of intensity.

As the brightness of the light produced depends not only on the energy of the radiation, but also on its colour, luminous efficiency, as we have defined it, has no direct connection with efficiency as ordinarily understood in connection with artificial illuminants. One source which radiates more energy between 410 $\mu\mu$ and 760 $\mu\mu$ than another may have that radiation distributed so disadvantageously over the spectrum that it gives less light than the other. C. E. Guillaume has, therefore, proposed to specify the efficiency by multiplying E_λ for every wave-length by the "visibility" for that wave-length, taking the maximum visibility in the spectrum as unity, and by dividing the quantity thus formed by the total power supplied. It may be urged against this proposal that the visibility of different colours is not very well known yet, and that in watts per candle or in candles per watt we have already a term that conveys Guillaume's meaning. Also the relative visibility of the different colours varies with their intensity. And the ordinary method of testing lamps on the photometric bench is certainly a much shorter and more accurate method for getting their watts per candle than the one suggested in Guillaume's definition. It seems to me, therefore, better to retain the old way of specifying luminous efficiency. It has, in addition, the merit of simplicity.

Various observers at different times have attempted to determine what has been called the mechanical equivalent of light—namely, how much energy is it necessary for a source to radiate per second in order to produce 1 c.p. of light. From the foregoing it is obvious that the mechanical equivalent of light must vary with the nature of the source. As a result of a recent determination, C. V. Drysdale "On Luminous Efficiency and the Mechanical Equivalent of Light," Proc. Roy. Soc., A, 80, 1907-08, p. 19), using glow lamps, obtained 16·7 candles per watt for yellow-green light.

The visibility is greatest for green light. This, consequently, is the cheapest kind of light; but, being monochromatic, it is of no use for the purpose of discriminating colour. The ideal illuminant must make all colours appear the same at night as by day. It might be possible to make a creditable white light by combining two monochromatic sources, but for making all colours appear the same by night as by day the illuminant must have all the colours of the spectrum in the same proportion as average sunlight. Consequently, we arrive at the specification of the energy curve of the perfect artificial illuminant after which technology is striving. *Throughout the visible spectrum it will have an energy curve like that of average sunlight; the energy curve will cease at the limits of the visible spectrum.*

(To be continued.)

Simmer Pan Power Station.—The June "Transactions" of the South African Institute of Electrical Engineers, which have only recently come to hand, contain a brief description of this power station, the members of the Institute having paid an official visit to the station on July 15th last. The party was received by the chief engineer, Mr. Bernard Price, who is vice-president of the Institute.

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THE BRITISH ASSOCIATION AT PORTSMOUTH.

(FROM OUR SPECIAL CORRESPONDENT.)

Wednesday, August 30th.

The eighty-first meeting of the British Association commenced this evening at Portsmouth, when Sir William Ramsay, K.C.B., F.R.S., delivered his Presidential Address in the Town Hall. In requesting Sir William to take the chair, Prof. Bonney, the outgoing President, referred to his great work in radio-activity, and said that he might be said to have brought down helium from the sun to earth by showing that it was all the while lurking in various terrestrial substances.

Since the new President's address has already been published in THE ELECTRICIAN, there is no necessity to refer further to it here except to say that it was warmly received by an appreciative audience. The Mayor of Portsmouth moved a vote of thanks to Sir William Ramsay, and at the same time extended a hearty welcome to the British Association on the occasion of its first visit to Portsmouth. Prof. Dixon seconded the motion, which was carried with acclamation.

Thursday, August 31st.

Work commenced in real earnest this morning when the respective Presidents of Sections opened the proceedings by reading their addresses. Reference has been made already to Prof. H. H. Turner's address to Section A, and there is nothing of electrical interest in Prof. J. H. Biles's address to Section G.

After a vote of thanks to Prof. Biles had been proposed by Sir William Ramsay, seconded by Mr. Alexander Siemens, and carried unanimously, Mr. Worby Beaumont read his Paper on "The Origin and Production of Corrugation of Tramway Rails." The author contended, as will be seen by the Paper which we publish on another page, that the primary cause of corrugation is really a triple one: (*a*) The great weight of the cars, (*b*) the small diameter of the wheels employed, (*c*) the high speeds at which cars are run. These three factors together, he maintained, are such as to render it impossible to procure any material which will not be deformed under the stresses put upon it. As a result of experiments, conducted at the request of Mr. Fell, on certain London County Council equipment, he came to the conclusion that the pressure between wheel and rail, in the case of driving wheels, rose as high as 100 tons per square inch when the car was rounding curves, and in the case of pony wheels it was even 120 tons. Hence, it is evident that the pressure per unit area exceeds the limit of elastic compression of the material of the ordinary rail, and that flow or deformation would occur if it were not that the area pressed is supported by the surrounding material and held *encastree*, so that flow cannot occur. The result is detrusion of both edges of the rail, but, of course, the inner is ground down by the flange of the rail. Another result is that the material of the rail moves forward with the advancing wheel until it becomes so compressed and hardened that the wheel mounts it, making it harder still, and then begins to make another depression on the other side. A third result is the minute crumbling and pitting of the rolled surface. Mr. Beaumont put forward four suggestions for dealing with the difficulty. The first was to reduce the weight of the car; this would have the effect of reducing the pressure between the tyre and the rail. He did not observe, nor did any speaker in the discussion which ensued, that decreasing the weight of the car would have the effect of decreasing the area of contact, and, therefore, to some extent, defeating its own object, since pressure is equal to force divided by area. His second suggestion was that larger wheels should be used; this, of course, would increase the contact area and therefore reduce the pressure. Speed reduction was his third point, and the use of harder material for the rails his fourth. With regard to this latter, however, he admitted that harder rails would necessitate the employment of methods more costly than those now in use.

Mr. Alexander Siemens opened the discussion, and said he could scarcely imagine that Mr. Beaumont believed his conclusions to be possible—viz., that the speed of cars should be reduced and the wheels made larger. He thought Mr. Beaumont was quite wrong to suggest harder rails; his own opinion was that they should be softer or, at all events, more elastic. This would secure a much larger area of contact by permitting the wheel to sink in as it were. Directly the wheel moved on the nature of the rail material would cause the depression to disappear. He suggested that rails should be made of hard material with a tread of soft or elastic material on the top. Sir William White said that corrugation was experienced on gun-beds due to the motion on recoil; this, however, had been overcome after lengthy experiments had been carried out, but he did not divulge the nature of the experiments. He did not agree with Mr. Siemens that the rails should be made of softer material. After one or two other speakers had interpolated remarks, Mr. Beaumont replied to the discussion. He asserted, with due respect to the President of the Institution of Civil Engineers, that Mr. Siemens had devoted very little study to the use of tramway materials if he could advocate the employment of soft rails, and in reply to a protest from Mr. Siemens he (Mr. Beaumont) said he thought Mr. Siemens meant ductility when he said elasticity. The question of speed reduction was a very difficult one, and would remain so owing to the fact that a tramcar was bound to keep to the rails. The consequence was that a high speed had to be attained whenever a clear course was available in order that the average speed could be kept up to the desired magnitude. He thought it would be quite possible to employ larger wheels, but at the same time he recognised that this would lead to a considerable modification in the design of cars. Corrugation was becoming a very serious matter, for it raised the cost of repairs and renewals to such a figure as to make some tramway systems financially impossible without aid from the rates. Moreover, the noise and vibration were becoming almost unbearable. He did not think it possible to do anything with the wheels or tyres so as to make the latter elastic, and thereby increase the area of contact with the rails.

The next Paper on the list was on the "Anschutz Gyro Compass," by Mr. G. K. B. Elphinstone. This device, as its name implies, is a gyroscope, carried on a float which rests in an annular vessel of mercury, the centre of mass of the whole arrangement being brought about 4 in. below the surface of support. Its action is entirely independent of the earth's magnetic field or of the presence of magnets or iron in the neighbourhood. The rotating element is electrically driven, and the air current set in motion by it is employed for damping purposes. The combined action of gravity and the earth's rotation is such as to cause the gyroscope always to point to the geographical north. Mr. Elphinstone showed a model compass, while in an adjoining room several instruments were exhibited. There was no discussion on the Paper, as time had slipped away, and it was one o'clock when the author finished.

In the afternoon a visit was paid to the Dockyard, and the visitors were shown over H.M.S. "St. Vincent." This visit was the occasion of a good deal of grumbling among members of the Association at the lack of organisation apparent. Association officials seemed to be conspicuous by their absence, and this may have accounted for the fact that very little of interest was seen. Our attention was directed to the wireless aerial, but we were informed that no one could be allowed to look inside the operator's cabin. Only by persistent efforts did a chosen few manage to get down to the engine room. This is divided into two distinct portions and it is necessary to go up to the main deck in order to get from one to the other. The ship is driven entirely by turbines of the Parsons type, the condensers being of the surface type. When running at full speed, the coal consumption works out at about 1·5 lb. per horse-power-hour, but when running at half speed the coal consumption goes up to about 3·5 lb. It appears that, by an Admiralty order, the turbines may not be opened up within five years from

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their installation. The gun-laying is carried out by hydraulic power and ammunition hoists, &c., are similarly worked; electric motors are, however, employed for ventilating.

In the evening a reception was given by the Mayor and Mayoress on the South Parade Pier.

Friday, September 1st.

After a discussion on the principle of relativity, Section A divided into two portions, one of which proceeded to listen to Papers on Mathematics and the other on General Physics. The first Paper in the latter category was "On the Radiation producing Aurora Borealis" by Mr. L. Vegard. Starting from the view advocated by Birkeland that auroræ are caused by electric solar radiations, the author treated the problem of determining their physical properties. From the form and structure of the luminosity a method is found of examining the way in which the solar rays are absorbed by matter, and he arrived at the conclusion that the law of absorption of the solar rays is essentially the same as that of α-rays. This coincidence with regard to law of absorption led the author to draw further consequences of the hypothesis that certain auroral forms are caused by α-rays. The author finds that the α-ray hypothesis, as far as our present knowledge goes, explains in a satisfactory way the properties of the definite auroral forms, while the assumption of a radiation of the β-ray type meets with serious difficulties.

The next Paper was entitled "A Friction Permeameter," by Mr. W. H. F. Murdoch. This we hope to publish in next week's issue of THE ELECTRICIAN.

Section G opened with a Paper on "Electrical Drives for Screw Propellers," by Mr. H. A. Mavor; the Paper is dealt with elsewhere in this issue. The author advocated the employment of three-phase working, and gave details of several installations in actual operation. It seems that high-speed propellers give very poor results on low-speed vessels, and hence a difficulty arises if it is desired to employ economical high-speed engines. In the case of turbines the problem resolves itself into a choice between mechanical gearing and what may be regarded as electrical gearing. Mr. Mavor described systems in which engines were employed for driving three-phase generators, the motors being connected directly to the propeller shafts. By this means very large speed reductions could be obtained with a trifling loss of power. Opening the discussion, Prof. W. E. Dalby asked for efficiency figures at full and half loads. He also inquired whether there were not serious flywheel effects obtained by connecting a motor of some 12 ft. in diameter to the propeller. Prof. Petavel suggested that the high efficiency obtained might compensate for the losses in transmission. At the same time he could not help thinking that additional liability to breakdown was introduced by the presence of the dynamo, motor, &c., as well as the engine, which had to be there in any case. Dr. J. Morrow said he thought that the electric drive might be very suitable for low-speed ships, but he was not convinced that it could be applied with advantage to high-speed vessels. He also suggested that the U.S. Navy authorities were discarding turbines in favour of reciprocating engines, but Sir William White at once explained that only in in the case of one slow-speed vessel, now building, were they putting in a reciprocating engine, and, therefore, Dr. Morrow's statement was hardly accurate. The chairman, Prof. Biles, asked whether short-circuiting would take place if the motor were flooded, and if so what would happen. In his reply, Mr. Mavor said that the full load efficiency was about 96 per cent., but that, as a rule, he preferred to work with large air-gaps and amply proportioned machines, the result being that the efficiency worked out at about 90 per cent. Although he had had considerable experience with large motors directly connected to propellers he had detected no trouble due to flywheel action, as suggested by Prof. Dalby. He quite agreed that it was useless to talk of electric driving if the propeller could be driven by the engine, but the fact remained that a low-speed ship could not be driven by a high-speed propeller. If electric driving were adopted there was nothing to prevent the use of an engine running at 3,000 revs. per min. in a low-speed ship. In a particular instance he had obtained an estimate from makers of mechanical gear, and it turned out to have practically the same weight, price and efficiency as the electrical gear. There was no additional danger of breakdown because there was practically no additional complication. Nothing could be simpler than a squirrel-cage rotor, and he called attention to the fact that the energy was generated in the stationary portion of the machine, it was transmitted by cables that did not move, and it was utilised in the stator of the motor. It was sometimes more economical to employ two or three small generating sets, rather than one large one, as they were frequently more efficient. Moreover, each machine could be connected to its own coils of the motor, and was, therefore, completely independent of the others. Complicated switch-gear was avoided, and since the motor coils were mutually non-inductive there was no fear of current being generated back into a machine which happened to be at rest. With regard to the chairman's suggestion of short-circuits, he pointed out that even if a short-circuit did occur it could have no serious consequences. The power of the engine was limited, and the only effect would be the production of a current two or three times greater than the normal, with a corresponding drop in voltage. This would produce nothing like the disastrous results associated with short-circuits on street mains designed for comparatively small currents, when there was practically unlimited power at the generating station. So far as he could gather, flooding of the motor did not make the least difference. Some time ago he made an experiment on an old continuous-current motor, which, of course, possessed the additional disadvantage of a commutator; this machine he put under water, and it ran quite sweetly all day. In reply to Sir William White, Mr. Mavor said that the voltage he employed was 2,000, but the pressure was quite immaterial.

The next Paper on the list was on "Electrical Steering," by Mr. B. P. Haigh. The problem is a difficult one because two very different conditions have to be fulfilled. On the one hand, it is necessary to have a system capable of dealing with the power necessary to put the helm hard over in emergency in the shortest possible time, and, on the other, it must possess sufficient sensitiveness to enable an accurate course to be kept by moving the rudder promptly through small angles. So far as sensitiveness is concerned, it appears that electrical gears are an improvement on steam gears, partly owing to the rapid wearing of valves and the loss of economy when large sensitive valves are employed. In the author's system the motor is kept running and is provided with two magnetic clutches, one at each end of the shaft. Three slip-rings are provided on the motor shaft, one being common to both clutches and the others distinct. Current is carried from the slip-rings to the clutches by means of leads passing through a hole in the shaft. These leads are quite small, the magnetising current being only about ½ ampere. The actual friction surfaces in the clutches consist of steel and red fibre.

The discussion was opened by Mr. Worby Beaumont, who thought that there would be considerable inequality of performance of the fibre employed in the clutch; he also thought it undesirable to carry leads in the motor shaft. Sir William White expressed himself strongly in favour of electrical steering. He had recently designed a yacht in which everything was done by electricity. He rather thought that great sensitiveness of steering gear was sometimes a positive disadvantage, for it tempted a steersman to manipulate it much too frequently; indeed, it might even be a source of danger in the hands of a nervous person. For this reason, he strongly advised the installation of a helm indicator in every case so that a steersman could see the immediate result of his movements. He would abolish all hunting gear, and give all orders from amidships. So far as sensitiveness and ease of control were concerned, the superiority of electric gear was undoubted. Prof. Dalby, who spoke next, said that the principal feature of Mr. Haigh's device was the clutch. He would like to know what was the coefficient of friction between the steel and fibre, and what was the pressure per square inch

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In the course of his reply, Mr. Haigh said fibre was the best substance he had tried. The difficulty with wood was that it soon charred, and then made an intolerable squeaking noise. Fibre, of course, was very hygroscopic, and on this account would prove unreliable when the clearance was small, the clearance on his clutch being $\frac{1}{16}$ in. He had, however, got over the difficulty by boiling the fibre in oil, which effectually prevented any absorption of moisture. There was no appreciable slipping even when oil was present. He had purposely poured oil into the clutch and then closed it; for about a dozen revolutions it slipped, then the oil was squeezed out between the fibre segments, and it held quite well. He had not noticed any falling off of friction with temperature, nor was there any variation when the rudder was hard over. The power demanded by the motor was not sufficient to affect the lighting circuit. He did not think there was any danger incurred by putting the leads in the shaft of the motor. Very sensitive gear was never put on low-speed ships. In reply to Prof. Dalby, the author stated that the coefficient of friction of steel on fibre was about one-sixth, and the pressure he employed did not exceed 100 lb. per square inch.

Mr. T. F. Wall next read a Paper on "The Single-phase Repulsion Motor," but as it was of a type seldom heard at a British Association meeting, there was no discussion. It will be given in full in future issues of THE ELECTRICIAN.

Next came a Paper entitled "Some Preliminary Notes on a Study as to Human Susceptibility to Vibration," by Mr. W. Pollard Digby and Capt. A. Riall Sankey. The Paper described the results undertaken with a view to ascertaining what amount of vibration can be said to constitute a nuisance. The audience treated the matter as something in the nature of a joke, and some additional "standards of degree of vibration" were suggested informally. Apparently, certain members seemed to think that "excessive" was not a sufficiently violent adjective to describe some forms of nuisance, and although they did not put them forward at the meeting there is no doubt that many would be prepared to offer suggestions to the authors with a view to adding to the different degrees. Prof. Dalby said he thought no subject should be treated who had not just completed three months' holiday. Sir William White thought there must be some scientific standard of vibration; the human element varied so greatly as to make it quite hopeless otherwise. Prof. Petavel called attention to the effect of sound, which made observers think a vibration very much more serious than it really was.

The chairman then announced that Prof. E. Wilson had asked for his Paper on "Some New Aluminium Alloys" to be taken as read, and this concluded the business of the day. (This paper will be given in next week's issue of THE ELECTRICIAN.)

Monday, September 4th.

Sections A and G had a joint meeting this morning for the purpose of discussing "Aeronautics," and then split up again. The first Paper on the programme for Section G was by Prof. J. W. O. Howe, on "Recent Developments in Radio-telegraphy," and it attracted a large audience. The author gave an excellent, though brief, account of the modern practice of wireless telegraphy, and succeeded in making some difficult points quite clear by means of diagrams. Moreover, he had erected up an aerial from the Town Hall to the roof of the Municipal Technical College, in which the meeting was held, and was able to receive—among other things—the Paris and Norddeich time signals. By means of a telephone relay of the pattern designed by Mr. S. G. Brown and conical trumpets these signals were made audible to almost everyone in the room. Prof. Howe's Paper is published in full in the present issue of THE ELECTRICIAN, and we will, therefore, refer to it no further here.

Next on the list came a Paper by Capt. H. Riall Sankey, entitled "Portable Equipment for Wireless Telegraphy." However, instead of reading a Paper Capt. Sankey contented himself with showing a number of quite interesting slides relating to portable sets for use by troops in the field. The first set was intended for cavalry, the various parts being carried on the backs of horses. For example, one horse carried the petrol engine and alternator, another the sending and receiving apparatus, while a third carried the mast and aerial. The capacity of the alternator was 0·4 kw., and the range was 20 miles over mountainous country and 100 over water. Each animal's equipment was securely fastened to a saddle of special design, and in no case did the total weight exceed 180 lb. When fully extended the mast had a length of 60 ft., but as a directive aerial was employed it was necessary to carry two masts, the effective length of aerial being 350 ft. between masts. In order to preserve the insulation of the high-tension transmitting apparatus the latter was completely enclosed in a metal case. On taking this case from the horse's back, a double lid is opened, one serving as a writing desk and the other as a protection against rain, &c. Capt. Sankey mentioned that the time occupied in getting a station set up and working was only nine minutes, while the time occupied in taking it down and packing it up again was six minutes.

At the conclusion of Capt. Sankey's remarks there was only about a quarter of an hour available for discussion of both Papers, owing to a fixture having been arranged for 2 p.m., but even this proved more than sufficient. In reply to questions from Prof. Dalby, Prof. Howe stated that the Marconi trans-Atlantic work was carried on with a wave-length of 6,000 metres. He had ascertained this from his own observations. The minimum that he knew of was 300 metres, and he believed that the Admiralty kept all wave-lengths between 600 and 1,600 metres for themselves. The sharp tuning of the receiving station depended on the tuning of the transmitting station, for if the coupling were too tight, harmonics came in; it was impossible to tune to an explosion. This concluded the work of the Section for the day.

In the afternoon a most interesting display was provided by the Admiralty, by arrangement of the Commander-in-Chief, Admiral Sir A. W. Moore, G.C.B. Members of the Association were taken on board H.M.S. "Revenge" at the Dockyard and sailed out to sea some miles from the coast. An attack was then made on the vessel by about a dozen torpedo boats. These boats advanced on the "Revenge" at full speed, discharging torpedoes at her as they passed alongside. Next, four submarines advanced in line ahead, the first passing with conning tower out of water and driven by her petrol engines. The second advanced and dived just as she came alongside, this vessel and the remainder being driven by electric motors. The third dived gradually as she passed, and reappeared after passing. Finally, the fourth boat, which could be seen rather more than a mile away, dived and advanced on the "Revenge" with only her periscope showing. When she got within striking distance she fired a torpedo which gave the onlookers a decided thrill, as it struck the vessel with a plainly perceptible "bump." Still advancing, she fired a second, and then dived so that even her periscope disappeared. In a few seconds she reappeared, and her commander, who presently emerged from the conning tower, was greeted with a storm of applause. The "Revenge" then returned to the Dockyard, and members were unanimous in describing the display as quite the feature of the Portsmouth Meeting.

Tuesday, September 5th.

Some very interesting work was done in Section G this morning, when the respective merits of steam, suction gas and Diesel engines were discussed. Mr. W. T. Marshall commenced with a Paper on "Economical and Reliable Power Generation by Over-type Superheated Steam Engines." He remarked that owing to the introduction of internal combustion engines, steam-engine builders had been stimulated to produce steam plants having a fuel cost quite on a par with that of internal combustion plants, and possessing additional advantages in the nature of superior reliability, flexibility and over-load capacity. The so-called "over-type superheated steam engine" is a distinct reversion to the old portable type, and consists of a compound engine fixed on top of a tubular boiler, with a superheater in the smoke box. Air pump, feed

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pump and other auxiliaries are attached to the side of the plant, and it is claimed that by this arrangement steam pipe losses are reduced to a minimum, while the full value of superheated steam can be employed. The author described in detail a plant of this type now being manufactured by Messrs. R. Garrett & Sons, of Leiston, Suffolk. The boiler is of the Cornish multi-tubular type, with a single circular furnace, and heating surface consisting of smoke tubes, through which the products of combustion pass. A special feature is that by means of a bolted joint between the ends of the furnace ring and the front end plate, and another between the back tube plate and the back end plate, the whole of the furnace and tube system can be readily withdrawn for cleaning and inspection. Saturated steam passes to the superheater, which consists of a number of zig-zag coils of solid drawn steel tubes expanded into cast-iron headers, and so arranged that the flow of steam is in the opposite direction to the flow of hot gases, thus ensuring maximum efficiency. The superheater itself can be easily withdrawn for cleaning. From the superheater steam passes to the engine, which is a side-by-side compound engine, fitted with piston valves to the high and low-pressure cylinders. The cylinder casing forms a steam jacket for both cylinders, the actual working barrel or liner of the cylinders being made of special cylinder metal pressed into this casing hydraulically. The engine is governed by varying the cut-off in the high-pressure cylinder, a crank-shaft governor operating upon the high-pressure piston valve. From a test on a 50 B.H.P. Garrett engine, it appears that the coal consumption was as low as 1·21 lb. of coal per brake-horse-power-hour. The author claimed that the cost of fuel per brake-horse-power-hour with the superheated steam engine is very nearly constant over a wide range of loads, and does not increase on light loads to anything like the same extent as with the suction gas engine.

Mr. Marshall was immediately followed by Mr. W. A. Tookey with a Paper on "Suction Gas Engines and Producers." Mr. Tookey explained that his Paper consisted of a series of figures representing the actual performance of suction gas power plants of various types and different powers, not only when tested by some form of brake dynamometer, but also when the output over the period of test could be measured by the generation of electric current or by the raising of water, thus taking into account the combined efficiencies of the electric or pumping machinery and that of the gas power plant. With regard to the oft-quoted pound of fuel per brake-horse-power-hour, the author's figures showed that it was often as low as 0·7 lb. to 0·85 lb. per brake-horse-power-hour.

The third Paper was by Mr. Chas. Day, on "Diesel Engines." The author opened with arguments against the selection of an engine being made on makers' guarantees of fuel consumption, as such guarantees could not possibly cover all working conditions. Thus, an engine which gave best results on tests might give inferior results over a long period in normal working, when items such as wages, repairs and maintenance were included. It was urged that judgment should be based on records of actual working results which included all items of expenditure, and it was pointed out that, owing to the power costs of electricity supply stations being kept on a uniform basis, these formed the best available data on which to judge the working results obtained with different types of plant. He agreed that the conditions of working in some factories differed considerably from those of an electricity supply station, but claimed that loss of efficiency was largely brought about by causes common to all places, and that consequently deductions from electricity station figures were applicable to the great majority of power cases. Stations having a plant capacity exceeding 1,000 kw. were excluded from the main comparisons. The following table gives Mr. Day's results :—

Average Cost in pence per B.T.U. Sold.

Type of engine.	Fuel.	Lubricating oil, waste, stores and water.	Wages.	Repairs & maintenance	Total works cost.	Load factor.
Steam	0·45	0·06	0·25	0·26	1·02	14·7
Gas	0·43	0·09	0·28	0·24	1·04	15·3
Diesel	0·23	0·04	0·19	0·07	0·53	14·3

With regard to efficiency at different loads, the author quoted the following figures: Full load, 0·44 lb. of fuel per brake-horse-power hour; three-quarter load, 0·45 lb.; half load, 0·47 lb.; ¼ quarter load, 0·62 lb. He was convinced that makers' tests and working tests were of no practical use for purposes of comparison; the only way was to take the average results over a number of years. With regard to reliability he quoted a case where, during four years, the average running time of a Diesel engine worked out at 23·75 hours out of every 24. The discussion on all three Papers was then commenced.

Capt. H. Riall Sankey said he would like to know on what basis the various engines were rated. This was an important matter because people bought engines on the basis of so much money per horse-power. Was it what the engine *could* do for, say, a quarter of an hour, or was it, as in the case of steam engines, the most economical load with an overload allowance of 20 per cent. or 30 per cent? Mr. Day's figures of fuel consumption for the Diesel engine at different loads, given above, corresponded to those of a steam engine, but the fuel consumption of a suction gas engine got much worse as the load decreased. He then drew a diagram on the board, based on Willan's law, to illustrate this, and pointed out that a gas engine of 125 H.P. would be required to perform the same work as a steam engine of 100 H.P., both ratings being based on fuel consumption under steady continuous load.

Prof. W. E. Dalby remarked that the reciprocating steam engine had been free from competition for 100 years, and now it had to face, not only the steam turbine, but the suction gas engine, the Diesel engine, &c. In his opinion, the only way of salvation for the small reciprocating steam engine was by the adoption of superheated steam. He wanted to know, however, whether, in the Garrett engine, superheated steam went right through both high-pressure and low-pressure cylinders or only through the former? Also, was it possible to cut-out the superheater? There was no doubt that very substantial economy had been effected by the use of superheated steam on locomotives. The secret of the advantage was that superheated steam was a bad conductor of heat, whereas saturated steam was a good one; it was a purely physical explanation.

Mr. E. Kilburn Scott was opposed to the suction gas engine as against either the steam or the Diesel engine. He did not like the gas. At all events, nothing could be raised from water but steam; the nature of producer gas, on the other hand, was an uncertain factor. Moreover, an escape of steam was plainly visible and did no great harm, whereas an escape of carbon monoxide could not be seen and was a very dangerous thing. He cited a case within his own personal experience where a suction gas plant was thrown out because a man had been "gassed"; the risk of having to pay a large sum by way of compensation for the death of a workman was too serious. He was strongly in favour of the Diesel engine. In steam plants there was always the trouble of the steam raising plant, with all its complication of pipes and valves. Practically there was no limit to the size of an engine and dynamo, but there was a very distinct limit to the size of a boiler, and the result was that the steam raising plant had to be split up into a large number of small units occupying a disproportionate amount of space. Then there was the water difficulty; generating stations had frequently to be built on extremely expensive sites merely because it was impossible to obtain water elsewhere. He did not like the idea of the superheater—it was too complicated. None of these disadvantages attended the Diesel engine, and he was sure there was a great future for its application to the generation of energy for electro-metallurgical processes.

Mr. H. E. Wimperis alluded to the fact that superheated steam was really a gas and could be condensed when it was desired to get rid of it. Herein lay its great advantage over suction gas, which could not be condensed. Moreover, it could be produced from a cheap common liquid. The future competition would be between what might be called internal combustion engines and external combustion engines, and he looked with confidence for the introduction of an internal combustion turbine which would be driven by superheated steam. He could not understand why some Diesel engines were made

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substantially; they gave one the impression of being armour-plated. With regard to the intricacy of the Diesel engine, he often refrained from recommending its adoption abroad where only unskilled native labour was available. Did Mr. Day see any prospect of its being as easy to look after by unskilled labour as the suction gas plant?

Capt. Sankey here remarked that he had before him, at that moment, a proposition for using superheated steam as a gas.

Mr. H. S. Russell called attention to the fact that the low costs of the Diesel engine depended on the load factor; its fuel costs were lower because there were no stand-by losses, and it had a high thermal efficiency. He thought Mr. Tookey's stand-by losses much too low, and instanced a case of a 500 H.P. suction gas plant being taken out owing to a breakdown, and replaced by a Diesel engine. It was subsequently found that the comparative costs in the two cases were 0·7d. per unit for the suction gas plant and 0·3d. per unit for the Diesel engine. Actual experience showed that while the working costs of a Diesel engine were about 14 per cent. in excess of the maker's guarantee, the working costs with a superheated steam plant were about 140 per cent. in excess. He had known of a case where a Diesel engine installed as an auxiliary on a battleship had run for 800 hours without stopping. There must be a saving in wages, because separate men were required in the producer house or boiler room, while this was not so with the Diesel engine. The latter also required about 0·2 gallons of water per brake-horse-power hour, against 2 gallons for suction gas.

Prof. Marchant called attention to the capital charges involved, and said he did not think sufficient regard was paid to these in the course of the discussion.

In his reply, Mr. Marshall explained that the rating of the engines depended on the boilers. He affirmed that a 140 H.P. engine would have practically the same efficiency between that load and 180 H.P., while its overload capacity would reach 200 H.P. for as long as six hours. He did not think Mr. Day's comparison of fuel and wages costs quite fair, because some of the steam engines in electricity stations were very old and uneconomical. Steam in the Garrett engine was superheated 150°F., making the final temperature 500°F. to 600°F. He did not think there was any superheat in the low-pressure cylinders, but the exhaust steam was quite dry.

Mr. Tookey, in his reply, said that the rating of gas engines was settled by commercial considerations. At the present day the rating was that of the maximum power which the engine was capable of working at, no matter how short that period might be. He preferred to ascertain the horse-power by calculation and assuming that 4 cubic ft. of piston displacements were required per minute for every brake-horse-power developed.

Mr. Day replied that the Diesel engine was rated on its steady working capacity. The master patent had expired, and in order to indicate the extent to which the engine is being manufactured, he said that no fewer than 30 firms had started to make it in Germany within the last three years. On going to a small town to try and open up business in connection with it, he found that five firms were already producing it. With regard to the difficulty of native labour, his experience was that the engine which was least known was the best run by native labour. The African negro was no good, but the Chinese coolie was excellent. The latter did what he was told and kept things clean; he did not form theories, and think he could improve the valve setting. He (Mr. Day) did not agree with Mr. Marshall about the age of steam engines in electric generating stations.

Wednesday, September 6th.

A Paper by Mr. E. Kilburn Scott, on "The Manufacture of Nitrogen Compounds by Electric Power," was first on the programme in Section G this morning. The author described several of the different types of "furnace" employed in the fixation of atmospheric nitrogen by electricity for the purpose of manufacturing artificial manures. In the Birkeland and Eyde process the nitrogen is fixed directly from the air, and the nitric acid produced then reacts with carbonate of lime. In the calcium cyanamide process the nitrogen, after being isolated from the air, is absorbed by calcium carbide. The author then drew attention to the manufacture of nitrogenous products for explosives, and enlarged on the desirability of some steps being taken by the nation to ensure a good supply of such nitrogenous products in time of war. He maintained that we were at present entirely dependent on supplies from Chili, and that if private enterprise would not provide for manufacture at home then the Government should do so. There was no doubt that power could be produced cheaply enough if only sufficiently large units were employed. The trouble in the past had been that we had been trying to produce cheap power with small units, and he referred to the number of small municipal stations scattered about the country, which he described as "tin-pot." Mr. Scott spoke at some length on the evils of municipal electricity supply, but the relevancy was hardly apparent. Ultimately, he reverted to the subject matter of his Paper, and concluded by expressing the hope that the matter would be taken up seriously in this country at no distant date.

Sir William Ramsay, in opening the discussion, agreed that coal costs in England were now low enough to enable Mr. Scott's proposals to be carried into effect. He advocated large electric power stations with chemical works adjoining.

The next speaker in the discussion was connected with some large works in Norway, which have actually been working for some time. On nearly every point he expressed disagreement with Mr. Scott. At present there was no chance in England; it had been gone into by people who knew, and they were convinced that the time was not ripe. A very high state of development had, however, been reached in Norway. They had a factory in course of construction on the Continent which would have a capacity of 250,000 kw., and the first half of this was practically completed. The works that Mr. Scott had referred to were only of an experimental nature, and there were many difficulties yet to be overcome. Hence the wise thing to do was to wait and secure the results of Continental experience. He disagreed with the author about national danger; the Government would not take up any process while it had the Navy to protect the Chili fleet. Sir William White said he agreed with the author regarding cost of generation in England. Only four or five years ago an eminent Swiss engineer, giving evidence before a Parliamentary Committee, had said that it was cheaper to generate by coal than by water-power, even in Switzerland. If this was the case, there could be no doubt about it in England, where generating stations could be built in situations convenient for coal supply. Electricity in bulk could be produced more cheaply here than in any other country in the world. He thought Mr. Scott need not go so far as Chicago for examples of cheap generation by large units; he need go no further from home than Newcastle-on-Tyne. With regard to the national question, he thought it a great advantage to any country to have powers of production within its own borders, without relying upon supplies from outside. Prof. Petavel called attention to the low figure of 3 per cent. which the author said was the proportion of energy actually utilised; he thought it should be possible to increase this. Some years ago he had been engaged with Dr. Hutton on experiments, the object of which was to ascertain the effect of increased pressure within the furnace, and it was found that there was an increase in the percentage yield. The pressure employed was as high as 3,000 lb. per square inch. Mr. H. E. Wimperis said he had calculated that there must be something like 1,000,000 H.P. going to waste from blast furnaces and coke ovens; if this were utilised the fuel costs would be very low. Mr. Scott then made a few remarks in reply.

The next Paper was one of considerable interest, entitled "Smoke Abatement" by Dr. John S. Owens. After showing the futility of the present legal standard of "black smoke of such quantity as to be a nuisance," the author pointed out how utterly inadequate existing methods of dealing with the trouble were. Even the best methods suffered from the defect of failing to take into account the diameter of the chimney. He,

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the author, had devised an instrument in the form of a telescope with a rotating diaphragm in the focus of the eye-piece. This diaphragm was mounted eccentrically with the axis of the telescope, but in it were pierced six circular apertures, each, when in position, being concentric with the axis. In each aperture was placed a semicircle of smoked glass, but the density of the smoking was varied according to the order of the aperture; that in aperture No. 2 was twice as dense as that in No. 1, and so on. If the density of No. 1 were taken as a standard for a particular diameter of chimney, then No. 2 would be used for a chimney of twice the diameter. The instrument enabled observations to be made by one person from almost any point, and the same background was available both for the smoke and the glass. What he asked for was the appointment of a responsible committee to fix a standard. The Paper was followed by a very brief discussion.

The last item was a Paper by Mr. W. Y. Lewis on "Continuous *versus* Intermittent Service in Passenger Transportation." This related to a proposal to do away with the intermittent train system in traffic, such as that encountered in tube railways, and to substitute a system of small cars running continuously and at comparatively short distances apart. These cars, however, were to be propelled by means of a gigantic screw engaging with rollers on the cars, and the great feature was that the pitch of the thread was to vary at points corresponding to stations about ¼ mile apart. Hence cars would always be in motion, but they would move more quickly between stations, and sufficiently slowly at stations to allow of passengers getting on and off. Moreover, in the course of being retarded they returned energy to the driving system. A letter was read from Capt. H. Riall Sankey saying that he had seen the system at work, and that the average acceleration obtained was about 4·5 ft. per second per second. From tests made something like 80 per cent. of the energy taken out by the car on acceleration running was put back on retardation. Mr. H. E. Wimperis remarked that it was not great acceleration which caused discomfort to passengers, but great rate of change of acceleration. He had observed that this quantity was sometimes as great as 20 ft. per second per second per second on stopping. In his reply, Mr. Lewis said that there was no intention of trying to instal the system on existing tube railways, but they hoped to put it in fresh ones, especially as it was found that an ordinary electric train service could not be made to pay if the stations were less than ½ mile apart. The new system had an efficiency of 90 per cent., and it was peculiarly suited to the working of lifts.

This concluded the work of the Section for the year. Next year the Association meets in Dundee under the presidency of Prof. E. A. Schäfer, in the following year at Birmingham and in 1914 in Australia.

A NEW TWO- TO THREE-PHASE TRANSFORMER.*

BY DR.-ING. M. VIDMAR.

Summary.—The system of transformation described in the following is employed by the Gesellschaft für elektrische Industrie at Weiz bei Graz for interlinking their old two-phase supply with a modern three-phase system. The author compares it with the Scott system, and shows that it is an improvement on the latter both as regards weight and cost, and also by the fact that the leakage, and therefore the voltage drop, is smaller.

The new transformer consists of a three-limbed iron core, similar to a three-phase transformer, but with special dimensions and special windings.

Considering first the transformation from a three-phase system to an interlinked two-phase system, we have, to start with, the three points A, B and C (Fig. 1) of the pressure triangle of the three-phase generator. The primary winding—that is, the three phase—is normal in so far as each winding is wound wholly on one core only, but the three phases do not have equal numbers of turns. Two phases, placed on the outer cores for the sake of symmetry, have the same number of turns, but the third has a different number, the value of which has to be determined. The transformer is connected star. Denoting the number of turns of the three phases by w_1, w_2, and w_3, we then have

$$w_1 = w_2 = w \gtrless w_3 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Considering now the triangle A B C in Fig. 1, we see at once that the back E.M.F.'s induced in any two phases must balance the pressures between the corresponding angles of the triangle.

Also the pressures in the two equal phases must be equal, and therefore the flux in their cores must also be equal. Moreover, if these two pressures are displaced by an angle a (Fig. 1), which is unknown as yet, the fluxes will be displaced by the same angle.

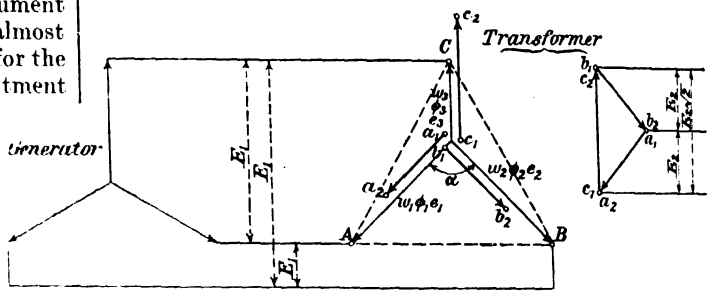

Fig. 1.

To obtain equilibrium, the flux in the third core must be equal and opposite to the resultant of these two equal fluxes.

The following symbols will be used :—

e_1, e_2, e_3 = the three phase pressures,
Φ_1, Φ_2, Φ_3 = the corresponding fluxes,
F_1, F_2, F_3 = the cross-sections of the three cores,
k = a constant,

and we can write

$$e_1 = e_2 = e. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$\Phi_1 = \Phi_2 = \Phi. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

The equation for magnetic equilibrium is

$$\Phi_3 = 2\Phi \cos \frac{a}{2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

while the corresponding electrical equations are

$$E_1^2 = e^2 + e_3^2 + 2ee_3 \cos \frac{a}{2}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

and

$$E_1^2 = 4e^2 \sin^2 \frac{a}{2}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

Now

$$e = k\Phi w \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

and

$$e_3 = k\Phi_3 w_3 = 2k\,\Phi\, w_3 \cos \frac{a}{2}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

Hence, from equations (5), (6), (7) and (8) we obtain

$$\frac{w}{w_3} = \frac{1 \pm \tan \frac{a}{2}\sqrt{3}}{1 - 2\cos a} 2\cos^2 \frac{a}{2}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

If now, according to the extended Kirchhoff's law, the current

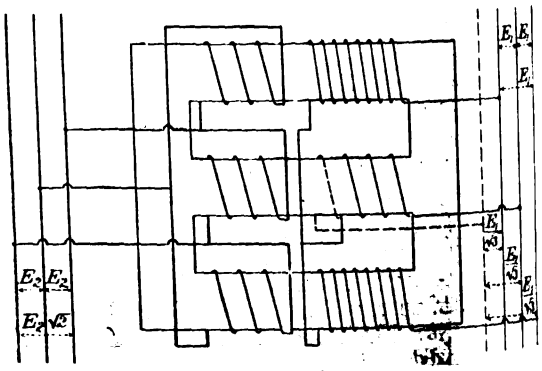

Fig. 2.

polygon of the three magnetising currents closes in the star point, the flux-densities in the three cores must be chosen to correspond. Hence we must make

$$F_1 = F_2 = F$$

and

$$F_3 = 2F \cos \frac{a}{2}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

in which F_3 can be taken slightly less than the above value, to allow for the dissymmetry of the core.

Equation (9) shows that any phase-displacement can be obtained between the two pressures e. If $a = 90°$, $\frac{w_3}{w} = 0{\cdot}366$, which is characteristic of this new transformer.

* Abstract of an article in "Elektrotechnik und Maschinenbau."

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Hence from equation (10) we have

$$F_3=\sqrt{2}F_1=\sqrt{2}F_2.$$

Passing now to the secondary—that is, the two-phase—side, the windings on the two outer equal limbs must have equal numbers of turns, since these produce the phase pressures of the two-phase system which are displaced by 90°. The winding on the third limb is connected in mesh with these two and arranged as shown in Fig. 2. The two outer wires of the system are connected to the middle coil and the middle wire to the common point of the two outer coils.

The third winding plays an important part in this transformer. Its duty is specially clear in transforming three-phase into uninterlinked two-phase currents; it carries equalising currents, the properties of which will be shown later.

To find the ratios of the numbers of turns on the two-phase side, it is clear that the pressure polygon must close, since the system is connected in mesh. Hence the pressure induced in the third winding must be $\sqrt{2}$ times the phase-pressure of the two-phase system. Since, however, the middle limb carries $\sqrt{2}$ times as much flux as the other two, the windings on all three limbs must have the same number of turns.

We will now proceed to find the ratios of transformation of the three cores, which we will denote by u_1, u_2 and u_3. Denoting the interlinked three-phase pressure by E_1, and the phase pressure on the two-phase side by E_2, we have

$$e=\frac{E_1}{\sqrt{2}},$$

$$e_3=0{\cdot}366E_1,$$

and therefore

$$u_1=u_2=u=\frac{E_1}{\sqrt{2}\,E_2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (11)$$

$$u_3=\frac{0{\cdot}366E_1}{\sqrt{2}\,E_2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (12)$$

The next point to consider is how a balanced non-inductive load on the two-phase side is transferred to the three-phase side. Magnetising currents and pressure drops will be neglected.

Where the outer wire enters the transformer, the current branches into two parts, one part passing to the other outer wire through the equalising winding. This current I_3 is as yet unknown both in phase and magnitude. Together with the load current J (Fig. 3) it forms the current I in the windings. Making use of the law of superposition, we now consider that the two currents J flow undisturbed to the

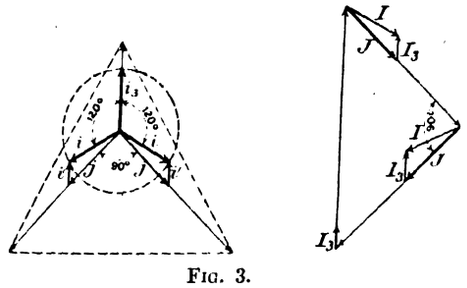

FIG. 3.

middle wire, while an equalising current flows through the whole mesh.

Considering the balance of the M.M.F.'s in the two outer primary cores, the currents

$$j=J\,.\,1/u \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (13)$$

must flow, displaced 180° from J.

Also in the same cores we must have

$$i_1'=i_2'=i'=I_3/u \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (14)$$

and in the middle core

$$i_3=I_3/u_3=I_3/0{\cdot}366u \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (15)$$

To determine the value of I_3, we will use the extended Kirchhoff's law for the primary star point. The three current vectors must form a closed polygon, or in other words, the resultant of i', i', j and j must be equal and opposite to i. Since, however, the resultant of j and j falls in the direction of the phase pressure of the middle core and since i' and i_3 have the same phase, it is clear that i_3 must also fall in in the same direction (Fig. 3).

We will now proceed to determine the magnitude of i_3.

The resultant of i', i', j and j is equal to

$$j\sqrt{2-2i'},$$

which is the magnitude of i_3.

Hence from equations (14) and (15) we obtain

$$\frac{I_3}{0{\cdot}366u}=\frac{J}{u}\sqrt{2-2\frac{I_3}{u}},$$

or

$$I_3=J\sqrt{2}\,.\,0{\cdot}366/(1+2\,.\,0{\cdot}366)=0{\cdot}299J, \quad . \quad . \quad . \quad . \quad (16)$$

and further

$$i_3=1/u\times 0{\cdot}815J. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (17)$$

Calculating now the values of the other two equal currents on the three-phase side, we have

$$i^2=j^2+i'^2-2i'j\cos 45°$$

or, using equations (14) and (15),

$$i_1=i_2=i=1/u\times 0{\cdot}815J \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (18)$$

and therefore equal i_3.

We see from this that the current polygon formed by i_1, i_2 and i_3 is closed and, since the three currents are equal, forms an equilateral triangle. Hence the three currents are displaced from each other by 120°. One of these, i_3, is known to be in phase with its phase pressure and hence it follows that a balanced non-inductive load on the two-phase side is also balanced and non-inductive on the three-phase side. The energy equation

$$2E_2J=\sqrt{3}i\,E_1$$

in conjunction with equation (11) gives us

$$i=\frac{\sqrt{2}}{\sqrt{3}}J\frac{1}{u} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (18a)$$

which checks with equation (18).

In a similar manner to the above a balanced inductive load can be shown to be transformed into a balanced load with the same phase-displacement.

It is also easy to show that the Scott system as well has the above advantage. The leakage of the latter, however, is greater than that of the new transformer, for the two halves of the primary winding by themselves produce a leakage flux, since they partly oppose each other.

Proceeding to examine the properties of unbalanced loads, we see that such a load can be considered as a superposition of a balanced load and a load in one of the three phases. Hence we need only consider this load in one phase.

For this we must obtain the star-point of the three-phase system.

The pressure induced in the middle winding is equal to

$$e_3=(\tfrac{1}{2}\sqrt{3}-\tfrac{1}{2})E_1,$$

and the phase pressure of the three-phase system is

$$E_{ph}=E/\sqrt{3}.$$

Hence by winding on the middle core

$$w'_3=w_3\frac{1/\sqrt{3}}{(\frac{1}{2}\sqrt{3}-\frac{1}{2})}$$

turns instead of $w_3=0{\cdot}366w$, we obtain the star-point (Fig. 2).

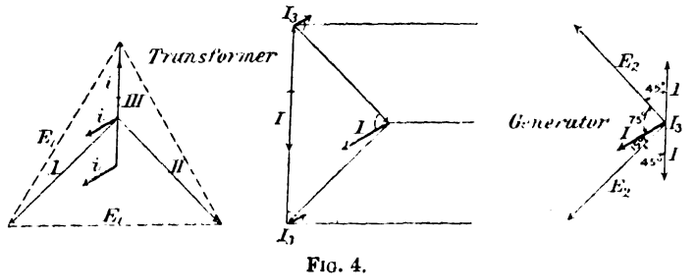

FIG. 4.

We now find two different kinds of load, according to the phase in which it occurs. In one case the load current i traverses the winding on one core only and in the other case windings on two cores.

A non-inductive load in phase III. (Fig. 4) can easily be investigated.

Considering the balance of the M.M.F.'s, the winding on the middle core on the two-phase side carries a current

$$I=i\frac{1/\sqrt{3}}{\frac{1}{2}\sqrt{3}-\frac{1}{2}}\,0{\cdot}366\,.\,0{\cdot}707E_1/E_2$$

or

$$I=i\frac{E_1}{\sqrt{3}\,.\,E_2}0{\cdot}707$$

The current I flows in both phases of the generator and is displaced 45° from its phase pressure, which is shown by re-writing the above equation

$$2E_2\,I\cos 45°=iE_1/\sqrt{3}.$$

Treating the Scott system in the same way, it can be shown that only one phase of the generator is loaded but with purely watt current. The copper losses in the generator are thus the same with both systems, but in the Scott system, they are not distributed so favourably as in the new transformer. Moreover, the two-phase system is largely distorted with the Scott transformer, apart from the far greater reactances of the same.

The second case is obtained by loading phase I. or II. (Fig. 4). The load current then flows through a part of the middle winding as well as one of the outers and thus induces a current in the equalising winding on the two-phase side.

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The primary currents are now equal to

$$I = i\,0{\cdot}707\,E_1/E_2$$

and

$$I_3 = i'\left(\frac{1/\sqrt{3}}{\frac{1}{2}\sqrt{3}-\frac{1}{2}}-1\right)0{\cdot}366\frac{E_1}{E_2}0{\cdot}707$$

or

$$I_3 = i\,0{\cdot}707\,\frac{E_1}{E_2}\,\frac{0{\cdot}366}{\sqrt{3}}.$$

Considering now the directions of the currents, we obtain the following two load currents in the two phases of the generator :—

$$J_1 = I - I_3 = i\,0{\cdot}707\,E_1/E_2\,(1 - 0{\cdot}366/\sqrt{3}).$$

at 15° to its phase pressure, and

$$J_2 = I_3 = i\,0{\cdot}707\,\frac{E_1}{E_2}\,\frac{0{\cdot}366}{\sqrt{3}}$$

with a displacement of 75°.
Hence we have

$$E_2 J_1 \cos 15° + E_2 J_2 \cos 75° = E_1 i/\sqrt{3}.$$

Examining the similar case for the Scott transformer, we find that the copper losses are again equal, but in both systems badly distributed, so that now the Scott system is slightly the better.

We will now consider the problem of the conversion of three-phase current into uninterlinked two-phase and vice versa, a procedure which is at once possible with the Scott system, but presents some new features with the new transformer. For this purpose it is necessary to separate the winding on the middle core, which carries the equalising current, so that it is not connected with the two phases.

We have treated the problem above by means of the principle of superposition and have first considered the two load currents to flow in their windings and then superposed the equalising current I_3 flowing in the closed circuit formed by the two-phase side connected in mesh.

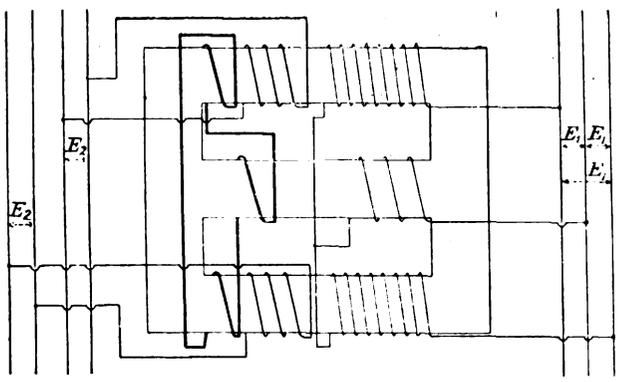

FIG. 5.

This condition is also possible physically, and it is clear that the circuits will have the same relations, if they are arranged as one short-circuited winding and one winding for each phase, which are not connected either to each other or to the short-circuited winding. This arrangement is shown in Fig. 5, and can be called a physical use of the principle of superposition.

Now from equations (15) and (11) we have

$$i_3 E_1 = \frac{\sqrt{2}}{0{\cdot}366} I_3 E_2$$

and we also have

$$E_2 = \Phi k W,$$

where W is the number of turns per limb of the secondary side, which is equal for all three limbs.

The expression on the left of the first of these equations is proportional to the load of the transformer and we can write

$$(I_3 W) k_1 = L \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (19)$$

where L is the load and

$$k_1 = 4{\cdot}44\,\frac{\sqrt{3}\sqrt{2}}{0{\cdot}366} \approx BF10^{-8}.$$

Equation (19) is evidently merely the value of the ampere-turns of the short-circuited winding and since we have no other equation for I_3 or W—with the interlinked two-phase system W depends on E_2—any arbitrary value may be chosen for W, so long as it can be designed for the corresponding current I_3.

Hence W is chosen small, so that there is no high pressure in the equalising winding and so that a good space-factor is obtained.

The chief advantages of the new transformer compared with the Scott system are the following :—

The leakage is considerably less.

The overall dimensions are smaller.

With uninterlinked two-phase current the weight is about equal to the Scott system, and with interlinked two-phase current it is considerably less.

PACIFIC CABLE BOARD.

The accounts for the year ended March 31, 1911, together with the report of the Chairman of the Board, have been issued.

The traffic receipts for the year were £140,313. 2s. 3d., less £4,170.6s.7d. paid to the Atlantic companies for work done and delivering double copies in London and other large centres in the United Kingdom, leaving, therefore, £136,142. 15s. 10d., which, together with interest on deposits (£225. 10s. 2d.), refund tolls and dues (£202. 16s. 3d.) and charter of "Iris" (£2,106. 12s. 3d.), made a total of £138,677. 14s. 6d., leaving £29,334 for meeting the annuity of £77,544 payable to the National Debt Commissioners in respect of interest and sinking fund on the capital advanced for laying and equipping the Pacific cable. This is £11,378 more than was available in 1909-10. The increase of £24,677 in the net traffic receipts was mainly due to increase of business and to receipts from new sources of revenue in the tolls on traffic between Montreal and Bamfield over the line leased by the Board from the Canadian Pacific Railway Co. The revenue of the year was further augmented by £2,106 received from the Eastern Extension Australasia & China Telegraph Co. on account of the chartering of the Board's repairing ship "Iris" for a fortnight in July, 1910. In February and March, 1911, the "Iris" was again chartered for a month by the Cie. Française des Cables Télégraphiques, for repair of the New Caledonia cable, and the extra expenditure on that occasion fell on the account for 1910-11, although the payment from the company was not received within that year. Thus the extra receipt of £2,106 was fully counterbalanced in the account for the year by increases on the expenditure side of the account. In the opinion of the Board it is not desirable to treat as current revenue the whole of the extra receipts derived from the chartering of the "Iris" on occasions of this kind, and it is proposed to balance extra receipts representing profit on a charter of the "Iris," by adding in the year affected a corresponding sum to the fixed sum of £30,000 now carried annually to reserve.

Expenditure for the year shows an increase of £15,576. This is almost wholly accounted for by the cost of the new Canadian land line service and the extra charges in connection with the hirings of the "Iris." But additional charges have also been incurred in respect of the annual increments to salaries, and of sundry requirements incidental to an expanding service. At the same time the working expenses, while showing an advance of over £15,000, fell short of the estimate by some £5,000. This was due to the fact that the actual taking over of the Canadian service was delayed to a later date than the Board had anticipated.

The preliminary forecast of revenue and expenditure for the year ending March 31, 1912, prepared on Dec. 7, 1910, was: Traffic revenue £141,000; renewal fund £30,000 and working expenses £80,975, excess £30,025. The renewal fund stood at £264,236 on March 31, 1911. No interruption of communication occurred on the Board's system during the year. The several sections of the cable, the depots, instruments and plant generally have been maintained in a high state of efficiency, with the single exception of the electrical condensers. These have shown somewhat serious deterioration due to climatic influences, and it has been found necessary to undertake repairs and renewals on a comprehensive and systematic scale. The process is an expensive one, and during the next year or two, during which the old condensers will be renewed or replaced, an extra expenditure of some £250 per annum will be entailed.

The arrangements for transferring to the Board's management the service over the section of the Canadian land lines between Montreal and Bamfield were completed in September last, and from Oct. 1 were brought into full operation. The results have been entirely satisfactory. As regards times of transmission the records show that in the three months October to December, of last year, the average time per message between the United Kingdom and Sydney was reduced by 15 minutes, compared with the three months June to August, and between the United Kingdom and Melbourne by 18 minutes.

The cable ship "Iris" has been maintained in first-class order, and the discipline and efficiency of the permanent officers and crew has left nothing to be desired. On three separate occasions during the year the "Iris" had to be ordered to sea. On no one of these was there found to be any difficulty or undue delay in completing her complement, or in getting her ready for sea, and the experience of the year has satisfied the Board as to the policy of maintaining only a skeleton crew during the times when the vessel is not actively engaged. The health of the staff during the year has given no cause for anxiety, and the zeal and efficiency have been fully maintained.

Following the reductions in Press rates to which reference was made in last year's report, the Board authorised a reduction from 3½d. per word to 2¾d. per word in the rate for Press messages between Bamfield and Fiji. At the same time they reduced from 1d. to ¾d. per word the charge on Press messages to Australia that are "dropped" at Fiji. These changes came into operation on Sept. 1 last, and constituted the only actual change made in rates during the year. But a prospective change of general and great importance—viz., the establishment of a system of allowing messages not of immediate urgency to be sent at reduced rates—has been the subject of prolonged consideration and negotiation. In May, 1910, the Board drew up a scheme for giving effect to this principle in the case of traffic passing over the Pacific cable. The Postmaster-General discussed the proposals with the British and American cable companies, and, after obtaining their approval of them, entered into negotiations with foreign Governments. As a result, such a measure of general agreement has been reached that there is every prospect that within the next few months it will be possible for messages in plain language to be sent at half the existing rates of charge, subject only to the condition that the transmission of them must await, for a period not exceeding 24 hours.

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COMMERCIAL AND INDUSTRIAL SECTION.

MUNICIPAL, FOREIGN & GENERAL NOTES.

BRITISH NOTES.

Brighton.—An interesting report on methods of charging for current, meter rent, &c., has been prepared for the Lighting Committee by Mr. John Christie, the engineer and manager of the electricity department.

In his report Mr. Christie points out that the Council should aim at having the simplest tariffs and one flat-rate of 1d. per unit, common to all classes of consumers, with special discounts to exceptionally large users, instead of the existing three rates. At present there are the maximum demand system of 6d. and 2d. per unit; a 3d. flat rate for hotels, licensed premises, clubs, &c.; and a 4d. flat rate for shop lighting and domestic supply. 80 per cent. of the consumers have reverted from the maximum demand system to the flat rates, and the remaining 20 per cent., who still elect to be charged on the maximum demand system, are obtaining their supply at a lower average price than they would get if they changed over to either of the respective flat rates to which they are entitled. To protect themselves against a serious loss upon such a transition as adopting one standard flat rate, Mr. Christie suggests that the policy be adopted gradually, the first step being to abolish meter rentals; next, gradually reduce the flat rate for shop lighting and domestic supply from 4d. to 3½d., then to 3d. per unit, and finally reducing the common flat rate of 3d., a little at a time, to such a figure as to induce all the maximum demand consumers to discard the system for the flat rates. The adoption of such a suggestion would involve a reduction in the current year's revenue equivalent to about £600. The concession would assist them in developing the undertaking, especially among the smaller householders, and he was assured of its ultimate success. The complete abolition of meter rentals would involve a loss of revenue of £1,200 per annum, and, although possibly for a few years increased business would not directly compensate for the loss, it was the only concession which they were able to afford at present, and must be regarded as a concession to which private consumers had some claim as a result of the satisfactory working of the undertaking during the last few years. The cutting off of supply between 5:30 p.m. and 8 p.m. during December and January, prevented a number of prospective customers from using the electricity, and those restrictions, too, would have to be abolished. Last year 173,576 1½d. units were sold, yielding £1,084. If the concession was granted Mr. Christie estimated that the loss would be £361, but increased business on the part of breweries, laundries, &c., would neutralise that. For outside consumers Mr. Christie suggested a reduction of charging to one flat rate of 1½d. per unit. The present tariffs are: For first 250 units used during each half-year, without restriction, 2d. per unit; from 250 to 500 units, 1¾d. per unit; and over 500 units 1½d. per unit. The revenue from the 3,757 units distributed outside the Brighton area last year was £30. 3s. 9d., and the reduction would make a difference of £6. 14s. 1d., which would quickly be wiped off by increased business.

The committee, having considered Mr. Christie's suggestions, recommended that they be approved by the Council and acted upon, and that the tariff of charges for the supply of electricity approved by the Council on April 16, 1908, be amended accordingly; also that from Oct. 1 the existing charges for meter rents be abolished except in cases of consumers upon the maximum demand system.

Darwen.—The Board of Trade recently suggested that speed indicators should be fixed on the tramcars, but the Tramways Committee have postponed action in the matter until the Association of Tramway Managers have interviewed the Board on the subject of speed indicators generally.

Eastbourne.—A rebate of ¼d. per unit is to be made to consumers whose supply exceeds 40,000 units per annum.

Electric Ambulances in Dockyard Work.—The Port of London Authority propose to supplement their first-aid agencies at the London docks by four electric ambulances, which are at present being constructed.

The electric ambulances will be employed for the areas of the Victoria and Albert, the Surrey Commercial, the London and the West India Docks and the estimated cost of the service per year is about £4,000.

Electrical Exhibition, Olympia.—The management of this exhibition will send any contractors pictorial posters of the exhibition on hearing from them, and on consideration of such contractors exhibiting these bills in their windows, they will be entitled to two complimentary tickets to the Exhibition. It is therefore hoped that contractors will assist in giving the Exhibition every publicity.

Electricity in Agriculture and Horticulture.—It was recently announced by the Board of Agriculture that the sum of £50,000 per annum was to be allotted by the Development Fund Commissioners for agricultural research and other work in connection with the development of agriculture and horticulture. There is a general impression that some portion of this large annual vote will be allocated to experiments in connection with the application of electricity to the acceleration of crop growing, and there is a likelihood of the State in this way helping the efforts of Mr. J. E. Newman, Sir Oliver J. Lodge and Mr. Lionel Lodge in their practical work in the Evesham district of Worcestershire, where much has been done to demonstrate the possibilities of this scientific advance.

Exhibition of Patents.—London is to have a permanent exhibition of patents which will be situated in a central position, and will be open to the public all the year round. There will be no charge for admission, the object being to establish a centre where inventors may display their patents for attracting the attention of purchasers. Particulars from the administration office, 165, Fleet-street, E.C.

Fire.—A fire broke out on Sunday at the works of the North of Scotland Electric Light and Power Co., Inverness. Damage to the extent of about £1,000 was done to the stores and plant, but supply of current was not interfered with.

Garvagh (co. Londonderry).—Arrangements have been made for the public electric lighting of this village by 14 25-c.p. metal filament lamps. Electric current will be supplied by Mr. Stewart.

Glasgow.—The Parliamentary and Tramways Committees have adopted recommendations of a sub-committee to obtain parliamentary powers to construct certain new tramways and to erect a new bridge over the Clyde from South Portland-street to St. Enoch-square. The proposal that the tramways be extended from Canniesburn Toll to Milngavie, and from Baillieston to Coatbridge, was not approved.

Greenock.—The Electricity Committee recommend a reduction in the price of electric current for private lighting from 4d. to 3½d. a unit and for public lighting from £15 to £14 per arc lamp per annum. The price of energy for power is also to be reduced.

Ilkley.—On Wednesday the Council decided to apply for a provisional electric lighting order for the urban district of Ilkley and the township of Myddleton.

Lighting of German Trains.—It is announced that in future passenger coaches of the Prussian railways will be lighted by electric light instead of gas. The Rosenberg system of electric lighting has been adopted.

Llandudno.—Application has been made for sanction to a loan of £500 for extensions of mains, &c.

Llangollen.—The Council have been advised that the transfer of their provisional electric lighting order to the Llangollen & District Electric Light & Power Co. is not legal, and a committee has been appointed to consider the situation.

Local Authorities and Fair Wages.—The L.G. Board have issued a circular to County and Town and Borough Councils, &c., drawing attention to the recommendation of the Advisory Committee of representatives of Government Departments with reference to the "fair wages" clauses in contracts.

The circular, which was signed by the secretary (Mr. H. C. Monro) and was accompanied by a copy of the "fair wages" clauses, stated that "the accompanying memorandum embodied the resolution passed by the House of Commons on March 10, 1909, on the subject of fair wages clauses in Government contracts, and the recommendations made by the Advisory Committee of representatives of Government Departments, which had been established as suggested in para. 124 of the report of the Fair Wages Committee of 1908. It would be seen that the Advisory Committee recommended that clauses such as those inserted in Government contracts should also be introduced into contracts which were not entered into by Government departments, but which involved the expenditure of public money or other consideration granted by a Government department, or which required the approval of the department. It appeared to the Board that the policy adopted in the case of Government contracts should be followed in the cases of all contracts for the execution of works or the supply of materials which are entered into by local authorities or by or on behalf of any committee wholly or in part appointed by a local authority. Whilst they are aware that many local authorities specify in their contracts conditions to be observed by the contractor as to the rates of wages and other matters affecting persons employed by him, the Board think that in every case the authority should give the matter careful consideration with the view to the introduction in the contracts of clauses on the lines of those inserted in Government contracts.

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L.C.C. Tramcar Accident.—An accident occurred on Saturday afternoon to a L.C.C. tramcar at the junction of Shardeloes-road and Lewisham High-road, resulting in the death of one person and injuries to several passengers. The car left the rails and was overturned.

An inquest was held on Tuesday, when a verdict of accidental death was returned, and on Wednesday a Board of Trade inquiry was conducted by Col. von Donop.

JARRETT, the driver of the car, said he thought if he could have got the car to stop it might have righted itself. The magnetic brake did not act when applied, but he thought the jerk of the car before overturning showed it had just then come into action and then skidded. He afterwards examined the rails, and found a quantity of hard sand in the groove He was certain it was not the sand he had released.

REEVE, the learner who was on the car, said that where the wheels left the rails the lines were full of old dirt. He did not connect the dirt in any way with the derailment. The magnetic brake failed to act, but he could not account for it in any way.

Evidence was given to show that the state of the track at the place of the accident was good and that the condition of the car and its brakes was normal before the accident.

Ormskirk.—The Council have sealed the agreement for the transfer of their provisional electric lighting order to the Ormskirk Electric Supply Co. Mr. J. W. Speight is consulting engineer to the company, which proposes to establish electricity supply in the district at an early date.

Pontardawe.—Messrs. Gilbertson & Co. are prepared to erect poles and supply electric current for public and private lighting, provided their position is made legal, and the Sanitary Committee has, therefore, been requested to consider a form of agreement to be entered into with the company.

Presentation.—On Friday the staff of Sheffield Tramways Department presented a silver tea-tray to Mr. H. E. Yerbury, chief engineer, on his marriage with Miss Dorothy Wood.

Mr. E. J. MARSH, chief electrical superintendent, in making the presentation, conveyed to Mr. Yerbury the congratulations of the staff on the happy event and mentioned that Mr. Yerbury had been on the department since the commencement of the electrification of the tramways. Mr. A. Handford, the traffic superintendent, and Mr. J. R. Williams, superintendent of the power station, also spoke.

Salford.—The borough electrical engineer (Mr. H. J. Hawkins) has prepared a report upon the present position of the electricity works, in which he recommends the installation of modern turbine plant and the scrapping of the existing reciprocating engines, one at a time, as required.

Mr. Hawkins puts the cost of carrying out his recommendations, which would increase the capacity of the works to 12,000 kw., at £85,350. The recommendations include the modernisation of the coal-hauling plant at an estimated cost of £3,100; displacing (as required) eight existing boilers by seven water tube boilers, £14,000; additional turbo-generator, £12,500; removing existing store and fitting shop, and erecting travelling crane for turbo plant, £750; new fitting shop and store, £1,500; extending switch room and building new switchboard, £3,500; replacing one at a time four 750-900 kw. engine sets by turbo-generators of 1,600 kw. at a cost of £12,500 each turbo-generator, £50,000. The increased capacity of the plant would reduce the capital expenditure per kilowatt from £90 to approximately £54.

Shoreditch (London).—The Lighting Committee have reported on a proposal to substitute metal filament lamps for the 1,055 gas lamps in streets north of Old-street.

The capital cost of laying about 14 miles of cables in 160 streets, of sufficient size to serve not only for street lamps but to meet any additional demand likely to arise, is put at £8,385, and the cost of converting the street lamps for electric lighting at £665. The scheme would make it not only possible to give supply of electricity to any occupier within the large area proposed to be dealt with, but there would also be a saving to the general rate of about £230. Although some of the streets in which it is proposed to lay mains are of a type not likely to require an immediate supply of electricity for power and lighting, a large number contain small factories, and are in neighbourhoods where new works are likely to be erected. It is proposed to lay mains in the ordinary side streets of sufficient capacity to supply power up to 25 H.P., or 350 50 c.p. lamps, and in the smaller streets mains sufficient to provide 6 H.P. or 84 50 c.p. lamps. The Committee recommend that this proposal be carried out at the sums mentioned, the work to be done gradually.

The Committee have also decided to adopt, as an alternative to the maximum demand system, a flat rate for electrical energy for power of 1¼d. per unit for all supplies of not less than 1,250 units per quarter, with a load factor of at least 10 per cent., and with a scale of discounts varying from 5 to 20 per cent., according to quantity. Where current is used for factory lighting equal to 5 per cent. of that taken for power a further discount of 2½ per cent. is to be allowed off power rate. For power supplies with a load factor of at least 10 per cent., the maximum price is to be 1·5d. per unit, and where the load factor is less than 10 per cent. 2d. per unit. Where factory lighting is equal to 5 per cent. of total used for power the rates per quarter are: 6,250 units and over, 2·5d. per unit; 5,000 and under 6,250, 2·75d. per unit; 3,750 and under 5,000, 3d.; below 3,750, 3·25d. Factory lighting where electric power is not used, 3·25d. per unit; public street arc lighting, 1·5d.; lighting public offices, 3½d. For current used for trade and testing purposes in electrical showrooms, 2·5d. per unit.

Stockton-on-Tees.—The Council are carrying out extensions of the electricity generating plant to provide for next winter's demand.

A contract has been placed with Richardsons, Westgarth & Co. for a mixed pressure turbine combined with a Siemens direct-current 400-500 kw. generator, at an inclusive price of £2,923, to be ready for running in November. The cooling tower is to be extended, the contract having been let to the Klein Eng. Co. The superheater contract has been let to T. Sugden (Ltd.), and the switchgear to Drake & Gorham.

Stourport.—The Council have decided to allow the Kidderminster and Stourport Electric Supply Co. to supply electricity in the district by overhead wires.

Trades' Union Congress.—Mr. W. Mullin, in the course of his presidential address at this year's Trades' Union Congress at Newcastle-on-Tyne, stated that the total membership was now 1,662,133, an increase of 14,418 over last year, and the delegates numbered 523, against 505.

Mr. MULLIN mentioned that since the last congress the Parliamentary Committee had carried out the instructions of the delegates in regard to presenting before Cabinet Ministers the various resolutions agreed to. His experience, as an old member of the Committee, was that those practical talks were of the utmost importance. They stood as the mouthpiece of the trade union movement. The experience of men who knew their subject was laid before the Government heads, and he asserted unhesitatingly that every new measure affecting the working classes before it reached the House of Commons, was influenced and moulded by reason of the views laid through the Parliamentary Committee before the Ministers in charge. The importance of that work increased every year, and was valued alike by whatever Government might be in power. In regard to the Insurance Bill, certain features of the measure called for their careful deliberation. He thought they all understood that any insurance bill that allowed the benefits to be paid to workmen whose share of the contributions were paid indirectly through the taxes of the country, would be a big bar to any effort to improve the weekly wage. The fact that a weekly contribution would be required would cause even the most indifferent to take a greater interest in the measure. One very valuable method of dealing with the administration was by a federation of trades, and he suggested that trade unions, wherever possible, should form themselves into federated groups. The Osborne judgment was still unrepealed, but the Coal Mines Bill had been beaten into shape in Grand Committee. As to the recent series of strikes affecting the transport and railway workers, practically all had been successful in securing advantages hitherto denied to them. Of late years the policy in regard to wages and working conditions had been in favour of mutual agreements, boards of conciliation and the like. It could hardly be said that they had altogether commended themselves in actual working to organised labour.

The Parliamentary Committee reported that it was safe to assert that the Coal Mines and Shops Bills would pass through the House of Commons during the autumn session. Another measure, introduced by the Government with the object of meeting what was known as the Osborne judgment, was also under way. Although, as drafted, it was not so favourable or so comprehensive as trade unionists would desire, it would doubtless be put into satisfactory shape before it reached its third reading. The question of making trade union combinations permanent in their character had occupied the attention of the Committee, and it seemed to them that the State Insurance Bill offered a possible means to that end. The tendency among organised workmen would be to have each separate trade union registered as an approved society for sickness insurance. The Committee, after mature deliberation, were of opinion that it would materially strengthen the unions, and consolidate the trade union movement if the various societies were grouped together into as few groups as possible; that each group should be made the sole channel of receiving and paying the money received from the Treasury for the purposes of sickness insurance; that the duty of administration should, so far as the Treasury requirements admit, be assumed by a representative body elected from each separate group, and that a united and immediate effort should be made to induce the Government to make such alterations in their bill as will admit of these suggestions being carried out.

Workmen's Compensation.—On Wednesday a long resolution on workmen's compensation was passed. In the resolution the Congress condemned the present practice in the appointment of medical referees and claimed that they should be appointed and paid by the State, and should devote themselves exclusively to their duties as referees. That the basis of compensation for all adult workers should be a minimum of 15s. per week where the weekly wages exceed that sum, and full wages when the wages are less than 15s. That in cases of loss of an eye or other permanent injury to body or limbs a fixed sum should be paid irrespective of earning capacity. That all outworkers should be included under the Act on the same terms as factory or other workers; and that compensation should be paid for accidents occurring within the area of the works of any firm to any workman employed in the works or on the premises of his employer, whether or not such accidents happen in the course of the employment of the individual workman.

Tramwaymen's Wages.—*Rochdale* have granted an increase of ¼d. per hour to all employés with over four years' service. This will cost about £500 a year.—*Rotherham* Corporation have also granted

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an increase of ¼d. per hour to their motormen and conductors. The men will work 54 hours instead of 60, in consequence of the provision of a meal relief, so that their week's wages will be less, although the aggregate expense to the Corporation will be more.

COLONIAL AND FOREIGN NOTES.

Australasia.—The New Zealand "Trade Review" states that the values of imports of electric machinery into New Zealand during the past five years were £187,697, £233,252, £258,851, £212,071 and £207,565 respectively.

The "British Australasian" says Mr. H. R. Harper, the Melbourne city electrical engineer, who recently accompanied the Victorian Premier and Minister of Public Works to Germany and Holland, to inspect the electric railways, will leave England on the 16th inst. and visit the United States with the object of making further observations there, prior to his return to Melbourne.

Ceylon.—The power station at Black Pool is nearing completion.

Chili.—The Government has approved projects (by Don Mario Ibar) for a telephone service in Constitucion, and (by Don S. Correa) for electricity supply in San Vincente (Caupelican).

Customs Duties.—A supplement to the Australian Customs Tariff Guide states that the following import duties will be imposed on telephone parts imported separately :—

Escutcheons, 5 per cent. ad val. (British goods free); round milled brass nuts and bell pillars, 30 per cent. (British 25 per cent.); porcelain bases (fitted), receiver hooks, ebonite or metal knobs, table telephone springs and vibrators (British and other) are duty free.

On shunt coils (imported separately) for arc lamps (British or other), 20 per cent. On main springs used with Morse registers, 5 per cent. (British free).

Under the French Customs tariff (according to recent decisions) the following are the classes under which the articles mentioned are classified: Small electric massage apparatus (524bis., electro-technical apparatus); land portions of submarine cables (535ter., wires and cables, insulated, for electricity). The submarine portions are duty free.

Damascus (Syria).—Mr. E. Weakley, the special commissioner of the Commercial Intelligence Committee of the Board of Trade, writes :—

Although the river Barada furnishes considerable water-power, as many as 150 electric motors (from ¼ to 2 H.P.) are in use for raising water, the motors and pumps being made by a Berlin firm. Damascus agents of British firms have, since 1907, supplied a considerable number of motors in the district. The demand for machinery in the Aleppo district has been insignificant, but the establishment of railway connections with Beyrout has greatly simplified the transportation of heavy machinery, and the introduction of mechanical power has been put on a practical footing. British makers are paying attention to this trade, and have supplied gas, oil and steam engines.

Electrical Schemes for Constantinople.—In connection with the proposal to form an international syndicate to acquire the concessions for the supply of electricity and gas, the equipment of electric tramways, &c., in this city, it is stated that the head office of the organisation (the Consortium of Constantinople) will be at Brussels, and that a limited liability company is to be formed with a share capital of 45,000,000 fr. (£1,800,000), and an equal amount in 4 per cent. debentures.

The board will be composed of representatives of German, French, Hungarian, Belgian and Swiss banks, financial houses and tramway and electrical firms, which have subscribed the capital. Of the capital, 36,000,000 fr. (£1,440,000) is to be devoted to tramways, the same amount for a tube railway, and 18,000,000 fr. (£720,000) to electricity supply and gas. The electrification of the Constantinople tramways and the construction of a submarine tunnel to connect Pera and Galata are public works already secured by the Consortium. The concession for the metropolitan railway has been applied for, but has not yet been granted. The gas and electric lighting will fall under the direct control of the Consortium at a later date, under conditions which have already been fixed.

Japan.—The British Consul-General at Kobé writes :—

The outstanding feature of 1910 was the number of gas plants set up for supplying towns with gas and for small suction gas electric power stations. In the early part of the year the bulk of the orders were given for British machinery, but during the latter half Continental firms secured a number of important contracts, principally by undercutting British prices.

A local rubber electric cable factory, equipped with British machinery and having the services of a British cable expert, has made great progress since last year, and can successfully compete with British goods in price and delivery. As regards quality, time alone will prove. For paper-insulated cables there is still a demand, and large contracts have recently been secured by Continental manufacturers at very low prices.

A report from Formosa states that six electric tower transporters have been ordered from England for Keeling Harbour, and electric capstans are to be erected for moving the cranes along rails on the quays.

The pumps ordered from a British firm for Takow (Formosa) waterworks are to be driven by three-phase electric current obtained either from the Government supply or from an independent station. Practically the whole of the electrical supplies have hitherto come from German and American makers.

Montenegro.—The Government have granted a concession to Mr. A. Dechkovitch for the erection and equipment of two electric power stations, one of 80,000 H.P. capacity at Kolassin, on the Tara river, and one of 5,000 H.P. at Podgoritza, on the Moracha. The former will supply power to an iron mine near Antivari.

South Africa.—The "British and South African Export Gazette" states :—

The early completion of the electrification of the plant of the Durban Roodepoort Deep has been decided upon.

Roodepoort-Maraisburg Council have obtained permission to borrow £8,000 for electricity works, and tenders will shortly be invited for electrical plant and material.

Klerksdorp (Transvaal) Council have reduced the charge for electrical energy from 1s. to 9d. per unit and have decided to advance the money for the wiring of consumers' premises, repayable by monthly instalments with interest at 6 per cent.

Spain.—The "Madrid Gazette" announces that tenders will be opened by the Junta especial de Subastas, Ministerio de Marina, MADRID, on a date to be announced later, for supply of two radio-telegraphic installations, one of a naval type and one capable of being carried by a landing party. The upset price is put at 42,000 pesetas (about £1,550), and a deposit of £80 will be required with each tender. Local representation is essential.

Telegraphic Feat.—The New York "Times" recently made an experiment in order to ascertain the speed at which an ordinary commercial telegraph message could be sent around the world by submarine cable.

The message in question, which was despatched from New York at 7:16:30 p.m. on August 20, was :—"Times, New York. This message sent around world.—Times." The time occupied in transmission over a journey of 28,613 miles (geographical) was 16 mins. 30 sec., including 16 relays, thus giving an average speed of 29 miles a second. The message was transmitted by the Pacific Telegraph Co. from New York to San Francisco, and thence transmitted over the lines of the Commercial Pacific and Eastern Extension Companies, the French Government, Eastern, Europe and Azores and Commercial Companies. The actual route traversed was :—

	Miles.
San Francisco to Honolulu (Com. Cable Co.)	2,287
Honolulu to Midway Island (Com. Cable Co.)	1,332
Midway Island to Manila (Com. Cable Co.)	4,232
Manila to Hongkong (Eastern Extension Co.)	736
Hongkong to Saigon (Eastern Extension Co.)	963
Saigon to Singapore (French Govt. Telegraphs)	630
Singapore to Madras (Eastern Extension Co.)	1,895
Bombay to Aden (Eastern Co.)	1,912
Aden to Suez (Eastern Co.)	1,402
Suez to Port Said (Eastern Co.)	84
Port Said to Alexandria (Eastern Co.)	154
Alexandria to Malta (Eastern Co.)	1,036
Malta to Gibraltar (Eastern Co.)	1,125
Gibraltar to Lisbon (Eastern Co.)	392
Lisbon to the Azores (Fayal) (Europe & Azores Co.)	872
Fayal to New York (Com. Cable Co.)	2,345
Total (nautical miles)	21,397
Equal in land miles to	24,963
Add land lines transmission :	
New York to San Francisco (Postal Telegraph Co.)	3,000
Madras to Bombay (Indian Govt. Telegraphs)	650
Total in land miles	28,613

The fastest previous dispatch was an official message sent by the President of the Commercial Pacific Cable Co. (Mr. Clarence H. Mackay) on the opening of that line in 1903, but on that occasion arrangements had been made to avoid delay. In the present instance it was an ordinary commercial message and no special arrangements were made in regard to its dispatch.

United States.—The city authorities of New York have adopted electric power for driving the pumps of their high-pressure fire extinguishing service. Two electrically-driven pumping stations, with a rated capacity of 3,000 gallons per minute, at a discharge pressure of 300 lb. per square inch, furnish service on every alarm within the high-pressure zone. Pumping by gas power has been found to be cheaper, but water is delivered from the electric pumps at a much higher rate. The outflow of the electric pumps (though rated at 3,000 gallons) averaged 5,000 gallons per minute on the occasion of the great fire of January, 1910, while the gas-driven pumps of Coney Island only averaged 1,450 gallons per minute at the fire of July, 1907.

Venezuela.—Imports to Venezuela during the fiscal year 1909-10 included the following :—

Electrical apparatus and fittings valued at £2,080 (from U.S.A. £1,625, Italy £264, Germany £117, other countries £74); machinery £61,289 (U.S.A. £28,636, U.K. and colonies £17,465, Germany £8,546, other countries £6,642); iron and steel goods, including railway material, £138,177 (U.K. and colonies £51,173, U.S.A. £47,767, Germany £32,348, other countries £6,889); other metal goods £28,038 (Germany £11,265, U.S.A. £7,569, U.K. and colonies £5,543, other countries £3,661).

The British Vice-Consul at Maracaibo states that there are tramways at that town, but there is an opening for further developments in this direction.

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Wireless Telegraphy Notes.—"The Marconigraph" states that among recent contracts entered into by Marconi's Wireless Telegraph Co. is one with the Crown Agents for the Colonies for the establishment of a station in Ceylon, which will be capable normally of sending a wave length 600 metres in length. In addition, however, with any wave between 1,000 and 2,000 metres, the station will maintain communication with any ship off Madras or with any ship up to a distance of 450 miles over sea (except during periods of severe atmospheric disturbances), provided the ship is fitted with an aerial having a mean height of not less than 100 ft., and suitable receiving apparatus.

According to an American journal, a wireless telegraph station is about to be completed establishing communication between Washington, U.S.A., and Colon, a point at the eastern entrance to the Panama Canal. Near this place is Guantanamo, where the United States is building a vast naval base, and the new station is designed to enable conversation to be arranged and maintained as far east as the Azores, and at least as far west as Washington, a distance of over 2,000 miles. It is stated to be the opinion of naval officers that San Francisco, to the west, and the Eiffel Tower, Paris, to the east of Colon, will ultimately be connected by this station, which has been designed by Mr. R. D. Holliday and is, it is stated, to be equipped with the Fessenden wireless system. The largest of the three towers, of which the station is to consist, will be 600 ft. high, the other two being 450 ft. high. The work of construction is to be carried out by the U.S.A. Navy Department and the officials anticipate that the station will be in operation in 12 months from now.

Mr. Marconi arrived at St. John's, Newfoundland on Friday last. A powerful wireless station is to be erected on Signal Hill, where a number of important experiments will be conducted.

It is announced that the Portuguese Government has decided to adopt the Marconi system of wireless telegraphy, and that stations are to be erected at Lisbon, on the Portuguese coast, and at Cape Verde. "The Times" Lisbon correspondent states that the only point to settle is the question of terms, which, he understands, is to those which have been accepted by the British Government.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Bexhill.—The accounts of the electricity supply department for the year ended March last show capital expenditure £71,828 (increase £3,203), of which £17,680 has been repaid.

Revenue was £10,908 (against £10,244 in previous year), working expenses were £5,834 (£5,157) and gross profit was £5,074 (£5,086). Total costs (including interest and sinking fund) were £10,644 (£9,620) and the net profit was £264 (£624). There are 990 consumers (increase 99) with 46,346 equivalent 35-watt lamps connected (increase 2,996). Maximum supply demanded was 506 kw. (474 kw.). Units generated were 765,271 (690,652), supplied to public lamps 189,102 (167,916), by contract 638 (1,056) and to private consumers by meter 422,713 (393,178). Cost per unit exclusive of capital charges was 0·45d. (0·43d.) of which coal cost 0·55d. (0·63d.).

Dartford.—The accounts of the electricity supply department for the year ended March last show capital expenditure £43,608 (increase £418), of which £10,854 has been repaid.

Revenue was £10,118 (against £9,078 in previous year), working and general expenses were £5,657 (£5,045), gross profit was £4,462 (£4,033); and after meeting capital charges, income tax and expenditure of a capital nature charged to revenue (£434), there was a net profit of £1,032 (£629), which has been placed to reserve.

The report of the engineer, Mr. J. D. Pember, states that the net gain in connections is equivalent to 1,040 30-watt lamps for lighting and 5,100 (=191½ H.P.) for power, the total connections being equal to 35,220 30-watt lamps, or 1,456 kw., including tramway demand. Motors connected amount to a total of 779 H.P. The maximum simultaneous demand for lighting, power and traction was 615 kw. Coal cost 0·48d. (against 0·57d.) per unit sold, total working expenses were 1·07d. (1·15d.), total costs, including capital charges, &c., 1·73d. (1·94d.), and net profit 0·19d. (0·14d.). The average price received (for all purposes) was 1·86d. (1·93d.). The profit is practically all made out of power supply at low rates. The average price for power is 1·44d. (1·63d.). Units sold were 1,266,039 (1,046,615), including 180,699 (164,750) for private lighting, 569,973 (354,105) for power, 123,193 (122,575) for public lighting, and 1,384,174 (405,185) for traction.

Greenock.—The income of the electricity department from private consumers was £30,442 for the year ended May, an increase of £7,510 over the previous year.

The income from tramway supply increased by £133, and the working expenses had increased by £4,379. The gross profit was £17,471, an increase of £3,127. Sinking fund required £5,937 and interest £4,757; and after allowing £970 for depreciation and £504 for Parliamentary expenses, the net profit was £5,520, of which £1,500 had to be carried to reserve. It is proposed that £2,000 be given in relief of general rates and the remainder be placed to reserve.

Halifax.—The accounts of the tramways department for the year ended March last show capital expenditure £400,633 (increase £4,755), of which £317,383 is outstanding

ELECTRICITY SUPPLY TABLES AND DATA.

This Valuable Set of Tables and Engineering Data relating to Electricity Supply and to Electric Traction on Railways and Tramways in the United Kingdom, the Colonies, and some important places abroad, is now ready, and can be obtained complete in handy book form, price 6s. 6d. post free, or on very hard paper for rough or constant use, price 8s. 6d. post free. A complete Index is included.

Revenue was £92,573 (against £89,270 in previous year), working expenses were £60,480 (£54,660), and net profit was £11,514 (£13,066). Passengers carried were 17,057,865 (16,323,755), car-miles run 1,909,397 (1,862,068), and units used 3,608,873 (3,479,464). Total revenue per car-mile was 11·64d. (11·51d.), working expenses, including power, 7·66d. (7·05d.), and average fare per mile 0·77d. (0·77d.).

Handsworth.—The accounts of the electricity department for the year ended March last show capital expenditure £73,478 (increase £1,158), of which £68,095 is outstanding.

Revenue was £8,231 (against £7,813 in previous year). Working and general expenses were £4,152 (£3,806), gross profit £4,078 and net result, after meeting capital charges, a deficit of £555. Total works costs were 0·74d. (against 0·67d.) per unit sold, the increase being chiefly in wages and repairs due to alterations in the tramway service. Coal cost 0·28d. (same as in previous year). There are 532 consumers (increase 109) and 44,769 (38,795) equivalent 8 c.p. lamps connected and 110 (93) motors 577 (479) H.P. Units generated were 1,013,626 (1,033,196), sold for private lighting 241,880 (201,082), for power 278,725 (265,917), for public lamps 132,850 (130,176) and for traction 219,828 (254,255). The maximum supply demanded was 606 kw. (602 kw.).

The report of the engineer, Mr. F. A. Nixon, states that the year under review is the first during which the hiring and hire purchase schemes have been in full operation, and they show a satisfactory result. A tariff of 1d. per unit for heating and cooking was introduced during the year and £57. 14s. 10d. revenue was derived from that source.

Perth (N.B.).—The accounts of the electricity supply undertaking for the year ended May 15 show capital expenditure £60,014 (increase £533), and the amount outstanding is £48,717.

Revenue was £7,892, working and general expenses were £4,920, and gross profit was £2,972. Interest and sinking fund required £2,879, and £150 was placed to reserve, £18 being carried forward. Units generated were 1,035,064 (1,021,935), supplied to public lamps 162,492 (155,898), to tramways 305,371 (309,019), and to private consumers 455,332 (449,042). The total maximum supply demanded was 700 kw. (698 kw.)

The capital expenditure on the tramways is £76,948 (including £22,259 for acquisition of horse tramways), of which £66,530 is outstanding.

Revenue was £8,949, working expenses were £5,428, gross profit was £3,504; and after meeting capital charges and providing £384 for depreciation and renewals, there was a deficit of £1,157. Passengers carried were 1,777,883, car-miles run 251,428, and units used 309,371 (=1·21 per car-mile). Total revenue per car-mile averaged 8·49d., working expenses, including power, 5·18d., and interest and sinking fund charges 4·08d.

Plymouth.—The report of the borough electrical engineer (Mr. E. G. Okell) for the year ended March 31 states that 140 new consumers were connected, making a total of 1,288, and the total connections in 30-watt lamps were 96,276, an increase of 7,169.

The total horse-power of motors connected is 663, an increase of 90 H.P. The total number of units sold increased from 2,456,070 to 2,601,277, there being an increase of 17,000 sold to tramways, 121,971 to private consumers and 6,236 used for public lighting. The works costs for the last three years have been 0·91d., 0·88d., and 0·83d. respectively, and the total cost 1·23d., 1·30d. and 1·22d. per unit, exclusive of capital charges. The cost of coal per unit was 0·5d., against 0·51d. The total expenditure for generation, distribution, management, &c., was £13,202, compared with £13,308, a reduction of £106, notwithstanding the increased output and load. The gross profit (£12,815) represented 8·3 per cent. on the capital. After setting aside £9,848 for interest and sinking fund, the net profit was £2,967, from which £1,797 was taken to meet cost of new meters, services and mains, leaving £1,170 to be applied in aid of rates. There was no addition to capital expenditure, and £1,945 was paid out of reserve towards an expenditure of £2,500 authorised in May, 1909, for turbo-generator, &c., also £145. 9s. (deferred payment for accumulators) was allocated to be met out of the fund in May, 1910.

Sheffield.—The annual report of the manager of the electric supply department for the year ended March 31 has been issued.

There was an increase in total revenue of £10,890, an increase in total costs of £4,370 and in capital charges of £1,067. There was an increase of 3,936,354 in the number of units sold (including 3,804,486 for power) and of 399 in consumers. Practically the whole of the increase in the units sold was for power. For the first time since March, 1908, the units for lighting have exceeded the previous year's sales although the lighting revenue is still slightly less than the preceding year, due to the use of metal filament lamps. The surplus was £3,417. 8s. 3d. on the year's working, compared with a deficit of £2,035 last year. The total costs showed a reduction from 0·555d. to 0·472d. per unit.

The Electric Light Committee recommend strengthening the financial position of the undertaking by transferring a further £5,000 from the accumulated surplus to a renewals fund for the renewal of old machinery, making £20,000 dealt with in this way.

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TRADE NOTES AND NOTICES.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1911 Edition of the Big Blue Book is READY, price 15s., post free in the United Kingdom, 15s. 9d. The volume brings a great mass of very valuable statistical and technical data quite up to date, and the Directorial Division has been thoroughly revised and amplified up to February 24th.

All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters receive every attention in the new volume, which aggregates more than 2,000 pages. The Directory Division is complete and thoroughly accurate, and has been completely revised. The Big Blue Book contains more names of live electrical firms and persons than any other Directory published, and this notwithstanding that all mere lists of members of Societies and Institutions (so easily and cheaply available) are excluded, as unreliable and of little value for Manufacturers' and Dealers' purposes. The full set of valuable Statistical and Engineering Tables, &c., have been very carefully revised and extended, and are now issued in a handy form. These are included in the 1911 Big Blue Book, making it the most complete work of the kind ever published.

TENDERS INVITED.

Tenders are invited up to Nov. 21 for supply of one automatic or semi-automatic switchboard and equipment to the Postmaster-General's Department in WESTERN AUSTRALIA. Tender forms and specifications may be obtained at the Commonwealth Offices, 72, Victoria-street, London, S.W. See an advertisement.

Tenders are invited up to Oct. 18 for the supply of 20 coin-in-the-slot attachments to the Postmaster-General's Department in WESTERN AUSTRALIA. Specifications, forms of tender, &c., may be obtained at the Commonwealth Office, 72, Victoria-street, London, S.W. See advertisement.

The Postmaster-General's Department in SOUTH AUSTRALIA require tenders up to Oct. 25 for supply of cable and paper sleeves. Tender forms and specifications may be obtained from the Commonwealth Office, 72, Victoria-street, London, S.W. See also an advertisement.

The WESTMINSTER ELECTRIC SUPPLY CORPORATION invite tenders for supply, delivery and erection at their Davies-street station of battery boosters and switchboards. Copies of specification, with drawing and general conditions can be obtained from the Secretary of the Corporation, Eccleston-place, Belgravia, S.W., to whom tenders by 10 a.m. of Sept. 12.

Tenders will be received until noon Monday, Sept. 18, for the supply of Swedish, Norwegian, Finland or Russian red fir telegraph poles, for the GENERAL POST OFFICE. Forms of tender from the Controller of Stores, Mr. G. Morgan, Stores Department, G.P.O., 17 and 19, Bedford-street, London, W.C.

ECCLES Electricity Supply Committee require tenders by noon, Sept. 12, for supply and erection of h.t. single phase a.c. switchboard. Specification, &c., from the Borough Electrical Engineer.

PONTYPRIDD Council want tenders by noon Sept. 12 for supply and erection of water tube boiler and Foster superheater. Specification, &c., from Mr. J. E. Teasdel, Electricity Works, Treforest.

MERTHYR TYDFIL Corporation want tenders by Sept. 12 for wiring and fitting the Mardy Hospital buildings. Plans with Borough Surveyor.

SWINTON and PENDLEBURY Council require tenders by Sept. 9 for 12 months' supply of cables, joint boxes, wood troughing, wood covers, bridges and bends, joint box compound and bitumen. Particulars from Clerk.

WISHAW Electricity Department require offers by Sept. 11 for supply of 30,000 pairs of carbons for Oriflame arc lamps burning 12 in series, 480 volts d.c.

Tenders are invited up to Sept. 26 for supply of telephone material and 30 miles of telephone cable, up to Oct. 2 for supply of 10,000 porcelain insulators to Postmaster-General's department in TASMANIA, and up to Oct. 3 for the supply of 42 miles of telephone cable to the Postmaster-General's department in VICTORIA. Tender forms and specifications at the Commonwealth Office, 72, Victoria-street, London, S.W.

The Metropolitan Water and Sewerage Board, Albert-street, BRISBANE, Queensland, want tenders by noon Jan. 30 next for supply and erection of one, two or three complete units, each consisting of power generating plant and pump or pumps to lift not less than 6,000,000 gallons per day. Particulars from the Secretary, and forms from the Agent-General for Queensland.

DUNEDIN (N.Z.) Corporation require tenders by Nov. 1 for supply of (1) 500 B.H.P. vertical type gas engine or Diesel oil engine, suitable for rope driving an a.c. motor and d.c. generator; and (2) direct-coupled vertical type gas engine or Diesel oil engine and d.c. generator (800 kw. at 550 volts). Specification at 73, Basinghall-street, London, E.C.

ANTWERP municipality require tenders by Sept. 14 for electric lighting of a shed on quay 77 of the canal basin. Specification at 73, Basinghall-street, London, E.C.

TULCEA (Roumania) municipality require tenders by Nov. 19 for electric lighting of the town.

Tenders are required for the erection and equipment of an electric power station at the port of VARNA (Bulgaria). Tenders to the Section des Finances of the Railways and Ports Department, Sofia, by 3 p.m. Sept. 30.

NORRKÖPING (Sweden) Harbour Authority require tenders by Sept. 15 for supply of electric windlasses. Specification (in Swedish) at 73, Basinghall-street, London, E.C.

Tenders are invited by the Municipal Council of PELOTAS (Brazil) for a 40 years' concession for the supply of electricity for power and lighting and the establishment and working of electric tramways. Tenders to Senhor Luiz M. da S. Pennafiel, Intendencia Municipal, Pelotas, up to 1 p.m. Nov. 14. A deposit (about £300) is required with each tender, to be increased by the successful tenderer to 25,000 milreis (about £1,670). Further particulars (in Portuguese) can be seen by British contractors at 73, Basinghall-street, London, E.C.

The Municipal Council of BUDAPEST, Hungary, require tenders for the manufacture and supply of plant for a steam-driven electrical generating station, including two groups of three-phase turbo-generators (5,000 kw. each), 10,000 volts 50 cycles, boiler equipment for mechanical output of 5,000 kw. with reserve, pipeline, central switching and accessory equipments, travelling crane for engine room and coal-conveying plant. Specifications, &c., can be obtained at the Presidial Section of the Council, 9: IV., Városház-utca 16, II. 1, Budapest. Tenders by 11 a.m. Sept. 30.

Tenders will be received at the Town Hall, SYZRAN, Russia, on Oct. 14, for the construction of an electric tramway and the supply of electrical energy for lighting.

TENDERS RECEIVED AND ACCEPTED.

The following tenders have been accepted by Salford Corporation: Crompton & Co., continuous-current generator for Ladywell sanatorium, £138. 17s.; Lancashire Electrical Co., system of intercommunication telephones in Town Hall and several departments, £232; Johnson & Phillips, installation of electric light in Health and Water offices, £123. 18s. 6d., and £12 for contingencies.

Warrington Council have accepted the tender of Matthews & Yates for supply of induced draught plant.

The Great Indian Peninsula Railway Co. have placed orders with Greaves, Cotton & Co., Turner Hoare & Co. and H. L. Rochat & Co. (all of Bombay) for lamps, &c., and with W. T. Henley's Telegraph Works Co. for cables, for the illumination of the Victoria (Bombay) terminus during the visit of the King and Queen.

Escher, Wyss & Co. have recently received orders for two 19,000 h.p. tangential wheels, patent oil pressure governors, two pipe lines, valves, &c., for the Rio de Janeiro Tramway, Light and Power Co., four 13,200 h.p. and two 1,000 h.p. high-pressure turbines with governors, for the Tata power works, Bombay, and four 3,000 h.p. and one 100 h.p. turbines, with governors, for the Fuji Cotton Mill, Japan.

Sale by Auction.—Messrs. Horne & Co., 35, Old Queen-street, Westminster, S.W., will sell by public auction at the Royal Arsenal, Woolwich, at 11 a.m. on Thursday, Sept. 21, by order of the Secretary of State for War, some unserviceable and obsolete stores, including quantities of iron, steel, brass, copper, gunmetal, zinc, lead, &c., two vertical engines and dynamos, an electric generator, some

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engineers' tools, instruments, electric lamps, 8,000 electric lamp bases, &c. Lots may be viewed at the Royal Arsenal, Woolwich, on Monday, Tuesday and Wednesday previous to and on morning of sale. Catalogues from the War Office, Whitehall, the Ordnance Office, Tower, and the Ordnance Office, Royal Arsenal, Woolwich. See also an advertisement.

Plant for Sale.—Mr. Alex. Mein, Station-street, Stratford, London, E., advertises for sale a Crompton three-phase alternator, switchboard, &c.

Fire.—Owing to the outbreak of fire at Ward, Lock & Co.'s premises on 30th ult, Messrs. C. H. Cathcart & Co., 2, Dorset-bldgs., Salisbury-square, E.C., are unable to continue business for a few days and they ask for the indulgence of the trade. The firm would be glad of new sets of lists from all firms who issue catalogues, as the whole of their stock is spoiled.

BANKRUPTCIES, LIQUIDATIONS, &c.

Claims against the Solium Electrical Co. (Ltd.) (in voluntary liquidation) to Mr. E. Harlow, 23, King-street, Nottingham, by Sept. 30.

A first and final dividend of 11d. is payable on Sept. 11 at 191, Corporation-street, Birmingham, to creditors of John D. Carlmark, electrical engineer, 402, High-street, West Bromwich.

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from *The Electrician* office, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published under 2s., and 5 per cent. for books published nett. Add 10 per cent. for abroad or for foreign books.]

"College Physics." By J. O. Reed and K. E. Guthe. (New York, 1911: The Macmillan Co.) 12s. net.

"Science Abstracts." No. 164. Vol. XIV., Part 8. Section A, Physics; Section B, Electrical Engineering. (London, 1911: E. & F. N. Spon.) 1s. 6d. each.

"The Transactions of the South African Institute of Electrical Engineers." Vol. II., Part 5. 2s.

COMPANIES' MEETINGS AND REPORTS.

ABERDEEN SUBURBAN TRAMWAYS CO.—At the meeting last week the chairman (Mr. Geo. J. Walker) said that the results of the half-year's working had been satisfactory. They would require in the future to make considerable additions to reserve and depreciation. The new car they had acquired had been of considerable assistance during the summer months, but another car was desirable. A dividend of 2½ per cent. for the past year was declared.

DIRECT WEST INDIA CABLE CO. (LTD.)—The accounts for the year ended June 30 show a profit of £6,323, out of which the directors recommend a further dividend of 3 per cent., making the usual distribution of 6 per cent. for the year, leaving £4,523 to be added to credit of revenue account, increasing it to £36,249.

ELECTRIC SUPPLY CO. OF VICTORIA (LTD.)—The accounts for the year ended March 31 last show a net profit of £11,340, and a credit balance after payment of preference dividend of £7,231.

HALIFAX & BERMUDAS CABLE CO. (LTD.)—The accounts for the year year ended June 30 show a profit of £8,168, out of which the directors recommend a further dividend of 2½ per cent., making the usual distribution of 5 per cent. for the year, leaving £5,668 to be carried to credit of revenue account, which now stands at £26,095.

UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON (LTD.)—The net revenue from investments and properties for half-year ended June 30 (after deducting general expenses) amounted to £106,105. 15s. The amount receivable under guarantee £2,686. 15s. 1d. The net income from the operation of the power house was £45,472. 3s. 7d., less interest, &c. (£20,870), leaving a surplus from the power house of £24,602. 3s. 7d. The bond service required £93,898. 2s. 11d., leaving a surplus over half-yearly charges of £39,496. 10s. 9d. This is to be applied in paying interest at the rate of 1½ per cent. on the 6 per cent. income bonds (£36,960. 7s. 6d.) and income tax (£2,289. 11s. 7d). Income from investments for the six months shows an increase of £15,678 (about 17 per cent.) over the same period last year. The traffics of the railway companies and the London United Tramways (Ltd.), in which this company is interested, is increasing satisfactorily. The eighth Parsons turbine has now been installed at the power house and is in operation. The net output of electric energy during the half-year was 69,636,800 units, against 63,627,200 units during the corresponding period of 1910.

NEW COMPANIES, MORTGAGES & CHARGES, &c.

NEW COMPANIES.

BERG, SHEPHERD & CO. (LTD.) (117,425)—Reg. Aug. 28, capital £1,250 in 1,000 6 per cent. preferred shares of £1 each and 5,000 deferred shares of 1s. each, to carry on the business of electrical engineers, contractors, suppliers of electricity, carriers of passengers and goods, manufacturers of electrical, railway, tramway and other apparatus, &c., to acquire the business carried on as J. Berg, and to adopt an agreement with J. Berg and F. H. Shepherd. Private company. First directors: J. Herman, C. A. Lageson, J. Berg and F. H. Shepherd.

BIRMINGHAM PRIVATE TELEPHONE (NEW SYSTEM) CO. (LTD.) (117,445)—Reg. Aug. 29, capital £2,500 in £1 shares, to carry on (so far as they lawfully can) the business of makers, sellers, maintainers and workers of private telephones, telegraphs and electrical apparatus, &c. Private company. First directors: A. Gunz (managing director and chairman) and F. T. Jackson. Reg. offices: 12, Livery-street, Birmingham.

CANADIAN POWER TRAMWAYS CONSTRUCTION SYND. (LTD.) (117,482) Reg. Aug. 31, capital £20,000 in £1 shares, to carry on the business indicated by the title. Private company. Reg. office: 6, Princes-street, London, E.C.

GROSART & KAY (LTD.) (7,976)—Reg. in Edinburgh, Aug. 28. Capital £1,000 in £1 shares, to acquire business of Grosart & Kay, electrical and engineering merchants, Glasgow. Private company. First directors: W. J. Grosart and A. E. R. Copeland. Reg. office: 196, St. Vincent-street, Glasgow.

ORIENTAL M. T. C. (LTD.) (117,469)—Reg. Aug. 30, capital £10,000 in £1 shares (4,000 preference, 4,000 ordinary and 2,000 founders), to carryion the business of financiers, concessionaires, electricians, engineers, suppliers of electricity, &c., and to adopt an agreement with the Radio & Electric Power Co. (Ltd.). Private company. First directors: W. J. Van Hoytema and A. C. Grover.

MORTGAGES AND CHARGES.

METALITE (LTD.)—Mortgage on freehold hereditaments and premises at Osmaston, Derby, and company's undertaking and property, present and future, including uncalled capital, dated Aug. 11, 1911, to secure all moneys due or to become due from the company to London, City & Midland Bank.

WARREN, BEATTIE & CO. (LTD.)—Charge on company's undertaking and property, including uncalled capital, dated Aug. 16, 1911, to secure all moneys for which the mortgagees (as guarantors) may become liable to company's bankers. Holders, Dr. D. Drummond and G. Jones. A memorandum of satisfaction in full on Aug. 16, 1911, of debentures dated May 7, 1907, and Nov. 30, 1908, securing £1,500 and £500, has also been filed.

CITY NOTES.

MEMORANDA (Sept. 7).—**Bank rate 3 per cent.** (since March 9, 1911.) **Price of silver, 24⅛d. per oz. Consols 77½—77⅝ for money; 77½—77⅝ for account. Consols Pay Day, Oct. 5; Stock and Shares Continuation Days, Sept. 12 and 25; Ticket Days, Sept. 13 and 27; Pay Days, Sept. 14 and 28; Mining Shares Carry Over Day, Sept. 11.**

PRICES OF METALS (London).—*Copper*, cash, 56; three months, 56¾. *Lead*, English, 14⅝—14¾; Foreign, cash, 14⅝—14¾; three months, 14½—14⅝. *Spelter*, 27½—27¾. *Tin*, English, 190—191; Foreign, cash, 187; three months, 185¼. *Iron*, Cleveland, cash, 46/10, three months, 47/7.

ASCOT DISTRICT GAS & ELECTRICITY CO. (LTD.)—The directors have declared an interim dividend at the rate of 5½ per cent.

BRISBANE ELECTRIC TRAMWAYS INVESTMENT CO. (LTD.)—This company's receipts for August were £24,650 (increase £2,700). Aggregate from Jan. 1, £163,520 (increase £18,725).

BRITISH ELECTRIC TRANSFORMER CO. (LTD.)—The directors have declared an interim dividend at the rate of 6 per cent. (less tax) on the ordinary shares for the past half-year.

DAVIS & TIMMINS (LTD.)—An interim dividend at the rate of 6 per cent. has been declared for the half-year to June 30.

GLOBE TELEGRAPH & TRUST CO.—The directors have declared an interim dividend of 2s. per share (tax free) on the ordinary shares for the past quarter.

HAMBURG ELECTRICITY WORKS CO.—The directors have declared a dividend of 8 per cent. for the past year.

NEWCASTLE DISTRICT ELECTRIC LIGHTING CO. (LTD.)—An interim dividend at rate of 3 per cent. has been declared for the past year.

OXFORD ELECTRIC CO. (LTD.)—The directors have declared a dividend at the rate of 6 per cent., less tax, on the ordinary shares for the half-year to June 30.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have granted quotations to a further issue of 37,900 £1 fully-paid ordinary shares and 227,011 £1 fully-paid 7 per cent. cumulative participating preference shares of *Marconi's Wireless Telegraph Co.*

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ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount	Inc. or Dec. (a)	AGGREGATE. No. of weeks.	Amount.	Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Aug. 30	1,696	+ 15	13	21,680	+ 1,347
Airdrie	„ 25	231	+ 18	34	7,380	+ 67
Anglo-Argentine	..	..	..	..	..	..
Ashton-under-Lyne	Sept. 2	399	+ 28	23	9,824	+ 799
Ayr Corporation	„ 2	364	+ 61	16	6,905	+ 88
Barnsley	Aug. 25	264	+ 58	34	6,272	+ 404
Barrow	„ 25	413	+ 108	34	10,273	+ 1,077
Bath Electric Trams, Ltd.	„ 30	1,010	— 36	35	29,882	+ 1,154
Birmingham Corporation	Sept. 2	8,759	+ 2,189	22	177,280	+ 27,608
Birmingham & Midland	Aug. 25	957	+ 41	34	30,696	+ 1,851
Blackpool & Fleetwood	Sept. 2	1,754	+ 333	..	..	..
Blackburn Corporation	Aug. 30	1,102	+ 119	†23	27,178	+ 2,489
Bolton Corporation	Sept. 3	2,638	+ 163	23	58,433	+ 4,350
Bombay	Aug. 4	2,782	+ 260	33	88,222	+ 5,397
Bournemouth Corporation	„ 30	2,358	+ 96	22	42,731	— 1,722
Bradford Corporation	Sept. 2	5,509	+ 418	22	126,799	+ 10,605
Brighton Corporation	„ 3	1,386	+ 114	¶22	26,187	+ 1,808
Bristol Trams & Carriage	„ 1	7,045	+ 731	22	162,596	+ 17,542
Burnley Corporation	„ 2	1,367	+ 169	22	23,632	+ 3,033
Burton Corporation	„ 3	335	+ 66	22	6,744	+ 624
Bury Corporation	„ 3	1,293	+ 70	¶22	29,971	+ 3,106
Calcutta Tramways Co.	„ 2	R56,390	— R2,120	9	R521,338	+ R41,626
Camborne-Redruth	„ 2	128	+ 1	35	4,297	+ 34
Cardiff Corporation	..	..	..	..	..	..
Central London Railway	„ 2	4,077	— 854	9	38,685	— 8,175
Chatham & Dist. Lt. Rys.	..	..	..	..	..	..
City & South London Rly.	„ 3	3,030	+ 40	9	27,168	— 455
City of Birmingham	Aug. 25	1,115	— 1,756	34	85,386	— 11,132
Clerk Electric Trams Co.	„ 31	542	+ 23	35	17,622	+ 505
Croydon	..	..	..	..	..	..
Devonport & Dist. Trams	„ 25	587	+ 126	34	16,812	+ 2,497
Dover Corporation	..	..	..	..	..	..
Dublin & Lucan Railway	Sept. 1	161	— 28	9	1,580	— 51
Dublin United	„ 1	6,070	— 362	9	65,399	+ 9,622
Dudley-Stourbridge	Aug. 25	931	— 78	34	28,982	+ 1,952
Dundee Corporation	„ 30	1,211	— 130	¶15	18,515	— 397
East Ham Council	Sept. 2	1,096	+ 42	22	24,659	+ 1,350
Exeter Corporation	„ 1	402	+ 48	22	8,219	+ 707
Gateshead & Dist. Trams	Aug. 25	1,127	+ 138	34	35,329	+ 2,016
Glasgow Corporation	Sept. 2	19,704	+ 1,789	§13	251,275	+ 16,378
Glossop Trams	„ 2	124	+ 15	35	4,348	+ 339
Gloucester Corpn.	..	..	..	..	..	..
Gravesend-Northfleet	Aug. 25	236	+ 3	34	7,261	+ 205
Great Northern & City Rly.	Sept. 2	1,337	— 3	9	12,110	+ 245
Greenock & Port Glasgow	Aug. 25	863	+ 142	34	24,534	+ 3,146
Halifax Corporation	„ 29	1,945	+ 162	†22	45,883	+ 5,143
Hampstead Tramways	„ 25	380	+ 79	34	9,260	+ 784
Hastings Elec. Trams Co.	„ 31	1,612	+ 144	9	13,159	+ 143
Hong Kong	Sept. 2	$9,707	— $1,984	..	..	..
Huddersfield Corpn.	„ 2	1,943	+ 231	22	44,288	+ 4,707
Hull Corporation	„ 2	2,810	+ 10	22	63,468	+ 2,960
Hull District Council	„ 2	545	+ 19	23	12,662	+ 525
Ilkeston District Council	Aug. 30	127	— 14	22	2,994	+ 110
Ilkeston Corporation	Sept. 2	584	+ 81	22	10,894	+ 694
Isle of Thanet Co.	„ 2	2,026	+ 321	48	31,876	+ 1,698
Ivybridge	Aug. 25	200	+ 58	34	4,570	+ 336
Jersey Corporation	..	..	..	..	..	..
Kidderminster & District	„ 25	142	..	34	4,114	+ 279
Kilmarnock Corporation	Sept. 2	167	+ 15	16	2,858	+ 312
Kinross-shire Trams Co.	Aug. 31	1,558	+ 110	35	49,230	+ 783
Lanarkshire United	„ 30	1,281	+ 39	35	47,341	+ 1,726
Leamington	„ 25	231	+ 14	34	6,050	+ 332
Leeds Corporation	Sept. 2	7,507	+ 466	22	170,327	+ 12,166
Leicester Corporation	„ 2	2,496	+ 146	22	57,599	+ 4,978
Lincoln Corporation	„ 2	694	+ 56	‡16	11,352	+ 999
Liverpool Corporation	..	..	..	..	..	..
Liverpool Corporation	Aug. 19	8,333	— 3,169	33	378,753	+ 12,296
Liverpool Overhead Rly.	Sept. 3	1,722	+ 294	9	13,783	+ 349
Llandudno&ColwynBayRy.	„ 1	753	+ 90	§39	11,899	+ 467
London County Council	Aug. 23	42,575	+ 660	‡13	935,467	+ 59,701
Lowestoft Elec. Ry. Co.	Sept. 2	10,925	+ 125	9	104,205	+ 1,475
Lytham United	„ 2	7,179	+ 386	35	234,298	+ 9,897
Macclesfield Corporation	„ 2	517	+ 98	48	10,190	+ 682
Manchester Corporation	„ 2	15,569	+ 236	22	364,414	+ 21,848
Manx Railway	„ 2	1,836	— 86	9	15,965	— 1,602
Maryport	Aug. 25	201	— 22	34	7,140	+ 134
Metropolitan Dist. Railway	Sept. 2	10,039	+ 509	9	94,208	+ 4,228
Metropolitan Elec. Trams	Aug. 25	8,863	+ 980	34	238,653	+ 46,782
Middleton	„ 25	643	+ 254	34	11,878	+ 1,046
Middlesbrough Corporation	Sept. 2	190	+ 40	§22	4,212	+ 896
Newcastle-on-Tyne Corp.	„ 2	4,037	+ 186	22	96,026	+ 6,762
Newport (Mon.)	„ 2	695	— 26	22	16,416	+ 891
Northampton Corporation	„ 1	563	+ 61	22	12,498	+ 1,159
North Ashton & Hyde	Aug. 25	735	+ 118	34	19,226	+ 734
Nottingham Corporation	Sept. 3	1,892	+ 123	23	45,261	+ 1,737
Oldham (B.) Corporation	Aug. 30	179	— 3	15	3,059	+ 214
Oldham (W.A.) Elec. Trams	..	..	..	..	..	..
Paisley	„ 25	139	+ 5	34	4,355	+ 427
Plymouth Corporation	..	..	..	..	..	..
Port	„ 25	1,880	+ 117	34	65,252	+ 6,380
Portsmouth Corporation	„ 30	798	+ 37	22	17,731	+ 1,365
Rawtenstall Corporation	„ 31	655	+ 19	22	15,160	+ 1,412
Rhyl	„ 25	508	+ 7	34	8,037	— 16
Rochdale Corporation	Sept. 4	4,872	— 37	§22	111,727	+ 6,056
Rotherham	Aug. 30	$11,500	+ $727	8	$97,000	+ $8,994
Rotherham	„ 25	73	+ 2	34	1,795	+ 70
Rotherham Corporation	Sept. 3	6,448	+ 411	22	148,822	+ 10,155
Rouen Trams	„ 2	$9,434	— $836	..	..	..
Rotherham Metropolitan	Aug. 25	973	+ 76	34	29,879	+ 1,686
Rotherham	„ 25	973	+ 35	34	30,580	+ 2,204
Rotherham	„ 30	1,495	+ 219	22	28,539	+ 3,752
Rotherham Corporation	„ 30	1,138	+ 232	22	17,597	+ 2,538
Rotherham Tramways	„ 25	380	+ 17	34	10,622	+ 444
Rotherham, Hyde, &c., Jt. Bd.	Sept. 2	787	+ 53	22	18,335	+ 1,754
Rotherham Corporation	„ 3	1,495	+ 160	22	31,006	+ 4,046
Rotherham District	Aug. 30	519	+ 33	44	20,579	+ 1,642
Rotherham Trams	„ 25	1,215	+ 18	34	39,050	+ 2,413
Rotherham Corporation	Sept. 30	177	+ 24	22	3,594	+ 433
Rotherham	„ 25	45	+ 4	34	1,466	+ 26
Rotherham and District	„ 25	562	+ 81	34	9,531	+ 356
Rotherham Trams Co.	„ 30	528	+ 70	9	5,245	+ 644
Rotherham Corporation	Sept. 2	1,183	+ 165	§22	26,270	+ 4,143
Rotherham Corporation	„ 2	540	+ 12	34	19,552	+ 789
Rotherham Corporation	Aug. 31	377	— 19	22	8,810	+ 203
Rotherham Corporation	„ 31	2,682	+ 210	22	61,289	+ 6,184
Rotherham-Mare	„ 25	419	+ 7	34	6,076	+ 641
Rotherham Co.	„ 25	483	+ 18	34	15,185	+ 712
Rotherham Corpn.	„ 30	954	+ 62	22	22,534	+ 1,416
Rotherham	„ 25	317	— 16	34	10,093	+ 462
Rotherham W.R. Trams	„ 25	118	+ 15	34	3,443	+ 159
Rotherham Woollen District	Sept. 3	1,304	+ 41	36	46,385	+ 2,457
	Aug. 25	1,161	+ 99	34	35,876	+ 2,575

a comparisons are with the corresponding period last year. * Partly electrical.
† Minus 3 days. ‡ Minus 2 days. § Plus 3 days. ¶ Plus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Nominal	Last Dividend	NAME.	Price Wed., Sept 6.	*Rate per cent. Yielded.	Dividend Due.	Business Week to Sept. 6. Highest.	Lowest.
		Electricity Supply.		£ s. d.			
10	5/0	Bournemouth & Poole Elec. Sup. Ord.	7¼—8¼	7 10 0	Mar, Sep	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref.	8½—9½	4 17 3	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Second Pref.	10 —10½	5 17 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101 —103	4 6 6	Jan, July	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	7¼—8¼	6 5 0	March	7½	..
5	3/6	Do. 7 per Cent. Pref.	7¼—7¾	4 11 9	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Deb. Stock	99 —102	3 19 6	June, Dec	..	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	3¾—4¼	5 0 0	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	4¼—5	4 12 3	Feb., Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	94 —98	4 3 3	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	100 —102	4 8 3	..	101½	..
5	2/3	Do. City Undertaking 4½% Cum. Pref.	3¾—4¼	5 10 6	Jan, July	..	..
5	3/0	Chelsea Electric Supply Ord.	4 —4½	5 11 0	March	4½	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	98 —100	4 11 0	June, Dec	..	..
10	6/0	†City of London Electric Lighting Ord.	12 —12½	4 18 0	Feb, Aug	..	..
10	6/0	†Do. 6 per Cent. Cum. Pref.	11½—12½	4 18 0	Jan, July	..	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	119 —123	4 2 9	June, Dec	..	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	100 —103	4 8 6	Jan, July	..	..
St.	5%	County of Durham Elec. P. D. 5% 1st Mort. Deb. Stk.	89½—91½	5 10 6	Jan, July	..	..
10	4/0	County of London Elec. Supply Ord.	7¼—7¾	3 5 9	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	10¾—11¾	5 8 0	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Deb Stock (red.)	108 —110	4 2 6	Jan, July	109	108½
St.	4½%	Do. Second Deb. Stock	100 —103	4 7 6	May, Nov	..	..
..	..	Edmundson's Elec. Corp. Ord.	¾—1¼	..	Jan, July	..	..
..	..	Do. 6 per Cent. Cum. Pref.	2 —2½	..	May, Nov	..	..
St.	4½%	Do 4½ per cent. 1st Mort. Deb. (red.)	83 —86	5 6 6	July	..	..
5	4/0	Folkestone Electricity Supply Co. Ord.	4¼—4¾	6 6 0	April, Oct	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4¾—5¼	4 15 3	Mar, Sept	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red)	95 —98	4 13 3	Feb, Aug	..	..
5	5/0	Hove Electric Lighting Ord.	6¾—7¼	6 4 0	April, Oct	..	..
St.	4½%	Isle of Wight E. L. & P. Co. Deb. Stk.	88 —91	4 19 0	..	..	..
5	4/0	Kensington & Knightsbridge Ord.	6¾—7¼	6 18 6	Feb, Aug	..	..
5	6%	Do. 6 per Cent. 1st Pref.	5¾—6	5 0 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	91 —93	4 6 0	..	..	..
St.	4%	Kensington & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	96 —99	4 1 0	April, Oct	..	..
St.	4½%	Kent Elec. Power Co. Irred Deb. Stk.	80 —84	5 10 0	Jan, July	..	..
3	1/2½	London Electric Supply Ord.	1¾—2	3 8 0	Mar, Sept	..	..
5	3/0	†Do. 6 per Cent. Pref.	4¼—4¾	6 8 0	Mar, Sept	4½	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	89 —92	4 8 0	Jan, July	..	..
5	2/0	Metropolitan Electric Sup. Ord.	3¾—4¼	6 0 0	April, Oct	..	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	4¼—4¾	4 17 0	Jan, July	4½	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	100 —105	4 8 0	June, Dec	101½	..
St.	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	84½—87½	4 1 6	Jan, July	..	..
..	4½%	Midland Elec. Corp. for P.D. 4½ 1st Mort. Debs	96½—98½	4 12 6	..	..	..
5	2/0	Newcastle Elec. Supply Ord. (1-50,000 & 57,010-137,500)	3¼—4	6 0 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non Cum. Pref.	4 —4½	5 17 6	Feb, Aug	..	..
100	4½%	Do. 4½ per Cent. 1st Mort. Deb.	97 —99	4 12 0	Jan, July	..	..
100	5%	North Metro. Elec. Power Sup. 5 Morts.	101 —104	4 17 6	..	..	..
1	6%	Northampton Elec. Lt. & P. Ord.	1¼—1⅛	4 11 6	Feb, Aug	..	..
1	5%	Do. 5% Pref.	1⅛—1⅜	4 6 0	Feb, Aug	..	..
St.	4%	Do. 4% Debs.	99 —101	3 19 0	June, Dec	..	..
10	6/0	Notting Hill Electric Ord.	..	5 17 6	March	..	..
5	4/3	Oxford Electric Ord.	6¼—6¾	5 10 0	March	..	..
St.	4%	Do. 4% Deb. Stk.	91 —94	4 5 1	..	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	8½—9½	5 11 0	Feb, Aug	..	..
5	3/6	Do. 7 per Cent. Pref.	6¾—7¼	5 0 0	Feb, Aug	..	..
St.	3½%	Do 3½ per Cent. Deb. Stock (red.)	85 —87	4 1 6	Jan, July	..	..
5	..	Smithfield Markets Electric Sup. Ord.	1¼—1¾	..	Feb.	..	..
5	4/0	South London Electric Supply Ord.	2¾—3	6 5 6	April	..	..
St.	5%	Do. 5% 1st Mort. Stock (red.)	98½—101½	5 0 6	..	..	..
1	0 8⅔	South Metrop'n Elec. Lt & Power 7% 1st Pref	1⅛—1¾	6 5 0	Feb, Aug	..	..
1	0/7½	Do. 6 per Cent. 2nd Pref.	⅝—¾	6 17 0	Feb, Aug	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	97 —100	4 11 6	April, Oct	..	..
5	1/3	Urban Electric Supply Ord.	¾—1	..	April, Oct	..	..
5	1/3	Do. 5 per Cent. Cum. Pref.	2 —2½	11 2 3	April, Oct	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	87½—89½	5 1 9	April, Oct	..	..
5	5/0	Westminster Elec. Sup. Ord.	7¼—8	6 15 6	Mar, Sept	..	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	5 —5½	4 3 6	Jan, July	5½	..
		Electric Railways and Tramways.					
1	..	Bath Elec. Trams Pref. Ord.	⅛—¼	..	April	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	⅛—¼	8 0 0	Jan, July	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	79 —83	5 8 6	April, Oct	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Deb. Stock.	91 —93	4 17 9	Jan, July	92½	92
10	4%	Bristol Tramways & Carriage Ord.	5¾—6¼	6 13 6	Feb, Aug	..	..
10	4%	Do. Cum. Pref.	7 —7½	5 10 0	..	..	..
St.	4%	Do. 4 per Cent. Debs.	100 —101	3 19 2	Feb, Aug	..	..
10	..	British Electric Traction Ord.	¾—1¼	..	June, Dec	..	..
10	..	Do. 6 per Cent. Cum. Pref.	3¼—3¾	..	Feb, Aug	3⅛	3⅛
St.	5%	Do. 5 per Cent. Perpetual Debs.	93 —96	5 6 0	April, Oct	93	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock.	75 —79	5 17 0	May, Nov	..	..
St.	3%	Central London Ordinary Stock	67 —69	4 8 0	Feb, Aug	67½	..
St.	4%	Do. 4 per Cent. Pref. Stock	85 —87	4 13 0	Feb, Aug	85	..
..	6/4	Do. 4½% Pref. Scrip 75% pd	83 —90	..	..	..	..
St.	2%	Do. Deferred Stock	49 —51	4 0 0	Feb.	..	..
100	4%	Do. 4 per Cent. Debs.	102 —104	3 16 11	Jan, July	104	102½
5	2/6	City of Birmingham Trams, 5 % Cum. Pref.	4¼—5⅛	4 19 6	April, Oct	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 18 9	April, Oct	..	..
St.	1¾%	City & South London Rly. Con. Ord.	27 —30	5 19 0	Feb, Aug	30	29½
St.	5%	Do. 5 per cent. Perp. Pref. (1891)	103 —110	4 11 9	Feb, Aug	..	..
St.	5%	Do. (1896)	104 —106	4 16 0	Feb, Aug	..	..
St.	5%	Do. (1901)	103 —105	4 17 0	Feb, Aug	..	..
St.	5%	Do. (1903)	102 —104	4 16 0	Feb, Aug	102½	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	102 —104	3 17 9	May, Nov	..	..
10	6/0	Dublin United Trams. 6 per Cent. Pref.	11½—12½	5 0 0	Feb, Aug	..	..
10	12/0	Gateshead and District Trams Ord.	8½—8¾	6 19 0	..	..	..
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	¾—1¼	..	Feb, Aug	..	..
5	..	Hastings & District Elec. Trams, 6% C. P.	..	..	Mar. Sept	..	..
St.	4½%	Do. 4½ Deb. Stock	75 —80	5 10 0	April, Oct	..	..
10	..	Imperial Tramways Ord.	3 —3¼	..	Mar, Sept	..	..
10	..	‡Do. 6 per Cent. Pref.	4 —4¼	..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Debs.	72 —74	6 3 6	Jan, July	..	..
..	2/0	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	2¼—3	4 11 0	Mar, Sept.	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	77 —82	5 1 0	Jan, July	..	..
10	5/6	Lanarkshire Tramways	9¾—10¼	5 15 0	Feb, Aug	..	..
St.	5%	Lancs Utd. Trams, 5% Prior Lien Deb. Stk.	79 —82	6 4 0	Jan. July	..	..
St.	4%	London Electric 4% Deb. St.	96 —98	4 2 6	..	97½	97
St.	4%	Do. 4% Pref.	82½—83½	4 16 6	..	83½	82½
10	..	London United Trams, 5% Cum. Pref.	3¼—3¾	..	Jan, July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	70 —75	5 10 6	Jan, July	..	..
St.	..	Mersey Con. Ord. Stock	6 —8	..	Feb, Aug	..	..
1	1/1½	Metropolitan Elec. Tramways Ord.	⅝—1⅛	6 0 0	..	..	..
1	..	Do. Deferred	⅛—¼	..	April	⅜	..
1	0/6	Do. 5 per Cent. Pref.	⅛—¼	5 8 0	Feb, Aug	⅜	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	99 —101	4 10 0	Jan, July	99½	..
St.	5%	Do. 5 per Cent. Db. Stk	102 —104	4 17 0	..	103½	102½

* No allowance has been made for accrued interest or redemption.
† Ex Dividend ‡ The London Stock Exchange Committee have declined to quote these.

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ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Electric Railways and Tramways—*Continued.*

Size	Last Dividend	Name	Price Wed., Sept. 6	*Rate per cent. Yielded (£ s. d.)	Dividend Due	Business Week to Sept. 6 Highest	Lowest
St.	2%	Metropolitan Railway Consolidated	43¼—43¾	4 12 0	Feb, Aug	43¾	43
St.	3%	Do. Surplus Lands Stocks	64—66	4 12 3	Feb, Aug	66	
St.	3½%	Do. 3½ per Cent. Preference	88—90	3 18 6	Feb, Aug	88½	88½
St.	3½%	Do. 3½ per Cent. "A" Preference	87—89	3 19 6	Feb, Aug	87½	–
St.	3½%	Do. 3½ per Cent. Convertible Pref.	87—89	3 19 6	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Debenture Stock	92—94	3 14 6	Jan, July	92	..
St.	3½%	Do. 3½ per Cent. "A" Deb. Stock	91—93	3 16 0	Jan, July	..	–
St.	..	Metropolitan District Railway Ord.	24—24½	..	Feb, Aug	24½	23¾
St.	4½%	Do. 4½% First Pref.	85—87	5 4 9	Feb, Aug	86¾	85½
St.	3½%	Do. Assented 1st Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	74—76	4 13 6	Feb, Aug	..	–
St.	3%	Do. 3 per Cent. Consoltd. Rent-charge	76—78	3 18 0	Jan, July	–	..
St.	4%	Do. 4 per Cent. Midland Rent-charge	102—104	3 17 9	Jan, July	..	–
St.	6%	Do. 6 per Cent. Perp. Deb. Stock	145—147	4 2 0	Jan, July	146½	..
St.	4%	Do. 4 per Cent. Ditto	96—98	4 2 6	Jan, July	..	..
1	4½d.	Potteries Electric Traction Ord.	[illegible]	6 11 3	April, Oct	¼	–
1	0/6	Do. 5 per Cent. Cum. Pref.	[illegible]	8 9 6	Feb, Aug	1⁄16	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	88—91	5 0 0	May, Nov	–	..
1	1/2⅗	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	[illegible]	10 2 0	..	–	..
St.	4%	Do. 4 per Cent. Deb. Stock	73—78	5 6 0	Jan, July	..	–
100	5%	Sunderland Dist. Elec. Trms. 5% 1stMtDb.	..	8 4 0	Jan, July	..	..
–	15/0	Undergd E.Rys. Lon. 6% In. bds ex coup 7	59—61	2 1 0	June, Dec	61	–
–	5%	Do. 5% Prior Lien Bonds	100½—101½	4 19 0	..	99½	..
–	4½%	Do. 4½% Bonds with coup. 8	98—100	4 11 0	–	–	..
–	4%	Do. 4 per Cent. 1st Power Ho. Dbs.	101—103	3 18 3	..	–	–
5	–	Yorkshire (W.R.) Elec. Trams. Ord.	⅛—⅜	..	March –	..	..
5	–	Do. 6 per Cent. Cum. Pref.	2⅛—2⅜	..	..	..	..
St.	4½	Do. 4½ per Cent. 1st Debs.	80—85	5 9 6	Jan. July	..	..

Electric Manufacturing, &c.

Size	Last Dividend	Name	Price Wed., Sept. 6	*Rate per cent. Yielded (£ s. d.)	Dividend Due	Business Week to Sept. 6 Highest	Lowest
St.	4½%	Anchor Cable Co. 4½ % Deb. Stock	99—101	4 10 0	–	..	–
1	1/2⅗	Aron Electricity Meter Ord.	[illegible]	..	..	¼	–
1	0/7⅕	Do. 6% Cum. Pf.	[illegible]	7 10 0	April, Oct	..	..
1	3/2⅗	Babcock & Wilcox Ord.	5⅛—5⅜	4 14 6	April, Oct	5¼	5⅜
1	0/7½	Do. Pref.	1⅛—1¼	4 0 0	..	..	..
5	6/0	British Insulated & Helsby Cables Ord.	6⅛—7⅛	6 15 6	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	5⅞—6¼	5 0 0	Jan, July	..	–
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	102—104	4 7 0	Jan, July	102¾	–
St.	..	Do. 5% Mort. Deb. Stock	104—106	..	..	..	–
St.	4½%	†British Thoms'n-Houst'n 4½% 1st Mt.Db.	94—97	4 14 3	Mar, Sept	..	..
5	..	British Westinghouse 6 per Cent. Pref.	¼—½	..	Feb, Aug	¼	..
100	6%	Do. 6 per Cent. Prior Lien Dbs. (rd.)	102—104	5 17 0	..	–	–
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	59—62	6 6 6	Jan, July	..	..
St.	4½%	†BrushE.Eng. Co. 4½% Perp. 1st Deb.Stock	55—61	7 15 0	Mar, Sept	56¼	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	39—44	10 10 0	Jan, July	–	–
5	10/0	Callender's Cable Con. Ord.	9⅛—9⅝	7 10 0	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4¹³⁄₁₆—5⅛	4 19 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort Debs. (red.)	101—103	4 8 0	Nov, May	..	..
1	1/6	Castner-Kellner Alkali Co.	3¼—3⅜	5 4 3	May, Nov	3½	3½
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103—107	4 5 9	Feb. Aug	104¼	104½
1	1/0	Chadburn's (Ship) Telegraph Ord.	1⅛—1⁵⁄₁₆	5 19 0	March ..	–	..
1	0/8⅓	Consolidated Electrical Co.	[illegible]	7 8 9	August ..	–	..
1	0/6	Consolidated Signal Co.	[illegible]	8 7 6	April, Oct	..	..
1	0/7½	Do. 6 per cent. Cum. Pref.	[illegible]	7 6 6	April, Oct	..	..
3	..	Crompton & Co (Nos. 1 to 85,000)	[illegible]	..	Jan, July	..	..
100	5%	Do. 5 per Cent. 1st Mort. Debs. (red.)	57½—67½	8 0 0	Jan, July	..	..
5	1/0	‡Dick, Kerr & Co. Ord.	[illegible]	5 14 0	Sept.	..	..
5	0/7½	Do. 6 per Cent. Cum. Pref.	[illegible]—1³⁄₃₂	5 6 0	Sept	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	95—98	4 13 3	Jan, July	..	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	[illegible]	..	Feb, Aug	..	..
	..	Do. (£5 paid)	1⅞—2⅛	9 3 0	Feb. Aug	–	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (red.)	67—71	5 16 0	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	78—81	6 3 6	Mar, Sept	..	..
2	2½%	Electric Construction Co.	[illegible]	6 3 0	Jan, July	..	..
2	2/9½	Do. 7 per Cent. Cum. Pref.	1¹¹⁄₁₆—1¹³⁄₁₆	7 4 6	July	..	..
St.	4%	Do. 4 per Cent. Perp. 1st Mort. Debs.	73—78	5 6 0	Jan, July	–	..
10	5/0	General Electric (1900) 5% Cum. Pref.	8½—9	5 14 0	June, Dec	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs	88—93	4 8 6	Mar, Sept	..	..
5	5/0	†Henley's Telegraph Works Ord.	12—12½	6 0 9	Feb, Aug	12	..
5	2/3	†Do. 4½ per Cent. Pref.	4¹³⁄₁₆—5⅛	4 9 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	103½—105½	4 3 6	Mar, Sept	..	..
10	15/0	India Rubber, Gut. Per., &c., Works	13—15	6 0 0	Feb, Aug	..	..
10	5/0	Do 5 per Cent. Cum. Pref.	9½—10½	4 19 0	..	..	..
100	4%	Do. 4 per Cent. Debs. (red.)	95—97	4 3 3	April. Oct	..	..
1	..	‡National Elec. Construction Co.	¼	..	April	..	..
1	..	‡Richardsons, Westgarth & Co., Ltd. Ord.	⁷⁄₃₂—⁹⁄₃₂	..	Nov	..	..
1	..	Do. 6 per Cent. Cum. Pref.	[illegible]	..	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. Perp. Deb. Stock	76—79	5 16 0	Jan, July	..	..
5	..	‡Simplex Conduits 6 per Cent. Cum. Pref.	4¾—5	..	..	..	..
12	12/0	Telegraph Construction & Maintenance	34½—36½	6 9 9	Mar, July	..	..
100	4%	Do. 4 per Cent. Deb. Bonds (1909)	100—102	3 19 3	Jan, July	..	..
1	1/0	Vickers, Sons & Maxim, Ltd., Ord.	1[illegible]—2[illegible]	5 0 0	..	2[illegible]	1[illegible]
1	0/6	Do. 5 per Cent. non-Cum. Preference	1⅛—1⅛	4 3 0	..	1[illegible]	1[illegible]
St.	5%	Do. 5 per Cent. non-Cum. Preferred	107—111	4 11 6	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Db. Sk. (red)	99—101	4 0 0	June, Dec	..	..
100	4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.)	103—105	4 6 6	June, Dec	101	..
100	5%	Do. 5 per Cent. 3rd Mort. Debs Scrip	103½—105½	4 15 6	..	104	..
10	12%	J. G. White & Co. 6% Cum. Pref.	14½—15½	7 14 10	..	..	–
1	..	Willans & Robinson Ord.	⁵⁄₃₂—⁵⁄₃₂	..	Apr, Oct	–	..
5	..	Do. 6 per Cent. Cum. Pref.	⅞—1	..	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	55—65	6 3 0	May, Nov	..	–

Telegraphs.

Size	Last Dividend	Name	Price Wed., Sept. 6	*Rate per cent. Yielded (£ s. d.)	Dividend Due	Business Week to Sept. 6 Highest	Lowest
10	..	Amazon Telegraph	7⅛—7⅞	..	June, Dec	7¼	7¼
100	5%	Do. 5 per Cent. Debs. (red.)	98½—100½	5 0 6	Jan, July	..	–
St.	15/0	Anglo-American	67½—69½	4 8 3	F,My,Ag,N	..	..
St.	30/0	Do. Preferred	111½—112½	5 7 0	F,My,Ag,N	112½	111¾
St.	30/0	Do. Deferred	24¾—25½	6 0 0	F,My,Ag,N	25¾	24¼
St.	4%	Commercial Cable 4 per Cent. Deb. Stk.	87½—89½	4 10 6	Jn,Ap,Jy,O	89	88
10	6/0	Cuba Submarine Ord.	10½—11	5 13 0	Feb, Aug	.	..
10	10/0	Do. Preference 10 per Cent.	17½—18½	5 13 0	Feb, Aug	..	..
5	2/0	Direct Spanish Ord.	3½—4	5 0 0	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	8½—8⅞	5 16 0	April, Oct	–	..
50	4½%	Do 4½ per Cent. Deb.	100—102	4 9 0	Jan, July	..	..
10	3/0	Direct United States Cable	7¾—8¼	6 1 6	Ja,Ap,Jy,O	8¼	7¹⁵⁄₁₆
100	4½%	Direct West India Cable 4½%Rg.Db.(rd.)	99—101	4 10 0	June, Dec	..	..
St.	25/0	Eastern Ordinary	137—140	5 1 0	Ja,My,Jy,O	139½	139
St.	17/6	Do. 3½ per Cent. Pref. Stock	84—86	4 2 6	Ja,My,Jy,O	85¼	84¼
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (red.)	102—104	3 17 9	May, Nov	[illegible]	..
St	2/6	Eastern Extension	13⅝—14⅛	5 1 0	Ja, Ap, Jy,O	14	13¾
10	4%	Do. 4 per Cent. Deb. Stock	100½—102½	3 19 0	Feb, Aug	..	..
25	4%	Eastern and S.Af., 4% Mauritius Sub.Debs	100—102	3 19 0	May, Nov	..	..
10	5/0	G.N. (of Copenhagen), with Coupon 83	31—32	5 14 3	Jan, July	–	..
25	52/6	Indo-European	56½—58½	5 6 6	May, Nov	..	..
100	5%	Mackay Companies Common	86—88	5 15 0	Ja,Ap,Jy,O	..	..
100	4%	Do. Preference	76—78	5 4 0	Ja,Ap,Jy,O	..	..
1	1/0	Marconi's Wireless Teleg. Co.	2¼—2⅜	..	April	2¼	2¼
1	2/9⅓	Do. 7% Partipg. Pref.	1⅛—2	..	..	1⅛	..
100	4%	Pacific & Europe'n Tel.4%Guar.Dbs.(red.)	99½—101½	3 19 9	June, Dec	100½	100¼
2½	1/3	West Coast of America	1⅛—1⅜	5 0 0	May	..	..
100	4%	Do. 4 per Cent. Debs.	93—100	4 1 0	Jan, July	..	..
10	1/6	West India & Panama	2⅛—2⅜	4 16 0	May, Nov	2¾	2¹¹⁄₁₆
10	6/0	Do. 6 per Cent. 1st Pref.	10½—10⅞	5 16 6	May, Nov	10½	–
10	6/0	Do. 6% 2nd Pref.	9½—10½	6 0 0	May, Nov	..	–
100	5%	Do. 5 per Cent. Debs.	101—103	4 18 0	Jan, July	..	..
10	3/0	Western Telegraph	13⅝—14	5 2 0	Mr,Jn,O,D	13¼	13¼
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	100—103	3 19 0	June, Dec	–	..
–	4%	Western Union Telegraph, $1,000 4% Bds	107—110	3 13 9	–	–	–
–	4½%	Do. $1,000 4½% Fdg. & Rl. Est.Gd.Bds	101—104	4 8 0	–	–	–

Telephones.

Size	Last Dividend	Name	Price Wed., Sept. 6	*Rate per cent. Yielded (£ s. d.)	Dividend Due
100	2$	Amer. Telephn. & Telegh. Cap. St.	137—139	5 16 0	–
..	4%	Do. Coll. Trust $1,000 4 per Cent. Bds.	94—96	4 4 0	Jan, July
St.	4%	Do. 4% Cons. Bonds 1936	108—110	3 3 0	..
St.	5%	†Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	100—102	4 19 0	Mar, Sept
5	4/0	Chili Telephone	6¹³⁄₁₆—7⅛	4 5 9	August ..
1	0/7½	Monte Video Telephone Ord.	⅞—1	6 0 0	Nov ....
1	0/6	Do. 5 per Cent. Pref.	[illegible]	5 11 0	May, Nov
St.	6%	National Co. Pref. Stock	104—106	5 14 0	Feb, Aug
St.	6%	Do. Def. Stock	117—120	5 [illegible] 6	Feb, Aug
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	10—10½	5 11 6	Feb, Aug
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10—10½	5 11 6	Feb, Aug
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.	5⅛—5⁵⁄₁₆	4 12 0	Feb, Aug
St.	3½%	Do. Deb. Stock 3½ per Cent. (red.)	98½—100½	4 0 6	June, Dec
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	98½—100½	4 0 6	Jan, July
..	4½%	New York Telephone Co. 30 yr. Bnds.	102½—103½	4 7 6	..
1	1/0	Oriental	1¹⁄₁₆—1³⁄₁₆	4 18 0	April, Oct
1	0/7½	Do. 6 per Cent. [illegible]m. Pref.	1⅛—1⁵⁄₁₆	4 16 0	April, Oct
St.	4%	Do. 4 per Cent. Red. Deb. Stock	88—90	4 10 0	Jan, July
St.	4½%	Telephone Co. of Egypt 4½%Db.Stk.(red.)	99—101	4 10 0	Jan, July
5	5/0	United River Plate Ord.	7⅛—7⅜	5 13 6	July ....
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼—5½	4 13 0	June, Dec
St.	4½%	Do. 4½ Deb. St. Red.	102½—104½	4 7 0	Jan, July

Financial, Investment, &c.

Size	Last Dividend	Name	Price Wed., Sept. 6	*Rate per cent. Yielded (£ s. d.)	Dividend Due
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4—4½	7 1 0	Jan, July
10	6/0	Globe Telegraph & Trust	10⅞—11¼	5 10 3	Sp,DcMrJu
10	3/0	Do. 6 per Cent. Pref.	13—13½	4 10 9	Sp,DcMrJu
10	6%	Submarine Cables Trust (Cert.)	132—135	4 10 0	April, Oct

Colonial and Foreign Electric Railways, Tramways, &c.

Size	Last Dividend	Name	Price Wed., Sept. 6	*Rate per cent. Yielded (£ s. d.)	Dividend Due
5	2/9	Anglo-Argentine 5½% Cum. 1st Pref.	5⅛—5⅜	4 17 6	April, Oct
5	2/9	Do. 5½% Cum. 2nd Pref.	4¾—5	5 12 9	Jan, July
St.	4%	Do. 4% Deb. Stock	94—96	4 3 4	June, Dec
St.	4½%	Do. 4½% Deb. Stock	101—103	4 8 3	..
St.	5%	Do. 5% Deb' Stock	101—103	4 18 0	..
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)	102—105	4 16 6	Jan, July
5	4/0	Brisbane Electric Trams. Invest. Ord	6⅛—7⅛	5 16 3	May ....
5	2/6	Do. 5 per Cent. Cum. Pref.	5—5¼	4 17 6	May, Nov
St.	4½%	Do. 4½ per Cent. Db. Prov. Certs.	102—105	4 7 0	Jan, July
St.	8%	British Columbia El..Rly. Df.Ord.	137—141	5 15 0	Mar, Sept
St.	6%	Do. Pref. Ord. Stock	119—123	4 19 0	May, Nov
St.	5%	Do. 5% Cum. Perp. Pref. Stock	106—109	4 13 0	Jan, July
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	100—103	4 7 6	April, Oct
100	4½%	Do. Vancouver Power Debs.	101—104	4 3 3	Jan, July
St.	4½%	Do. 4½% Perp. Con. Deb. St.	103—105	4 1 6	..
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	98—100	5 1 0	Mar, Sept
St.	6%	Buenos Ayres Port & City Tram, 1st Mt. Deb. Stock	92—96	6 8 0	Feb, Aug
5	3/6	Calcutta Tramways (1 to 137,610)	5¾—6¼	4 19 6	Mar, Sept
100	2/6	Do. 5 per Cent. Cum. Pref.	5—5½	4 17 6	Jan, July
1	4½%	Do. 4½% 1st Deb. Stock (red)	102—105	4 5 9	Jan, July
St.	..	Cape Electric Tram Shares	¹⁄₁₆—⅛	..	..
5	1/3	City of Buenos Ayres Trams Co. (1904) Sh.	5⅛—5¹¹⁄₁₆	4 8 0	F,My,A,N
St.	4%	Do. 4 per Cent. Deb. Stock	95—98	4 3 0	June, Dec
..	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.	95—100	5 2 6	May, Nov
1	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	100—103	4 19 0	Feb, Aug
100	5%	Hong Kong Tramways Co. 5 per Cent. 1st Mort. Debs.	77—81	6 6 6	June, Dec
1	..	Kalgoorlie Elec. Trams Sh.	[illegible]	..	..
100	5%	Do. 5 per Cent. "A" Deb. Stock	92½—95½	5 4 6	Jan, July
5	6%	Do. 6 per Cent. "B" Ditto	63—67	8 15 0	Jan, July
5	0/6	Lisbon Elec. Trams. Ord.	1—1½	4 16 0	July ....
100	0/7½	Do. 6 per Cent. Cum. Pref.	1—1¼	4 16 0	Jan, July
St.	5%	Do. 5 per Cent. Reg. Mort. Debs.	97—101	5 1 0	Jan, July
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	95—98	5 3 6	Jan, July
100	5%	Manaos Trams and Lt. Co. 5% Debs	88—91	5 12 0	..
..	5%	Manila Elec. Ry. $1,000 Gold Bonds	97½—99½	5 1 0	Feb, Aug
100	$1½	Mexico Trams Co. Com. St.	117—119	5 19 0	..
..	5%	Do. Gen. Con. 1st Mort. 5% Gold Bds.	96½—97½	5 3 0	–
St.	6%	Do. 6% 50 yr. Mort. Bds	98½—100½	6 0 6	–
St.	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922) (Nos. 601 to 2,000)	100—102	4 9 0	Feb, Aug
St.	4½%	Do. do. (Nos. 1 to 4,600)	102—104	4 7 6	..
1	0/6	Perth Elec. Trams Ord.	¹⁵⁄₁₆—1⅛	2 10 0	May ....
St.	5%	Do. 1st Mt. Db. Stock	101½—103½	4 17 6	Jan, July
5	3/0	Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	5¼—5¾	5 8 0	–
St.	4½%	Do. 4½% 1st Mort. Deb. Stk.	98—101	4 10 6	–
100	$1½	Rio Janeiro Tram, Lt. & P. Co.	115½—116½	4 6 0	–
..	5%	Do. 30 yr. Gold Bnds.	101½—102½	4 18 3	–
100	5%	Do. 50 yr. Mt. Bnds	93—99	5 1 6	–
..	$2½	Sao Paulo Tramway, Light & Power Co. $100 Stock	177—180	5 12 0	June, Dec
..	5%	Do. 5 per Cent. 1st Mt. $500 Db.	102½—104½	4 16 6	Feb, Aug
100	4½%	†Toronto Ry. Co 1st Mt. 4½% Ster. Bonds	97—99	4 11 9	

Colonial and Foreign Electricity Supply, &c.

Size	Last Dividend	Name	Price Wed., Sept. 6	*Rate per cent. Yielded (£ s. d.)	Dividend Due
5	3/0	†Adelaide Elec. S'ply Co. 6% Cu. Pr.	5¼—5¾	5 11 6	Mar, Sept
St	..	Do. 5% Deb. Stk.	102½—104½	–	..
10	6/0	Bombay E.S. & T. 6% Cm. Pf.	10¾—11¼	5 9 0	Jan, July
St.	4½%	Do. 4½ per Cent. Deb. Stk. (red).	96½—98½	4 12 0	..
..	5%	Do. 5 per Cent. 2nd Mort. Deb. Stock	97—99	5 2 0	April, Oct
5	5/0	Calcutta Elec. Supply Ord.	6⅞—7¼	5 19 6	..
5	2/6	†Do. 5% Cum. Pref	4¾—5¼	5 0 0	–
100	5%	Calgary Power Co. 5% 1st Mort. Bnds.	96—98	5 2 0	–
100	7/2½	Canadian Gen. Elec. Co. Com. St.	107—112	6 8 0	–
100	$3½	Do. 7% Cm. Pf. Stock	121—125	5 14 0	–
100	5%	Castner Electrolytic Alkali Co (of U.S.A.) 1st Mort. Stl. Debs.	94—99	5 3 6	Jan, July
500	5%	†Elect. Development Co. of Ontario	85—87	5 16 0	..
St.	5%	Elec. Supply Co. of Victoria 5 per Cent 1st Mort. Deb. St.	84¾—87¼	5 4 0	Jan, July
5	..	Indian Elec. Sup. & Trac. Co.	1—1¼	..	..
10s	..	Kalgoorlie Elec. Power & Ltg. Ord.	[illegible]	..	April, Oct
1	0/7½	Do. 6 per Cent. Cum. Pref.	[illegible]	8 6 6	..
5	5%	Kaministiquia Power Co. 5% Gold Bnds.	101¼—103¼	4 17 6	..
St.	..	Madras E. S. Corp. Ord.	2¾—3¼	..	–
St.	..	Melbourne E. S. Co. Cons. Ord. St.	39—44	..	–
500	5%	Do. 5% 1st Mortg Deb. Stock	95—97	5 4 0	
	5%	Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	87½—89½	5 13 0	–
St.	$1	Mexican Lt. & Power Co. Com. St.	87—89	4 11 0	–
500	$3½	Do. 7% Cum. Pref. St.	107—109	6 9 6	–
St	5%	Do 5% 1st Mort. Gold Bnds.	95—97	5 4 0	..
100	5%	Monterey Rly. L. & P. Co. 1st Mort.Db.Sk.	83½—90½	5 12 0	F,My,A,N
100	8/2½	Montreal Lt. Ht. & Power Co. Cap. St.	165—170	5 18 6	..
St.	5%	Northern Lt. Power & Coal 5% Gd. Bds	39—41	6 5 0	April ....
St.	£10	River Plate Electricity Co. Ord. Stk.	218—228	4 7 9	May ....
St.	6%	Do. 6 per Cent. non-Cum. Pref. Stk.	107—114	5 5 0	Jan, July
100	5%	Do. 5 per Cent. Deb. Stock	101½—103½	4 17 6	–
..	$1½	Shawinigan Water & Power Co.Ca..	114—116	4 7 0	Jan, July
St.	5%	Do. 5 per Cent. Bds.	107—109	4 12 6	–
St.	4½%	Do. 4½ Per Con. Mt. Db. St.	103—105	4 6 0	–
–	4½%	Toronto Power Co. 4½% Db. St.	99—[illegible]	4 8 0	Jan, July
–	11·85	Victoria Falls Power Co. Pref.	[illegible]	[illegible]	[illegible]

* No allowance has been made for accrued interest or redemption. † Ex Dividend. ‡ The London Stock Exchange Committee[illegible]

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NOTES.

Universities and University Colleges.

GOVERNMENT grants are proverbially inadequate; no matter who the recipient may be, the complaint is always the same. The life of a Chancellor of the Exchequer must be a troubled one, for he is either being asked to make a grant where nothing has been given before, or to increase an existing grant. To discriminate between the worthy and the unworthy must be sometimes a difficult task, and available funds are by no means unlimited, while the prospect of the next general election is not without influence. Now, however, it would appear that Ministers are tired of being accused of parsimony and they actually turn round and complain of what is called "the apathy of the public."

A BLUE BOOK relating to British Universities and University Colleges which participate in the Government Grant was issued on Tuesday and contains an interesting introductory report signed by Mr. RUNCIMAN, Mr. TREVELYAN and Sir ROBERT MORANT. This report complains that the public do not give the financial support which they owe to these institutions; and not only is the accusation directed against the public but also against local authorities. That this is true there can be no doubt; the bulk of the people of this country take exceedingly little interest in higher education, and as to giving financial assistance, nothing is further from their minds. If it were not for a few wealthy, public-spirited individuals, our modern universities would not be in existence. The same thing is true of local authorities, who spend fabulous sums on elementary education and generally leave the rest to private enterprise.

UNFORTUNATELY, this sort of thing has a two-fold effect, for hitherto it has been the custom of the Government to intimate that the magnitude of the Parliamentary Grant is to be dependent on "local support," so that if the local support falls off so does the Parliamentary Grant. What Ministers fail to realise is that a university is an institution which renders not only local service but also national service, and that its existence should not, therefore, depend on local support. As a matter of fact, the Government itself is the chief sinner in this failure to support the universities. The total amount contributed is under £300,000 a year; there are instances, in the United States, of a single university receiving an amount equal to this from its Government. However, the report is evidence that the Board of Education, at all events, are alive to the necessity of providing larger funds, but they would rather extract them from private individuals than from the Treasury. We maintain that the State should lead the way and there would be no doubt about the public following.

Rail-less Traction at Bradford.

IT is unusual for an experimental installation to give such satisfaction from the outset as it appears the system of rail-less trolley traction at Bradford has done. In view of

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the fact that this was the first time the system had been put to a practical test in this country it was anticipated that unforeseen conditions might render some modification of Continental practice necessary. This, however, does not appear to be the case, for although the installation has only been in operation some three months, Mr. C. J. SPENCER, manager of the Corporation tramways, has declared that both from an engineering and operating point of view the rail-less trolley system is an unqualified success. Moreover, not only have the Tramways Committee adopted Mr. SPENCER'S recommendations for extensions amounting to over 9 miles of route, but have added thereto a further extension of 2 miles. On account of the short length of route in operation, and of the limited experience that has so far been gained, it is rather early yet to pronounce as to the ultimate success of the rail-less trolley system, but there is no doubt that Mr. SPENCER'S report will give a fillip to electric traction in this country and provide support for those rail-less schemes which were approved by the Board of Trade in the past session of Parliament.

Electricity and Agriculture.

ALTHOUGH at the present time agriculture provides few examples of the application of electric power, it is noticeable that considerable attention is being devoted to the question, and the difficulty of obtaining manual labour is resulting in inquiries as to what can be done by the aid of electrical energy. Greater progress has been made in Germany than in most countries as regards supplying electrical power for agricultural purposes, but up to the present the results do not appear to have been very encouraging. Thus, from a note which appears in another column of this issue, it seems that the large generating stations which have been erected in Germany for supplying farms with electrical power have not so far proved a financial success. Owing to the large network which must usually be necessary to obtain an agricultural load, it is unlikely that a satisfactory return can be shown on the capital outlay in the early years of such undertakings, and it is interesting to notice that in Germany such schemes are looked to as a step towards the electrification of main railway lines.

ANOTHER direction in which important agricultural developments are likely to take place is in connection with the investigation of the effects of electricity upon the growth of plants. This, of course, does not possess such interest for the electrical engineer, since it does not promise to increase appreciably the demand for electrical energy. Important researches, however, are being carried on by a number of investigators, and it is noteworthy that two Papers on the effect of electricity upon plant life were read before the newly-formed section of Agriculture at the recent meeting of the British Association. Since the subject is of great interest to this country, and as the means at the disposal of private investigators are often limited, it is to be hoped that part of the annual grant of £50,000 which the Board of Agriculture propose in future to allocate to agricultural research will be devoted to furthering experiments on the electrification of crops.

Anglo-American—Western Union Agreement.—Yesterday (Thursday) a notice was issued to the stockholders of the Anglo-American Telegraph Co. that an extraordinary meeting will be held on Friday, Sept. 29th, for the purpose of considering and approving resolutions amending the memorandum of association of the Company in conformity with an agreement which has been entered into between the Anglo Company, of the one part, and the Western Union Telegraph Co. of the other part. The conditional agreement which has been exchanged between the Western Union Co. and the Anglo Co. provides for the purchase by the latter of the former's new trans-Atlantic cable and its equipment at a cost of about £700,000, and for the lease of the whole of the Anglo Company's cables, properties and business to the Western Union Company. A summary of the agreement accompanies the notice. The result of the confirmation by the stockholders of both companies of this agreement by the necessary majorities, and the ultimate sanction by the Court, will mean that, subject to the conditions of the lease, the Anglo Company will for 99 years be guaranteed a rent equal to dividends upon its total capital of £7,000,000 of 6 per cent. per annum on the preferred stock, 3¾ per cent. on the ordinary stock, and 1½ per cent. on the deferred stock. A circular accompanying the notice informs the stockholders that, in view of the more stringent enforcement recently in America of the Sherman Anti-Trust Act, the new agreement has been considered essential. Reference is made to the regular profits of the Western Union Company for the past ten years exceeding £1,000,000 per annum.

"Faraday House Journal."—The September issue of this periodical contains articles on "The Experimental Tank at the National Physical Laboratory"; on "The Electrification of the Randfontein Central," by Mr. T. P. E. Butt, and on a "Method of Finding the Neutral Point in C. C. Machines," by Mr. F. T. Chapman. There are besides the usual interesting news columns devoted to the doings of Faraday House and its Old Students' Association.

Thomas Alva Edison.—Mr. Edison, who has been in England for some time, is now in Vienna, and is staying at the Park Hotel, Schoenbrunn. A day or two ago Mr. Edison met an old assistant in Mr. Etienne de Fodor, general manager of the Budapest General Electric Co., who as far back as 1881 commenced pioneer work in the Edison Institute, which he continued for many years. Our good friend, Mr. Francis Jehl, informs us that the meeting of these old acquaintances was a very cordial one, and the conversation turned upon events of long ago, in which Mr. Edison and Mr. De Fodor were the principals. Mr. Edison appears to have much enjoyed his Continental trip, and expresses himself as very much refreshed. From Schoenbrunn Mr. Edison and Mr. De Fodor motored to Budapest, where Mr. Edison will be entertained.

Electric Lighting of Motor Omnibuses.—The Paris correspondent of the "Commercial Motor" states that experiments have been carried out by the Paris General Omnibus Co. with electric lighting, in place of the acetylene lamps which are at present used, on the new "single-deckers" in service in the French capital. The Company declares itself quite satisfied with the trials, and it is most probable that on the 'buses now being built electric lighting will take the place of acetylene. The apparatus used in the trials was a "Phi" dynamo supplied by the Bleriot Co.

The Practical Training of Engineers.—The "Engineer" states that a new service has been created in France during the month under the name of the French Mission of Engineers to the United States. It has been placed under the direction of M. Leclerc de Pulligny, chief engineer of the Ponts et Chaussées. The new mission is the outcome of the controversy that has been carried on for some time past concerning the value of the training given to engineers in France. No objection can be made to the theoretical and scientific character of this training although in the opinion of many it is carried to an extreme, and if combined with practical instruction there is no doubt that the result would be highly satisfactory. As it is, engineers leaving the different *écoles* are often totally lacking in prac-

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tical knowledge, and have some difficulty in acquiring the experience necessary to succeed in their profession. As far back as 1908 the matter was brought up in the Chamber of Deputies, when the Government was invited to send a certain number of engineers from the Ecole des Ponts et Chaussées to complete their training in the United States. The idea is now being put into effect by the Minister of Public Works, who has decided upon sending engineers from the Ecole des Ponts et Chaussées to the United States, where they will be employed for a period of at least two years in the public works departments, or by the railway companies or big industrial concerns. After completing this practical training they will be required to take up service with the State for a minimum period of 10 years. M. Leclerc de Pulligny is on the point of leaving for New York, where he will take up his residence and organise the new service. It is believed in France that the experience gained on the other side of the water will considerably raise the standard of engineers, who, in the opinion of the heads of some big industrial undertakings, have been steadily declining in value for some years past on account of the purely theoretical character of the instruction given them.

Electrodes for Electric Furnaces.—The "Electrical World" states that two patents relating to electric furnaces were issued to Mr. Carl Hering on August 1st. Of these one covers electric furnace electrodes so designed as to afford the greatest economy in material and the least loss in electrical energy. The invention is based on deductions from the laws of electrode losses discovered by the inventor some years ago and described by him at that time in various Papers and articles. Briefly, the fundamental principle is as follows: An electrode should be a good electrical conductor to reduce the loss of energy due to electrical resistance; on the other hand, good electrical conductors are as a rule also good heat conductors; they thus tend to conduct heat away from the inside of the furnace where the heat is wanted. Increasing the cross-section reduces the former loss, but increases the latter, while increasing the length does the reverse. The problem therefore is to find the conditions under which the total combined losses are least. This the inventor found is the case when the length and section are so proportioned that the current heats the electrode sufficiently to raise the inner or hot end to the furnace temperature. Under these conditions no heat will be abstracted by the electrodes from the charge in the furnace, and the entire loss of heat energy will thus be only that portion generated in the electrodes. This, moreover, is the condition under which the total loss of energy will be the least possible, for under any other conditions the total combined losses will be greater and the electrodes will either chill the furnace product or will develop excessive heat where they pass through the walls. These same laws also lead to economy of the materials of the electrodes, thus reducing their cost. Determinations of physical constants in the application of these laws showed the surprising fact that copper is the best material for electrodes, iron is nearly as good, and that gas carbon, which was the most generally used electrode material, is the worst, graphite being decidedly better than carbon. In general, the results showed that metal electrodes are cheaper and more economical in energy and should therefore be employed whenever it is possible to use them. The other patent of the same date is for furnaces whose electrodes are designed and proportioned in this way; that is, for combinations of such electrodes with furnaces, more especially with furnaces in which the electrodes are not consumed, as in the one recently devised by the same inventor. When such electrodes are virtually prolongations of the resistances and are of the same material they automatically adjust their length so that the proportions will remain practically correct for different temperatures and currents.

Cable Interruptions.	Date of Interruption.
Assab—Perim	July 8, 1909
Latakia—Palura	May 26, 1910
Zanzibar—Mombasa	July 11, 1911
Sabang—Koetaradja	Aug. 18, 1911
Kotonou—Grand Bassam	Aug. 23, 1911
San Thiago—Bathurst	Sept. 4, 1911
Bathurst—Sierra Leone	Sept. 4, 1911

Improvements in Magnetic and Electrostatic Separators.—According to the "Engineering and Mining Journal," one of the principal defects in the ordinary electromagnetic or electrostatic separator arises from mechanical interference between the particles of ore, due partly to incomplete screening before concentration, and partly, also, to the fact that when mixed particles are allowed to pass under the influence of the lines of force in the magnetic field, the magnetic particles coalesce into a mass which will generally include and prevent the removal of non-magnetic particles. As a means of overcoming this defect when due to the latter cause, Mr. Q. Payne, of New York, has patented an improved type of drum to be used in connection with either an electromagnetic or an electrostatic separator. The drum is composed of a series of metal discs, iron or steel in the case of a magnetic separator, and brass, aluminium or any other metal, in the case of an electrostatic separator. These discs are mounted on a shaft and are insulated from one another by corresponding discs of some non-conducting material, like fibre, mica, &c. The object of the discs is to prevent the accumulation of masses of metal particles, in which non-metallic particles will be embedded. Theoretically, the best results would be secured if the discs were of the same thickness as the grains of ore to be treated, but, practically, it is found that sufficiently good results are secured if the discs do not exceed three or four times the diameter of the grains.

Current Topics.

Subjects of current interest dealt with in this issue include the following:—

Dr. R. A. Houstoun continues his series of articles on "Studies in Light Production," considering this week "The Black Body."

Dr. J. R. Ashworth contributes an article on "A Simple Graphical Method for the Harmonic Analysis of a Cyclic Function."

We give abstracts of the following Papers read at the recent meeting of the British Association: "Electrical Steering," by Mr. B. P. Haigh; "Some Preliminary Notes on a Study as to Human Susceptibility to Vibration," by Mr. W. Pollard Digby and Capt. H. Riall Sankey; "The Manufacture of Nitrogen Compounds by Electric Power," by Mr. E. Kilburn Scott; "Continuous versus Intermittent Service in Passenger Transportation," by W. Y. Lewis; "Suction Gas Engines and Producers," by Mr. W. A. Tookey; "The Electrical Conductivity of Light Aluminium Alloys," by Prof. E. Wilson.

At the Annual Convention of the American Institute of Electrical Engineers Major G. O. Squier read a Paper on "Multiplex Telephony and Telegraphy by Means of Electric Waves guided by Wires."

We analyse the accounts of the West Ham electric supply department for the year ended March 31, 1911.

Bradford Tramways Committee recommend the equipment of about 11 miles of route on the rail-less trolley system. It is reported that the experimental line has proved an unqualified success.

OBITUARY.

W. Hey.—We regret to record the death of Mr. Wm. Hey, who for many years was head foreman in the dynamo shops at the Halifax and Woodfield works of Messrs. W. T. Goolden & Co., and who afterwards held the same position with Messrs. Greenwood & Batley at Leeds. Although of a strong personality, the deceased had a most affectionate nature, and was extremely popular with the large number of pupils who passed through his hands, as well as with the staff and the men who worked under him. The news of his death will doubtless be learnt with regret by many old "Goolden" men.

E. Stiff.—We also regret to record the death on the 6th inst., at Eastbourne, of Mr. Ebenezer Stiff, of Lambeth and Wimbledon. Deceased, who was 71 years of age, had been a member of Messrs. Jas. Stiff & Sons.

APPOINTMENTS VACANT AND FILLED.

An analytical chemist is required for a cable factory. Preference will be given to one having electrical knowledge. See an advertisement.

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An assistant superintendent of railway telegraphs is required by the Government of Southern Nigeria for one tour of 12 months' residential service, with possible extension. Salary £250, rising to £300 per year by annual increments of £10. Applications by letter to the Crown Agents for the Colonies, Whitehall Gardens, London, S.W. See also an advertisement.

Swindon Corporation require an assistant electrical and mechanical engineer for their electricity and tramways departments. Salary £130, rising to £180. Applications to the Town Clerk by Sept. 23.

Mr. T. Harris, B.A., B.Sc., has been appointed assistant lecturer and demonstrator in the physics department of East London College.

Mr. D. M. Dunlop has been appointed secretary of the National Electrical Manufacturers' Association.

Mr. W. J. Carter, of Oldham, has been appointed assistant electrical engineer at Batley at a commencing salary of £130 a year.

Mr. Chas. T. Cole has been appointed mains assistant at Devonport.

Dewsbury Council have appointed Mr. S. H. Fowles as an assistant in the mains department.

INSTITUTIONS AND SOCIETIES.

British Association.—The following is a list of the Papers and reports dealt with by the Engineering Section of this Association during the recent meeting at Portsmouth. Presidential Address, by Prof. J. H. Biles; "The Anschutz Gyro-Compass," by Mr. G. K. B. Elphinstone; "Electrical Drives for Screw Propellers," by Mr. H. A. Mavor; "Electrical Steering," by Mr. B. P. Haigh; "The Single-Phase Repulsion Motor," by Mr. T. F. Wall; "Some Preliminary Notes on a Study as to Human Susceptibility to Vibration," by Mr. W. Pollard Digby and Capt. H. Riall Sankey, R.E.; "The Electrical Conductivity of Light Aluminium Alloys," by Prof. E. Wilson; "Recent Developments in Radio-Telegraphy," by Prof. G. W. O. Howe; "Portable Equipment for Wireless Telegraphy," by Capt. H. Riall Sankey, R.E.; "Economical and Reliable Power Generation by Over-type Superheated Steam Engines," by Mr. W. J. Marshall; "Suction Gas Engines and Producers," by Mr. W. A. Tookey; "Crude Oil Marine Engines," by Mr. J. H. Rosenthal; "The Manufacture of Nitrogen Compounds by Electric Power," by Mr. E. K. Scott; "Smoke Abatement," by Dr. J. S. Owens; "A New System of Continuous Transportation," by Mr. W. Y. Lewis; Report of the Committee on Gaseous Explosions and a joint discussion with Section A on "Aeronautics." The following matters of electrical interest were dealt with by Section A: "The Infinitesimal Transformation of an Electromagnetic Field into Itself," by Mr. H. Bateman; "A Friction Permeameter," by Mr. W. H. Murdoch; "The Work done at the Bureau of Standards on the Absolute Measurements of Electric Current," by Prof. N. E. Dorsey; "The Specific Heats at High Temperature and the Latent Heats of Metals. Part I.: Aluminium and Zinc," by Mr. H. C. Greenwood; and the Report of the Committee on Experiments for Improving the Construction of Practical Standards for Electrical Measurements. In Section B a Paper on "The Present Position of Electric Steel Making" was read by Prof. A. McWilliam, and a report on "Electro-analysis" was also presented.

Tramways and Light Railways Association.—The "Journal" for September of this Association contains the following matters: The recently published Board of Trade Regulations with respect to the use of electrical power by tramways; the official report on the accident at Stalybridge on June 5, 1911; correspondence in regard to Tramway Fares; a copy of the "Special Case" stated for the King's Bench Division *in re* "Metropolitan Electric Tramways v. Tottenham U.D.C."; a reprint of a Paper on "Tramcar Meters, &c." read by Mr. A. Sharman Giles before the Institution of Civil Engineers, and other matters relating to the Association.

International Congress for the Applications of Electricity, Turin.—At the opening meeting of this Congress on Sunday, Sept. 10, the following were among those appointed to offices in connection with the Electrical Congress now in session at Turin:—As Vice-Presidents of the Congress: Mr. Alexander Siemens and Dr. S. P. Thompson, F.R.S.; as President of the Section of Telegraphy and Telephony: Major W. A. J. O'Meara, C.M.G.; as Vice-President of the Section for Accumulators and Electro-chemistry: Mr. W. Duddell, F.R.S.

Association of Mining Electrical Engineers (West of Scotland Branch).—The local Council of this branch have just submitted their first annual report, in which they mention that the branch was successfully inaugurated on Sept. 17, 1910, at a public meeting in Glasgow, and eight meetings have since been held in the Glasgow Technical College, by the kind permission of the Governors. There were also two very successful joint meetings with the National Association of Colliery Managers. The first was held in Edinburgh, when Mr. H. W. Clothier gave a very interesting account of the progress made in "Switchgear" from the earliest known to recent types, suitably illustrated by numerous lantern slides; and the second in Glasgow, when Mr. R. Nelson, H.M. Electrical Inspector of Mines, gave a very interesting Paper on "The Avoidance of Electrical Accidents in Mines," to an audience numbering close on 500. Papers read at the other branches throughout the Kingdom have also been freely discussed. The branch has been particularly fortunate in the matter of Papers during the past session, as evinced by their widespread interest, but it is felt that sufficient use is not being made of the Association in another direction, namely, in the matter of questions and answers. It is sufficient for a member to submit a query, under a *nom de plume* if he prefers it, at any of the public meetings, and obtain enlightenment or a discussion on the point in doubt. The first examinations for admission were held throughout the country during March last, when 75 members sat. Of these 32 gained first class passes, 25 second class and 6 service certificates. Although the percentage of candidates from Scotland was small, possibly the addition of the branch president to the examination board, on which the branch is to be congratulated, may in the future mend this feature. The branch is also to be congratulated on having had the services of Prof. Burns as local examiner. It is appropriate that the General Council should thus early in the life of the Association accept the invitation of this branch to hold the annual meeting in Glasgow, the district possessing the first colliery in the world to make use of electricity in any form. Since the acceptance of the invitation the branch Council, along with representatives from the East of Scotland Branch, have been assiduous in drawing up an attractive programme, and it is earnestly hoped every member of the branch will do his utmost to attend personally. The programme covers two days, viz., October 6 and 7. As regards the coming session, the local Council make the suggestion that interesting Papers can be written on the following subjects, but do not suggest they be confined to any or all named:—"Speed Reduction, so far as it relates to Electric Motor Driving"; "Cable Systems and Earthing"; "Relative Advantages of A.C. and D.C. Systems for Small Collieries"; "Systems of Lighting from Power Mains, especially with regard to Personal Safety Underground"; "The Standardisation of Colliery Electrical Equipment to the recommendations of the Engineering Standards Committee"; "Methods of installing Shaft Cables"; "Leakage Protection Devices of proved efficiency." It is advisable and will avoid overlapping if the hon. secretary is early acquainted with the intentions of any member in this connection. It may interest local members to know that there are numerous premiums offered for excellence in Papers read before the Association, and that a £5 premium has been recommended to be awarded to Mr. Thomas Thomson, a member of this branch, for his Paper last session. It is the intention of the local Council to hold additional meetings at various centres in the area, such as Larbert, Hamilton, Kilmarnock, &c., but the details are not yet sufficiently advanced for a programme to be embodied with this report. The idea is to broaden the basis of the organisation, increase its usefulness, and incidentally to increase the membership. The number of members on the branch at present is 125, a matter for congratulation, considering it is the first session. It is felt, however, that in such a district as the west of Scotland, where there are over 300 collieries, the number of members can be considerably increased with mutual benefit to all concerned. Members will greatly assist the local Council in considering the claims of special districts for these lectures if they will submit the names of localities where they think it would be advantageous to hold a special meeting. In doing so they should be prepared to co-operate with the Council to ensure the success of a meeting

Institute of Metals.—The autumn meeting of this Institute will be held at Newcastle-on-Tyne on September 20, 21 and 22. The members will be entertained by the Lord Mayor, and visits will be paid to certain works of metallurgical interest in the neighbourhood. The following Papers, among others, will be read: "The Corrosion of Brass with Special Reference to Condenser Tubes," by Mr. P. T. Brühl; "The Electrical Conductivity and Constitution of Alloys," by Dr. W. M. Guertler; "Non-Ferrous Metals in Railway Work," by Mr. G. Hughes; and "The Mechanical Properties of Hard Drawn Copper," by Mr. D. R. Pye.

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EDUCATIONAL NOTICES.

University of London, University College.—The new session commences on Monday, Oct. 2. There are complete courses of study, extending over three years, in mechanical, electrical, civil and municipal engineering. Intending students should communicate with the Provost as soon as possible, and full particulars may be obtained on application to the secretary, Mr. Walter W. Seton, M.A., Gower-street, W.C.

University of London, King's College.—Complete courses of study, extending over three or four years, are provided by this college in civil, mechanical and electrical engineering for engineering degrees of the University of London, and for the diploma and certificate of the college. The four years' course provides, in addition to the academic training, opportunity for practical training in works. Full information may be obtained from the Dean or the Secretary, King's College, Strand, London, W.C.

University of Manchester.—In the faculty of science complete courses of study extending over three years are arranged for the University degrees in civil, mechanical and electrical engineering. The session commences on Oct. 2.

University of Edinburgh.—The next session opens on Oct. 10. The University provides complete courses in civil, mechanical and electrical engineering, qualifying for the degree of B.Sc. in engineering, and extending over a period of three years. Particulars of the entrance examination, scholarships, fees, &c., can be obtained from the Matriculation Office, The University, Edinburgh.

University of Bristol.—The session in the faculty of engineering commences Sept. 15 and in faculties of arts, science and medicine on Oct. 2.

The faculty of engineering of this university is provided and maintained in the Merchant Venturers' Technical College. There are courses in civil, mechanical, electrical and motor-car engineering. The Dean of the Faculty is Prof. J. Wertheimer, B.Sc., B.A. Copies of calendar or prospectus may be obtained from the Registrar.

The Proctor-Baker scholarship, tenable by a pupil of the Merchant Venturers' Secondary School in the faculty of engineering of the university has been awarded to Mr. John Rogers.

University of Durham.—Armstrong College, Newcastle-upon-Tyne.—The 1911-12 session commences Sept. 25. There are departments of mechanical, marine, civil and electrical engineering, naval architecture, mining, metallurgy, agriculture, pure science, arts and letters. Particulars may be obtained from the secretary, Mr. F. H. Pruen, M.A.

Goldsmith's College (University of London).—At this college complete evening courses of instruction are provided in mechanical, electrical and constructional engineering, land surveying, fitting and machining, pattern-making and smithing. Students are prepared for the London University degree of B.Sc. in engineering, for the examinations of the Institution of Civil Engineers, Board of Education, and City and Guilds of London Institute, &c. Particulars from the Warden of the College, New Cross, S.E. The new session commences on Monday, Sept. 25, and enrolling will begin on the 18th inst.

University College of North Wales.—At this college a systematic course of instruction in electrical measurements and practical electricity is provided for students proposing to enter the electrical engineering profession. The physical laboratory is well equipped for practical work and the fee for the ordinary course is £17. 1s. per session. The next session commences in October.

Northampton Polytechnic Institute, Clerkenwell, London.—The full day courses in the theory and practice of mechanical and electrical engineering and in electro-chemistry will commence on Oct. 2, and entrance examinations will take place on Sept. 27 and 28, at which five entrance scholarships will be offered. The courses for mechanical and electrical engineering include periods spent in commercial workshops, and extend over four years, and they also prepare for the degree of B.Sc. in engineering of the University of London. There are also full and partial day courses in technical optics. Particulars from the Principal, Dr. R. Mullineux Walmsley.

Borough Polytechnic Institute.—A four years' course of instruction in electrotechnics is provided at this Institute. There are also classes in electric wiremen's work, and elementary and advanced courses in electrical design and workshop drawing. The head of the department is Mr. John Henderson, D.Sc., F.R.S.E., A.M.I.E.E. Prospectuses, containing further particulars and detailed syllabus, from the Principal, Mr. C. T. Millis, Borough-road, S.E. The session begins on 25th inst.

Battersea Polytechnic (London, S.W.).—The new session commences on Monday, 25th inst. There are complete day college courses in civil, mechanical and electrical engineering, extending over three or four years. These courses are suitable for preparing for the B.Sc. (Eng.) of the University of London, the Associateship examination of the Institution of Civil Engineers, &c. There are also evening classes in electrical technology, electrical design and power distribution, theory of machines, hydraulics, heat engines, strength of materials, &c. Further particulars can be obtained from the Secretary.

A course of 12 lectures, six during the first term and six after Christmas, will be given on "Illuminating Engineering." On Oct. 17 and 24 Prof. J. T. Morris will lecture on "Electric Lighting;" on Oct. 31 and Nov. 7. Mr. J. G. Clarke will lecture on "Gas Lighting." Mr. E. Scott Snell will deal with "Oil, Petrol-air and Acetylene Gas" on Nov. 14, and Dr. W. J. Ettles will give a lecture on "Illumination and the Eye" on Nov. 21. The remaining six lectures (to be delivered in the second term) will deal with the Measurement of Light and Practical Problems in Illumination and will be delivered by Mr. J. S. Dow, B.Sc., The fee for the full course is 7s. 6d. Further particulars from the Secretary.

The calendar for the new session, which opens on Sept. 25, gives full details of the numerous courses and classes. Full day and evening courses in preparation for the Intermediate and Final Degree examinations in science, engineering and music are offered, and the lecturers in the various subjects are fully recognised by the University of London, so that students attending the Polytechnic may be registered as internal students of that University. In the Day Technical College, full time courses are arranged in mechanical, civil, electrical and motor engineering, architecture and building, chemical engineering and art, the courses covering a period of 3 years, at the end of which time students passing the necessary examinations are awarded the Polytechnic diploma. Concurrently with the diploma courses, students can prepare for and take the degree courses in science and engineering of the University of London. The Commerce department gives a course extending over two or three years in preparation for civil service and other examinations and for secretarial and other business appointments. In addition to the scholarships already existing, the governing body have instituted one of £40 a year for three years tenable at the Day Technical College. It is believed that this scholarship will fill a direct want by providing a scholarship which not only entitles to free fees, but gives a sum of money to help towards maintenance. Full and complete evening courses are provided in the departments of mechanical engineering and building trades, electrical engineering, mathematics, physics, chemistry, natural science, languages, commerce, &c. In the mechanical engineering department a course of lectures on illuminating engineering has been arranged, and should the course prove successful it will be amplified and continued during succeeding sessions.

In the electrical engineering department special attention is being given to the subject of electric traction, and new machinery and apparatus are being purchased in order that the subject may be more fully and thoroughly dealt with. In the physics department, the course on acoustics for music students will be repeated, and a class in physical chemistry for chemistry students has been arranged. In the chemistry department, the chemical engineering course has been extended by the addition of a practical class.

It may be also stated that the Edwin Tate Library, which was opened last October by the Archbishop of Canterbury, has fully justified its erection, and has proved a great boon to students, the number of books borrowed having increased nearly 50 per cent. during the session. With the many valuable additions to the books there is now available for the use of students a really first-rate library housed in a building of which the Polytechnic may justly be proud.

East London College (University of London).—In the Faculty of Engineering complete courses of instruction are provided in engineering subjects, including civil, mechanical and electrical engineering. There are special facilities for apprentices on the sandwich system. The fee for the session is 10 guineas. Further particulars from the Registrar or from the principal, Mr. J. L. S. Hatton, M.A.

L.C.C. School of Building.—Up till recently no adequate course of instruction was available for students of reinforced concrete, but last winter the deficiency was repaired by the establishment of classes in this subject at the L.C.C. School of Building, Ferndale-road, Brixton, S.W., the lecturer being Mr. H. Kempton Dyson, secretary of the Concrete Institute. As the result of the experience last session the scheme of instruction has been further extended, and the scope enlarged for next session which commences on 18th inst. This year many more testing appliances, tools, &c., have been added, and a more systematised courses of instruction will be possible. Detailed syllabus can be obtained free at the school.

ARRANGEMENTS FOR THE WEEK.

THE LONDON ELECTRICAL ENGINEERS.

Officer Commanding, Col. H. M. Leaf.

The following orders have been issued :—

Head-quarters will be closed for instruction, but will be open for office work as under until further orders :—

Monday to Friday, 10 a.m. to 4 p.m.

Saturday, 10 a.m. to 12 noon.

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ELECTRICAL STEERING.*

BY B. PARKER HAIGH, B.SC.

Summary.—The author describes the two different ways in which the electric drive may be applied to the average steering gear and the questions of design that have to be solved in so applying it. Motors for this purpose need not be designed to carry their full power continuously. Details as to power requirements and of actual gears are also given.

To many who are familiar with the development and the present reliability of steam steering engines, it must appear doubtful whether electrical power can offer any considerable advantage for this purpose. The steering gear being one of several important auxiliaries carried by the ship, the question involves the power supply for all of these. It is generally admitted that the present system of supplying auxiliaries with steam is not only inconvenient but wasteful in the extreme, partly on account of the low economy of small engines worked non-expansively, and partly on account of leakage and condensation in the steam mains. A number of vessels have been equipped with partial installations of electrical power, in some cases for the cranes and boat hoists, in other cases for fans, and as the difficulties connected with these have now been largely overcome a considerably extended use may be expected.

It is beyond the scope of this Paper to deal with the use of electrical power for auxiliaries in general, but it is desired to emphasise the disadvantages of a mixed power system involving the upkeep charges on both steam mains and electrical installation. Vessels fitted with internal-combustion engines offer a special field for electrical steering; for on such vessels the steam supply, if available at all, would not generally be maintained at sea.

Electrical power may be applied in steering in connection with two separate problems. In the first place, electrical apparatus may be used in place of the customary control shafting or hydraulic telemotor to transmit the motion of the hand wheel aft to the steering engine. Several such electrical "telemotors" are now available, and these have the advantages of being very easily worked, even in the longest ships, and of convenience in installation. The second problem is that of supplying and controlling electrical power for moving the rudder itself, and it is here that electrical steering offers the greater advantage over gears now in general use requiring a supply of steam. The main difficulties experienced in electrical steering have been those of limiting the amount of power required to the capacity of the ship's dynamos, and in controlling the heavy power in a reliable manner. The electric motor must not only be arranged to move the rudder promptly and accurately within the small angles of 5 deg. or less that are required for keeping a course, but must also be capable, without any adjustment of the control gear, of rapidly putting the helm hard over, 35 deg. to either side, against heavy water resistance. As this is the crux of the whole question, it may be well to state working conditions in some detail.

The action of a rudder in steering is similar to that of the blades of an "Impulse" turbine. Water flowing under the counter of the vessel strikes the rudder surface and is deflected so that its subsequent motion is more or less parallel to the direction of helm. In changing its direction of motion the water exerts a certain force on the rudder, tending to swing the vessel about an axis somewhere well forward in its length, and also acting as a drag, reducing the speed of the vessel. The steering moment reaches a maximum when the angle of helm is about 40 deg., and as the drag increases quickly it is not customary to arrange the steering gear for angles of over 35 deg. The time generally taken to bring the rudder from hard-over port to hard-over starboard, or vice versa, varies from 15 seconds or even less in small vessels, to about 40 seconds in the largest, these times being those required while under way ahead.

The power required in the steering engine depends upon the torque produced in the rudder post by the water pressure, which is usually of considerable magnitude, as the centre of water pressure is generally some distance abaft the axis of the rudder post, even when a "balanced" rudder is used. Little effort is required to move the rudder within small angles, even when an "unbalanced" rudder is used, partly because the angle of deflection of the water is small and partly because the centre of pressure on the rudder surface is near the leading edge. Unless a heavy sea strikes the rudder, the steering motor has, therefore, little to do beyond overcoming friction within the gear itself; and as the great majority of steering motions consist in moving the rudder through small angles near the midships position it will be recognised that electrical power promises economy as compared with either steam or hydraulic power. When the angle of helm is increased, the torque in the rudder post increases rather more rapidly than the sine of the angle, for an increasing body of water is deflected and the centre of pressure shifts further from the leading edge of the rudder surface. After the rudder has been held hard-over for a few seconds the torque in the rudder post falls off somewhat, partly because the vessel commences to swing and partly because the vessel's speed is reduced, but it is clear that the steering gear must be designed to meet the heavier initial stresses and it is fortunate that these can be readily estimated.

In order to economise power the gearing between the electric motor and rudder post should be designed for a high efficiency, and consequently it will not be "self-sustaining." Means must therefore be provided to hold the rudder in its hard-over position. A magnetic brake similar to those used on cranes is suitable for this purpose and will also serve to stop the gearing promptly when the required position has been reached. In returning the rudder to the midships position while the vessel is moving ahead, the force of the water assists the motion of the rudder, and this complicates the matter of the control. Further, when the flow of water past the rudder is reversed, by reversing the propellers, the centre of pressure shifts towards the after edge of the rudder surface and considerable power is then required to bring the rudder back amidships even when the speed of the ship is low. It is this fact which prevents a rudder being balanced under all conditions, but nevertheless balancing is a great advantage for electrical steering, allowing a smaller motor to be used, minimising the demand for current and reducing the wear and tear on the control gear.

Experience has led to the design of steam engines of special proportions for steering, and in the same way electrical motors used

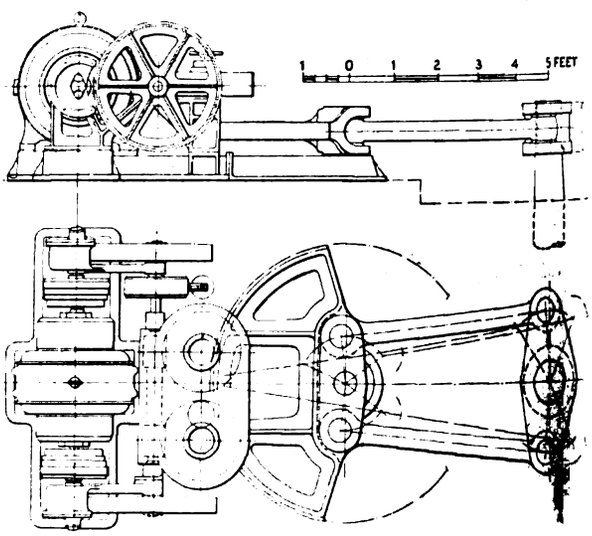

FIG. 1.—ARRANGEMENT OF ELECTRICAL STEERING GEAR FOR 11½ IN. RUDDER POST.

need not be designed to carry their full load continuously. Motors of smaller dimensions, for "half-hour rating" and fitted with commutating poles are preferable, and as the heating limit is not here in question the motor may be totally enclosed even in large sizes, without any considerable increase in its dimensions.

Besides possessing adequate power, a steering gear must be satisfactory as regards sensitiveness, that is, it must be capable of moving the rudder to an angle that accurately corresponds to the position of the steering wheel. This is especially necessary within the range of small angles that are used for keeping the vessel on its course. In any steering gear there is naturally some "idle travel" of the steering wheel within which the gear will not respond. In long ships this is minimised by using a telemotor in place of control shafting with gearing, in which latter the total effect of spring and back-lash may be objectionable. But apart from such loss of motion there is a further idle travel due to the practical necessities of the control valve or control switchgear, and this loss is kept as low as possible. Requirements as regards sensitiveness vary greatly and high-speed vessels naturally require closer control than slower vessels, for as the size of the rudder cannot be reduced without loss of manœuvring power at low speeds, very small angles of helm are sufficient for ordinary steering. In the highest class work the steering gear should respond to a motion of the hand wheel corresponding to one degree of helm (less than one-eighth turn of the wheel). Little advantage is gained by working closer than this, and many high-speed vessels with fine lines are worked with gears requiring double this allowance. A certain small amount of idle travel is desirable to prevent the gear

* Paper read before Section G (Engineering) of the British Association at Portsmouth.

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being used too frequently. Sensitiveness does not only depend on the idle travel of the wheel but also on the "time lag," i.e., the interval between the movement of the wheel and the corresponding movement of the rudder. In this respect it appears that electrical steering may possess considerable advantage over ordinary steam gears, for as it can be arranged that the rudder responds more quickly a closer course may be kept with watchful steering. As regards idle travel there is little to choose between steam or electric gears. In steam gears the idle travel is kept down by reducing the already small steam lap on the control valve, which, in order to obtain a fast-running gear with little time lag, is generally a piston valve of ample size. Such a valve is liable to leakage when slightly worn. In electrical gears, on the other hand, sensitiveness does not reduce the economy but complicates the control arrangements.

In the following table a number of different types of electrical steering gear are classified according to the method of control :—

A. Steering gears in which the motor is started and stopped for every motion of the rudder.

(1) The motor being supplied with current at variable voltage from a special generator.

(2) The motor being controlled by reversing switch and resistances.

B. Steering gears in which the motor is kept running continuously ; mechanical control being introduced in one of the following forms :

(1) Friction clutches with gearing.

(2) Hydraulic transmission with rotary or reciprocating pumps.

(3) Magnetic friction clutches on motor shaft.

The second line of development, including the gears grouped together under heading B, appears to offer more promising results than method A, to which one great objection is the wear and tear unavoidable where so much switchgear for heavy currents is used. A further advantage of the different types classed together under B is that the shock of the sea on the rudder is greatly reduced before it reaches the ship's electrical installation. The armature of the motor acts as a flywheel, or extra flywheel weight may be added, and by using a compound motor a large part of the energy kinetically stored in the revolving masses is given up to the steering gear before any excessive current is demanded from the ship's mains. The steering gear can therefore be supplied from the ship's lighting generator without any noticeable flicker in the lamps coupled to the same mains. It is difficult to overestimate the importance of this feature, both as regards simplicity, and consequently reliability, and as regards economy of power.

To indicate the amount of power required under these conditions we may take the case of the proposed gear described later, and shown in Figs. 1 and 2. This is designed for an 11½ in. rudder post, suitable for a vessel of, say, 450 ft. in length, of 16 knots speed. In this case a motor of 30 B.H.P. is provided, capable of developing a torque of 175 ft. tons in the rudder post, and of moving the rudder through 70 deg. in 20 seconds. These figures are based on special features in the design of the gear and on an efficiency of 64 per cent. in the gearing, which, though high in comparison with that of gears having right and left-hand screws, is not higher than that obtainable with double-worm drive. The 30 H.P. motor would be a continuous-current motor with compound winding, and would run at a speed of 500 revs. per min. under full load, and at varying speeds up to 1,000 revs. per min. on lighter loads. The current required at full load would be 270 amperes at 100 volts. In some respects, and especially as regards reliability, a three-phase motor is preferable to the continuous-current motor, but its constant speed characteristic causes a heavier maximum demand for power. The choice of the type of motor to be used on any particular vessel naturally depends on many matters outside the steering gear. A vessel of this size, engaged in passenger service, would probably be provided with generating plant for lighting and forced-draught purposes of about 200 kw. and if this is divided among four dynamos, each of 500 amperes capacity at 100 volts, it should be possible for any one of these running alone to put the helm hard-over in emergency.

Probably the first electrical steering gear in which the motor was kept running continuously was that designed and built in 1895 by the late Mr. A. B. Brown, who may be justly regarded as the pioneer in the scientific development of power-steering gear. Being constructed on the same principle as his well-known steam tiller, the motor of this gear was mounted on a forged steel tiller which carried a pinion engaging with a toothed rack attached to the deck. The control was by means of two metal to metal friction clutches with coil springs, driven at a lower speed than the motor by means of gearing. The clutches were arranged to move the tiller in opposite directions and the chief difficulty experienced was that of obtaining accurate and sensitive control.

In the steering gear designed by the writer in conjunction with Messrs. Brown Bros. & Co., of Rosebank, Edinburgh, the control is by means of magnetic friction clutches, which have several advantages due to the absence of external thrust and the ease of the control. A number of tests have been made on an experimental gear of fair size and it is hoped that some particulars may be of interest. Figs. 1 and 2 show details of a proposed gear suitable for an 11½ in. rudder post, to which reference has already been made in connection with the amount of power provided. Although the motor in this gear runs continuously, no gearing is kept in motion as the motor shaft is extended at either end to carry the two magnetic clutches, which are normally out of gear, leaving the rudder stationary. The driven portions of these clutches are carried on bearings and are geared to the countershaft carrying the worm gear in such a way that the rudder is moved to either port or starboard by bringing one or other of the clutches into action. The two parts of the clutch are drawn together by magnetic attraction and a light spring is provided for withdrawing the clutch after the motion required is completed. The friction drive is transmitted by red fibre blocks bearing on the conical edge of the light steel disc that acts as the keeper of the magnet, and no thrust remains to be taken up by collars. Either ball bearings as shown in Fig. 2 or ring oiling journals may be used, provided the motor has not excessive end play. Provision is made for taking up wear on the fibre blocks by adjusting the inner ring on the clutch body to feed the blocks through holes in the outer ring. In the gear suitable for an 11½ in. rudder post, the clutch coils are fed with a current of ½ ampere, supplied through slip-rings enclosed within the motor. No electrical parts are therefore exposed to the action of damp, for as the motor is always running, it keeps itself dry. Should it be de

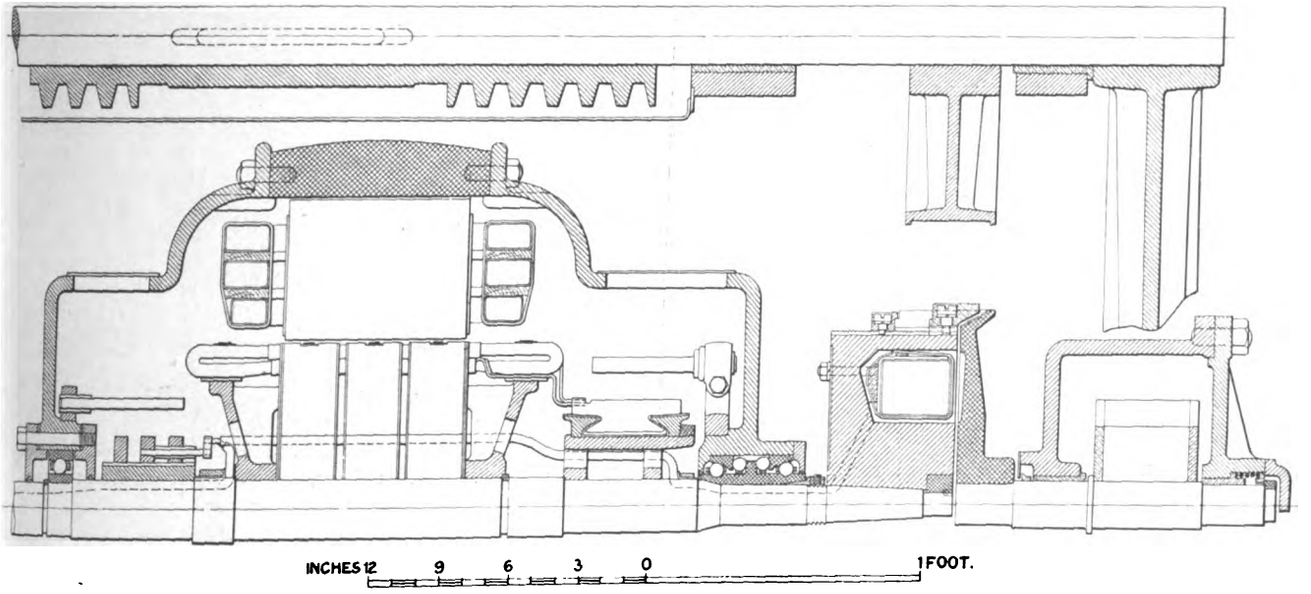

FIG. 2.—MOTOR, CLUTCH AND GEARING FOR STEERING GEAR FOR 11½ IN. RUDDER POST.

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sired to remove the armature, the clutches are removed at the same time, after sliding the fibre friction blocks back by turning both screwed rings on the clutch body. Impregnated fibre friction blocks have the advantage of engaging silently, whereas wood, although in some cases having a higher coefficient of friction, appears liable to squeak painfully. The mechanical arrangement of the gear, shown in Fig. 1, has certain novel features, notably the use of two pinions engaging with the toothed sector. As these carry equal loads the wear is distributed, and a lighter sector may be used, with teeth of reduced pitch as compared with those necessary if only one pinion were provided. Further, a lower ratio of worm gear is required and a higher efficiency obtained. The loads on the two pinions are kept equal by using right and left-hand worm-gear with an intermediate pinion to keep the directions of rotation right. The two worms are cut on a sleeve sliding freely on the shaft without thrust blocks, and as a certain amount of end play is provided between the bearings, the teeth of the sector can be allowed a considerable amount of wear without disturbing the equal distribution of the load. The quick pitch of the worms and the absence of frictional loss at thrust blocks ensures a very high efficiency being obtained.

The power required is further reduced by the use of variable leverage linkwork, in which the rudder crosshead and the dummy crosshead carrying the toothed sector are connected together at different radii so that the connecting rods do not form a parallel motion. The leverage, which in the midships position is 1·5 to 1, increases gradually to 2·2 at the hard-over position of 35 deg., so that the maximum torque is obtained with less current when the rudder is hard-over; and, further, the gear responds more quickly in the ordinary working range amidships. As this linkwork is not a so-called "geometrical" motion the position of the crosshead pins must be carefully chosen, and when this is properly done no difficulty is found in working over to 38 deg. of helm. In this way a saving of 30 per cent. can be made in the motive power, and taking account of the extra efficiency of the double worm-gear, the maximum torque of 175 ft. tons is obtained from a current of 270 amperes at 100 volts instead of 450 amperes as would be required with gearing of the ordinary type.

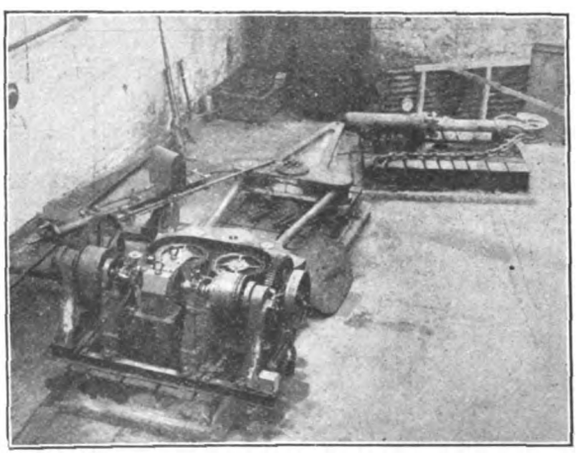

FIG. 3.—EXPERIMENTAL STEERING GEAR FOR 7 IN. RUDDER POST; WITH HYDRAULIC APPARATUS FOR TESTING.

These features are incorporated in the experimental steering gear shown along with testing apparatus in Figs. 3 and 4. The hydraulic cylinder for applying the artificial load is connected to the dummy tiller provided for test purposes by chain and is so lined off that the tiller leverage is the same when the rudder is hard-over at 35 deg. as when in the midships plane. It was found that the currents required to produce a pressure of 980 lb. per sq. inch on the 5 in. ram were 60 amperes when hard-over, and 90 amperes when amidships, corresponding to a change of leverage of 1·5 to 1. The time required to cross from hard-over to hard-over was 23 seconds when moving against the above load for 35 deg. out of the total of 70 deg., the voltage of supply being 90 volts. At this load, which corresponds to a torque of 20·4 ft.-tons in the rudder post, the overall efficiency is 48 per cent., indicating an efficiency of over 60 per cent. in the gear alone without hydraulic cylinder or motor. Under normal conditions the slip of the clutches when engaging was found to be small, estimated by means of a contact maker at between 1 and 2 revolutions, and up to the present, after a considerable period of testing in the works, no wear has had to be taken up on the fibre blocks. When the motor is loaded up to 150 amperes, corresponding to a torque of 50 ft.-tons, the clutches slip, and this current is not exceeded, even when the tiller is butted against a solid obstacle or when the chain is drawn taut from no load to full load.

The arrangements for controlling the clutches, also seen in Fig. 3, consist of one of Brown's improved hydraulic telemotors with a cut-off attachment coupled to the tiller crosshead. The switchgear, which is operated by mechanism equivalent to cam-gear, is enclosed in the small case (14 in. by 12 in. by 4 in.) mounted above the telemotor. In many vessels the telemotors are now attached to the deck beams overhead and this arrangement is very suitable for electrical steering as it keeps the switchgear free from water. Being fitted with carbon contacts, and dealing with such small currents, the switches should require but little attention. The cams require to be carefully arranged and free from backlash, to gain sensitive steering; and to stop the gear promptly a quick-acting brake, not necessarily very powerful, is used. The amount of stored energy is minimised by using light steel clutch discs and a motor with shunt regulation, running at its lowest speed when engaging and disengaging.

In installing electrical steering gear it is preferable to avoid the use of fuses or circuit breakers in the supply mains as these are liable to operate just when the use of the helm is most urgently required, and any possible damage to the electrical plant is greatly outweighed by risk in navigation. When a gear with friction clutches is used, a circuit breaker, adjusted for something over the limiting current of the clutches, may be fitted in the engine-room along with an auxiliary motor starter, so that the gear may be immediately restarted without leaving the main switchboard.

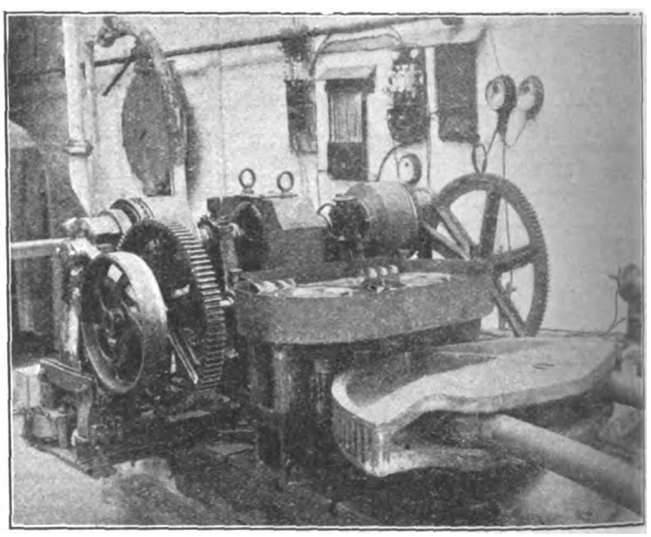

FIG. 4.—ELECTRICAL STEERING GEAR, SHOWING DOUBLE-WORM GEAR AND CROSSHEAD SECTOR.

In the foregoing notes it may be thought that the advantages of high efficiency are over-rated, but economy is not only valuable in itself and in the reduction in weight which it allows, but also on account of the increased reliability due to reduced wear and tear in the control gear and generating plant.

THE MANUFACTURE OF NITROGEN COMPOUNDS BY ELECTRIC POWER.*

BY E. KILBURN SCOTT.

Summary.—The author describes the electrical processes for the fixation of atmospheric nitrogen and urges the importance of establishing a factory in this country for the manufacture of nitric acid from the nitrogen of the air. Such works would render the country in time of war independent of overseas supplies for the manufacture of explosives. The author also considers the question of cost of electric power and thinks that the cost with a waste heat station might compare favourably with a supply from large hydro-electric stations.

The author here draws attention to several methods of fixing the nitrogen of the air with the help of cheap electric power, and he gives particulars of some of the products. The processes were started on a commercial scale in Norway and Italy about six years ago and they are now well established, the principal products being the artificial manures:—(*a*) Nitrate of lime, containing 12¾ per cent. nitrogen; (*b*) Calcium cyanamide or nitrolim, with 18 per cent. nitrogen. These manures are now being made at prices which compare favourably with the older artificial manures, such as nitrate of

* Abstract of a Paper read before Section G of the British Association at Portsmouth.

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soda and sulphate of ammonia, when calculated on the nitrogen contents. For actual delivery to farmers, prices are perhaps not so favourable, because the quantities handled are small and the selling organisation is not so complete. The prejudices of the farmers have also to be overcome, and much propaganda expense is therefore necessary.

In the nitrate of lime process, as introduced by Birkeland and Eyde, the nitrogen is fixed *directly* from the air in the electric furnace, and nitric acid made from this fixed gas then acts on carbonate of lime. In the calcium cyanamide process, which was introduced by Frank and Caro, the nitrogen is first isolated from the air and then absorbed by carbide of calcium, itself an electric furnace product. It will thus be seen that a principal difference between the two processes is that the cost of raw materials for nitrate of lime is low, whereas in the case of calcium cyanamide the nitrogen has to be specially prepared by the Linde process, and the carbide of calcium by which it is absorbed (made from lime and coke or anthracite) costs about £6 a ton. The nitrate of lime process is certainly unique amongst industrial processes in using a raw material—nitrogen—that costs nothing; but, on the other hand, more electric energy is required for a given amount of nitrogen fixed. The prices of the resulting products are therefore very similar.

Many agricultural experts have tested these manures, and conclusively proved that when properly applied they are very valuable for increasing plant growth, also that they are especially useful for cereals—wheat, oats, &c., that require large quantities of nitrogen. As the Chilian deposits of nitrate of soda and the virgin soils of the world are rapidly becoming exhausted, and, at the same time, there is a steady increase in the number of wheat-eating people, it is fortunate that new sources of nitrogen manures have been developed. The output is small at present, but it promises to be the greatest development of electrical engineering science of the near future.

Nitrate of lime is usually added to the soil as a top dressing after the seed is in, whereas calcium cyanamide is dug into the soil about 10 days before planting. It is an interesting fact, however, that the best results are obtained by mixing the two manures together.

Besides manures, many other materials are made by these processes, and the writer specially draws attention to the manufacture of nitrogenous products for explosives. The nitric acid made by the nitrate of lime process can be concentrated to any value, and sold for manufacture of explosives, such as gun-cotton, dynamite, smokeless powder, &c.

Ammonium nitrate, which is the main constituent for the manufacture of safety explosives and laughing gas, is made by the very simple process of mixing the weak nitric acid that comes from the absorption towers of the Birkeland-Eyde process, with ammonia liquor obtained from English gasworks. The solution is crystallised and dried, and the resultant, containing 35 per cent. of nitrogen, is sold freely in England at £27 a ton. This material is also made from calcium cyanamide, and the Loteringen Works at Gerthe, near Bochum, produce about 2,000 tons per annum. As this does not come on the market, it is presumably all taken by the German Government as a substitute for nitro-glycerine.

At the present time this country is largely dependent on overseas supplies for the manufacture of explosives, and we should be in an extremely serious position in case of war. There is no reason whatever why a factory should not straightway be established in this country for the manufacture of nitric acid from the nitrogen of the air. Even if the product could not at first *compete* in price with existing supplies, the fact that it was a necessary addition to our national insurance against war would justify its establishment. Again, what is true of this country regarding the manufacture of explosives is applicable to other parts of the Empire, as, for example, Australia, New Zealand and South Africa.

In this connection, it is well to remember that various Government factories for the supply for the munitions of war, &c., do not pay from a competitive industrial point of view; yet everyone recognises that such factories must be kept going. In just the same way a factory for making nitrogenous products from the air by electric power should be started and kept going whether it pays its way or not. As a matter of fact, there is every reason for supposing that it would pay its way, and one of the objects of this Paper is to bring out that fact.

The author next proceeds to describe the processes for manufacturing nitrate of lime, as carried out at Notodden, and for calcium cyanamide, as carried out at Odda, in Norway.

It may be mentioned that calcium cyanamide is made in the following countries: Italy, France, Switzerland, Dalmatia, United States, Canada, Mexico and Japan, whilst in Germany alone there are about half a dozen factories.

Cost of Power.—As to whether it is possible to manufacture these nitrogen products in Great Britain, from a strictly commercial point of view depends on whether power can be obtained cheaply enough. In such countries as Norway and Switzerland, where there is plenty of water power, and no coal, there are several water-power plants which, having inexpensive hydraulic works, are said to produce power at £2 per kilowatt-year. For the total number of hours in a year £2 is equal to 0·055d., or $\frac{1}{18}$ of a penny per kilowatt-hour. At Notodden the power is said to cost 33s. per kilowatt-year, or 0·045d. per kilowatt-hour, and at Odda 30s. per electrical horse-power-year is paid for power.

It is interesting to compare these figures with the well authenticated statistics of the largest hydro-electro plant in the world, namely Niagara. For 1909, 362 million kilowatt-hours were sold for £210,000; of which 322 million units went to 33 electrochemical and metallurgical consumers at 0·133d. per kilowatt-hour. The remaining 40 million units were sold to electric light and traction consumers at an average price of 0·19d. per kilowatt-hour.

Now, electro-metallurgical works have usually a 100 per cent. load factor, and unfortunately there are very few such works in this country. There is, however, good reason to suppose that waste heat power stations in Great Britain could produce as cheaply as Niagara for such a load factor. Even to-day, electric energy is sold in Yorkshire and Durham at extremely low rates to collieries and ironworks, &c., where the load factor is nearer 33 per cent. than 100 per cent. The actual prices charged do not transpire publicly, but 0·25d. per kilowatt-hour has been mentioned.

Suppose an electric power plant of 10,000 kw. is erected at a cost of £10 a kilowatt, and that on a 33 per cent. load factor, the energy is sold for 0·25d. per kilowatt-hour. Now, let us see what would be a fair charge on a 100 per cent. load factor:—

The annual fixed charge for interest, depreciation, &c., may fairly be taken at 15 per cent., which gives £15,000. At a 33 per cent. load factor, this has to be spread over—33 per cent. of $(10{,}000 \times 8{,}760) = 29{,}200{,}000$ kw. hours, and therefore = 0·123d. per kilowatt-hour.

Deducting 0·123d. from 0·25d., which is the charge per kilowatt-hour, we get 0·127d. to cover the variable expenses.

Dividing the annual fixed charges by the total number of kilowatt-hours in a year namely, 87,600,000, we get 0·041d. Therefore, on a 100 per cent. load factor, the energy could be sold at 0·127d. + 0·041d. = 0·168d. per kilowatt-hour.

It may be suggested that nothing has been allowed for spare plant, but, as a matter of fact, £10 per kilowatt of plant installed is too high for a waste heat station. We are so accustomed to the absurdly large amounts that have been laid out on municipal electric light stations, &c., that the actual figure for which modern electric power plant can be installed comes as a surprise.

Even so long ago as 1906, the Manchester Corporation extension station cost only £12 per kilowatt of plant to instal, as shown by Mr. Pearce's figures:—

Generating machinery, turbine, condenser, alternator, &c.	£3·75
Boilers, economisers, superheaters, steam pipes, coal and ash conveyors, foundations, &c.	2·25
Switchgear for generators and feeders	0·55
Elaborate buildings with accessories	5·05
	£12·05

Prices of electrical machinery have come down very much since then, and there has also been a decline in the prices of mechanical parts of the plant, such as boilers, turbines and steam accessories. The figure of £5 per kilowatt for land and buildings and accessories is also high, because municipalities usually erect buildings that are much too elaborate. If fresh tenders for the Manchester plant were obtained to-day, the total would probably not exceed £10 per kilowatt installed.

Waste Heat Station.—The above is for a complete steam plant, and with the same data it is interesting to see how much a waste heat station using waste steam from, say, rolling mills as at Sir Bernard Samuelson's works would cost.

Generating machinery, turbine, condenser, alternator, &c.	£3·75
Steam reservoir and a small amount of piping, no boilers	0·20
Switchgear for generators, feeders	0·55
Plain shell building, no chimney	2·00
	£6·50

The figures for a waste heat station using gas from blast furnaces or coke ovens, would probably cost about the same, for although the gas engine and alternator might cost a little more, there is no condenser. There would, of course, be gas-cleaning apparatus, provision for cooling water, and a small amount of piping, but these are small items. The switchgear and buildings should be about the same as for the waste steam station.

Analyses of electrical accounts of the majority of existing power plants show that the interest and depreciation with sinking fund in the case of municipal plants form the largest items in cost per unit

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generated. If, therefore, the initial cost of the plant can be brought down from, say, £50 a kilowatt, which is a fair average of existing plants, to, say £6 a kilowatt, which seems feasible, then the cost of electric power should fall to a figure that is comparable with the most favoured hydro-electric plants.

One reason for the low prices for electric energy in Norway is because the harnessing of the power can be done so easily; but as a matter of fact, very few hydro-electric plants are built for as low as £10 per kilowatt installed. Even in the United States, where there is much water power and the harnessing of it has reached a very high pitch, most of the large power houses in that country depend on steam.

As water power becomes more developed, the tendency will be for the cost of power generated in that way to increase. One reason is that the owners of water powers will want more for their rights, and another is that, as industries are attracted to the centres where the water power is available, there will be greater competition for the power. At present they are mostly situated in inconvenient places. Steam and gas plants, on the other hand, can always be installed close to the market for power and where freights for raw materials and finished products are low. Therefore, as the generating units become larger and power becomes centralised in larger stations the cost per kilowatt-hour generated should steadily decrease.

The writer considers that the time is ripe for the establishment of many electrochemical and electro-metallurgical processes, which at present are only carried on abroad. Amongst these the manufacture of nitrate manures, and especially nitrogen compounds for explosives are very important, especially the explosives, for reasons put forward in this Paper.

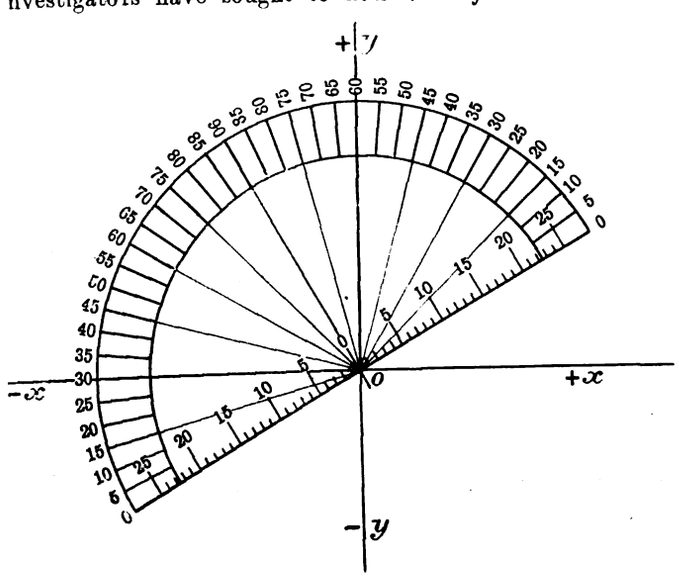
A SIMPLE GRAPHICAL METHOD FOR THE HARMONIC ANALYSIS OF A CYCLIC FUNCTION.

BY J. R. ASHWORTH, D.SC.

In the harmonic analysis of a curve the determination of the constants in the expression—

$$A_0+A_1\sin(\theta+\phi_1)+A_2\sin(2\theta+\phi_2)+\ldots\ldots$$

presents some tedious arithmetical work which numerous nvestigators have sought to minimise by various devices.



Of the graphical methods which have been suggested a good example is given by J. Harrison (" Engineering," Vol. LXXXI., 1906, p. 201), in which the ordinates of the curve are drawn as vectors at equal angles from a given point and from their components, obtained by graphical projection on two rectangular axes, the values of A and ϕ are calculated.

This method may be still further simplified and nearly all arithmetical work eliminated by the following procedure. Let the period of the given curve be divided into n equal elements, and let y_1, y_2, $\ldots\ldots y_n$ be the ordinates of this curve. They may be measured advantageously as the excess over the least, so that all quantities are positive, one of course being zero. These ordinates are then to be treated as co-planar forces radiating from a common centre at angles θ, 2θ, 3θ, &c., measured from a horizontal axis in the counter-clockwise direction, and then *by the polygon of forces* their resultant is to be found by drawing the line which closes the polygon. This resultant in magnitude will be $n/2$ times the amplitude A, of the first term of the analysis, and the angle ϕ_1 is determined by the relation $\tan\phi_1 = \cot\alpha$, where α is the angle which the resultant makes with the positive part of the horizontal axis.

The constants of the second term are to be found in the same way, the vectors now being placed at angles 2θ, 4θ, $\ldots 2n\theta$. The third and higher terms are treated similarly.

The practice of the method is facilitated by using a transparent protractor like the one figured in the text. Suppose, for example, that the period of the given curve is divided into 12 equal parts and that the ordinates are 9·8, 6·5, 4·3, &c., then. θ being equal to 360/12 or 30 deg., the line on the protractor marking 30 deg. is put along the horizontal axis, the centre of the scale being at the origin, and the length 9·8 is marked with a needle on the straight edge. The zero of the protractor is then pushed up to this needle, the protractor turned so that the line 30 deg. passes through the origin, and the length 6·5 is marked with a second needle. The first needle being removed, the zero of the scale is pushed up to the second one, the line 30 deg. is made to pass through the first prick and the third length marked off. The proper placing of the zero is very quickly performed by having a projecting lip on the straight edge of the protractor at the zero of the scale (which must also be the centre of the angular graduations). Proceeding step by step in this way the polygon is smoothly and rapidly constructed and the resultant easily found.

The accuracy of the final result depends in part on the skill of the operator, but if the angle θ is not very small, and if the values y_1, y_2, $\ldots y_n$, are read off on an enlarged scale no serious errors will be made.

The number of operations can be reduced to one-half, or even less for the higher terms, by a preliminary grouping of the vectors y_1, y_2, &c., those in the same line being added algebraically, but as this may introduce negative quantities, some care has to be exercised to avoid mistakes in carrying out the graphical work.

In engineering practice, where the higher harmonics are often unimportant and not required, this graphical process of harmonic analysis will be found useful, and it is exceedingly rapid and easy to carry out.

SOME PRELIMINARY NOTES ON A STUDY AS TO HUMAN SUSCEPTIBILITY TO VIBRATION.*

BY W. POLLARD DIGBY AND CAPTAIN H. RIALL SANKEY.

Summary.—A few notes are given on the results of some preliminary work made on the susceptibility of human beings to vibration. Certain distinctive general tendencies seem to be clearly indicated and are enunciated. The work is being continued.

In regard to all the senses of taste, sight, sound or smell, the range of the individual sensitiveness of human beings is recognised as a matter of considerable variation. Even those with no pretence to scientific training class their fellows as short or long sighted. In regard to sound, the degree of discrimination of different people, both at any one age or at different ages, is a matter of much anthropometric interest. The physiological effects of mechanical vibration are probably worthy of investigation, but before the medical aspects can be discussed, fairly exhaustive preliminary investigations are necessary. It has long been known that different persons are affected in different manners by the same conditions of vibration. So far as the authors are aware this subject has not yet been the subject of any very definite study and investigation.

In the course of his professional work, one of the authors had occasion to design a portable instrument for taking permanent records of the amplitudes of vibration of steam turbines and reciprocating engines, and of measuring the effect of such vibrations on neighbouring buildings. On showing this to his co-author the latter referred to a statement by Admiral Melville that the effect of vibration depends upon the frequency and on the actual amount

* Paper read before Section G (Engineering) of the British Association at Portsmouth.

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of linear motion, and that the frequency multiplied by the amount of motion was a constant.*

Further, in the same Paper, which deals with steamship vibrations, Admiral Melville quotes Mallock's statement in regard to the Central London Railway cases, that vibrations rarely exceeding a thousandth of an inch, when the frequency is over 10 per second, are a genuine source of annoyance.

After discussing Admiral Melville's dictum (which one presumes applies to normal persons) the authors decided to pursue the present study. The phrase "human susceptibility to vibration" was coined to cover the range of sensitiveness of various people to vibrations of short duration of different amplitude and frequency, together with their opinions as to when those vibrations approached or exceeded the point of being a nuisance.

At the time of writing this Paper only a certain number of cases have been studied. The information collected is not yet sufficient for the enunciation of a comprehensive law, but it does suffice for the propounding of certain general statements.

At the outset the authors found it necessary to adopt both verbal standards of degree of vibration and precise units of measurements in order that the comparative value of the conceptions of the verbal standards by different persons might receive some co-ordination.

The verbal standards of degree of vibration selected were as follows:—(1) Imperceptible, (2) Very faintly perceptible, (3) Faintly perceptible, (4) Perceptible—not a nuisance, (5) Perceptible—just a nuisance, (6) Perceptible—distinct nuisance, (7) Perceptible—serious nuisance, (8) Perceptible—excessive nuisance.

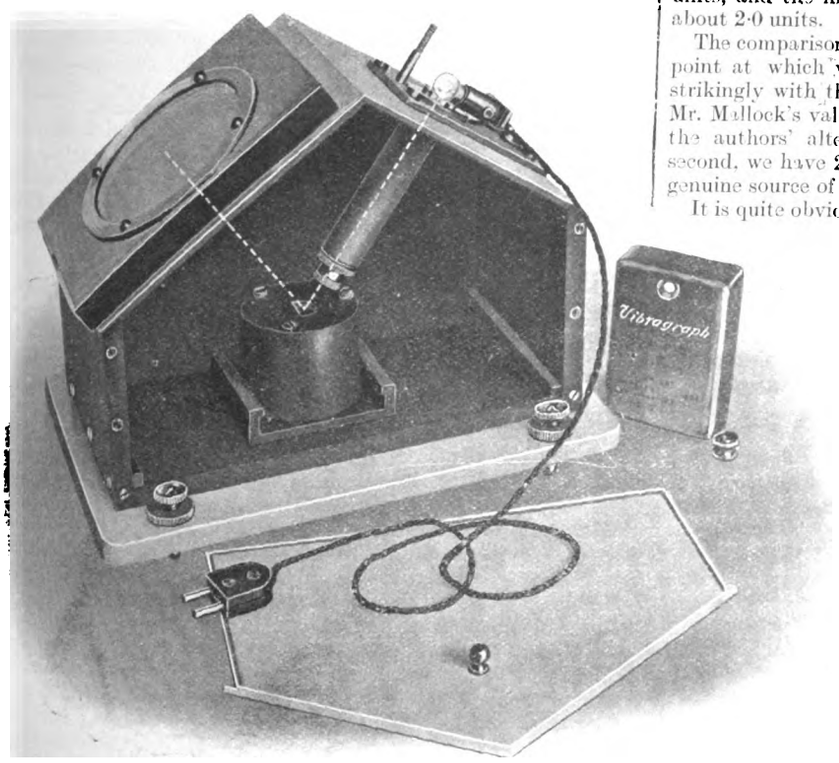

FIG. 1.—VIBRAGRAPH OF MESSRS. SIEMENS BROTHERS & CO.

The precise unit of measurement adopted by the authors as a mechanical unit of intensity of vibration is a vibration having a maximum linear amplitude of one-tenth of a millimetre at a frequency of 10 cycles per second. (Alternatively, and of course identical in value, would be the definition of one millimetre at 1 cycle per second).

Referring to the verbal standards of degree of vibration, it should perhaps be explained that the series starts at unity and not at zero, because the apparatus used in these measurements indicates vibration not felt by any persons resting the palm of the hand on a table vibrating under the effect of a variable speed electric motor placed on it.

As the writers have stated, only a certain number of individuals have so far been investigated. While this number does not permit the enunciation of definite laws, certain distinctive general tendencies seem to be clearly indicated. Among these may be noted the following:—

1. That for various individuals the range of vibration rated as degree 1 (*i.e.*, as imperceptible) is a wide one. Thus upwards of 21 cases are recorded in which a vibration of from 0·10 to 0·20 units is classed as imperceptible, while six cases classify vibrations in this range as degree 2, and five cases as degree 3.

2. That there is also wide variation in regard to vibration rated as degree 2 (*i.e.*, as very faintly perceptible). Three cases class this as under 0·10 units, six as between 0·10 and 0·20, six as between 0·40 and 0·50, while seven cases could only distinguish vibrations in excess of 0·50 units.

3. That each individual shows a "fatigue" effect, and gives expressions of opinion as to the degree of vibration after 30 or 40 minutes of observation which are not consistent with his previous expressions of opinion. In general these point to a diminished sensitiveness.

4. That individuals can be classed into the broad classes of (*a*) delicate and (*b*) coarse perceptiveness. The former class, although capable of discrimination in regard to vibrations of small intensity, give uncertain and contradictory readings when the vibrations exceed a certain amplitude. The latter class, while distinguishing clearly between vibrations of differing large intensities, cannot feel vibrations of small intensity, and are not always consistent in their classification of vibrations of medium intensity.

5. That so far the general consensus of opinion points to the degree of vibrations classed as 5 (perceptible—just a nuisance) being reached for a mean intensity of 1·0 units. The lower range for persons of delicate perceptiveness is in the neighbourhood of 0·70 units, and the higher range for persons of coarse perceptiveness is about 2·0 units.

The comparison of the mean value of an intensity of 1·0 unit as the point at which vibration just becomes a nuisance compares very strikingly with the value quoted by Admiral Melville. Converting Mr. Mallock's value of one mil multiplied by cycles per second into the authors' alternative of millimetres multiplied by cycles per second, we have 2·54 units of intensity of mechanical vibration as a genuine source of annoyance.

It is quite obvious that the present study is purely of a preliminary nature. For the purposes of this research, perceptiveness to vibration has been estimated by the sense of touch of a person's hand resting on a table, the table being disturbed by a variable speed electric motor. Flywheels attached to each end of the motor shaft have concentric rings of holes drilled and tapped in them so that the amount of the unbalanced force can be varied at will. In one or two cases observations have been made of the opinion expressed when the elbows of the subject rested on the table, the palm of the hand supporting the face. Another interesting alternative (and there are many such) would be for the subject to sit on the table.

In the further pursuit of this investigation it will probably be of interest to ascertain:—

1. To what extent the susceptibility of any single individual is influenced by conditions of physical health, the effect of over-work or railway travelling.

2. To what extent age and sex are modifying factors.

3. Whether occupation has any broad general effect, *i.e.*, whether say surgeons, barristers or engineers (regarded as classes) differ to any marked degree from the mean value obtained.

All the present vibrations have been due to practically pure sine waves at a stated frequency, which latter was kept of constant value at the time of observation. Nothing has yet been done to simulate in the laboratory the super-imposition of waves giving a third or fourth harmonic. Neither has anything yet been done to simulate in the laboratory a recurring intermittent vibration such as that produced when propellers or the exhausts from non-condensing engines approach, reach and get out of synchronism with one another.

The authors hope to pursue this research along the lines indicated. They will be glad if members of this Association and their friends care to visit Mr. Digby's laboratory on either Monday or Thursday afternoons after October 1st, and form the subjects of experiment. It is desirable from many points of view, and not least the legal one, that there should be some definition of what exact intensity constitutes a nuisance. It is not possible to deal with more than, say, three cases in any afternoon, and to prevent waste of time the authors would therefore be glad of notice of intending calls. For the enunciation of a general law they would like to deal with a

*"Engineering," Vol. LXXV., 1903, p. 33.

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total of 100 to 150 cases. The nature of the experiments will be demonstrated in an adjoining room.

Attention may be drawn in connection with the above Paper to the "Vibragraph" of Messrs. Siemens Brothers & Co. This is claimed to be the first practical instrument for measuring and recording vibration in definite units.

Fig. 1 herewith illustrates the complete instrument. A mercury cup is provided with a floating mirror, pivoted so as to avoid lateral movement and the mercury ripples caused by vibration result in an angular movement of the mirror. The beam of light emanating from the small glow-lamp, and reflected by the mirror, will therefore record on photographic paper a straight line if the vibration is in one plane only, or a complex figure if the vibration be in planes at different

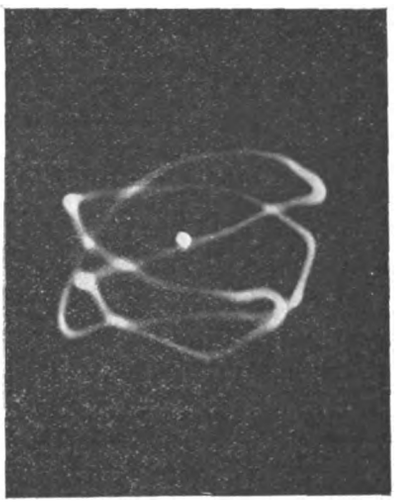

FIG. 2.—VIBRAGRAM FROM CRANK CASING OF ENGINE DRIVING ALTERNATOR.

angles, as will usually be the case in practice. In this connection Fig. 2 is interesting as showing a vibragram from the crank casing of an engine driving a 1,250 k.v.a. alternator at 188 revs. per min. [The scale is 1 in.=77mils. (1·96 mm.) actual vibration.] When records are not required a screen permits of direct visual observations.

We understand that the apparatus has proved very satisfactory in practical tests extending over 18 months; among others, for two large municipal electric supply undertakings in connection with litigation in respect of alleged nuisance through transmitted vibration of the central station.

STROBOSCOPIC METHODS OF MEASURING THE SLIP IN INDUCTION MOTORS.*

BY A. BRUCKMANN.

Many methods have been described for measuring slip, but none are altogether satisfactory. One of the most interesting is the stroboscopic method. A black disc is mounted directly on the spindle of the rotor, and on this disc there is a white line, drawn either along a diameter or along a radius, the whole being illuminated by an arc lamp which is fed with alternating current of the same frequency as that supplied to the stator. The brightness of the illumination given by the lamp varies between a maximum and a minimum, the frequency of the variation being twice that of the source of supply of alternate current, seeing that the negative impulses also contribute maximum effects. The white diameter or radius, as the case may be, appears brightly illuminated every time that the arc lamp gives out its maximum light, and the observer therefore notices on the disc as many images of the radius as correspond to the number of variations in the light over one revolution. At synchronism the effect produced is that of a stationary star, or wheel, the number of the spokes being equal to the number of pairs of poles on the stator. If the motor is then loaded the wheel begins to turn at a rate which depends on the amount of slip. By noting the rate at which the wheel is seen to revolve, the slip can be calculated from the following formula:—

$$s\% = \frac{n_s - n_r}{n_s} 100,$$

where n_s is the speed of the rotating field and n_r the rate of revolution of the rotor.

If the number of pairs of poles is small, the star or wheel rotates so fast that it is difficult to count the number of revolutions if the slip is considerable: on the other hand, if the number of poles is considerable, the wheel has so many spokes that again the work of counting is not very easy. For instance, suppose the slip to be 6 per cent. and the periodicity 50, the motor having only a single pair of poles, the revolutions appear to be at the rate of 360 a minute, seeing that the images appear twice at their maximum brightness for every complete cycle of the alternating current. Take, again, a motor with six poles, the other conditions being as before, the rate of revolution is now 60 per minute, but the wheel has six spokes, which makes the counting almost as difficult as before. There is also another point to be considered: at 50 cycles the sluggishness due to the heat-conductivity of the carbons is considerable, and produces a sort of equalising effect, so that the separate images are not as distinct as they might be.

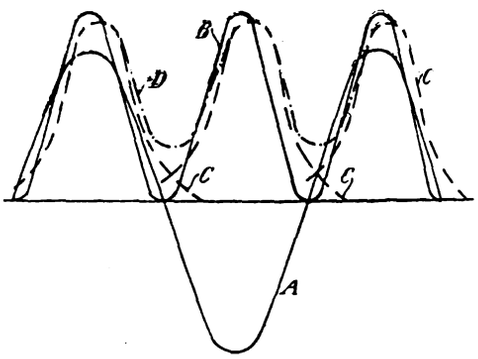

FIG. 1.—SHOWING CURVES OF ILLUMINATION FROM AN ALTERNATE CURRENT ARC.

There is, however, a simple method by which the number of spokes in the wheel may be halved, and this method indirectly has another advantage, as will be explained. According to this proposal, with a six-pole motor the wheel would have only three spokes, and with a considerable slip it is possible to count the revolutions quite easily, and, moreover, the images stand out very distinctly on the disc. As has been stated above, the negative currents give also a maximum illumination of the disc in exactly the same way as the positive maximum impulses. Now if the negative currents can be suppressed the images which correspond to the negative maxima will be equally suppressed, and the images corresponding to the positive maxima will be all the more clearly defined. Figs. 1 and 2 explain this.

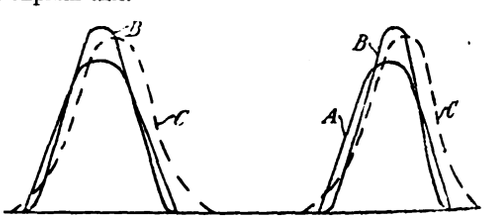

FIG. 2.—SHOWING CURVES OF ILLUMINATION FROM AN ALTERNATE CURRENT ARC WITH THE NEGATIVE CURRENT SUPPRESSED.

Let A represent the wave of alternate current, while B represents the square of the alternate current, which corresponds to the brightness of the illumination. In Fig. 1 the curve C shows the illumination to a first approximation, but owing to the sluggishness of the heat-conductivity of the carbons, the true curve of illumination is given by D, which never falls as low as the datum line. If, however, suitable means are employed for suppressing the negative impulses things are very different, as shown in Fig. 2, where the positive impulses alone are shown. The arc now receives no current during every alternate half-period, during which time the carbons have time to cool and no image of the revolving radius exists, the corresponding spoke of the wheel being therefore suppressed. The curve showing the illumination is correspondingly modified, as shown in Fig. 2.

It remains to describe the means by which this virtual suppression of the negative impulses can be produced. Something can be done

* Abstract of an article in the "Elektrotechnische Zeitschrift." We would refer our readers to an article on this subject by Dr. C. V. Drysdale, which appeared in THE ELECTRICIAN, Vol. LV., p. 734, 1905. —ED. *E.*

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by inclining the carbons at suitable angles, so that, whereas the light from the one is reflected on the disc, the light from the other is thrown in another direction, where it largely escapes the disc. In this way a wheel is produced the spokes of which have alternately a varying degree of brightness. But a far better method consists in the use of the aluminium cell. Let us suppose such a cell to be inserted in the circuit, as shown in Fig. 3. As is well known, current now passes only in the one direction, and the number of the spokes in the wheel is at once halved. A further advantage of this method lies in the fact that the lamp now works more or less as a direct-current lamp, and if the carbon which is connected to the aluminium cell is placed uppermost the effect is intensified, owing to the fact that the convection currents in the surrounding air tend to heat the upper carbon and cool the lower one. The tips of the carbons approach somewhat to the characteristic shapes associated with direct current, and the maximum illumination is always thrown in

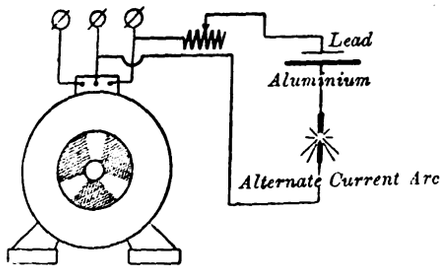

FIG. 3.—SHOWING THE REVOLVING "WHEEL" OR "STAR," TOGETHER WITH THE LEAD-ALUMINIUM CELL.

one direction. The electrolytic cell is easily prepared from ordinary aluminium and lead plates, and a saturated solution of bicarbonate of soda may be used as the electrolyte with a current-density of 0·05 ampere per square centimetre. The volume of the electrolyte should not be too small in order to keep it reasonably cool.

MULTIPLEX TELEPHONY AND TELEGRAPHY BY MEANS OF ELECTRIC WAVES GUIDED BY WIRES.*

BY GEORGE O. SQUIER.

Summary.—The author describes a series of experiments on the effect of superimposing upon ordinary telephone circuits electric waves of ultra-sound frequencies.

The limits of audibility, being physiological functions, are well known to vary considerably, but they may be taken to be in the neighbourhood of 16 complete cycles per second as the lower limit and 15,000 to 20,000 cycles per second as the upper limit. If, therefore, there are impressed upon a wire circuit for transmitting intelligence harmonic E.M.F.s of frequencies between 0 and 16 cycles per second, or, again, above 15,000 to 20,000 cycles per second, it would seem certain that whatever effects such electric wave frequencies produced upon metallic lines, the present apparatus employed in operating them could not translate these effects into audible signals.

There are, therefore, two possible solutions of the problem of multiplex telephony and telegraphy upon this principle by electric waves—viz., by employing (1) electric waves of infra-sound frequencies, and (2) those of ultra-sound frequencies. One great difficulty in designing generators of infra-sound frequencies is in securing a pure sine wave, as otherwise any harmonic of the fundamental would appear within the range of audition. Furthermore, the range of frequencies is restricted, and the physical dimensions of the tuning elements for such low frequencies would have a tendency to become unwieldy.

The electromagnetic spectrum at present extends from about four to eight periods per second, such as are employed upon ocean cables, to the shortest waves of ultra-violet light. In this whole range of frequencies there are two distinct intervals which have not as yet been used—viz., frequencies from about 3×10^{12} of the extreme infra-red to 5×10^{10}, which is the frequency of the shortest electric waves yet produced by electrical apparatus, and from about 80,000 to 100,000 cycles per second to about 15,000 to 20,000 cycles per second. The upper limit of this latter interval represents about the lowest frequencies yet employed for long-distance wireless telegraphy.

Within the past few years generators have been developed in the United States giving an output of 2 kw. and above at a frequency of 100,000 cycles per second, and also capable of being operated satisfactorily at as low a frequency as 20,000 cycles per second. Furthermore, these machines give a practically pure sine wave.

The necessary conditions for telephony by electric waves guided by wires are an uninterrupted source of sustained oscillations, and some form of receiving device which is quantitative in its action. In the experiments described in multiplex telephony and telegraphy it has been necessary and sufficient to combine the present engineering practice of wire telephony and telegraphy with the engineering practice of wireless telephony and telegraphy.

The frequencies involved in telephony over wires do not exceed 1,800 to 2,000, and for such frequencies the telephonic currents are fairly well distributed throughout the cross-section of the conductor. As the frequency is increased the so-called "skin effect" becomes noticeable, and the energy is more and more transmitted in the ether surrounding the conductor. It has been found impossible to superimpose upon the ordinary telephonic wire circuits now commercially used electric waves of ultra-sound frequencies without producing any harmful effects upon the operation of the existing telephonic service. Fortunately, therefore, the experiments described below are constructive and additive, rather than destructive and supplantive.

Apparatus.—Under a special appropriation granted to the Signal Corps by Congress in the Army Appropriation Act of 1909, a small research laboratory has been established at the Bureau of Standards, in the suburbs of the city of Washington. This laboratory is equipped with the latest forms of apparatus now employed in the wireless telephone and telegraph art, and also with the standard types of telephone and telegraph apparatus now used upon wire circuits. The small construction laboratory of the U.S. Signal Corps is located at 1710 Pennsylvania-avenue, and is also equipped with the usual type and forms of apparatus used in transmitting intelligence by electrical means. Each of these laboratories is supplied with a wireless telephone and telegraph installation with suitable antennæ. In addition, these two laboratories are connected by a standard telephone cable line about 7 miles in length, which was employed in the experiments described below.

The high-frequency alternator used is a special form of the inductor type designed for a frequency of 100,000 cycles with an output of 2 kw., making it adapted for use in wireless telephony or telegraphy.*

The telephone line used is made up of the regular standard commercial equipment, and consists of paper-insulated twisted pairs in lead-covered cable, placed in conduit in the usual manner employed for city installation. The air-line distance between the two laboratories is a little over 3 miles (4·8 km.), but the telephone line, by passing through three exchanges, covers about 7 miles (11·27 km.).

DUPLEX-DIPLEX TELEPHONY OVER WIRE CIRCUITS.

Any plan which permits the present telephone system to remain intact and superimposes thereon additional telephone circuits would possess cardinal advantages. Accordingly, the first experiments were directed to as whether or not it is possible to superimpose upon the minute telephonic currents now employed in telephony over wires, electric waves of ultra-sound frequencies without causing prohibitive interference with the battery telephone currents.

With a collection of telephone receivers ranging from about 50 to over 8,000 ohms and of a variety of designs a series of tests was made. It was found, in general, that alternating currents of frequencies ranging from 30,000 to 100,000 cycles per second, when coupled conductively, inductively or electrostatically to local circuits from the generator produced absolutely no perceptible physiological effects in the receivers, excepting only that at certain of the lower frequencies a distinct audible note could be faintly heard in one of the receivers of about 250 ohms resistance. This note was found to be due to a slight variation of the amplitude of the high-frequency current of the generator, and appeared to be caused by a very slight vibration of the rotor as a whole in the magnetic field of the generator. It was almost entirely removed by the simple device of opening out the stator, which increases the clearance and materially cuts down the flux of the machine. In practice it is a distinct advantage, however, to have a trace of this note still left on the high-frequency side of the circuit, otherwise there is no ready means of determining at the receiving end of the cable line whether or not the high-frequency current is present on the line.

The next step consisted in introducing various forms of detectors, such as are now used in wireless telegraphy, between the telephone receiver itself and the energising circuit. Since the frequencies here considered are entirely above audition, it was necessary, in order to produce a physiological effect, to introduce another element in this transformation—viz., some method of modifying the continuous train of sustained oscillations from the generator into groups or trains, the period of which falls within the limits of audition. Since it is well known that the human ear is most sensitive at a period of

* Abstract of a Paper presented at the Annual Convention of the American Institute of Electrical Engineers.

* *See* THE ELECTRICIAN, July 16, 1909, p. 541.

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about 500 cycles per second, or 1,000 alternations, interrupters giving this frequency were employed.

Experiments were next made over local circuits at a range of frequencies from 20,000 to 100,000 per second, with the result that speech was transmitted very satisfactorily. Upon removing the detector from the above arrangement all perceptible effect in the telephone receiver ceased; in fact, no arrangement of connections of a telephone receiver to such a high-frequency circuit which did not include some form of detector was found to be operative for telephony unless certain low resistance telephones were used, in which case the speech was so much weaker as to be of an entirely different order of magnitude. The presence of a detector in this chain of operations is not absolutely necessary in the case of telegraphy, since, if the interrupter automatically produces a definite number of wave-trains per second, each train consisting of at least several complete oscillations, an effect may be produced upon a telephone receiver directly without a detector.

The test line was then taken and the machine was run at a frequency of 100,000 cycles per second, one wire of the telephone cable being connected to one terminal of the secondary of an air-core transformer, the other terminal being connected to earth. At the receiving end of the line this wire was connected direct to earth through a "perikon" crystal detector, and a high-resistance telephone receiver of about 8,000 ohms was shunted around the crystal. In this preliminary experiment no attempt was made at tuning, either at the transmitting end or at the receiving end of the line.

A loose coupling was employed between the two circuits at the transmitting end, and the line circuit adjusted by varying the coupling until the current in the line was 20 to 30 milliamperes. With this arrangement (1) telegraphic signals were sent and easily received, and (2) speech was transmitted and received successfully over this single wire with earth return. The actual ohmic resistance of the line apparently played an unimportant part for telegraphy at 100,000 cycles.

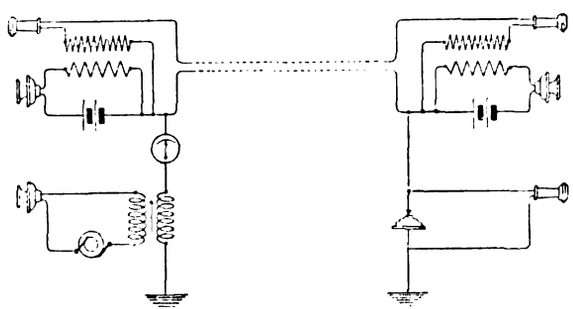

FIG 1.

Duplex Telephony, Using One Earthed Circuit.—To determine the fact that electric waves of ultra-sound frequency produce no perceptible effect when superimposed on the same circuit over which telephonic conversation is being transmitted, the next step was to use such a train of sustained oscillations as the vehicle for transmitting additional speech over the same circuit. For this purpose the twisted-pair telephone line was equipped with a complete standard local battery telephone set (Fig. 1). When the earth connections were introduced without tuning elements therein the metallic circuit experienced the usual disturbances found under city conditions, but it could be reduced to silence again by introducing in the earth connections the necessary tuning elements of magnitudes suited to wireless telegraphy.

Next, the twisted-pair telephone line was equipped with a complete standard local battery telephone set, as installed for commercial practice, with the exception that the local battery circuit of the transmitter telephone set was opened and a few turns of coarse wire inserted in series with the two dry cells which are normally used, as shown in Fig. 2. Inductively connected with this coil was the armature circuit of the generator. A hot wire milliammeter was placed in the line circuit to indicate the magnitude of the high-frequency current which was flowing on the line. With this arrangement tests were made to determine whether or not there were any effects upon the transmission of speech, due to superimposing high-frequency currents upon the battery telephone sets. With an operator at each end of the line, using the equipment in the regular commercial way, the direct-current voltage and the alternating-current voltage in series with it in the primary circuit of the transmitter were varied individually and relatively in a variety of ways, with the striking result that just at the point where the direct-current voltage was decreased, so that no sounds were received, the line became absolutely silent, although the alternating voltage in the circuit was at its largest value, or, again, speech would reappear at the receiving station at the moment when sufficient direct-current voltage was introduced to produce it, and the simultaneous presence of both the maximum direct voltage and maximum high-frequency voltage in a circuit produced exactly the same result as the maximum direct-current voltage did alone. When, however, the high-frequency current in the local circuit was forced to a point which caused "burning" in the transmitter itself, then, and then only, did the high-frequency current in any way interfere with the transmission.

By transferring this coil from the local circuit of the telephone set directly into the line itself, so that the high-frequency oscillations would be superimposed upon the line beyond the iron-cored induction coil of the telephone transmitter, it was not possible to detect the presence or absence of high-frequency currents.

As a test under severest conditions the effect was noted upon speech received at the same station at which the high-frequency current is being impressed, for here are the attenuated telephonic currents at the receiving end of the telephone line, on which is superimposed a high-frequency current of vastly greater magnitude at the same point. No effects of any kind could be detected under these conditions. From the above experiments it appears that in any attempt at multiplex telephony by means of electric waves of ultra-sound frequencies superimposed upon the minute telephonic currents employed in battery transmission there is nothing to fear from disturbances of such currents upon the operation of the ordinary battery equipment.

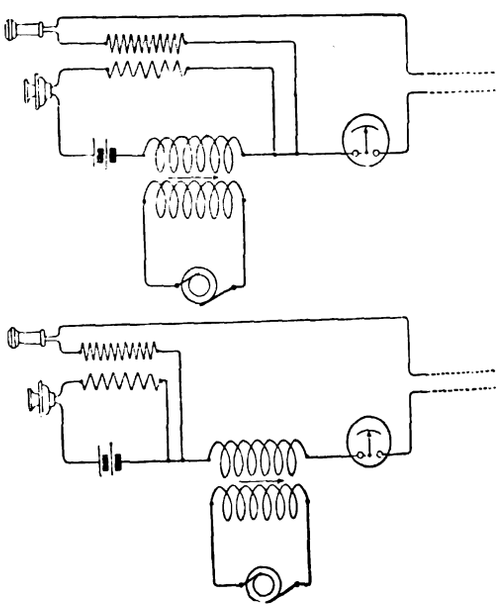

FIG. 2.

Silent Earth Circuits.—In providing tuning elements for earth connections there is at the same time afforded a certain means of eliminating any harmful disturbances from the earth, for the condensers employed for tuning to frequencies above audition possess an impedance to the frequencies involved in speech and also any disturbances from the earth, which effectively prevents the passage of any disturbance of audible frequency. These condensers offer a comparatively free passage to the electrical oscillations of the frequencies here being considered. When such earth connections are selectively tuned with the line to frequencies entirely above audition it is evident that no audible frequencies, either in the earth itself or from the line, can pass.

The point was now reached where the road was clear for duplex telephony, and for this purpose the apparatus and methods employed in wireless telephony were applied to one of the wires of the metallic circuit as though it were an antenna. The actual arrangement of this circuit is shown in Fig. 3, in which G is the source of sustained high-frequency oscillations, C′ is the tuning condenser of the oscillatory circuit, L′ is the tuning inductance of the oscillatory circuit, P is the primary of the oscillation transformer, A is the ammeter, M is the transmitter microphone, S is the secondary of the oscillation transformer in the line circuit, C is the tuning condenser in the line circuit, L is the tuning inductance in the line circuit, A′ is the ammeter in the line. At the receiving end of the line C_1 is the line tuning condenser, L_1 is the line tuning inductance, P_1 is the primary of the oscillation transformer, S_1 is the secondary of the oscillation transformer, L_1' is the tuning inductance in the oscillatory circuit, e_1' is the tuning condenser in the oscillatory circuit, between which and the telephone F′ the detector D is operatively connected; E is the earth connection.

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The local battery telephone sets are connected across the two-line wires in the usual manner. In both sets 1 is the microphone transmitter, 2 is the local battery, 3 is the induction coil, 4 is the ringing system, including the bell and hand generator, 5 is the switch-hook, 6 is the telephone receiver.

It was found that cross-talk was heard in the detector circuit from the battery transmitter at the transmitting end when the detector circuit alone was connected directly to earth from the line without any tuning coil or condenser. If, however, the tuning condenser was inserted, this cross-talk entirely disappeared even though the tuning coil was not inserted. This is because the impedance of the small tuning condenser is large for telephonic frequencies, while the tuning coil impedance admits these telephonic frequencies. Both elements of tuning are required for selective absorption of energy, so that the high-frequency circuit is available as an additional telephonic circuit. With this arrangement talking in the transmitter of the high-frequency side of the system was heard only in the detector and there was no cross-talk from the ordinary local battery circuit. Similarly, there was no effect of the high-frequency transmission on

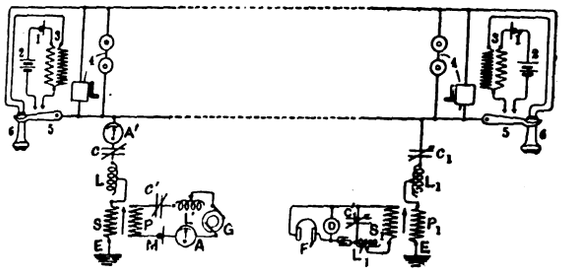

FIG. 3.

the local battery transmission, and the two telephonic messages were completely separated. Both circuits were entirely free from earth disturbances.

The volume of speech at the receiving end of the cable is greatly increased by the simple device of inserting the transmitter in the dynamo circuit and operating this circuit at or near resonance. In addition, the coupling at both transmitting and receiving stations should be so designed as to permit adjustment for optimum.

The frequency used in this experiment was about 100,000 cycles per second. The talk on the regular battery circuit was of the usual high standard both ways, so that the only reason at this point why complete duplex-diplex telephony was not obtained was the fact that there was no high-frequency dynamo available at the laboratory. There is, however, available at this laboratory one of the latest forms of the high-frequency arc, and accordingly this was arranged with suitable electromagnetic constants to give a period of about 71,000 cycles per second. This source of high-frequency E.M.F. was induced upon the high-frequency line wire in a similar

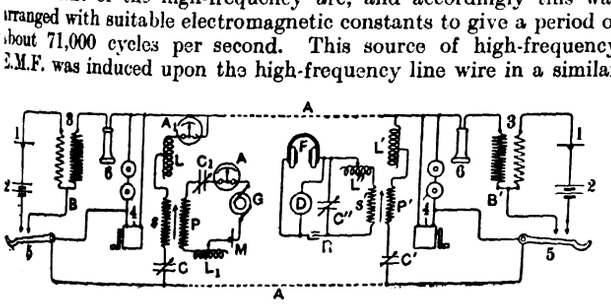

FIG. 4.

manner to that described in the station at the Bureau of Standards, with the result that one of the wires of the twisted-pair was made to carry simultaneously the battery telephonic currents from the two transmitters, the high-frequency oscillations of about 100,000 cycles per second, applied at the Bureau of Standards, and the high-frequency oscillations of about 71,000 cycles per second, applied at the laboratory. No influence from these conditions was perceptible upon the excellence of the battery transmission and reception of speech either way.

Duplex Telephony, Using Metallic Circuit.—The next step was to remove entirely the earth connections from the metallic circuit and superimpose both telephonic circuits upon the same pair of wires, as shown in Fig. 4

The transmitters were of the microphone type inserted in the armature circuit of the dynamo; provision for cooling was found to be unnecessary, especially when the transmitter was inserted in the line circuit instead of in the armature circuit of the dynamo. The telephone receivers were those regularly furnished for wireless telephony, ranging in resistance from 2,000 to 8,000 ohms.

The phenomena of resonance were very pronounced and highly consistent, since there is here a definite circuit free from the disturbances and variations inherent in radio-telegraphy and telephony.

Articulation tests, including music, numerals and other difficult combinations, gave satisfactory results, with no interference whatever between the two sides of the circuit. By holding one telephone receiver to one ear and the other receiver to the other ear the receiving operator could hear two entirely different conversations simultaneously over the same pair of wires.

A circuit was also made up with high-frequency apparatus inserted directly in the line in series. This gave apparently as good results as the bridging arrangement of the circuit.

Duplex-Diplex Telegraphy.

Having described in detail the experiments for obtaining the simultaneous transmission of two telephonic messages over a single circuit, it will be apparent that the problem of transmitting two telegraphic messages over the same circuit may be solved by methods and apparatus, as far as the high-frequency side of the circuit is concerned, which are practically identical with those described above.

In this connection the metallic circuit referred to was equipped with a standard Morse set for manual operation, and upon this circuit was superimposed an equipment for transmitting in one direction telegraphic messages by means of sustained high-frequency oscillations, employing the telephone as the means for receiving the signals.

Although little mention of telegraphy by high-frequency electric waves has been made thus far, as a matter of fact, it was found convenient during the experiments upon telephony actually to employ telegraphy as a quick and ready means of determining resonance between the circuits in each particular case. When any particular arrangement was being employed the first steps were invariably to send simple Morse signals over the circuit until the operator at the distant end of the line reported maximum loudness in the receiving telephone, which indicated that the terminal apparatus with the line circuit was properly tuned. This being accomplished it was necessary only to throw a switch, to substitute for the automatic interrupter and telegraph key the telephone transmitter, and the experiments could then proceed on telephony without any material change being made at the receiving station. Telephony and telegraphy thus proceeded hand in hand as a mere matter of convenience, and one of the practical advantages in the use of electric waves for transmitting intelligence is that the whole set-up of apparatus is practically the same for each and they can be used interchangeably over the same circuit.

Since the standard telegraph circuits of the world use an earth return, this same equipment was arranged to operate on one of the wires of the twisted-pair in the telephone cable as such a circuit with earth connections at each end, and its operations was equally successful.

Since it is a well-known characteristic of high-frequency apparatus used in tuned circuits that there shall be no iron involved in the circuit, it is evident that in cases where such a high-frequency current is to be superimposed upon a line comprising way-stations, where line relays are inserted directly in the circuit, it will be necessary and sufficient to shunt such way-stations by condensers of the order of magnitude of thousandths of a microfarad. Such condensers offer a comparatively free path for the high-frequency electric waves, but interpose a practical barrier to the Morse frequencies.

Since a portion of the telegraph lines now used is still composed of iron wires, it would be expected that electric waves would be propagated over such wires less efficiently than over copper wires, although it is well known that electric waves penetrate only about one-thirteenth as deeply into soft iron for a given frequency as into copper, but this is modified by the fact that the iron in telegraph wires is not soft iron and in addition is galvanised.

Measurements of Electric Waves.

In order to understand more fully the conditions for the successful transmission of electric waves along commercial telephone cable conductors, a preliminary study of this particular line was made, and the engineering data obtained are submitted by the author.

Typical resonance curves were constructed, first with the line open at the receiving end, and, second, with the line short-circuited at the receiving end, after which the modifications introduced by the presence of certain terminal apparatus were briefly investigated. These are shown in the Paper for four frequencies between 95,000 and 36,500 cycles per second.

In order to interpret the curves from an engineering point of view, it is more valuable to plot them as selectivity curves, in which the line current is plotted as a function of the frequency. This is done in Fig. 5 for the case of $n=53{,}000$. It appears from an inspection of this curve that it is not symmetrical with respect to the ordinate

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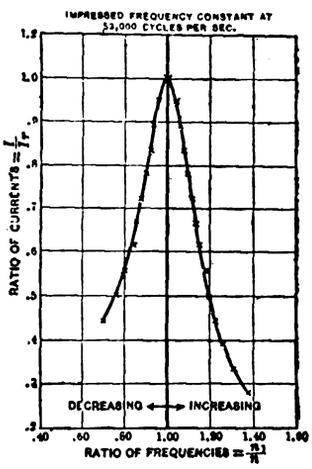
corresponding to resonance. The slope of the curve is steeper for increasing frequencies than for decreasing frequencies. A curve of this kind makes it possible to predict that terminal apparatus could be inserted in this line at the receiving end, provided it was in the nature of ohmic resistance, and that there would be no interference between several of such instruments operated at different frequencies, provided the interval between the frequencies of each of the different receiving sets was greater than 44 per cent., and that each receiving apparatus was not rendered inoperative by the presence of a stray current of 50 per cent. of its normal operating value. It should be remembered that this interpretation is from conditions controllable at the transmitting end only, and provides for no selective tuning whatever of the apparatus at the receiving end. In other words the curve given shows the selectivity of the line itself.



I_r = Line current at resonance.
I = Line current.
n = Frequency at resonance.
n_1 = Frequency of line circuit tuned to given dissonance.

FIG. 5.—SELECTIVITY CURVE OF TELEPHONE CABLE LINE, RECEIVING END SHORT-CIRCUITED.

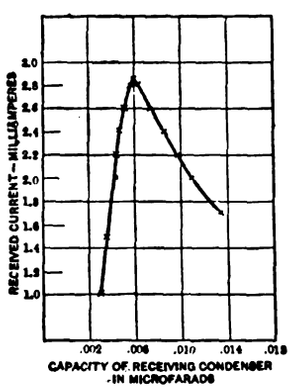


FIG. 6. — RESONANCE CURVE AT RECEIVING END OF TELEPHONE CABLE LINE. TRANSMITTING CURRENT CONSTANT AT 200 MILLIAMPERES AND AT 40,000 CYCLES.

For the range of frequencies involved in these experiments the values of the standard variable air condensers and variometers which are at present employed in wireless telegraph practice could better be made of larger electrical dimensions in order to be better adapted to the frequencies here considered.

The effects of introducing tuning elements across the line at the receiving end are shown in Fig. 6. At the transmitting end of the line the current and frequency were kept constant throughout, and at the receiving end of the line only the capacity element of the tuning apparatus was varied, which caused a rise and fall of the received current, as shown in Fig. 6.

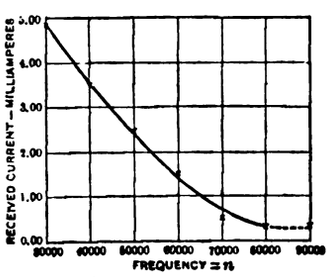


FIG. 7.—ATTENUATION-FREQUENCY CURVE AT RECEIVING END OF TELEPHONE CABLE LINE, SHORT-CIRCUITED THROUGH DUDDELL THERMO-AMMETER OF 17·1 OHMS.

To determine quantitatively the influence of variation of frequency upon the attenuation of the current transmitted over this telephone line the curve shown in Fig. 7 was obtained. In this experiment the transmitting current was kept constant at 240 milliamperes, the only thing varied being the frequency of the alternator.

The author sums up as follows: The foregoing experiments indicate that either the existing wire system, or additional wires for the purpose, may be utilised for the efficient transmission of telephonic and telegraphic messages, and the former without interfering with the existing telephone traffic on these wires. The fact that each of the circuits created by the use of superimposed high-frequency methods is both a telephone and a telegraph circuit interchangeably makes it possible to offer to the public a new type of service, which, it is believed, will offer many advantages to the commercial world. This type of circuit should be particularly applicable to Press Association service, railroad service and leased-wire service of all kinds.

The experiments described should not be interpreted as in any way indicating limitations to radio-telegraphy and telephony in the future, for their present rapid development gives justification for great prospect for the future. It is rather considered that the whole system of intercommunication, including both wire methods and wireless methods, will grow apace, and as each advance is made in either of these it will create new demands and standards for still further development.

Accustomed to the methods of transmitting energy for power purposes by means of wire, it is a matter of wonder that enough energy can be delivered at a receiving antenna from a transmitting point thousands of miles distant to operate successfully receiving devices. The value of a metallic wire guide for the energy of the electric waves is strikingly shown in the above experiments, and it furnishes an efficient directive wireless system which confines the ether disturbances to closely bounded regions and thus offers a ready solution of the serious problems of interferences between messages which of necessity have to be met in wireless operations through space.

The distortion of speech, which is an inherent feature of telephony over wires, should be much less, if not practically absent, when we more and more withdraw the phenomena from the metal of the wire and confine them to a longitudinal strip of the ether which forms the region between the two wires of a metallic circuit. The ohmic resistance of the wire as shown can be made to play a comparatively unimportant part in the transmission of speech and the more the phenomena are of the ether, instead of metallic conduction, the more perfectly will the modified electric waves, which are the vehicle for transmitting the speech, be delivered at the receiving point without distortion.

It has been shown that the phenomena of resonance exhibit very striking and orderly results when applied to electric waves propagated by means of wires. By utilising this principle it has been shown that the receiving current at the end of the line may be built up and amplified many times over what it would be with untuned circuits. The tuned electrical circuit at the receiving end readily admits electromagnetic waves of a certain definite frequency, and bars from entrance electromagnetic waves of other frequencies. This permits the possibility of utilising a single circuit for multiplex telephony and telegraphy.

ELECTRICITY IN MINES: AVOIDANCE OF ACCIDENTS.

We give below a short account of the adjourned discussion at a joint meeting of the Scottish Branch of the National Association of Colliery Managers and the West of Scotland branch of the Association of Mining Electrical Engineers, on the Paper contributed a few months ago by Mr. Robert Nelson, H.M. Electrical Inspector of Mines. An abstract of this Paper appeared in THE ELECTRICIAN, April 7, 1911.

Mr. C. A. ATCHLEY (Kilmacolm), in reopening the discussion, said he wished that on a Paper of this kind they could elicit more freely than they had hitherto done the views of colliery managers who were actually using electric plant, because there was no doubt that the question of accidents and loss of life was becoming very serious indeed. The fact of the matter was that electrical engineers needed all the light and leading they could get, especially from the practical standpoint, from those who had electrical plant in operation. For the present he proposed only to deal with one single point—namely, the vexed question of the use of armoured cables. In regard to the proposal of the Home Office to enforce the use of armoured cables, he felt that in the majority of instances, particularly in regard to new works, armoured cables were safer than unarmoured cables. He had the fear, however—and he believed others felt the same way—that in discarding unarmoured cables straight away, and adopting armoured cables universally, they were going much too fast. The point that appealed most strongly to him was that the class of man who was quite able to superintend and maintain the insulation of an unarmoured cable might not, except after a considerable period of training, be equal to the responsibility of maintaining an armoured cable system.

Mr. A. B. MUIRHEAD thought that the principal points involved in the present Paper were those in relation to earthing and the number of fatal accidents. Candidly, he was bound to admit that he was not satisfied in his own mind that the earthing of everything was going to result in safety. There was just the chance that they would get to that stage—since everything electrical in the pits was to be connected up through armoured cables and carefully earthed—when the standard of insulation would begin to deteriorate, and they would rapidly reach the stage when they would be worse off than they were to-day. He

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whole contention frankly was that the question of insulation was not receiving the same measure of attention as that of earthing.

Mr. McVIE, speaking as a colliery manager, said it was a pity that the author of the Paper was not present, otherwise he would have asked him to reply to the very straightforward observations which Mr. Muirhead had made. Colliery managers were in somewhat of a difficulty, because they had the Home Office definitely laying down rules that everything was to be earthed, while, on the other hand, they had acknowledged experts like Mr. Muirhead and others declaring that Mr. Nelson and the Home Office were practically wrong. It was his feeling that at the last joint meeting Mr. Alexander Anderson, President of the West of Scotland Branch of the Association of Mining Electrical Engineers, had raised some very important points, and it did not appear to the speaker that the replies which he got from Mr. Nelson were at all satisfactory.

Mr. ALEXANDER ANDERSON (chairman) said he had it from quite an authoritative source that Mr. Nelson intended replying to the discussion when it was concluded.

Mr. GEORGE L. KERR (secretary of the Scottish branch of the National Association of Colliery Managers) said he would be glad if electrical experts would give their opinion as to whether earthing locally or at one central point on the surface was preferable. Then there was the further point as to whether earthing was preferably effected outside rather than inside the cable. He knew of one fatal accident where the victim actually lost his life due to the earth wire. In conclusion, he desired to remark that 80 per cent. of the accidents he had investigated in the course of his professional duties were on three-phase systems, and less than 20 per cent. on direct-current installations.

Mr. ALEXANDER ANDERSON remarked that the point raised by Mr. Kerr as to whether the earth wire should be outside or inside the cable was one which was giving electrical engineers some little concern at the present time. At one period he might tell them quite frankly that he favoured the idea of the earth wire being inside. Now, however, he was absolutely opposed to that arrangement, if it was possible to earth on the outside. He believed that if an earthed system was adopted they could not have too many earthing points. Further, he held strongly to the belief that, in the majority of cases, the surface should be one of these points. With regard to the question as to whether three-phase or direct current was the more dangerous system, he had no hesitation in giving a verdict against three phase. No doubt the three-phase was an admirable system, but so far as relative safety was concerned there was no doubt in his mind as to which he would prefer.

The discussion was then adjourned to a future meeting.

REPORT OF THE BRITISH ASSOCIATION COMMITTEE ON PRACTICAL STANDARDS FOR ELECTRICAL MEASUREMENTS.*

The Committee have to regret the death since the last meeting of the Association of Dr. G. Johnstone Stoney, F.R.S. He had been a member since 1861, and up to a few years since continued his active interest in the work. In its earlier stages his skill in definition and admirable choice of nomenclature had proved invaluable to the Committee. The collected reports which are to be issued shortly will indicate how large a share in the establishment of the C.G.S. system of units is due to him.

Republication of Reports.—The republication of the reports is not yet completed, but this should be done within the present year. The proofs of the reports from 1862 to 1883 have been finally revised and the remaining proofs will soon be ready.

Current Apparatus.—The progress made has been satisfactory. Preliminary experiments have shown that the apparatus is uninfluenced by changes in the earth's magnetic field and that the thermal E.M.Fs at the brushes on the two discs very nearly balance. With the form of brush in use at present there are sudden changes in the difference of the thermal E.M.Fs amounting to 2×10^{-7} volt, and it will be difficult entirely to eliminate these. With other forms of brush, *e.g.*, those made of gauze, the difference was often 1,000 times as great. It was this difficulty which led Lord Rayleigh in 1884 to amalgamate the edge of the disc, and as a further improvement Prof. Viriamu Jones and Prof. Ayrton used mercury jets instead of brushes. Since in the present apparatus the changes are only 1 in 100 of the difference of potential produced in one arrangement of brushes and less for a second arrangement, it is hoped that mercury contacts will not be necessary. Further experiments will be made in order to obtain greater perfection if such is possible.

Resistance Standards.—The construction of new mercury standards of resistance in accordance with the specification of the London Conference is being proceeded with, and some of the standards will be completed this year. Similar work is in progress in France, in Germany, in Austria, and in the United States. In the latter country four standards have had all of their constants determined, and the resistance unit so obtained is in very close agreement with that obtained from the old National Physical Laboratory standards.

In the Committee's Report for 1908 it was shown that many manganin resistance coils—some of which were purchased by the Committee in 1895—were very changeable in resistance, and in consequence frequent comparison with mercury standards was necessary. In 1908 it was shown at the Bureau of Standards, and confirmed at the National Physical Laboratory and at the Reichsanstalt, that these changes were largely due to the effect of moisture on the shellac covering the wire. To eliminate this source of trouble, many of the coils were hermetically sealed in 1909, and it is satisfactory to record that they are now much more constant. The importance of this hermetical sealing is so great when manganin resistances are to be sent to such places as cable stations in the tropics that the attention of instrument manufacturers is drawn to the matter. Standard coils are readily sealed and boxes of coils may be sealed in metal cases. The following figures for standard coils of manganin show the advantage of hermetical sealing :—

Nominal value . . .		100 ohms.		1,000 ohms	10,000 ohms
		No. 2450.	No. 740.	No. 2449.	No. 2448.
Open coils	Oct.: 1903	99·995$_9$	1,000·15$_2$	1,000·01$_2$	10,000·2$_4$
	1904	100·000$_2$	0·17$_2$	0·24$_4$	2·4$_0$
	1905	0·000$_8$	0·21$_8$	0·49$_4$	3·5$_7$
	1906	0·009$_2$	0·24$_8$	0·66$_8$	3·8$_2$
	1907	0·013$_2$	0·26$_6$	0·81$_4$	3·7$_4$
	1908	0·028$_8$	0·30$_2$	1·13$_0$	3·8$_5$
Hermetically sealed in paraffin oil	June 1909	0·036$_9$	0·36$_5$	1·01$_6$	5·5$_3$
	1910	0·038$_4$	0·35$_7$	1·07$_5$	5·5$_5$
	1911	0·039$_9$	0·35$_9$	1·06$_9$	5·6$_1$

It will be noted that the changes during the last three years are very small.

Silver Voltameter and Standard Cell.—Although the actions which take place when a current passes through a solution of silver nitrate as in a silver voltameter are now well understood, the effects of septa—such as silk, filter paper, and porous porcelain—are by no means clear, and experiments have, therefore, been made to decide whether any septum at all should be used in a voltameter. Such experiments were suggested at the Washington meeting in 1910. The results of the experiments made at the National Physical Laboratory indicate that a septum of any kind is usually a source of trouble, and may produce secondary reactions during the electrolysis which affect the weight of the silver deposit. Fortunately, voltameters have been designed which render a septum unnecessary, and these may be useful not only in precise current measurements with the silver voltameter, but for the deposition of metals other than silver.

The reproducibility and constancy of the Weston normal cell are still being carefully examined. The chief anomaly is the hysteresis effect mentioned in last year's report: for this effect we have no explanation although one is much needed, as probably it would enable cells to be made so as to remain even more constant in E.M.F. than at present. It is necessary to point out that while the effect is called a hysteresis one, the E.M.F. does not lag behind the temperature. Briefly put, with ascending temperatures the E.M.F. changes in close agreement with the temperature—E.M.F. formula, but with descending temperatures the E.M.F. changes too rapidly, corresponding to values at temperatures lower than the temperature of the cell, by from 3 deg. to 15 deg.

The Committee had hoped to have made this their last report, but in view of the fact that the republication is not complete they ask for reappointment, with Lord Rayleigh as chairman and Dr. R. T. Glazebrook as secretary.

Utility of the "Dead Man's Handle."—According to the "Electric Railway Journal," on July 14th, as a train on the New York Subway was proceeding at full speed, the motorman looked out of the side door of his compartment, and in so doing his head struck a signal post. The man was killed by the blow and his body was thrown out of the compartment. This freed the stop in the motor controller handle, so that it rose automatically, cutting off the current and applying the brakes, and pulled up the train in three cars' length.

* Report presented at Portsmouth. The Committee consists of Lord Rayleigh (chairman), Dr. R. T. Glazebrook (secretary), Profs. J. Perry, W. G. Adams and G. Carey Foster, Sir Oliver Lodge, Dr. A. Muirhead, Mr. W. H. Preece, Profs. A. Schuster, J. A. Fleming and Sir J. J. Thomson, Mr. W. N. Shaw, Dr. J. T. Bottomley, Rev. T. C. Fitzpatrick, Prof. S. P. Thompson, Mr. J. Rennie, Principal E. H. Griffiths, Sir Arthur Rücker, Prof. H. L. Callendar and Messrs. G. Matthey, A. P. Trotter, Prof. T. Mather, and Mr. F. E. Smith.

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THE FIXATION OF NITROGEN.

The advance of the electrical fixation of nitrogen as an industry has been one of the most remarkable events of the last few years. It is not so very long ago that Sir WILLIAM CROOKES called attention to the extreme importance of obtaining a greater agricultural output from the soil than is at present customary, and that this could only be done by supplying the soil with greater quantities of manure. This in itself, was a fairly self-evident statement, but the argument with which it was met was that the quantity of manure available was insufficient to carry out such a policy. Sir WILLIAM pointed out that the nitrogen of the air, if it could be brought into service sufficiently cheaply, provided a solution of the difficulty. No commercial process was then available, but before so very long the Birkeland-Eyde process came into existence, and this has been followed by two or three others, so that at the present time the power so utilised is running into very large figures.

Although nitrogen is remarkable in chemistry for its apparent inertness, it plays a most important part in Nature. In plant life it is indispensable, and if the soil does not contain a sufficient quantity of nitrogen in some form or another the results are poor. As a manure it is generally applied in the form of a nitrate or a salt of ammonium. In the Birkeland-Eyde process the product takes the form of calcium nitrate; whereas in the Frank-Caro process the product is cyanamide. These products differ somewhat in their properties and in the way in which they are used, but it appears that they may be very advantageously mixed together, the applica-

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a manure being then more easy than when these materials are used separately.

Another field in which nitrogen is important is that of explosives, though the quantity required in this direction is small compared with that which could be used profitably in agriculture. Most of our explosives depend in their production upon nitric acid in some form or another.

As the deposits of Chile saltpetre become exhausted, the electrical production of nitrates will assume enormous proportions. It is only natural therefore that the electrical engineer should look upon this growing industry with covetous eyes and wish to see some development of it in this country. This reason is sufficient to account for the Paper read by Mr. KILBURN SCOTT before the British Association last week. As will be seen by the abstract which appears elsewhere, Mr. SCOTT takes up the subject from two points of view—the agricultural and the explosive. The great difficulty in fostering an industry of this kind in Great Britain is that extremely cheap electrical power is a *sine qua non*, the cost of power being the most important item in the total cost of production. The suggestion is put forward that the manufacture of explosives should not be treated commercially, for the reason that in the event of war this country might find itself placed in a very awkward predicament if the supply of nitrate were cut off. In order that we might manufacture explosives without being dependent upon outside supplies of nitrate the Government might erect a factory for the production of nitric acid from atmospheric nitrogen by one of the electrical processes now available. Although it is to be hoped that this country will be saved from the horrors of war indefinitely, there is no better means of preventing war than by preparing for it, and from that point of view there is something to be said in favour of Government action of this kind. We must confess that we doubt very much whether any Government will act in this direction, though possibly a subsidy might be given to some private enterprise on condition that this method of manufacture might be available for the Government in case of need.

At the conclusion of his Paper Mr. SCOTT discusses the question whether electrical power might not be generated sufficiently cheaply in this country to compete with Norway's water power. We fear that this cannot be done. The capital cost of water power in certain parts of Norway is extraordinarily low, and consequently the price per kilowatt-hour for which electrical energy can be obtained is something like one-twentieth of a penny. Undoubtedly the capital cost of steam stations has been very much reduced during the last few years, and a figure of £10 per kilowatt installed is now quite possible. With waste heat stations the cost may be still lower, but there seems to be great difficulty in getting down to the desired figure, even when the difference in freight is taken into account. It appears to us that the most feasible means is for some of the power companies to supply energy on the "restricted hour" basis. From the point of view of uniformity in electro-chemical manufacture this method is at a disadvantage, but possibly the lowness in cost might be a sufficient offset to enable intermittent working to be adopted. It may also, perhaps, be worth asking if there is not sufficient water power available in the British Isles to warrant the starting of a factory with a hydro-electric plant. It would not be possible to rival the factories now to be found in Norway, but the plant might be sufficiently large to be commercially successful and to be of use to the Government in time of need.

REVIEWS.

(Copies of the undermentioned works can be had from THE ELECTRICIAN Office, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.)

Mesures Electriques Industrielles. By J. A MONTPELLIER and M. ALIMET. (Paris; H. Dunod and E. Pinet.) Pp. 468. 18fr.

This book, forming the third volume of a series intended as a practical guide to industrial measurements, covers more or less familiar ground in an orderly manner and with the clearness and conciseness of statement one has come to associate with French scientific text-books. Commencing with two chapters of an introductory character in which units, definitions, classification of instruments, attainable accuracy, sources of error, and classification of methods are successively dealt with, the authors pass on to a consideration of electrostatic, electromagnetic, dynamometric, induction, and thermal instruments in the order named, this section of the book closing with a chapter on what are conveniently classed as accessories, viz., resistances, shunts, and instrument transformers. The remaining space, representing a little over one-half the book, is devoted to methods of measuring resistance, E.M.F., current, quantity, capacity, power, energy and inductance, each of which gets a chapter to itself. The penultimate chapter discusses special methods in alternating-current measurement such as determination of wave-form, measurement of frequency, and measurement of phase difference; and the last chapter contains a condensed account of electricity meters with instructions for testing.

The book is mainly descriptive, theory being kept well in the background, although enough is usually given to make clear the "how" and the "why" of the particular instrument or method under consideration. More than occasionally, however, the reader's powers of faith are largely drawn upon, as, for instance, in an otherwise excellent chapter on the measurement of three-phase power, where the reader is asked to accept without any attempt at proof the bald statement that the sum of the readings of two wattmeters arranged in a certain way gives the true power.

Inequality of treatment strikes one forcibly in several places. The authors are certainly to be commended for introducing quite a full account of such a recent instrument as the Drysdale alternating-current potentiometer. On the other hand the measurement of insulation resistance and of dielectric strength hardly receive their fair share of treatment; the latter subject being dismissed in nineteen lines of text and a few tables without allusion to the half-dozen or so different conditions which affect the results. Again, valuable space to the extent of two pages is taken up by a table of doubled square roots for use with Kelvin's balance; whereas the subject of the arithmetical analysis of alternating-current wave-forms is dismissed with the curt remark that it "does not come within the scope of this book," a reference, however, being given to another work (by the same publishers) where the necessary information may be found.

But references are not much in evidence, a paucity which undoubtedly constitutes a serious defect in a work of this kind. Seeking, as it does, to cover within a limited space a wide and still widening field, careful selection is of course necessary, and a few typical examples of apparatus and methods can alone be dealt with adequately. Therefore it would not be surprising to find, for example, that electrostatic ohmmeters, vibration galvanometers, and several well-known forms of alternating-current wave tracers, like the instruments of

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Duddell, Francke, Rosa, and Siemens and Halske, are not discussed at length; but to find them omitted altogether is more than one is prepared for. Opinions may differ as to what particular types should receive preference, and doubtless the authors are justified in giving that preference to the home-grown article, but surely they might at least have mentioned and given references to the above-named instruments instead of ignoring them entirely. Much may be forgiven a book of this class if only a full list of references is provided; at the worst, it still serves as a directory or inventory of ways and means, and as such fulfils a most useful function however meagre or unsatisfactory its text may be.

Needless to say there is no alphabetical index, the authors apparently imagining that a distended table of chapter contents placed at the end of the book is a satisfactory equivalent.

R. BEATTIE.

The Development of the Telephone in Europe. By H. LAWS WEBB. With an Introduction by H. COX. (London: *Electrical Press, Ltd.*) Pp. 78. 1s. nett.

What is in many respects an interesting contribution to the literature of telephonic development is marred by exaggerations. Mr. Webb holds the State responsible for all the errors of policy, management and engineering in countries where the telephones are State controlled. The *motif* of the book is the taking over by the Government of the National Telephone Co.'s system—the term of years for which the licence was granted to that Company expiring at the end of this year.

The main arguments against State control are:—The Government have not made the telegraphs pay, therefore the telephone purchase must result in loss also. Government officials having assured positions cannot be expected to be conscientious and carry out in an energetic and business-like manner the highly technical business of telephony. Money will not be readily obtainable to carry out extensions and reconstructions necessary in a rapidly developing business in which plant so frequently needs replacing.

The book deals with "The Rise and Evolution of the Telephone Service" (Chapters I. and II.), "American and European Development Compared" (Chapter III.), "The Telephonic History of Great Britain," (Chapters IV., V. and VI.), "Some Reasons for Popular Prejudice Against the Telephone" (Chapter VII.), "The Essential Features of Telephone Policy" (Chapter VIII.), "Survey of Telephone Development on the Continent of Europe (Chapters IX. to XII.).

In the first paragraph the author compares the telephone development of the United States with the whole of Europe—one wealthy and highly developed State of 80 million people against a conglomeration of wealthy and poor States, many of them badly developed, with a population of 400 millions. This is done to show poor benighted Europe with 6·4 telephones per thousand against 87 in "God's Own Country." Why not take an area in America having 400 million people, or nations in Europe having 80 millions for comparison? The figures would still be bad enough, but the author wants to paint us as black as possible.

The author makes the statement that America is the only country where telephony has been developed, or is in process of being developed, to its utmost capacity, and that because there is no State control. This freedom may be one reason, but another is the competition of independent companies. These have had a far-reaching effect on telephone development in the United States. Up to the time they started, about 1896, the Bell system was comparatively small in numbers, not very good, and the rates very high. On the expiry of the Bell patents the "independents" started active competition, and in some of the Western states to-day their telephones equal in numbers those of the "Bell." They threatened the Eastern States also, but by introducing modern plant, and the message-rate system, the Bell Co. have prevented their making the same headway. The independent companies own to-day at least one-third of the total telephones in use. No greater argument could be cited in favour of competition in telephones than the splendid results attained in America, and, as Mr. Webb says in another part of his book, "If the municipal systems in this country had been better organised, and conducted more in accordance with the technical requirements of the telephone business, there might be a different story to tell."

In this country we have largely followed the lead of America, and therefore we are behind. We were two or three years late with the C.B. system; we followed, and less thoroughly, with the message-rate system, and similarly with the private branch exchange development.

There are many points in the book one would like to query, *e.g.*, "When the P.O. succeeds to the telephone service it will succeed to a congested plant, without proper facilities for expansion and without proper development studies to govern plans for future construction." Will this be so?

Has the limited tenure been entirely to blame for the comparatively slow introduction of the C.B. system? Mr. Webb states that New York introduced this system between 1898 and 1901. If London and other large cities had been similarly converted at the same time, practically the life of the switch-boards would have terminated with the licence.

Mr. Webb mentions a more cogent reason for slow development in another place, viz., the opposition of the local authorities and the want of powers, such as the Post Office possesses, to over-ride difficulties.

Mr. Webb thinks the terms of purchase harsh, and we sympathise with him when he says:—"The National Telephone Co., which has built up a great business under very difficult and discouraging conditions, and has organised and developed a great public service to a high pitch of scope and efficiency, is treated with discouraging harshness and parsimony." May the final result be otherwise.

The die is cast, and for good or evil we are to have State control—unless the belated suggestion of a central authority finds favour and support.

W. A.

Génératrices de Courants et Moteurs Electriques. By C. GUTTON. (Paris, 1911: H. Dunod et E. Pinat.) Pp. vi.+292. 9fr.

This book is one of those occupying a definite place between the elementary text book and works written by specialists on electrical machine design.

It is the outcome of lectures given at the Electrotechnical Institute of the University of Nancy by the author, to students intending to become electrical engineers, and within a moderate compass he has succeeded in developing a clear and connected argument covering practically the whole subject indicated by the title.

This has been done by concentrating attention on a broad comparative study of different types of machines to the exclusion of discussion on points of unessential detail. For instance, great elaboration in the treatment of the circle diagram of the induction motor has been avoided, while the analogies between it and the continuous-current shunt motor have been dwelt upon.

There are, however, a few matters on which more might have been said. On page 56 it would appear that the heating of a machine is the only limit to its output. No reference is made to limits sometimes imposed by sparking or excessive voltage drop. On the same page, the manner in which losses due to eddy currents and hysteresis are taken together would leave the reader ignorant of their different variation with speed. The chapter on commutator motors contains no reference to the use of high-resistance connections between commutator and armature winding, and in considering the Latour motor some mention should have been made of the work of Eichberg and Winter. The treatment of converting machinery is incomplete by the omission of any discussion of the motor converter.

On the other hand, the elaborate method of predetermining alternator regulation curves in which three coefficients are required might well have been omitted, in favour of Potier's ingenious adaptation of Rothert's and Behn-Eschenburg's constructions.

A valuable feature running through the whole book is the method adopted of separately constructing the magnetic field due to each winding of a machine when carrying current, and then investigating the result. This has led in the hands of the

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author to a real presentment of working conditions. Although this method is not of great use in the derivation of numerical formulæ, yet, as the author truly remarks at the end of his preface, this has not been the object aimed at.

The book will well repay study both by teachers and students.

W. C. C.

STUDIES IN LIGHT PRODUCTION.*

BY R. A. HOUSTOUN, M.A., PH.D., D.SC.

(Lecturer in Physical Optics in the University of Glasgow.)

(*Continued from page 862.*)

Summary.—In these studies the author deals with the theory of light production, the scope being briefly indicated by the following contents: (1) The distribution of the energy in the spectrum and the measuring of efficiency. (2) The importance of "black body" radiation and the experimental realisation of the black body. Comparison of the energy curves of a black body and of platinum, and the variation of the position of maximum energy with temperature. (3) Mechanism of flame, and the temperature, energy and efficiency of flames. (4) The Welsbach mantle and selective radiation. (5) Radiation and efficiency of the carbon glow lamp. (6) Physical properties and temperature of the arc. (7) Temperature and energy curves of the Nernst glower. (8) Efficiency of the metal filament. (9) The mercury arc and its difficulties. (10) The light of the future and the possibility of obtaining "cold light."

No. 2.—The Black Body.

According to the modern view, light may be produced in two ways, by temperature radiation and by luminescence. If the source is emitting light merely as a result of being heated, and if it is not suffering any chemical change in the process, we have a case of temperature radiation. The electric glow lamp, the Nernst filament and the incandescent mantle belong to this class. Here the electrons which emit the light waves are caused to vibrate as a result of the motion of the molecule as a whole. If, on the other hand, light is produced, not as a result of heat, but as a result of electric energy being conveyed to the source, or as a result of chemical energy being liberated, we have luminescence. The aurora borealis, the vacuum tube, the light given off by phosphorus in the dark, are all cases of luminescence. In these cases the source is cold, and no kinetic energy is given to the atom or molecule as a whole.

Luminescence has not been studied much from the point of view of the energy curve, chiefly on account of experimental difficulties. Temperature radiation has been studied very fully and accounts of the principal facts have been given by Kayser, Day and Van Orstrand, and Waidner and Burgess. (Kayser's "Spectroscopie," Vol. II., Chapters I. and II. Arthur L. Day and C. E. Van Orstrand, "The Black Body and the Measurement of Extreme Temperatures," Astrophys. J., 19, p. 1, 1904. C. W. Waidner and G. K. Burgess, "Optical Pyrometry," Bull Bureau of Standards, p. 189, I., 1905.)

In 1859 Kirchhoff published the law that the ratio of the radiating power to the absorbing power of all bodies is the same and a function of the wave-length and the temperature. By the radiating power of a body is meant the quantity of heat radiated from unit area of its surface in unit time; by the absorbing power is meant that fraction of the energy incident on the surface which is absorbed by the body.

The law may be proved for one particular case as follows: Let CDFB, GJHK (Fig. 2) be pieces of two bodies. They have the form of slabs extending to infinity on all sides. Let the faces CB, JK, which are turned away from one another, be impervious to heat. Let E_1, A_1 denote the radiating power and absorbing power of the body on the left, and E_2, A_2 the radiating power and absorbing power of the body on the right.

Suppose that there is equilibrium of temperature between the two bodies. Then each receives as much heat as it radiates. From the shape of the bodies it is evident that the radiation from each must be normal to their surfaces. It is sufficient, therefore, to consider the unit area of the one surface and the unit area of the other surface opposite it. Consider the energy E_1 originally emitted from 1. A_2E_1 is absorbed by 2, $(1-A_2)E_1$ reflected. Of the reflected energy $(1-A_2)A_1E_1$ is absorbed by 1, $(1-A_2)(1-A_1)E_1$ reflected. Of this $(1-A_2)(1-A_1)A_2E_1$ is absorbed by 2, and so on. It is easy to see that the quantity absorbed by 1 is

$$\begin{aligned}&(1-A_2)A_1E_1+(1-A_2)^2(1-A_1)A_1E_1\\&\qquad+(1-A_2)^3(1-A_1)^2A_1E_1\ldots\\&=(1-A_2)A_1E_1\{1+(1-A_1)(1-A_2)+(1-A_1)^2(1-A_2)^2\ldots\}\\&=\frac{(1-A_2)A_1E_1}{1-(1-A_1)(1-A_2)}.\end{aligned}$$

And the quantity absorbed by 2 is

$$\begin{aligned}&A_2E_1+(1-A_1)(1-A_2)A_2E_1+(1-A_1)^2(1-A_2)^2A_2E_1\ldots\\&=\frac{A_2E_1}{1-(1-A_1)(1-A_2)}.\end{aligned}$$

If we interchange the suffixes we obtain the quantity of the energy E_2 that is absorbed by 1. It is

$$\frac{A_1E_2}{1-(1-A_1)(1-A_2)}.$$

The total quantity of energy absorbed by 1 is

$$\begin{aligned}&\frac{(1-A_2)A_1E_1}{1-(1-A_1)(1-A_2)}+\frac{A_1E_2}{1-(1-A_1)(1-A_2)}\\&=\frac{(1-A_2)A_1E_1+A_1E_2}{A_1+A_2-A_1A_2}.\end{aligned}$$

This must equal E_1. Therefore

$$(1-A_2)A_1E_1+A_1E_2=(A_1+A_2-A_1A_2)E_1.$$

Hence $$A_1E_2=A_2E_1,$$

or $$E_1/A_1=E_2/A_2,$$

which proves the proposition.

The only form of energy considered by the proof is heat. Hence the above quantitative relation holds only for temperature radiation. The body must radiate solely on account

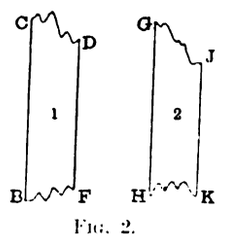

Fig. 2.

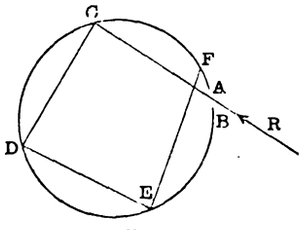

Fig. 3.

of its high temperature, and not in virtue of electromagnetic energy received or of chemical energy liberated. Under this limitation the law is universally accepted as true. Numerous facts point to its truth, and Paschen has verified it quantitatively. How far it holds for luminescence is not known.

A very important result follows at once from the law. A body cannot emit those rays which it totally reflects, or for which it is perfectly transparent. If the surface of the body is a perfect mirror, all the incident light is reflected, none is absorbed and A is equal to zero; again, if the body is transparent, the intensity of the light is not altered by passing through it, and A is again equal to zero. If A is zero, E must also be zero.

In the rigorous proof of his law Kirchhoff introduced the idea of a perfectly black body. A perfectly black body is one for which A = 1 that is, one which absorbs all the rays which fall upon it. Hence, for any given wave-length and temperature no body can radiate more than a black body. None of the surfaces which we are accustomed to regard as black is black in this sense. They all reflect some of the incident light. Black cloth, for example, reflects 1·2 per cent. of the light that falls on it, and black velvet 0·4 per cent. Let the radiating power of the black body be denoted by S. Then $E/A=S$; S gives the ratio of the radiating power to the absorbing power for any body, and is a function of the wave-length and the temperature. Kirchhoff pointed out the importance of determining the function S, and stated that it would undoubtedly be of a simple form, as it was independent of the properties of any particular body. S is sometimes called Kirchhoff's function.

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It would be extremely difficult to measure E and A for one particular body for different wave-lengths and thus determine S, for, of course, A would have to be measured at the same temperature as E—that is, while the body is radiating. Paschen commenced a series of researches in 1892 with the purpose of determining S, the method being to measure E for a series of bodies which were more or less black. Then, if these bodies were arranged in order of their "blackness," it would be possible by a species of extrapolation to arrive at the behaviour of the ideal black body. Paschen used a piece of platinum foil folded double, in the fold of which a thermo-element was placed for the purpose of determining its temperature. The foil was heated by a current from a secondary battery, and was coated with the substances the radiation from which was to be examined. The radiation was measured with a bolometer; the spectral apparatus had concave mirrors instead of lenses, and the prism was of fluorite. The substances used were carbon filaments, platinum foil, platinum foil covered with iron oxide, copper oxide and soot. They all behaved pretty much the same with the exception of platinum, which radiated considerably less.

Meanwhile, attempts were being made from the theoretical side to find S as a function of λ and of T, the absolute temperature. In 1896 Wien gave the following expression:—

$$S=\frac{c_1}{\lambda^5}e^{-\frac{c_2}{\lambda T}},$$

which was afterwards derived by Planck in another manner. The proofs are not simple and are not quite beyond question.

The next important step was the experimental realisation of the perfectly black body by Lummer and Pringsheim. A perfectly black body is one that absorbs all the rays that fall on it and reflects none. Consider the accompanying diagram (Fig. 3). It represents a section of a hollow sphere which has a small opening at AB. R is a ray which enters the opening and is reflected in succession at C, D, E and F. The inside surface of the sphere is blackened. Only a small portion of the energy is reflected each time, the greater part being absorbed. The hole AB is of such a size that the chances of the ray finding its way out again are very small. Light falling on AB is practically all absorbed. Consequently, if the sphere be maintained at a uniform temperature, sufficiently high to make its inner surface radiate out heat appreciably, the radiation from AB will be the radiation of the black body for that temperature, or the black radiation for that temperature, as it is called. Also, if any body be heated inside the sphere to the temperature of the latter, the radiation issuing from its surface through the opening will be black radiation.

For low temperatures double-walled vessels were used, the space between the walls being filled with steam, ice, carbon dioxide snow or liquid air, so as to keep the interior at a uniform temperature. The radiation escaped by means of a tube. For high temperatures an electrically-heated body of porcelain was used.

With this apparatus Lummer and Pringsheim first proved Stefan's law for the black body, showing that the radiation was proportional to the fourth power of the absolute temperature. Then in 1899 they published energy curves taken with the same radiators. These energy curves are reproduced in the first (Fig. 4) of the following diagrams.

Thus Kirchhoff's function S was determined as a function of λ for several different values of T. Lummer and Pringsheim's results did not agree so well with Wien's formula as Paschen's results did, and further investigation showed that Lummer and Pringsheim's results were the more accurate. As a result of their work Planck proposed the following formula:

$$S=\frac{c_1}{\lambda^5}\frac{1}{e^{\frac{c_2}{\lambda T}}-1},$$

which he sought to justify on theoretical grounds. It represents the experimental results satisfactorily within the error of observation.

On comparing Planck's formula with Wien's we notice that it is only when $e^{\frac{c_2}{\lambda T}}$ is not large in comparison with 1 that they differ appreciably—that is, only for high temperatures and large values of λ. Wien's formula may thus be regarded as an approximate form of Planck's, and has the advantage of simplicity. From it a number of important results about black body radiation can be deduced.

We have $S=c_1\lambda^{-5}e^{-\frac{c_2}{\lambda T}}$. To find for what values of λ S is a maximum, take the logarithm of S, differentiate it with respect to λ and equate to zero.

$$\text{Log } S=\log c_1-5\log\lambda-\frac{c_2}{\lambda T},$$

$$-\frac{5}{\lambda}+\frac{c_2}{\lambda^2 T}=0,$$

hence

$$\lambda T=\frac{c_2}{5}.$$

Denote the value of λ corresponding to the maximum value of S by λ_m. When T is measured in degrees abs. and λ_m in 10^{-4} cm., $c_2=14{,}500$. Therefore

$$\lambda_m T=2{,}900.$$

As the temperature increases the maximum moves towards the visible spectrum. By substituting λ_m in the expression for S, we find that the maximum value of S increases as the fifth power of the absolute temperature. S always increases with temperature for every value of λ, no matter on which side of the maximum it is.

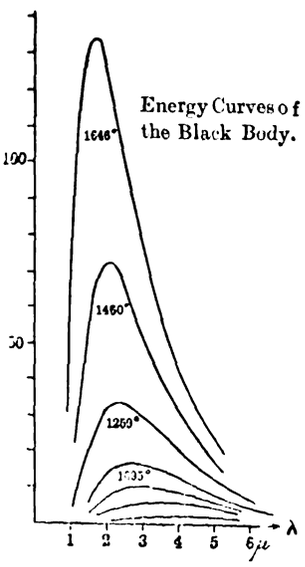

FIG. 4.

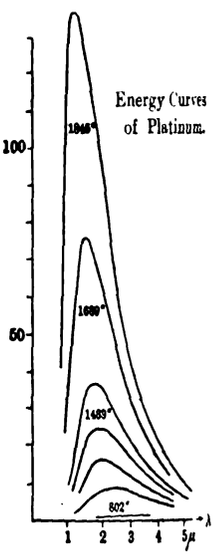

FIG. 5.

To find the total radiation, integrate $\lambda^{-5}e^{\frac{c_2}{\lambda T}}$ from $\lambda=0$ to $\lambda=\infty$. The integration follows easily if λT is put $=1/\theta$, and θ is regarded as the variable. The result is $6T^4/c_2^4$. This is Stefan's law. It holds only for the black body; Stefan thought that it held for all bodies.

The radiant efficiency may be found by integrating S between the limits λ_1 and λ_2 and substituting the values for the ends of the visible spectrum; but there is a more convenient graphical method. When $1/\theta$ is substituted for λT, the integral takes the form $c_1T^4\int\theta^3e^{-c_2\theta}d\theta$. The values of θ corresponding to the ends of the spectrum depend on the value of T. If the curve $\theta^3e^{-c_2\theta}$ be plotted, if ordinates be set up at values of θ corresponding to the ends of the visible spectrum for different temperatures, and if the areas between the ordinates be determined graphically and divided by the area of the whole curve, then we obtain the values of the radiant efficiency for these temperatures. The following results have been obtained in this way:—

Abs. temp.	Radiant efficiency.
1,000	0·0 per cent.
1,500	0·0 „
2,000	1·7 „
3,000	14·6 „
4,000	31·8 „
6,000	49·7 „
8,000	47·7 „
12,000	18·6 „

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Thus 7,000 deg. abs. gives the most favourable result. Above this the intensity maximum moves into the ultra-violet.

The temperature radiation of bodies that are not black follows more complicated laws. The energy curves vary all the way from shapes not differing widely from that for the black body to curves with two or three sharp maxima. The wave-length of maximum intensity, however, always decreases as the temperature increases, and many substances which radiate selectively at low temperatures become similar to the black body at high temperatures. Of course, no body can radiate more than a black body for any wave-length and temperature.

The metals form an interesting class, and an attempt has been made to represent their energy curves by formulæ of the same form as Wien's, but with a different power of λ in place of the λ^{-5}. At ordinary temperatures they all reflect much better in the infra-red than in the visible spectrum. Hence their absorbing power, and consequently their radiating power, is less in the infra-red. This selective reflection seems to persist at high temperatures, and the energy curves resemble the black body somewhat; but with the ordinates on the infra-red side of the maximum diminished, and consequently the radiant efficiency increased. Lummer and Pringsheim's curves, representing the radiation from glowing platinum at different temperatures, are given by the second (Fig. 5) of the two preceding diagrams. The total radiation from platinum varies as the fifth power of the absolute temperature.

The theory of the black body has been applied in three different ways to the measurement of temperature. Temperature may be read by the hydrogen thermometer up to 600°C., and thence by the nitrogen thermometer to 1,150°C. Beyond this it is customary to use thermo-couples which have been calibrated as far as the gas thermometers go and to extrapolate for values beyond. Thermo-couples are, however, unsuitable for some purposes, and in any case they cannot be used beyond the melting point of platinum. This is where optical pyrometry finds its use.

The first optical method consists in finding the position of λ_m and applying the equation $\lambda_m T = 2{,}900$. The second consists in measuring the total radiation by some instrument such as Féry's thermo-electric telescope and using Stefan's law, or as it is now more often called the Stefan-Boltzmann law. In this instrument an image of the source is formed on a thermo-couple by a concave mirror, and the instrument is calibrated by pointing it at two sources of known temperature. The third method consists in measuring the brightness of the source for one wave-length in the visible spectrum and calibrating the photometer by means of two sources of known temperature.

These methods give relative measurements satisfactorily and enable one to reproduce any temperature with accuracy, which is all that is required for industrial purposes; but they must be used with considerable care if absolute measurements are required. There are many people in possession of optical pyrometers who are, unfortunately, unaware of the limitations of their instrument, and have too profound a faith in its empirical formula.

All three methods hold in the first instance only for the black body. The first method holds also for a "grey" body—that is, one that reflects all colours equally well. In the case of a grey body the ordinates of the energy curve are supposed to be diminished in the same ratio all over and the position of the maximum is unaltered. The first method is, however, not so accurate as the other two, for the position of the maximum cannot be easily determined. The last two methods if applied indiscriminately will not give the true temperature of a body, but its "black" temperature—that is, the temperature of a black body which would have the same total radiation, or which would have the same brightness for the wave-length in question.

To get the true temperature we may proceed in two ways. On the first method, which is due to Lummer and Pringsheim, the scale of the instrument is calibrated by using glowing platinum as well as the black body. We thus have two determinations of the temperature, the second value being that which the body would have if it had the same properties as platinum. As platinum differs widely from the black body as a radiator, there is a presumption that the true temperature of the body will lie between the limits thus obtained. On the second method, the body is placed inside a sphere, the inner surface of which is a good reflector, and the radiation through a hole in the surface examined. The radiation from the body is thus increased until its black temperature equals its true temperature.

Optical pyrometry has been applied to the determination of the temperature of the sun, and values somewhat below 6,000°C. have been obtained and have found their way into the text-books. In a recent Paper (Ann. d. Phys. (4), 25, pp. 905-920, 1908), Dr. A. Goldhammer, however, finds its temperature to be 10,000°C. If the sun is a black radiator at 6,000°C., according to the table given above, this is not far from its most economic temperature. Probably it is not the sun that has adapted its temperature to our eyes, but our eyes which have suited themselves to the sun through long ages of evolution.

(*To be continued.*)

DURATION OF ELECTRICAL CONTACT BETWEEN IMPACTING SPHERES.

In a recent issue of the "Journal of the Franklin Institute" Messrs. A. E. Kennelly and E. F. Northrup contribute an article on this subject. The conclusions reached by the authors are stated by them as follows:—

1. If a metallic sphere impinges either upon another like metallic sphere or upon a hard flat steel surface, the duration of impact is proportional to the diameter of the sphere. (Although this experimental result has not previously been published, so far as the writers are aware, yet this particular fact seems not to be new. In particular, it has been known in the Jefferson Physical Laboratory, at Harvard University, for a number of years.) Consequently, the duration per centimetre of diameter, or "specific duration," depends only on the nature and hardness of the metallic impacting surfaces and on the velocity of impact. By referring then to specific duration, the influence of varying diameter, in what follows, can be eliminated.

2. The harder the metals at their mutually impacting surfaces, the shorter the "specific duration."

3. The "specific duration" is roughly about 20 per cent. greater when a sphere impacts upon an anvil or stationary hard plane surface of a mass large as compared with that of the ball, than when it impacts with a stationary sphere of the same size. This increase in duration is attributable not only to the difference in relative curvature of the impacting surfaces, but also to the fact that in the former case the impinging ball has its velocity approximately reversed before breaking contact; whereas in the latter case the velocity of the impacting ball is merely reduced to zero, the initial velocity being communicated to the impacted ball.

4. Whether the impacting ball strikes another like ball or an anvil, the "specific duration" of impact T_μ/D varies inversely as the $\frac{1}{10}$th root of the vertical drop, h cm., or the $\frac{1}{2}$th root of the impacting velocity, v cm. per second, according to the formula:

$$\frac{T_\mu \text{ microseconds}}{D \text{ cm. diam.}} = \frac{a'}{h^{\frac{1}{10}}} = \frac{a''}{v^{\frac{1}{2}}}$$

where a' and a'' are constants depending on the nature and curvature of the impacting surfaces.

For a copper ball on a steel anvil, $a' = 55$, $a'' = 117$ approximately.
For a steel ball on a steel anvil, $a' = 42$, $a'' = 90$ approximately.
For a steel ball on a steel ball, $a' = 35$, $a'' = 75$ approximately.

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from *The Electrician* office, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published under 2s., and 5 per cent. for books published nett. Add 10 per cent. for abroad or for foreign books.]

"Journal of the Institution of Electrical Engineers." Vol. XLVII., No. 209. August, 1911. (London: E. & F. N. Spon.) 5s.

"Analytical Mechanics." By E. H. Barton. (London, 1911: Longmans, Green & Co.) 10s. 6d. net.

"Original Papers on Commercial Dynamo Design." By W. L. Waters. (London, 1911: Chapman & Hall.) 8s. 6d. net.

"The Transactions of the South African Institute of Electrical Engineers." Vol. II. Part 6. July, 1911. 2s.

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WEST HAM CORPORATION ELECTRIC SUPPLY ACCOUNTS.

The West Ham electric supply undertaking has made very satisfactory progress during the past year, and a marked improvement is shown on the previous year's working. This is not altogether indicated by the fact that a deficit of £2,900 has been changed into a surplus of £3,986, since a number of special items have been met in the present accounts. Thus, for the first time consumers' meters have been purchased out of revenue; this has entailed an addition of £1,413 to the expenditure.

There are several features of considerable interest in the report of Mr. H. H. Couzens, engineer and manager of the undertaking, to the Electricity Committee on the year's accounts. The output for private lighting has increased by no less than 15·6 per cent. In view of the extensive use of metal filament lamps, this indicates that the use of electricity for lighting is making rapid strides. As the increase reported last year was only 1 per cent., compared with a considerable decrease in the previous year, it is evident how rapidly the depression brought about by the change-over to high-efficiency lamps has been surmounted.

Power and heating show the large increase of 24·2 per cent., and now are the predominating factor in the total output, accounting for 14,518,555 units out of 22,690,266 units sold for all purposes. The other items included in this total are traction 5,182,257 units, private lighting 2,253,904 units and public lighting 735,550 units.

Whilst the revenue per unit has remained practically constant for lighting—viz., 2·78d., as against 2·79d. a year ago—there is an increase in the revenue per unit received from the power sales. For the 12 months ended March 31st last the average price obtained for power was 0·60d. per unit, compared with 0·58d. in the previous year. Taking the whole of the supply, the average revenue per unit sold was only 0·93d., a similar figure to that recorded last year.

The number of consumers connected to the mains at March 31, 1911, was 2,860, an increase of 306 during the 12 months, a practically similar increase to that recorded a year ago. The motor load has increased by 1,245 H.P., representing 120 new motors connected; and the total number of motors now supplied from the Corporation's mains is 1,119, of 11,558 H.P. in the aggregate.

Considering next the generation of the energy, 28,105,881 units were generated, the maximum demand being 9,404 k.v.a., or 8,123 kw. This represents a load factor of 31·9 per cent., compared with a load factor of 34·38 recorded a year ago. The capacity of the station remains at 11,400 kw. The number of units used on the works was 1,493,090, and 3,922,525 units were lost in distribution, &c.

From the analysis of the accounts which we give below, it will be noticed that on the whole there is a slight reduction in the total cost per unit sold, repairs and maintenance showing some reduction, whilst, owing to the loans taken up during the year, "Corporation stock expenses" have materially increased

There is considerable improvement in the results shown by the Sales Department. Owing to the Local Government Board only granting a period of three years for the repayment of the loans raised for carrying on this Department a heavy burden is placed on its operation. The capital charges on this Department amounted to £1,582 for six months only, so that there will be a considerable increase in this item during the present year. For the period under consideration the capital charges eliminated the profit of over £1,000 in the Sales Department, and result in a deficit of £514 being shown. The above profit was shown by this Department after debiting it with rents, rates, establishment charges, &c.

The item "Special charges," which it will be noted accounts for £3,070 of the total costs, comprises £639 for the replacement of a 1,200 kw. alternator, £240 for the replacement of a stoker, £754 in connection with the old motor hiring scheme, £24 for the extension of offices and £1,413 for the purchase of meters.

The public lighting at the end of the year comprised 363 arc and 182 incandescent lamps. The average price received per unit sold for public lighting was 1·54d.

We give below an analysis of the accounts for the year ended March 31, 1911, the cost per unit sold being tabulated for each item for the year in question and for the previous year.

		Per unit sold. 1910-11.	1909-10.
Generating Costs.			
Coal	£22,087	0·23d.	0·23d.
Oil, waste, water and stores	933	0·01d.	0·01d.
Wages at station	5.180	0·05d.	0·06d.
Repairs and maintenance	3,802	0·04d.	0·05d.
Miscellaneous	610	0·01d.	0·00d.
Total Generating Costs	£32,662	0·34d.	0·35d.
Distribution Costs.			
Repairs and maintenance of mains and services	£1,765	0·02d.	0·02d.
Repairs and maintenance of transformers	992	0·01d.	0·01d.
Repairs and maintenance of meters	1,850	0·02d.	0·02d.
Use of tramway feeders	42	0·00d.	0·00d.
Total Distribution Costs	£4,649	0·05d.	0·05d.
Management Costs.			
Salaries	£2,932	0·03d.	0·04d.
Printing, stationery, &c.	612	0·01d.	0·01d.
Publicity and bulletin expenses	373		
General establishment charges	692	0·01d.	0·01d.
Corporation stock expenses	698	0·01d.	0·00d.
Total Management Costs	£5,307	0·05d.	0·03d.
Attending public and private lamps	£.1937	0·02d.	0·02d.
Rents, rates and taxes	£6,620	0·07d.	0·08d.
Special charges (including insurance and discounts)	£4,170	0·04d.	0·04d.
Sales Department deficit	£514	0·01d.	0·01d.
TOTAL COSTS (*ex.* capital charges)	**£55,859**	**0·591.**	**0·611.**
Capital Charges, &c.			
Interest	£14.619	0·15d.	0·18d.
Sinking fund and repayments	16,411	0·18d.	0·17d.
Contribution to capital account pending borrowing	1	0·00d.	0·03d.
Special works	3,070	0·03d.	0·04d.
Total Capital Charges, &c.	£34.101	0·36d.	0·42d.
TOTAL COSTS (*inc.* capital charges)	**£83,96)**	**0·951.**	**1·03d.**
Revenue.			
Private lighting	£26,581		
Power	37.823		
Traction	21,593		
Heating	252		
Special lighting	353		
Public lighting	6,619		
Interest (hire purchase)	24		
Meter rents, &c.	237		
Miscellaneous	449	—	—
TOTAL REVENUE	**£93,946**	**0·99d.**	**0·99d.**
Balance	£3,936	0·04d. surplus.	0·04d. deficit.

This balance has been allocated as follows: Outstanding debt on accumulators and arc lamp rectifiers £1,757, outstanding debt on transformers and writing down value of 300 kw. set. £2.229.

The capital expenditure during the year was £46,495. mains and services accounting for £12,264, motors on hire £11.931 and Sales Department £9,760 of this total. The total capital expenditure to March 31, 1911, was £503,357, made up as follows:

Land and buildings	£78.385
Machinery and plant	192.164
Tools	525
Mains and service	135.156
Cables, &c.	2.480
Transformers, &c.	42.603
Motors	17.487
Meters and demand indicators	14.705
Electrical instruments	1.224
Lamps and columns	7.355
Office furniture	692
Arc lamps on hire	811
Hire-purchase installation	2.760
Materials, &c.	7.000
Total	£503.357

This represents £44·1 per kilowatt of plant installed in the stations. At the same date the amount of capital repaid or in sinking fund was £135,455, or 26·9 per cent. of the total capital expenditure.

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CORRESPONDENCE.

UNITS *V.* RESISTIVITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The discussion on page 751 in your issue of August 18th by Prof. David Robertson is upon a quite different subject from that of my article of August 11th. My article had the fundamental purpose of clarifying the conceptions of the *quantity*—viz., "resistivity"—and the associated quantities; it was not a discussion of the *names of units*. The latter subject is open to differences of opinion. I purposely avoided the subject, and used only the commonest names of the units, which, though illogically derived, are familiar and of long standing. Questions of scientific nomenclature have always been stumbling blocks, and in the past the efforts of individuals to improve the terminology have frequently added confusion to a complicated situation. It is to be hoped that in the future such questions will be dealt with by scientific congresses, preferably international, and that the efforts of individuals will be directed toward bringing about such congresses.—I am, &c.,

Bureau of Standards, Washington, Aug. 29. J. H. DELLINGER.

CONTINUOUS *versus* INTERMITTENT SERVICE IN PASSENGER TRANSPORTATION.*

BY W. Y. LEWIS.

As regards passenger transportation systems, the situation in all large cities is a very serious one. The travelling habit is increasing directly as the square of the population and in many cities at a greater rate, while notwithstanding the demand for additional facilities, developments are held up owing to the heavy initial and operating cost of subways equipped with electric trains. It is becoming evident, too, that passengers should be handled in streams rather than in crowds. It is obvious if instead of running trains once a minute, and thus damming up the human stream flowing at 3 miles per hour, accommodation at the rate of about three seats per second, moving at a sufficiently low speed to enable passengers to step on and off the cars, were provided, all delay and congestion would be eliminated. There would be no need for a station platform or of trains large and long enough to accommodate the congestion. To meet these requirements the present method consists of trains running at sufficiently short intervals to ensure the passing of at least 10,560 seats per hour. This involves about 35 trains per hour, each of six 50-seat cars. The London Underground can now run trains every 90 seconds at a schedule speed of 15 to 16 miles per hour with stations averaging ½ mile apart. This service intensity corresponds to only about 15 per cent. of the track being occupied by the trains. Thus, the periodic character of the train system is the factor limiting the schedule speed, and consequently the capacity of the system. Intermittency also involves the problem of repeatedly starting and stopping heavy train masses, stresses on the rolling stock and sudden demands on the power house due to acceleration. Acceleration could not be increased without discomfort to passengers, and the average speed from street to street is very low, not exceeding 6 to 7 miles per hour by any of the public services; consequently the loss of time to business men getting about London is still very great. The principal reason why tubes are unable to compete better with surface traffic and render available their superior schedule speeds of 15 to 16 miles per hour is that intermittency is there doubly operative, owing to the use of lifts.

Apparently the only reason why the idea of continuously operating trains has not so far been generally adopted is that the moving platforms, stairways and lifts which have been suggested, operate at a low uniform speed, which perforce has to be sufficiently slow to enable passengers to mount and dismount. The multiple speed platform partially overcame this objection by its series of moving ways, run with a relative speed difference of 3 miles per hour. Still, even with this combination, final speeds above 9 miles per hour cannot easily be attained for the arrangement becomes too cumbersome. It is obvious, therefore, that what is wanted is a continuous system which, whilst providing sufficiently low initial speeds where desired, shall also provide high speeds between stations, so that a high schedule speed, approaching and, if possible, exceeding that of the electric trains, may be obtained. The author then goes on to describe the "A. & L." system, of which he is the joint inventor.

This system is extremely simple. It comprises the provision on a circular route of a series of independent cars, positively controlled and driven by a roller engagement. A shaft extends throughout the route, and is rotated at a constant speed; consequently the speed imparted to the cars is proportional to the pitch of the spiral engaged. To give low speeds at station points the pitch is, therefore, close, and to give high speeds en route the pitch is six or eight times greater, the intermediate pitches to give the necessary acceleration and deceleration being graduated. There is a return of over 80 per cent. of the kinetic energy of the cars during deceleration, instead of a dissipation at the brakes, as in electric traction. Obviously no brake or signal apparatus is required, and many other accessories essential to electric trains are avoided. Compared with a subway equipped with electric traction, the system provides 25 per cent. higher schedule speed when the stations are the same distance apart, 50 per cent. greater capacity when the space occupied is about 30 per cent. less, whilst the operating cost per seat-mile is only one-quarter and the initial cost about one-half.

The shaft is carried in cradle roller bearings of the well-known "anti-friction" type, which, whilst providing for a clear passage, also enable the energy consumption for shaft rotation to be kept so low that the total consumption, including shaft train resistance, train resistance and all losses associated with the efficiency of the elements comprising the system, is only about a quarter, in watt-hours per seat-mile, of the corresponding amount required by electric trains.

The driving motors are inserted at intervals of every ¼ mile. As the size of the shaft is governed by the speeds required, it must be enormously strong for the amount of energy it would be called upon to transmit, and there will be no appreciable twist. The spirals are mounted either on a tubular core or one composed of standard sections, at moderate cost, the construction of the spiral thread being the only element presenting any considerable difficulty.

At first sight the question of wear and tear would appear to be a serious one, but here again the proposition scores heavily. It should be noted that, owing to the substitution by light independent cars of the heavy trains in the present intermittent system, the rolling stock is split up into small units, uniformly distributed over the tracks, and that as there is no necessity to resort to such high crest speeds to get even higher schedule speeds, the result is that the weight of the rolling stock per seat, instead of being from 800 lb. to 1,600 lb., as with electric trains, need not be more than 300 lb. to 400 lb., and even so would furnish infinitely more comfortable riding. Consequently the permanent way calls only for light section rails, which, subjected to such insignificant service, would last indefinitely, compared with those necessitated by electric trains meeting with much more severe treatment. The wear of the spirals would not be great.

As regards safety of operation, owing to the system of driving the cars cannot touch one another, while the whole line can be brought automatically to a standstill in the event of the slightest irregularity. The control of the motors would be centralised, and communication could be established throughout by the usual simple means. The entire route would be brilliantly illuminated.

* Abstract of a Paper read before Section "G" of the British Association.

SUCTION GAS ENGINES AND PRODUCERS.*

A COMPARISON OF TEST PERFORMANCES, WITH RESULTS OBTAINED IN DAILY OPERATION, AND NOTES UPON WORKING COSTS FOR FUEL, OIL, AND LABOUR, &c.

BY W. A. TOOKEY.

Summary.—This Paper comprises a comparison of the test performances of gas plants with the results actually obtained in daily operation. Notes are also given upon the working costs for fuel, oil, labour, &c. The results are given in the form of tables (some of which are abstracted below) and curves. The author shows that gas plant can generally show considerable economy over steam plant, and that it is quite reliable.

It is the object of the present Paper to record in a useful form a series of figures representing the actual performances of suction gas power plants of various types and different powers, not only when tested by some form of brake dynamometer, but also when the output over the period of test can be measured by the generation of electric current or by the raising of water, so taking into account the combined efficiencies of the electric or pumping machinery and that of the gas power plant. Further figures are also presented which have

* Abstract of a Paper read before Section G of the British Association at Portsmouth.

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been compiled from the statements of users themselves both in Great Britain and in other parts of the world.

Brake-Horse-power Tests.—It has so long been customary to state that the consumption of coal—anthracite—by suction gas engines and producers is about 1 lb. per brake-horse-power per hour that it is rarely borne in mind that such a statement is made by makers merely for the purpose of stipulating a safe figure in contract guarantees. It will come as a surprise to many, therefore, that in the majority of the tests mentioned the actual consumption of a combined set of engine and producer working with anthracite, irrespective of size, but, naturally, dependent somewhat upon design and the date of manufacture, is between 0·7 and 0·85 lb. per brake-horse-power-hour. It will be observed that the uniformity of coal consumption ranges from about 10 to over 220 B.H.P. Fig. 1 has been plotted from the figures in a Table given in the Paper. Another Table given later in the Paper referring to the performances, under test conditions, of combined suction gas engine and dynamo sets, shows the average figure for fuel consumption to be less than 1·4 lb. per kilowatt-hour, including the efficiencies of the dynamo, and of the method of power transmission employed between the engine and the dynamo.

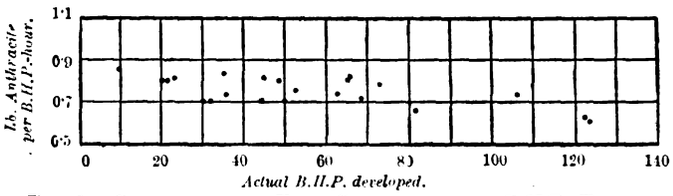

FIG. 1.—CHART SHOWING FUEL CONSUMPTION IN B.H.P. TESTS.

Columns have also been included in the first-mentioned Table to indicate the relative cylinder dimensions and piston speeds of the various engines. Fig. 2 indicates graphically the relation between the actual piston displacement per cycle per minute per brake-horse-power developed, and the coal consumption in lb. per brake-horse-power-hour.

From further figures given in this Table it would appear that the brake-horse-power-hour can still be obtained at half load from less than 1 lb. of anthracite. It is usually stated that the efficiency of gas power plants falls off very considerably when the output is low, but this does not seem to be borne out by facts. In this connection it is interesting to reproduce a chart (Fig. 3), which represents a consumption curve of a Winterthur engine tested by Prof. Aimé Witz in March, 1906. This engine was served with town gas, and the amount of heat admitted to the engine cylinder in the form of gas is plotted against the output of the engine.

Figures in actual Practice.—The factory owner also desires to know what he can expect the average consumption of a gas engine and producer to be when the engine is working throughout the day under

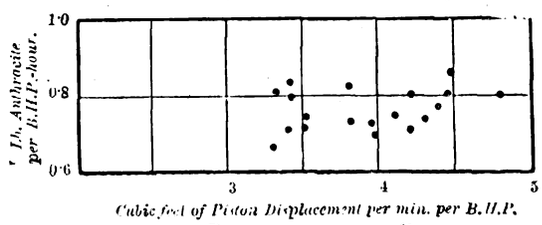

FIG. 2.—CHART SHOWING RELATION BETWEEN CONSUMPTION OF FUEL PER B.H.P.-HOUR AND SPECIFIC PISTON DISPLACEMENT PER B.H.P.-MINUTE.

loads that are ever varying. He wishes to know how far the test figures will be affected by the unavoidable losses due to the continued slow combustion of the fuel during stand-by hours. He also requires information as to probable total fuel consumption when desiring to fix upon the maximum capacity of an engine he is about to purchase.

What are believed by the author to be reliable figures in this connection are given in a second Table. This has been compiled mainly from reports forwarded to the makers of the engines and producers by the users. In order to show more clearly the relation of rated horse-power to hourly consumption of fuel, the accompanying chart has been prepared (Fig. 4). It will be observed that, notwithstanding the great divergence that must exist in the different conditions that apply in individual installations, the results, as plotted, are more uniform than one would expect to be possible. Only in one or two cases do the performances nearly approach the figure that would be reached if the fuel consumed amounted to 1 lb. per rated brake-horse-power-hour, even when, as in all the cases mentioned, stand-by and all other losses are included. It appears that practice, as represented by such figures, well bears out the claims advanced by the makers of suction gas engines and plants. Speaking generally—and none but general assumptions can be made upon such a Table—it would appear that the average consumption of fuel of suction gas plants is at the rate of 0·6 lb. of fuel per rated brake-horse-power per hour, inclusive of all losses.

The more one ponders over the results as set forth in the Table and Fig. 4, the more one wonders that so much power can be procured for so little fuel. Taking the group of engines between 30 and 50 B.H.P., in a score or more of engines, all working with different kinds of fuel, in different districts, in charge of men of different ability, driving machinery at work for a different number of hours per day, and with a different load factor, and with a constantly differing rate of output, involving, apart from differences in the size and styles of producers,

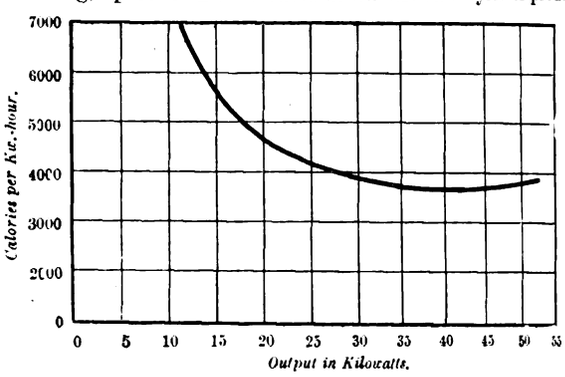

FIG. 3.—CHART SHOWING SLIGHT CHANGE IN COMBINED EFFICIENCY OF GAS ENGINE AND DYNAMO BETWEEN FULL AND HALF LOAD.

different rates of fuel combustion per unit of fire area, a difference of 10 lb. of fuel per hour, or thereabouts, represents the higher and lower limits of fuel consumption. This is a record that stands unrivalled by any other form of prime mover in units of equal size.

It must also be remembered that to obtain the best results from a gas-power plant it is not only the production of good gas that matters, but also the admixture of that gas with a suitable quantity of air to form an explosive mixture within the walls of the engine cylinder. Upon the efficacy of such proportioning of the mixture on the part of the attendant depends the amount of energy obtained per working stroke, and thereby the power and economy of the engine is at once affected. That such low hourly consumptions can be so universally obtained with suction gas plants proves that the attendant is powerless to affect the economy to any appreciable extent, and conversely,

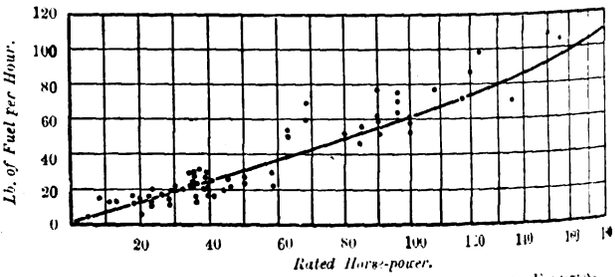

FIG. 4.—ACTUAL HOURLY CONSUMPTION OF FUEL INCLUDING VARIATIONS DUE TO DIFFERENT GRADES OF FUEL, LOAD FLUCTUATIONS, DIFFERENT LOAD FACTORS, LENGTH OF STAND-BY PERIODS, ABILITY OF ATTENDANTS, RATE OF COMBUSTION IN PRODUCER, &c.

that the necessary manipulation is so readily learned that the factory owner can safely rely upon uniformly economical working.

Generation of Electricity.—In the next Table (Table I. herewith) particulars are given of the test performances of a few combined sets

Table I.—*Test Performances of Combined Gas Engine, Suction Gas Plant and Dynamo Sets.*

Maker and size.	User.	Pounds per kw.-hour.
	Anthracite.	
Gardner engine, 65 H.P. (Mersey producer)	Walton-on-Naze Electricity Works	1·57
Benz engine, 33 H.P.... (Piat producer)	Verreries de Montlucon	1·58
Tangye, 39 H.P.	Sterling Telephone & Electric Co. .	1·43
Tangye, 68 H.P.	„ „ „	1·58
Campbell, 45 H.P.	Morris-Hawkins	1·24
	Coke.	
Tangye, 68 H.P.	Cie. Anon. Continentale	1·67
Guldner, 250 H.P.	Julius Pintsch, Berlin	1·3

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Table II.—*Actual Working Results.*

Maker and size.	User.	——	Fuel.	Pounds per kw.-hour	Pence per kw.-hour.
Gillieron, 12 H.P.	Soc. Suisse Electrique Accumulateurs	45 hours per week	Anthracite	2·125	—
Campbell, two 20 H.P.	Great Eastern Railway	46 hours per week	Anthracite, at 31s. 6d., and waste carbon ends	1·935	0·3265
Guldner, two 60 H.P.	New Berlin Beleuchtungswerke	—	Anthracite	1·40	—
Tangye, one 68 H.P., one 39 H.P.	Sterling Telephone & Electric Co.	Over 12 months	Anthracite	2·0	0·364
Gardner, 65 H.P. (Mersey producer)	Walton-on-Naze Electricity Wks.	10 per cent. load factor	Anthracite	2·9	0·632
Campbell, 70 H.P.	Robb Bros., Birkenhead	1,000 hours per annum	Anthracite, at 30s., foundry coke, at 17s. 6d. (mixed)	—	0·306
Campbell, 96 H.P.	Broxburn Electric Station	9 hours per day, 15 hours stand-by	Anthracite, at 16s. 9d.	1·48	0·133
Hornsby-Stockport, 115 H.P.	Ascot Dist. Gas & Electric Co.	—	Coke, at 16s. 6d.	—	0·197
Campbell, 120 H.P.	Workington Bridge & Boiler Co.	53 hours per week	Coke screenings, at 8s. per ton	2·9	0·1243
Tangye, two 132 H.P.	Wanganui Electric Tramways	17½ hours per day, 364 day	Coke	2·97	0·443
Westinghouse, two 250 H.P. (Campbell producer)	Davis & Timmins	273,583 units per year of 2,712¼ hours	Anthracite, at 30s.	2·15	0·246

of gas engines, suction gas plants, and dynamos. In spite of the effect produced by the varying efficiency of the dynamos, the different types of engines, and the divergences in producer design and rates of combustion per unit of furnace area, there is little difference to be noted in the relative performance upon the basis of pounds of fuel per kilowatt-hour.

In order to compare the test figures with those obtained per kilowatt-hour in actual practice, with varying load factors and different conditions of working, Table II.* herewith is also presented. From this it is evident that the average consumption, including stand-by losses and other wastage of fuel—the latter being burnt at different rates of combustion and being of different grades of quality—amounts to about 2 lb. of anthracite per kilowatt-hour. In cases where this figure is exceeded it will be observed that the fuel is coke, while in one instance the load is on the engine for only four hours out of the 24 when anthracite is used.

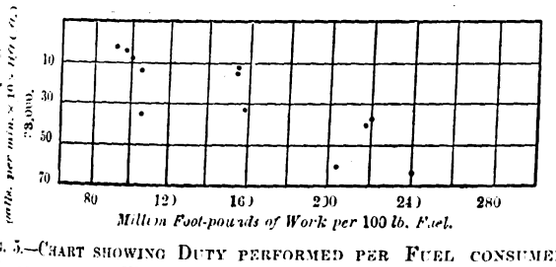

Fig. 5.—Chart showing Duty performed per Fuel consumed in relation to Water Horse-power of Pumping Plants.

Pumping Plants.—The next Table in the Paper records the performances of combined suction gas engines, producers and pumping plants during tests lasting from 5 to 27 hours, with varying types of pumps dealing with quantities of water and heights of lift which indicate that the actual water horse-power exerted ranges from less than 2 to 64. In order that these widely different duties should be brought to a comparable basis the author has computed the number of foot-lbs. of work performed by each set per 100 lb. of fuel consumed. The results obtained differ greatly as shown in Fig. 5, but in view of the undoubtedly uniform results given by the engines and producers as evidenced by the previous Tables, it can be stated with confidence that the divergences are due more to the varying efficiencies of the pumping machinery than to the gas-power plant.

A further table shows the performances of the combined pumping plants under ordinary conditions of working. Three instances in which it is possible to make a comparison with the test figures show that, taking into account fuel wastage from all causes, the hourly consumption of coal in every-day work is increased from 18 to 28 per cent., as compared with the "test" result.

General Reliability.—Much has been stated at various times with regard to the lack of strength or "sensitiveness" of some portions of the mechanism of a gas engine which makes it unreliable. But, after all, the question of reliability is largely dependent upon the ability of the attendant. If the driver fails to detect the development of a fault, and omits the "stitch in time," it is indisputable that a gas-power plant is more liable to sudden interruptions than steam. This does not infer that it is necessary for the attendant to stand by the engine during the whole period of working. Occasional inspection only is called for; but this should be given carefully, thoughtfully, and systematically. Experience soon shows the parts most likely to give trouble, and once these are kept under watchful care, long-continued operation is secured.

A number of users' reports as to reliability are set out in the Paper. These include a run of 1,465 consecutive hours in the case of a 96 H.P. Hornsby Stockport engine, a similar engine of 50 H.P. running 144 hours per week, without stop, and other instances of long runs.

The statement made by, or on behalf of, the Workington Bridge & Boiler Co. well summarises the matter in question: "As regards reliability, there is practically nothing in it between the two; possibly the steam plant has the advantage, if anything, as regards actual stoppage." This is the opinion of the firm in question after making a change from steam power, comprising a compound, horizontal, enclosed type of engine, with forced lubrication, supplied with steam at 80 lb. pressure from a Lancashire boiler. This almost equal reliability has been obtained simultaneously with a reduction in working costs from 1·195d. to 0·452d. per unit, including fuel, labour, oil, water, repairs, &c.

Elasticity of Output.—Recent improvements in design have done much to increase the elasticity of the gas engine. At the present time most British makers are offering engines of both "hit-and-miss" and "throttle-governing" methods of speed regulation; but there can be little doubt that if no question of price came into consideration, and if no choice were to be submitted, users generally would accept the throttle-governed engine and admit its great advantages. It is not the fractional saving of coal of one method of governing over the other that matters, even if that were positively in favour of either; but it is the greater smoothness of running, the graduated force derived from consecutive explosions instead of a greater or lesser number of explosions of full intensity, that makes for so distinct an improvement, while the diminution of working stresses in the more important working parts gives consequent longer life.

But there is another improvement that has synchronised with the development of the throttle-governed engine and which has been somewhat overlooked, or, at all events, not properly appreciated, and that is the increased rotative speed of the later types of gas engines. The higher speed of revolution that is now common practice, coupled with the improved method of throttle governing, undoubtedly brings the gas engine into a more favourable position to withstand the criticism of lack of overload capacity that has so frequently been levelled against it.

Consumption of Lubricating Oil.—Another considerable improvement that has recently been effected is in connection with methods of lubrication. The common practice of older types of gas engines consisted of fitting some form of mechanical lubricator supplying a practically unalterable quantity of oil to one end of a tube communicating with the walls of the cylinder. This tube was intended to lead the oil to both the piston and the gudgeon pin bearing, but in fact dispersed as much oil over the paintwork of the engine as found its way to the intended destination. For the bearings, lubrication by worsted wicks was deemed sufficiently good practice.

In the most modern engines, the lubrication of the cylinder and the gudgeon pin are separately provided for. Forced lubrication is fitted to the cylinder and piston, the quantity of oil pumped per stroke being adjustable to meet varying grades of oil and varying temperatures which affect viscosity. The main bearings are provided with oiling rings. As may be imagined, the consumption of lubricating oil has now been brought down to extremely low figures, while, after

* This Table, as well as Table I., has here been curtailed.—Ed. *E.*

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filtration, most of the oil can be used again upon the line shafting and general machinery of the factory.

For convenience of keeping works costs, the consumption of lubricating oil is usually referred to in comparison with the actual or estimated output of the engine. This, however, does not seem to the author to be a correct method of record keeping. So long as the engine is running, the oil consumption is in direct relation to the engine speed and not to the output of power. In the latest types of gas engines there appears to be a fair degree of uniformity in oil consumption, to some extent independent of size. Some of the measured quantities supplied to engines of various powers over an extended period of working are given in Table III; in some cases the total oil used has been remarkably small, on account of the re-use of filtered oil.

Table III.—*Consumption of Lubricating Oil: Working Results.*

Maker.	B.H.P.	Pints of oil per hour.	Remarks.	User.
Tangye	Three 63	0·422	Engine and pumps	N.E. Rly., York
Tangye	Two 63	0·536	Engine and pumps	Basingstoke
Tangye	68	0·278	No filter 1st year	Cie. Anon. Continentale
Tangye	68	0·1044	Filter 2nd year....	" "
Tangye	68	0·0947	Filter 3rd year ...	" "
Tangye	68	0·55	Engine & dynamo	—
Guldner.....	60	0·376	—	—
Tangye	39	0·40	—	J. Bryce
Sillieron	12	0·46	—	Soc. Suisse Elec. Accumulateurs

Consumption of Water.—In all the records that the author has been able to collect there are very few reliable figures which indicate the consumption of water for washing the gas, for generating water vapour in the producer, and for cooling the engine cylinder. The reason for this is that the water service is taken from the mains supplying the other portions of the factory.

From M. Mathot's tests, actual figures under test conditions are noted for a few engines in Table IV. The quantity of water used greatly depends upon the men in charge.

Table IV.—*Water Consumption.*

Maker and B.H.P.	Fuel.	Water per B.H.P.-hour (gallons).
Benier, 14·59	Anthracite	12·5
Tangye, 20·1	"	0·11 Generator only
Tangye, 10·9	"	0·14 " "
Koerting, 21·6	"	10·2
Tangye, 29·87	"	0·063 Generator only
Stockport, 53·0	"	5·3
Delamarre, 75·86	Coke and coal	15·15
Winterthur, 149·8	Coke	5·75
National, 184·0	Coal	3·64
Otto Deutz, 222·83	Anthracite	7·75

Combined Costs of Fuel, Oil and Labour.—Table V. shows a few of the actual working costs per hour of engines of various sizes, given in a large Table in the Paper.

From this Table it can be claimed, without fear of contradiction, that suction gas engines and producers enable users of power to obtain the means of driving their factories at extremely low cost, and in these days of keen commercial competition it suggests that they may well consider whether it would not be economical to instal gas power in preference to existing methods of power generation, which, although probably adequate as regards power, and reliable in everyday work, are interior to the gas power installation in respect to the whole of the working expenses attached to them.

Repairs and Renewals.—Low cost of operation, however, would not in itself be a sufficient basis for comparison. Consideration must also be given to the amount of repairs necessary and the expense attached to renewals. Information collected and presented in a Table in the Paper shows that for periods varying from one to seven years the expense for upkeep of the gas power plant is practically negligible. The author's experience in this matter extends over many years of working of individual installations, and with but one or two exceptions he can confirm the statements made by the users of the engines. Naturally, much depends upon the attendant, and if compensation for wear and tear be neglected, and if the "stitch in time" is not given, the engine will continue to operate until "something happens." Then either a big bill has to be faced for an expensive overhaul, or a smaller amount is spent in making as good a job as possible for the money.

The chief items of expense occur in the renewal of piston rings, refacing and, perhaps, renewal of exhaust valve, reboring or renewal of cylinder liner. The bearings require occasional refitting, but rarely need relining. As far as the piston rings are concerned, the usual rate of renewal is at the rate of one a year. The exhaust valve may need to be replaced about every four or five years, while the life of a liner and piston can be taken as an average at about seven years. Of course these periods vary according to the actual number of hours worked during the periods referred to, and according to the attention given to minor matters, such as rebushing of levers, replacement of worn pins and spindles, which, if neglected, may cause excessive deterioration of other working parts.

As far as the producer is concerned, the firebricks lining the generator require to be renewed about every two years, for which the material costs little; but the time occupied in dismantling and re-erecting runs into about three days. Generators made with sheet-steel casing will usually require patching around the portion exposed to the action of the heated moist gases within the ashpit after about five years of work, and perhaps renewal of this portion about every seven years. Cast-iron is preferable for this portion of the apparatus, but is only used for the smaller powers on account of first cost. Fire-bars will be wanted about every two years, or at longer periods, unless the fire is worked at a high temperature, arising from an insufficiency of steam, which causes burning out.

The cost of these renewals and repairs, which from their record would appear to be somewhat high, are not actually more than would be required to cover the cost of similar work in connection with steam plants, including the cost of cleaning, scaling and preparing boilers for inspection, repairs to feed pumps, and other auxiliary apparatus. Indeed, as will be seen from the information given in the Table, one firm with an engine and producer of 120 H.P. capacity estimate that they save £7 per annum over the charges incurred for the upkeep of the steam plant previously in use.

Capital Outlay.—For the purpose of computing the average cost of installing gas engines and suction gas producers, the author has decided not to take into account any approximate figure for the cost of space occupied, or for any special buildings erected for their special housing, owing to the very few instances that occur in practice when it becomes necessary to do otherwise than fit them up in some corner of a factory already in existence. The prices indicated in Fig. 6 include the cost of the engine, producer, pulley, water circulating tanks, piping (to what gas engines makers call "standard arrangement"—that is, when the component parts are disposed within about 20 ft. from one central point), foundation and builders' work, and labour in erection.

As a basis, the ruling prices listed by two different makers have been plotted, additions being made for the builders' work and for labour, according to the author's experience of what may be considered average "fixings." These prices are probably on the high side, but will be quite sufficiently correct for rough estimating purposes.

Table V.—*Combined Costs for Fuel, Oil and Attendance.*

Maker and H.P.	User.	Remarks.	Fuel. Pence per hour.	Labour. Pence per hour.	Oil & Stores. Pence per hour.	Total Pence per hour.
Campbell, 96	Martin & Co., Hull	Coke breeze	5·67	6·9	0·41	13·
Campbell, 120	Workington Bridge & Boiler Co.	Coke screenings, at 8s.	4·7	9·05	0·965	14·
Campbell, 70	Robb Bros., Birkenhead	Anthracite, at 30s.; coke, at 17s. 6d. ends, at 31s. 6d.	9·12	3·84	1·1	14·
Campbell, two 29	G. E. Railway, Hunstanton	Anthracite, at 31s. 6d.; carbon (mixed)	4·5	8·75	0·81 and water	14·
Tangye, 6	Welwyn Water Works	Anthracite at 24s.	0·68	2·0	0·153	2·
Tangye, 63.....	Basingstoke Water Works.....	Anthracite, at average 30s. per ton; 95 tons 6 cwt.	7·84	10·05	3·88	21·
Westinghouse, two 150	Davis & Timmins	Anthracite, at 30s.	35·0	14·6	5·34	55·
Hornsby, 50	F. B. Grant & Co., Teddington ...	82 weeks, 4,587 hours	4·4	2·22	0·602	7·

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It will be seen that from 150 to 50 B.H.P. the total cost is at the rate of about £7·5 to £8 per brake-horse-power. From 40 B.H.P. downwards the rate per brake-horse-power increases, ranging from about £9 to £11·5 in the smallest sizes.

Comparison with Diesel Engines.—There is no doubt that the Diesel engine, as made by firms possessing wide experience in their design and operation, permits a nearer approach to the ideal efficiency with regard to the conversion of heat units available into work than any other motor yet produced. Repeated tests have shown that as much as 42 per cent of the total heat value of the fuel is represented by the work performed upon the piston of the engine as recorded by the indicator, whereas the equivalent of a consumption of 0·7 lb. of anthracite per brake horse-power-hour with a combination of gas engine and suction gas producer would represent a thermal efficiency on the indicated-horse-power basis of but 31 per cent.

The consumption of liquid fuel per brake-horse-power with a Diesel engine is usually at the rate of 0·45 lb. per hour. The price of the oil fluctuates according to the ruling market prices, and for the present purposes can be fixed at 50s. per ton. At this rate, the cost per brake-horse-power-hour is about 0·12d

Upon the basis of 0·7 lb. of anthracite per brake-horse-power-hour at 30s. per ton, the cost of fuel for the suction gas plant is 0·1125d. It will be seen, therefore, that as far as fuel cost alone is concerned, there is not very much to choose between the Diesel and suction gas engines, and the decision to instal the one or the other must rest upon other considerations. One very serious consideration, to the disadvantage of the Diesel engine, is the matter of capital outlay, involving, as this does, not only increased annual standing charges for interest on the sums expended beyond the relative cost of a suction gas installation of equal power, but also the allowance for depreciation must be increased in proportion.

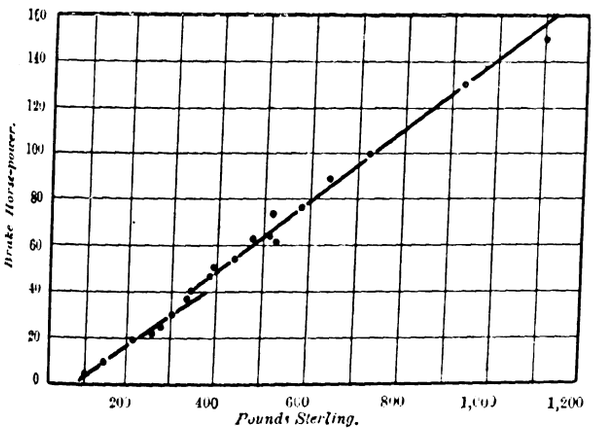

FIG. 6.—CAPITAL OUTLAY, INCLUDING ENGINE PRODUCER, PIPES AND ACCESSORIES, FOUNDATIONS AND ERECTION.

There is no warrant for a general assumption of superiority, as far as total costs of running are concerned, in favour of either one or the other motor; but in few factories is a skilled engineer not required by the type of industrial machinery, so it will not be seriously challenged that in that factory there is no room for a Diesel engine.

Comparison with Semi-stationary Steam Engines.—Semi-stationary steam engines combined with a high-pressure boiler with superheater, jet condenser, with two-stage or compound expansion, have come to the front during recent years. From test results, it has been found that under full loads the consumption of fuel per brake-horse-power-hour has been brought to the low figure of approximately 1 lb. of coal, and this being so, the steam engine has been able to show to much better advantage than ever before in competition with the suction gas engine.

From the circumstances inseparable from steam generation, however, this remarkably low consumption cannot be maintained in actual operation with the same continuity as, from the Tables presented in this Paper, has been proved to be existent with the gas power plant. This is due to the gradual formation of scale within the boiler, the sooting up of the superheating tubes by the flue gases, and the general lessening of efficiency, only to be restored by frequent periodical cleaning and overhaul.

In the latest designs of semi-stationary engines special attention has been given to accessibility of the boiler tubes and to the superheater, to enable the necessary cleaning to be carried out with thoroughness and despatch; but from the point of view of the gas engine builder, this only accentuates the inherent defects of the steam plant. With a gas engine there is no excessive temperature or high pressure in any part of the apparatus other than within the engine cylinder, and then only for but a fraction of a second. This in itself is no slight recommendation.

A further advantage in favour of the suction gas engine and producer is that with the latter the attendant can be engaged in other work throughout the factory, and need give only occasional inspection when fuel charging at long intervals. With the steam plant, a man has to be constantly in attendance to keep the fire going, while it is well known that the manner in which the stoking is carried out frequently affects the fuel consumption by as much as 15 to 20 per cent.

When it is remembered that for the best results to be maintained it is advisable to adopt some system of water softening and purification, and that the cost of the whole equipment is thereby increased far beyond the cost of the gas power plant, it will be recognised that the advantages of the latter are still further emphasised. Especially is this so when the engine is required to deal with a load much above or below the rated power of the plant, or for unsteady and widely varying outputs. In the one case the economical limits of condensing steam engines are sharply defined, while the liability of sudden fluctuation of load must involve some waste of fuel due to the blowing off of excess steam from the safety valves, due to the natural anxiety of the stoker to have his plant ready for any emergency.

THE ELECTRICAL CONDUCTIVITY OF LIGHT ALUMINIUM ALLOYS.*

BY PROF. ERNEST WILSON.

The physical properties of certain light aluminium alloys have formed the subject of several communications,† and, as stated therein, a specimen of each alloy has been placed on the roof of King's College, London, in order to investigate the influence of exposure upon electrical conductivity. Another light alloy of aluminium known as "Duralumin" has recently been added, and the result of exposure will be duly investigated, but for the moment only certain of its electrical properties are dealt with in this Paper. All the specimens are in the form of wire 0·126 in. (3·2 mm.) diameter. The results are set forth in the following table.

Copper.—It has been pointed out that the deterioration of the copper series increases with the percentage of copper. Specimen No. 15 contains 2·61 per cent. copper, and has so far corroded that it broke when being bent into a loop for attachment to the bridge. For this reason the percentage increase found in 1908 has been inserted in the table. Specimen No. 14 has also corroded, but not to the extent of No. 15. Alloying commercial aluminium with copper *alone* is not to be recommended, except in very small quantity.

Copper-Manganese.—It is interesting to note that specimen No. 23, containing 1·78 per cent. manganese, has not seriously deteriorated during 10 years' exposure. It has a fairly high breaking load of 35,000 lb.

Copper-Nickel.—Specimen No. 22 is remarkable in that it has a small temperature coefficient and a breaking load of 45,900 lb. Its resistance has increased to the extent of 18·7 per cent. in 10 years.

Duralumin.—This alloy is stated‡ to contain about ½ per cent. magnesium, 3½ to 5½ per cent. copper, ½ to $\frac{8}{10}$ per cent. manganese. It has recently attracted attention in that a breaking load of about 90,000 lb. can be obtained if desired, according to treatment. The specimen No. 26 used in these tests is the B quality, and has a breaking load of about 67,000 lb. (30 tons), and from 12 to 15 per cent. elongation. As received, specimen 26 has a specific resistance at 15°C. of $5{\cdot}35 \times 10^{-6}$ ohms. It has a length of about 76 ft., and was wound on a wooden drum 12 in. diameter before placing in an oil bath for temperature coefficient experiments. During the first heat to 110°C. the figures given in the table (specimen No. 26) were obtained, and it is interesting to note that the temperature coefficient is almost exactly the same as the copper-nickel alloy No. 22. The effect of the first heat to 110°C. has been to lower the specific resistance by about 1·3 per cent., but subsequent heating to the same maximum has had practically no further effect. This alloy becomes brittle after heating in a Bunsen flame and allowing to cool in air. It is stated§ to have a melting point of about 650°C. It will be

* Paper read before Section G of the British Association.

† See "Journal" Inst. Elec. Eng., 1902, Pt. 154, Vol. XXXI. B.A. Reports, 1901, 1902, 1903, 1904, 1908. THE ELECTRICIAN, Vol. XLVIII., pp. 387, 389; Vol. XLIX., p. 868; Vol. LI., p. 898; Vol. LIII., p. 752; Vol. LXI., p. 837. "Journal" of the Society of Arts, December 13, 1901.

‡ Value found in 1908.

§ See "American Machinist," April 8, 1911, p. 516.

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No. of specimen.	Analysis.							Specific resistance in 10^{-6} ohms at 15°C. before exposure and heating.	Average temperature coefficient per 1°C. between		Percentage increase of electrical resistance taken on value in 1901 at 15°C.		Percentage extension with 16,250 lb. per square inch of cross-section.	Limit of elasticity in lbs. per square inch of cross-section.	Breaking load in lbs. per square inch of cross-section.
	Si.	Fe.	Cu.	Ni.	Mn.	Zn.	Mg.		0°C. and 50°C. per cent.	0°C. and 100°C. per cent.	during 1901–1904.	during 1901–1911.			
16	0·31	0·37	0·11	...	...	...	...	2·92	0·354	0·318	1·5	6·1	0·177	19,500	26,600
4	0·38	0·25	0·16	...	...	...	...	2·88	0·341	0·324	4·8	7·7	0·200	17,900	25,700
13	0·38	0·25	1·58	...	...	...	...	3·34	0·295	0·283	6·25	13·7	0·194	32,500	39,000
14	0·40	0·31	1·86	...	...	...	...	3·25	0·302	0·303	7·9	21·0	0·183	32,500	40,600
15	0·40	0·40	2·61	...	...	...	...	3·34	0·311	0·296	11·5	24·3†	0·186	34,500	43,500
1	0·38	0·22	0·17	...	...	0·62	...	2·86	0·369	0·357	7·1	12·6	0·286	23,600	28,100
2	0·43	0·28	0·30	...	...	1·20	...	2·94	0·346	0·320	5·8	10·8	0·171	20,300	30,500
5	0·43	0·39	0·09	...	...	2·04	...	3·07	0·319	0·325	4·2	10·8	0·171	20,700	26,000
7	0·37	0·25	0·05	0·75	...	...	...	3·05	0·328	0·320	3·7	7·4	0·189	20,300	29,700
8	0·35	0·29	0·09	1·19	...	...	...	3·24	0·337	0·320	4·3	8·8	0·237	23,600	33,700
20	0·37	1·10	0·06	2·25	...	...	...	3·18	0·335	0·329	2·05	9·9	0·189	20,300	38,600
24	0·35	1·16	0·09	...	...	...	...	2·97	0·365	0·357	1·7	9·2	0·194	20,300	31,300
3	0·37	0·28	0·59	...	...	0·59	...	3·06	0·327	0·306	4·7	6·8	0·180	22,300	30,500
6	0·39	0·31	0·63	...	...	1·20	...	3·12	0·324	0·316	3·6	10·7	0·237	24,400	30,900
17	0·35	0·53	0·10	0·83	...	0·90	...	3·03	0·324	0·320	1·9	8·8	0·191	18,300	31,700
12	0·31	0·59	0·19	1·09	...	0·73	...	3·33	0·330	0·318	2·2	9·1	0·197	21,500	31,700
18	0·43	0·40	0·21	1·13	...	1·94	...	3·24	0·332	0·319	4·1	14·8	0·189	22,300	34,500
19	0·35	0·29	0·11	2·01	...	1·77	...	3·26	0·263	0·238	5·3	16·9	0·160	20,300	36,200
11	0·39	0·56	0·24	2·31	...	0·38	...	3·48	0·308	0·300	4·3	12·4	0·194	24,400	34,500
22	0·37	0·43	1·08	1·29	...	...	...	3·41	0·173	0·178	6·9	18·7	0·146	36,600	45,900
21	0·39	2·57	0·10	1·39	...	...	...	3·24	0·352	0·320	9·5	11·6	0·194	24,400	42,200
10	0·32	0·54	0·02	...	0·05	...	...	3·09	0·322	0·311	2·1	8·7	0·191	22,700	29,200
9	0·31	0·35	0·03	...	0·35	...	...	3·30	0·311	0·291	2·3	7·7	0·183	22,300	30,500
23	0·44	0·56	0·09	...	1·78	...	...	3·49	0·273	0·245	2·7	8·6	0·186	24,400	35,300
25	0·14	0·31	Commercial Aluminium.					2·762	...	0·393	3·6	15·9	0·190	19,376	28,200
26	?	?	?	...	?	...	?	5·35	0·173	0·181	...	...	...	...	67,000

interesting to see the effect which exposure will have upon the electrical resistance of this alloy, for which purpose it is suspended with the other specimens on the roof of King's College, London.

It is unfortunate that if tested for breaking load the samples would be rendered useless for further exposure tests, as they are none too long at present. The author, however, feels sure that alloying commercial aluminium with certain materials, for example manganese, in proper proportions will have a beneficial effect upon durability as well upon tensile strength.

Rail-less Trolley Traction.—An interesting report upon the working of the rail-less trolley system of traction at Bradford has been prepared for the Tramways Committee by the tramways manager, Mr. C. J. Spencer.

A rail-less trolley service was commenced in June along Sticker-lane between Laisterdyke and Dudley-hill, linking up two of the routes from the city. Mr. Spencer, who had been requested to consider what districts might be profitably served by an installation of the system, states that from an engineering and operating point of view the rail-less trolley system has been an unqualified success. No serious difficulties of any sort have cropped up on the Laisterdyke–Dudley-hill experimental section, such as might have reasonably been expected in connection with a new installation. From the traffic revenue point of view the returns are not quite up to anticipations. They had no experience of the traffic value of a cross-town route in Bradford, and Mr. Spencer is surprised to find that instead of a 10 to 20 minutes' service being required for the district a 15 to 30 minutes' service seemed to be ample to meet normal requirements. The route was very short and hardly served a sufficiently wide area to test fairly the traffic possibilities of the district. In all probability the traffic revenue will improve very considerably when the route is extended, with suitable overlapping stages. Mr. Spencer recommends several extensions of the system within the city, making up a total route mileage recommended of 9 miles 13 yds., and costing about £13,500 for street equipment. Assuming an average service of 15 minutes, 12 cars would be required, including spares, at an estimated cost of £9,000, and depôt accommodation would cost £4,000. The total amount of capital required, therefore, would be £26,500, and the annual charges would be £2,247.

The Tramways Committee have adopted the report and have added to the proposed routes one of a distance of about 2 miles. In connection with this Mr. Spencer reported that it would undoubtedly be a suitable route if arrangements could be made with certain authorities outside Bradford. The Committee have also decided to confer with the Bingley local authority in regard to tramway facilities in the Bingley district.

LEGAL INTELLIGENCE.

Electricity Generating Station Regulations.

At Jarrow, on 7th inst., Palmer's Shipbuilding & Iron Co. were summoned for having committed a breach of the Home Office Regulations for the Use of Electricity in Factories and Workshops.

Mr. W. B. Lauder, H.M. Inspector, said regulation 21 provided that where necessary, to prevent danger by metal becoming charged, earthing or some other method of protection should be adopted. On July 7 a man named Byers, a driller, while using a radial drilling machine on a steel plate, received a fatal electric shock, and two other men received shocks in trying to get him away from the tool. The whole plate had become charged through a puncture in the cable, but if it had been earthed that would not have been possible. No steps had been taken to meet the regulations, although the machine had been erected two months.

The offence was admitted, and Alfred Baker, foreman electrician, said that the drill and other machines which were not earthed had been erected, while he was away, by his assistant, but earthing was such an elementary precaution he had not thought it necessary to see that it had been done. He should have done so.

A fine of £10 was imposed.

Coal Mines Regulations.

At the Manchester County Police Court on Thursday last week, a haulage lad named Fred Beresford, employed by the Clifton & Kearsley Colliery Co. at their Newtown No. 2 pit, at Clifton, was charged with having committed a breach of the special rules under the Coal Mines Regulation Act.

For the prosecution it was stated that the offence with which defendant was charged was that he had interfered with the electric cable which ran along one side of the main haulage road. On the evening of Aug. 11 a hammer was found on the top of a girder, and it was alleged that defendant had acted in such a way as to make both the girder and the hammer "alive with electricity." Anyone who happened to pass under the girder would be liable to get an electric shock from current at 220 volts. Last year there were four deaths in this country by miners receiving shocks from current at 200 to 250 volts. Another serious matter was that at the time of the discovery the lives of between 400 and 500 men were endangered, as if any sparks had flown and come into contact with the dust in the pit an explosion might have taken place.

Defendant, when asked whether he had anything to say, said he "did not do it." The magistrates fined him 10s., and costs.

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COMMERCIAL AND INDUSTRIAL SECTION.

MUNICIPAL, FOREIGN & GENERAL NOTES.

BRITISH NOTES.

Armadale (N.B.).—Mr. Geo. Balfour has intimated that he will apply for a provisional electric lighting order.

Bampton (Devon).—The Council have sealed an agreement with Dr. J. W. Purves, for the public electric light for £49 a year for se ven years. Current will be available in three months and the scheme will be completed in nine months.

Brighton.—The Council decided on Thursday last that, before adopting the report of the borough electrical engineer, Mr. John Christie, recommending reductions of charges for electrical energy, abolition of meter rents, &c. (referred to in our last issue), a report be obtained from the Borough Accountant as to the financial effect of the proposals.

Burnham.—The Council have resolved to apply for a provisional electric lighting order.

Cotton Mill Driving.—The firm who recently took over the Norfolk-street Rink, Darwen, have put in about 70 looms and the machinery is being driven by electric motors.

Dover.—The borough electrical engineer (Mr. L. W. Woodman) has been authorised to prepare a report upon the question of providing adequate coal storage facilities.

Electric Stoking Plant for Gas Works.—On Monday Perth Council adopted a recommendation to adopt electric stoking plant at the local gas works at an estimate cost of £3,900.

Exhibitions.—The 10th International Motor Exhibition will be held at Olympia, London, from Nov. 3 to 11. Particulars from the Society of Motor Manufacturers & Traders, Maxwell House, Arundel-street, London, W.C.

An International Smoke Abatement Exhibition will be held at the Royal Agricultural Hall, London, from March 23 to April 4, 1912. Particulars from Mr. F. W. Bridges, Balfour House, Finsbury-pavement, London, E.C.

The Baku branch of the Imperial Russian Technical Society is organising an international engineering exhibition at Baku (Russia) in April next.

Among the chief exhibits will be electric motors, internal combustion engines, air compressors and other equipment for oilfield development. Reduced railway charges from Batoum to Baku have been arranged for the exhibits, and at the close these will be returned freight free to Batoum, whence there are regular sailings to England. No duty is payable on the exhibition goods entering Russia. The exhibition will remain open for six weeks. Dr. P. Dvorkovitz, 1, Broad-street-place, London, E.C., is the official honorary representative of the exhibition in England.

Farnham.—The Council have considered a report from the Public Works Committee on a proposal to substitute suction gas plant for steam power at the sewage pumping station.

The Farnham Gas and Electricity Co. recently offered to supply motors and electric current for sewage pumping and it has been decided that, provided the company reduce their terms from £240 to £210 per annum (the estimated annual cost of a suction gas plant) and provided an agreement with the company for a term of 10 years can be satisfactorily arranged, the Council will adopt electric pumping.

Forthcoming Books.—Messrs. S. Rentell & Co. will shortly publish a new book by Mr. W. Perren Maycock, entitled "Small Switches, &c., and their Circuits."

"The Electrician" Company will have ready next week Mr. H. Broughton's great book, "Electric Cranes and Hoists: their Design, Construction and Application." Price 25s. nett; postage to U.K., 1s. 8d. abroad.

The book is the first volume of a complete manual on lifting and hauling machinery, and it deals in a comprehensive manner with the design, construction and application of electrically-driven cranes.

Glasgow.—The Tramways Committee have further considered the tramway extension schemes which at the last meeting of the Council were held over for a week. A statement was submitted by the manager (Mr. J. Dalrymple) showing the probable cost of the various schemes, which had been recommended. It was decided to revive the scheme for the extension of the line from Baillieston to Coatdyke.

Hawes (Yorks).—A meeting of the parish electors has approved a proposed agreement with Mr. E. Chapman for the electric lighting of the streets for 20s. per annum.

Herne Bay.—The Board of Trade have deferred the question of the revocation of the provisional order for 12 months. A public meeting of ratepayers is to be held to discuss the steps to be taken to carry out the terms of the order.

Holmfirth (Yorks.).—A ratepayers' meeting has approved of the Council's electricity supply scheme.

Kilsyth (N.B.).—The Council have been notified by a London company of its intention to apply for a provisional electric lighting order.

Leigh (Lancs.).—Sanction has been received to a loan of £5,300 for additional generating plant.

Llanelly.—The demand for electrical energy for power and lighting is increasing very rapidly and additional plant is being put down by the company. The Pemberton tinplate works are being electrically driven, and a scheme is being prepared to use electricity throughout the Copper Works.

National Electrical Manufacturers' Association (Inc.).—The proposals for the reorganisation of the work of this association have now been successfully carried through and will shortly be put into effect.

They include alteration of title of the association (which will in future be known as "The British Electrical and Allied Manufacturers' Association (Inc.)"), appointment of a new secretary (vice Mr. F. O. B. Hawes, resigned) and of a larger working staff, leasing of offices in a central position and certain necessary amendments of the constitution, including the revision of qualifications for members, associate members and associates, &c. The new secretary of the association is Mr. D. N. Dunlop, sales manager of the British Westinghouse Company's supply department, manager of the publishing department and superintendent of the printing bureau, at Trafford Park, Manchester. Mr. Dunlop was unanimously elected secretary at the meeting of the Council on 7th inst., and has been empowered as from that date to begin the reorganisation of the association. Mr. Dunlop's appointment dates from Jan. 1, 1912.

Nelson.—The agreement with Colne & Trawden Light Railway Co. for through running between Nelson Centre and Laneshawbridge and Trawden has been continued for six months further, and two new cars are to be purchased for the Colne and Trawden light railway.

Penmaenmawr.—The whole of the promenade, about a mile in length, is now illuminated electrically.

Presentation.—On his marriage, Mr. W. F. Rathbone has been presented by the Norwich staff of the National Telephone Co. with fish knives, and a case of fish carvers and serviette rings, and by the Tunbridge Wells staff with a silver tea kettle and sugar tongs.

Sheffield.—Various extensions of mains, estimated to cost about £500, are to be carried out and tenders are to be invited for a new water-tube boiler.

Small Power and Model Engineering Exhibition.—The third exhibition of small power engineering appliances, models and scientific apparatus, organised by the proprietors of "The Model Engineer," will be held at the R.H. Hall, Vincent-square, Westminster, London, S.W., from Oct. 13 to 21.

A feature will be a completely equipped model engineering workshop in which demonstrations of metal working processes and small engine building will be given. Particulars from 26-29, Poppin's-court, Fleet-street, London, E.C.

Swansea.—At the end of August there were 2,137 consumers of the electricity supply department (an increase of 63), and the equivalent of 28,750 32-watt lamps was connected.

Torquay.—The Council have received sanction to a loan of £5,250 for additional plant at the electricity works, the period for repayment being 17 years.

Wimbledon.—The Council has received sanctions to a loan of £2,993 for h.t. mains, £3,600 for l.t. mains and house services, and £110 for meters. The L.G. Board have deferred their decision as to £750 for sub-stations and transformers.

Marriage.—The marriage took place on Sept. 7 of Mr. Douglas Gray, manager of Keighley Corporation tramways, and Miss E. M. Rhodes, eldest daughter of the Mayor of the borough, Ald. S. Rhodes.

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COLONIAL AND FOREIGN NOTES.

Angola (West Africa).—A Consular report states that the Lobito, Benguella & Catumbella Electric Light & Power Co., formed to supply the three townships and surrounding districts with electric light and power, is a British company, and the consulting engineers are Sir Douglas Fox & Partners. The contractors for the generating plant are Messrs. Johnson & Phillips.

The falls on the Catumbella river, 3 miles from Catumbella Town, are being utilised. A dam is being constructed which will give a minimum of 4,000 B.H.P. at the driest period of the year. The present power-house will have a capacity of 1,800 B.H.P., of which 900 B.H.P. is now being installed. The work is well advanced. All the materials for the work have been brought from the United Kingdom and landed at Lobito, from which place they are distributed over the Benguella Railway. Overhead transmission lines (carrying three-phase current at 20,000 volts) are taken to Catumbella (3 miles) and from there to Lobito (8 miles) and Benguella (14 miles). The lines consist of copper wires attached to porcelain insulators on steel poles. The town of Catumbella (which embraces Lobito) undertakes to use 300 lights (from 16 to 32 c.p. each) for street lighting in Catumbella and 100 in Lobito. The town of Benguella will use 1,000 lights for street lighting. The demand for private lighting in Catumbella and Benguella is considerable, as the business houses are busy and prosperous, and the only form of illuminant at present is oil, except for a few acetylene gas plants. There is also likely to be a considerable demand for power for irrigation. At Lobito the railway company will probably require a considerable amount of energy both for light and power. For the present, provision is being made for: Catumbella, 150 B.H.P.; Lobito, 150 B.H.P.; Benguella, 300 B.H.P.

Work was begun in connection with the Lobito electric lighting concession in May, 1910. In May, 1911, about one-half of the river had been dammed and sluice gates erected. It is probable that all will be running order by the end of this year. Poles have been erected at Benguella, Catumbella and Lobito.

Amongst the works projected for St. Thomé for the current year is the supply of electricity for lighting and power.

Australasia.—The "Australian Mining Standard" says the electric lighting plant at Euroa (Victoria) was recently started. This is all British, and consists of an 81 H.P. suction gas engine, a 44 kw. generator and a storage battery. The price for current is 8d. per unit for lighting and 4d. for power.

The Australian General Electric Co. have entered into a contract for the erection of a 1,000 kw. plant for supply of energy at the Victorian State coal mine (Victoria).

The Supply Bill recently passed by New South Wales Parliament provides for expenditure of £1,300,000 on railways and tramways, £15,000 towards cost of Moree–Mungindi railway, and £40,000 for tramway construction.

Redfern (N.S.W.) Council have agreed to sell their electric generating plant to Sydney Council for £20,000.

Drummoyne (N.S.W.) Council have accepted the offer of Sydney Council for supply of electrical energy for lighting and power.

The Agent-General for Tasmania (Sir John McCall) recently stated at an interview that in order to provide cheap power for the iron mines of the northern area of Tasmania, the waters of the Great Lake are to be tapped. The first proposal is to put down turbines of 20,000 H.P. Nearly half this power will be utilised at North-West Bay, near Hobart, where it is proposed to erect metallurgical works to deal with refractory ores from the north coast of Tasmania, and probably also from Broken Hill (N.S.W.)

Austria-Hungary.—The Allgemeine Oesterreichisch-Ungarische Gasgesellschaft has purchased the Mödling gas works and has offered to establish electricity works, and to construct an electric tramway either direct to Vienna or to Wiener Neudorf to join the Vienna-Baden line. The communal authorities have appointed a committee to consider the matter.

Railless trolley cars are to be run from Müglitz through the northern Moravian towns of Meedl, Neustadt, Aussee and Mürau.

A syndicate has been formed to carry out the project for the equipment of hydro-electric works on the Danube, near Pressburg, with a capacity of 70,000 H.P. Dr. M. Hoor-Tempis, of Buda Pest, is one of the promoters.

Japan.—A report by the acting commercial attaché of the British Embassy, Tokio, shows that Japanese imports of machinery in 1910 were of the value of £1,606,700, decrease £465,800 compared with 1909.

The machinery included dynamos and motors £123,300 (compared with £184,400 in 1909), other electrical machinery £100,400 (against £121,800), lifting machines £33,300 (£189,900), steam boilers £49,500 (£93,200), steam engines £61,800 (£72,000), gas, oil and hot air engines £53,200 (£39,100), pumping machines £52,900 (£45,100), steam turbines £15,200 (£23,700), mining machinery £10,400 (£7,800), and telephones £30,300 (£12,200). Of the £1,606,700 worth of machinery the following were the contributions of the countries mentioned: United Kingdom £954,500 (£1,409,000), U.S.A. £370,500 (£382,500), Germany £237,800 (£252,800), France £9,800 (£12,000), other countries £34,100 (£16,100).

The gradual improvement in trade in 1910 had not been in existence long enough by the end of the year to affect the amount of the annual import, but to judge from the amount of capital invested in new and the extension of old industrial concerns during the year the prospects of the machinery business for the coming year are comparatively rosy. Other factors conducing towards the same end were the organisation of a large hydro-electric power scheme and preparations for establishing two or three more similar undertakings; also the passing by the Diet of a bill for subsidising light railways. The alteration of the tariff which took place in July caused orders to be placed for machinery to be delivered before the new tariff came into force. An interesting feature has been the increase in the use of gas engines. Factories, small municipal electric light undertakings and similar enterprises have recently begun to instal suction gas plants for the generation of power where water-power is unavailable, as gas is found cheaper than steam or oil. At the end of the year the Imperial Government Railway Board made a contract with a British firm for the erection of gas-driven electricity works. Speaking generally, gas engines imported are chiefly of British manufacture.

The import of telephones represents chiefly desk and office telephones. The telephone service is a Government undertaking, and the authorities have not been able to keep pace with the large number of applications for installations which are continually being received. At the end of the year there were 128,000 telephones in operation throughout the country and 66,000 applicants waiting to be supplied. The Government obtains telephones from two factories in Tokio, one of which is a Japanese and the other a joint American-Japanese concern. Telephone cables are imported, but doubtless an attempt will soon be made to manufacture them in Japan. It is feared that the alteration of the tariff from an ad val. to a specific basis as regards most kinds of machinery will exercise rather an unfavourable influence.

It is stated that the Government have authorised Tokio municipality to take over the electric tramways of the city as from Aug. 1. It is proposed to abolish 13 or 14 miles of the existing lines and to construct five new lines, three of which were especially ordered by the Government to be completed by July 31, 1916. An endeavour is to be made to finish the whole of the lines by the end of 1914. The municipal authorities propose to build about 500 new cars. It is stated that the change has caused a great deal of discussion in municipal and political circles as it is thought that it will be but the beginning of the wholesale municipalisation of tramway, electric lighting and gas supply undertakings. It is stated that electric lighting will be the first to be transferred to the city, for the Tokio electric tramways have their own electric lighting department, which the city will now have to maintain. Strong public feeling was aroused against the change, for there seemed a general fear that the practical result would be a raising of the fares.

Russia.—Archangel municipal authorities are raising a loan of 1,000,000 roubles (about £105,000) for the construction of an electric tramway, the erection of electricity works, &c.

Spain.—A recent U.S.A. Cnsular report on the trade of this country says:—

There is a brisk demand at Valencia for dynamos, motors and all kinds of electrical supplies, as well as for pumps of 2 H.P. to 12 H.P. The available electrical energy in the district has been recently increased by an additional 6,000 H.P., making in all about 13,000 H.P., in consequence of which the demand for every class of machinery workable by electricity is rapidly advancing. Pumps, motors and dynamos are made in the country, but some are still imported. The trade is worked through agencies at Barcelona or Madrid, as there are no wholesale merchants or importing jobbers at Valencia. The Thomson-Houston and the Siemens-Halske Co.s have established branch houses at Valencia. There are three classes of local agents, but in no case does the agent bear any of the initial expense, and it is owing to this difficulty, together with the fact that provincial dealers are used to buying from travelling salesmen in Barcelona or Madrid and not to importing direct, that probably 90 per cent. of all foreign exporters doing business in Spain have either appointed general agents or have opened branch houses at one of the two cities mentioned.

Imports at Bilbao in 1910 included 42 tons of electrical machinery and fittings from the United Kingdom out of a total of 284 tons, an increase on former years, but, consisting principally of purchases by a British mining company.

A Consular report from San Sebastian states that an electric line is in course of construction from San Sebastian to Hendaye (the frontier town) and is expected to be ready for traffic by June, 1912. A tramway is being constructed from the important town of Tolosa to the frontier, taking in all the towns and villages on the way. Very little of the material employed in these enterprises is of British origin. Belgians and Germans appear to monopolise this trade, cheapness being the chief point.

Sweden.—A Consular report from the Gothenburg District states that in 1910 there was an important increase in the amount of water-power made available.

21 hydro-electric installations have been completed, 20 are projected, installations, varying from 300 H.P. to the Stora Kopparbergs Bergslags Aktiebolag's station at Bullerforsen with 24,000 H.P. and the Svenska Kraftaktiebolaget's last two stations of 10,000 H.P. The Trollhätta installation (40,000 H.P.), is the largest of them all. In addition, installations, totalling 7,650 H.P., were rebuilt during the year. Four building seven private water-power installations with a total of 63,000 and the installation by the State at Porjus (50,000 H.P.), also commenced during the year, will raise the total horse-power at the stations being to 115,000.

A report from Halenstad says the great power plant on the Lagan River was opened by the King on Sept. 17. An extension has already been decided upon.

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At Helsingborg one of the older harbour basins has been extended and partially rebuilt, and electric cranes for discharging cargoes of coal and minerals will be erected.

Plans have been adopted for the erection of electrical works at Ystad, which are expected to be completed in the course of next year.

Wireless Telegraph Notes.—A report from Boston, U.S.A., is to the effect that a wireless telegraph station, to be established at Charlestown Navy Yard, will be the most important and most powerful official station of the U.S. Government on the Atlantic Coast, and will enable the shores of the entire North Atlantic Ocean to be in intercommunication, from the north coast of Ireland to the Caribbean Sea; 3,200 miles is the distance given. Coast shipping from above Newfoundland to south of the Gulf of Mexico will be in touch with Boston.

Travellers via Cape Horn will learn with interest that a powerful installation of wireless telegraphy is to be erected near Port Stanley in the Falkland Islands, the point usually made by vessels which meet with difficulties on this route. The station will be capable of communicating as far as Monte Video.

The following hails from Los Angeles, in California: Mr. Peard is editor of the "Herald," and he was recently holiday-making at Avalon. A wireless message was sent to him which was intercepted by some amateur wireless operators (who, by the way, abound in the United States). These amateurs got the message and forthwith took it to Mr. Earl, who is editor of the rival "Tribune." Mr. Earl published the message without asking questions. It appears that the message originated with General Otis, who had been conducting a newspaper war with the "Tribune." The General had Mr. Earl arrested for having "stolen" his message. A novel legal point immediately arose as to whether messages sent through the air, where they can be read by anyone and everyone possessing a receiver, could be called private or be copyrighted. As the message was sent by a private person the State is not a party to this interesting legal duel. In the meantime Mr. Earl is out on bail, and newspaper folk are watching the sequel with considerable interest.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Aberdeen.—The accounts of the electricity department for the year ended July 31 last show that the total capital expenditure is £373,375, of which £73,587 has been repaid.

Revenue was £21,201, gross profit £26,352. After meeting capital charges, £1,984 has been carried to reserve. Units generated were 7,094,900 (against 6,416,276 in previous year), supplied to private consumers 3,597,727 (3,141,749), for public lighting 281,325 (291,435), for Corporation tramways 1,903,084 (1,856,089), for Suburban tramways 140,000(146,792). Fuel costs were 0·30d. per unit sold (against 0·31d. works costs were 0·48d. (0·50d.), total costs (exclusive of capital charges) 0·79d. (0·81d.)

Bath.—The accounts of the electricity department for the year ended March last, presented to the City Council last week, show revenue £20,435, and working and general expenses £10,718. 7s. The gross profit was £9,708. 12s. 2d., and the net deficit £616.

Bridlington.—The accounts of the electricity supply undertaking for the year ended March last show capital expenditure £41,547 (increase £2,928), of which £6,199 has been repaid.

Revenue was £5,998 (against £5,598 in previous year), and working and general costs were £2,344 (compared with £2,710), and, after meeting capital charges and contributing £220 out of revenue for meters, £33 to machinery insurance account, &c., the net profit was £10,007 (against £437). Units generated were 444,443, supplied to public lamps 174,509 and to private consumers 210,966. The maximum supply demanded was 922 kw. Coal cost was 0·488d. per unit sold (against 0·573d.), and total working cost 1·455d. (against 1·831d.).

Middlesbrough.—The accounts of the electric lighting department for the year ended March last show capital expenditure £116,658 (increase £2,758), of which £31,227 has been redeemed.

Revenue was £18,852, total costs £9,668, net profit £2,079 (after providing for interest and redemption, interest and sinking fund £7,105). Works costs were 0·890d. per unit sold (against 0·889d. in previous year), total costs were 1·147d. (1.219d.) and interest and redemption of capital required 0·843d. (0·942d.). The total number of units sold was 2,021,886.

Sheffield.—The annual report and accounts of the tramways department for the year ended March was submitted to the Council on Wednesday.

Total annual revenue was £323,098 (increase £20,606), including £316,738. 17s. 4d. passenger traffic revenue. Working expenses were £186,024. 10s. 9d., and gross profit was £133,735. 7s. 10d. (increase £16,098. 3s. 2d.). The amount transferred for relief of rates (£26,541. 8s. 3d.) is the highest on record. 84,500,331 passengers were carried and 7,618,383 car-miles run.

The Tramways Committee have considered the alternative routes suggested for the proposed Upperthorpe tramway, and after receiving the report of the general manager and surveyor, the committee re-affirmed their previous decision recommending the construction of a tramway from Infirmary-road on the Hillsborough section along Albert-terrace-road and Oxford-street into Crookes Valley-road, there joining the Walkley route opposite Harcourt-road.

At the meeting of the Corporation on Wednesday, Ald. Bennett submitted the annual statement of accounts of the electric lighting department, and expressed satisfaction at the fact that the year's working showed an improvement on the previous year of £5,452. The increased use of current for power represented an increase of 56 per cent. He could not hope that the department would be able for some years to come to make any contribution to the rates, because, owing to the increased demand, they would have to incur additional capital expenditure.

Councillor Neal suggested that the electric light and tramway power stations should be connected by cable to provide against possible difficulties owing to strikes.

In replying to the discussion, Ald. Bennett said he was unable to hold out any hope of a further reduction in price for shopkeepers.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Tenders are invited up to Nov. 21 for supply of one automatic or semi-automatic switchboard and equipment to the Postmaster-General's Department in Western Australia. Tender forms and specifications may be obtained at the Commonwealth Offices, 72, Victoria-street, London, S.W. See an advertisement.

Tenders are invited up to Oct. 18 for the supply of 20 coin-in-the-slot attachments to the Postmaster-General's Department in Western Australia. Specifications, forms of tender, &c., may be obtained at the Commonwealth Office, 72, Victoria-street, London, S.W. See advertisement.

The Postmaster-General's Department in South Australia require tenders up to Oct. 25 for supply of cable and paper sleeves. Tender forms and specifications may be obtained from the Commonwealth Office, 72, Victoria-street, London, S.W. See also an advertisement.

Tenders are invited by the City of Melbourne for the supply of 8,000 yds. three inch fibre conduit, suitable for laying underground in concrete, and to be used for containing lead-covered cables. Specification, tender form and conditions of tender from the Agents for the City Council, Messrs. Mellwraith, McEacharn & Co. Ppty. (Ltd.), Billiter-square-buildings, London, E.C., to whom tenders by noon of Tuesday, Oct. 3. See also an advertisement.

London County Council require tenders by 11 a.m. Oct. 24 for supply of hand-power overhead crane, h.t. and l.t. cables and switchgear, &c., rotary converters and static transformers, for sub-stations. Specifications, &c., from the Clerk.

Manchester Markets Committee require tenders by Sept. 25 for supply and erection of electrical and mechanical plant and wiring at the cold air stores, Elm-street, Manchester. Specification from the Superintendent.

Manchester Electricity Committee require tenders by noon, Oct. 4, for supply and erection of a 4,000—4,500 kw. low-pressure exhaust type turbo-alternator. Specification from the Secretary, Town Hall, Manchester.

Keighley Council require tenders by Sept. 25 for supply and erection of coal handling plant and water storage reservoir and pumps for the electricity department. Specification, &c., from the Borough Electrical Engineer.

Durban (Natal) Corporation require tenders by Sept. 25 for supply of 6 miles of steel girder tram rails (95 lb. per yd.), with fish plates, bolts and nuts, tie bars and copper bonds. Specifications from Messrs. Webster, Steel & Co., London, E.C.

Dover Guardians have accepted the tender of John Wright & Sons for supply of an indoor telephone at £16. 12s. 9d. The National Telephone Co. also tendered at £16. 1s. 5d.

Hastings Guardians require tenders by Oct. 18 for the electric lighting of the workhouse premises, Ore, Hastings. Spesification from Mr. S. Bumstead, 11, Wellington-sq., Hastings.

Bray (Ireland) Council require tenders by Sept. 19 for supply of 2,500 yds. 7/18 S.W.G. concentric paper-insulated and lead-covered cable.

Winnipeg (Canada) municipality require tenders by Sept. 25 for fire apparatus, including 30 fire-alarm boxes. Specifications from the Chief of the Fire Department, Central Fire Station, Winnipeg.

Tenders are invited up to Sept. 26 for supply of telephone material and 30 miles of telephone cable, up to Oct. 2 for supply of 10,000 porcelain insulators to Postmaster-General's department in Tasmania, and up to Oct. 3 for the supply of 42 miles o

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telephone cable to the Postmaster-General's department in VICTORIA. Tender forms and specifications at the Commonwealth Office, 72, Victoria-street, London, S.W.

The Metropolitan Water and Sewerage Board, Albert-street, BRISBANE, Queensland, want tenders by noon Jan. 30 next for supply and erection of one, two or three complete units, each consisting of power generating plant and pump or pumps to lift not less than 6,000,000 gallons per day. Particulars from the Secretary, and forms from the Agent-General for Queensland.

DUNEDIN (N.Z.) Corporation require tenders by Nov. 1 for supply of (1) 500 B.H.P. vertical type gas engine or Diesel oil engine, suitable for rope driving an a.c. motor and d.c. generator; and (2) direct-coupled vertical type gas engine or Diesel oil engine and d.c. generator (800 kw. at 550 volts). Specification at 73, Basinghall-street, London, E.C.

TULCEA (Roumania) municipality require tenders by Nov. 19 for electric lighting of the town.

Tenders are required for the erection and equipment of an electric power station at the port of VARNA (Bulgaria). Tenders to the Section des Finances of the Railways and Ports Department, Sofia, by 3 p.m. Sept. 30.

Tenders are invited by the Municipal Council of PELOTAS (Brazil) for a 40 years' concession for the supply of electricity for power and lighting and the establishment and working of electric tramways. Tenders to Senhor Luiz M. da S. Pennafiel, Intendencia Municipal, Pelotas, up to 1 p.m. Nov. 14. A deposit (about £300) is required with each tender, to be increased by the successful tenderer to 25,000 milreis (about £1,670). Further particulars (in Portuguese) can be seen by British contractors at 73, Basinghall-street, London, E.C.

The Municipal Council of BUDAPEST, Hungary, require tenders for the manufacture and supply of plant for a steam-driven electrical generating station, including two groups of three-phase turbo-generators (5,000 kw. each), 10,000 volts 50 cycles, boiler equipment for mechanical output of 5,000 kw. with reserve, pipeline, central switching and accessory equipments, travelling crane for engine room and coal-conveying plant. Specifications, &c., can be obtained at the Presidial Section of the Council, 9: IV., Városház-utca 16, II. 1, Budapest. Tenders by 11 a.m. Sept. 30.

Tenders will be received at the Town Hall, SYZRAN, Russia, on Oct. 14, for the construction of an electric tramway and the supply of electrical energy for lighting.

Tenders will be received on Sept. 25 at the Central Military Telegraphy Stores, Boul. de Latour-Maubourg, PARIS, for supply of 1,500 kg. of 6-10 mm. bi-metallic wire.

Tenders will be received at the Italian State Railway offices ROME, on Sept. 26 for supply of five cranes (one electric) and on Oct. 3 for three electric cranes.

Tenders will be received at the Town Hall, GRAZALEMA, Spain, on Sept. 29 for the town electric lighting for 20 years.

Tenders will be received at the Austrian State Railway Offices, VILLACH, on Sept. 19 for supply of a cylindrical compressor with a.c. motor, &c.

TENDERS RECEIVED AND ACCEPTED.

The Great Eastern Railway Co. have placed an order with Royce Limited for 11 electric capstans, 10 electric jib cranes and two electrical hoists and spares for the company's wharf and goods yard at Blackwall.

Sheffield Council have accepted the tender of the British Thomson-Houston Co. for supply of 50 R.G.E. traction motors at £100 each for the Tramways Department.

Melbourne Council have accepted the tender of the local electric supply company for supplying current for cluster lamps, at 30s. each per annum, and for tantalum lamps at 15s. each.

Worksop Council have accepted the tender of Nalder Bros. & Thompson for switchboard instruments and that of the Rhodes Motors (Ltd.) for alterations to booster.

Salford Council have accepted the following tenders:—

Crompton & Co., d.c. generator for Ladywell Sanatorium, £139; Johnson & Phillips, wiring health and water offices, £124, with £12 for contingencies; Aiton & Co., c.i. discharge pipes for circulating water, £20.

Dudley Council has accepted the tender of the Worthington Pump Co. (at £390) for additions to the air and circulating pumps of the condenser plant at the generating station.

The tender of Falk, Stadelmann & Co. has been accepted by the Metropolitan Asylums Board for supply of metal filament lamps to Grove Hospital.

Gateshead & District Tramways Co. have placed an order with Chamberlain & Hookham for equipment of their cars with meters.

Wolverhampton Electricity Committee have accepted the following tenders:—

Chloride Electrical Storage Co., 230 cell storage battery (£9,260) and also for the annual maintenance; Phœnix Dynamo Mfg. Co., two motor-driven boosters, £1,538; Electric Construction Co., battery switchgear, £1,058; Bruce Peebles & Co., 400 kw. rotary converters, £1,060.

Stockport Council have accepted the following tenders:—

McClure & Whitfield, spare motor, £38. 10s.; Dussek Bitumen Co., bitumen, £5. 10s. per ton; Evershed & Vignolles, recording meter, £8. 16s. 10d.; British Insulated & Helsby Cables, trolley wire, 32 in. bonds, £8. 18s. 6d. per 100, 8 in. ditto, £5 per 100.

Nelson Council have placed an order with Davidson & Co., Belfast, for a 40 in. induced draught fan for the electricity station.

Wolverhampton Council have accepted the tender of J. Cave & Sons for additions to the generating station at £6,000.

Commonwealth P.O. Contracts.—The Australian Postmaster-General's Department has accepted the following tenders:—

Victoria.—India Rubber, Gutta Percha & Telegraph Works Co., earth plates, brass nuts and screws, £144; J. Bartram & Son, magnets, microphones, &c., £428; Cameron & Sutherland, desiccating plant, £135; Williams & Co., 15,000 spindles, £312. 10s.; Western Electric Co., 350 duplex translators, £188; Lacy-Hulbert & Co., petrol-driven winch, £164. 10s.; Burrough's Adding Machine Co., one electric duplex adding machine and one normal duplex adding machine, £340.

The Victorian Railways Department have accepted the tender of the Australian General Electric Co. for supply of 150 telegraph relays at £4. 4s. 7d. each.

South Australia Works and Buildings Department have accepted the tender of Unbehaun & Johnstone for an electric lighting installation in a public library at £314.

N.S.W.—Burrough's Adding Machine Co., four electric adding machines, £620.

Queensland.—C. Monteath & Sons, 150 tons c.i. pipes, £9. 13s. 10d.; B.I. & Helsby Cables, 5,000 copper pockets, £55. 19s. 10d., 40 gross connecting screws 1½d. each, and 6,000 zincs 6¾d. each; Dalgety & Co., 6 tons magnesia, £5. 2s. 6d.; J. Bartram & Son, 5 tons sal-ammoniac, £35 per ton; India Rubber, Gutta Percha & Telegraph Works Co., 2,000 zincs, 1s. 1½d. each; Lawrence & Hanson, 20,000 copper binders 56s. 6d. per 1,000, 15,000 copper binders 46s. 6d. per 1,000, 20,000 copper binders 17s. 6d. per 1,000, 2,500 copper sleeves 47s. per 1,000, 20,000 copper tapes for 70 lb. wire 14s. per 1,000, 15 tons phosphor-bronze wire £75. 10s. per ton, 2,000 leads 4d. each, 1,000 zincs £8. 5s., 2,000 zincs £155. 16s., and 2,000 zincs £468. 15s.; T. Zwicker & Co., 4,000 copper sleeves £5. 12s. 6d. per 1,000, 2,000 ditto £4. 12s. 6d. per 1,000, and 10,000 sleeves £5 per 1,000; Western Electric Co., 10,000 sleeves, £8. 7s. 6d. per 1,000; British General Electric Co., 20,000 copper tapes at 27s. 11d. per 1,000, supply of 15,000 copper tapes for 200 lb. wire at 27s. 11d. per 1,000, 1,500 pots 2s. 2d. each and 8,000 pots 1s. 4½d. each; Webster & Co., 3 tons g. steel wire, £20. 17s. 6d. per ton; W. T. Henley's Telegraph Works Co., 5,280 yds. cable, £186 per mile; Siemens Bros. & Co., 12 local spring inkwriter registers, £16. 11s. each.

BUSINESS NOTICES.

Messrs. W. T. Glover & Co. have removed their Glasgow offices and stores to 158, Hope-street. The telephone number is changed to 3856 Douglas, the telegraphic address remaining "Conductor Glasgow."

Messrs. Paterson & Service, 38, Bath-street, Glasgow, have been appointed sole agents for Scotland for the Walsall Electrical Co.

The Imperial Lighting Co. ask us to announce that the fire which occurred recently at their Pocock-street premises was practically confined to the packing department. Business will be carried on as usual.

Sale by Auction.—Messrs. Fuller, Horsey, Sons & Cassell will include in their sale by auction at H.M. Dockyard, Portsmouth, on Tuesday, Oct. 10, and following days at 11 a.m., 10 tons white metal, 50 tons scrap brass and mixed metal, 1,200 tons mild scrap steel, 700 tons wrought and c.i. scrap, 190 tons old steel tubes, 117 tons old wire rope, 26 tons zinc bottoms, ashes and scrap zinc, 2 tons lead ashes, 50 tons old electric cable, electric fans and electrical stores, tools, &c. May be viewed three days' prior to and on mornings of sale, and catalogues, 6d. each, had at the Dockyard, or of the Auctioneers, 11, Billiter-square, London, E.C., and 100, King-street, Manchester. See also an advertisement.

Plant for Sale.—Mr. Alex. Mein, Station-street, Stratford, London, E., advertises for sale a Crompton three-phase alternator, switchboard, &c.

Patent Development.—The owners of patents No. 23,501/99, relating to "Improvements in vacuum tube lighting," and No. 12,582/02, relating to "An improved system of electric lighting," desire to negotiate with electrical engineers with the view of granting licences. Applications to Messrs. Lloyd Wise & Co., patent agents, 46, Lincoln's Inn Fields, W.C.

Agency.—A German firm of accumulator manufacturers advertises

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for a London firm with a connection among motor-car makers, &c., to take over the sole agency of their portable accumulators.

"The Journal."—Part 209 of the "Journal" of the Institution of Electrical Engineers is now ready, price 5s. For particulars of contents see advertisement.

Imports.—The following are official values of electrical machinery material and apparatus imported into this country (*a*) during August, 1911, and (*b*) during the current year from Jan. 1 to Aug. 31, with the increases or decreases compared with the corresponding periods of 1910:—

Electrical machinery (*a*) £87,756 (increase £27,402), (*b*) £715,117 (increase £331,619); telegraph and telephone cables (*a*) £17,337 (increase £5,178), (*b*) £244,491 (increase £152,635); telegraph and telephone apparatus (*a*) £16,553 (decrease £1,604), (*b*) £113,991 (decrease £3,772); other electrical wires and cables, rubber insulated (*a*) £5,405 (decrease £12,278), (*b*) £57,006 (decrease £81,072); with other insulations, (*a*) £3,114 (increase £1,136), (*b*) £24,307 (increase £4,969); carbons (*a*) £8,798 (decrease £3,414), (*b*) £81,377 (decrease £9,051); glow lamps (*a*) £19,940 (decrease £33,795), (*b*) £188,528 (decrease £185,934); arc lamps and electric searchlights (*a*) £201 (decrease £55), (*b*) £1,073 (decrease £1,208); parts of arc lamps and searchlights (other than carbons), (*a*) £6,180 (decrease £2,028), (*b*) £68,307 (increase £19,907); primary and secondary batteries (*a*) £2,770 (decrease £925), (*b*) £28,046 (increase £412). Total of electrical goods and apparatus, other than machinery and telegraph and telephone wire, (*a*) £92,150 (decrease £43,378), (*b*) £887,215 (decrease £89,404).

Exports.—The exports of electrical machinery, material, &c. (*a*) during August, 1911, and (*b*) during the current year from Jan. 1 to Aug. 31, and the increases and decreases compared with the corresponding periods of 1910, are as follows:—

Electrical machinery, (*a*) £160,701 (increase £25,619), (*b*) £1,162,754 (increase £135,997); telegraph and telephone cables (*a*) £84,023 (decrease £353,700), (*b*) £496,672 (decrease £971,144); telegraph and telephone apparatus (*a*) £16,813 (decrease £15,617), (*b*) £168,209 (decrease £35,645); other electrical wires and cables, rubber insulated (*a*) £27,595 (decrease £32,691), (*b*) £261,004 (decrease £27,605); with other insulations (*a*) £28,547 (decrease £11,506), (*b*) £496,672 (decrease £971,144); carbons, (*a*) £991 (decrease £855), (*b*) £11,069 (decrease £638); glow lamps (*a*) £14,172 (increase £4,531), (*b*) £104,589 (increase £22,583); arc lamps and searchlights, (*a*) £1,402 (decrease £1,754), (*b*) £12,319 (decrease £1,859); parts of arc lamps and searchlights (other than carbons), (*a*) £1,238 (decrease £471), (*b*) £10,817 (increase £1,076); primary and secondary batteries (*a*) £19,914 (increase £9,287), (*b*) £10,024 (increase £19,575). Total of electrical goods and apparatus, other than machinery and telegraph and telephone wire, (*a*) £239,287 (decrease £400,960), (*b*) £1,781,520 decrease £821,516).

BANKRUPTCIES, LIQUIDATIONS, &c.

A dividend is to be paid to creditors of Geo. Valentine Barker, electrical engineer, Gledhow Wood-grove, Roundhay, and John-street, Albert-street, Harrogate. Claims to Mr. D. S. Mackay, Red House, Duncombe-place, York, by Sept. 23.

The trustee (Mr. E. S. Grey, Bankruptcy Buildings, London, W.C.) in the bankruptcy of Morris Zains, lately electrical engineer, &c., of 98 and 105, Wardour-street, London, W., has been released.

The trustee (Mr. F. T. Holcomb, King-street, Newcastle, Staffs.) in the bankruptcy of John Wm. Barnett, electrical engineer, 25, Waterloo-street, Burslem, has been released.

Silicaware Limited is being wound up voluntarily, and Mr. P. W. Straus, 7, Great Winchester-street, London, E.C., has been appointed liquidator.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

*Note.—The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application, an asterisk is affixed.*

July 24, 1911.

875 Eccles & Makower. Producing electrical oscillations.
876 Brooks & Alston. Contact breakers.
877 Brooks & Alston. Distributors of magneto-electric machines.
906 Buckau. Magnetite electrodes. (Convention date, 22/7/10, Germany.)*
907 Thomas, Thomas & Holme. Electrically-operated cranes.
908 Siemens Bros. Dynamo Works. (Siemens-Schuckertwerke, Germany.) Earthing devices for electrical circuits.*
917 Easton Lift Co. & Huggett. Reversing switches for electric motors.
923 Rickards & Beale. Electric lamp-holders.
952 Mohr & Hansen. Glowing body for incandescent electric lamps.
954 Marks. (Webb, U.S.) Telephone instruments (receiver.)*
955 Marks. (Webb, U.S.) Transmitter for telephones and other sound-transmitting instruments.*
956 Marks. (Webb, U.S.) Telephonic instruments including transmitters.*
962 Compagnie des Compteurs Aron. Electromagnetic circuit-breakers. (Convention date, 27/7/10, France.)*
968 Heyer. High-pressure current distributors for electric ignition apparatus. (Convention date, 23/7/10, Germany.)*

July 25, 1911.

16,986 Ferra. Multiple contact in thermo-electric elements.
16,992 Duschnitz. Process and arrangement for forming an electric arc. (Convention date, 29/7/10, Germany.)*
17,007 Perry. Electrically-heated cooking apparatus.
17,020 Quain & Roudebush. Effecting telegraphic or telephonic communication between distant points at sea or between a ship and the shore, or across a strip of water.
17,027 Vojen. Telephone receiver of the radiating field type. (Convention date, 30/8/10, Belgium.)*
17,028 Vojen. Application of radio-active phenomena to telephony. (Convention date, 4/3/11, Belgium.)*
17,039 Weertz. Electric lamps or filaments therefor.
17,040 Siemens Bros. Dynamo Works. (Siemens-Schuckertwerke G.m.b.H., Germany.) Alternating-current commutator generators.*
17,046 Siemens Schuchertwerke G.m.b.H. Safety device for electric cables. (Convention date, 25/7/10, Germany.)*
17,051 Goss. Electric alarm clocks.*
17,053 Heyer. Make-and-break device for the primary circuit of electromagnetic ignition. (Convention date, 25/7/10, Germany.)*
17,060 B.T.H. Co. (C. E. Co., U.S.) Electric furnaces.
17,061 Bellamy. Electrical igniters for gas, oil, and similar internal-combustion engines.

July 26, 1911.

17,110 Huther. Cooling enclosed electrical machines. (Convention date, 26/7/10, Germany.)*
17,121 Lake. (Schoenberg & Co., U.S.) Electrical switches particularly adapted to electric light sockets.*
17,132 Pape. Electric accumulator elctrodes and means for use therein. (Addition to 905/11.)
17,140 Trist. Electro-pneumatically or electrically-operated organ or multiple instrument playing mechanism and the like.
17,142 Larzelere. Magnetically-operated switch. (Convention date, 2/8/10, United States.)*
17,149 Dymond. (Ges. für Drahtlose Telegraphie m.b.H., Germany.) Electrical oscillation apparatus particularly adapted for use in wireless telegraphy.*
17,151 Faiella. Telegraphic systems. (Addition to 4,920/11. Convention date, 30/7/10, Italy.)*

July 27, 1911.

17,179 Stobie. Manufacture of electric steel.
17,189 Nicholson & Ricardo. Direct-coupling internal-combustion engines and dynamos.
17,204 Royce & Rolls-Royce. High-tension distributors for electrical ignition systems for internal-combustion engines.*
17,208 Siemens Bros. & Co. (Siemens & Halske Akt.-Ges., Germany.) Current transformer for high voltages.*
17,211 McBerty. Semi-automatic telephone exchange systems. (Convention date, 27/7/10, United States.)*

July 28, 1911.

17,263 Partington. Earthing device for electrical conduit fittings.
17,278 Gwozdz. Telephones. (Addition to 11,234/11. Convention date, 2/12/10, Germany.)*
17,281 Pouteaux. Electric cells.*
17,284 Fagerlund. Auromatic circuit-breakers. (Convention date, 8/8/10, Sweden.)*
17,286 Hatfield. Electric switching devices.
17,294 Callender's Cable & Construction Co. & Kay. Supports for electrical conductors.*
17,300 Gwozdz. Telephones. (Addition to 11,234/11. Convention date, 2/12/10, Germany.)*
17,304 Allgemeine Elektricitats-Ges. Locking the high tension of electrically-driven vehicles. Convention date, 13/8/10. Germany.)*

July 29, 1911.

17,347 Henley's Telegraph Works Co. & Bishop. Wiring for electric lighting and for analogous purposes.
17,358, 17,360 & 17,361 Cowper-Coles. Electroplating.
17,362 Cowper-Coles. Electro-galvanising.
17,363 Gwozdz. Telephones. (Convention date, 3/6/11, Germany.)*

July 31, 1911.

17,381 Stevens. Control for trackless trolley vehicles and the like having auxiliary batteries for independent propulsion.
17,383 Mansell (Ltd.) & Mansell. Method of holding carbons in hand-feed arc lamps.
17,387 Cheese. Telephones, electrophones, electric lamps, electric radiators and the like.*
17,412 Bloch. Electric incandescent lamps. (Convention date, 27/8/10, France.)*
17,419 Grillet & Truchetet. Automatic regulating mechanism applicable to electric generators.*
17,425 Part. Electrical connections for secondary batteries and for other purposes.
17,426 Part. Secondary battery plates.
17,429 Gwozdz. Telephones. (Addition to 11,234/11. Convention date, 20/4/11, Germany.)*
17,430 Charlton & Smith. Visible electrical signals and safety backing devices in connection with colliery-winding engines.
17,441 Otto Sterkel. Telephone cabinets.*

August 1, 1911.

17,452 Thomas Clark. Electrical influence machine for the stimulus of plant life, the production of X-rays and ozone, therapeutic and other medical work, and wireless telegraphy.
17,479 Houskeeper. Electric heaters. (Convention date, 6/8/10. United States.)*
17,480 Houskeeper. Processes of preparing filaments for incandescent lamps. (Convention date, 5/8/10, United States.)*
17,481 Schairer. Electrical terminal devices. (Convention date, 6/8/10. United States.)*
17,482 Knight. Supports for incandescent lamp filaments. (Convention date, 6/8/10, United States.)*
17,502 Furneaux & Rock. Electric switches.
17,516 Mehne. Apparatus operated by clockwork for turning on and off lighting arrangements at given times. (Addition to 14,052/09.)*
17,518 Griffiths & Comissiong. Electrical timing devices for races and the like.
17,519 Fairbrother. (Vesta Accumulator Co., U.S.) Adjustable electric lamps.*
17,530 Gwozdz. Telephones. (Addition to 11,234/11. Convention date, 21/4/11, Germany.)*

SPECIFICATIONS PUBLISHED.

1910 Specifications.

9,775 Olvis. Switching means for dynamos for charging accumulators.
12,931 Friedmann. Joint boxes for electric wiring. (1/12/10.) (Convention date not granted.)
13,035 Gabreau. Electric lighting for vehicles.
17,126 Hawley (Ltd.), Saunders & Jones. Electromagnetic separator, drum or pulley.
17,322 Kessels. Printing telegraph instruments.
17,349 Electric & Ordnance Accessories Co., Garner & Mubller. Controllers for use in connection with electro-motors.
17,650 Helfenstein. Electric furnace. (27/7/09.)
18,012 Hallstream. Electric contact mechanism for the automatic stopping of machines.
18,190 Adams Mfg. Co. (Cutler Hammer Mfg. Co.). Controllers for electric motors.
18,191 Adams Mfg. Co. (Cutler Hammer Mfg. Co.) Electric motor controllers.
18,195 Brown, Boveri & Co. (Akt.-Ges. Brown, Boveri & Cie. Dynamo-electric machinery.
18,241 Wardle. Lamps or lanterns for incandescent electric lamps.
18,300 Ges. fur Chemische Industrie in Basel. Apparatus for the electrolysis of fused alkali chlorides. (22/12/09.)
18,306 Adams Mfg. Co. (Cutler Hammer Mfg. Co.) Means for controlling dynamo-electric machines.

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18,656 RENTON. Flexible cord attachment for electric lamp-holders.
18,680 RIDEAL. Utilisation of the silent electric discharge.
18,631 LANCHESTER. Propulsion of vehicles by combination of prime mover and electrical storage.
19,608 SMITH. Incandescent vapour lamps.
19,851 REYROLLE & REYROLLE & Co. Electrical cut-outs.
19,972 RITCHIE. Telewriter apparatus.
20,257 LEITNER. Automatic electric switches.
20,685 SUTTON & SUTTON. Controlling the connection and disconnection of a plurality of electrical circuits to or from another such circuit.
20,696 GIRARDELLI & HOLZMAN. Electric time alarm device.
20,995 ELECTRIC & ORDNANCE ACCESSORIES CO. & MUELLER. Combined electric switch and fuse distribution boxes for use with electric cranes.
21,080 GRAY. Electric portable lamps for use in mines and other places.
22,355 ETCHELLS. Push-button electric switches for controlling electric lifts and the like. (9/3/11.)
23,066 B.T.-H. Co. & MARTIN. Electric meters.
23,153 BULLERS (LTD.) & DAGNALL. Method of supporting electric cables or wires and means therefor.
23,669 NEUHOLD. Automatic telephone systems. (27/10/09.)
23,807 FLETCHER & DALE. Sparking plugs for internal combustion engines.
23,902 HIRST & ARCHER. Electric heating irons (1/11/10.)
24,485 FIELD & FERRANTI. Electrical resistances.
26,856 HABERMANN. Morse transmitter.
27,144 KLUPATHY & BERGER. Submarine audible telegraphy and signalling. (30/7/10.)
27,804 SPEAKMAN. Electrical insulators for use in mines. (29/11/09.)
30,390 POPP. Electric furnaces. (6/5/10.)

1911 SPECIFICATIONS.

1,028 SMITH & PLATT. Ignition plugs for internal combustion engines.
1,909 ADAM. Electric tightening devices for cable conveyors. (26/1/10.)
3,151 TRIBELHORN. Driving mechanism for electrically-propelled vehicles.
3,272 BULLERS (LTD.) & TWISS. Electric insulators.
3,648 WEINTRAUB. Electrolytic meters. (14/2/10.)
4,457 ELECTRIC & ORDNANCE ACCESSORIES Co. & COLLINS. Time limit or retarding devices for use with electric circuit-breakers.
4,602 TIMAR & PRESSER. Process for the closing of the seams of tubes by means of electrical resistance welding. (2/5/10.)
4,724 OCHS. Device for continually rolling about a number of articles by means of endless bands for electrical or mechanical treatment.
4,806 PARKES. Construction of electromagnets for indicators, relays and similar apparatus.
5,167 B.T.-H. Co. (G.E. Co.) Insulating material.
6,182 WASSERZIER. Electric ignition device for gas burners.
6,526 DOWSING. Apparatus for the application of radiant heat or light to the human body.
6,861 WALLACE & GRAHAM. Electrical switch or controlling device
6,862 WALLACE & GRAHAM. Electrical time switch.
7,045 FRIED. KRUPP AKT.-GES. Continuous electric current generators with separate excitation. (16/5/10.)
7,501 SIEMENS SCHUCKERTWERKE GES. Arc lamps. (26/3/10.)
7,569 FRISBY. Electric current detectors or apparatus for detecting the presence and direction of electric current.
7,736 SCHATTNER. Rheostats.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES & CHARGES, &c.

NEW COMPANIES.

INGLEBY & CO. (LTD.) (117,463.)—Reg. Aug. 30, capital £10,000 in £1 shares, to take over the business of electrical and general engineers carried on by J. C. B. Ingleby, H. S. Ingleby and E. C. Ingleby at Leeds. Private company. First directors: J. C. B. Ingleby, H. S. Ingleby and E. C. Ingleby. Reg. office: Elland-road, Leeds.

PHŒNIX TELEPHONE & ELECTRIC WORKS (LTD.) (117,562.)—Reg. Sept. 6, capital £50,000 in 49,000 6 per cent. preference shares of £1 each and 11,800 ordinary A and 8,200 ordinary B shares of 1s. each, to carry on the business of manufacturers of electrical, mechanical, scientific and telephonic apparatus and appliances, &c. Private company. First directors: H. Oppenheimer (chairman and managing director), E. J. Reid and R. Tayler. Reg. office: 6, Chatsworth-road, Brondesbury, London, N.W.

STATUTORY RETURNS.

SHEERNESS DISTRICT ELECTRIC POWER & TRACTION CO. (LTD.)—Return dated June 20 gives capital £75,000 in £10 shares (2,500 preference). 5,000 ordinary and 2,473 preference shares taken up. £10 per share called up. £74,730 paid. Mortgages and charges, £15,300.

SIEMENS BROS. DYNAMO WORKS (LTD.)—In return to June 29 capital is £300,000 in £1 shares. 20,000 shares taken up. £10 per share called up on 7. £70 paid. £199,930 considered as paid on 19,993 shares. Mortgages and charges, £200,000.

TRAFFORD POWER & LIGHT SUPPLY (1902) (LTD.)—In return to June 13 capital is £80,920 in £1 shares (23,120 preference). All shares taken up. £80,920 paid. Mortgages and charges, £54,897. 11s. 1d.

VERITAS (LTD.)—According to return to July 4, capital is £210,000 in 7,000 5 per cent. cumulative first preference, 7,000 6 per cent. cumulative second preference and 6,980 ordinary shares of £10 each and 200 management shares of £1 each. 7,000 first preference, 7,000 second preference, 5,630 ordinary and 200 management shares taken up. £10 per share called up on 4,670 first preference, 7,000 second preference and 1,430 ordinary, and £1 per share on 30 management. £131,030 paid. £65,470 considered as paid on 2,330 first preference, 4,200 ordinary and 170 management. Mortgages and charges, £58,999.

MORTGAGES AND CHARGES.

ELECTRIC & GENERAL INVESTMENT CO. (LTD.)—Particulars of debentures to secure an amount not exceeding the uncalled capital (£201,500 to date), created Aug. 18, have been filed, the amount of the present issue being £22,500. Property charged: the company's undertaking and property, present and future, except uncalled capital. The debentures are issued to Mr. Emile Garcke and Mr. J. Cecil Bull, as trustees for the holders of the stock to be created by virtue of these debentures.

ENGLISH ELECTRICAL CO. (LTD.)—Issue, on Aug. 29, of £750 debentures, part of a series of which particulars have already been filed.

T. E. SMITH & CO. (LTD.)—Debenture, dated Aug. 29, to secure £50, charged on the company's undertaking and property, present and future, including uncalled capital. Holder: Mrs. M. Smith, 7, Cavendish-street, Keighley.

CITY NOTES.

MEMORANDA (Sept. 14).—Bank rate 3 per cent. (since March 9, 1911.) Price of silver, 24½d. per oz. Consols 77⅜—77⅝ for money; 77½—77¾ for account. Consols Pay Day, Oct. 5; Stock and Shares Continuation Days, Sept. 26 and Oct. 10; Ticket Days, Sept. 27 and Oct. 11; Pay Days, Sept. 28 and Oct. 12; Mining Shares Carry Over Day, Sept. 25.

PRICES OF METALS (London).—*Copper*, cash, 55⅛; three months, 56½. *Lead*, English, 14½—15⅛; Foreign, 14⅛—14½. *Spelter*, 27¼—27⅝. *Tin*, English, 185—186; Foreign, cash, 180; three months, 177¾. *Iron*, Cleveland, cash, 46/9, three months, 47/6.

BRITISH INSULATED & HELSBY CABLES (LTD.)—The directors have declared an interim dividend on the ordinary shares for the half-year ended June 30 at the rate of 8 per cent. per annum.

CANADIAN GENERAL ELECTRIC CO.—The directors have declared a quarterly dividend of 1¾ per cent. on the common stock for the three months to 30th inst. (at the rate of 7 per cent.). A half-yearly dividend of 3½ per cent. for the six months ending 30th inst. (at the rate of 7 per cent.) has been declared on the preferred stock.

DIRECT WEST INDIA CABLE CO. (LTD.)—At the meeting on Wednesday it was reported that the net result of the year's working was an available balance of £6,323. 6s. 10d., compared with £4,530. 15s. 3d. for the year ended June 30, 1910. An interim dividend of 3 per cent. (tax free) had already been paid, and it was decided to make a further equal payment, leaving £4,523. 6s. 10d. to be carried forward. The balance to credit of revenue account, which was last year £32,626. 0s. 5d., has been debited with £900 applied to dividend, and credited with £4,523. 6s. 10d. surplus revenue of the past year, and it now stands at £36,249. 7s. 3d.

DUMBARTON BURGH & COUNTY TRAMWAYS CO. (LTD)—At the meeting last week the chairman (Mr. Geo. Balfour, M.I.E.E.) stated that the traffic receipts were fully £1,000 in excess of the receipts for the preceding year. Since October the receipts had shown satisfactory increase, and the improvements appear likely to be maintained.

HALIFAX & BERMUDAS CABLE CO. (LTD.)—The directors' report for the year ended June 30 was adopted at the meeting on Wednesday. The net result of the year's working was an available balance of £8,168. 6s. 2d., compared with £5,737. 11s. for 1910. An interim dividend of 2½ per cent. (tax free) had already been paid, and it was decided to make a further equal payment, leaving £5,668. 6s. 2d. to be carried forward. The balance to credit of revenue account, which was last year £21,676. 16s. 2d., has been debited with £1,250 applied to dividend, and credited with £5,668. 6s. 2d. surplus revenue of past year, and it now stands at £26,095. 2s. 4d. The company's cable has worked efficiently. The subsidy from the Imperial Government of £8,100 per annum expired on July 14, 1910.

MANILA ELECTRIC RAILROAD & LIGHTING CORPN.—A dividend is announced of 1¼ per cent. ($1.25 per share) for the quarter ending Sept. 30.

NATIONAL ELECTRIC CONSTRUCTION CO. (LTD.)—Mr. L. B. Schlesinger stated at the meeting on Wednesday that they were making arrangements for securing a contract for the construction of an electric railway on the Continent, the first part of which would cost £150,000. They had another contract on hand for £450,000, and various smaller contracts. The undertakings in which they were interested in this country were making slow progress. Rhondda Tramways Syndicate were paying 6 per cent. Mexborough and Swinton Tramways showed increased receipts: Torquay Tramways (having adopted the overhead system) showed largely reduced costs and better prospects. The Musselburgh and District Company was paying 6 per cent. on the preference shares, and Dewsbury and Ossett tramways showed a profit of £261, compared with a loss of £820 last year. The gross profit for the past year of the National Electric Company was £11,456.

NATIONAL ELECTRIC CONSTRUCTION CO. (LTD.)—The directors' report for the year ended Dec. 31, 1910, states that the available balance is £7,350, of which the directors recommend that £1,550 be transferred to debenture redemption fund and £644 to depreciation on free-wired installations, &c., carrying forward £5,156.

UNITED ELECTRIC CAR CO. (LTD.)—The report for the year ended June 30 states that during the year there had been a great stagnation in the car-building trade of the country. The works are now well employed. After paying debenture interest (£2,366) and charging £5,886 for depreciation, the profit is £4,420, added to £4,061 from last year, making £8,481. The Preference dividend to Dec. 31 absorbed £3,000, leaving £5,481. The directors recommend payment of balance preference dividend (less tax) (£3,000) and to carry forward £2,481. The Hadley and Trafford Park works have been disposed of. The directors regret that a loss of £46,17[illegible] has been incurred, which they propose shall be written off.

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ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
erdeen Corporation	Sept. 6	1,654	+ 145	14	23,335	+ 1,493
rdrie	„ 1	231	— 12	35	7,611	+ 55
glo-Argentine	„ 9	51,335	+ 3,943	36	1,753,893	+ 162,759
hton-under-Lyne	.. ..	..	..	..	..	..
r Corporation	„ 9	310	— 26	17	7,216	+ 61
rnsley	„ 1	181	+ 14	35	6,453	+ 418
rrow	„ 1	379	+ 83	35	10,653	+ 1,160
th Electric Trams, Ltd.	„ 6	1,007	— 28	36	30,888	+ 1,125
rmingham Corporation	„ 9	9,228	+ 2,540	23	186,508	+ 30,148
rmingham & Midland	„ 1	908	+ 35	35	31,640	+ 1,836
ckpool & Fleetwood	„ 9	1,952	+ 258	..	..	..
ckburn Corporation	„ 6	1,292	+ 117	†24	28,471	+ 2,622
ton Corporation	„ 10	2,854	+ 15	24	61,287	+ 4,364
nbay	Aug. 11	2,791	+ 219	32	91,013	+ 5,616
rnemouth Corporation	Sept. 6	2,471	+ 233	23	45,202	— 1,519
dford Corporation	„ 9	5,490	+ 174	23	132,289	+ 10,779
hton Corporation	„ 10	1,353	+ 119	¶23	27,545	+ 1,927
tol Trams & Carriage	„ 8	7,466	+ 1,016	23	170,062	+ 18,558
ley Corporation	„ 9	1,514	+ 60	23	25,146	+ 3,693
on Corporation	„ 10	292	+ 17	23	7,037	+ 641
Corporation	„ 10	1,340	+ 87	¶23	31,312	+ 3,194
tta Tramways Co.	„ 9	R59,874	+ R5,032	10	R581,212	+ R46,653
orne-Redruth	„ 9	127	— 9	36	4,424	+ 25
ff Corporation	„ 2	2,544	+ 65	22	57,116	+ 5,106
al London Railway	Sept. 9	4,163	— 1,189	10	42,848	— 9,364
am & Dist. Lt. Rys.	.. ..	..	..	..	..	..
& South London Rly.	„ 10	3,138	— 35	10	30,306	— 491
of Birmingham	„ 1	1,101	— 1,567	35	86,487	— 12,799
Electric Trams Co.	„ 7	652	+ 59	36	18,275	+ 564
on	.. ..	..	..	..	..	..
port & Dist. Trams	„ 1	549	+ 93	35	17,360	+ 2,589
Corporation	„ 2	360	+ 71	22	6,358	+ 975
& Lucan Railway	„ 8	183	+ 5	10	1,763	— 46
United	„ 8	6,444	+ 412	10	71,844	+ 10,002
y-Stourbridge	„ 1	1,028	+ 192	35	30,010	+ 2,144
e Corporation	„ 6	1,362	+ 119	¶16	19,877	— 278
fam Council	„ 9	1,122	+ 80	23	25,781	+ 1,424
Corporation	.. ..	..	..	..	..	..
ead & Dist. Trams	„ 1	1,049	+ 40	35	36,378	+ 2,056
w Corporation	„ 9	20,302	+ 1,675	§14	271,577	+ 17,672
Trams	„ 9	128	+ 13	36	4,476	+ 352
ster Corpn.	„ 6	349	— 3	..	..	..
and-Northfleet	„ 1	236	+ 10	35	7,497	+ 215
Northern & City Rly.	„ 9	1,350	— 9	10	13,460	+ 237
k & Port Glasgow	„ 1	815	+ 159	35	25,380	+ 3,305
Corporation	„ 5	2,196	+ 232	†23	48,069	+ 5,375
ool Tramways	„ 1	323	+ 16	35	9,583	+ 800
s Elec. Trams Co.	„ 7	1,599	+ 176	10	14,753	+ 319
ong	„ 9	$9,131	+ $763	..	..	..
field Corpn.	„ 9	1,999	+ 278	23	46,290	+ 4,987
rporation	„ 9	2,901	+ 265	23	66,370	+ 3,225
istrict Council	„ 9	545	+ 22	24	13,207	+ 547
District Council	„ 6	140	+ 7	23	3,134	+ 117
Corporation	„ 9	559	+ 91	23	11,453	+ 786
banet Co.	„ 9	1,934	+ 318	49	33,810	+ 2,016
	„ 1	140	+ 10	35	4,711	+ 346
Corporation	.. ..	..	..	..	..	..
inster & District	„ 1	135	— 10	35	4,250	+ 289
ox Corporation	„ 9	153	+ 7	17	3,015	+ 319
ire Trams Co.	„ 7	1,595	+ 61	36	53,825	+ 844
re United	„ 6	1,579	+ 4	36	48,927	+ 1,723
on	„ 1	222	+ 36	35	6,272	+ 368
poration	„ 9	7,639	+ 575	22	178,017	+ 12,730
Corporation	„ 9	2,563	+ 264	23	60,162	+ 5,242
poration	„ 9	674	+ 44	‡17	12,026	+ 1,243
rporation	„ 9	124	— 1	23	3,091	+ 210
Corporation	Aug. 26	9,659	— 1,342	34	388,412	+ 10,954
Overhead Rly.	Sept. 10	1,702	+ 204	10	15,482	+ 553
& Colwyn Bay Rly.	„ 8	665	+ 76	§40	12,565	+ 543
unty Council	Aug. 30	42,570	+ 2,122	‡14	978,057	+ 61,824
ec. Ry. Co.	Sept. 9	11,150	— 265	10	115,355	+ 1,210
nited	„ 9	7,258	+ 639	36	241,551	+ 10,541
Corporation	„ 9	472	+ 120	10	10,652	+ 802
r Corporation	„ 9	16,594	+ 485	23	391,008	+ 22,337
Way	„ 9	1,861	— 90	10	17,825	— 1,692
	„ 1	205	— 7	35	7,345	+ 127
an Dist. Railway	„ 9	10,278	+ 116	10	101,481	+ 4,344
an Elec. Trams	„ 1	9,235	+ 1,495	35	307,883	+ 49,277
	„ 1	353	+ 51	35	12,236	+ 1,097
poration	.. ..	..	..	..	..	..
m-Tyne Corp.	„ 9	4,156	+ 410	23	100,182	+ 7,202
don	„ 9	722	+ 23	23	17,138	+ 913
on Corporation	„ 8	574	+ 88	23	13,072	+ 1,247
nton & Hyde	„ 1	579	+ 20	35	20,105	+ 753
poration	„ 10	1,947	+ 78	24	47,203	+ 1,815
) Elec. Trams	„ 6	195	+ 10	16	3,255	+ 225
h	.. ..	..	..	..	..	..
Corporation	„ 1	153	+ 28	35	4,513	+ 455
	„ 9	2,868	+ 253	23	53,690	+ 5,942
poration	„ 1	1,884	+ 119	35	67,136	+ 6,498
Corporation	„ 6	837	+ 14	23	19,609	+ 1,397
	„ 7	655	+ 11	23	15,825	+ 1,422
oration	„ 1	407	+ 62	35	8,444	+ 46
	„ 11	4,978	+ 190	‡23	116,705	+ 6,177
	.. ..	..	..	..	..	..
poration	„ 1	69	+ 3	35	1,864	+ 74
rams	„ 10	6,308	+ 399	23	155,130	+ 10,479
olitan	„ 9	$10,516	+ $160	..	..	..
	„ 1	972	+ 115	35	30,851	+ 1,801
	„ 1	930	+ 77	35	31,509	+ 2,232
poration	„ 6	1,459	+ 225	23	29,999	+ 3,967
amways	„ 6	1,113	+ 230	23	18,710	+ 2,927
ds. & Jt. Bd.	„ 1	360	+ 43	35	10,982	+ 487
poration	„ 9	819	..	23	19,154	+ 1,754
nstrict	„ 10	1,425	+ 233	23	32,432	+ 4,289
ns	„ 6	491	+ 53	45	21,071	+ 1,696
oration	„ 1	1,225	+ 35	35	40,255	+ 2,448
	„ 6	184	+ 20	23	3,778	+ 453
id District	„ 1	49	+ 1	35	1,515	+ 27
ns Co.	„ 1	389	+ 47	35	9,911	+ 402
oration	„ 6	527	+ 80	10	5,772	+ 724
ration	„ 9	1,218	+ 149	§23	27,487	+ 4,293
poration	„ 9	568	+ 23	35	20,129	+ 817
rporation	.. ..	..	..	..	..	..
Mare	„ 7	2,814	+ 309	23	64,103	+ 6,492
on Co.	„ 1	421	+ 99	35	6,497	+ 739
on Corpn.	„ 1	463	+ 41	35	15,618	+ 753
	„ 6	1,022	+ 82	23	23,556	+ 1,498
	„ 1	352	— 44	35	10,456	+ 505
& Trams	„ 1	103	+ 1	35	3,545	+ 160
ollen District	„ 10	1,321	+ 79	37	47,705	+ 2,535
	„ 1	1,090	+ 71	35	36,967	+ 2,647

Comparisons are with the corresponding period last year. * Partly electrical. ‡ Minus 2 days. § Plus 3 days. ¶ Plus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Shares	Last Dividend	NAME.	Price Wed., Sept 13	*Rate per cent. Yielded.	Dividend Due.	Business Week to Sept. 13. Highest.	Business Week to Sept. 13. Lowest.
		Electricity Supply.		£ s. d.			
10	5/0	Bournemouth & Poole Elec. Sup. Ord.	7½ —8½	7 10 0	Mar, Sep	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref.	8½ —9½	4 17 3	Feb, Aug	9½	..
10	6/0	Do. 6 per Cent. Cum. Second Pref.	10 —10½	5 17 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101 —103	4 6 6	Jan, July	102½	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	7½ —8½	6 7 0	March	..	..
5	3/6	Do. 7 per Cent. Pref.	7½ —7½	4 11 9	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Deb. Stock	99 —102	3 19 6	June, Dec	..	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	3½ —4½	5 0 0	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	4½ —5	4 12 3	Feb., Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	94 —98	4 3 3	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	100 —102	4 8 3	..	101½	101
5	2/3	Do. City Undertaking 4½% Cum. Pref.	3½ —4½	5 10 6	Jan, July	3½	..
5	3/0	Chelsea Electric Supply Ord.	4 —4½	5 11 0	March	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	98 —100	4 11 0	June, Dec	..	..
10	6/0	†City of London Electric Lighting Ord.	12 —12½	4 18 0	Feb, Aug	12½	..
10	6/0	†Do. 6 per Cent. Cum. Pref.	11½ —12½	4 18 0	Jan, July	..	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	119 —123	4 2 9	June, Dec	120½	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	100 —103	4 8 6	Jan, July	103	101½
St.	5%	County of Durham Elec. P. D. 5% 1st Mort. Deb. Stk.	89½ —91½	5 10 6	Jan, July	..	..
10	4/0	County of London Elec. Supply Ord.	7½ —7½	3 5 9	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	10½ —11½	5 9 0	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Deb Stock (red.)	108 —110	4 2 6	Jan, July	..	..
St.	4½%	Do. Second Deb. Stock	103½ —103½	4 8 0	May, Nov	10.½	101
..	..	Edmundson's Elec. Corp. Ord.	½ —½	..	Jan, July	..	..
5	..	Do. 6 per Cent. Cum. Pref.	2 —2½	..	May, Nov	..	..
St.	4½%	Do 4½ per cent. 1st Mort. Deb. (red.)	83 —86	5 6 6	July	..	..
5	4/0	Folkestone Electricity Supply Co. Ord.	4½ —5	6 6 0	April, Oct	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4½ —5½	4 15 3	Mar, Sept	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red)	95 —98	4 13 3	Feb, Aug	..	..
5	5/0	Hove Electric Lighting Ord.	6½ —7½	6 4 0	April, Oct	..	..
St.	4½%	Isle of Wight E. L. & P. Co. Deb. Stk.	88 —91	4 19 0	..	..	..
5	4/0	Kensington & Knightsbridge Ord.	6½ —7½	6 18 6	Feb, Aug	..	..
5	6%	Do. 6 per Cent. 1st Pref.	5½ —6	5 0 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	91 —93	4 6 0	..	..	..
St.	4%	Kensington & Knigtsg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	96 —99	4 1 0	April, Oct	..	..
St.	4½%	Kent Elec. Power Co. Irred Deb. Stk.	80 —84	5 10 0	Jan, July	..	..
3	1/2½	London Electric Supply Ord.	1½ —2	3 8 0	Mar, Sept	..	..
5	3/0	†Do. 6 per Cent. Pref.	4½ —4½	6 8 0	Mar, Sept	4½	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb	89 —92	4 8 0	Jan, July	91	..
5	2/0	Metropolitan Electric Sup. Ord.	3½ —4½	6 0 0	April, Oct	..	..
5	2/3	Do 4½ per Cent. Cum. Pref.	4½ —4½	4 17 0	Jan, July	4½	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	100 —105	4 8 0	June, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	84½ —87½	4 1 6	Jan, July	84½	..
..	4½%	Midland Elec. Corp. for P.D. 4½ 1st Mort. Debs	96½ —93½	4 12 6	..	..	..
5	2/0	Newcastle Elec. Supply Ord. (1-50,000 & 57,010-137,500)	3½ —4	6 0 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non Cum. Pref.	4 —4½	5 17 6	Feb, Aug	..	..
100	4½%	Do. 4½ per Cent. 1st Mort. Deb.	97 —99	4 12 0	Jan, July	..	..
100	5%	North Metro. Elec. Power Sup. 5 Morts.	101 —104	4 17 6	..	..	..
1	6%	Northampton Elec. Lt. & P. Ord.	1½ —1½	4 11 6	Feb, Aug	..	..
1	5%	Do. 5% Pref.	1½ —1½	4 6 0	Feb, Aug	..	..
St.	4%	Do. 4% Debs.	99 —101	3 19 0	June, Dec	..	..
10	6/0	Notting Hill Electric Ord.	..	5 17 6	March	..	..
5	4/3	Oxford Electric Ord.	6½ —5½	5 10 0	March	..	..
St.	4%	Do. 4% Deb. Stk.	91 —93	4 5 1	..	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	8½ —9½	5 11 0	Feb, Aug	8½	..
5	3/6	Do. 7 per Cent. Pref.	6½ —7½	5 0 0	Feb, Aug	..	..
St.	3½%	Do 3½ per Cent. Deb. Stock (red.)	85 —87	4 1 6	Jan, July	..	..
5	..	Smithfield Markets Electric Sup. Ord.	1½ —1½	..	Feb.	..	..
5	4/0	South London Electric Supply Ord.	2½ —3	6 5 6	April	..	..
St.	5%	Do. 5% 1st Mort. Stock (red.)	93½ —101½	5 0 6	..	..	..
1	0 8‡	†South Metrop'n Elec. Lt & Power 7% 1st Pref	1½ —1½	6 5 0	Feb, Aug	..	..
1	0/7½	†Do. 6 per Cent. 2nd Pref.	½ —½	6 17 0	Feb, Aug	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	97 —100	4 11 6	April, Oct	..	..
5	1/3	Urban Electric Supply Ord.	½ —1	..	April, Oct	..	..
5	1/3	Do. 5 per Cent. Cum. Pref.	2 —2½	11 2 3	April, Oct	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	87½ —89½	5 1 9	April, Oct	83½	..
5	5/0	Westminster Elec. Sup. Ord.	7½ —8	6 15 6	Mar, Sept	7½	7½
5	2/3	Do. 4½ per Cent. Cum. Pref.	4½ —5½	4 10 0	Jan, July	5½	4½
		Electric Railways and Tramways.					
1	..	Bath Elec. Trams Pref. Ord.	½ —½	..	April	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	½ —½	..	..	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	79 —83	5 8 0	Jan, July	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Deb. Stock	91 —93	4 17 9	April, Oct	..	..
10	4%	Bristol Tramways & Carriage Ord.	5½ —6½	6 13 6	Jan, July	93	91
10	4%	Do. Cum. Pref.	7½ —7½	5 4 6	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Debs.	100 —101	3 19 2	..	..	..
10	..	British Electric Traction Ord.	½ —½	..	Feb, Aug	..	..
10	..	Do. 6 per Cent. Cum. Pref.	¾ —¾	..	June, Dec	..	..
St.	5%	Do. 5 per Cent. Perpetual Debs.	93 —95	..	Feb, Aug	3½	3½
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	74 —78	5 6 0	April, Oct	94½	93
St.	3%	Central London Ordinary Stock	66 —68	5 18 0	May, Nov	..	..
St.	4%	Do. 4 per Cent. Pref. Stock	85 —87	4 9 9	Feb, Aug	66	..
..	6/4	Do. 4½% Pref. Scrip 75% pd	83 —90	4 13 0	Feb, Aug	..	..
St.	2%	Do. Deferred Stock	49 —51	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	102 —104	4 0 0	Feb.	..	..
5	2/6	City of Birmingham Trams, 5% Cum. Pref.	4½ —5½	3 16 11	Jan, July	10½	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	4 19 6	April, Oct	..	..
St.	12%	City & South London Rly. Con. Ord.	29 —30	3 18 9	April, Oct	..	..
St.	5%	Do. 5 per cent. Perp. Pref. (1891)	108 —110	5 19 0	Feb, Aug	29½	29
St.	5%	Do. (1896)	104 —106	4 11 9	Feb, Aug	..	..
St.	5%	Do. (1901)	103 —105	4 16 0	Feb, Aug	..	..
St.	5%	Do. (1903)	102 —104	4 17 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	102 —104	4 16 0	Feb, Aug	..	..
10	6/0	Dublin United Trams. 6 per Cent. Pref.	11 —12	3 17 9	May, Nov	..	..
10	12/0	Gateshead and District Trams Ord.	5 4 0	Feb, Aug	..	..	..
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	8½ —8½	6 19 0	..	..	..
5	..	Hastings & District Elec. Trams, 6% C. P.	½ —1½	..	Feb, Aug	1	..
St.	4½%	Do. 4½ Deb. Stock	..	..	Mar. Sept	..	..
10	..	Imperial Tramways Ord.	73 —80	5 10 0	April, Oct	..	..
10	..	‡Do. 6 per Cent. Pref.	3 —3½	..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Debs.	4 —4½	..	Mar, Sept	..	..
..	2/3	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	72 —74	6 3 6	Jan, July	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	2½ —3	4 11 0	Mar, Sept.	..	..
10	5/0	Lanarkshire Tramways	77 —82	5 1 0	Jan, July	..	..
St.	5%	Lancs Utd. Trams. 5% Prior Lien Deb. Stk.	9½ —10½	5 15 0	Feb, Aug	..	..
St.	4%	London Electric 4% Deb. St.	79 —82	6 4 0	Jan, July	..	..
St.	4%	Do. 4% Pref.	96 —98	4 2 6	..	..	..
10	..	London United Trams, 5% Cum. Pref.	82 —84	4 16 6	..	97½	96½
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	3 —3½	..	..	82½	82½
St.	..	Mersey Con. Ord. Stock	72 —76	5 8 0	Jan, July	..	..
1	1/1½	Metropolitan Elec. Tramways Ord.	6 —9	..	Feb, Aug	7½	7½
1	..	Do. Deferred	⅝ —1⅛	6 0 0	..	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	⅝ —¾	..	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	½ —1	5 8 0	April	..	..
St.	5%	Do. 5 per Cent Db. Stk	99 —101	4 10 0	Feb, Aug	..	..
			102 —104	4 17 0	Jan, July	..	..

* No allowance has been made for accrued interest or redemption.
† Ex Dividend ‡ The London Stock Exchange Committee have declined to quote these.

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ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Par Value	Last Dividend	NAME.	Price Wed., Sept. 13	*Rate per cent. Yielded.	Dividend Due.	Business Week to Sept. 13. Highest.	Lowest.
		Electric Railways and Tramways— *Continued.*		£ s. d.			
St.	2%	Metropolitan Railway Consolidated	43 —43½	4 12 0	Feb, Aug	43½	43
St.	3%	Do. Surplus Lands Stocks	64 —66	4 12 3	Feb, Aug	64	—
St.	3½%	Do. 3½ per Cent. Preference	88 —90	3 18 6	Feb, Aug	88½	—
St.	3½%	Do. 3½ per Cent. "A" Preference	87 —89	3 19 6	Feb, Aug	88	87½
St.	3½%	Do. 3½ per Cent. Convertible Pref.	87 —89	3 19 6	Feb, Aug	88	87½
St.	3½%	Do. 3½ per Cent. Debenture Stock	92 —94	3 14 6	Jan, July	92½	—
St.	3½%	Do. 3½ per Cent. "A" Deb. Stock	91 —93	3 16 0	Jan, July	91½	—
St.	—	Metropolitan District Railway Ord.	24 —24½	..	Feb, Aug	24½	24
St.	4½%	Do. 4½% First Pref.	85 —87	5 4 9	Feb, Aug	86½	86
St.	3½%	Do. Assented 1st Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	74 —76	4 13 6	Feb, Aug	75	—
St.	3%	Do. 3 per Cent. Consoltd. Rent-charge	76 —78	3 18 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Midland Rent-charge	102 —104	3 17 9	Jan, July	..	..
St.	6%	Do. 6 per Cent. Perp. Deb. Stock	145 —147	4 2 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Ditto	96 —98	4 2 6	Jan, July	..	..
1	4½d.	Potteries Electric Traction Ord.	⅛ —⅛	6 11 3	April, Oct	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	⅛ —⅛	8 9 6	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent, Deb. Stock	88 —91	5 0 0	May, Nov	..	..
1	1/2½	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	⅛ —⅛	10 2 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	73 —78	5 6 0	Jan, July	..	..
100	5%	Sunderland Dist. Elec. Trms. 5% 1stMtDb.	..	8 4 0	Jan, July	..	..
10	—	Underground Elec. Rys. Lon. Shares	1¼ —1⅝	..	..	..	..
—	4½%	Do. 4½% Bonds with coup. 8	98 —100	4 11 0	—	99½	..
—	15/0	Do. 6% In. bds. ex. coup. 7	62 —64	1 19 0	June, Dec	60½	60
—	4%	Do. 4 per Cent. 1st Power Ho. Dbs.	101 —103	3 18 3	..	..	..
5	—	Yorkshire (W.R.) Elec. Trams. Ord.	⅛ —⅛	..	March	..	..
5	—	Do. 6 per Cent. Cum. Pref.	2⅛ —2½	..	..	..	..
St.	4½	Do. 4½ per Cent. 1st Debs.	80 —85	5 9 6	Jan, July	..	..
		Electric Manufacturing, &c.					
St.	4½%	Anchor Cable Co. 4½ % Deb. Stock	99 —101	4 10 0	—	..	..
1	1/2½	Aron Electricity Meter Ord.	⅛ —⅛	..	..	..	..
1	0/7½	Do. 6% Cum. Pf.	⅛ —⅛	7 10 0	April, Oct	..	..
1	3/2½	Babcock & Wilcox Ord.	5⅛ —5⅛	4 14 6	April, Oct	..	..
1	0/7½	Do Pref.	1⅛ —1⅛	4 0 0	..	..	..
5	6/0	British Insulated & Helsby Cables Ord.	6⅛ —7⅛	6 15 6	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	5⅛ —6⅛	5 0 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	102 —104	4 7 0	Jan, July	..	..
St.	..	Do. 5% Mort. Deb. Stock	104 —106	..	..	..	..
St.	4½%	†British Thoms'n-Houst'n 4½% 1st Mt.Db.	94 —97	4 14 3	Mar, Sept	..	..
5	..	British Westinghouse 6 per Cent. Pref.	⅛ —⅛	..	Feb, Aug	⅛	..
100	6%	Do. 6 per Cent. Prior Lien Dbs. (rd.)	102 —104	5 17 0	..	102½	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	59 —62	6 6 6	Jan, July	..	..
St.	4½%	†BrushE.Eng. Co. 4½% Perp. 1st Deb.Stock	55 —61	7 15 0	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	39 —44	10 10 0	Mar, Sept	..	..
5	10/0	Callender's Cable Con. Ord.	9 —9½	8 2 0	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅛ —5⅛	4 19 3	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort Debs. (red.)	101 —103	4 8 0	Nov, May	100½	..
1	1/6	Castner-Kellner Alkali Co.	3½ —3⅝	5 4 3	May, Nov	3⅝	3½
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 —107	4 5 9	Feb, Aug	105½	104½
1	1/0	Chadburn's (Ship) Telegraph Ord.	1⅛ —1⅛	5 19 0	March	..	..
1	0/8½	Consolidated Electrical Co.	⅛ —⅛	7 8 9	August	..	..
1	0/6	Consolidated Signal Co.	⅛ —⅛	8 7 6	April, Oct	..	..
1	0/7½	Do. 6 per cent. Cum. Pref.	⅛ —⅛	7 6 6	April, Oct	..	..
3	..	Crompton & Co (Nos. 1 to 85,000)	⅛ —⅛	..	Jan, July	..	..
100	5%	Do. 5 per Cent. 1st Mort. Debs. (red.)	57⅛ —67½	8 0 0	Jan, July	..	..
5	1/0	Dick, Kerr & Co. Ord.	⅛ —⅛	5 14 0	Sept	..	..
5	0/7½	Do. 6 per Cent. Cum. Pref.	⅛ —1⅛	5 6 0	Sept	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	95 —98	4 13 3	Jan, July	..	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	⅛ —⅛	..	Feb, Aug	..	..
..	..	Do. (£5 paid)	1⅛ —2⅛	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (red.)	67 —71	5 16 0	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	78 —81	6 3 6	Mar, Sept	..	..
2	2½%	Electric Construction Co.	⅛ —⅛	6 3 0	Jan, July	..	..
2	2/9½	Do. 7 per Cent. Cum. Pref.	1⅛ —1⅛	7 4 6	July	1⅛	..
St.	4%	Do 4 per Cent. Perp. 1st Mort. Debs.	73 —78	5 6 0	Jan, July	..	..
1.	5/0	General Electric (1900) 5% Cum. Pref.	8½ —9	5 14 0	June, Dec	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	88 —93	4 8 6	Mar, Sept	..	..
1	5/0	†Henley's Telegraph Works Ord.	4⅛ —5⅛	6 0 9	Feb, Aug	..	..
1	2/3	†Do. 4½ per Cent. Pref.	..	4 9 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	105½ —108½	4 3 6	Mar, Sept	..	..
10	15/0	India Rubber, Gut. Per., &c., Works	13½ —15½	..	Feb, Aug	..	..
10	5/0	Do 5 per Cent. Cum. Pref.	9½ —10½	4 19 0	..	..	..
10.	4%	Do. 4 per Cent. Debs. (red.)	95 —97	4 3 3	April, Oct	..	..
1	..	National Elec. Construction Co.	⅛ —⅛	..	April	..	..
1	..	Richardsons, Westgarth & Co., Ltd. Ord.	⅞ —⅞	..	Nov	..	..
1	..	Do. 6 per Cent. Cum. Pref.	⅞ —⅞	..	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. Perp. Deb. Stock	75 —78	5 18 0	Jan, July	..	..
5	..	Simplex Conduits 6 per Cent. Cum. Pref.	4⅛ —5	..	..	..	..
1.	12/0	Telegraph Construction & Maintenance	34½ —36½	6 9 9	Mar, July	34⅞	34½
10.	4%	Do. 4 per Cent. Deb. Bonds (1909)	100 —102	3 19 3	Jan, July	..	..
1	1/0	Vickers, Sons & Maxim, Ltd., Ord.	1⅛ —2	5 1 0	..	2	1⅞
1	0/6	Do 5 per Cent. non-Cum. Preference	1⅛ —1⅛	4 3 0	..	1⅞	..
St.	5%	Do. 5 per Cent. non-Cum. Preferred	107 —111	4 11 6	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Db. Stk. (red)	98 —100	4 0 9	June, Dec	99	98
10.	4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.)	103. —105	4 6 6	June, Dec	..	..
10.	5%	Do. 5 per Cent. 3rd Mort. Debs Scrip.	103½ —105½	4 15 6	..	104½	104
10	12%	J. G. White & Co. 6% Cum. Pref.	14½ —15½	7 14 10	..	..	—
1	..	Willans & Robinson Ord.	⅛ —⅛	..	Apr, Oct	..	..
5	..	Do. 6 per Cent. Cum. Pref.	⅛ —⅛	..	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	55 —65	6 3 0	May, Nov	..	..
		Telegraphs.					
10	..	Amazon Telegraph	7⅛ —7½	..	June, Dec	..	..
10.	5%	Do. 5 per Cent. Debs. (red.)	98½ —100½	5 0 6	Jan, July	..	..
St.	15/3	Anglo-American	67½ —69½	4 8 3	F,My,Ag,N	..	..
St.	30/0	Do Preferred	111½ —112½	5 7 0	F,My,Ag,N	112½	112
St.	30/0	Do Deferred	25 —25½	5 19 6	F,My,Ag,N	25½	24½
St.	4%	Commercial Cable 4 per Cent. Deb. Stk.	87½ —89½	4 10 6	Jn,Ap,Jy,O	87½	..
10	6/0	Cuba Submarine Ord.	10½ —11	5 13 0	Feb, Aug	..	..
10	10/0	Do. Preferences 10 per Cent.	17½ —18½	5 13 0	Feb, Aug	..	..
5	2/0	Direct Spanish Ord.	3½ —4	5 0 0	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	8½ —8½	5 16 0	April, Oct	..	..
5.	4½%	Do 4½ per Cent. Deb.	100 —102	4 9 0	Jan, July	..	..
10	3/0	Direct United States Cable	7½ —8½	6 3 0	Ja,Ap,Jy,O	8⅛	7½
10.	4½%	Direct West India Cable 4½% Rg.Db.(rd.)	99 —101	4 10 0	June, Dec	..	..
St.	25/0	Eastern Ordinary	137 —140	5 1 0	Ja,My,Jy,O	139½	137½
St.	17/6	Do. 3½ per Cent. Pref. Stock	84 —86	4 2 6	Ja,My,Jy,O	85½	84
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (red.)	102 —104	3 17 9	May, Nov	103½	103½
St	2/6	Eastern Extension	13½ —14	5 2 0	Ja, Ap, Jy,O	13½	13½
10	4%	Do. 4 per Cent. Deb. Stock	100½ —102½	3 19 0	Feb, Aug	..	..
25	4%	Eastern and S.Af., 4% Mauritius Sub.Debs	100 —102	3 19 0	May, Nov	..	..
10	5/0	G.N (of Copenhagen), with Coupon 83	33½ —34½	5 16 0	Jan, July	34	33½
25	52/6	Indo-European	56½ —58½	5 6 6	May, Nov	..	..
100	5%	Mackay Companies Common	86 —88	5 15 0	Ja,Ap,Jy,O	..	..
100	4%	Do. Preference	75 —78	5 4 0	Ja,Ap,Jy,O	..	..
1	1/0	Marconi's Wireless Teleg. Co.	2½ —2⅝	..	April	..	..
1	2/9½	Do. 7½ Partipg. Pref.	1½ —2	..	..	..	..
100	4%	Pacific & Europe'n Tel.4%Guar.Dbs.(red.)	99½ —101½	3 19 9	June, Dec	..	..
2½	1/3	West Coast of America	1⅛ —1⅛	5 0 0	May	..	..
100	4%	Do. 4 per Cent. Debs.	99 —100	4 1 0	Jan, July	..	..
10	1/6	West India & Panama	2½ —2⅝	4 16 0	May, Nov	2⅝	2½
10	6/0	Do. 6 per Cent. 1st Pref.	10½ —10½	5 16 6	May, Nov	10⅝	10½
10	6/0	Do. 6% 2nd Pref.	9½ —10½	6 0 0	May, Nov	..	..
100	5%	Do. 5 per Cent. Debs.	101 —103	4 18 0	Jan, July	..	..
10	3/0	Western Telegraph	13½ —14	5 2 0	Mr,Jn,O,D	13⅝	13½
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	101 —103	3 18 6	June, Dec	..	..
—	4%	Western Union Telegraph, $1,000 4% Bds	107 —110	3 13 9	—	—	—
—	4½%	Do. $1,000 4½% Fdg. & Rl. Est. Gd. Bnds	101 —104	4 8 0	—	—	—

Par Value	Last Dividend	NAME.	Price Wed., Sept. 13	*Rate per cent. Yielded.	Dividend Due.
		Telephones.		£ s. d.	
		Amer. Telephn. & Telegh. Cap. St.	137 —139	5 16 0	..
		Do. Coll. Trust $1,000 4 per Cent. Bds.	94 —96	4 4 0	Jan, July
St.	4%	Do. 4% Cons. Bonds 1936	106½ —110½	3 13 0	..
		†Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101 —103	4 18 0	Mar, Sept
5	4/0	Chili Telephone	6⅛ —7⅛	4 5 9	August
1	0/6	Monte Video Telephone Ord.	⅛ —⅛	6 0 0	Nov
		Do. 5 per Cent. Pref.	⅛ —⅛	5 11 0	May, Nov
St.	6%	National Co. Pref. Stock	104 —106	5 14 0	Feb, Aug
St.	6%	Do. Def. Stock	116 —119	5 2 0	Feb, Aug
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	10 —10½	5 11 6	Feb, Aug
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10 —10½	5 11 6	Feb, Aug
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.	5⅛ —5⅛	4 12 0	Feb, Aug
St.	3½%	Do Deb. Stock 3½ per Cent. (red.)	98½ —100½	4 0 6	June, Dec
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	98½ —100½	4 0 6	Jan, July
1	4½d.	New York Telephone Co. 30 yr. Bnds.	102½ —103½	4 7 6	..
1	1/0	Oriental	1⅛ —1⅛	5 2 0	April, Oct
	0/7½	Do 6 per Cent. Cum. Pref.	1⅛ —1⅛	4 16 0	April, Oct
St.	4%	Do. 4 per Cent. Red. Deb. Stock	88 —90	4 10 0	Jan, July
St.	4½%	Telephone Co. of Egypt 4½% Db.Stk.(red.)	99 —101	4 10 0	Jan, July
5	5/0	United River Plate Ord.	7⅛ —7⅞	5 13 5	July
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅛ —5⅜	4 13 0	June, Dec
St.	4½%	Do. 4½ Deb. St. Red.	102½ —104½	4 7 0	Jan, July
		Financial, Investment, &c.			
		Elec. & Gen. Investment 6% Cum. Pref.	4 —4½	7 1 0	Jan, July
10	6/0	Globe Telegraph & Trust	10½ —11	5 7 0	Sp,Dc&rJn
10	3/0	Do. 6 per Cent. Pref.	13 —13½	4 10 9	Sp,Dc&rJn
10	6%	Submarine Cables Trust (Cert.)	132 —135	4 10 0	April, Oct
		Colonial and Foreign Electric Railways, Tramways, &c.			
		Anglo-Argentine 5½% Cum. 1st Pref.	5⅛ —5⅛	4 17 6	April, Oct
	2/9	Do. 5½% Cum. 2nd Pref.	4⅞ —5	5 12 9	Jan, July
	2/9	Do. 4% Deb. Stock	93 —95	4 5 0	June, Dec
St.	4%	Do. 4½% Deb. Stock	101 —103	4 8 3	..
St.	5%	Do. 5% Deb Stock	101 —103	4 18 0	..
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)	102 —105	4 16 6	Jan, July
	4/0	Brisbane Electric Trams. Invest. Ord.	6⅛ —7⅛	5 16 3	May, Nov
	2/6	Do. 5 per Cent. Cum. Pref.	5 —5⅛	4 17 6	May, Nov
St.	4½%	Do. 4½ per Cent. Db. Prov. Certs.	102 —105	4 7 0	Jan, July
St.	8%	British Columbia El..Rly. Df.Ord.	137 —141	5 15 0	Mar, Sept
St.	6%	Do. Pref. Ord. Stock	119 —123	4 19 0	May, Nov
St.	5%	Do. 5% Cum. Perp. Pref. Stock	106 —109	4 13 0	Jan, July
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	100 —103	4 7 6	April, Oct
100	4½%	Do. Vancouver Power Debs.	101 —104	4 3 3	Jan, July
St.	4½%	Do. 4½% Perp. Con. Deb. St.	103½ —105½	4 1 0	..
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	98½ —100½	5 0 6	Mar, Sept
St.	6%	Buenos Ayres Port & City Tram. 1st Mt. Deb. Stock	92 —96	6 8 0	Feb, Aug
	3/6	Calcutta Tramways (1 to 137,610)	5⅛ —6⅛	4 19 6	Mar, Sept
	2/6	Do. 5 per Cent. Cum. Pref.	5 —5⅛	4 17 6	Jan, July
1	4½%	Do. 4½% 1st Deb. Stock (red)	102 —105	4 5 9	Jan, July
St.	..	Cape Electric Tram Shares	⅜ —½	..	..
5	1/3	City of Buenos Ayres Trams Co. (1904) Sh.	5⅜ —5⅝	4 8 0	F,My,A,N
St.	4%	Do. 4 per Cent. Deb. Stock	95 —98	4 3 0	June, Dec
	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.	95 —100	5 2 6	May, Nov
1	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	100 —103	4 19 0	Feb, Aug
100	5%	Hong Kong Tramways Co. 5 per Cent. 1st Mort. Debs.	77 —81	6 6 6	June, Dec
1	..	Kalgoorlie Elec. Trams Sh.	⅜ —½	..	..
		Do. 5 per Cent. "A" Deb. Stock	92½ —95½	5 4 6	Jan, July
5	6%	Do. 6 per Cent. "B" Ditto	63 —67	8 15 0	Jan, July
5	0/6	Lisbon Elec. Trams. Ord.	1 —1⅛	4 16 0	July
100	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1⅛	4 16 0	Jan, July
St.	5%	Do. 5 per Cent. Reg. Mort. Debs.	97 —101	5 1 0	Jan, July
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	95 —98	5 3 6	Jan, July
100	5%	Manaos Trams and Lt. Co. 5% Debs.	88 —91	5 12 0	..
	5%	Manila Elec. Ry. $1,000 Gold Bonds	98 —100	5 1 0	Feb, Aug
100	$1½	Mexico Trams Co. Con. St.	117 —119	5 19 0	..
	5%	†Do. Gen. Con. 1st Mort. 5% Gold Bds.	96½ —97½	5 3 6	..
St.	6%	Do. 6% 50 yr. Mort. Bds.	98½ —100½	6 0 6	..
St.	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922) (Nos. 601 to 2,000)	100 —102	4 9 0	Feb, Aug
		Do. do. (Nos. 1 to 4,600)	102 —104	4 7 6	..
1	0/6	Perth Elec. Trams Ord.	⅛ —1⅛	2 10 0	May
St.	5%	Do. 1st Mt. Db. Stock	101½ —103½	4 17 6	Jan, July
5	3/0	Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	5⅛ —5⅝	5 8 0	..
	4½%	Do. 4½% 1st Mort. Deb. Stk.	98 —101	4 10 6	..
100	$1½	Rio Janeiro Tram. Lt. & P. Co.	115 —116	4 6 6	..
	5%	Do. 30 yr. Gold Bnds.	101½ —102½	4 18 3	..
100	5%	Do. 50 yr. Mt. Bnds	97½ —98½	5 2 0	..
	$2½	Sao Paulo Tramway, Light & Power Co. $100 Stock	177 —180	5 12 0	..
	5%	Do. 5 per Cent. 1st Mt. $500 Db.	102½ —104½	4 16 6	June, Dec
100	4½%	†Toronto Ry. Co 1st Mt. 4½% Ster. Bonds	97 —99	4 11 9	Feb, Aug
		Colonial and Foreign Electricity Supply, &c.			
5	3/0	†Adelaide Elec. S'ply Co. 6% Cu. Pr.	5⅛ —5⅝	5 11 6	Mar, Sept
St	—	Do. 5% Deb. Stk.	102½ —104½	..	..
10	5/0	Bombay E.S. & T. 6% Cm. Pf.	10⅜ —11⅛	5 9 0	..
St.	4½%	Do. 4½ per Cent. Deb. Stk. (rsd).	96½ —98½	4 12 0	Jan, July
St.	5%	Do 5 per Cent. 2nd Mort. Deb. Stock	97 —99	5 2 0	..
5	5/0	Calcutta Elec. Supply Ord.	6⅛ —7⅛	5 19 6	April, Oct
		†Do. 5% Cum. Pref.	4⅞ —5⅛	5 0 0	..
100	5%	Calgary Power Co. 5% 1s: Mort. Bnds.	96 —98	5 2 0	..
100	7/2½	Canadian Gen. Elec. Co. Com. St.	105 —110	6 10 0	..
100	$3½	Do. 7% Cm. Pf. Stock	121 —125	5 14 0	..
100	5%	Castner Electrolytic Alkali Co (of U.S.A.) 1st Mort. Stl. Debs.	94 —99	5 3 6	Jan, July
		† Elect. Development Co. of Ontario	85 —87	5 16 0	..
500	5%	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	84½ —87½	5 4 0	Jan, July
5		Indian Elec. Sup. & Trac. Co.	1 —1⅛	..	..
10s	..	Kalgoorlie Elec. Power & Ltg. Ord.	⅛ —⅜	..	..
	0/7½	Do. 6 per Cent. Cum. Pref.	8½ —9	8 6 6	April, Oct
5	5%	Kaministiquia Power Co. 5% Gold Bnds.	101½ —103½	4 17 6	..
St.	..	Madras E. S. Corp. Ord.	2⅛ —3⅛	..	..
St.	..	Melbourne E. S. Co. Cons. Ord. St.	42 —47	..	..
500	5%	Do. 5% 1st Mortg Deb. Stock	95 —97	5 4 0	..
	5%	Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	87½ —89½	5 13 0	..
St.	$1	Mexican Lt. & Power Co. Com. St.	85 —88	4 12 0	..
500	83½	Do. 7% Cum. Pref. St.	106½ —103½	6 10 0	..
St	5%	Do 5% 1st Mort. Gold Bnds.	94 —96	5 5 6	..
100	5%	Monterey Rly. L. & P. Co. 1st Mort. Db. Stk.	83 —90	5 12 3	F,My,A,N
100	8/2½	Montreal Lt. Ht. & Power Co. Cap. St.	165 —170	5 18 6	..
St.	5%	Northern Lt. Power & Coal 5% Gd. Bds.	39 —41	6 5 0	..
St.	£10	River Plate Electricity Co. Ord. Stk.	218 —228	4 7 9	April
St.	6%	Do. 6 per Cent. non-Cum. Pref. Stk.	107 —114	5 5 0	May
100	5%	Do. 5 per Cent. Deb. Stock	101½ —103½	4 17 6	Jan, July
	$1½	Shawinigan Water & Power Co. Cm.	114 —116	4 7 0	..
St.	5%	Do. 5 per Cent. Bds.	107 —109	4 12 6	Jan, July
St.	4½%	Do. 4½ Per Cent. 1st Mt. Db. Stk. (red.)	103 —105	4 6 0	..
—	4½%	Toronto Power Co. 4½% Bds.	100 —102	4 9 0	..
		Victoria Falls Power	⅛ —1	—	Jan, July

* No allowance has been made for accrued interest or redemption. † Ex Dividend ‡ The London Stock [illegible] declined to quote these.

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THE ELECTRICIAN:

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COMMERCIAL AND INDUSTRIAL SUPPLEMENT.

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NOTES.

Steam v. Internal Combustion Engines.

ONE of the most interesting discussions that took place at the recent meeting of the British Association was on the relative merits of steam plant, suction gas plant and Diesel engines. Three Papers were read in which the claims of the advocates of each type of plant were clearly set forth; an abstract of the Paper by Mr. W. A. TOOKEY on suction gas plant appeared in our last issue, whilst elsewhere in the present issue will be found abstracts of the Papers contributed by Mr. W. T. MARSHALL and by Mr. C. DAY on "Over-type Superheated Steam Engines" and "The Diesel Oil Engine" respectively. These three Papers are more than usually interesting since they give the results of tests carried out over considerable periods on plant under normal working conditions.

THE low fuel consumption of internal-combustion engines has, as Mr. MARSHALL points out, undoubtedly stimulated the manufacturers of steam engines to perfect more efficient steam plant for small installations. The "locomobile"—to use the name which is better known abroad—is to some extent the result of this competition. With this plant a fuel consumption of from 1·2 lb. to 1·4 lb. per brake horse-power-hour is recorded by Mr. MARSHALL, but a consumption as low as 0·9 lb. per brake horse-power-hour has, we understand, been obtained with the Wolf locomobile. This last-mentioned figure is certainly comparable with the best records of gas plant, with which Mr. TOOKEY mentions that 0·7 lb. to 0·85 lb. per brake horse-power-hour is regularly obtained in normal working. Although Mr. TOOKEY quotes a number of instances to illustrate the low cost of maintenance and the reliability of suction gas plants, we think that engineers will not yet be convinced that in these respects suction gas plant is as satisfactory as steam plant, whilst capital charges will frequently have more effect than that allowed by the author.

WITH regard to Mr. DAY's Paper on Diesel engines, the author mentions the importance of not paying too much attention to manufacturers' guarantees of fuel consumption, owing to the different conditions obtaining in practice. We think, however, that the Table which he gives, based on the published records of electric supply stations, is also liable to be misleading. Much of the steam plant on which this Table is based is probably inefficient and out of date. That the Diesel plant considered is probably of more recent installation is shown by the figures for repairs and maintenance, this item for steam plant being stated as 0·26d. per unit, as against 0·07d. for Diesel stations and 0·24d. for gas plants. The desirability, if not necessity, of employing skilled labour in running Diesel plant may sometimes prove a disadvantage, but there is no doubt that this engine shows to advantage in the case of stations with a poor load factor, and in which the stand-by losses are heavy. Electrical engineers, however, are hoping that such cases will become comparatively rare in the future.

The Exhibition.

As we go to press we are on the eve of the opening of the second Electrical Exhibition held in London within the past 10 years. During the four weeks in which it remains

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open the people of the Metropolis and the Home Counties (at any rate) will have opportunities of inspecting the latest electrical devices for making homes brighter and cleaner and for rendering commerce and industry more efficient. We are glad to see that the British Electrical Allied Manufacturers' Association, to use its newly adopted title, has made the Exhibition an essentially popular one. An exclusively trade exhibition would have done little or no good at the present time. On the other hand, the industry is not sufficiently well grouped to run a show which would appeal solely to the public and make no demands upon the trade. In the present Exhibition we have a happy combination of the two. There is very little heavy machinery, plenty of "apparatus and accessories," and an abundance of lamps, fittings, small motors, cookers, heaters, radiators, cigar lighters, &c. This combination represents in their proper proportions the elements needed to make up a combined trade and popular Exhibition.

FROM a preliminary inspection of the stands we can vouch for a full measure of completion by the time of the opening to-morrow. The body of the huge hall is well filled; in fact, almost too well, for the gangways and stands seem narrower than at the last show. The gallery is about half filled and is devoted to the smaller and lighter exhibits. The electric cooking demonstrations in particular should attract special notice, and we hope that the daily press will be given facilities for witnessing these and for providing their readers with intelligent copy regarding electric cooking generally. The large sums spent by the London gas companies in newspaper advertising have resulted in the publication of well-written articles on gas cooking and heating, and the benefits of these disquisitions are now being reaped by those fundamentally responsible for them. We ourselves are dealing with the Exhibition in the columns of the Commercial and Industrial Supplement and we refer our readers to this section in the present and succeeding issues for a fully illustrated description of the exhibits. In particular we would direct attention to the map of Olympia and guide to the exhibits which occupies the centre pages of the Supplement this week.

WE gather from the Executive Committee that up to the present moment there has been practically no attempt on the part of company and municipal supply authorities to purchase tickets for the Exhibition in the same way as was done at Manchester. It may be that these public bodies are slow to take action in matters of this sort. There is plenty of time; but we may voice a reminder that co-operation of this character is essentially practical and will result in undoubted advantage to electricity supply both in London and the Provinces. The public will need to be specially attracted to the Exhibition, and the wise distribution of tickets among present and prospective consumers will materially assist in popularising what is, after all, a popular electrical show.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Assab—Perim	July 8, 1909 ...	—
Latakia—Palura	May 26, 1910 ...	—
Zanzibar—Mombasa	July 11, 1911 ...	—
Sabang—Koetaradja	Aug. 18, 1911 ...	Sept. 5, 1911
Kotonou—Grand Bassam	Aug. 23, 1911 ...	—
San Thiago—Bathurst	Sept. 4. 1911 ...	—
Bathurst—Sierra Leone	Sept. 4, 1911 ...	—

Mr. Edison.—Mr. Thomas Alva Edison, who with his family is continuing his Continental tour, has been féted in Vienna and Budapest, and, according to the Austrian papers, is now journeying onwards to Switzerland, Holland and France.

University of Christiania.—In celebration of its jubilee this University recently conferred a number of honorary degrees. Among those so honoured were Sir Wm. Ramsay, F.R.S., Sir J. J. Thomson, F.R.S., and Dr. H. A. Miers, F.R.S.

New Electro-Steel Works on Tyneside.—The "Engineer" mentions that the Electro-Flex Steel Co. have acquired a site adjoining the new Dunston power station of the Newcastle-on-Tyne Electric Supply Co., and propose to manufacture steel entirely by means of electric furnaces. The initial installation is to consist of two 200-kw. Stassano furnaces.

The B.A. Report on Electrical Measurements.—Mr. A. P. Trotter informs us that his name has been attached to the report of the British Association Committee on Practical Standards for Electrical Measurements without his authority, and doubtless as the result of a mistake. But it compels him to state that he withdrew from the Committee in July, 1910, because he strongly disagreed with some of their resolutions, and with the mode in which their business was conducted.

Popular Science.—During the last week or two our daily contemporaries have been in ecstasies about the wireless telephony experiments of Mr. H. Grindell Matthews. The articles on such occasions are generally amusing, and for the benefit of our readers we cannot refrain from quoting the following from the "Daily Chronicle":—

> The man who has made the discovery is a young scientist, Mr. H. Grindell Matthews, who has been so richly endowed as an inventive genius that he was the other day made a Member of the Royal Institution at an earlier age than that ever before recorded in the membership rolls of the institution . . . The invention is so far-reaching in its possibilities of useful application that its author has been strongly advised to compete for the coveted Nobel prize, and he has decided to do so next year.

Electric Power and the Farmer.—A pamphlet recently published by Dr. L. C. Wolff in Germany, under the title of "Der Landwirtschaft und die Uberlandzentrale" contains an indictment of the recent policy of erecting large generating stations principally for agricultural purposes. It is reported that millions of marks have been lost in these schemes. The Crottorf station, which was erected 10 years ago for supplying current to 10 towns, has inflicted a capital loss of £140,000 and a loss of interest of £20,000 on its shareholders. The power stations at Wandersleben, Blankenheim and Floh are in a state of bankruptcy. The stations at Birnbaum and Meseritz have had to quadruple their capital, and the station at Derenburg has had to increase the original sum eight times. These facts are not, however, considered to show that these stations are a failure, for wherever they are properly engineered and managed they will eventually become valuable components of the nation's wealth. The large manufacturers argue that it is only by such schemes that the way can be paved for the electrification of all main railway lines. They maintain that as soon as railways, factories and farmers are counted amongst the consumers of such power stations a good return will be received from the capital invested. The condition of these undertakings, however, at present seems to be not unlike that of many of our "power" companies.

Current Topics.

Subjects of current interest dealt with in this issue include the following:—

Dr. R. A. Houstoun continues his series of "Studies in Light Production." The title of his article in the present issue is "Flames."

Mr. W. Dubilier contributes an article on "An Improved Wireless Telephone Transmitter."

The following Papers read at the recent meeting of the British Association will be found in the present issue: "The Single-phase Repulsion Motor," by Mr. T. F. Wall; "Economical and Reliable Power Generation by Over-type Superheated Steam Engines," by Mr. W. J. Marshall; "The Diesel Engine," by Mr. C. Day; "A Friction Permeameter," by Mr. W. H. Murdoch; "Smoke Abatement," by Dr. J. S. Owens.

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We describe a new form of flexible steel mast known as the Fontana Mast, which has been introduced in Germany, and is suitable for wireless telegraphy.

We describe the electrical equipment of the Craighead and Bothwell Collieries.

The Electrical Exhibition at Olympia opens to-morrow. An account of some of the exhibits will be found in our "Commercial and Industrial Supplement."

An abstract is given of the report of Sir F. Oppenheimer (British Consul-General) on the trade of Germany in the past year.

Companies' Meetings and Reports.—At the meeting of the Yorkshire Electric Power Co., on Tuesday, particulars were given of the progress made by the Company during the half-year, many additional customers having been connected to the mains.

A report of the meeting of the United Electric Car Co. appears in another column.

The directors' report of Cleveland & Durham Electric Power (Ltd.), which gives information as to the Company's progress during the past year, states that arrangements have been made to erect further waste heat generating stations.

The directors' report of the Direct United States Cable Co. is also given.

OBITUARY.

P. A. EDMUNDSON.—We regret to record the death of Mr. P. A. Edmundson, electrical engineer, in the service of the Cornwall Electric Power Co., who was drowned while bathing at Hayle on the 9th inst.. Deceased, who was only 28 years of age, was a native of Dublin.

A. SCHWIEGER.—The death is announced of Herr Adolph Schwieger, a director of the Siemens Schuckert and Siemens Halske works, and a pioneer of electric railways. The deceased was 66 years of age.

PERSONAL NOTES.

Mr. J. H. Butters, B.Sc., A.M.I.E.E., has been appointed chief engineer of the new Hydro-Electric Power & Metallurgical Co. (Ltd.), of Tasmania, and manager of their hydro-electric supply department.

Mr. Butters, who was educated at Hartley University College, and is a graduate of the University of London, served as apprentice with Thornycroft & Co., leaving them to join Siemens Bros. Dynamo Works, of London and Stafford. Whilst with the latter Mr. Butters held the position of designing engineer, and was subsequently in charge of the estimating and design department at the Stafford works, being later transferred to the head office as central station and power engineer. Two years ago he was appointed engineer of the firm's Australasian branch, which position he has now resigned to take up his new appointment. Mr. Butters is proceeding immediately to Tasmania to prepare specifications, &c., for the machinery which will be necessary to carry on the new company's work.

Mr. James Strachan has resigned the position of works manager, which he has held for the last three years with Messrs. Tetley & Co., Salford, and is now manager of the works of Salford Electrical Instruments (Ltd.), North George-street, Salford.

Mr. R. J. Rosser, A.M.I.E.E., Assistant City Electrical Engineer of Cape Town, left for England in the s.s. "Buluwayo" on Sept. 4 for a six month's holiday. He will be visiting the Electrical Exhibition at Olympia and will afterwards proceed to the Continent of Europe and the United States on a general tour of inspection.

APPOINTMENTS VACANT AND FILLED.

Test-room assistants, for adjusting and calibrating a.c. and d.c. instruments, are wanted; also assistants for photometry. See advertisement.

A switchboard attendant is required for South Africa (h.t. three-phase system). Salary £300 per annum. See advertisement.

Swindon Corporation require an assistant electrical and mechanical engineer for their electricity and tramways departments. Salary £130, rising to £180. Applications to the Town Clerk by Sept. 23.

An assistant lecturer in physics is required at St. Andrews University. Stipend £100 per annum. Applications to the Secretary.

A firm in the Midlands require an assistant tester, well up in testing a.c. and d.c. machinery. See advertisement.

Mr. Philip Kemp, M.Sc.Tech., has been appointed lecturer in electrical engineering at East London College (University of London) in succession to Mr. L. Murphy, who has resigned to take up the position of managing engineer to the Perry Barr Fan Works, Birmingham.

Mr. Kemp, after a distinguished career at Manchester Municipal School of Technology, spent two years at Messrs. Mather & Platt's works in the testing department, designing room and drawing office. Since then he has had two years of teaching experience in electrical design and laboratory classes under Prof. Schwartz. He was awarded in 1910 the "Joule" medal for a paper on "Some Thermo-dynamic Properties of Rubber," and is joint author of a Paper printed in the "Journal" of the I.E.E. on "The High-Tension Spark Discharge in Air."

Mr. Harry Pulling, superintendent of the mechanical and electrical department of Accrington Corporation tramways, has been appointed manager of the tramways at a salary of £200 per annum, in succession to Mr. Jas. Wilson, who has retired.

Mr. G. W. Cansdell Hirst has been appointed demonstrator in electrical engineering at Sydney (N. S. W.) Technical College.

INSTITUTIONS AND SOCIETIES.

Junior Institution of Engineers.—Mr. G. Marconi, D.Sc., has been elected president of this Institution in succession to Sir J. J. Thomson, F.R.S.

Iron and Steel Institute.—The proposed Italian meeting for which arrangements had been announced has had to be abandoned owing to numerous withdrawals, during the last week or two, of members who had intended to be present. The falling-off is attributed to labour conditions in this country, the political situation in Europe, and rumours as to the prevalence of cholera in Italy. As the statutory requirements of the Charter of the Institute necessitate a meeting being held in the autumn, arrangements have been made to hold a meeting at the Institution of Civil Engineers on Thursday, October 5, when the Papers down for reading at the Turin meeting will be considered.

EDUCATIONAL NOTICES.

University of London, University College.—The new session commences on Monday, Oct. 2. There are complete courses of study, extending over three years, in mechanical, electrical, civil and municipal engineering. Particulars from the secretary, Mr. Walter W. Seton, M.A., Gower-street, W.C.

University of London, King's College.—Complete courses of study, extending over three or four years, are provided in civil, mechanical and electrical engineering for engineering degrees of the University of London, and for the diploma and certificate of the college.

The four-years' course provides, in addition to the academic training, opportunity for practical training in works. Special advanced lectures and courses in civil and mechanical as well as electrical engineering, will commence in October. Among the lecturers in electrical engineering are Mr. W. H. Patchell, who will deal with "Electric Generating Stations" and "The Application of Electric Power to Mines and Heavy Industries"; Mr. F. Lydall, who will lecture on "Electric Traction, Direct and Alternating Current"; and Mr. Wm. Brew, who will deal with "Electric Lighting." Detailed syllabus and further particulars may be obtained from the Secretary, King's College, Strand, London, W.C.

University of Edinburgh.—The next session opens on Oct. 10. The University provides complete courses in civil, mechanical and electrical engineering, qualifying for the degree of B.Sc. in engineering, and extending over a period of three years. Particulars from the Matriculation Office, The University, Edinburgh.

University of Manchester.—Complete courses of study, extending over three years, are arranged for the University degrees in civil, mechanical and electrical engineering. The session commences on Oct. 2.

University of Durham.—Armstrong College, Newcastle-upon-Tyne.—The 1911-12 session commences Sept. 25. Courses of instruction are provided in mechanical, marine, civil and electrical engineering, naval architecture, mining, metallurgy, agriculture, pure science, arts and letters. Particulars from the secretary, Mr. F. H. Pruen, M.A.

The Calendar for the 1911-12 session has been issued, and contains particulars of the courses of instruction in engineering, physics, mathematics, chemistry, metallurgy, &c. Good provision is made for evening classes and there is also suitable accommodation for practical work and research.

Goldsmiths' College (University of London).—At this college complete evening courses of instruction are provided in mechanical, electrical and constructional engineering, land surveying, fitting and machining, pattern-making and smithing. Students are prepared for the London University degree of B.Sc. in engineering, for the examinations of the Institution of Civil Engineers, Board of Educa-

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tion, and City and Guilds of London Institute, &c. Particulars from the Warden of the College, New Cross, S.E. The new session commences on Monday, Sept. 25.

University College of North Wales.—At this college a systematic course of instruction in electrical measurements and practical electricity is provided for students proposing to enter the electrical engineering profession. The session commences in October.

Borough Polytechnic Institute.—A four years' course of instruction in electrotechnics is provided at this Institute. There are also classes in electric wiremen's work, and elementary and advanced courses in electrical design and workshop drawing. The head of the department is Mr. John Henderson, D.Sc., F.R.S.E., A.M.I.E.E. Prospectuses from the Principal, Mr. C. T. Millis, Borough-road, S.E. The session begins on 25th inst.

Northampton Polytechnic Institute, Clerkenwell, London.—The full day courses in the theory and practice of mechanical and electrical engineering and in electro-chemistry will commence on Oct. 2, and entrance examinations will take place on Sept. 27 and 28, at which five entrance scholarships will be offered. The courses for mechanical and electrical engineering include periods spent in commercial workshops, and extend over four years, and they also prepare for the degree of B.Sc. in engineering of the University of London. There are also full and partial day courses in technical optics. Particulars from the Principal, Dr. R. Mullineux Walmsley.

We have received a copy of the "Announcements" for the session 1911-12 and among the new developments may be noted:—

In the electrical engineering department the new generating station, which was opened by the chairman of London County Council last winter, is now available for the instruction of senior students in both day and evening courses. The equipment of the station (which was described at the time of the opening in THE ELECTRICIAN) is very complete in all details of the generation and distribution of continuous and alternating currents. In the mechanical engineering department the equipment for experimental work in aeronautics has been much increased and it is hoped that valuable work of a research character will be done by the senior students during the winter. In other departments various additions have also been made.

In the evening classes an important series of lectures is being given jointly by the Electrical Engineering, Technical Chemistry and Technical Optics Departments on Illuminating Engineering. These lectures will be given by various specialists in the different sections of the subject and form an important development in the work of the Polytechnic. Changes have been made in the telegraphy and telephony courses in the electrical engineering department to meet the changes which are taking place outside. The position is complicated by the abolition of the stage I. examinations of the Board of Education which have hitherto been required by the Post Office authorities as one of the conditions for certain departmental advances. These authorities have not yet decided as to what shall take the place of the Board of Education examinations, but students are strongly advised by their senior officers to continue their studies on the old lines. In submarine cable work and in radio-telegraphy the advanced classes are being continued and developed. In the mechanical engineering department, to meet the growing development, the course in aeronautical engineering has been divided into two courses, one being the advanced engineering course of previous sessions, and the other a more advanced course for senior students. In technical optics and in technical chemistry some of the evening courses have been remodelled to adapt them more to the requirements of students. Throughout there have been a fair number of changes in the various syllabuses bringing them up to date, and the educational work is being carried on along the lines which have been found so successful in previous years. New departures are made in the day work of the technical chemistry and of the horological departments by the institution of morning classes for apprentices in workshops. In these classes students, all of whom are engaged in commercial workshops, are in attendance from 9 a.m. to 1 p.m. and spend the afternoons in their employers' workshops.

Battersea Polytechnic (London, S.W.).—The new session commences on Monday, 25th inst. There are complete day college courses in civil, mechanical and electrical engineering, extending over three or four years. These courses are suitable for preparing for the B.Sc. (Eng.) of the University of London, the Associateship examination of the Institution of Civil Engineers, &c. There are also evening classes in electrical technology, electrical design and power distribution, theory of machines, hydraulics, heat engines, strength of materials, &c. Further particulars from the Secretary.

A course of 12 lectures, six during the first term and six after Christmas, will be given on "Illuminating Engineering." On Oct. 17 and 24 Prof. J. T. Morris will lecture on "Electric Lighting;" on Oct. 31 and Nov. 7. Mr. J. G. Clarke will lecture on "Gas Lighting." Mr. E. Scott Snell will deal with "Oil, Petrol-air and Acetylene Gas" on Nov. 14, and Dr. W. J. Ettles will give a lecture on "Illumination and the Eye" on Nov. 21. The remaining six lectures (to be delivered in the second term) will deal with the Measurement of Light and Practical Problems in Illumination and will be delivered by Mr. J. S. Dow, B.Sc., Fee for full course, 7s. 6d.

South-Western Polytechnic Institute.—This institute provides a complete three-years' course, leading to a diploma or university degree, in electrical engineering. A four-years' course is held in the evening. Separate courses of lectures and practical work are given in elementary, intermediate and advanced electrical engineering, electrical design, a.c. and polyphase currents, wiring and fitting, &c.

Mr. A. J. Makower, M.A., M.I.E.E., is head of the electrical engineering department, and he is assisted by a competent staff of teachers. The course of instruction is suitable for students, either before or after gaining practical experience in workshops. The institute is lighted by its own generators which have been specially arranged to allow of complete tests to be carried out from time to time by students. Those who take the complete electrical course will be instructed in practical wiring and the making of joints, and the practical work in the laboratory is made to illustrate the principles given in the lectures as far as possible. Ample provision is also made for evening students in the department, and complete courses of three evenings per week for four years are arranged for those desirous of gaining a thorough training in the principles of the theory of electrical engineering, and of those subjects that are intimately connected therewith. A prospectus, containing full particulars of day and evening classes, may be obtained (post free 3½d.) from the Secretary Manresa-road, Chelsea, London, S.W.

East London College (University of London).—In the Faculty of Engineering complete courses of instruction are provided in engineering subjects, including civil, mechanical and electrical engineering. There are special facilities for apprentices on the sandwich system. The fee for the session is 10 guineas. Further particulars from the Registrar or from the principal, Mr. J. L. S. Hatton, M.A.

Sir John Cass Technical Institute.—During the Autmun and Lent terms special courses of instruction will be given at this college in "Engineering Metals and Alloys," by Mr. Wesley J. Lambert (there will be 24 lectures, followed by suitable work, commencing Oct. 5), and on "Liquid, Gaseous and Solid Fuel," by Mr. J. S. Brame (20 lectures, commencing Oct. 16). A detailed syllabus of the course may be obtained from the offices of the Institute, or by letter to the Principal, Jewry-street, Aldgate, London, E.C.

Northern Polytechnic Institute, London.—We have received a copy of the prospectus for the 1911-1912 session. There are day and evening classes in engineering, physics, mathematics, chemistry, &c.

ARRANGEMENTS FOR THE WEEK.

SATURDAY, September 23rd.

ELECTRICAL EXHIBITION AT OLYMPIA.

2 p.m. Formal opening of the Exhibition, by Sir William Preece, K.C.B., F.R.S.

TUESDAY, September 26th.

JUNIOR INSTITUTION OF ENGINEERS.

6:30 p.m. Visit to the Electrical Exhibition at Olympia.

MUNICIPAL TRAMWAYS ASSOCIATION.

WEDNESDAY, September 27th.

10:30 a.m. Annual Conference at Glasgow. Reception by the Lord Provost and the Convener and Members of the Glasgow Tramways Committee, in the Council Chamber.

11 a.m. Presidential Address by Mr. J. Dalrymple (General Manager, Glasgow Corporation Tramways); and Paper on "The Common Good of the City of Glasgow, its Origin, History and Present Position in Relation to the Tramways Undertaking," by Councillor W. Nelson (Sub-convener of the Tramways Committee.)

3:30 p.m. Paper on "Tramways Finances and Policy," by Councillor J. H. Rodgers (Chairman of the Newcastle-upon-Tyne Corporation Tramways Committee). Discussion to be opened by Mr. W. J. Squires, of the London County Council.

7:30 p.m. Dinner in the City Chambers.

THURSDAY, September 28th.

10:30 a.m. Conference in the Hall at Newlands Depot. Paper on "Tramcar Meters," by Messrs. R. G. and J. G. Cunliffe (Technical Assistants, Manchester Corporation Tramways). Discussion on this Paper to be opened by Mr. T. B. Goodger (General Manager, Croydon Corporation Tramways) and Mr. W. Clough (General Manager, Bury Corporation Tramways). Report on "Tramway Track: Methods of Construction and Maintenance," by the Representatives of the Glasgow, Manchester and Leeds Corporation Tramways.

2:30 p.m. Annual Business Meeting in the Hall at Newlands Depot.

3:15 p.m. Visit to Rouken Glen.

7:45 p.m. Association Dinner in the Grosvenor Restaurant, Gordon-street.

FRIDAY, September 29th.

11 a.m. Excursion to Ayr and the land of Burns (arriving back at Glasgow at 7:20 p.m.).

THE LONDON ELECTRICAL ENGINEERS.

Officer Commanding, Col. H. M. Leaf.

The following orders have been issued:—

Head-quarters will be closed for instruction, but will be open for other work as under until further orders:—

Monday to Friday, 10 a.m. to 4 p.m.
Saturday, 10 a.m. to 12 noon.

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THE SINGLE-PHASE REPULSION MOTOR.*

BY THOMAS F. WALL, M.SC., M.ENG.

Summary.—In the first part of this Paper expressions are deduced for the E.M.F.s induced in the stator and rotor windings, and curves are given which enable some of these E.M.F.s to be rapidly determined for any value of the displacement of the rotor brushes from the stator axis. In the second part of the Paper the results previously obtained are employed in developing the theory of the repulsion motor. A series of simultaneous equations enable expressions to be obtained for the speed, stator current, power factor and power of the motor. In the third part of the Paper the results of some tests on a 6 B.H.P. motor are given, and the values of the stator current, power factor and speed are shown to be in agreement with the theory. Finally, a method of calculating the open circuit characteristic of a single-phase motor is given.

In dealing with the subject of alternating-current commutator motors it is not easy to adapt the methods used for other types of alternating-current machinery, since the commutator motor partakes partly of the nature of a transformer and partly of the nature of an alternator, and for this reason, in evolving a theory of these machines it is of the greatest importance that the methods adopted should be as simple as possible in order that the subject, which is intrinsically of considerable complexity, may not be made more so by complicated methods of treatment. In order that the practical engineer may have a clear idea of the physical aspect of the subject, it is most desirable that the methods of design should not involve any other ideas than those usually employed in the design of transformers and electrical machines. The subject has been dealt with by several writers, notably Steinmetz,† Bragstad,‡ and Fischer-Hinnen.§ The treatment of Steinmetz and Bragstad involves the use of the symbolic method, and assumes sinusoidal distribution of the flux in the air-gap. Although the symbolic method leads to a singularly elegant solution, it is not at present familiar to the practical engineer. Moreover, the assumption of sinusoidal flux distribution is not very satisfactory. Fischer-Hinnen has shown how the vector diagram may be drawn for one position of the rotor brushes, but the solution is not a general one.

In the following treatment the plain repulsion motor has been dealt with, and it is hoped that the results obtained may be of immediate use to the designer. Experimental evidence as to the accuracy which may be expected from the theory is given, tests having been made on a motor designed for 6 B.H.P. at 50 cycles 120 volts.

The Déri modification of the plain repulsion motor may be considered as a special case, and can be dealt with quite easily by slight modifications of the formulæ deduced in the Paper.

The only assumptions made in the following development are that the iron losses and commutation effects are small and that the permeability of the magnetic circuit is constant. That the influence of the circulating currents in the coils undergoing commutation is extremely small is evident from Fig. 20.

No assumption as to sinusoidal flux distribution in the air-gap has been made, the triangular or trapezoidal flux distribution, as the case may be, having been dealt with throughout.

PART I.

Before developing the author's theory of the repulsion motor, formulæ for the following will be established :—

1. The E.M.F. induced in the stator winding due to an alternating current in that winding.
2. The E.M.F. induced in the rotor winding due to an alternating current in the stator winding.
3. The E.M.F. induced in the rotor winding when rotating in the field due to an alternating current in the stator winding.
4. The E.M.F. induced in the stator winding due to an alternating current in the rotor winding.
5. The E.M.F. induced in the rotor winding due to an alternating current in that winding.

Now, since we can write for the case of a sine wave form of applied pressure

Effective E.M.F. = 4·44 × frequency × maximum flux linkages × 10^{-8}

(the flux linkages being the sum of the products—flux × number of turns linked—taken for all the turns), expressions for the maximum flux linkages in the five cases stated above may be at once deduced from the expressions for the E.M.F.s.

It is quite justifiable to assume a sine wave form for the applied pressure (and consequently for the corresponding induced flux), since in practice a sine wave form is the standard for alternating current generators.

In establishing the above five expressions no assumption will be made as to sinusoidal distribution of flux in the air-gap space, but as far as possible the actual flux distribution will be considered.

Fig. 1 represents diagrammatically a plain repulsion motor having two poles. The axis of the stator winding is represented by the line AB, and CD represents the brushes, which are short-circuited, and thus forms the axis of the rotor winding. (In what follows the letters A, B, C, D refer to points on the rotor or the stator, according to the member considered.) The angle between the axes of the stator and rotor windings respectively is represented by θ, and $2a$ is the angle subtended by the unwound portion of the stator periphery.

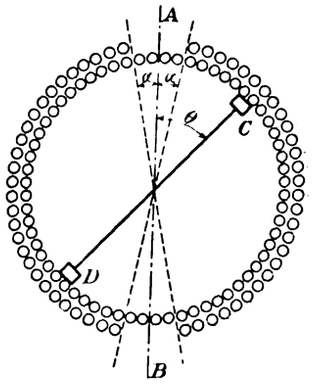

FIG. 1.

If a current be led into the stator winding, and if we suppose for a moment that both stator and rotor have smooth peripheries, the flux distribution in the air-gap will be represented by Fig. 2 for an indefinitely large number of stator conductors. As a matter of fact, both stator and rotor will be slotted in practice, and the number of conductors will not be indefinitely large. Suppose that only the stator be slotted, then the flux distribution may be represented in some such way as is given by the full line in Fig. 2*a*. The value of the flux linkages, however, given by the full line in Fig. 2*a* will be the

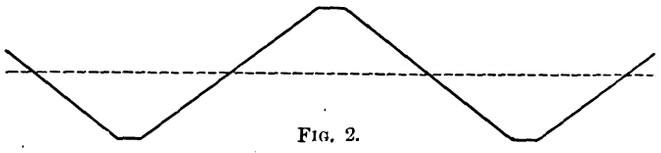

FIG. 2.

same as the value obtained by considering the distribution to be as shown by the dotted line in Fig. 2*a*, diminished by some constant which is independent of the magnitude of the current in the winding. The effect of slotting the rotor core may be similarly dealt with by introducing a second constant. These two constants may be combined in a single constant,* a knowledge of which enables the actual flux linkages to be obtained by considering the stator and rotor as having smooth cores, and the flux distribution as shown in Fig. 2.

FIG. 2*a*.

Let r be the mean radius of the air-gap measured in centimetres.

l be the mean effective axial length† of the stator and rotor cores measured in centimetres.

w_1 be the number of conductors per centimetre length of stator periphery.

w_2 be the number of conductors per centimetre length of rotor periphery.

$B_{max.}$ be the maximum flux-density in the air-gap *as regards both time and space*. That is to say, if the flux distribution be represented by Fig. 3 *when the stator current is a maximum*, then B_{max} will be given by the ordinate AA′.

$B_{max.}$ be the maximum flux-density in the air-gap as regards space only—that is, the density *at any instant* at the points A or C (Fig. 1).

The maximum value of the flux-density at any point, X, distant x cm. from R, is

$$= B_{max} 2x/r(\pi - 2a), \text{ for a two-pole machine.}$$

* Paper read before Section G of the British Association at Portsmouth.

† Steinmetz, "Alternating-Current Phenomena."

‡ Bragstad, "Transactions" of the International Electrical Congress, St. Louis, 1904, Vol. III., pp. 153-173.

§ Fischer-Hinnen, "E.T.Z.," 30, May 27, June 3, June 10, 1909.

* *See* Arnold, "Die Wechselstromtechnik," Vol. V., part I., p. 42. Also Wall, "Journal" Inst. Elec. Eng., Vol. XL., p. 550.

† Calculated as shown by Arnold, "Die Wechselstromtechnik," Vol. IV., p. 13.

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If the machine have P pairs of poles, and π and a be measured in electrical degrees, then the flux-density at X will be

$$= B_{max} 2x\mathrm{P}/r(\pi-2a).$$

The effective E.M.F. induced between the stator terminals will be

$$= 2\mathrm{P}\left[\int_{x=o}^{x=r(\pi/2-a)/\mathrm{P}} 2\bar{B}_x l w_1 x 4{\cdot}44\,\nu\,10^{-8}\,dx + 2\bar{B}_{max}\, l\frac{a}{\mathrm{P}} r w_1 \frac{(\pi/2-a)}{\mathrm{P}} r\, 4{\cdot}44\,\nu\,10^{-8}\right]$$

for frequency ν, if all the conductors are in series.

If the conductors be arranged in p_{2s} sets in parallel, this expression must be divided by p_{2s}.

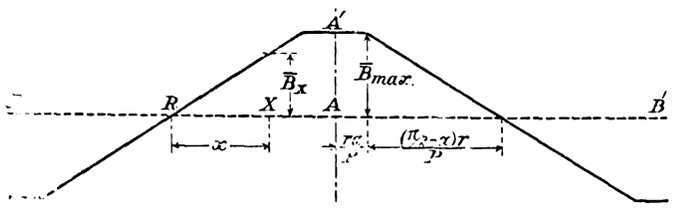

FIG. 3.

Simplifying this expression, we get :—

The effective E.M.F. induced in the stator winding due to a current in that winding is

$$= \frac{1}{3\mathrm{P}p_{2s}} 4{\cdot}44\,\nu\,\bar{B}_{max} l w_1 r^2(\pi-2a)(\pi+4a)10^{-8} \quad . \quad . \quad . \quad (1)$$

or, dividing this expression by $4{\cdot}44\,\nu\,10^{-8}$, we get :—

The maximum flux linkages of the stator winding due to a current in that winding is

$$L'_s = \frac{1}{3\mathrm{P}p_{2s}} \bar{B}_{max} l w_1 r^2(\pi-2a)(\pi+4a) \quad . \quad . \quad . \quad . \quad (1a)$$

We may proceed in a somewhat similar manner in order to obtain the E.M.F. induced between the rotor brushes by the flux due to a current in the stator winding. Referring to Fig. 4, the flux distribution in the air-gap is again shown, and C and D represent the short-circuited brushes. It is clear that no E.M.F. is induced in the

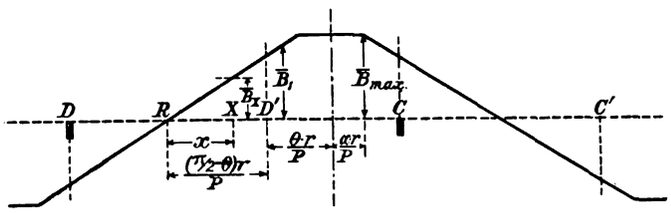

FIG. 4.

band of conductors on the rotor subtended by the angle θ on each side of the stator axis. Hence it is only the conductors contained in the bands CC' and DD' of the rotor periphery which develop an E.M.F., of which the effective value is

$$= \frac{2\mathrm{P}}{p_{2r}}\left[\int_o^{r(\pi/2-\theta)/\mathrm{P}} 2\bar{B}_x l w_2 x 4{\cdot}44\,\nu\,10^{-8}\,dx + 2\bar{B}_1 l\frac{\theta-a}{\mathrm{P}} r\, 4{\cdot}44\,\nu\,10^{-8} w_2 \frac{(\pi/2-\theta)}{\mathrm{P}} r\right.$$
$$\left. + 2\bar{B}_{max} l r\frac{a}{\mathrm{P}} 4{\cdot}44\,\nu\,10^{-8} w_2 \frac{\pi/2-\theta}{\mathrm{P}}\right],$$

in which p_{2r} represents the number of parallel paths in the rotor winding, and $\bar{B}_1$ is the mean value of the flux-density over the band of conductors $(\theta-a)r/\mathrm{P}$.

Simplifying this expression, we get :—

The effective value of the E.M.F. induced between the rotor brushes due to an alternating current in the stator winding is

$$= \frac{\mathrm{I}}{3\mathrm{P}p_{2r}} \bar{B}_{max} l w_2 4{\cdot}44\,\nu\,10^{-8} r^2\left[\pi-2\theta\right]\left[\frac{\pi^2+2\pi\theta-2\theta^2-6a^2}{\pi-2a}\right] \quad (2)$$

or, dividing by $4{\cdot}44\,\nu\,10^{-8}$, we get :—

The maximum flux linkages of the rotor winding due to a current in the stator winding is

$$L'_R = \frac{1}{3\mathrm{P}p_{2r}} \bar{B}_{max} l w_2 r^2\left[\pi-2\theta\right]\left[\frac{\pi^2+2\pi\theta-2\theta^2-6a^2}{\pi-2a}\right]. \quad (2a)$$

The expressions 2 and 2a hold if θ is equal to or greater than a. If, however, θ is less than a, we must obtain a new expression for the flux linkages. This becomes

$$= \frac{1}{3\mathrm{P}p_{2r}} \bar{B}_{max} l w_2 r^2\left[\pi^2+2\pi a-6\theta^2-2a^2\right].$$

The case of θ less than a is not of very great importance, and we shall not further consider it.

In the expression (2a) the product of the quantities in brackets may be represented by Θ_c, and has been worked out for various values of θ from 0 to $\pi/2$. Fig. 5 shows a curve connecting Θ_c and θ (assuming $a=0{\cdot}1\pi$, which is a reasonable value), but it must be remembered that this curve is only applicable for values of θ between a and $\pi-a$.

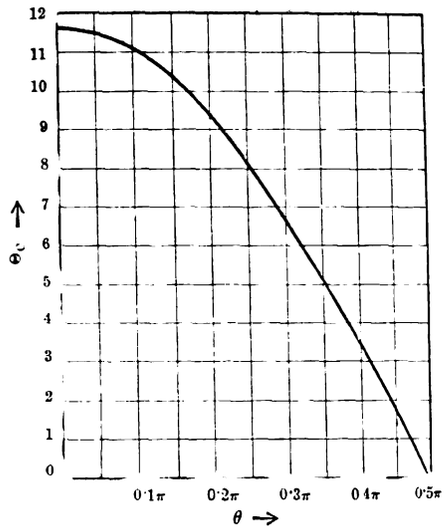

FIG. 5.

In order to deduce the E.M.F. induced between the rotor brushes when the rotor is revolving in the field due to an alternating current in the stator winding, we may proceed as follows :—

The effective E.M.F. due to rotation is

$$= \frac{\mathrm{N}Z_2 n 2\mathrm{P}}{\sqrt{2}\cdot 60 p_{2r} 10^8} \text{ volts},$$

N being the maximum flux threading the short-circuited coil, Z_2 being

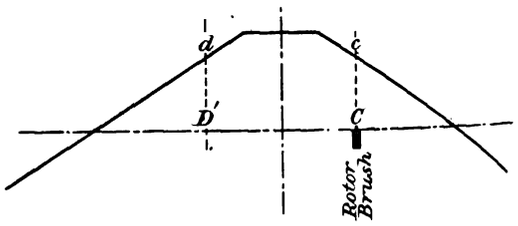

FIG. 6.

the number of conductors in the rotor winding, n being the speed of rotation in revolutions per minute, and the other symbols having the same signification as before.

Referring to Fig. 6, the flux threading the short-circuited coils may be represented by the area CcD'd.

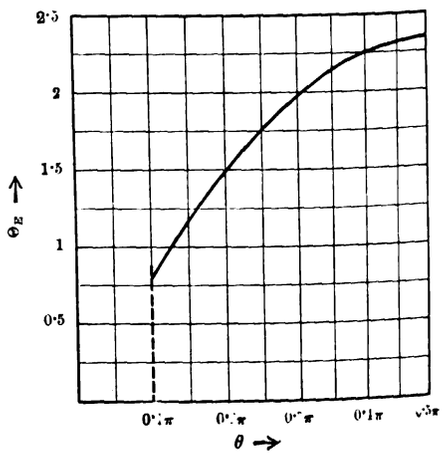

FIG. 7.

Making the necessary substitutions, we get :—

The effective value of the E.M.F. induced in the rotor winding when rotating in the field due to an alternating current in the stator winding is

$$= \frac{Z_2 n \bar{B}_{max} r l 4}{60\sqrt{2}\, p_{2r}}\left[\frac{\pi\theta-\theta^2-a^2}{\pi-2a}\right]10^{-8}. \quad . \quad . \quad . \quad .$$

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For this particular case it is not important to know the value of the flux linkages represented by this expression, and we shall not, therefore, consider it further.

In the expression (3) the numerator of the quantity in brackets may be denoted by Θ_E, and Fig. 7 shows the relationship between Θ_E and θ for values of θ between a and $\pi/2$ (assuming $a = 0{\cdot}1\pi$).

It is to be noticed that the frequency of the E.M.F. induced at the rotor brushes in this way is independent of the speed and is equal to the frequency of the supply pressure at the stator terminals.

Expression (3) would appear to indicate that the E.M.F. is independent of the number of poles. This, however, is not the case, since the angles are measured in electrical (not geometrical) degrees.

If a current be caused to flow in the rotor winding the flux distribution will be as shown in Fig. 8, and we get :—

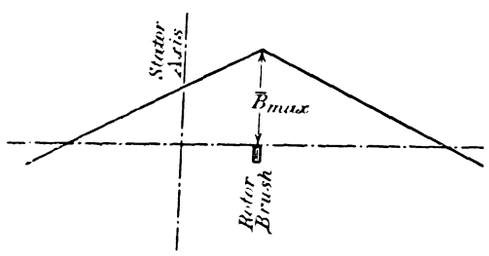

FIG. 8.

The effective E.M.F. induced at the stator terminals due to a current in the rotor winding is

$$= \frac{1}{P p_{2s}} \bar{B}_{max} l w_1 4{\cdot}44\, \nu\, 10^{-8} r^2 \left[\frac{\pi^3/3 - 2\pi a^2 - 2\pi\theta^2 + 4a^2\theta + 4/3\theta^3}{\pi} \right] \quad (4)$$

or, dividing by $4{\cdot}44\,\nu\,10^{-8}$, we get :—

The maximum flux linkages of the stator winding due to a current in the rotor winding is

$$L'_s = \frac{1}{P p_{2s}} \bar{B}_{max} l w_1 r^2 \left[\frac{\pi^3/3 - 2\pi a^2 - 2\pi\theta^2 + 4a^2\theta + 4/3\theta^3}{\pi} \right] . \quad (4a)$$

Expressions (4) and (4a) hold if θ is equal to or greater than a.

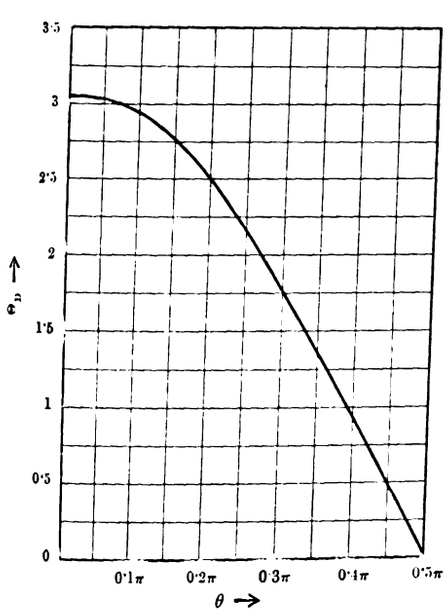

FIG. 9.

f, however, θ is less than a, a new expression must be obtained for ie flux linkages. This has been found to be

$$= \frac{\bar{B}_{max} r^2 l w_1}{P p_{2s}} \left[\frac{\pi^3/3 + \frac{4}{3}a^3 + 4a^2\theta - 2\pi a^2 - 2\pi\theta^2}{\pi} \right].$$

We shall not further consider the case of θ less than a.

In the expression (4a) the quantity in brackets may be represented Θ_D, and the values of Θ_D have been worked out for various values θ from 0 to $\pi/2$.

Fig. 9 shows a curve connecting Θ_D and θ, but this curve is, of nurse, only applicable for values of θ between a and $\pi - a$.

For the last case (case 5) to be considered we may deduce the following by considering this as a special form of case 1 :—

The effective E.M.F. induced in the rotor winding due to an alternating current in that winding is

$$= \frac{4{\cdot}44\,\nu\,\bar{B}_{max} l w_2 r^2 \pi^2 10^{-8}}{3P p_{2r}} . \quad . \quad . \quad . \quad . \quad . \quad . \quad ; \quad (5)$$

or, dividing by $4{\cdot}44\,\nu\,10^{-8}$, we get :—

The maximum flux linkages of the rotor winding due to an alternating current in that winding is

$$L''_s = \frac{1}{3P p_{2r}} \bar{B}_{max} l w_2 r^2 \pi^2 . \quad . \quad . \quad . \quad . \quad . \quad ; \quad (5a)$$

The foregoing results will now be utilised in the development of the theory of the repulsion motor.

(To be continued.)

EXPERIMENTS ON SPARK GAPS WITH ALTERNATING CURRENT.*

BY DR. W. WEICKER.

Summary.—The author examines the methods of measuring alternate-current voltages by means of spark-gaps, and shows the various influences that require to be taken into account for purposes of correction. He defines the "initial voltage" and the "limiting voltage of brush discharge," and shows how these are affected by the nature of the electrodes, by the length of the spark-gap, by moisture, atmospheric pressure, ultra-violet light and other disturbing influences.

Discharges at high voltages have been frequently studied and described, but the measurements mostly have reference to tests carried out with influence machines and induction coils over short sparking distances. Very little has been published of a precise nature, referring to sparks produced by ordinary alternating current, and the author, therefore, thinks that the following tests, carried out by him in the laboratory of the porcelain factory at Hermsdorf may be of interest. The apparatus included an alternator with an output of 10 kw., and a transformer giving 20 kw., and a voltage of 200,000, the frequency being 52. The voltage given by the transformer was always regulated by adjusting the excitation of the alternator. But spark phenomena depend not on the effective voltage, but on the maximum value, and an accurate knowledge of the wave-form was therefore necessary. This was obtained by an oscillograph of the Siemens-Blondel type, and it was discovered that the wave-form depended on the experimental arrangements, such, for instance, as the length of the conductors joined to the transformer. This made it necessary to determine the wave-form separately for each experiment. In determining the spark voltage it was found—as, indeed, Toepler had already found—that it was very important to distinguish between the different forms of discharge, and that this distinction helps to clear up many points which would otherwise seem of a puzzling nature.

If with two given electrodes the spark voltage is plotted as a function of the distance between the electrodes, it is not usual to obtain any steady curve. It is found that sparks tend to appear when one form of discharge passes into another. For purposes of definition, it is necessary to note the following: The "initial voltage" is defined as that at which the first faintly visible glow appears; the "limiting voltage of glow discharge" is that at which the glow gives place to the brush discharge; and the "limiting voltage of brush discharge" is that at which the brush passes into the arc. With ordinary alternating current it is generally sufficient to distinguish between the "initial voltage" and the "limiting voltage of brush discharge." In Fig. 1 are given curves showing results obtained with pointed and spherical electrodes; but it must be understood that the conditions under which these curves were taken were merely accidental—that is, they correspond to certain chance conditions of the atmosphere at the moment of test; and it will be shown later that the atmospheric conditions are a very important element in the calculation. On the other hand, the results shown in Fig. 2 are those corresponding to certain stated conditions—viz., a temperature of 20°C., a barometric pressure of 740 mm. of mercury, the presence of 50 per cent. of relative moisture, and an exact sine wave voltage.

With pointed electrodes it is specially important to distinguish between the different forms of discharge. If the spark-gap is very small, the "initial voltage" may be the same as the "spark voltage," but not otherwise. The shape of the extreme tip is of the greatest importance, and the slightest injury to the tip affects results enormously. A blunted tip requires a much increased voltage to jump

* Abstract of an article in the "Elektrotechnische Zeitschrift."

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the gap. With increased gap, the glow discharge begins, and passes at once with an increase of voltage into a spark discharge. With very sharp and very blunt tips, the spark voltages are apt to be irregular. With a further increase of gap, the glow is succeeded by the brush and then this passes into the spark discharge. But here again the shape of the tip is very important. With very sharp tips with a taper of less than 7 deg. there is often no brush discharge with long spark-gaps, the sparks immediately succeeding the glow; with a taper up to 15 deg. a partial brush discharge may accompany the sparks; with a taper of more than 20 deg. a well-defined brush appears preceding the spark discharge which now takes place at a constant voltage over a constant gap—*i.e.* the voltage is independent of any further increase of the taper, until we come to quite blunt conical tips, with angles of more than 100 deg. If, for a constant gap, the spark voltage is plotted as a function of the taper, it is found that very high voltage values correspond to very sharp tips; but the voltage quickly falls to a constant normal value for increased tapers, until with very blunt tips it begins to rise again slightly. As may be imagined, sewing needles, which are often used for this class of work, proved almost useless on account of the sharpness of their tips. For purposes of measurement with pointed electrodes, the "limiting voltage of the brush discharge," which is almost independent of the shape of the tip, is the main feature, and involves voltages above about 60 kv. or 70 kv.; and for this it is best to use tapers of not less than 20 deg., the extreme tip being preferably filed off.

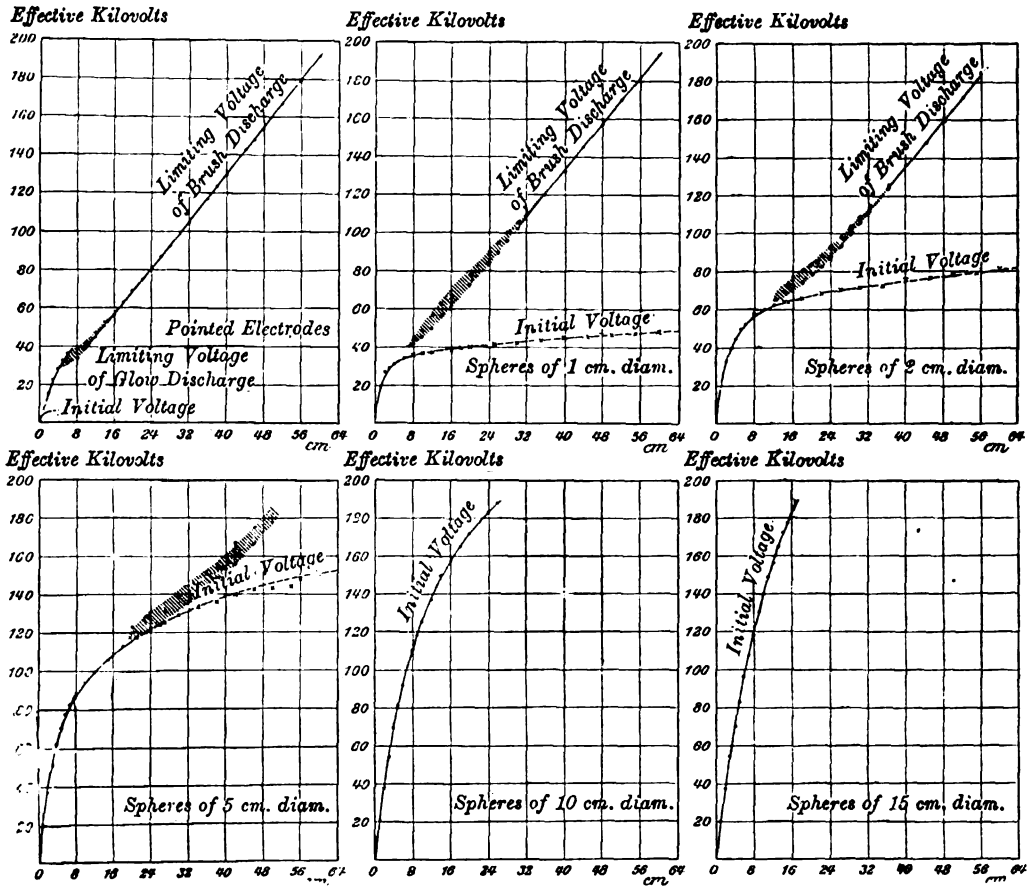

FIG. 1.—SHOWING THE RELATION BETWEEN VOLTAGE AND SPARK-GAP WITH ELECTRODES OF DIFFERENT TYPES.

The effects of the atmosphere on these phenomenon must next be examined, and here again it is necessary to distinguish carefully between the "initial voltage" at which the first faint glow is observed and the "limiting voltage of brush discharge." Considering the "initial voltage" first, the effect of moisture in the atmosphere was first examined, the barometric pressure and the temperature being kept as nearly constant as possible. An artificial state of dampness was produced by gradually passing steam into the room; but there was found to be no relation between the amount of moisture and the initial voltage. Results obtained with short spark-gaps by other observers show that the "initial voltage" is proportional to the density of the atmosphere; therefore, if the barometric pressure is constant, the "initial voltage" would be inversely proportional to the absolute temperature. This was proved to be the case by experiments on spherical electrodes ranging from 2 cm. to 10 cm. in diameter, with spark-gaps up to 50 cm. The range of temperature at Hermsdorf, where the tests were carried out in the open, is very great, and as the experiments extended over several years, temperatures reaching from 33°C. to 23°C. below zero were recorded. It has also long been known that for low voltage values there is a direct proportion between the "initial voltage" and the barometric pressure. The correction for errors of this kind is, therefore, easily made. The author examined the matter from the point of view of higher pressures. One test was with spherical electrodes of 10 cm. diameter and with a spark-gap of 10 cm., the pressure rising to 127 effective kilovolts, and another was with spheres of 2 cm. diameter and a spark-gap of 35 cm.; the results confirmed the law as stated above. It may be stated in passing that the formula, due to Toepler, connecting the sparking voltage for spherical electrodes with barometric pressure and temperature, gives results agreeing very closely with those obtained by the author. Toepler's formula was only intended to apply to pressures up to 60,000 effective volts; but it now seems to apply for much higher pressures up to 200,000 effective volts and for spark-gaps up to 60 cm.

The next point to examine is with regard to the "limiting voltage of brush discharge," and the effects produced by the atmosphere. This case is much more complicated, seeing that the amount of moisture in the air affects matters as well as the barometric pressure. Pressure, temperature and moisture are the three independent variables, and their effects have now to be considered. As has been already shown, there exists a linear relation between the length of the spark-gap and the "limiting voltage of the brush discharge." Such deviations from this law as could be detected were due to unavoidable experimental errors. For instance, on different occasions curves were constructed showing the relation between spark-gap and the limiting voltage of brush discharge; these curves were in all cases straight lines, but their inclinations to the axes of co-ordinates were different, owing to the different atmospheric conditions on the days of test. Still, these straight lines appeared to intersect at a point corresponding to a spark-gap of 6 cm. This seems to show that 6 cm. is in this particular case that gap for which temperature and moisture produce no effect; and probably it is correct to suppose that this is the smallest gap over which a brush discharge is possible. The influence of moisture and temperature is mostly seen in the retarding effect which is exerted on the growth of the brush discharge, and they do not appear to exert any influence on the discharge of sparks from the body of the electrode. In a darkened room it is clearly seen how an increase of moisture hinders the growth of the brush discharge; and if the atmosphere is saturated with moisture there is scarcely any sign of a brush discharge before the spark appears. The following equation expresses the general conditions for the brush discharge—viz.,

$$P = c_1 + (F - 6)kZ(q, t),$$

where P is the voltage, F is the length of the gap in centimetres, c_1 and k are constants, and $Z(q, t)$ is a function, at present unknown, of the absolute moisture q (expressed in grammes per cubic centimetre), and the temperature t.

The influence of moisture was next tested over a constant spark-gap between pointed electrodes and also between two small spherical electrodes. If the "limiting voltage of the brush discharge" is plotted as a function of the relative moisture, a curve is obtained which is to all intents and purposes a straight line, if the values below 40 per cent. relative moisture are neglected. The function $Z(q, t)$ between the limits of 40 and 100 per cent. relative moisture is therefore, capable of being written in the form

$$Z(q, t) = c_2 + a.\, q,$$

where c_2 is a constant depending on the temperature, q is the absolute moisture expressed in grammes per cubic centimetre, and a is the increase in the voltage for a moisture of 1 gramme per cubic centi-

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metre over a spark-gap of a length of 1 cm. The spark voltage in this case, therefore, is given by the following equation—viz.,

$$P = c_1 + (F-6) \cdot (c_2 + a.\ q).$$

For an exact determination of a, tests were carried out over all sorts of lengths of spark-gaps, and the average value was found to be 0·059, or, roughly speaking, 0·06 for voltages following a sine wave and for a temperature of 20°C. For lower temperatures the value of a increases slightly, and for a temperature of 6°C. amounts to 0·07. From other readings the value of c_1 was found to be 30 kv. (effective), and with a temperature of 20 deg. the value of c_2 was found to be 2·8. The above equation can, therefore, be written in the following form

$$P = 30 + (F-6) \cdot (2{\cdot}8 + 0{\cdot}06q) \text{ effective kilovolts.}$$

The influence of the temperature on the limiting voltage of the brush discharge is very difficult to ascertain, because a change of temperature affects generally the absolute as well as the relative moisture. The best results were obtained in the open air on bright days, and experiments were made at different times of the year over constant spark-gaps and with constant barometric pressure. The result seemed to be that the spark voltage decreased rather more rapidly than it would if it followed the law of inverse proportion to the absolute temperature. The effect of barometric pressure was also deduced from a large number of experiments, and the "limiting voltage of the brush discharge" seems to increase more rapidly than the density of the atmosphere, and this increase seems to be independent of the length of the spark-gap. Roughly speaking, it may be said that an increase of 10 mm. in the height of the mercury column raises the voltage by about 2·4 per cent. Still, at a given spot, the variations of barometric pressure are not great, and it is not certain that it is possible to draw any general conclusion from results obtained n this way.

The frequency was changed from 15 to 75, but these changes appeared to be without effect on the maximum values, as opposed to the effective values of the spark voltage. The effective values did, indeed, vary somewhat, but this was due to the reaction of the magnetising current of the transformer on the field of the generator,

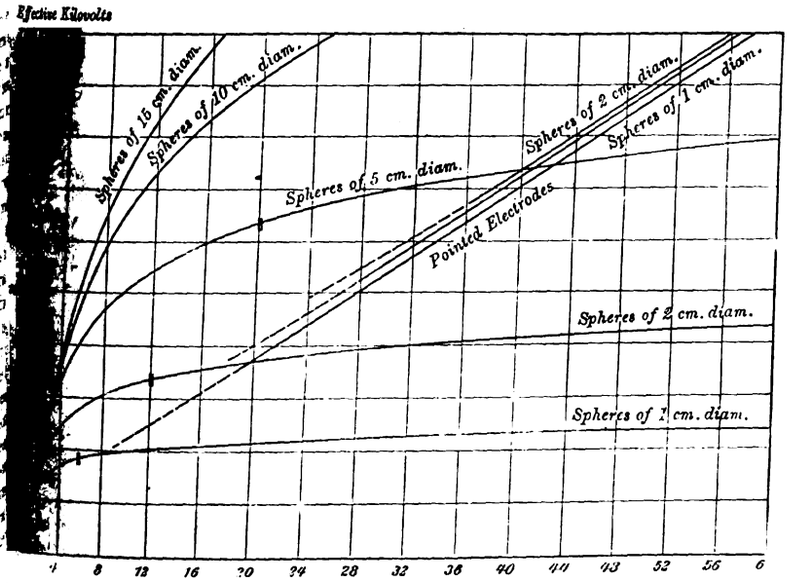

FIG. 2.—SHOWING THE "INITIAL VOLTAGE" AND THE "LIMITING VOLTAGE OF BRUSH DISCHARGE" BETWEEN SIMILAR ELECTRODES OF DIFFERENT KINDS.

These curves hold for a barometric height of 740 mm. of mercury, a temperature of 20° C., and a relative midity of 50 per cent., the voltage-waves being exactly sine-shaped. The short vertical double lines give the ite up to which the "Initial Voltage" coincides with the sparking-voltage.

whereby a considerable distortion of the wave-form was produced, esulting in a difference in the amplitude factor. The capacity of he electrodes appears also to have no effect, apart perhaps from a light displacement in what may be called the neutral territory that es between the various forms of discharge, and forms a kind of ransition area in which the one passes into the other. Various bservers have noted the effect of ultra-violet light, and the author, herefore, examined the results produced by a couple of arc lamps. t was found that the radiation from the lamp had a marked effect n the "initial voltage," which was lowered by amounts up to 4 per ent.; but no effect was produced on the "limiting voltage of brush scharge," probably because ionisation was already present as a sult of the brush discharge itself.

A source of error that is frequently fogotten lies in the effects oduced by the connecting wires or by the presence of large earthed odies. The effect is specially noticed in the "initial voltage," whereas so long as the brush discharge itself is not affected the "limiting voltage of brush discharge" appears to be unaffected. In a certain case, which may be taken as typical, the gradual shifting of the position of some connecting wires had the effect of raising the "initial voltage" from 68 kv. to 87 kv. For purposes of measurement, the "initial voltage" may be taken between two fairly large spherical electrodes, the mean of several readings being taken with a view to excluding any chance effects due to irregularity in the surface; and it is well to see that the electrical field is so arranged as to be likely to be as free as possible from reactive disturbances. These disadvantages are not so marked in the case of pointed electrodes; but, on the other hand, in this case, the more pronounced effects of temperature, pressure and moisture are counterbalancing considerations.

In conclusion, it may be pointed out that if attention is directed to the various corrections necessary for reducing the readings to a pre-arranged system of standard conditions, it is possible to obtain wonderfully consistent results.

The original article contains a number of curves and figures relating to the various tests which have had to be omitted from the present abstract owing to considerations of space.

ECONOMICAL AND RELIABLE POWER GENERATION BY OVERTYPE SUPERHEATED STEAM ENGINES.*

BY W. J. MARSHALL.

Summary.—The author considers that the type of steam plant in which the engine is mounted on the boiler can compete as regards low cost of running with the internal-combustion engine. He describes the engine manufactured by Messrs. R. Garrett & Sons, and gives results of tests on actual installations.

On account of the severe competition which they have felt from internal-combustion engines, steam engine builders are now able to produce steam plants having a fuel cost quite on a par with that of internal-combustion plants, and having other advantages which make them preferable to internal-combustion plants where reliability, flexibility and overload capacity are essestial. The author's Paper deals particularly with plants of comparatively small capacity, say, up to 500 B.H.P.

The name "overtype superheated steam engine" does not in itself sufficiently describe the plant, consisting as it does of engine, boiler, superheater, air-pump, condenser, &c.; in fact, all the integral parts which go together to make a complete steam plant. This form of plant is known by various names. In Germany the term "locomobile" has been applied to it, in France it is called "demi-fixé," and in this country it is sometimes known as the "semi-stationary engine." It is a direct development of the well-known semi-portable engine, but the element of portability which seems to be implied in the above names does not mean that it is an engine which is only to be used for temporary purposes, although the great simplicity of the foundation and the arrangements generally of the plant render it an easy matter to move the plant from one position to another should this be desirable at any time.

The overtype superheated steam engine consists of a special tubular boiler, having the superheater placed in the smoke box. The engine is mounted on the boiler, and the air-pump, feed-pump, &c., are attached to the side. The boiler forms the foundation or bed-plate for the engine. The result of this arrangement is that the steam-pipe losses are reduced to a minimum, and the full value of superheated steam can be employed. The cylinders can also be jacketed with high-pressure steam from the boiler without any loss due to drains and steam-traps, as the cylinder casing forms a portion of the steam space of the boiler.

A number of eminent firms are now manufacturing this type of steam plant, but it should be recorded here that the German firm, Messrs. R. Wolf, of Magdeburg, was the first to apply this type of engine to any great extent. Messrs. Richard Garrett & Sons, of Leiston, Suffolk, were the first English firm to take up the manufacture of this type of engine, and they also have made a considerable number of these engines and have had great success with them.

* Abstract of a Paper read before Section G of the British Association at Portsmouth.

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In general principles the Garrett engine follows the lines laid down by our friends in Germany, but in details of construction the Garrett engine follows British practice, and, being more massive in construction, is more easily kept in good order and condition.

Fig. 1 gives the general appearance of the Garrett engine, and indicates clearly how the arrangement is carried out. The boiler is what is sometimes known as a "Cornish multi-tubular boiler," in that it has a single circular furnace and heating surface consisting of smoke tubes, through which the products of combustion pass. This type of boiler gives the large steam and water space of the Cornish boiler, together with the high efficiency of the locomotive-type boiler. A special feature of the boiler, and one which does away with all the disadvantages of a tubular boiler, is that the whole of the furnace and the tube system can be readily withdrawn for cleaning and inspection. The actual time taken to withdraw the tube system and replace it is from 5 to 6 hours.

The saturated steam from the boiler is conducted first to a superheater, which is situated in an extension of the smoke box. The superheater consists of a number of zig-zag coils of solid-drawn steel tubes expanded into cast-steel headers, and the steam in passing through these tubes travels in the opposite direction to the flow of the hot gases past the tubes, thus ensuring that the maximum efficiency of the superheater is obtained. The joints in the pipes connecting the superheater to the boiler and to the engine are situated outside the smoke box, where they can be readily disconnected, and the superheater itself can be completely withdrawn from the chamber in a very easy manner. A notable point of difference between English and German design in respect of the superheater is that, in the former, the coils are more accessible for cleaning, and are placed in such a position that they do not interfere with the free use of a tube brush for cleaning the boiler tubes. In the latter the coils are not so accessible, and the smoke tubes of the boiler cannot be cleaned by a steam jet, which is not sufficient to remove the deposit with many classes of fuel.

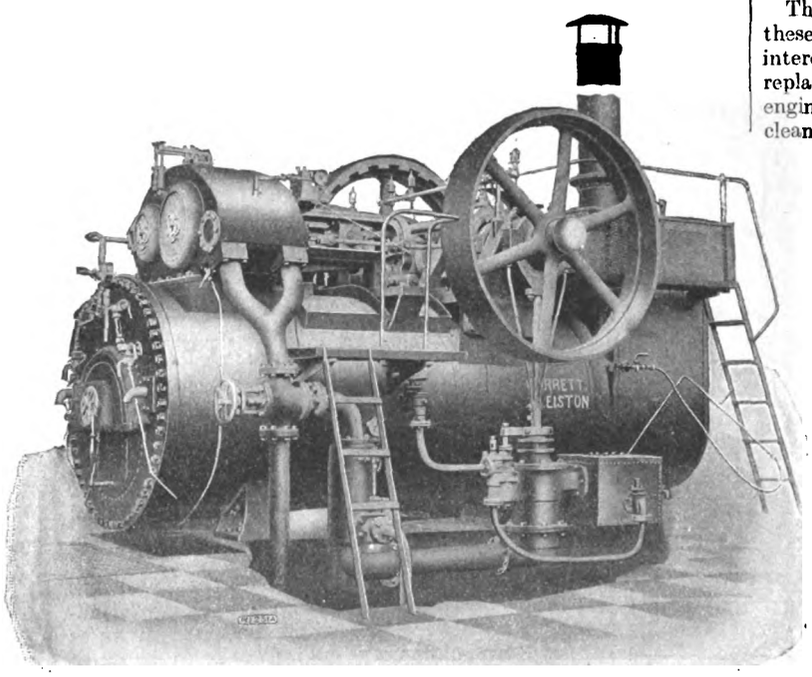

FIG. 1.—GENERAL VIEW OF A GARRETT PLANT.

From the superheater the steam is conducted to the engine, which is a side-by-side compound engine fitted with piston valves to high and low-pressure cylinders. The main crank-shaft journals are of the self-oiling type, and all other points are fitted with sight-feed lubricators. With superheated steam care must be taken that the cylinder lubrication is carried out properly, and to ensure this a positively driven sight-feed lubricator is supplied, which forces the oil both to the high and low-pressure piston valves, and thus the whole of the interior of the engine is efficiently lubricated.

The engine is governed by varying the cut-off in the high-pressure cylinder, a highly sensitive and powerful crank-shaft governor operating upon the high-pressure piston valve. This arrangement gives high economy at light loads, especially as superheated steam is used and initial condensation consequently reduced to a minimum. From the low-pressure cylinder the exhaust steam is led to a jet condenser of a simple and efficient type; where necessary a surface condenser can be employed. The condensed water and steam are drawn away by means of an air-pump driven from crank-shaft of the engine. To the air-pump crosshead is connected the feed-pump, which in Fig. 1 is shown with its suction pipe connected to the hot well, a plan that can be adapted when there is an ample supply of cooling water.

Where a cooling plant is used, it is not advisable to take the feed water from the hot well, as there is a chance of putting large quantities of oil into the boiler, but every engine is fitted with a Wilkinson patent direct-contact internal feed-water heater, so that cold feed can be used without any fear of damage to the boiler, and with the highest efficiency.

It will be seen from this brief description of the Garrett engine that the whole plant is of very straightforward design, and in no way is anything new or untried embodied in this design.

In October, 1909, Capt. H. Riall Sankey carried out a seven-hours' test on a standard Garrett engine of 50 B.H.P. rated output, and in Table I. are given some of the principal figures obtained on this test. It will be agreed that the figure of 1·21 lb. of coal per brake horse-power-hour is really astonishing for an engine of such small size.

It is not necessary to enter into a detailed examination of the reasons why such a high economy is obtained, but put briefly they are as follows: (1) The boiler, superheater, and engine are carefully designed with regard to their proportions to each other for the output required. (2) The steam pipe losses are eliminated. (3) Cylinder condensation is eliminated by the use of superheated steam and by jacketing the cylinders with live steam from the boiler without drainage losses.

The author proceeds to describe an actual installation of one of these engines in a flour mill. This particular installation is of special interest as the overtype superheated steam engine was put in to replace a suction-gas plant. It was found with the suction-gas engine that a great deal of time had to be spent overhauling and cleaning in order to obtain a continuous run, and that even with this attention it occasionally failed during the week's run. It was also found that the speed was liable to vary considerably, and, in spite of a very heavy flywheel, the drive was somewhat irregular.

None of these difficulties are experienced with the superheated steam engine, and since it has been at work it has actually been found that the cost of fuel per sack of flour made is lower than was obtained with the suction-gas engine. This is a very praiseworthy result, especially when it is taken into consideration that the steam engine is at the present time running at only about 0·65 of its full load.

In Table II. are shown actual figures recently taken from a day's run of this mill in ordinary work. These show that the high economy obtained on the test-bed is still maintained under running conditions.

Further figures are given in Table III. for the case of an engine driving a weaving factory.

One of the most important advantages of this type of engine is the readiness with which any type of fuel can be used, and the economy with the other types of fuel is proportionately as good as that obtained with steam coal. Special furnaces have to be supplied for some of these fuels. In one case an engine of this type gave 1 B.H.P.-hour with a consumption of 3·9 lb. of wood refuse, consisting of shavings, chips and saw-dust. Various types of furnaces for special use are illustrated in the Paper.

It has already been mentioned that the superheated steam engine is a successful rival of the internal-combustion engine. The internal-combustion engine has achieved its success by reason of its very low fuel consumption, this fuel consumption being so much lower than that obtained with the ordinary type of separate engine and boiler using saturated steam that manufacturers are prepared to put up with a certain amount of unreliability in order to obtain the economy. This has not always been a wise procedure, as is indicated by the number of factories which have gone back to steam engines after having adopted internal-combustion engines.

Again, the actual cost of fuel in any factory is by no means the most important of the various items which make up the cost of power production, and its relative importance varies according to the type of factory. The author gives the following hypothetical case as a conservative estimate for an average example:—

Assume that a machine shop employing 100 men—whose average wages are 7d. per hour—requires an engine of 100 H.P. to drive it. The total amount of wages per hour comes to £2·9. For management expenses, &c., the usual figure to add is 100 per cent., making the prime cost of running the shop £5·8 per hour. Taking a 54-hour week and 50 weeks per annum, and the following prices per ton of fuel: Steam coal 16s., anthracite 26s., fuel oil 45s., and including the stand-by losses per hour of the overtype superheated steam

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Table I.—*Results obtained by Capt. H. Riall Sankey.*

Duration of trial	7 hours
Revolutions per minute	201·5
Mean temp. of superheated steam	536·5°F.
Average indicated horse-power	58·25 H.P.
Average brake horse-power	55·6 H.P.
Mechanical efficiency	95·5 per cent.
Water evaporated per pound of coal	8·91 lb.
Coal per brake horse-power-hour	1·21 lb.
Water per brake horse-power-hour	10·66 lb.
Calorific value of coal	14,260 B.Th.U. per lb.

Table II.—*Test in a Flour Mill.*

Duration of trial	12 hours
Coal per hour	164·5 lb.
Temperature of steam	540 to 550°F.
Vacuum	24 in. to 24½ in.
Speed	170 revs. per min.
Calorific value of coal	12,404 B.Th.U. per lb.
Moisture in coal	10·29 per cent.
Mean indicated horse-power	115·8 H.P.
Mean B.H.P. at 92 per cent. efficiency	106·5 H.P.
Coal per indicated horse-power-hour	1·42 lb.
Coal per brake horse-power-hour	1·55 lb.
Corresponding consumption per B.H.P.-hour of dry coal of 14,000 B.Th.U.s per lb. value	1·24

Table III.—*Week's Test in a Weaving Factory.*

Duration of test	Running time	49 hours
	Standing time	119 hours
Coal used while running*		3,420 lb.
Coal used while standing		1,175 lb.
Power developed, calculated from the number of machines in use		45 to 50 B.H.P.
Coal per brake horse-power-hour running		1·55 lb. to 1·4 lb.
Coal per hour standing		10 lb.
Calorific value of coal		About 13,500 B.Th.U. per pound

engine plant at 10 per cent. of the total coal burnt per hour at full load, and those of the suction-gas plant at 5 per cent. of the same quantity, the Diesel engine having no stand-by losses whatever, the following is the cost of fuel for each type of engine :—

——	Steam.	Suction-gas.	Diesel.
Consumption per B.H.P.-hour ... lbs.	1·5	1	0·5
Consumption per week ..... lbs.	8,100	5,400	2,700
Stand-by consumption per week lbs.	1,710	570	nil
Total consumption per week ... lbs.	9,810	5,970	2,700
Cost per week	£3·5	£3·46	£2·7
Cost per annum	£175	£173	£135

This comparative statement shows that under the above conditions the plant having the lowest fuel cost is the Diesel engine, which shows a saving of £40 per annum over the superheated steam engine, but it should also be noted that if—through bad starts or involuntary stops—the power supply be interrupted to the extent of 10 hours per annum, the prime cost of such stoppages would amount to £58, absolutely wiping out any gain due to lower fuel consumption.

If we carried this comparison still further, it would be found that the capital cost of the Diesel engine would be considerably higher than that of the superheated steam engine, and, consequently, the capital charges per annum would be greater. These form a very considerable item in the cost of power. Further, the steam engine can be run satisfactorily by a man of a lower order of skill than that required by Diesel or suction-gas engines, and his wages would consequently be less.

In addition, the wages required for maintenance would be less, as the parts requiring attention about a steam engine can be attended to by an ordinary driver, whereas with the internal-combustion engines expert mechanics are necessary to effect adjustments and repairs. In the above comparison the load has been taken at an average of 100 B.H.P. This average might be that of a very fluctuating load, which might range between 60 and 150 B.H.P.

The greater the difference between the peaks and hollows of the load curve the more striking is the advantage of the steam engine, on account of the fact that the internal-combustion engine has a very definite limit as to the maximum load which it is capable of dealing with, and, consequently, engines sufficiently large to deal with the peak loads must be installed, increasing the capital cost and, in the case of the suction-gas engine, giving very poor results as regards economy on the lighter loads.

On the other hand, the steam engine is capable of producing, when required, as much as 50 per cent. above its normal load for considerable periods, and, owing to its high mechanical efficiency, maintains a low consumption per brake horse-power over a wide range of loads. Fig. 2 illustrates this feature of the superheated steam engine in comparison with the suction-gas engine very clearly.

From these curves it is clearly shown that the cost of fuel per brake horse-power per hour with the superheated steam engine is very nearly constant over a wide range of loads, and does not increase on light loads to anything like the same extent as with the suction-gas engine. A further advantage of the steam engine is that the exhaust can very readily be used for heating purposes when required. In the weaving factory previously referred to, the exhaust steam, on its way to the condenser, is conducted round 600 ft. of the heating pipe during the winter months, and is sufficient to keep a room 300 ft. long by 75 ft. wide at the proper temperature. This heat is obtained at no cost.

The author feels that he has merely touched on the fringe of a very large subject, but is confident that the few facts he has brought forward show that, as a prime mover, the steam engine is still more than able to hold its own. Every case must be considered on its merits, and there are admittedly propositions which are very admirably filled by internal-combustion engines. He is, however, of opinion

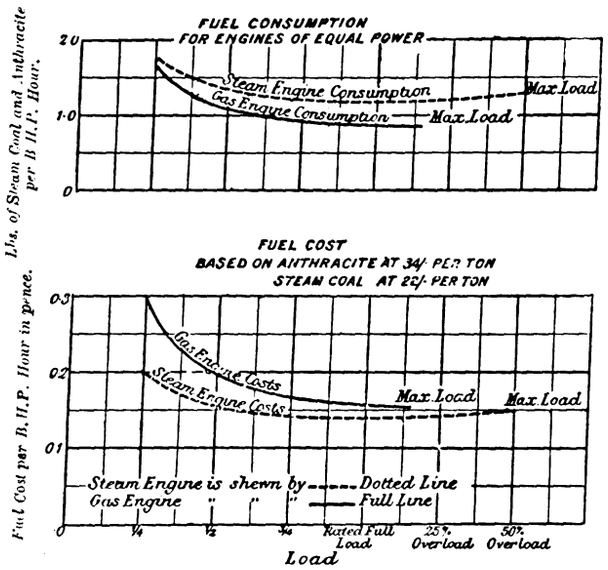

FIG. 2.—DIAGRAM OF COMPARATIVE FUEL CONSUMPTION AND FUEL COST OF SUPERHEATED STEAM ENGINES AND SUCTION GAS ENGINES.

that the use of the internal-combustion engine has latterly become somewhat of a fashion, and is certain that when the overtype superheated steam engine is more widely known it will take the place of the internal-combustion engine in a great number of power propositions.

THE FONTANA MAST.

The following particulars, which have been supplied by the inventor, Herr A. Siewert, and the manufacturers, of an extensible metallic mast that is being tried in Germany and possesses some novel features, should prove of interest. The apparatus is called the Fontana mast, and it was designed to provide a metallic mast which can be quickly raised or lowered, but without the disadvantages of a telescopic mast. This latter has not come into very extensive use for several reasons, the main one being that since the tubes must fit into each other very closely, their erection is likely to be hampered by sand or ice, or in other cases by the rusting of the metal. In addition, where a telescopic mast has to carry a load it is difficult in practice to erect it without using complicated mechanical apparatus at the base of the mast; this makes it expensive and limits its applications.

The Fontana mast is of interest owing to the new principle involved, and it is claimed that the design overcomes most of the drawbacks which up to the present time have limited the applications of such masts in electric work. Its construction is most simple, as will be noticed from the illustrations herewith. Considering, for the moment, a four-sided hollow mast, this is formed of four flexible steel strips (*see* Fig. 1). The edges of these strips have teeth cut in them in such a way that the teeth of one strip interlock with the recesses of the adjoining one, so as to join the four strips at their edges. The teeth project to some extent. This makes up a hollow column, and

* For 10-12 hours the engine was run non-condensing, thus affecting the result of the test.

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it remains to brace it. For this purpose thin sheet steel brace plates are placed at frequent intervals.

The mechanism for raising or expanding a mast of this kind is seen in Fig. 2, illustrating a four-sided section. The steel strips are wound upon the drums AA, and on two corresponding drums placed in the front and rear. A second set of drums B is mounted below to feed

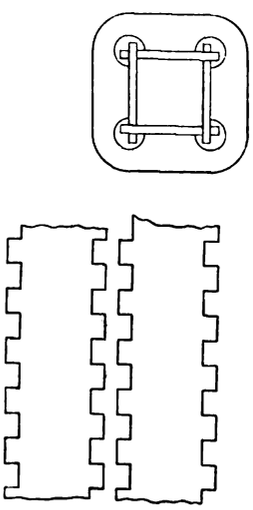

Fig. 1.—Toothed Strip and Brace Plates.

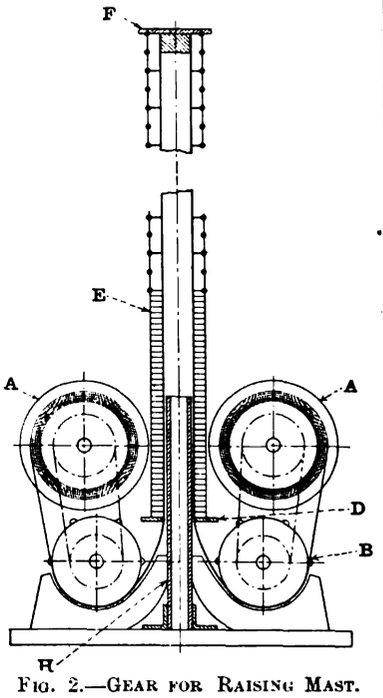

Fig. 2.—Gear for Raising Mast.

out the strip and guide it properly. These latter drums have projecting teeth around the centre which engage in holes in the steel band. A chain drive connects both drums, and the lower or feeding rollers are driven by a hand crank or in other cases by an electric motor.

As the four steel bands pass up through the guide plate D they become interlocked and form the steel tube. Upon the guide plate

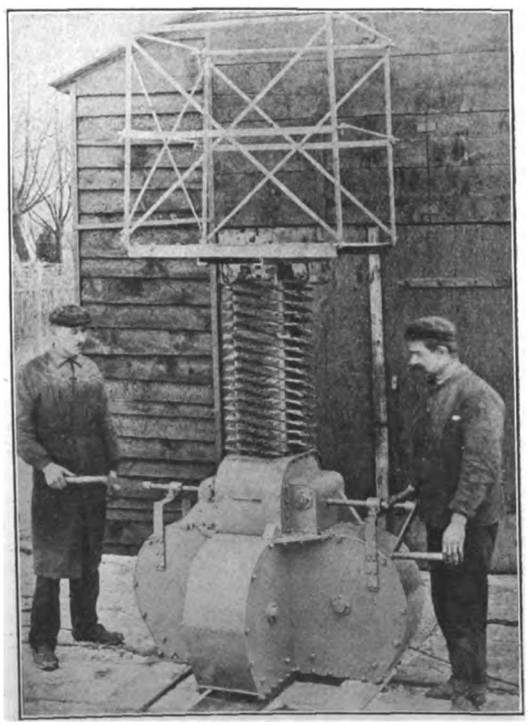

Fig. 3.—View of Mast when Nearly Lowered.

is a pile of section discs E. The top head of the mast F carries the first of a set of links which go to join all the section plates. When the head F rises in the first place, it picks up the first section disc by means of the first four links placed on the four sides, so that the disc is automatically fitted around the column. As the mast continues to rise, the second disc is taken along in the same way; the result is that the section discs are situated all along the mast, their spacing depending on the length of the link which is determined according to circumstances. A light portable mast, such as is used for wireless telegraphy, can be raised to 20 metres height using a base about 1 metre square. When lowered, the height of the apparatus is only 1·7 metres and it weighs 175 kgm. The bending stresses are taken up by a short column, H, which projects up the centre and transmits the stresses to the base. Means are provided for clamping the base of the mast tightly against the bottom column.

A crank attached directly to one of the drums B, or by gearing, can be used for raising and lowering the mast (Fig. 3) and the remainder of the drums do not need gear drive, as the rest of the strips are drawn along by means of the interlocking teeth. It is evident that sections varying from three sides to eight sides can be employed, but in practice the square or hexagonal forms are found to be best; the eight-sided form is more complicated and not much more useful. The mast is strongly braced by the section discs; these are calculated so that the mast can stand a given maximum load without the steel strips bending. The length of the teeth which engage with one another must be such that the strips are prevented from bending inwards. For stamping the strips and obtaining the spacing of

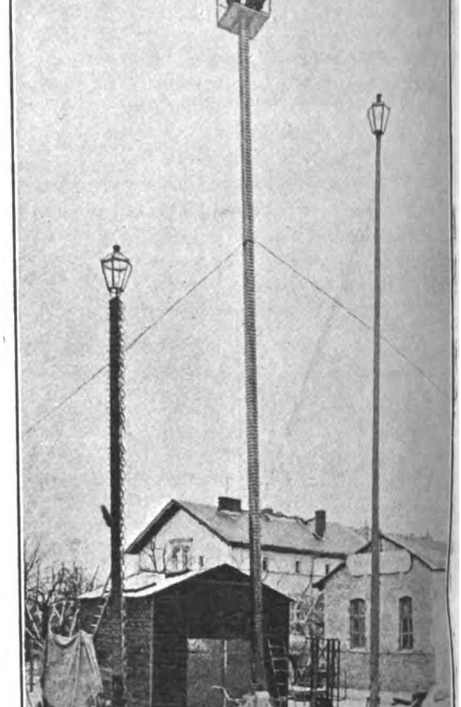

Fig. 4.—View of Mast in Use.

the discs a set of curves are used, based on a load of 2,500 kg. per square cm., assuming a certain thickness of strip and a certain factor of safety.

The strips employed are made of tempered crucible steel or of Swedish steel of great tensile strength. For the lighter masts the thickness of metal should be at least 1·5 mm., and for heavier masts this is increased to suit the case. The Fontana masts, of which one is shown erected in Fig. 4, are made in sizes to reach a height of 80 ft. and can carry a load of 2 tons. The manufacturers are the Fontana Maste und Träger Gesellschaft, Bernburgerstrasse 24-25, Berlin.

Electricity in Textile Mills.—The "Electrical World" in commenting on the recent appointment of a Committee in this country to investigate the application of electricity in textile mills, says: "Apparently knowledge of the great progress in this country in the utilisation of the electric drive in such mills, which dates from about 1894, has not penetrated to the British Isles."

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THE POSSIBILITY OF ESTABLISHING A NEW STANDARD OF SMOKE EMISSION FOR FACTORY CHIMNEYS.*

BY DR. J. S. OWENS.

I do not think that anyone will contradict me when I say that the emission of dense smoke from furnaces consuming bituminous coal is unnecessary and indicative of waste of fuel and bad furnace construction or working. At the same time, it should be remembered that the total absence of all smoke is in practice usually impossible of attainment when the economy of manufacturing processes requires the burning of bituminous coal. An illustration of the difficulty of avoiding all smoke is provided by the large electric generating stations, where unforeseen variations of load occur, such as the increase due to a London fog, with its accompanying demand for artificial light. Even in steady working it is practically impossible to avoid all smoke; a faint brown smoke is regarded as indicating more efficient working of boiler furnaces than none at all.

The present position therefore is this: we know that dense smoke is unnecessary, and that entire absence of smoke is impossible of attainment, but we have not yet settled what, being fair and reasonable, should be permissible in the way of smoke, having regard to the improved methods of combustion which are now at the disposal of manufacturers. This is the question an answer to which is, I submit, within our reach and should be sought for.

The Public Health Act of 1875 supplies the present standard by which smoke is judged throughout the country, except in the case of a few important cities possessing special powers on the subject. In this Act it is stated that "Any chimney not being the chimney of a private dwelling-house sending forth black smoke in such quantity as to be a nuisance shall be deemed to be a nuisance liable to be dealt with summarily under the Act."

The standard "black smoke in such quantity as to be a nuisance" takes cognisance of two separate things in relation to smoke: its quality—that is, it must be black; and its amount—that is, enough to cause a nuisance; but, while these two essentials are taken into account, it is done in such a way that it would be practically impossible to prove in any particular case either that the smoke was black or that it was in sufficient quantities to be a nuisance. The point I wish to make is that the two essentials, kind and quantity, form part of the standard.

What is wanted is a standard of efficiency of combustion from the smoke prevention point of view. This must clearly take into account the amount of fuel burnt, and—if we could measure it—the proportion of the fuel passing out of the chimney as soot would be the ideal standard. I suggest that the word "black" in the present standard should be altered to "smoke of a density exceeding" some fixed standard. The standard should, however, also include a time of emission, and the form suggested is "smoke which exceeds a certain density (as measured in a way to be determined), and which is emitted for a period exceeding so many minutes per hour."

As to how the smoke is to be measured, we may set ourselves to measure any one of the following: (1) Total quantity of soot emitted in a given time; (2) weight of soot emitted as percentage of fuel burnt; (3) density of smoke or weight of soot per unit volume of flue gases; (4) ratio of density to a standard; (5) colour; (6) opacity, or degree of blackness. In addition to deciding which of these objects to aim at, we must keep in view that whatever method is used must give reasonable accuracy and a fair basis of comparison between chimney and chimney, or with a standard; it must also be easily applied from outside the factory by a single observer.

Of these methods (1) measures the amount of pollution by a particular chimney, but takes no account of the amount of fuel burnt; and it would be unfair to limit a large fuel consumer to the same total quantity of soot as a small one. (2) is open to the same objections as (1), but it implies at least the measurement of density of smoke, volume of flue gases, and weight of fuel. It would be a fair basis for a standard, but is quite impracticable as a method for the use of sanitary inspectors.

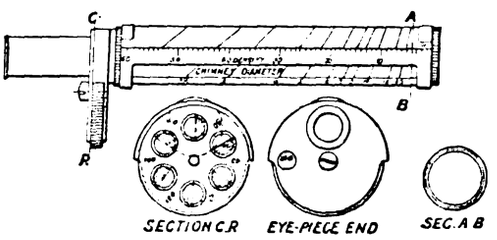
A quantitative measure of the density of the smoke might be obtained by the filtration method, in which the soot from a known volume of smoke is trapped and weighed, but it would be too cumbrous for general use. Density can also be measured optically, in which case access to the chimney or factory would be unnecessary. It would give a fair measure of efficiency of the plant, and a good basis of comparison whatever the quantity of fuel burnt or diameter of the chimney.

The measurement of the colour of smoke may be dismissed as useless, since colour bears no relation to quantity of soot emitted or evil done by the smoke.

To measure the opacity of a smoke column or its degree of blackness, which is the commonly-accepted method now adopted, is worse than useless, since it is misleading, because opacity alone, unless adjusted for thickness of column, is neither a measure of the density of smoke nor of the amount of pollution of the air.

We are thus reduced to a measurement of smoke density as the only satisfactory basis to work on. Suppose we can measure the weight of soot in a column of smoke 1 sq. ft. in section, and the same length as the diameter of the chimney. Let S = weight of soot in such a column, V = velocity of flue gases in feet per second, D = diameter of chimney in feet; the weight of soot in 1 cubic ft. of smoke will be = S/D, and the weight emitted per second $\pi D^2VS/4D = \pi DVS/4$, or $DVS \times a$ constant; that is, it varies as the volume of flue gases × the weight of soot per cubic foot. The amount of soot emitted will therefore vary directly as the volume of flue gases, assuming the density to remain constant. Or if we measure only S, the amount of soot emitted will vary as S × VD. If we assume V to be a constant value, the weight of soot emitted will vary as S × D, and the density of the smoke as S ÷ D. This shows that the measurement of S alone is of little use unless an adjustment is made for D, and it must be noted that all smoke charts now in use measure something which depends on S alone, but neglect D. It also points to the conclusion that with an adjustment for D, the measurement of S can be made to give a fair approximation to the relative weight of soot emitted or to the density of the smoke.

We can measure S indirectly on the basis of the light obstructed. For example, we may compare the degree of opacity of the smoke with a smoked glass which obstructs as much light as a smoke column of known density and thickness. Suppose, then, we take such a glass of an opacity equal to that of a column of smoke of unit thickness and standard density, we might prepare an instrument having several shades of such glass, the lightest being the standard for the smallest chimney, followed by other shades made by superimposing various thicknesses of shade 1, corresponding to various thicknesses of smoke



column or chimney diameter. We could then, by comparing the smoke at the top of a chimney with such a set, say whether or to what extent the standard was being exceeded.

The accompanying drawing illustrates an instrument which I have designed to meet the requirements laid down in this Paper. This is in the form of a small telescope, having fixed in the optical system, at a point which may be brought into the focus of both object-glass and eye-piece, a revolving eccentric disc containing a number of graduated smoked glasses arranged in cells round the centre. The glasses only fill half of each cell so that by revolving the disc, as each cell with its glass is brought successively into the axis of the telescope, the smoke may be viewed through the open half of the cell and matched to the glass in the other half. The glasses are numbered in the ratio of their thickness, and a table is provided giving the number of the glass divided by the diameter of the chimney, and thus a figure which is a measure of the density of the smoke and can be made to read the actual weight per cubic foot of soot in the smoke if desired. This necessitates the inspector knowing the chimney diameters in his district; but these may be tabulated once for all. I have found when, in instruments for smoke measurement, the smoke is viewed through a small aperture, as is essential in order not to take in too much background, that it is impossible to get true results owing to the eye being unable to focus at the same time the object aperture and the object; so that the edges of the aperture are hazy and ill-defined. This results in the whole aperture, when small, being overlaid by a hazy film, due to its ill-defined edges, which film prevents accurate readings of the smoke shade. The same applies to the aperture containing smoked glasses for comparison.

There are many difficulties remaining which apply to all optical methods of measuring smoke, but before enumerating these it is well to remind you that we have no other means of attaining our object, since all methods requiring access to a factory or a chimney are useless from the sanitary inspector's point of view. (It is easy to imagine the welcome such an inspector would get on presenting himself at the door of a factory and announcing that he had come to measure the density of the smoke from the chimney.)

*Abstract of a Paper read before Section G of the British Association Portsmouth.

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As to these difficulties, it is well to consider what are the factors which influence the apparent density of smoke, as given by an observation based upon its degree of blackness; these are: (1) The true density of the smoke; (2) diameter of chimney; (3) background of smoke and shade it is compared with; (4) the colour of the smoke particles; (5) the size of the smoke particles; (6) the amount and colour of the light falling on the smoke from the observer's side; (7) the direction of the line of vision; (8) presence or absence of wind; (9) the observer's personal factor.

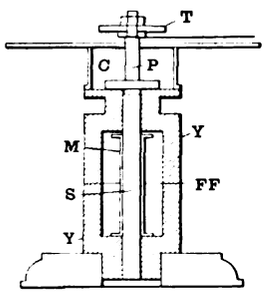
There is not time to discuss each of these in detail, but I may say that (1), (2) and (3) can be dealt with satisfactorily, (4) and (5) are probably sufficiently constant not to affect results seriously, excluding exceptional cases, (6) is the most difficult to deal with, and should be allowed for in making observations, (7) can be overcome, to a great extent, by keeping the angle which the line of vision makes with the horizon fairly constant, (8) would not, as a rule, be a serious obstacle, while (9) is not, I think, of great importance.

Assuming, then, that we have decided on the method of measurement to be adopted, and on the type of standard to be fixed, the question remains, how is the standard to be arrived at? It would seem that this might be done best by the appointment of a technical committee, which would make observations over a certain period, say, a year, of certain selected representative chimneys, where up-to-date and well-designed furnaces are installed, and bituminous coal is burnt. A consideration of the results of such observations, both as to smoke density and time of emission, should enable the committee to fix a fair and reasonable standard, both as to the density of the smoke, and the time during which such density should be permitted.

A FRICTION PERMEAMETER.*

BY W. H. F. MURDOCH, B.SC.

In making measurements with friction permeameters of the types described in a previous paper ("Magnetic Testing of Iron," "Journal" Inst. Elec. Engs., Vol. XL., p. 137) the specimen was allowed to slide a short distance on a yoke or yokes of iron, and the



SECTION SHOWING NEW TYPE OF INSTRUMENT.
(The spring is omitted for clearness.)

friction pull measured. A screw starting device was used to obtain a uniform starting impulse, and the specimen had to be reset at each reading. The heavy yoke made the instrument cumbersome, and the spring when the instrument was used as a direct reading one was attached to the sliding specimen. In addition the ends of the specimen had to be faced, which, of course, was a more or less troublesome matter. The results obtained with this type of instrument although satisfactory for moderate inductions were not so good at high inductions owing to leakage.

The accompanying illustration shows the arrangement now adopted; S is the specimen to be tested, Y the yoke faced at FF, a magnetising coil, M, is placed on the specimen, a dial, D, is attached to R, the top portion of the yoke, together with a spring, C, and a torsion head, T, attached by a collar to the pillar P.

The method of testing is first to adjust the pointer so that when the top portion of the yoke is sliding slowly, under mechanical friction only, the pointer remains at the zero of dial. The specimen is then magnetised and the angle of torsion, when steadily sliding, measured. The square root of this angle is proportional to the induction in the specimen.

It will be seen that in this instrument the same sliding surface is used for all specimens tested, the top portion of the yoke being rotated round the specimen as axis and sliding on the lower portion. The magnetic induction is kept constant during the test and the magnetic circuit remains unbroken, whilst the magnetisation is not reversed. The sliding being a continuous process, a series of readings may be rapidly taken. The specimen being cylindrical enables it to be accurately turned, and the magnetising coil acts symmetrically upon it.

In designing instruments of this tpye the areas of contact between specimen and yoke, and between the sliding surface of the yoke must be large compared with the area of the specimen itself, in order to eliminate errors in H, and the longer the specimen the less will be the effect of gap resistance. Care must also be taken that the stream lines of magnetic induction over the yoke gap are uniformly distributed, otherwise the Law of Traction will not be obeyed.

Friction on the specimen is practically eliminated first by lubrication, and secondly by making the radius of the specimen small, so that the torque due to any stray friction is small compared with the torque on the yoke sliding surface.

As regards the coefficient of friction on the sliding gap surface, since the pressure on this surface is always small the coefficient is kept invariable. Lubrication on this surface must be avoided, and the surface should be cleaned before making a test.

By using a torsion spring arrangement such an instrument may be made direct reading, and in calibrating it with a fluxmeter or ballistic galvanometer, only one point need be determined, so this operation takes but a few minutes. In testing iron the method adopted by the author is to use equal currents for the magnetising solenoid and to observe the angles of torsion for the standard piece and the specimen under test. If the instrument has been calibrated as mentioned above, a standard bar is unnecessary.

There is, however, a difficulty. The readings of the instrument are made while the pointer and dial are in motion, and it might be suggested that here an acceleration error comes in, one person moving the top of the yoke at a different rate from another. Since, however, when a reading is being taken the observer will naturally make the sliding motion as slow as possible, the acceleration error is in consequence practically negligible. For making comparisons the instrument need not be calibrated, and one observer is just as good as another so far as this error is concerned. In the same way different observers may press differently on the torsion head and the same remarks apply in this case also.

The theory of the instrument is briefly as follows:—The work done in turning the top of the yoke through a small angular distance is equal to the frictional force on the sliding gap acting through this distance. This frictional force is due to the mechanical weight acting on the gap together with a magnetic pull. If the mechanical portion of the friction is eliminated by adjusting the pointer to read zero when the specimen is not magnetised then we have only to consider the magnetic pull. When a spring is used the torque is proportional to the angle of torsion, and the frictional torque can be found by simple integration. Hence by equating these quantities we obtain a formula involving the gap induction. Since the same total number of lines pass through the gap, and through the specimen (the magnetic leakage being very small) the magnetic induction B in the specimen might be written:

$$B = k\sqrt{\delta},$$

where k is a constant, and δ is the angle of torsion.

By altering the springs the instrument may be made of considerable range, and the induction in the specimen may be pushed to a high degree without the proportionality of the readings to the true magnetic induction breaking down.

One is frequently asked what is the degree of accuracy obtainable with such instruments. Now, as is obvious, the errors are errors in H, and errors in B. Those in H depend solely on the magnetic circuit equation and may made as small as we please for any given case. The errors in B will depend on the accuracy of the reading of δ. The former errors diminish rapidly as saturation is approached, whereas since the friction pull at saturation is only slowly increasing the error at that point begins to increase.

The following figures are actual results:—

Current.	Fluxmeter reading $\sqrt{\text{Angle.}}$	Remarks.
0·25	1·892	300 turns on bobbin.
0·50	1·835	Length of specimen
0·75	1·915	2 in. Specimen of
1·00	1·909	mild steel.
2·00	1·901	
2·50	1·875	

It is therefore difficult to say what the error is in using an instrument of this type, but with properly adjusted springs measurements to within one to two per cent. seem possible at ordinary inductions.

The rapidity with which comparisons can be made seems to render the instrument suitable for practical workshop tests, more especially as practically no previous experience is necessary.

* Paper read before Section A of the British Association at Portsmouth.

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AN IMPROVED WIRELESS TELEPHONE TRANSMITTER.

BY W. DUBILIER.

Summary.—An account is given of a telephone transmitter in which two diaphragms are used, opposed to one another, and water cooling is adopted. The holder for the carbon granules is in the form of an annular space. It is found that much heavier currents can be used than with the usual type of transmitter.

In wireless telephony quite a lot of trouble has been experienced in attempting to get a transmitter that would withstand the current, ranging from 1 to 6 amperes, and at the same time respond to the variations of speech. In order to overcome this difficulty several attempts have been made to obtain a stronger effect by a number of loose contacts, or several diaphragms, actuated by the same mouthpiece. In all these cases, however, it was found that when the energy is increased, distinctness is sacrificed; that is to say, when we increase the number of diaphragms we decrease the clearness of articulation.

In some cases an attempt was made to remove the resulting heat by surrounding the carbon cup with a water jacket and circulating a stream of water constantly through it. This method was only partially successful, due to the fact that the

FIG. 1.

real point where heat is produced—the point where the carbon button makes contact with the granules—received no cooling effect at all, the jacket only serving to dissipate the exterior heat. Even though the ordinary transmitter could be used, the writers doubt its perfect working owing to its lack of amplitude in vibration. Therefore the ideal transmitter must carry the current without detrimental heating and must respond with a good vibratory effect to the spoken words.

Experiments were made with several different types of transmitters to determine how the results varied with the vibratory effect impressed upon the diaphragm. The first test was made on an ordinary Western Electric transmitter. A simple oscillograph was employed to observe the variations, It was impossible, however, to make a permanent record of the variations owing to the type of oscillograph employed, but Figs. 1 and 2 illustrate the variations and the comparative difference in the transmitters. One voltage was used for all the tests. In order to maintain the same intensity of sound, a phonograph was employed for talking, the record being run over the same portion for each test. A standard Western Electric transmitter was first employed and its change in the current flow, when spoken into, is illustrated in Fig. 1.

The next test was made with a transmitter of the double diaphragm type. This transmitter is a compromise between

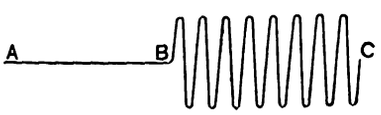

FIG. 2.

the solid-back and series arrangement. In the solid-back type the contacts are usually placed behind the diaphragm, and consequently only the increasing and decreasing of pressure on the front of the diaphragm is utilised.

In the solid back a certain amount of energy is lost, due to the vibrations of the diaphragm and back in synchronism; that is, they both vibrate to and fro in the same direction at the same time. This type, however, when properly constructed overcomes this effect to a certain extent and in actual tests a greater current could be passed through it and a larger variation was caused in the current, as shown in Fig. 2. In action the voice tones divide and act on each diaphragm, thus causing the diaphragms to act simultaneously against and away from each other.

The third test was made with a Western Electric transmitter mounted so that its diaphragm was controlled magnetically instead of by the voice tones direct. The magnets were approximately 5 in. long by 2 in. in width from pole to pole, made of the highest grade hard steel. Additional steel plates were screwed to the magnet poles and bent until they were approximately $\frac{1}{2}$ in. apart. Two-ohm windings were placed on and connected to a local transmitter and battery. The diaphragm of the Western Electric transmitter was now placed so that it held nearly the same relation to the magnet poles that a diaphragm does to the ordinary receiver. A circuit was made from the Western Electric transmitter to the oscillograph and from local transmitters around the two-ohm windings over the magnet poles. When the local transmitter was spoken into and the oscillograph action noted, it was found that the variation was greater than when the same transmitter was acted

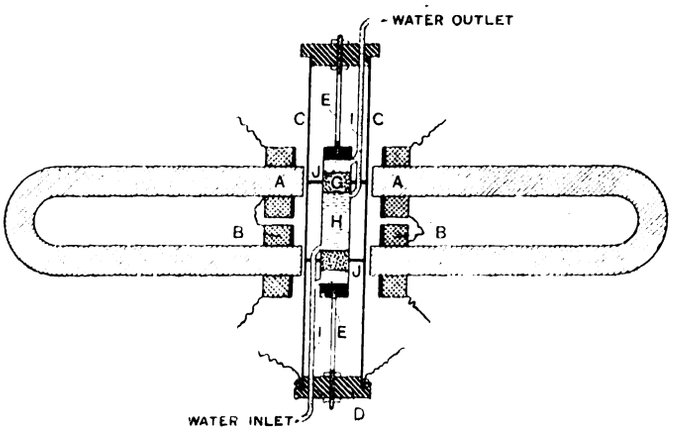

FIG. 3.—SECTION OF TRANSMITTER.

upon direct by the voice but hardly so great as when the double-diaphragm type was used. Therefore it was obvious that if we could apply the magnetic control to the double-diaphragm type the results would be still better.

This was accomplished by building up a transmitter according to the plan shown in Fig. 3. Fig. 4 shows a general view of this instrument. The transmitter complete consists of the magnets A, A, wound with the two-ohm windings B, B, and placed opposite to each other with the diaphragms and carbon containing cup between. The diaphragms are approximately 5 in. in diameter and $\frac{1}{25}$ in. thick. The ebonite disc D is used to mount the diaphragms on and is drilled with large-sized holes so as to prevent "air packing" or talking against one another.

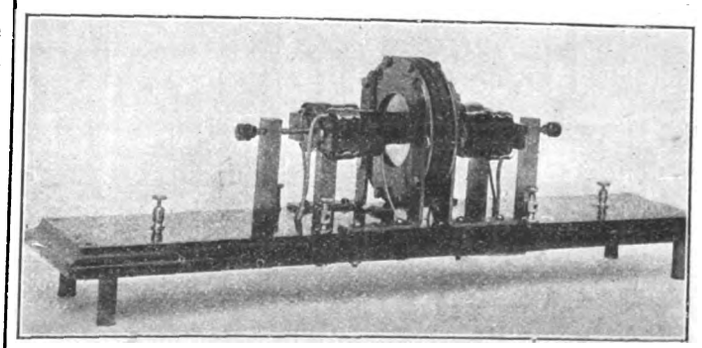

FIG. 4.—GENERAL VIEW OF TRANSMITTER.

A cross-section view of the carbon-containing cup is shown in Fig. 5. It resembles three brass rings placed within one another, forming three independent containing portions. Water circulates through the chambers F and H by means of the inlet and outlet tubes I, and the middle chamber G (Fig. 4) is used to retain the carbon granules. To make contact with the granular mass circular rings of platinum, J, J, are used, which are first soldered to the diaphragms C, C. The platinum rings are drilled with small holes round the entire circumference so as to allow a free circulation of air, and through one of these

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holes the small inlet and outlet tubes are run. The contact is made in the centre of the granular mass. A mica disc is used to retain the granules in the chamber.

It would appear that this method of mounting the contact would decrease the efficiency, but experiments were first made with an ordinary solid-back transmitter made up in this manner, without the water-cooling arrangement, and the results were even better than with the usual transmitter. The advantages of this method of construction is that the contact is made round the interior of the chamber instead of being centred at one point, thus giving more room for the dissipation of heat, and the closed centre prevents packing of the granules. It also allows of cooling means which are impossible with the usual construction method. Pieces, E, E are used to hold the cup in position.

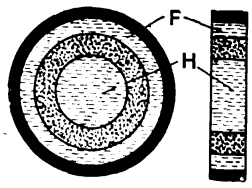

FIG. 5.—CROSS-SECTION OF CARBON-CONTAINING CUP.

A local transmitter is connected in series with a set of dry cells and the windings B. Leads are taken from the diaphragms to the aerial circuit. When the transmitter is spoken into, the current flowing round the windings varies the magnetic pull of the magnets in the usual manner, and the diaphragms, C, C, are set in vibration to the same proportion. The maximum vibration should be figured as the resultant of the two; that is, for the sake of illustration, consider that the maximum vibration of each diaphragm is $\frac{1}{16}$ in., the result would be equivalent to $\frac{1}{8}$ in.; for each diaphragm works oppositely in the same proportion.

The main feature against using this type of transmitter is the difficulty of constructing and adjusting. However, in actual practice it gives the desired results and comes near to being the ideal transmitter for heavy currents.

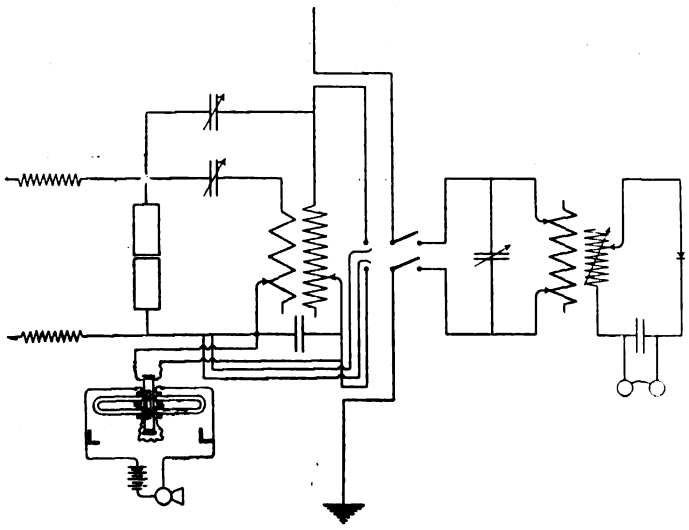

FIG. 6.—WIRING DIAGRAM OF DUBILIER SYSTEM.

The transmitter as shown in Fig. 4 has been tried and can be successfully used as a telephonic relay, and details of these experiments will be given later.

Fig. 6 is a wiring diagram of the Dubilier Wireless Telephone System, showing the method of connecting the transmitter, from which it can easily be seen that wires, L, L, can easily be made the line wires, and so it is possible to have a telephone system consisting partly of wire and partly wireless transmission, and which may make it possible for a regular telephone subscriber to talk to a boat without any further equipment at his home.

ELECTRIC TRANSIENTS.*

BY DR. C. P. STEINMETZ.

Summary.—The author discusses, without the aid of mathematics, the electrical disturbances in high-voltage systems. He obtains two fundamental relations governing such disturbances: one the relation between the maximum current and the maximum voltage of the oscillation, and the other the transformation ratio of the voltages and currents at the transition point between two adjoining circuits.

With the increasing size and importance of electrical systems, those phenomena which temporarily occur in all electrical circuits, such as oscillations, surges, electric impulses and travelling waves, are becoming of increasing frequency and destructiveness, and a knowledge and understanding of their general nature and characteristics, and the cause of their origin, has become important and necessary for the electrical engineer. An attempt is here made to give, without the use of mathematics, a general discussion of these phenomena and their bearing on the operation of electrical systems.

The magnetic field is proportional to the current i, with a proportionality factor which is called the inductance L of the circuit, and thus is Li; the dielectric field is proportional to the voltage e, with a proportionality factor which is called the capacity C of the circuit, and thus is Ce. The energy stored in the magnetic field is $Li^2/2$, and that stored by the dielectric field is $Ce^2/2$.

Two classes of transients exist: single energy transients, in which energy is stored in one form only and the phenomenon is a steady increase or decrease of the stored energy; and double energy (or multiple energy) transients, in which, in addition to an increase or decrease of the stored energy, a transformation of stored energy between its two forms occurs, which usually is periodic.

In electric distribution circuits of 110 to 220 volts, in 600-volt railway circuits, and even in 2,200-volt primary distribution circuits, the dielectric energy is still so very small compared with the magnetic energy that the former can be neglected compared with the latter (except under special conditions, as with lightning discharges, &c). The transients of such circuits thus are single energy transients. The dielectric energy becomes comparable in magnitude with the magnetic energy in transmission lines of 30,000 volts and over, and in underground cables of 10,000 volts and over, and such high voltage circuits then give double energy transients—that is, surges of the stored energy. This is the reason for the appearance in high-voltage circuits of electrical disturbances different from those met in low and medium-voltage circuits.

The single energy transients of electric circuits, which result from the stored magnetic energy, are rarely of serious importance. Magnetic transients, however, become of serious moment when of abnormally great energy—that is, in very extended systems or in highly inductive circuits, as motor fields, and especially when forced to be of very short duration; as in the latter case, even with a moderate amount of energy, the power may be very great, since it is the energy divided by the time in which it is dissipated. The latter is the case with the opening transient of an inductive circuit. To a considerable extent an inductive circuit protects itself against too rapid opening by the arc following the switch blades. The more rapidly the switch opens the greater is the induced voltage, and the further the arc follows and maintains the circuit—that is, limits the rapidity of the circuit opening. The problem of switching inductive circuits thus is to open the circuit sufficiently rapidly to limit the burning of the switch contacts by the arc, but to open sufficiently slowly to limit the induced voltage below the value which would seriously endanger the insulation.

Occasionally magnetic transients are of importance, not directly by their stored energy, but by the power production which they cause. A characteristic instance hereof is found in the momentary short-circuit currents of alternators.

The most important, because most dangerous, electrical transients are the double energy transients of high-voltage circuits. In these circuits the gradual increase of the total stored energy, at a change of circuit conditions, is accompanied by a surge or transformation of the stored energy between the dielectric and magnetic forms. During the periodic transformation between magnetic and dielectric stored energy the magnetic energy is a maximum, $Li_0^2/2$, and therefore the oscillating current i a maximum, i_0, at the moment when all the energy is magnetic—that is, when the dielectric energy is Ce^2 and therefore the oscillating voltage e is zero. Similarly, the dielectric energy is a maximum when $Ce_0^2/2$, when during the periodic transfer of stored energy all the energy has become dielectric—that is, when the magnetic energy, and therefore the oscillating current i, is zero.

It is, however, the same amount of stored energy (neglecting the gradual and slow decrease of energy by power dissipation)

* Abstract of an article in the "Journal" of the Franklin Institute.

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which at one moment appears as magnetic and at the next moment as dielectric energy—that is

$$Li_0^2/2 = Ce_0^2/2.$$

This relation between the maximum value of the oscillating current i_0 and the maximum value of the oscillating voltage e_0 is of the greatest industrial importance. It applies to all double energy transients—that is, surges of stored energy. Transposed, it gives $e_0/i_0 = \sqrt{L/C}$. $\sqrt{L/C}$ is of the nature of an impedance, and is called the natural impedance of the circuit, and may be denoted by z_0. In transmission lines, z_0 is usually between 200 and 600 ohms; it is much lower in cables, due to their high capacity and low inductance, and it is much higher in the windings of high-voltage transformers.

The importance of this relation between the maximum oscillating voltage and the maximum oscillating current is that it allows the calculation of the one from the other. In most cases of electric surges of energy one of the two quantities, the current or the voltage, is known, or can be estimated approximately from the cause of the disturbance; the above relation allows the calculation of the other.

Consider, for instance, the switching on of a transmission line at 30,000 volts. With the switches open the voltage on the line is zero; with the switches closed the voltage has an effective value of 30,000, and thus a maximum value of $30{,}000\sqrt{2} = 42{,}400$ volts. That is, at the moment of closing the circuit a sudden change of voltage occurs on the line which as a maximum can amount to 42,400. If, then, the natural impedance of the line is 400 ohms, the maximum oscillating current, which can be produced in the line by the operation of switching the dead line on to the live transformer, is

$$i_0 = e_0/\sqrt{L/C} = 42{,}400/400 = 106 \text{ amperes.}$$

Inversely, when a line carrying 30,000 volts is suddenly earthed or short-circuited—that is, its voltage changed to zero—106 amperes is the maximum current oscillation which may occur, and which, in case of short-circuit, superimposes on the wave of the permanent short-circuit current.

An interesting application of this relation is for the calculation of the maximum lightning discharge from a transmission line, against which the stations have to be protected. While the voltage of lightning may be practically unlimited, the maximum voltage which lightning can produce on the line obviously is limited by the disruptive strength of the line insulation against momentary voltages.

Assuming a 30,000-volt line, the insulators must be expected to stand continuously double voltage, or 60,000, and momentarily at least twice as much, or 120,000 to 150,000. Thus the lightning discharge current is limited to that given by the oscillating voltage of a maximum $e_0 = 150{,}000$. At a natural impedance of the line of $z_0 = 400$ ohms, this gives $i_0 = 375$ amperes.

This is the maximum discharge current which lightning could produce in this line, and thus the maximum current against which the lightning arresters in the station have to protect in case of a lightning stroke on the line near a station. If the lightning strikes at a considerable distance from the station, obviously the discharge current at the station is much less, as the energy of the oscillation is rapidly dissipated in its passage along the line.

Allowing a momentary rise of voltage at the station of 50 per cent., the maximum voltage drop across the lightning arresters would be limited to half the maximum line voltage, or 21,400 volts. At 375 amperes discharge, this allows an impedance of the lightning arrester and its discharge path of $21{,}400/375 = 57$ ohms. To afford effective lightning protection, the resistance of the lightning arrester and impedance of its connection to line and earth should, therefore, not exceed 57 ohms in this case.

The relation considered above may be applied to determine the oscillating voltage that may be produced by a sudden change of current in the line. Assuming that the full load current of the 30,000-volt line is 200 amperes effective—that is, it has a maximum value of $200\sqrt{2} = 283$ amperes. If, then, in switching off full load, the circuit were broken at the maximum value of the current, the oscillation which results would be that due to a sudden change of current from 283 amperes to zero—that is, $e_0 = 283 \times 400 = 113{,}000$ volts. This is more than double voltage, and would cause a flasher or a puncture of insulation.

Switching at or near maximum current thus is dangerous and frequently destructive, and the problem of controlling transmission lines is to devise a switching mechanism which can be relied upon always to open the circuit at zero current. This is the reason which has lead to the development of the modern oil circuit-breaker, as this type has the characteristic of opening the circuit at the zero value of the current. It also has led to the abandonment of all types of air circuit-breakers as dangerous on high voltage circuits, since the air circuit-breaker cannot be relied upon to open always at zero current, but occasionally opens at or near maximum current, and thus is liable to be destructive to the circuit insulation. The operation of the present extended high-voltage systems thus has become possible only by the development of the modern oil circuit-breaker.

The author next shows the effect of opening a short-circuit at or near maximum current. This is seen to produce the most destructive transient of a high-voltage circuit.

Occasional short-circuits, however, are unavoidable in transmission lines, and, as far as they are opened by the oil circuit-breakers in the system, they are relatively harmless. More dangerous are flash-overs on the line, resulting in flaring arcs, which lengthen and then blow themselves out. Fortunately, such flaring arcs only occasionally develop their destructive possibilities, and usually go out at the zero of the current wave. Occasionally, however, such arcs blow themselves out explosively by the rapid expansion of the air due to the heat of the arc, and as the heating effect is a maximum at or near maximum current, this explosive rupture of a flaring arc tends to occur near maximum current, and then produces a destructive oscillation. Especially is this the case in low-reactance high-capacity circuits, as cables, where the current, and therefore the heating effect in the flaring arc, is very large and the arc inherently more unstable. Such flaring arcs thus constitute the most dangerous and destructive phenomenon of high-voltage circuits.

We have seen that in the surge of stored magnetic and dielectric energy the current is a maximum when the voltage is zero, and inversely—that is, the oscillating current and the oscillating voltage, are in quadrature, and the power thus surges to and fro, but does not flow along the circuit. Such a surge of energy is called a stationary oscillation, standing wave or surge.

Oscillating current and voltage may also be in phase with each other. Then there is a flow of power along the circuit, and the phenomenon is called a travelling wave or an electric impulse. Travelling waves of high frequency frequently precede standing waves. Travelling waves have been observed of frequencies from a few hundred cycles to millions of cycles; the former by oscillograph, the latter by spark-gap across a small reactance.

In circuits comprising sections of different character, as transmission line, transformer, load, &c.—that is, in most industrially important cases—the energy surge is a combination of standing waves and travelling waves. The energy surge obviously must die down simultaneously in all circuit sections. In some circuit sections, however, as the transmission line, energy dissipation occurs at a greater rate than in other circuit sections, as transformer coils, and left separate, the surge would die down in the line much more rapidly than in the transformer. Thus, when line and transformer are connected together, energy must be supplied to the line from the stored energy of the transformer by a travelling wave. Thus in the energy surge, or the transient of such a compound circuit, a flow of oscillating power occurs between the circuit sections. This results in a transformation of the oscillating voltage and current at the transition point between the successive circuit sections.

In this connection the author shows that at the transition point between two circuit sections a transformation of voltage occurs, with a transformation ratio which is the square root of the ratio of natural impedances of the two circuit sections, and a transformation of currents by the inverse ratio. That is, $e_2/e_1 = \sqrt{z_2/z_1}$, and $i_2/i_1 = \sqrt{z_1/z_2}$, where e_1, c_1, z_1 and e_2, c_2, z_2 are the maximum voltage, maximum current and natural impedance of the line and transformer respectively.

Hence, a travelling wave coming from one circuit-section into another circuit-section of higher natural impedance increases in voltage and thereby in destructiveness; and, inversely, when entering a section of lower natural impedance it decreases in voltage. Thus, electrical disturbances originating in one circuit section frequently develop their destructiveness in adjacent sections. The result, and the indication, of a transmission line disturbance thus often is the breakdown of the transformers connected to the line, not because the transformers are weaker in insulation, but because the disturbance, while of harmless voltage in the line, has in entering the transformer risen in voltage to destructive values.

When speaking of voltage transformation at the transition point between two circuit sections, it is obvious that at the transition point the voltage is the same in both circuits, but a change of phase occurs which results in a different maximum voltage some distance further on in the circuit at the point where the voltage maximum occurs. With a voltage increase, this maximum is approximately a quarter wave distant from the transition point. Thus, transformers may break down in the middle of their winding as a result of disturbances in the transmission line to which they are connected, if the disturbance is of moderate frequency, while the breakdown would occur in the end turns if the disturbance in the line is of very high frequency. That is, the location of a breakdown in a transformer does not indicate whether the disturbance originated in the transformer or entered from the outside.

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With "THE ELECTRICIAN" for Sept. 14, 1906, was issued the first of a series of "Industrial Supplements," to be published from time to time with "THE ELECTRICIAN." The fifty-third issue of the Supplement published (Gratis) with the number of "THE ELECTRICIAN" for September 23, 1910, was the last of the monthly issues. "THE COMMERCIAL AND INDUSTRIAL SUPPLEMENT" to "THE ELECTRICIAN" is now issued weekly (Gratis). It will be found towards the end of the present issue.

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THE INTERNATIONAL ELECTROTECHNICAL COMMISSION.

The meeting of the International Electrotechnical Commission which has just terminated at Turin will be remembered not only for the important decisions reached, but more especially for the very cordial relations established between the various delegates. This once again shows that to men of science there are neither national boundaries nor susceptibilities. That during the present disturbed state of international politics a Frenchman (M. R. V. PICOU) should propose the election of a German (Prof. Dr. E. BUDDE) to the highest post of honour which the Commission has to offer is, indeed, most significant.

Representatives of 19 nations were present at the Meeting, the total attendance being 52, and the discussions were carried on in French and English, the official languages of the I.E.C. (as the Commission may in future come to be known). The difficulties of translating and of formulating resolutions at such a meeting are obviously very great, and one may say without fear of contradiction that to a very large extent the success so far attained is due to the fact of the Commission having to deal with only two languages, either one or other of which was known to every delegate present. Even so, however, we understand that on one occasion the meeting was obliged to adjourn for a few minutes so as to enable the French and English texts to be unified. At the same time, it is most important to realise that the resolutions as recorded in the official languages are

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not literal translations one of the other, but are rather in the nature of equivalent renderings.

It is very satisfactory to notice that both the British Government and the Indian Government were officially represented at the Meeting, which doubtless points to further recognition in the near future of the utility and importance of the work.

The decision of the delegates, taken at the unanimous and official request of the Electrical Congress, that, subject to the ratification of the various National Committees, the I.E.C. will henceforth be the sole body to authorise the holding of electrotechnical congresses should put a stop once and for all to those mushroom organisations which in the past have done so little to enhance the reputation of the electrical industry. The official standing thereby given to any future Congresses should undoubtedly be of considerable advantage; for, being organised under the auspices of the I.E.C., such Congresses will have the assistance of the national committees of every country affiliated with the movement. As more than 20 countries are now represented on the Commission, future electrical Congresses will, therefore, be international in more than name. Lest it may be thought, in connection with the above decision, that the Commission is taking upon itself unwarranted control, we would draw attention to the fact that the resolution only affects electrotechnical Congresses.

As regards the other decisions reached at Turin, we hope to give in our next issue a full account of the meetings. For the present we may mention that progress is reported under the headings of nomenclature, symbols, vector rotation and the rating of electrical machinery. With regard to nomenclature considerable progress has been made. This is due in large measure to the work of Dr. BUDDE, supported by Mr. E. BRUNSWICK (France) and Dr. S. P. THOMPSON. The recommendations of these delegates have been provisionally adopted, in the sense that, if absolutely necessary, modifications may be introduced at the meeting in 1913.

The question of symbols is one to which much attention is necessary, and it is satisfactory to know that the proposals put forward at Brussels have been adopted, with the exception that, in the case of magnetic quantities, either Script, Gothic, Clarendon or any special type may be adopted. This may possibly lead to considerable divergence of practice, but in view of the criticism levelled at the previous type suggested, the delegates could scarcely come to any other decision. As regards the use of I, E and R for current, pressure and resistance respectively, these symbols were approved with acclamation. For this decision alone the labours of the Commission are likely to prove noteworthy. Again, the international adoption of the counter clockwise direction of rotation for vectors should facilitate the work of all students of electricity—using the word "students" in the widest sense—as well as being of value to the electrical industry in general.

The last of the four main subjects under discussion was the rating of electrical machinery, and in this connection the proposals of the unofficial Conference last year were approved, and a small International Committee has been appointed to continue the study of the subject. That the American Institute of Electrical Engineers should adopt, in the new edition of their Standardisation Rules, the unofficial suggestion of the Commission last year with regard to the rating of motors in international watts is typical of the general desire to co-operate as far as possible with the Commission. This effect is likely to become more pronounced now that the Commission has given such a satisfactory record of work accomplished.

The Commission has decided to meet two years hence at Berlin, and we need scarcely say that it will receive a very warm welcome when one remembers the kindly hospitality of our German cousins. Moreover, under the guiding hand of its new and eminent President, Prof. Dr. E. BUDDE, we can safely predict further and even more important practical results of which the whole industry should feel the benefit. And, to look further into the future, the meeting in San Francisco in 1915, on the occasion of the Exhibition to celebrate the opening of the Panama Canal, is certain to be an important milestone in the history of the I.E.C. There is, however, much serious work to be accomplished before that date—spade work which will have to be carried out, to a large extent, by the small international committees appointed at Turin. In the I.E.C. we now have an impartial world's tribunal of electricians which can safely be trusted to assist the general progress of the industry by well matured and wise decisions. Certainly, the potentialities of this international co-operation can scarcely be overestimated.

REVIEWS.

(Copies of the undermentioned works can be had from THE ELECTRICIAN Office, post free, on receipt of published price, adding 8d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.)

Mathematical and Physical Papers. Vol. V.: THERMODYNAMICS, COSMICAL AND GEOLOGICAL PHYSICS, MOLECULAR AND CRYSTALLINE THEORY, ELECTRO-DYNAMICS. By Sir W. THOMSON (Lord KELVIN). Arranged and revised by Sir JOSEPH LARMOR. (Cambridge, 1911: University Press.) Pp., xv. + 602. 18s.

The original intention was that the present volume should complete the collected works of Lord Kelvin. In order to do this, however, it was found that extensive omissions would have to be made, and so it was decided to run into a sixth volume. A perusal of this volume has convinced us that the decision was a wise one. We have not come across any paper that could, in our opinion, have been omitted with advantage. Notwithstanding his many and varied interests, whatever Lord Kelvin discussed he made intensely interesting.

The present volume begins with Thermodynamics, and much of the theory given is controversial. But it brings forward, in a very vivid manner, those aspects of the problem which the great physicists of the second half of last century regarded as vital. Possibly, if there were more controversies nowadays, especially if combatants like Clausius, Tait and Kelvin would join in the fray, scientific progress would be more rapid.

The Papers on cosmical and geological physics are given after the thermodynamical Papers. Such subjects as the age and rigidity of the earth, its thermal history, the duration of the sun's heat and the formation of stars and nebulæ are discussed with the energy and enthusiasm of a pioneer who has discovered new and wonderful countries. Kelvin in his early youth would have classed all these subjects under "Natural History," but in later life, in deference to conventional usage, he considered them branches of "Natural Philosophy." His conclusions may be open to question, but of the transparent honesty of his aims and the brilliancy of his achievements there can be no question. Those of us who are old enough to remember how profoundly the scientific men of the early 'seventies were roused to enthusiasm by these writings of Kelvin will always regard them as amongst the great classics of our language.

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To the younger physicists, who look on the doctrine of the dissipation of energy in the same way as they look on Euclid's axioms, the reluctance of the early natural philosophers to accept it will seem strange. Sir Andrew Ramsay, the great geologist, after a long discussion with Kelvin in 1867 said: "I am as incapable of estimating and understanding the reasons which you physicists have for limiting geological time as you are incapable of understanding the geological reasons for our unlimited estimates." This attitude of some of his contemporaries explains why Kelvin was at such pains to state and restate his axioms. It was only, as he says, by sheer force of reason that geologists were compelled to admit that this world as an abode fitted for life must have had a definite beginning and must equally have a definite end.

To electricians this volume is of very special interest, as many of the papers—which the editor classes as of minor importance—deal with electrical suggestions that have borne fruit, and profoundly modified the history of the world. It is merely necessary to refer to his connection with the laying of the first Atlantic cable, to his suggestions for utilising the newly invented dynamo for lighting our towns and villages, to the transmission of power by direct current at very high pressures, &c., in order to prove that his judgment and foresight were equally admirable.

The beautiful Kelvin bridge which holds an honoured place in every electrical laboratory suggested itself at once to Kelvin when studying the theory of the Wheatstone bridge, or as he preferred to call it the Wheatstone balance. It interested the reviewer very much to learn that Kelvin invented his method of measuring the resistance of a galvanometer by applying the method of duality to Mance's method of measuring battery resistance. It is an excellent illustration of this method which is not so well known as it deserves to be.

In 1872 we find him writing to "Nature" urging makers of galvanometers, Ruhmkorff coils and electromagnets to measure the resistances of the copper wires they use in their construction. He asks them to measure these resistances in millions of centimetres per second. He suggests that the specific resistance of the copper should not exceed 16,000 gramme-centimetre-seconds. We wonder if there are many instrument makers of the present day who could interpret this specification.

In 1881 Kelvin proved the well-known rule for finding when the efficiency of a shunt dynamo is a maximum, and in the same year he showed an automatic cut-out to be used for charging accumulators. Then follows on account of the magnificent series of instruments and balances for measuring current, pressure, and power which are familiar to every electrician. Although at first sight these instruments seem to have sprung into existence in a similar manner to the way that Minerva sprang fully armed into existence out of Jupiter's head, yet his assistants can tell of the endless calculations he was always making, and the constant alterations of the designs so as to secure a still higher accuracy.

His association with Mr. Ferranti at Deptford in the early days gave rise to interesting papers on skin effect and "anti-effective" copper in cables. Many of us will remember his last public appearance at the Institution, and how he welcomed the Thury system as the realisation of his thirty-year old idea, and the generous appreciation he gave of the work of Mr. Highfield its able exponent. ALEXANDER RUSSELL.

Encyclopédie Electrotechnique. ELECTROCHIMIE. By HENRI VIGNERON. (Paris, 1911: L. Geisler.) Pp. 160.

It is a strange fact that although the number of books on electrochemistry is multiplying with extraordinary rapidity, it is very rare to find any variation in the introductory chapters. They almost all commence with a theoretical introduction in which the laws governing electrochemical reactions are more or less clearly stated. The book before us, for example, commences with a definition of first and second class conductors, then follows a dissertation upon the ionisation theory, primary and secondary reactions, other theoretical considerations such as conductivity and the law of Kohlrausch, E.M.F., and so on, and it is not until the sixth chapter is reached that one arrives at the practical part of the book. In this respect then this book does not differ to any extent from dozens of others which a reviewer comes across. The idea, of course, is to make the books complete in themselves, but it often happens that by endeavouring to do so both the theoretical and the practical parts are apt to be scrappy.

The chapter on the electrolytic processes of copper refining is quite interesting, but too much attention is given to relatively unimportant processes and not sufficient to the great industrial practice which is carried on in the United States and elsewhere. Bearing in mind the enormous quantity of copper which is electrolytically refined in the United States it is strange that the processes adopted there are passed over.

Electrolytic processes for the purification of zinc are mentioned, but there is only a passing reference to the electric furnace. We venture to think that in the near future electric furnace methods will be largely employed to obtain zinc from its ores. This book, however, does not deal at all with furnace methods; thus there is no mention of the various methods employed in refining steel; therefore one cannot take exception to the fact that the production of zinc in the electric furnace is not mentioned.

Electrolytic methods for obtaining or refining most of the metals are given, and there is a short chapter dealing with the preparation of certain inorganic salts and some organic compounds. Considerable attention is devoted to the electrolysis of common salt solutions and the preparation of hypochlorites and chlorates.

One of the most interesting and most complete sections is that dealing with the production of ozone and its industrial applications. In connection with the manufacture of ozone and the increased efficiency of the apparatus there is an interesting diagram. This shows that in 1890 the apparatus then in use, that of Berthelot, only yielded about 1 gramme of ozone per kilowatt-hour. The apparatus of Otto in 1908 yielded about 40 grammes per kilowatt-hour, and the apparatus of Gerard, brought out in 1909, yields 100 grammes of ozone per kilowatt-hour. As the efficiency of the apparatus has increased so the industrial applications of the gas have increased. Ozone is employed for sterilisation of water, for the purification of air in the ventilation of buildings, for the bleaching of oils, for bleaching flour, as a decolouriser in the sugar manufactory, to prepare certain artificial perfumes (such as heliotrope), and for a variety of other purposes.

Taken as a whole, the book gives a useful short review of electrolytic processes, and a general idea as to what is being done. F. M. P.

Wie stellt man Projekte, Kostenanschläge und Betriebekostenberechnungen für elektrische Licht- und Kraftanlagen auf? By FRITZ HOPPE. 5th Edition. (Leipzig, 1910: J. A. Barth.) Pp. xi. + 556. M. 7.

The popularity of this excellent and comprehensive German pocket-book on the preparation of estimates and working costs for electric light and power installations is well proved by the rapid succession of editions through which it has passed. The present edition is the 5th and shows several marked improvements over the 4th edition which appeared in 1907 and was reviewed in these columns in Vol. LXI., p. 257. As in the 4th edition the book is subdivided into three main sections, but these sections have been re-arranged, altered and revised, and the work as a whole has been largely extended, containing over 120 additional pages. It simply abounds in useful tables and data of every description relating to electrical matters in general (exclusive of traction), and it is well-nigh impossible to look in vain for any desired information within the domain of electric illumination and power. As already intimated in our previous review, the book is to a large extent based on the rules and regulations of the German Institution of Electrical Engineers (V.D.E.). The articles on electric illumination in Chapter I. (Part I.) are very instructive and exceedingly clear. They contain a mass of reliable information and data. Chapter II. goes very thoroughly into the question of electric motors, and includes a large amount of data of the horse-power required by all classes of industrial and domestic machines. Chapter III. is on electric cooking, heating and electro-medical

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apparatus. Chapter IV. deals with electricity meters. The calculation of electric conductors and cable networks is given in Chapter V. and is very exhaustive. Chapter VI. and Chapter VII. treat respectively of electrical generating machinery (dynamos, transformers, &c.) and prime-movers (boilers, engines, turbines, gas plant, &c.) Chapter VIII. is a short one on buildings, and examples of actual estimates with explanatory notes are given in Chapter IX. which forms the last of Part I.

Part II. gives the average prices, arranged alphabetically, of dynamos, engines, apparatus, lamps, &c.; in short, everything appertaining to an electrical installation, in three chapters. The table on p. 339, giving the cost per horse-power of various hydro-electric plants, will be found most interesting.

Part III. shows how to calculate the probable working costs and to determine the revenue-earning capacity of lighting and power plants, and is very complete.

The book is certainly of great value, not only to those engaged upon the planning of electrical schemes, but to those who so often at very short notice are called upon to give a fairly close estimate of the probable cost of an installation. Of course, the prices given are those obtaining in Germany, but they will, nevertheless, be found useful. In the Appendix there are some highly interesting notes relating to the fees and allowances of consulting electrical engineers as fixed by the Verein beratender Ingenieure für Elektrotechnik E.V. in Berlin (Society of Consulting Electrical Engineers). They afford much food for reflection. Why not place these matters on some such proper basis in this country?

STUDIES IN LIGHT PRODUCTION.*

BY R. A. HOUSTOUN, M.A., PH.D., D.SC.

(Lecturer in Physical Optics in the University of Glasgow.)

(*Continued from page 901.*)

Summary.—In these studies the author deals with the theory of light production, the scope being briefly indicated by the following contents: (1) The distribution of the energy in the spectrum and the measuring of efficiency. (2) The importance of "black body" radiation and the experimental realisation of the black body. Comparison of the energy curves of a black body and of platinum, and the variation of the position of maximum energy with temperature. (3) Mechanism of flame, and the temperature, energy and efficiency of flames. (4) The Welsbach mantle and selective radiation. (5) Radiation and efficiency of the carbon glow lamp. (6) Physical properties and temperature of the arc. (7) Temperature and energy curves of the Nernst glower. (8) Efficiency of the metal filament. (9) The mercury arc and its difficulties. (10) The light of the future and the possibility of obtaining "cold light."

No. 3.—Flames.

Flames are the simplest and historically the first means of producing light. When or how prehistoric man first learned the use of fire we know not. The ancient Greeks ascribed a supernatural origin to it in the myth of Prometheus, and other legends have other legends; but it was probably obtained at first accidentally by a spark from a flint. Be that as it may, the mastery and use of fire is one of the signs that distinguish man from the brutes, and marks the first stage in the development of the artificial light of to-day.

As different stages in this development we have the primitive pine torch, the oil lamp of the ancients, which attained a great development in ancient Rome, the rush light of the Middle Ages, the different kinds of candle, from the tallow dip to the modern paraffin candle, the burning whale, seal or bear fat of the Esquimaux, the Argand lamp, ordinary coal gas and acetylene gas. In all these cases light is produced in substantially the same way—by the flame formed when hydro-carbons are burned in air. The spectra produced have in every case essentially the same character; upon the continuous spectrum of the incandescent carbon particles is superimposed the discontinuous spectra of the gaseous products of combustion, principally water vapour and carbon dioxide.

To gain an insight into the mechanism of the flame we shall therefore study as a typical case the candle, which has been made the subject of a course of six lectures by Faraday. (Michael Faraday, "The Natural History of a Candle." London 1894. Chatto & Windus.) When an ordinary paraffin candle is burning, a cup is formed at the foot of the wick. The flame melts the paraffin at the foot of the wick, while the air moving upwards by the force of the current, which the heat of the candle produces, keeps the sides cool and prevents the edge from melting. The fluid in the cup is sucked up the wick by capillary attraction. After travelling up the wick the fluid vaporises and is burned as a vapour in the flame, the heat of combustion vaporising more fluid and thus maintaining the flame. The flame travels down the wick until it is put out by the fluid in the cup. The top of the wick bends over and is consumed in the edge of the flame. In a candle, gas is manufactured for combustion just as on a large scale in the gas works of our cities.

A candle flame on examination is seen to consist of four regions. First of all there is a transparent part round the wick. It may be shown by withdrawing some through a glass tube that the transparent part consists of vapour before combustion. Below this, on the edge of the flame, there is a blue part, due to the formation of carbon monoxide. This blue part gives the Swan spectrum, and it is not known whether the latter is due to carbon or carbon monoxide. There is recent work favouring both views. Above the transparent part is the bright opaque region, which gives far the greater part of the light of the flame, and finally the flame is surrounded by a faintly luminous mantle, which in the case of the candle is somewhat difficult to see. The chemical actions occurring in the different regions of the flame are complicated and not thoroughly understood; but the bright part is due to incandescent carbon particles from the vapour after its decomposition, before they combine with the oxygen of the atmosphere to form carbon dioxide. These bright particles are carried upwards by the air current. Smoke is due to the carbon particles not having sufficient oxygen to combine with. In the Bunsen flame, on the other hand, the oxygen combines with the carbon before the latter has time to radiate as a solid.

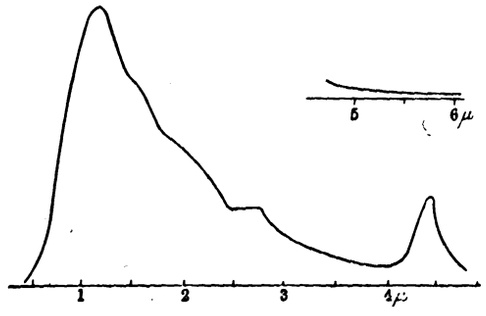

FIG. 6.

Energy curves of flames have been taken by G. W. Stewart ("The Spectral Energy Curve of the Acetylene Flame," Phys. Rev., 16, 1903, p. 123), K. Angström ("Energy in the Visible Spectrum of the Hefner Standards," Phys. Rev., 17, 1903, p. 302) and R. Ladenburg ("Uber die Temperatur der glühenden Kohlenstoffteilchen leuchtender Flammen," Phys. Zs., 7, 1906, p. 697). Stewart gives a very carefully taken energy curve of a cylindrical acetylene flame. The light was resolved by a mirror spectroscope with a fluorite prism, and the energy measured by a radiometer. The curve is reproduced above (Fig. 6).

The elevations at 1·46μ and 1·90μ are emission bands of the water vapour, and the maxima at 2·6μ and 4·4μ emission bands of the carbon dioxide in the flame, the remainder of the area being due to the glowing carbon. Stewart also gives the energy curve of an ordinary gas flame. ("The Temperatures and

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Spectral Energy Curves of Luminous Flames," Phys. Rev., 15, 1902, p. 306.) It has the maximum at 1·13μ. Angström gives a prismatic energy curve for the amyl acetate flame of the Hefner lamp. It shows the two emission bands of carbon dioxide very clearly, but there are depressions at the positions of the two water bands, showing that more energy is absorbed by the water vapour in the atmosphere than is emitted by the water vapour in the flame. Angström uses a rock salt prism and bolometer. Ladenburg gives both the energy curves for the acetylene flame and the Hefner lamp, taken with a mirror spectroscope, quartz prism and thermopile, but not so far into the infra-red. Both his curves show the absorption bands of water, and in the Hefner lamp curve the carbon dioxide band nearer the shorter wave-lengths—the only carbon dioxide band shown—appears as an absorption band. The maximum of his acetylene flame is at 1·21, and its shape does not agree well with Stewart's curve.

The temperatures of the acetylene, gas and candle flames have been measured by E. L. Nichols ("On the Temperature of the Acetylene Flame," Phys. Rev., 10, 1900, p. 234) with a platinum platinum-rhodium thermo-element. The introduction of a thermo-element into the flame lowers the temperature of the flame. Four different thermo-junctions were, therefore, used, made of wires of different diameter. The thinner the wire the higher was the temperature recorded; hence by plotting the temperature as a function of the diameter of the wire and continuing the curve he found what temperature would be recorded by an infinitely thin wire. The determination was also complicated by soot forming on the junction and lowering its temperature, and, in the case of acetylene, by the junction melting. The thermo-element was gradually pushed into the flame and the readings plotted as a function of the distance from its centre until the junction melted or soot began to form. Then the portion of the curve found was simply produced to the centre of the flame. In this way the centre of the luminous region of the acetylene flame was estimated to be at 1,900°C., while the sheath surrounding the luminous region may be 20°C. higher. The luminous region of the gas flame was found to be not more than 1,780°C., and the hottest portion of the candle flame to be 1,670°C. From the diagram given the average value for the luminous region of the latter is probably 100°C. lower. In standardising his thermo-element Nichols took the melting point of platinum as 1,775°C.

Assuming that the carbon in flames radiates more selectively than a black body and less selectively than platinum, and using the formulæ established by Lummer and Pringsheim for the maximum of the energy curve in these cases—namely,

$$\lambda_m T_{max.} = 2{,}940,$$
$$\lambda_m T_{min.} = 2{,}630,$$

we obtain the following results:—

	λ_m	$T_{max.}$	$T_{min.}$
Candle	1·5	1,687°C.	1,477°C.
Argand lamp.....	1·55	1·627°C.	1.427°C.
Acetylene flame ...	1·05	2,527°C.	2,232°C.

The formulæ give the temperatures in degrees abs., but in the table they are expressed in degrees cent. $T_{max.}$ is the temperature which the flame would have if we assume that it radiates as a black body, $T_{min.}$ if we assume that it radiates as platinum.

The value thus obtained for the temperature of the acetylene flame is very much higher than Nichols' value. Stewart states that he considers it much too high. Kurlbaum suggests the cause of the difference (Phys. Zs., 3, 1902, p. 187). While a luminous flame of very great thickness may be expected to radiate as a black body, yet we may expect a candle flame to radiate as a very thin film of soot at that temperature. Now lamp black is more transparent to long waves than short waves—*i.e.*, the absorption and radiation increase with decrease of wave-length. Hence on applying the formula $\lambda_m T = \text{const.}$ the temperatures obtained will be too high, for the maximum will be much further towards the short wave-lengths than in the case of a black body at the same temperature. Thus, according to Kurlbaum, the radiation of glowing carbon is usually more selective than that of bright platinum.

This has been proved by Ladenburg (loc. cit.). As has been already stated, he took an energy curve of the acetylene flame and of the Hefner lamp. He then caused the light from a Nernst glower to pass through these flames and plotted the percentage absorbed as a function of the wave-length, thus determining the absorption as well as the emission of the flame. The absorption of both flames increases as the wave-length decreases. If now we divide the emission by the absorption we obtain the emission of the theoretical black body at the same temperature. As a final result, Ladenburg obtains 1,838°C. for the acetylene flame and 1,431°C. for the Hefner flame. He states that Nichols' value of the melting point of platinum is 55°C. too high. The latter's value for the centre of the flame should thus be 1,845°C., which is in very good agreement with his own.

Stewart (loc. cit.) finds the radiant efficiency of the acetylene flame to be 0·039. The result was obtained by dividing the area of the energy curve to the left of 0·76μ by its whole area. K. Angström had previously found it to be 0·055. K. Angström has also made a very careful determination of the radiant efficiency of the Hefner lamp by an original method. He first took the energy curve, and found that, in the visible spectrum and in the infra-red as far as 1·5μ, it agreed with the curve of a certain glow lamp for one particular current. By means of a prism and screen the light from the glow lamp was separated from its heat rays. After the heat rays were separated out the light rays were allowed to come together again and fall on one face of a wedge photometer on the other face of which the light from a Hefner lamp fell, and the distance of the latter adjusted until balance was obtained. The photometer was then removed and a bolometer placed in exactly the same position. The intensities of the two beams were then measured in succession by the bolometer; their ratio gave the radiant efficiency. The value found was 0·0096.

For an oil lamp with glass funnel W. Wedding finds 0·01 by the water-filter method.

So much for the radiant efficiency—the ratio of light emitted to total radiation. But the question arises of the luminous efficiency—the ratio of the light emitted to the total energy consumed. In order to determine the latter we require the total radiation in absolute measure, the rate at which the substance is being burned and the calorific value of its unit mass. For the case of the Hefner lamp the ratio of the whole energy radiated to the energy consumed has been calculated by O. Tumlirz, and we take the following details from his article ("Die Wärmestrahlung der Wasserstoffflamme," Wien. Ber., 113 (Abt. II.a), 1904, pp. 501-509). The energy received by a surface element at a distance of 1 metre from a Hefner lamp is $1{\cdot}62\ 10^{-5}$gm. cals. per square centimetre per second, the surface element being normal to the straight line joining it to the flame and the latter line being horizontal. K. Angström (loc. cit.), it may be noted, found $2{\cdot}15\ 10^{-5}$ gm. cals. per square centimetre per second for the same quantity by means of his pyrheliometer. Hence in a second the flame radiates $4\pi \times 10^4 \times 1{\cdot}62\ 10^{-5} = 2{\cdot}04$ gm. cals. The quantity of amyl acetate burned in a second is 0·002678 gms. According to Favre and Silbermann the heat of combustion of 1 gm. of amyl acetate is 7,971·2 gm. cals.; hence the heat given out by the Hefner lamp in one second is $7971{\cdot}2 \times 0{\cdot}002678 = 21{\cdot}35$ gm. cals. We arrive, therefore, at the result that the ratio of energy radiated to energy consumed is 2·04/21·35, or 0·096. The greater part is lost by convection. If we assume Ångström's value for the radiant efficiency—namely, 0·0096, the luminous efficiency becomes $0{\cdot}0096 \times 0{\cdot}0956 = 0{\cdot}00092$. That is, the efficiency of the Hefner lamp as an energy transformer is less than one-tenth per cent. There is no reason to believe that our ordinary illuminating gas is any better.

In the same article, Tumlirz describes a determination of the ratio of the total energy radiated to the energy consumed by a hydrogen flame. The value found was 0·0615.

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THE ELECTRICAL EQUIPMENT OF THE CRAIGHEAD AND BOTHWELL CASTLE COLLIERIES.

These collieries, which are amongst the oldest in Scotland, are situated at Bothwell Castle near Glasgow, and are owned by Messrs. William Baird & Co. The experience of this firm, who were one of the first in Scotland to adopt electricity for underground mining work, has been such that they are now one of the firmest advocates of the electric drive.

In the present article it is intended to deal with the power equipment rather than with the actual work carried out. The power house is situated at the Bothwell Castle Colliery, and a portion of the output is transmitted at a pressure of 8,200 volts to Craighead Colliery, a distance of about a mile. At a later date power may be transmitted to other collieries in the same way.

The generating plant at present comprises a mixed-pressure straight-flow turbine of the Westinghouse impulse type, direct-coupled to a 300 kw. 500-550 volt three-phase 50-cycle turbo-alternator with coupled exciter. The turbine takes exhaust steam from two engines, one driving a fan and the other a haulage. The

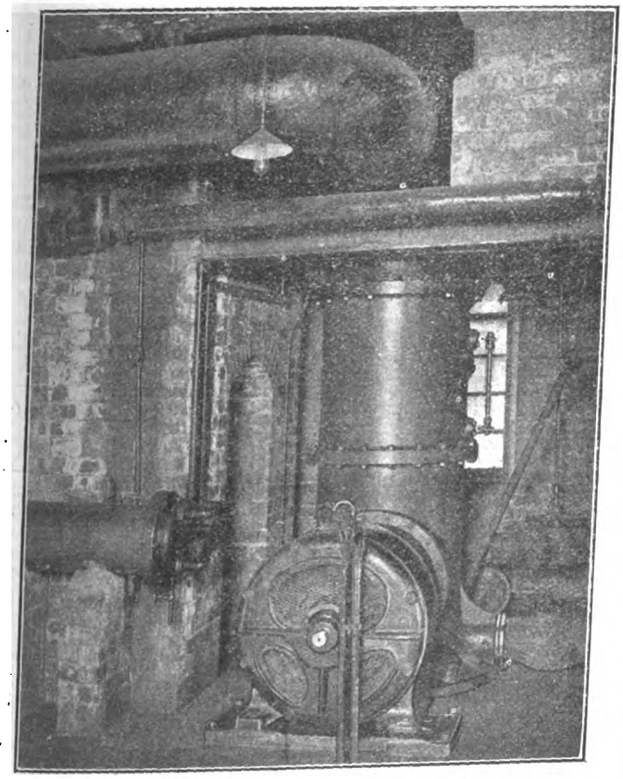

FIG. 1.—WESTINGHOUSE LEBLANC MULTIPLE JET CONDENSING PLANT DRIVEN BY 47 B.H.P. SQUIRREL-CAGE MOTOR.

amount of power thus available is from 115 to 180 kw., and when this supply is insufficient to carry the load, live steam is taken from the boilers at 60 lb. per sq. in. pressure, regulation being effected automatically.

The condensing plant, which has an average duty of 12,000 lb. of steam per hour, is of the Westinghouse-Leblanc multiple jet type, and is capable of maintaining a vacuum of between 27½ and 28 in. of mercury at full load, the air and circulating pumps being driven by a squirrel-cage motor rated at 47 B.H.P. at 720 revs. per min. (*see* Fig. 1). This motor, which with the condenser is situated in the basement, is controlled from the engine room by a mining type control pillar, comprising oil switch, oil immersed controller and ammeter. The water and vacuum gauges are also mounted on this pillar, the whole forming a remarkably complete and accessible control system.

The current generated is used at the terminal pressure at Bothwell Castle on motors both above and below ground, but is transformed to 2,200 volts for transmission to Craighead. The line is designed for working later at a pressure of 6,600 volts, but as all the electrical machinery has not yet been erected the lower voltage is quite sufficient for the small amount of power at present being transmitted.

A six-panel black-enamelled slate switchboard controls the generator and outgoing feeders, and comprises one high-tension and five low-tension panels. One of the latter is for the main generator and carries the main oil switch, exciter switch, ammeters and voltmeters. A "Summation panel" carries a wattmeter, power-factor meter, milliammeter and watt-hour meter.

There are three low-tension feeder panels for station supply, surface, and underground feed respectively, two of which carry oil switches and ammeters. The other is mounted with a three-pole

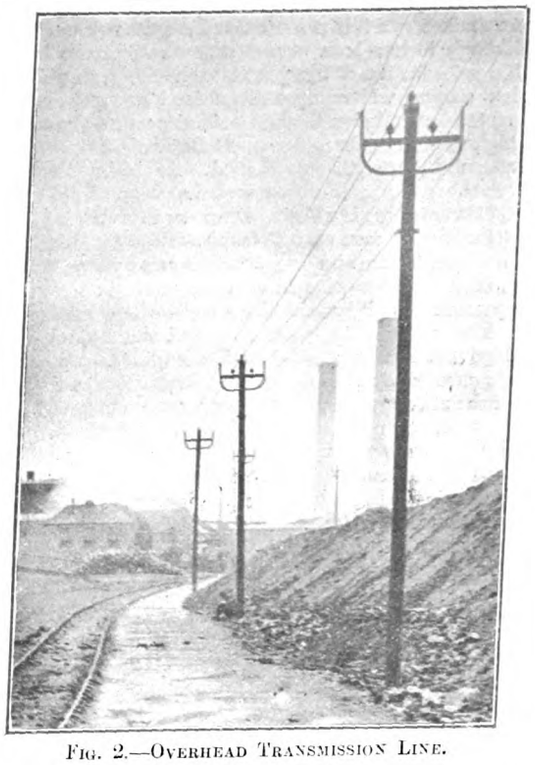

FIG. 2.—OVERHEAD TRANSMISSION LINE.

knife switch for the condenser motor, and a two-pole switch, fuses and ammeter for the lighting circuit. On the high-tension panel there is a voltmeter and an ammeter, two static ground detectors, and a high-tension oil switch. The panels are fitted with pilot lamps to indicate whether they are "live" or not.

Current is taken from the high-tension bus bars and led underground by a three-core paper-insulated lead-covered cable to a

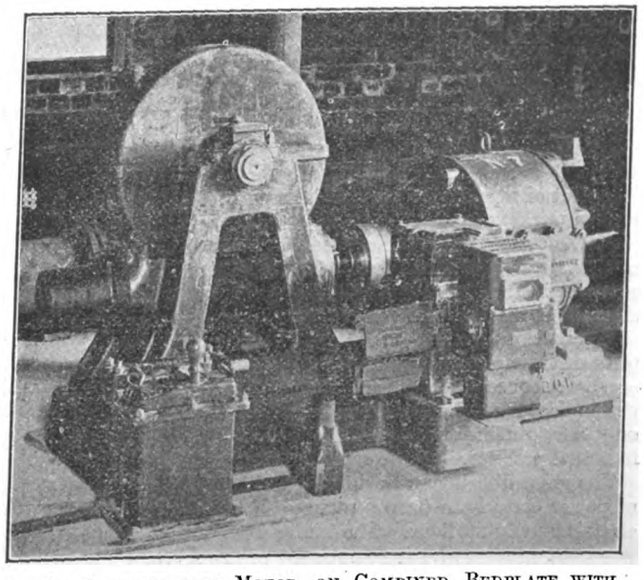

FIG. 3.—SQUIRREL-CAGE MOTOR ON COMBINED BEDPLATE WITH WORM-DRIVEN HAULAGE GEAR.

point clear of the Bothwell Castle works, and thence by an overhead aluminium line, supported at intervals of about 50 yds. on wooden poles, to Craighead, where it is stepped down to 500 volts for use.

This line is led across country over road and woods, finally crossing the river Clyde at a point where it is 210 ft. wide. A view of the overhead aluminium line is given in Fig. 2. The line was tested at

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11,000 volts to meet the Board of Trade requirements, and was found perfectly satisfactory in every way. It is composed of three aluminium cables, each consisting of three No. 10 S.W.G., and having no joint from end to end. These cables are fastened by aluminium clips to brown porcelain insulators, the latter having been tested to 22,000 volts.

At the Clyde, steel guard wires are fixed underneath the lines for the double purpose of taking the pull and preventing the lines from falling in the event of a break. A high-tension telephone line connects the two mines, and it is mounted on the same poles as the power lines. Although it has been stated that the pressure is stepped down to 500 volts for use at Craighead, it should be mentioned that high-tension current will be used direct for large motors, and will also be used for transmission to other collieries where the supply will be direct high-tension to the motors. At Bothwell, Nos. 1 and 2 pits, 500-volt alternating current only is used. At present there are five motors in use at the former and seven at the latter, all of the squirrel-cage type. One of these is a 7 H.P. motor used for driving a winding equipment for hauling men up a 25 ft. pit.

At the Bothwell Castle and Craighead pit some very neat haulages are in use, motive power being furnished by two-speed squirrel-cage motors, operated by oil-immersed controllers and mining type oil switches. The drive is by worm gear, and the motors, which are rated at 10-5 H.P. run at a speed of 970-480 revs. per min. This variation is effected by a controller which makes the different connections of the stator winding so as to vary the number of poles, the minimum number of poles giving the maximum speed. A view of one of these motors is given in Fig. 3.

This plant represents practically the last word in colliery work and reflects great credit on Messrs. Stevenson & McGuffie (consulting engineers to Messrs. William Baird) and also on the British Westinghouse Electric & Manufacturing Co., who are responsible for the entire electrical equipment.

THE DIESEL OIL ENGINE.*

BY CHARLES DAY.

Summary.—The author gives two tables based on the published costs of electric supply stations. These tables show the comparative cost per unit sold for steam, gas and Diesel plant up to 1,000 H.P. capacity; and, secondly, the effect of the size of steam plant on the cost of generation. The main features of the Diesel engine are also discussed.

The economical generation of power for industrial purposes depends mainly upon the following factors:—

1. (*a*) The attainable economy of working at different loads of the prime mover itself, including boiler or gas-producer, and all accessories, such as condensers, feed pumps, water pumps, &c. (*b*) The degree to which this attainable economy can be practically maintained under the conditions of working, and the load factor.

2. The stand-by losses *i.e.*, the expenditure necessary to keep the plant ready for work when wanted.

3. Wages of engine-room attendants, stokers and other men employed about the power house.

4. Expenditure on lubricating oil, cleaning waste and sundry stores.

5. Cost of repairs and the maintenance of all parts of the plant in good working condition.

6. The cost of water for condensing, and for boiler feeding in the case of steam plant, for the engine water jackets, and for the gas-producer in the case of gas plant, or for the engine water jackets in the case of Diesel plant.

From the mere enumeration of these items it is very obvious that tests either on makers' works or on site, even though the tests extend over a week or so, do not form a sufficient guide as to the real value of the engines for industrial purposes, and that a far safer, in fact, the only safe, conclusion can be formed from a study of results obtained in actual practice.

The great difficulty most buyers find is in securing reliable figures of power costs from people engaged in trade, except in the case of electric supply stations. The writer does not know of any body of large power users who systematically prepare accounts showing their power costs on a uniform basis, and publish them. This practice in connection with electric supply stations fortunately does give an independent and authoritative basis, from which valuable deductions can be made. From the figures published in the "Electrical Times" the author has determined the following average results with different types of plant for stations having a plant capacity not exceeding 1,000 H.P.

* Abstract of a Paper read before Section G of the British Association at Portsmouth.

Table I.—*Average Cost in Pence per Unit sold.*

Type of engine.	Fuel.	Lubricating oil, waste, stores & water.	Wages.	Repairs & maintenance.	Total works cost.	Load factor.
Steam	0·45	0·06	0·25	0·26	1·02	14·7
Gas	0·43	0·09	0·28	0·24	1·04	15·3
Diesel	0·23	0·04	0·19	0·07	0·53	14·3

The limit of 1,000 H.P. was fixed owing to there being as yet no large electricity supply stations equipped solely with Diesel engines or gas engines. Of course, better results are obtained when driving machinery which gives a better load factor, but the causes which produce loss are, as a rule, the same, though modified in extent. The general conclusion formed from a study of electricity stations holds good for the great majority of power users, though perhaps not applicable to some special trades, where engines can be run continuously on almost uniform loads. It is also necessary to point out that the figures include some items which should not strictly be charged against the power plant. For instance, the wages items include figures for men working on cables, street lamps and in sub-stations, whilst the repairs items include repairs to such parts. Also it is necessary to mention that the figures give the costs per unit sold, and not per unit generated.

From the averages it is clear that a substantial gain is obtained by the adoption of Diesel engines as against either gas or steam engines, the figures being beyond doubt substantially accurate. It is also noticeable that the gain is not only on fuel consumption, but is practically in the same proportion on the other items of expenditure. The great saving shown by these average figures is confirmed by repeated experiences of the author.

When going through costs records to prepare the average figures previously given, the author noticed very wide differences of cost per unit, particularly in the case of the steam plant. He, therefore, had the average cost calculated for steam stations of different capacity, and as the results are interesting, they are given separately in Table II.:—

Table II.—*Average Works Cost in Pence per Unit sold for Steam Stations of Different Sizes.*

Stations not exceeding	Fuel.	Lubricating oil, waste, water & stores.	Wages.	Repairs & maintenance.	Total.	Load factor.
250 kw.	0·63	0·09	0·35	0·36	1·43	13·2
500 ,,	0·56	0·06	0·27	0·29	1·18	13·3
750 ,,	0·43	0·05	0·23	0·24	0·95	15·4
1,000 ,,	0·40	0·05	0·23	0·21	0·89	16·8
1,500 ,,	0·42	0·04	0·17	0·18	0·81	16·9
2,000 ,,	0·37	0·04	0·16	0·21	0·78	17·7
3,000 ,,	0·33	0·04	0·15	0·17	0·69	17·4
4,000 ,,	0·40	0·03	0·14	0·20	0·77	18·8
5,000 ,,	0·34	0·03	0·11	0·16	0·64	18·7
7,000 ,,	0·36	0·04	0·13	0·20	0·73	17·9
10,000 ,,	0·26	0·03	0·09	0·13	0·51	22·6
20,000 ,,	0·30	0·03	0·11	0·16	0·60	19·6
50,000 ,,	0·23	0·02	0·10	0·11	0·46	20·56

This table shows the great improvement which follows increase of size with steam stations, or, expressed in the reverse direction, it shows how great is the disadvantage of small stations when steam power is used.

It is, further, to be noted that, even with the largest steam stations, the costs per unit generated are no better than for quite small stations using Diesel engines, and this in face of the improved load factor. This is a most important point, and shows that small Diesel stations can profitably supply current at prices hitherto thought to be obtainable only in densely populated centres having large power stations.

In all cases the figures which have been given are works cost, and do not include anything for interest on capital or depreciation. It is hardly possible to give a definite statement showing the cost of constructing and equipping power houses of different types, as there are so many variable factors. However, the author's experience of a considerable number of estimates indicates that up to a capacity of, say, 1,000 kw., there is generally little difference between the gross capital expenditure required, whether steam, gas or Diesel engines be adopted.

Having now dealt with what may be termed the commercial aspect, it may be well to study briefly the constructional features desirable in engines for dynamo driving. In the first place the dynamo should be coupled direct to the engine shaft, and not be driven by belt or ropes, as the up-keep cost of these is considerable; also, with belt or rope drive, the space occupied is considerable. Direct coupling of dynamos means that low-speed engines are to be avoided, otherwise the cost of the dynamos is very high. For speeds

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which are not low, engines of the multi-crank type become desirable, otherwise serious vibration is likely to be caused. For the same reason it is important that the distance between the centre lines of the cylinders of an engine be reduced as much as possible. If far apart, as, for instance, in the case of a cross-compound steam engine with dynamo between, then each cylinder or line of parts will produce its own vibrating effects on the foundation without being materially influenced or counteracted by the other. For multi-crank engines with cylinders close together the vertical construction is much more suitable than the horizontal, and gives much better accessibility. Also, any unbalanced inertia forces do not tend to slide the engine about, but merely increase or decrease the weight on the foundations.

The vertical design is also better from the point of view of piston wear. Multi-crank engines are also advantageous as regards speed regularity during each revolution, and when high-speed engines are adopted, the multi-crank vertical type becomes imperative.

There is another point in regard to the multi-cylinder design of engine which should be mentioned—viz., that with this design a smaller diameter of cylinder is required for a given power than with a single-cylinder engine. With internal-combustion engines this is of great importance, as after a certain size every enlargement of cylinder diameter brings with it increased constructional difficulties and a greater liability to breakdown.

Turning next to the particular features of the Diesel engine itself, the author describes briefly the development of the present Diesel cycle.

The cycle enunciated by Carnot in 1824 appears quite an impossible one, because during the one portion of the compression heat must be perfectly carried away—*i.e.*, the working fluid and the surrounding materials must be perfect conductors. Then during the second portion of the compression no heat must be carried away or added, meaning that the materials must now be perfect non-conductors. With these opposing conditions it is not surprising that no application of the Carnot cycle appeared in practice for so long. Diesel, however, propounded a scheme which, to a certain degree, met the Carnot conditions. This scheme was as follows :—

The isothermal period of compression was obtained approximately by spraying water into the cylinder during compression, this water spray being discontinued for the adiabatic compression. For the isothermal expansion fuel-oil was sprayed in to give the requisite addition of heat. The spraying in of fuel-oil for this purpose necessitated the adiabatic compression being carried to a high degree, so as to give a sufficiently high temperature to the air in the cylinder as to cause ignition of the oil sprayed in. Unfortunately, this cycle did not meet with success in practice owing to the very high pressure required, and to the small amount of work obtained, and gradually the original cycle has become modified to that now adopted, which may therefore be claimed to be the nearest to the Carnot cycle that present-day practical limits admit. Briefly it is as follows: (1) During the suction stroke air is drawn into the cylinder. (2) During the compression stroke this air is compressed to a considerable pressure and temperature. (3) For a short period during the next stroke oil is sprayed into the cylinder, and burns in consequence of the high temperature to which the air has been raised by compression. During the remainder of the stroke expansion takes place. (4) The products of combustion are exhausted.

The heat efficiency of the Diesel engine, though far from perfect, is still much better than any other heat engine, as is readily seen from the fuel consumption, which is 0·44 lb. of fuel oil per brake horse-power per hour. The fuel consumption is also low at partial loads, viz. :—

¾ load	0·45	lbs. per	B.H.P. per hour.
½ ,,	0·47	,,	,, ,,
¼ ,,	0·62	,,	,, ,,

These are every-day figures, and are for engines of quite moderate size. With larger engines the fuel consumption per horse-power is rather lower, but increase of size does not give anything like the improvement in fuel consumption that occurs with steam engines. This is a point to be remembered when fixing the size of engine to be adopted in a station.

Owing to the high economy at light loads it is often found distinctly advantageous to run a Diesel engine in preference to using a storage battery.

The fuel oil used can be almost any of the fuel oils which are used for boiler firing, and a wide variety of oils can be used with no alteration of the engine. The use of oil fuel carries with it certain advantages in the way of ease in handling and of cleanliness. With coal it is difficult to avoid dust, and this must be particularly objectionable in the case of steam plant, where the engines are carried on the boilers, thus placing a considerable quantity of moving machinery in the neighbourhood of the coal. With oil there are no ashes to cart away, and thus handling of gritty materials is entirely eliminated. Usually the oil is pumped from an outside storage tank to the small tanks near the engines.

The question may naturally be asked whether Diesel engines are suitable for long periods of continuous running. In reply to this the following instance may be quoted :—

At the Birkdale electricity works a "Mirrlees Diesel" was put down a little over four years ago. The station engineer recently made a return which showed that the engine had, on the average, worked 23¾ hours out of every 24 hours throughout the four years, or an average stoppage of about 1¼ hours each Sunday.

Numerous cases could be given of large savings effected, but the figures already given substantially prove this.

Diesel engines of the Mirrlees make have been fitted on board many warships and first-class cruisers, for driving dynamos; also, some have been used for boat propulsion. It might be of interest to mention that the first Diesel engine made in Great Britain was a Mirrlees Diesel engine, and was made over 14 years ago, consequently the present Mirrlees Diesel engines represent quite a long experience; and the present appreciation of this engine is not a temporary boom, but is based on substantial experience.

A MECHANICAL LAMP-TESTER.

An interesting device which we show in the accompanying illustrations is a mechanical lamp-tester. It was invented by M. Vincent, one of the engineers of the Western Railroad Department of Paris, and it is designed for testing incandescent lamps by subjecting them to repeated shocks. In this way it is desired to imitate as nearly as possible the treatment which the lamps would receive when used on

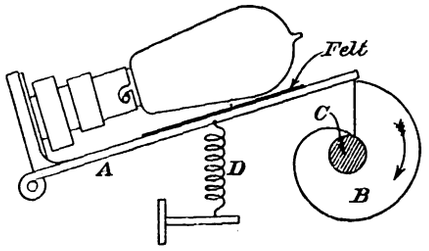

Fig. 1.—Diagram of Lamp Tester. (General Arrangement.)

railway trains, and thus to find out their weak points, and to improve their manufacture by selecting the types which will withstand shocks the best. Some device of this kind is specially needed for metal filament lamps, for as yet such lamps have not been used extensively for train lighting, at any rate in France, on account of their frâgility. For instance, a correspondent informs us that on the new North-South Paris subway metal filament lamps are used for lighting the stations, but carbon filament lamps are retained for lighting the cars.

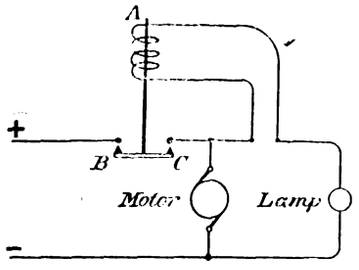

Fig. 2.—Connections for Hot Test.

M. Vincent states that he is endeavouring to get manufacturers to improve metal filament lamps in the directions indicated by the results of tests with his apparatus. Thus he hopes finally to secure a suitable type of lamp for train lighting.

The device used for the purpose is of the simplest form, as will be observed by reference to the illustrations. The lamp (Fig. 1) is fitted into a socket which is mounted upon a small board, A, hinged at one end, while the other end is movable and is actuated by a cam, B, fixed to the shaft C. Each time the cam revolves, the end of the board is dropped down, thus giving a definite shock to the lamp. By means of a spring, D, the amount of this shock can be adjusted and made heavy or light. The shaft is driven by a small electric motor, and carries at its further end a counter, so that the number of revolutions can be read off.

For testing the filament when burning normally or otherwise heated by the current, the method shown in Fig. 2 is used. Current

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from the mains first passes to the motor and to the lamp which is in parallel with it. In series with the lamp, however, is a solenoid, A, of very low resistance. This solenoid normally holds up the main switch BC, but should the lamp filament break the current through it will fail and the core will drop, and thus open the switch in the motor circuit. The motor then stops, and the number of shocks which the lamp has stood can be read off on the counter.

In order to test the lamp when the filament is cold, the following method is employed: A small current is passed, which simply acts as a detector, and shows whether the lamp is broken or not. In this

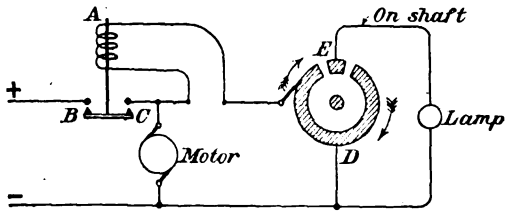

FIG. 3.—CONNECTIONS FOR COLD TEST.

case, too, the current is passed through the lamp for a short time during each revolution. The same apparatus as that described above is used except (*see* Fig. 3) for an extra rotating contact maker, which carries a long segment, D, and a short segment, E. For the greater part of a revolution the current passes through the solenoid and not through the lamp, and for a very short time it passes through the solenoid and the lamp in series. The time is too short to cause the lamp to become heated by the current, and the solenoid normally keeps its core held in position. Should the filament be broken, the current fails in the solenoid for an instant, and this suffices for the core to drop and open the switch. In any case the apparatus goes on working without needing any attention, so that it can be left to itself and the number of shocks is always exactly recorded at the end of any length of time.

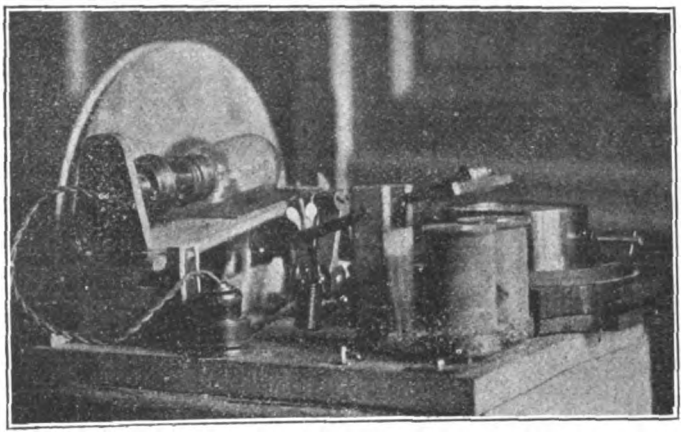

FIG. 4.—VIEW OF LAMP TESTING DEVICE.

HOMOPOLAR GYROSTATS.

At the Electrical Exhibition which is just about to open at Olympia visitors will have an opportunity of seeing a gyrostat which is driven by a homopolar motor. The exhibit is by Messrs. Homopolar Machines, of London. It is a common thing to drive gyrostats by ordinary continuous-current motors, but as the speed must usually be high such motors are not very suitable; special construction must be adopted, and if they are run in vacuo there may be trouble from flashing over at the commutator. These difficulties are avoided in the present apparatus by making the gyrostat wheel the rotor of a homopolar motor, a couple of slip-rings being then the only electrical connection.

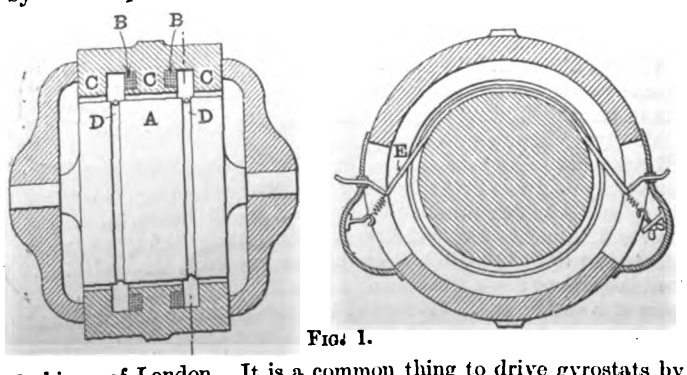

FIG. 1.

There are two ways of doing this as indicated in Figs. 1 and 2. In the first the gyrostat wheel is absolutely simple, without any insulation, and is indicated at A in Fig. 1. The stationary poles C are produced in the casing by two annular windings B. Current is led in and out of the flywheel by flexible cord brushes E, which lie in the grooves D. If preferred, one brush may bear on the periphery of the flywheel and the other on the shaft or transmission.

In Fig. 2 the arrangement is such that the flywheel carries the magnetising coil B, and the current to this is supplied by a brush running in the groove A (one end of the coil being earthed to the wheel), and a second brush running on a slip-ring C to which the other end of the coil is connected. The coil is preferably wound as a volute with flat copper strip, the broad faces of the strip being in contact so that the centrifugal force has no tendency to cut insulation or to force any part of the coil on sideways. The flywheel is shown as in one piece, but it is preferably built up of different qualities of steel, that of high tensile strength being used where strength is important, whereas a ring of high permeability iron is used where necessary for the magnetic circuit.

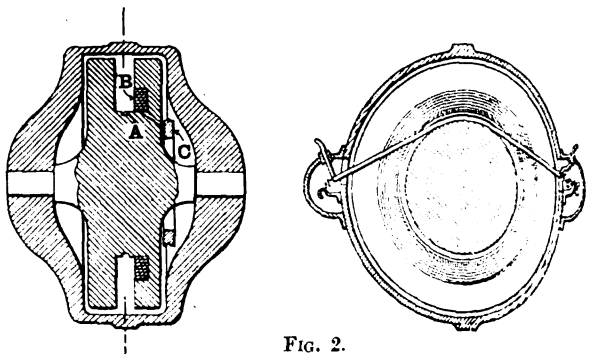

FIG. 2.

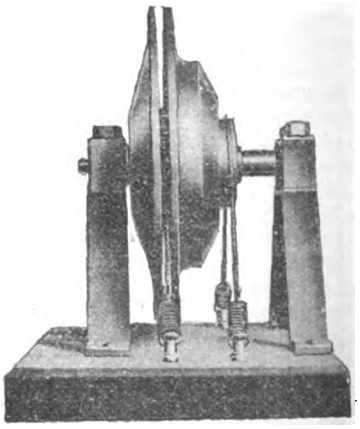

FIG. 3.—VIEW OF HOMOPOLAR GYROSTAT.

The outer casing shown in Fig. 2 is only fitted to enable a vacuum to be obtained; it has no electrical use, so that the whole *motor* revolves, excepting only the brushes. This is more clearly shown in Fig. 3, which is a photograph of an actual model shown at the Electrical Exhibition. The patentees are Messrs. R. H. Barbour and E. Kilburn Scott.

OERLIKON EXTRA HIGH PRESSURE TEST TRANSFORMERS.

The voltage of modern high-tension transmission schemes has gradually increased year by year, and it is to-day quite a common thing to work at a pressure of 60,000 volts or above. Since machines, transformers, insulators, cables, switchgear, &c., have generally to be tested under twice and three times the normal working pressure the tendency to use higher pressures has, therefore, necessitated the designing of transformers for pressures of 200,000 volts and higher.

The Oerlikon Co. have constructed a large number of such apparatus. The illustrations herewith show some of the transformers constructed at the Oerlikon Works. These transformers have horizontally placed cores, and are provided with oil cooling.

A series of such transformers is at the present moment in course of construction at the Oerlikon shops. These transformers have been

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designed for the testing of insulation materials, mainly porcelain, and we are informed that those which have been in use for some 1½ to 2 years are giving excellent results.

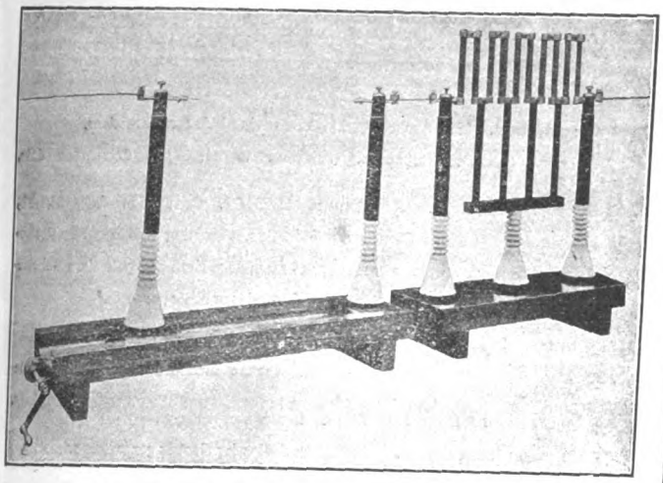

FIG. 1.—SPARK GAP WITH NON-INDUCTIVE RESISTANCE IN SERIES.

It is not difficult to manufacture transformers which can stand for a short time the extra high pressure above referred to, but when they are kept constantly under this pressure it is by no means a rare occur-

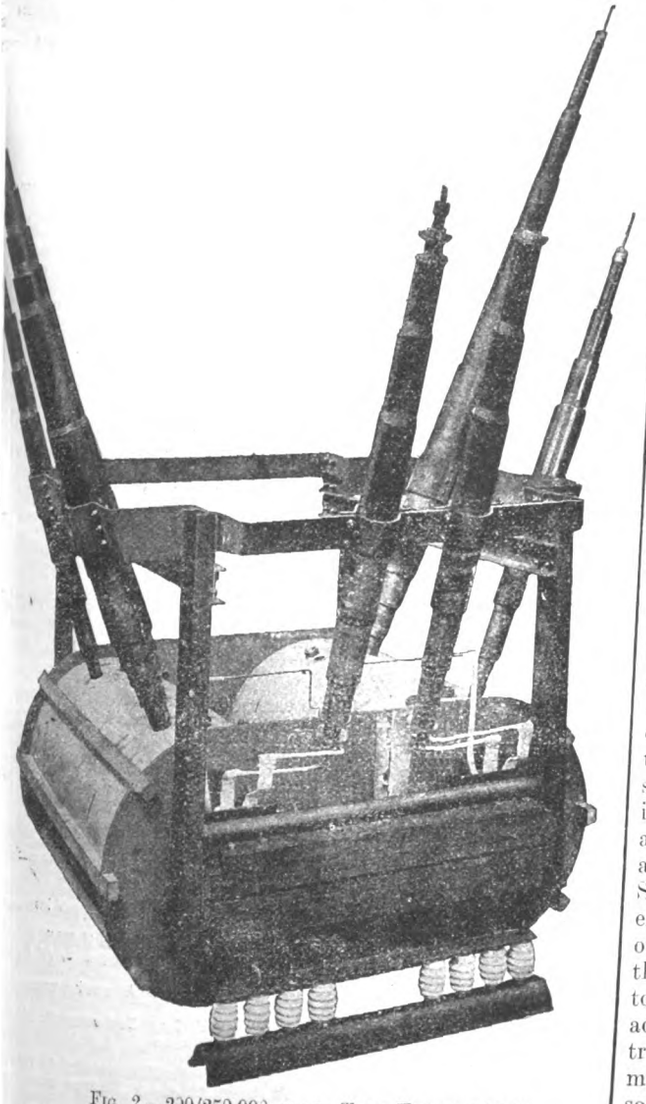

FIG. 2.—200/250,000 VOLTS TEST TRANSFORMER.

rence for brush discharges to develop. Lengthening discharge paths gradually ensue, ultimately resulting in short-circuits. It is, therefore, of particular interest to note that the Oerlikon Works claim that their transformers can operate continuously under the maximum pressure without experiencing such troubles.

For measuring and limiting the pressure in connection with such transformers, the Oerlikon Works use a carefully calibrated spark-gap, with a large non-inductive resistance in series, arranged as shown in Fig. 1. The resistance damps the surges when using the above air-gap.

Fig. 2 illustrates a 25 k.v.a. 200/250,000 volts 50 frequency test transformer, whilst Fig. 3 shows the construction of a 250 k.v.a.

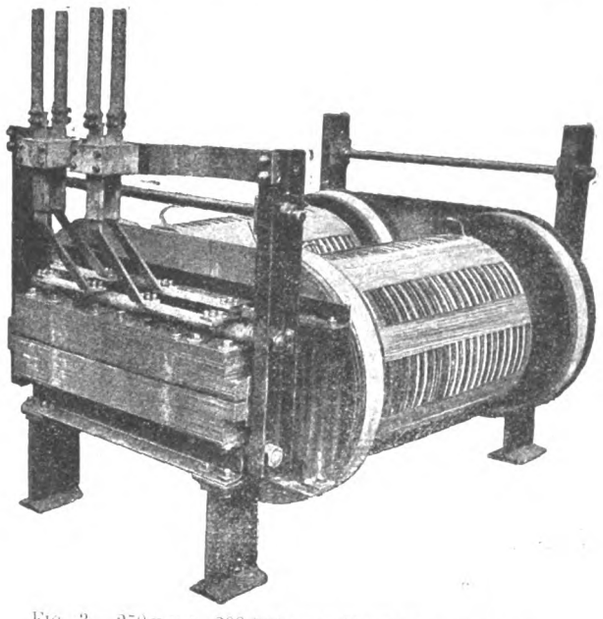

FIG. 3.—250 K.V.A. 200,000 VOLT TEST TRANSFORMER.

transformer for increasing the pressure from 140 to 200,000 volts at a frequency of 50 cycles.

Further particulars can be obtained from Mr. G. Wüthrich, manager of the London branch of the Maschinenfabrik Oerlikon.

ATLANTIC CABLE MATTERS.

We were able to give last week some brief particulars of the arrangement arrived at by the Anglo-American and the Western Union Telegraph Companies in the matter of the fusion of interests which the directors of these companies have been negotiating for some time past. We are now in a position to state that similar arrangements have been made between the Direct United States Cable Co. and the Western Union Co. This arrangement provides that the Direct Co. shall lease to the Western Union Co. for a term of 99 years, as from April 1 last, its cables, telegraph lines, offices, landing places, plant, stores, &c., at an annual rental of £58,568, the period between April 1 and June 30 this year being a matter of a separate item of account. In the case of the Anglo Co. the Western Union takes over all the employés other than those required in the secretary's office at existing rates of pay, terms and conditions, including the benefits under the Anglo Company's Pension and/or Endowment Assurance Scheme. Arrangements are also made which provide for the upkeep of the Anglo Company's Staff Pension Fund. The Western Union Co. also pays the expenses of administering the affairs and maintaining the organisation of the Anglo Co. along with a contribution towards the directors' fees. In the case of the Direct Co., in addition to the rental, the Western Union Co. provides the cost of administration of the Company's business and makes a contribution to the remuneration of the directors and to the maintenance of the value of the Company's Pension Fund so that it may be adequate to meet all subsisting and future liabilities. The Direct Co. retains its reserve fund (£512,323. 2s. 11d.) and remains responsible for the repair and renewal of the leased properties. Provision is made that the Direct Co. shall not be at liberty to pay a dividend of over

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5 per cent. per annum without the consent of the Western Union Co.

All these matters will be fully put before the shareholders at the meeting of both companies at Winchester House, London, on Friday next, Sept. 29.

Mention has been freely made of late of the Sherman Anti-Trust Act and its effect upon the relations between the cable and telegraph companies for the British and American services, and this mention of the Anti-Trust Act has led to much correspondence in the American journals. Among the statements published on this and other points which have been raised is a lengthy one from Mr. George Clapperton, the well-known vice-president of the Commercial Cable Co., from which we make the extract following :—

The announcement (of the Western Union Co.) is grossly erroneous in its statement that cables are utilised to the extent of only about 25 per cent. of their capacity. By working continuously day and night the cables might carry a third more matter than they do carry, but this does not allow for cables out of service because of injury, or unfavourable electrical conditions, or the interruption of terminal land lines. The cable service must be apportioned like any other service which has to deal with congested periods. Its facilities must be expensive enough to take care of its customers during the busy hours. The announcement does not disclose the essential feature of the transaction, and is made for the purpose of covering up the march of the vast Telephone-Telegraph-Cable combination to an illegal monopoly.

In the last report of the American Telephone and Telegraph Company the stand was boldly taken that the cost of aggressive uncontrolled competition was eventually borne by the public and should be eliminated. It will be borne in mind that that company formerly gave a night message rate on its long distance telephone lines, but after it had fully established itself it abolished these night message rates. That is what will happen in the telegraph and cable business if the combination ever succeeds in establishing a monopoly. The plan is not for the public good.

There is very good reason for the Western Union trying to cover up these transactions by talking about reducing cable rates away back in 1882. Those three companies formed a pooling agreement by which they divided, in fixed proportions, their entire Atlantic cable receipts. That pooling agreement was lived up to by all three of those companies until March, 1911; then the Western Union suddenly notifies the Anglo-American and Direct United States Cable Companies that that pooling agreement was in violation of the Anti-Trust Act of Congress of July 2nd, 1890. You will notice that for 21 years, namely from 1890 (the date when the Anti-Trust Act was passed) to 1911, down to the present year, the burning coal of illegality has been lying upon the tortoise back of the Western Union conscience. It quickened when the Western Union coveted the property of its two allies and friends. Accordingly the Western Union on March 1, 1911, threw out the Anglo-American and Direct from the eastbound Atlantic cable business which the Western Union collected by its telegraph system throughout the United States, and which the Anglo and Direct Companies could not collect because they had no American land line telegraph system of their own. That action by the Western Union on March 1, 1911, was for the purpose of clubbing the two English companies into leasing their cables to the Western Union, and it accomplished that purpose.

The pertinent question now is how can this combination by lease be legal, if the combination by pool was illegal? If the Anti-Trust Act of Congress prohibited one how in the world does it not prohibit the other? If it is illegal to combine by pool, it is equally illegal to combine by a lease, and in fact it would seem much more so, because the lease is to cover 99 years, and gives control of the physical properties instead of merely dividing receipts.

This utter disregard of the law and public sentiment in regard to combinations beats anything I have seen lately. It remains to be seen what the attorney-general of the United States will do about it. The proof of the attorney-general is absolute, inasmuch as the notice of the Western Union to the Anglo and Direct Companies that the pooling agreement was illegal under the Anti-Trust Act of Congress is an admission that that Act of Congress prohibits the combination of those three cable companies in any form. Even the counsel of the combine has advised that it is impossible in the present state of decisions to pronounce with certainty upon the validity of the agreement. I get this from the notices which were issued yesterday to the stockholders of the Anglo-American and Direct Companies.

One thing is certain, and that is that the outrageous inconsistency of the whole proceeding on the part of the Western Union has not helped the standing of American business methods in London. So far as a reduction of cable rates is concerned, a reduction was arranged a long time ago with all the cable companies and will be put into effect as soon as the Postmaster-General of Great Britain can bring some other Governments into line.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have granted quotations to £441,620 5 per cent. first mortgage convertible bonds of the *Cuban Telephone Co.*; 268,235 10s. fully paid ordinary shares, and 80,000 £1 fully paid 6 per cent. cumulative preference shares of the *Hastings and District Electric Tramways Co.*; 20,000 £5 fully paid 7 per cent. first cumulative preference shares of the *Melbourne Electric Supply Co.*, and a further issue of £400,000 5 per cent. 50 year mortgage bonds of the *Rio de Janeiro Tramway, Light and Power Co.* The Committee have been asked to grant a quotation to a further issue of 40,370 £5 fully paid 5 per cent. cumulative preference shares of the *Calcutta Electric Supply Corpn.*

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked* are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application, an asterisk is affixed.*

August 2, 1911.

17,550 BRODIE-INNES. (Ela Archer, U.S.) Life-saving belt for electricians.
17,567 BURTON. Electrically-controlled clocks and the like.
17,587 GWOZDZ. Thermic telephones. (Addition to 11,234/11. Convention date, 22/4/11, Germany.)*
17,593 ANNESS. Electrical terminals.
17,595 GWOZDZ. Telephones. (Addition to 11,234/11. Convention date, 22/4/11, Germany.)*
17,597 FELTEN & GUILLEAUME CARLSWERK AKT.-GES. Treating substances by electro-osmosis. (Convention date, 2/8/10, Germany.)*
17,605 ASHCROFT. Electrolytic manufacture of metallic sodium and potassium and electrolyte for use therein.
17,612 OLDHAM. Terminals for electric storage batteries or other purposes.*

August 3, 1911.

17,634 KRAMER. Inductive wireless telephone and telegraphic installations.
17,635 DODDRELL. Method for timing telephone calls.
17,675 Pieper. Speed regulation of dynamo-electric machinery. (Convention date 6/8/10, Germany.)*
17,678 PEMBERTON. Apparatus for the destruction of flies and other insects by electricity.
17,685 STILL & SONS, ADAMSON & KITSON. Incandescent lamps.
17,690 SCHIFF. Carbon electrodes.*
17,708 BALCOMBE & CALVERLEY. Regulating device for electric generators or motors.
17,716 COOPER. Electric motors and dynamos.
17,718 ZENNER. Time switches and the like.*
17,723 B.T.-H. Co. (G.E. Co., U.S.) Arc lamp electrodes.*
17,724 B.T.-H. Co. (C.E. Co., U.S.) Electric switches.

August 4, 1911.

17,761 FIELD. System of electrical cab signalling for railways or the like.
17,768 SIEMENS-SCHUCKERTWERKE G.M.B.H. Driving of rotary field induction motors. (Convention date, 4/8/10, Germany.)*
17,778 WETTER. (Ges. fur Maschinen und Metall-Industrie m.b.H., Germany.) Electric arc lamps.
17,780 B.T.-H. Co. (G.E. Co., U.S.) Method and apparatus for shaping filaments for electric incandescent lamps and the like.
17,784 EDMUNDS. Device for reducing the electrical disturbances produced in electrical signalling circuits by the proximity of alternating currents.
17,788 ALLISON & ARNOLD. Electric switches for use with timing or other predetermining mechanism.
17,791 LEITNER. Means for regulating electric lamp circuits.
17,810 WELCH & FROST & Co. Electrical heating apparatus, particularly vulcanisers.
17,820 GWOZDZ. Telephones. (Addition to 11,234/11. Convention date, 22/4/11, Germany.)*

August 5, 1911.

17,835 GREENWOOD. Dynamo-electric machines.
17,840 DOWDELL. Arc lamps.
17,869 SIEMENS BROS. DYNAMO WORKS. (Siemens-Schuckertwerke G.m.b.H., Germany. Holders for electric lamps.*
17,874 WESTERN ELECTRIC CO. (Western Electric Co., U.S.) Registering device for telephone systems.*
17,875 WESTERN ELECTRIC CO. (Western Electric Co., U.S.) Telephone receivers.*
17,900 GWOZDZ. Telephones. (Addition to 11,234/11. Convention date, 22/4/11, Germany.)*

August 8, 1911.

17,932 DOUGLAS. Design applicable to magneto cut-out and control.
17,978 SCHEPELER. Receiving apparatus for electric transmission of signals. (Convention date, 5/8/10, Germany.)*

August 9, 1911.

18,036 STAFFORD & BARNES. Carriers for supporting incandescent lamp shades.*
18,051 KLEINSCHMIDT. Electric power transmission devices.*
18,078 MEIROWSKY & Co. A.-G. Insulation material. (Convention date, 18/4/11, Germany.)*
18,080 GWOZDZ. Telephones. (Addition to 11,234/11. Convention date, 26/4/11, Germany.)*
18,082 BOSCH. Starting combustion motors having magneto ignition. (Convention date, 1/10/10, Germany.)*
18,083 BOSCH. Interrupter for the electric ignition of internal combustion engines. (Convention date, 10/4/11, Germany.)*

August 10, 1911.

18,115 TAYLER. Automatic switch for telephone circuits.
18,131 HANDCOCK. Wiring of installations.
18,132 LAMME. Windings for dynamo-electric machines. (Convention date, 6/9/10, U.S.)*
18,160 GRIGSBY. Reflector fittings for electric lamps.*

SPECIFICATIONS PUBLISHED.

1911 SPECIFICATIONS.

8,283 CROOK. Selective electric signalling over a number of conductors.
8,387 GOLDSCHMIDT. Method of and means for receiving electric waves in wireless telegraphy and telephony. (4/4/10.)
8,783 LEWIS. Control systems for alternating-current electric motors. (9/4/10.)
8,890 HATHORN, DAVEY & Co. & TOWLER. Controlling gear for or connected with electrically-driven hydraulic pumps.
8,901 STASJANO. Electric furnace.
9,038 CRESWICK & BENTHAM. Cartridge fuses for electrical purposes.
9,050 LOBEL & BRITISH EVER READY ELECTRICAL CO. Portable electric lamps.
9,201 RAILING & BARTLETT. Cooling of the commutators of dynamo-electric machines.
9,633 IMRAY. (Shawinigan Carbide Co.) Electrodes for electric furnaces.
10,080 CHAMBERLAIN & HOOKHAM (LTD.). & HOLDEN. Electricity meters.
10,341 SIEMENS BROS. & CO. (Siemens & Halske Akt.-Ges.) Subscribers' instruments for automatic telephones.
10,545 ZICKEL. Electric shutter indicators. (2/5/10. Addition to 26,502/08.)
10,639 GALLETTI. Production of quenched electrical spark discharges. 3/5/10.)
10,767 FROSALI & VISCONTI. Electrical heating apparatus.
10,834 SIEMENS BROS. & CO. (Siemens & Halske Akt.-Ges.) Alternating current block circuits for railway signalling.
12,117 SIEMENS BROS. & CO. (Siemens & Halske Akt.-Ges.) Semi-automatic telephone exchange systems.
12,742 WHALTON. Electric hammers. (26/5/10.)
12,921 ALLGEMEINE ELEKTRICITATS-GES. Systems of electric motor control. (27/5/10.)
13,707 SIEMENS BROS. & CO. (Siemens & Halske Akt.-Ges.) Electrical measuring instruments of the dynamometer type.
13,317 SOCIETE ANONYME ELECTROMETALLURGIQUE. (Procédés Paul Girod.) Method of supplying electric furnaces with triphase currents. (9/6/10.)
13,715 SUCHTING & OLOFF. Thermo-electric batteries.
13,808 RODECK. Electro-deposition of metals. (10/6/10.)
13,985 ALLGEMEINE ELEKTRICITATS-GES. Railway signals. (10/6/10.)
14,432 SIEMENS-SCHUCKERTWERKE GES. Automatic regulators for electric circuits. (17/6/10.)
17,047 GES. FUR CHEMISCHE INDUSTRIE IN BASEL. Apparatus for the electrolysis of fused alkali chlorides. (22/12/09.) (Divided application on 18,300/10, Aug. 2.)

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COMMERCIAL AND INDUSTRIAL SECTION.

MUNICIPAL, FOREIGN & GENERAL NOTES.

BRITISH NOTES.

Aberdeen.—The Electricity Committee recently fixed the rate for electricity for lighting at 3½d. per unit, 2½d. to ⅝d. for power, and 1d. for heating. The reduction in the charge for lighting is ¼d. per unit.

Bacup.—Sanction to a loan of £1,250 for electricity supply has been applied for by the Council.

Bath.—An inquiry was held here last week into the Council's application for sanction to borrow £7,900 for additional electric generating plant.

It was stated that the money was required for a Diesel oil engine and electric generator, motor alternator and coaster, &c. In the course of the inquiry the electrical engineer (Mr. F. Teague) asked the inspector to make the amount a round £8,000 so as to provide for contingencies.

Replying to the inspector (Mr. T. C. Ekin), Mr. Teague gave particulars of the proposed plant. Unfortunately they had been unable to obtain an English-made Diesel of the size they required, and they had been obliged to get one made by Carels Frères, of Ghent. That firm had built engines of the size they required. They proposed to put in a three-cylinder engine about 250-260 H.P. per cylinder. The total cost would be £5,451, the Diesel Company being responsible for the whole combination. The storage tank would be made through a local tender, and price would be based on that of previous tanks. It was for the foundations that he wanted the contingency money. The booster would cost £400, and it was required to enable them to supply Messrs. Stother & Pitt, who were their largest consumers for power. The cost for the steam driven plant for the year to March 31, for 1,750,000 units was £5,625. That included wages, waste, maintenance and everything connected with generation, but excluded distribution. He estimated that the Diesel engine would generate 1,000,000 units per year, and would run for 80 per cent. of the total number of hours in the year. The dimensions of the full tank was 15 ft. × 10 × 10, and was sufficient for one week's supply. That was considered sufficient, as at Avonmouth (20 miles away), where they got their oil supply, there was always an available supply of 6,000,000 gallons of oil there. In case of a railway strike it could be brought to Bath by road or river.

Bermondsey (London).—The Electricity Committee report the loss of about 75,000 units owing to many consumers shutting down their works in consequence of the late strike. The figures for the current month would also be affected, and there would be a serious loss of revenue.

Bexley.—Last week the Council adopted a scheme for the wiring of consumers' premises on the deferred payment system.

Carlisle.—An unopposed inquiry was held on Tuesday into the application of the Corporation for sanction to borrow £9,000 for mains extensions, the provision of a new storage battery, &c.

The Town Clerk gave particulars of the ratable value, existing loans, &c., and the borough electrical engineer (Mr. S. T. Allen) said that six tenders had been received for the new battery, and the lowest, which was accepted, amounted to £1,755. With regard to the adaptation of the Unitarian Church to the purposes of the Electricity Works, it was stated that £2,750 was the actual purchase money paid for the church, and the adaptation of the building would cost £369. Among other things there would be a new office provided, leaving the old office to be used for stores.

Carnarvon.—On Wednesday the Council decided to adopt electric lighting for the central portion of the town at an estimated cost of £100 per annum.

Douglas (Isle of Man).—The Council have retained Messrs. Handcock & Dykes to report on the proposal to establish electricity works and to construct municipal electric tramways.

Dublin.—The Port and Docks Board have agreed to allow the city electrical engineer (Mr. M. Ruddle) to lay electric mains across O'Connell Bridge.

Electric Fan for Queen Mary.—The American General Electric Co., at their Pittsfield works (Massachusetts), have just made an electric fan for Queen Mary of England. The fan is mounted in gold and has an ebony switch. It has been specially designed en suite with the Royal toilet articles, and is a present from some of the Queen's American admirers.

Electrically-operated Transport Scheme.—Mr. A. W. Gattie continues to move ahead with his great scheme for the transport of goods from a central source, where they will be put on trains by electrically-operated unloading and loading machinery. His great scheme, which has been fully explained in our columns, is certainly making progress, and Mr. Gattie's activities in this direction promise to be fruitful at no distant date. Many men of light and leading are beginning to take an interest, financially and otherwise, in the project, and the leading newspapers are giving their readers up-to-date particulars of the progress that is being made. A recent contribution on the subject appeared in the "Standard" (London) on Sept. 14.

Electricity in Mining.—The Cramlington Colliery Co. are erecting an electricity generating station at Cramlington colliery, at a cost of £10,000.

Exhibition Awards.—Mr. R. Wolf, 7, Laurence Pountney Hill, London, E.C., and Magdeburg-Buckau, who secured a number of distinctions last year at the Brussels and Buenos Ayres Exhibitions (3 grands prix), has now been awarded a grand prix for "Wolf" superheated steam locomobiles shown at the exhibition of the North of France at Roubaix, and the firm has also received the gold medal of the Imperial Russian Ministry of Industry at Odessa. These honours complete a series of highest awards obtained by "Wolf" locomobiles this year at the exhibitions at Omsk, Siberia (2 gold medals), Crefeld (Germany) and Allahabad, India (gold medals).

Hammersmith (London).—In Nov., 1907, the Council agreed to supply Messrs. Gwynnes (Ltd.) with one 50 H.P., four 30 H.P., one 18 H.P and three 10 H.P. motors in addition to a spare motor and a motor generator upon hire, subject to the company entering into an agreement to take current for five years. As the firm now desire three additional motors on similar conditions the Electricity Committee have decided to purchase the motors required and lend same to the company provided they take current for a further period of five years on the terms of their present agreement.

Ilford.—In a report on the tramways undertaking for the past year it is stated that, although a considerable amount had been spent in equipment, a balance out of revenue of £679 was being carried forward, which with interest (£778) made a total of £6,919. The surveyor has been instructed to put in a crossover at the Loxford Bridge terminus at a cost of £130.

Light Railways.—Application is being made to the Light Railway Commissioners for an order authorising a lateral and vertical deviation from the lines shown on the original plans of the Gosport & Lee Light Railways.

Mansfield.—The Council have received sanction to a loan of £3,500 for the electricity undertaking.

Marylebone (London).—The Electrical Contractors' Association have threatened to bring an action against the Borough Council to restrain them from carrying on their wiring and fittings department.

At the Council meeting on Oct. 5 Councillor O. Lewis will move that this Council does not desire to continue competitive trading and that the Electric Supply Committee be instructed to report to the Council as to the advisability of discontinuing the execution of contracts for wiring and the sale of electric fittings.

Norwich.—On Tuesday the Council decided that, as there was no possibility of an arrangement being come to for the purchase of the undertaking of the Norwich Electric Tramways Co., there was no use in entering into negotiations for their acquisition.

Presentations.—Presentations have been made to four members of the staff of the Aberdeen electricity works who are leaving for situations in Vancouver and Australia. To Messrs. A. Allan and A. Rowell a kit bag each, to Mr. Pirie a Gladstone bag and to Mr. J. Coutts a watch were presented.

The staff of Siemens Bros. Dynamo Works (Stafford) have presented a silver tea service to Dr. M. Kloss, who is leaving to take up a university professorship in Germany.

Radcliffe (Lancs.).—The Lancashire Electric Power Co. have decided to renew their application for a provisional order to enable them to supply electric energy for power in this district.

In 1910 the company's application for a provisional order was refused by the Board of Trade, as there was a municipal electricity supply scheme in operation. In communicating their decision the Board stated that "the facilities afforded to power users in Radcliffe to obtain a supply of energy at reasonable terms were inadequate, and in the opinion of the Board should be promptly extended by varying the arrangement with the company or otherwise; and in the event of the company making a fresh application at some future date, and it being shown that the demand for energy for power purposes is not being adequately met, the Board may find it necessary to arrive at a different conclusion." In September, 1910, representatives of the company (Messrs. F. E. Gripper and C. D.

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Taite) had an interview with Mr. E. M. Lacey, consulting engineer of the Council, and in consequence of this interview the company's proposals for arriving at a settlement were put into writing, and included the following suggestions:—

1. That applications from power users be divided into two classes, namely, (*a*) those coming from power users who desire a supply of energy for use within a certain radius of the Council's generating station, and (*b*) those coming from power users desiring a supply outside the said radius.

2. That all applications from power users within the radius be referred to the Council to supply if they so desire. If the Council is unable to give the supply the application shall be referred to the company, and if the company is successful in arranging for a supply to be given, the company shall be empowered by the Council to give the supply for a term of years; and if at the end of the term the Council is desirous of taking over the supply, the Council shall purchase the service cables on terms to be agreed. If the Council do not desire to take over the supply, the agreement empowering the company to give the supply to be renewed.

3. That the company be given general powers to deal with all enquiries received from power users outside the said radius provided that the supply required is equivalent to 50 H.P. or upwards. If the power user requires less than 50 H.P. the inquiry to be dealt with as provided under proposal 2.

4. That the company notify the Council when any agreement to give a supply has been entered into under the above proposals, and that the company pay the Council an annual acknowledgment in each case, the amount of such acknowledgment not to exceed one guinea per annum.

The company's offer appears to have been ignored, but on Jan. 31, 1911, the Council invited the company to quote for supply of electricity in bulk, in accordance with certain requirements, and in due course a quotation was submitted. Correspondence followed, and eventually the company, in the hope of coming to terms, made a reduction in the price originally quoted. Ultimately the Council decided to take a supply of electricity from Bury Corporation. Mr. Taite contends that his company has not been fairly treated, and maintains that if any preferential treatment is to be granted, the power company should be the favoured party rather than Bury Corporation. He sets out his reasons for this in the "Bury Guardian" of the 16th inst. It is submitted that if an agreement is made with the power company so that the company can supply large users of power direct and the Council the smaller consumers, the district will benefit in various ways, and that Radcliffe Council, if they decide to buy power from Bury rather than from the power company, will be lending themselves to forging another link in the chain in favour of Radcliffe's ultimate absorption by Bury. In conclusion, Mr. Taite states that "the company has no desire to in any way infringe the Council's privileges; but being convinced as we are on the one hand of the potential demand for electrical energy from Radcliffe power users and from manufacturers who could be brought into the district were the attitude of the Radcliffe Council more encouraging, and being faced on the other hand with the determined hostility of the Council, the company is bound to assert itself."

St. Pancras (London).—The Finance Committee will utilise £6,977 of the £13,203 profit on the electricity undertaking for the past year in relief of rates. The Electric Lighting Committee will continue the central arc lighting in the widened portion of Euston-road.

Southampton.—Extensions of the tramcar depot at Portswood are to be carried out at an estimated cost of £3,400.

Sunderland.—The Health Committee have accepted the offer of the Lighting Committee to supply electric current for the lighting of each tenement in the Harrison Buildings at 4d. per week.

Walsall.—The Electricity Committee have placed on record their satisfaction at the ability and energy displayed by Mr. Ashton Bremner during the period of six months for which he has been acting electrical engineer of the Corporation electricity undertaking, and the manner in which he has discharged, under trying circumstances, the numerous duties devolving upon him during the absence (owing to illness) of the Borough electrical engineer (Mr. A. S. Barnard), and they have instructed that a copy of the resolution under the common seal should be forwarded to Mr. Bremner.

Wireless Telegraph Notes.—Successful wireless communication was established last week between the French military air cruiser "Adjudant Vincennott," at Lamotte-Breuil and the fortress at Verdun and the Eiffel Tower in Paris, during the whole of a 13½ hours' flight.

The wireless installation at the General Post Office (London) is reported to be nearing completion. On the roof of the south block at the G.P.O. the masts of the installation may now be seen. The equipment is not intended to be used for public messages, but it will be devoted to the carrying out of tests by the engineering staff.

The action brought by the editor of the "Los Angeles Herald" against the editor of a rival journal for intercepting by amateur wireless operators a message sent to the former has been decided. The court held that no offence was committed by the amateurs in intercepting the message or by the rival paper in publishing the intercepted message. The ruling is regarded as unsatisfactory in wireless quarters, and it is probable some further steps may follow to have the decision reversed.

COLONIAL AND FOREIGN NOTES.

Argentina.—A 30-years' concession has been granted to Senor Antonio Grego for the installation and working of a telephone system at Macachin, in the Pampa Central district.

Australasia.—In consequence of the enormous increase in railway traffic, 48 acres of land have been purchased in connection with improvements at the Rome-street station (Brisbane), and on this land it is proposed to construct engine and carriage cleaning sheds, coal stages, and an electric generating station, with sufficient plant to drive all the machinery in and to light the several buildings, and all the suburban stations and tunnels.

The half-yearly report of the Electric Light & Power Supply Corpn. (Balmain, N.S.W.) states that there were 299 consumers in Balmain and 178 in Newtown. The company has entered into an agreement with Petersham Council for the supply of electric light and power in Petersham. A dividend at the rate of 5 per cent. has been declared.

"The Australian Mining Standard" states that for the year ended June 30, 1910, about 187,000,000 passengers were carried by the N.S.W. tramway department, Sydney, and up to June 30 this year the total was 230,000,000. Revenue last year was £1,090,000. At present all the electric power for the service is obtained from the Ultimo power house. On special occasions the output has been hardly sufficient, and it has been decided to erect a new station at Rozelle, in the western suburbs. The proposed plant will, it is stated, be the largest and finest in Australia and will comprise ten 5,000 kw. turbo-alternators. Tenders for the first five turbo-alternators are due by Oct. 30 next.

The Wages Board which decided, amongst other matters, in June, 1910, that linesmen's and arc-lamp trimmers' wages shall be 8s. 6d. per day has been asked by the Secretary of the Electrical Trades Board of N.S.W. to vary the award by increasing this minimum. Mr. Black says Sydney Council pay linesmen 10s.

A new wing has been added to Sydney Technical College, the lower storey of which will be devoted to electrical engineering. New plant for electrical students is to be obtained. There are over 2,500 students attending the college.

During the first wek of August an Order-in-Council was issued authorising the municipalities of Prahran, St. Kilda, Malvern and Caulfield to construct an electric railway between Caulfield, Prahran and St. Kilda. The contractors for the construction of the line (Messrs. Youlden & Howitt) had commenced the construction work, when the men (80 in number) "struck" for an additional 1s. a day.

Woodonga (Victoria) Electric Supply Propy. (Ltd.) has been formed to take over an electric supply concession from Woodonga Shire Council.

The question of the allocation of the cost of regrading the South Geelong (Victoria) Railway to allow the proposed Belmont tramway to run under it has been settled. The Melbourne Electric Supply Co. and the Geelong Council will pay £2,000 each and the Railway Commissioners the remaining £11,000.

Bairnsdale (V.) Shire Council will shortly consider a proposal to borrow £5,000 for electric-lighting plant.

The demands made on the electric power plant at Korumburra (V.) by Poowong and Jeetho Council have increased so rapidly that it is proposed to secure a larger battery.

Renewed attention is being given in the Bendigo district of Victoria to the question of the supply of electricity for haulage and other purposes at the various mines. Mr. G. Smith Morison (Melbourne manager for Siemens Bros. Dynamo Works), Mr. Walter Tuerk (electrical engineer), and Mr. Hoffman (geological expert of the Prussian Government) recently visited Bendigo and inspected various mines. It is reported that the visitors obtained the impression that the Bendigo field was most suitable for the application of electric power.

At a recent meeting of Sydney Electric Light Committee, the city electrical engineer (Mr. H. R. Forbes-Mackay) suggested that a duplicate of the two 4,000 kw. sets, recently installed at the Council's station, be ordered from Messrs. Dick, Kerr & Co. at a cost of £17,245.

Corowa (N.S.W.) Council have adopted a scheme (prepared by Mr. G. A. Julius) for the erection of a small generating station of about 50 kw., the generator being driven by a gas or Diesel oil engine.

The negotiations for the formation of a company to take over the patents, &c., of Complex Ores, Ltd., have been practically completed, and a contract for underwriting the capital has been entered into. The contract stipulates for the immediate provision of the capital necessary for carrying on the hydro-electric part of the scheme, also for a supply of capital as required for other enterprises of the company. The new company is to be known as Hydro-Electric and Metals (Ltd.) and arrangements have been made for the underwriting of £145,000 5 per cent. debentures. The Great Lake hydro-electric works, Tasmania, have been in progress for a considerable time. It is proposed to generate 9,000 H.P. out of which 2,500 H.P. will be required in Hobart. The canals and pipes leading to the power house are to be large enough to give 40,000 H.P., and the first power main to Hobart will be able to transmit 15,000 kw. The company has carbide patents and has also secured the Australian rights for an iron and steel electric furnace. These industries, with the metallurgical works for utilising the J. H. Gillies electrical process for the deposition of zinc, are to be started simultaneously at North West Bay, 10 miles from Hobart.

Canada.—The General Assembly of Nova Scotia recently passed an Act by which the Government can grant aid, under certain con-

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ditions, to companies proposing to construct electric railways in the province. This aid may take the form of a subsidy not exceeding £410 per mile, a loan not exceeding £1,640 per mile of railway built and worked, or a guarantee of the bonds or debentures issued.

The Dominion Government will grant assistance towards the construction of the proposed civic hydro-electric works at La Colle Falls, on the Saskatchewan River. Mr. Cecil B. Smith, who supervised the construction of the Winnipeg power plant, thinks that the new power plant in Prince Albert will result in largely increased activity in manufacturing in the city.

China.—A Shanghai journal states that the Peking Board of Communications has authorised an inquiry into a tramway scheme for Peking.

Colombia.—The municipal authorities of Riosucio have consented to a proposal by Mr. Geo. Gartner to erect electricity works for the town.

Electric Traction in Chili.—It is reported that the Chilian Government does not propose to accept any of the tenders submitted for the electrification of the Santiago-Valparaiso section of the State railways, and that it will carry out the work itself. The cost of the operation, according to the Westinghouse Co.'s tender, will be about £4,500,000.

Germany.—The report of the British Consul-General, Sir F. Oppenheimer, on the trade of Germany for 1910 and the first four months of 1911 states that the import of copper in 1910 was 181,551 tons (compared with 154,672 tons in 1909) and that this increase may be regarded more especially as a criterion of the activity in the German electrical industry, which consumes nearly half of the 200,000 tons of copper annually imported into Germany.

A Bill is being promoted to revise the rates for telephones so that the annual subscription will entitle the subscriber only to a limited use, all calls beyond a given number being paid for on the message-rate system. Among the industries for which the year 1910 was above the ordinary were the electrical, the chemical and the toy industries; the machinery industry also fared better than during recent years. In the electrical and chemical industries, and to a certain extent also the machine industry, the steady rise is due to the scientific training as applied to industry which has ensured a stock of highly skilled workers. The electrical industry had barely been affected by the last commercial depression. It steadily conquers new fields (shipbuilding, mining, the production of steel, &c.), and when a revival of trade sets in it benefits from an increased demand in its new branches also. In Germany the industry is combined in three large concerns. These firms compete against each other for the erection of electric power transmission works, which have of late increased with exceptional rapidity. They erect power stations for parish or rural councils, and endeavour as far as possible to manufacture in their own workshops and factories all the material which is necessary for such stations. On the other hand there also exist in Germany electrotechnical factories, which specialise in the manufacture of the extraordinarily numerous electrotechnical products. These employ 55,000 hands out of a total of 125,000 engaged in the industry. There is a third group (the electrical installation firms), but the first-named concerns have tried by means of ingenious contracts with communities and district councils to exclude more and more the competition of the other two branches and so to secure for themselves the furnishing of the entire material and the installation work. Most of the Governments which make up the German Empire have prohibited the conclusion of such contracts, and have warned the communities against allowing any creation of private monopolies. Among all German industries (continues the report) there is none which so thoroughly resembles the much-dreaded American Trust in aspect and methods as the electrical industry. The export of motors and dynamos amounted to 299,687 doppelcentners (the doppelcentner is equal to 220 lb.) in 1910 against 237,380 doppelcentners in 1909. Of electric lamps there were exported 19,782 doppelcentners against 16,552; arc lamps, 7,491 against 7,601; electrical appliances for lighting, transmission of power, &c., 99,563 against 71,895; and telegraphic apparatus, &c., 15,708 against 16,004 in 1909. The value of the export in these six groups alone amounted in 1910 to 146,000,000 marks against 116,000,000 marks in 1909.

The Prussian State Railway administration seems inclined to introduce electric power. In 1909 the means for the necessary experiments on a full gauge line were voted by the Landtag. The line chosen was the one between Bitterfeld and Dessau, 26 kiloms. (over 16 miles) in length, which forms a part of the Magdeburg Leipzig Halle main line. The electrification was begun on Jan. 18, 1910, and the line was in working order at the end of the year. Electric power was produced in a generating station in the centre of that lignite district. The State has secured the supply of brown coal at 2 marks per ton for 30 years. The results achieved with this experimental electric railway are described as extremely satisfactory. Speeds of 125 kiloms. per hour were reached, the working itself was characterised by punctuality and cleanliness, the permanent way is spared wear and tear, and the work of the staff is facilitated. A memorandum presented to the Prussian House of Representatives states that the experiments with electric locomotives on the line have been so satisfactory that the Prussian State Railway Administration will in future pay the greatest attention to electric traction for trains, the more so since steam locomotives have reached a degree of perfection which would almost seem to exclude any further improvement. In spite of the excellent work done by steam locomotives they will in future not be able to meet the increased demands of the passenger and goods traffics. The size of the new express locomotives cannot be exceeded for technical reasons, and owing to their enormous consumption of coal the firing of these giant machines by hand is already causing serious difficulties. It will in future be necessary to fall back upon electric locomotives if the speeds and the number of trains are to be increased. The advantages of electric over steam traction are very considerable, and include diminution of working expenses in consequence of concentration of power production, the use of lignite instead of mineral coal, the diminution of the dead weight of trains through the absence of fuel and water, the greater power of electric locomotives, which can under certain conditions accomplish non-stop runs of many hundred kilometres, decreased cost of maintaining locomotives and permanent way, the possibility of heavier traffic through an increase in the number of trains, the absence of damage done to adjoining land by sparks from the engine, increased facilities for the men no longer exposed to the weather and to coal dust since the driver's cabin in an electric locomotive is entirely closed and in view of the simplicity of the working of an electric locomotive, the driver can pay even greater attention to signals.

Italy.—The Soc. Italiana di Industrie Elettriche, Spezia, have obtained a concession for the construction of an electric tramway from Spezia to Cadimare.

Poland.—A consular report on Poland and Grodno says there is a good opening in the Lodz district for steam turbines and electrical machinery. Important orders for this class of machinery are constantly being placed in Germany. By far the greater number of steam, gas and oil engines continue to be imported from Germany and Austria. It is seldom that an English made steam engine is heard of in this district, and the question of price, it is asserted, is not the cause for this.

Buildings of from 8 to 14 storeys are being built in this district, and there is a good opening for lifts of British make. The trade is at present in German and American hands. Electric lifts find most favour.

Electric light is practically always installed in the new buildings, either alone or in conjunction with gas. Birmingham electroliers and electric light accessories are both cheaper and better than the German goods, but British manufacturers of these articles are little represented in Poland.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Ayr.—The report of the borough electrical engineer (Mr. R. Marshall) for the year ended May 15 states that the capital expenditure is £103,367, increase £1,038 over 1910.

Income was £14,851 (decrease £16), working and general expenses were £6,868 (increase £115), gross profit was £7,983 (decrease £131), and net profit £2,256 (decrease £188). Total (equivalent) 30 watt lamps connected are 72,470 (increase 4,220), including 138 motors (500 H.P.). There are 109 arc and 242 incandescent lamps for public lighting, and all the latter have been converted from 32 c.p. carbon to 64 c.p. metallic filament lamps, not only doubling the candle power, but considerably reducing the consumption for pulic lighting by 52,052 units. The total units sold were 1,456,394 (decrease 26,089).

The total revenue of the tramways department for the year ended May 11 was £15,492, an increase of £485. The number of passengers carried was 3,760,746, an increase of 82,118, and the car-miles run was 386,434, a decrease of 1,270, due chiefly to a reduction of the service during the winter months. Working expenses (excluding power) amounted to £6,429, or 3·99d. per car mile, and including power charges to £8,492, or 5·29d. per car mile. The percentage of working expenses to receipts was 54. Revenue from parcels delivery again showed satisfactory increase. The number of parcels dealt with was 22,046, and the receipts amounted to £148. The balance from the year's working was £3,046, of which £1,963 was carried to depreciation and renewals fund and £1,083 was transferred to the Burgh general assessment.

Newcastle-on-Tyne.—The accounts of the Corporation tramways department for the year ended March last show capital expenditure (including public lighting) £1,184,644 and the total amount of loans repaid and sinking fund instalments is £301,189.

Revenue was £215,850 (£209,676 in previous year), gross profit was £101,877 (£92,081) and, after meeting capital charges and contributing £1,538 to rates (for interest, &c., on unexpired horse tramway loans) the surplus was £23,703 (£15,120). 45,335,207 (44,516,958) passengers were carried, 4,437,639 (4,430,085) car-miles run and 8,481,806 (8,213,651) units used. Traffic revenue per car-mile was 11·15d. (11·016d.) and total operating cost was 6·164d. (6.37d.)

Portsmouth.—The accounts of the electricity supply department for the year ended March show capital expenditure £339,083 (increase £4,266).

Revenue was £47,309 (against £47,194), working and general expenses were £21,845 (£24,321), gross profit was £25,464 (£22,873). After meeting capital charges and paying £367 income tax, the balance was £4,579 (£1,801), of which £579 (£301) has been transferred to insurance fund, £3,500 (£1,500) voted in aid of rates and £500 carried forward. Units generated were 45,38,500 and units sold 3,464,420. Total maximum supply demanded was 2,720 kw. Public lamps include 272 large and 144 flame arcs and 496 incandescents.

At the last meeting of the Electric Light Committee Coun. Mactavish criticised the policy of applying the profit to relief of rates. The method

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of using the profits from the undertakings must necessarily mean discriminating between one class of ratepayers and another. A small amount of the profit might be used for the relief of rates, but the bulk of it should be used for extension of the system, increasing wages, &c. The trading committees of the Council paid too much (£15,000) to relief of rates.

Coun. H. R. Pink, who supported the proposal, said that while ratepayers benefited from profits, they had also to meet the losses on some undertakings, and after some discussion the report was adopted.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Tenders are invited up to Dec. 20 for the supply of one branching multiple magneto switchboard at Broken Hill to the Postmaster-General's Department in NEW SOUTH WALES. Tender forms and specification from the Commonwealth Offices, 72, Victoria-street, London, S.W. See an advertisement.

Tenders are invited up to Nov. 21 for supply of one automatic or semi-automatic switchboard and equipment to the Postmaster-General's Department in WESTERN AUSTRALIA. Tender forms and specifications may be obtained at the Commonwealth Offices, 72, Victoria-street, London, S.W. See an advertisement.

Tenders are invited up to Nov. 1 for the supply of 5,000 porcelain (No. 8) insulators to the Postmaster-General's Department in SOUTH AUSTRALIA. Tender forms and specification from the Commonwealth Offices, 72, Victoria-street, London, S.W. See an advertisement.

Tenders are invited by the City of MELBOURNE for the supply of 8,000 yds. three-inch fibre conduit, suitable for laying underground in concrete, and to be used for containing lead-covered cables. Specifications, &c., from the Agents for the City Council, Messrs. McIlwraith, McEacharn & Co. Ppty. (Ltd.), Billiter-square-buildings, London, E.C., to whom tenders by noon October. 3.

LONDON County Council require tenders by 11 a.m. Oct. 24 for supply of hand-power overhead crane, h.t. and l.t. cables and switchgear, &c., rotary converters and static transformers, for sub-stations. Specifications, &c., from the Clerk.

HACKNEY (London) Borough Council require tenders, by 7 p.m., Oct. 12, for supply of 100,000 pairs of white open type arc lamp carbons. Specification, &c., from the Town Clerk.

MANCHESTER Electricity Committee require tenders by noon Oct. 4, for supply and erection of a 4,000—4,500 kw. low-pressure exhaust type turbo-alternator. Specification from the Secretary, Town Hall, Manchester.

HASTINGS Guardians require tenders by Oct. 18 for the electric lighting of the workhouse premises, Ore, Hastings. Specification from Mr. S. Bumstead, 11, Wellington-sq., Hastings.

Tenders are invited up to Oct. 18 for the supply of 20 coin-in-the-slot attachments to the Postmaster-General's Department in WESTERN AUSTRALIA; up to Oct. 25 for supply to the Postmaster-General's Department in SOUTH AUSTRALIA of cable and paper sleeves; up to Oct. 2 for supply of 10,000 porcelain insulators to Postmaster-General's Department, TASMANIA; and up to Oct. 3 for supply of 42 miles of telephone cable to the Postmaster-General's Department, VICTORIA. Tender forms, &c. at the Commonwealth Office, 72, Victoria-street, London, S.W.

The Metropolitan Water and Sewerage Board, Albert-street, BRISBANE, Queensland, want tenders by noon Jan. 30 next for supply and erection of one, two or three complete units, each consisting of power generating plant and pump or pumps to lift not less than 6,000,000 gallons per day. Particulars from the Secretary, and forms from the Agent-General for Queensland.

DUNEDIN (N.Z.) Corporation require tenders by Nov. 1 for supply of (1) 500 B.H.P. vertical type gas engine or Diesel oil engine, suitable for rope driving an a.c. motor and d.c. generator; and (2) direct-coupled vertical type gas engine or Diesel oil engine and d.c. generator (800 kw. at 550 volts). Specification at 73, Basinghall-street, London, E.C.

WEST DERBY Guardians want tenders by Sept. 26 for 12 months' electrical supplies, &c. Forms of tender from the Clerk, Broughamterrace, West Derby-road, Liverpool.

BELFAST Markets Committee want tenders by Sept. 26 for wiring new abbatoir in Stewart-street. Specifications from the City Surveyor.

HACKNEY (London) Guardians want tenders (by 10 a.m. Sept. 27) for extension of the telephone systems at Homerton. Forms from the Clerk

MANCHESTER Tramways Committee require tenders by 10 a.m Oct. 3 for permanent way special track work, for points, tongues and hardened steel centres. Specificam Mr. J. M. McElroy.

LIVERPOOL Select Vestry require tenders for electric lifts and electric lighting at the workhouse. Names of intending tenderers should be sent by Sept. 30 to the Clerk, Brownlow-hill, Liverpool.

TULCEA (Roumania) municipality require tenders by Nov. 19 for electric lighting of the town.

Tenders are invited by the Municipal Council of PELOTAS (Brazil) for a 40 years' concession for the supply of electricity for power and lighting and the establishment and working of electric tramways. Tenders to Senhor Luiz M. da S. Pennafiel, Intendencia Municipal, Pelotas, up to 1 p.m. Nov. 14. A deposit (about £300) is required with each tender, to be increased by the successful tenderer to 25,000 milreis (about £1,670). Further particulars (in Portuguese) can be seen by British contractors at 73, Basinghall-street, London, E.C.

Tenders will be received at the Town Hall, SYZRAN, Russia, on Oct. 14, for the construction of an electric tramway and the supply of electrical energy for lighting.

TENDERS RECEIVED AND ACCEPTED.

Poplar (London) Electricity Committee have received the following tenders for two water-tube boilers with underfeed stokers and hot-air economisers:—

Babcock & Wilcox (2 motors) (*accepted*) £8,190; Stirling Boiler Co., £7,673 (3 motors),* £7,202 (4 motors), £7,983 (2 motors);* Howden Boiler Co., £8,200 (3 motors),* £8,408 (4 motors),* £8,608 (2 motors); Clarke, Chapman & Co., £8,571; Fraser & Chalmers, £10,498. *Not to Specification.

The borough electrical engineer (Mr. J. H. Bowden) thought the tender of Messrs. Babcock & Wilcox should be accepted, but instead of both boilers being fitted with underfeed stokers and hot-air economisers, only one should be fitted in this manner and the other with close link travelling grate, with water economiser and induced draught. After considering the facts the Committee decided to recommend the acceptance of the tender of that firm.

For supply and erection of a 30-ton electric overhead travelling crane the following tenders were received by the Poplar (London) Electricity Committee:—

Royce (Ltd. (*accepted*). £960; Chatteris Engineering Co., £845; Jas. Carrick & Sons, £912; A. Jack & Co., £950; S. H. Heywood & Co., £961 and £1,060; Cowans, Sheldon & Co., £995; J. Booth & Bros., £965; C. & A. Musker, £998; Marshall, Fleming & Co., £1,010; Babcock & Wilcox, £1,025; Stothert & Pitt, £1,040; Howden Boiler Co., £1,045, £1,104, £1,134 and £1,290; Sir William Arrol & Co., £1,046; Herbert Morris & Bastert, £1,062; Ransomes & Rapier, £1,155; Carrick & Ritchie, £1,169; Alex. Chaplin & Co., £1,220; J. Carter & Sons, £1,295; Craven Bros., £1,310; Jas. Spencer & Co., £1,320; J. Smith, £1,325; J. Henderson & Co., £1,605 and £1,620.

The contract for an extension to existing coal conveyor has also been placed by Poplar Council with Babcock & Wilcox at £373. Consideration of the tenders for an overhead bunker and for a combined coal elevator and conveyor has been deferred.

Farnham Gas and Electricity Co. have placed the following tenders for generating plant:—

Mirrlees, Bickerton & Day, two high-speed Diesel engines, two 90 kw. alternators, with d.c. exciters, &c., £3,795; Spagnoletti Limited, switchboard (with additions), £727.

The consulting engineers are Messrs. Handcock & Dykes.

The tender of the Corona Lampworks (Ltd.), Aschem-street, St. Pancras, N.W., has been accepted for the whole of the metal filament lamps for the Queen's Theatre, Shaftesbury-avenue, where the new comic opera "Bonita" is being produced by Mr. Courtneidge.

Auckland (N.Z.) Council have accepted the tender of Siemens Bros. Dynamo Works for electric power plant, including two Bellis-Siemens direct-coupled alternators of 1,000 kw. and two others of 600 kw. each, with boosters, balancers, switchboards, &c. The total amount of the contract is over £37,000.

Mr. C. W. Webster has obtained an order (through Messrs. McIlwraith, McEacharn & Co. Ppty., Ltd., of London) to supply Melbourne City Council with a large quantity of flame carbons, approximating 700,000 ft.

Mr. Webster's firm (the Compania Fabril de Carbones Electricos, of Barcelona) are manufacturing highest grade beacon flame carbons, and he has lately received contracts and orders to supply many Corporations in this country.

Southwark (London) Council have accepted the following tenders:

Siemens Bros. Dynamo Works, 40 kw. motor-generator and switchgear, £121. 15s.; British Insulated & Helsby Cables, 440 yds. one l.t. cable, £97. 10s.; Reavell & Co., air compressor for cleaning the generators, £64. 10s.

Blackburn Guardians have accepted the tender of J. W. Garsden & Co. for an electric heater at £192. 10s., in place of a compressed air heater previously recommended for acceptance.

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North Ormesby Council have accepted the tender of Baker Bros. for a fire-alarm installation at £68.

Sherburn Council have accepted the tender of Haydn Harrison for 36 250-volt 50 c.p. Osram lamps.

Mansfield Education Committee have accepted the tender of the Mansfield Engineering Co. for wiring Carter-lane schools at £40.

Waterloo Council have placed an order with H. Leake & Co. for the electric lighting of the secondary schools at £421.

Brighton Guardians have accepted the tender of G. Virgo for electric light fittings at £37.

Warrington Education Committee have accepted the tender of H. Bibby for wiring Evelyn-street schools at £344. 10s.

Westinghouse Contracts.—Among recent orders secured by the British Westinghouse Electric & Mfg. Co. are the following :—

R. Jeffry, two 140 k.v.a. alternators, trans. switchgear, motors, compressors, &c.
Montague Higginson & Co., one 150 kw. alternator, exciter and rheostat.
London County Council, 100 sets controllers, &c., and 10 magnetic brakes.
Hetton Coal Co., one 250 H.P. motor controller.
Noyes Bros. (for Adelaide tramways), 40 T.I.F. controllers.
Ditto (for Sydney), two 60 kw. d.c. generators.
Met. Dist. Railway Co., one 1,200 kw. rotary converter, transformers and switchgear.
British Insulated & Helsby Cables, one 200 kw. rotary converter, transformer and switchgear.
Port of London Authority, three 300 kw. rotary converters.
London Electric Railways Co., one 1,500 kw. rotary converter and three 550 k.v.a. transformers.
National Telewriter Co., 50 14,060 double-gear machines.
Consolidated Gold Fields of S. Africa, one 275 k.v.a. and one 940 k.v.a. steam engine sets.
Ocena Cons. Co., two 200 kw. d.c. generators with equipment and switchgear.
Crains Limited, one 85 kw. a.c. generator and exciter, six 20 H.P. and various motors.
Rintoul & Davis, one 118 kw. motor-generator set.
Cambrian Combine, one 35 kw. motor-generator set.
Workington I. & S. Co., one 80 kw. d.c. generator, haulage gear, pumps and control gear
Randfontein Gold Mining Co., one electric main hoist.
Ingersoll, Rand & Co., two 540 H.P. d.c. motors.
A. Ransome & Co. (for Grangemouth Docks), one 2 H.P., two 10 H.P., one 30 H.P., two 50 H.P., 220-volt G. motors, starters and switchboards.
Greenwich Inlaid Lin. Co., one 100 H.P., one 50 H.P. and one 35 H.P. a.c. motors and control gear.
Sir W. G. Armstrong, Whitworth & Co. (for Murray Docks), six 20, 2,315 G., six 4 H.P. 1,609 G. 460 volt motors and control gear.
M. Samuel & Co., one 65, one 64, one 25 a.c. motors and pumps.
Central Argentine Railway Co., eight motors aggregating 70 H.P., 500 volt FFB motors.
Staveley Coal & Iron Co., 16 10 H.P. motors and 4,000 k.v.a. transformers.
Babcock & Wilcox, 16 motors aggregating 30 H.P., 220 volt.
Gt. Indian Pen. Railway, G. motors, control gear and spares.
Leys Malleable Castings Co., six 12 H.P. 550 FFB motors and panels (one back geared).
Agar, Cross & Co., various CCB motors and auto-starters, one 20 H.P. 565 FFB and starting rheostat.
Thomas Barlow & Sons, two 312 H.P. slip-ring motors, &c.
Powell, Duffryn & Co., Elliot pit pump ventilation.
Daimler & Co., switchgear.
City of Santos Improvement Co., spare parts for equipments supplied.
Metropolitan Railway Co., one 1,200 kw. rotary transformer, switchgear, &c.
Stalybridge Tramways, transformers.
West Ham Corporation, transformers and switchgear.
Strain & Robertson (Alianza Co.), transformers and switchgear.
Daimler & Co., transformers and switchgear.

Government Contracts.—The British Government Departments have placed contracts with the following firms during August :—

War Office.—British Insulated & Helsby Cables, W. T. Henley's Telegraph Works Co., Hooper's Telegraph & India Rubber Works, India Rubber, Gutta Percha & Telegraph Works Co., London Electric Wire Co. & Smiths, Midland Electric Wire Co., St. Helen's Cable & Rubber Co., and Siemens Bros. & Co., electric cable, &c. ; J. A. Prestwich & Co. and Willans & Robinson, oil engines ; Siemens Bros. Dynamo Works, generating set.

General Post Office.—British Insulated & Helsby Cables, bell sets, flexible cords and bronze wire ; London Electric Wire Co., flexible cords ; British L. M. Ericsson Mfg. Co., plugs and lightning protectors ; Western Electric Co., paper core cables and extension of telephone apparatus at Mayfair Exchange ; Medway's Safety Lift Co., electric lifts for W.C. London) District Post Office.

India Office.—J. Stone & Co., armatures and electrical fittings.

Crown Agents for the Colonies.—Western Electric Co., telephones, &c. ; Marconi's Wireless Telegraph Co., wireless installation.

H. M. Office of Works.—Siemens Bros. & Co., cables for Imperial College of Science.

BUSINESS NOTICES.

A temporary (Post Office) telephone exchange was opened yesterday (Thursday) at the Electrical Exhibition, Olympia, London. All connections are being made via "City" Exchange.

The partnership between Wm. and Jacob T. Walmsley and Ernest F. Lucas (trading as the W. & L. Electrical Engineering Co.), Granville-street, Swinton, near Manchester, has been dissolved. Debts by Messrs. W. and J. T. Walmsley, who continue under the old style.

The address of the International Institute of Technical Bibliography and of "Engineering Abstracts" has been removed to 68, Hampstead-way, N.W.

Directive Wireless Telegraphy.—In order to comply with the requirements of the Patents and Designs Act, 1907, apparatus for the Bellini-Tosi directive system has been manufactured by the Helsby Wireless Telegraph Co. under licence from the patentees.

Agency.—A German firm of accumulator manufacturers advertises for a London firm with a connection among motor-car makers, &c., to take over the sole agency of their portable accumulators.

Plant for Sale.—Mr. Alex. Mein, Station-street, Stratford, London, E., advertises for sale a Crompton three-phase alternator, switchboard, &c.

Mr. D. Spero, 31, Duke-street, Aldgate, London, E.C., advertises for sale a steam engine, two dynamos, switchboard, battery, motor, &c.

Plant Wanted.—The New Transport Co., Bath House, Holborn Viaduct, London, E.C., require a second-hand 10 H.P. (12 H.P.) motor, single-phase, 100 volts, 40 periods.

An advertiser requires a portable petrol-driven electric light plant for cinematograph theatre. Applications to Mr. A. West, Illawarra House, All Saint's-road, Bromsgrove.

Patents Development.—The owners of patents No. 23,501/99, relating to "Improvements in vacuum tube lighting," and No. 12,582/02, relating to "An improved system of electric lighting," desire to negotiate with electrical engineers with the view of granting licences. Applications to Messrs. Lloyd Wise & Co., patent agents, 46, Lincoln's Inn Fields, W.C.

The proprietor of patent No. 20,324, 1902, for "Improvements in conduits for electric cables," desires to grant manufacturing licences. Applications to Mr. C. Lean, patent agent, 231, Strand, London, W.C.

The owners of British patent No. 23,778/1907, for "Improvements in the manufacture of electric resistances," desire to sell their patent rights or to grant licences thereunder. Particulars from Messrs. Day, Davies & Hunt, patent agents, 321, High Holborn, London, W.C.

Business for Sale.—The business of an electric motor manufacturing company is advertised for sale in another column.

BANKRUPTCIES, LIQUIDATIONS, &c.

The official receiver (Mr. H. E. Burgess) has issued his report in the liquidation of J. G. Childs & Co. (Ltd.)

The accounts show total liabilities £30,202, of which £22,978 is unsecured, the assets valued at £3,410 being absorbed in the debenture claims. The deficiency to the contributories is estimated at £41,060. The company was formed in Dec., 1901, with a capital of £20,000 to acquire and carry on the business of electrical engineer belonging to Mr. J. G. Childs. The trading, which consisted chiefly of the manufacture and sale of electrically-controlled lifts, was carried on throughout at a loss, and since Feb., 1908, with the assistance of debentures. In the following October the directors resolved to take up the manufacture of wind turbines, incorporating certain inventions of Mr. Childs relating thereto. Considerable expense was incurred in developing and advertising the wind turbines, and a small number was sold, about five in this country and four abroad. On March 31 last Mr. H. W. Freshwater was appointed receiver on behalf of the debenture holders and is realising the company's assets and completing a number of unfinished contracts. The insolvency of the company is attributed chiefly to contracts having been undertaken at prices which were not remunerative, and to excessive expenditure in carrying on the business.

A meeting of creditors of Silicaware (Ltd.) will be held at the offices of Messrs. Gundry, Straus & Soper, 7, Gt. Winchester-street, London, E.C., on Oct. 17.

A first and final dividend of 3s. 9½d. will be payable on Sept. 26 at 12, Duke-street, Bradford, to creditors of Wm. Hy. Illingworth (trading as the Yorkshire Metal Filament Lamp Co.), 30, Pellon-lane, Halifax.

The trustees (Mr. Chas. H. King, 26, Baldwin-street, Bristol) in the bankruptcy of Valentine Geo. Burkitt, electrical engineer, 38, Park-row, Bristol, has been released.

The liquidator (Mr. C. Mercer, 14, Bedford-row, London, W.C.) of Electrical Instrument Manufacturers (Ltd.) has been released.

COMPANIES' MEETINGS AND REPORTS.

CLEVELAND & DURHAM ELECTRIC POWER (LTD.)—The report of the directors for the year ended June 30 states that the gross profits for the year amounted to £20,973, compared with £12,942 for the previous year. After providing for debenture and other interest the net profit was £8,342, which it is proposed to carry forward. During the past year the capital expenditure was £9,107. The connections to the company's system aggregated 40,460 H.P., an increase of 4,177 H.P. In addition 12,500 H.P. has been recently contracted for and other important negotiations are proceeding. Arrangements are being made to work further waste heat generating stations at the Tees Furnace Co.'s Lackenby Ironworks, Redcar ; the Port Clarence works, Messrs. Bell Bros., Middlesbrough ; the Ayresome Ironworks of Mills & Co., and also at the Redcar Ironworks of Walker Maynard & Co. The scheme for the rearrangement of the capital was confirmed by the Court in December last and the capital now stands reduced by £299,915.

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DICK, KERR & CO. (LTD.)—The directors' report for the 12 months to June 30 last states that the profits earned amounted to £37,994. 3s. 2d. Out of this debenture interest and trustees' fees had been paid and there had been reserved the sum required to provide for the premium payable on redemption of debenture stock. These items absorb £12,060. 8s. 11d., leaving £25,933. 14s. 3d., added to the profis brought forward from last year (£42,858. 0s. 8d.) making £63,191. 14s. 11d. available to pay the 6 per cent. preference dividend (£18,300), and an ordinary dividend of 5 per cent. (less tax) (£13,000), carrying forward £36,891. 14s. 11d. Notwithstanding continued competition in all branches of the business during the past year, the directors are pleased to submit accounts which show considerable improvement in comparison with the two preceding years. Should the present hopes of the directors be fulfilled the prospects are encouraging.

DIRECT UNITED STATES CABLE CO. (LTD.)—The report of the directors states that for the six months to June 30 the half-year's revenue, after deducting out-payments, amounted to £46,229. 17s. 11d., compared with £58 555. 0s. 5d. for the corresponding period of 1910, a decrease of £12,326. 2s. 6d. This falling-off is due to the Western Union Telegraph Co. having departed from the arrangement that has been in force since 1882, by withholding traffic collected by that company in America which has hitherto been transmitted over the cables of the Anglo-American Telegraph Co. and of this company. Working and other expenses during the six months, including income tax, amounted to £27,743. 19s. 4d., compared with £25,277. 6s. in the corresponding six months in 1910, an increase of £2,471. 13s. 4d., which is accounted for by expenses at the Harbour Grace station, established in the latter part of last year and which appear now for the first time in the accounts. The reserve fund account, after being debited with the cost of maintenance of cables, balance of expenditure on fire extinguishing plant at Ballinskelligs station, expenditure in connection with the diversion of the cable to Newfoundland, and the transfer to revenue of £7,168. 6s. 7d. (to provide for the dividend and bonus paid on July 31 last), and being credited with interest on the investments and profit on sale of securities, stands at £512,323. 2s. 11d., compared with £533,024. 5s. 1d., at June 30, 1910, showing a decrease of £20,701. 2s. 2d. If, however, the expenditure of a capital nature upon the company's properties and in connection with the diversion of the cable (£31,203. 19s), which has been charged to reserve during the year, be taken into consideration, it will be seen that £10,502. 16s. 10d. has been added to reserve during the year, after charging against it cost of maintaining and renewing the cables.

As the result of negotiations, extending over many months, an agreement, of which particulars accompany the report, has been provisionally entered into by the directors with the Western Union Telegraph Co. This agreement will [as mentioned elsewhere] be submitted to the shareholders at an extraordinary general meeting at the conclusion of the 68th ordinary general meeting. The negotiations were in progress in July when the final accounts have hitherto been issued, but in the circumstances the directors considered it was not in the interests of the shareholders then to issue them. They therefore deferred the publication of the accounts, paying a dividend and bonus for the quarter to June 30 last at the same rate as for the corresponding quarter in 1910. Thus a dividend of 4 per cent., with a bonus of 1 per cent., making 5 per cent. in all, was paid to the shareholders during the past financial year.

[Reference is made to the agreement between the Direct Company and the Western Union on p. 943.]

DUNDEE, BROUGHTY FERRY & DISTRICT TRAMWAYS CO. (LTD.)—The directors report for the year ended July 31 states that the profit (including amount brought forward), after providing for debenture interest, was £5,163. The directors propose placing to renewals fund £600, to sinking fund for redemption of debenture stock £600, paying a dividend on the ordinary shares at rate of 2 per cent. per annum for the year, and carrying forward £388. The earnings of the tramways remain approximately the same as last year, the traffic receipts showing a decrease of £46.

UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON (LTD.)—At the half-yearly meeting on Tuesday the chairman (Sir Edgar Speyer) said the accounts showed good progress, but the dividends did not represent a fair return on the large capital invested. The receipts for the half-year were £158,536, an increase of £10,921, and the net revenue was £39,497, a gain of £13,104. The income from investments was £105,975, or £15,678 more than in the first half of 1910, chiefly due to the better earnings of the London Electric Railway Co.

UNITED ELECTRIC CAR CO. (LTD.)—At the meeting on Wednesday Mr. Geo. Richardson said that the directors regretted the smallness of the profit (£4,420), but they considered it perfectly satisfactory in face of the stagnation in the car-building trade. The Company had had a very fair share of the limited business given out, but the prices had been cut very fine, and the output had been so small that necessarily there had been a very bare margin of profit after taking into account the fixed charges. Financially the company was in an exceedingly strong position, and the prospects were better than for some years past, the order book being in a satisfactory condition. In regard to the Hadley and Trafford Park works, the directors regretted the unavoidable loss, but both works had been disposed of on the best possible terms.

YORKSHIRE ELECTRIC POWER CO.—At the meeting on Tuesday the chairman (Mr. A. G. Lupton) said that the company showed the same steady progress as for some years past. The gross profit for the past half-year was £6,633, against £4,950 for the corresponding half-year of 1910, and £2,598 for 1909, whilst the net profit had increased from £1,069 in 1909 to £2,621 in 1910, and £4,137 for 1911. They had, however, to meet a new item of expense for dividend on the cumulative preference shares, which amounted to £1,136 for the half-year. There had been a general increase in the sale of energy to all classes of customers, textile, colliery and general power users, and the directors were glad to note that that also was the case with local authorities, and the Electrical Distribution Co, showing a growing appreciation of the advantages gained by purchasing in bulk. They had taken a supply for Ossett and the urban districts of Horsforth, Farsley, Gomersal, Liversedge, Hipperholme, Sowerby Bridge and Castleford, and steps were being taken to apply during the 1912 Session for further orders. Since the issue of the report there had been a serious breakdown of the generating plant at Thornhill, which would entail considerable expenditure for repairs, and occasion a loss of revenue owing to delay in connecting new customers Temporary plant had been installed to help over the difficulty. There were more inquiries on hand from likely customers than at any time since the company started, so that the prospects were very encouraging. The result of the company's appeal to the Board of Trade against the refusal of Batley Council to lay a main through that borough was in the company's favour. The demand on the company by collieries for hauling, pumping, ventilating, winding and other purposes continued to grow. They were already supplying pits in the areas of Thornhill, Ravensthorpe, Mirfield, Kirkheaton, Emley, Lepton, Allerton Bywater, Stanley, Ledstone, Dodworth and Wakefield Rural, During the half-year there had been further extensions of mains and the company had now trunk feeders extending from Horsforth on the north to the Barnsley coalfield, and Penistone on the south, and from Castleford on the east to Sowerby Bridge on the west, with numerous branches on the main routes. Further extensions were being proceeded with, and arrangements made with a number of customers for supply which would yield increased revenue in the future.

MORTGAGES AND CHARGES.

CORONA LAMP WORKS (LTD.)—Issue, on Aug. 22, 1911, of £200 debentures, part of a series of which particulars have already been filed.

HINDHEAD & DISTRICT ELECTRIC LIGHT CO. (LTD.)—Issue, on Sept. 8, of £200 debentures, part of a series of which particulars have already been filed.

MAXIM LAMP WORKS (LTD)—Charge on company's undertaking and property, including uncalled capital, dated Sept. 4, 1911, to secure all moneys due or to become due from the company to Barclay & Co.

CITY NOTES.

MEMORANDA (Sept. 21).—**Bank rate 4 per cent.** (since Sept. 21, 1911.) **Price of silver, 24⅛d. per oz. Consols 77⅛—77⅜ for money; 77⅛—77⅜ for account. Consols Pay Day, Oct. 5; Stock and Shares Continuation Days, Sept. 26 and Oct. 10; Ticket Days, Sept. 27 and Oct. 11; Pay Days, Sept. 28 and Oct. 12; Mining Shares Carry Over Day, Sept 25.**

PRICES OF METALS (London).—*Copper*, cash, 54⅛; three months, 55⅜. *Lead*, English, 15⅝—15⅞; Foreign, 15¼—15½. *Spelter*, 27⅛—27⅜. *Tin*, English, 180—181; Foreign, cash, 176¾; three months, 175¾. *Iron*, Cleveland, cash, 46/6½, three months, 47/4½.

ANGLO-AMERICAN TELEGRAPH CO. (LTD.)—An extraordinary general meeting of this company will be held at Winchester House, London, E.C., on Friday next, Sept. 29, at 12 noon, for the purpose of considering and, if thought fit, passing resolutions to amend the company's memorandum of association in view of the arrangement with the Western Union Telegraph Co., referred to on page 943.

BROMLEY (KENT) ELECTRIC LIGHT & POWER CO. (LTD.)—The directors have declared an interim dividend at the rate of 4 per cent per annum (2s. per share), less tax, on the ordinary shares for the half-year to June 30.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—The number of units delivered to consumers during the four weeks ended July 23 were 912,348, compared with 794,120 in the corresponding four weeks of 1910. For the four weeks ended Aug. 25 the figures were 968,855 (compared with 824,917).

HOVE ELECTRIC LIGHTING CO. (LTD.)—The directors have declared an interim dividend on the ordinary shares at the rate of 8 per cent. for the six months to June 30.

KALGOORLIE ELECTRIC TRAMWAYS (LTD)—This company's traffic receipts for August were £3,853. Aggregate from Jan. 1, £27,657.

MADRAS ELECTRIC TRAMWAYS (1904) (LTD)—The traffic receipts of this company for the fortnight ended Sept 15 were R24,324 (increase R2,336). Aggregate from Jan. 1, R377,848 (increase R32,228).

METROPOLITAN ELECTRIC TRAMWAYS (LTD.)—The directors have declared an interim ordinary dividend on account of the year 1911 at the rate of 6d. per share (less tax), payable Oct. 16.

SHAWINIGAN WATER & POWER CO.—A dividend of 1½ per cent. has been declared for the quarter ended Sept. 30.

SIR W. G. ARMSTRONG, WHITWORTH & CO. (LTD.)—The directors announce an interim dividend at the usual rate of 10 per cent. (tax free) on the ordinary shares.

WINNIPEG ELECTRIC RAILWAY CO.—A quarterly dividend at the rate of 12 per cent. per annum has been declared.

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ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount	Inc. or Dec. (a)	Aggregate. No. of weeks.	Amount.	Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Sept. 13	1,566	+ 107	15	24,900	+ 1,600
irdrie	" 8	226	− 6	36	7,837	+ 49
nglo-Argentine	" 16	49,505	+ 7,519	37	1,803,398	+ 170,278
shton-under-Lyne	..	..	..	..	..	..
yr Corporation	" 16	329	− 366	18	7,545	− 304
arnsley	" 8	189	+ 22	36	6,642	+ 440
arrow	" 8	424	+ 98	36	11,077	+ 1,258
ath Electric Trams, Ltd.	" 13	981	+ 21	37	31,870	+ 1,146
rmingham Corporation	" 16	9,099	+ 2,240	24	195,607	+ 32,388
rmingham & Midland	" 8	955	+ 65	36	32,559	+ 1,951
ackpool & Fleetwood	" 16	1,476	+ 129	..	..	..
ackburn Corporation	" 13	1,290	+ 84	†25	29,761	+ 2,689
lton Corporation	" 17	2,538	+ 198	25	63,825	+ 4,562
mbay	Aug. 18	2,857	+ 211	33	93,870	+ 5,827
urnemouth Corporation	Sept. 13	2,303	+ 191	24	47,505	− 1,323
adford Corporation	" 16	5,434	+ 433	24	137,723	+ 11,212
ghton Corporation	" 17	1,253	+ 117	¶24	23,798	+ 2,045
stol Trams & Carriage	" 15	6,749	+ 519	24	176,811	+ 19,077
nley Corporation	" 16	1,551	+ 164	24	26,697	+ 3,257
ton Corporation	..	..	..	..	..	..
y Corporation	" 17	1,271	+ 17	¶24	32,583	+ 3,210
cutta Tramways Co.	" 16	R60,820	+ R5,022	11	R642,032	+ R51,680
borne-Redruth	" 16	125	− 2	37	5,550	+ 23
diff Corporation	" 16	2,421	+ 119	24	62,114	+ 5,423
ral London Railway	" 16	4,470	− 923	11	47,318	− 10,287
ham & Dist. Lt. Rys.	..	..	..	..	..	..
& South London Rly.	" 17	3,122	+ 23	11	33,428	− 468
of Birmingham	" 8	1,235	− 1,718	35	87,722	− 14,517
Electric Trams Co.	" 14	571	+ 37	37	18,846	+ 601
don	..	..	..	..	..	..
nport & Dist. Trams	" 8	606	+ 109	36	17,967	+ 2,699
r Corporation	" 9	333	+ 62	23	6,691	+ 1,036
n & Lucan Railway	" 15	165	+ 7	11	1,929	− 39
n United	" 15	5,962	+ 458	11	77,806	+ 10,410
y-Stourbridge	" 8	993	+ 113	36	31,003	+ 2,258
e Corporation	" 13	1,217	− 8	¶17	21,095	− 286
ham Council	" 16	1,107	+ 29	24	26,888	+ 1,455
r Corporation	" 15	381	+ 29	24	9,003	+ 772
ead & Dist. Trams	" 8	1,081	+ 67	36	37,459	+ 2,123
w Corporation	" 16	20,425	+ 1,133	§15	292,002	+ 19,340
p Trams	" 16	138	+ 16	37	4,614	+ 368
ster Corpn.	..	..	..	..	..	..
end-Northfleet	" 8	249	+ 26	36	7,746	+ 242
Northern & City Rly.	" 16	1,364	+ 6	11	14,824	+ 243
ck & Port Glasgow	" 8	854	+ 100	36	26,231	+ 3,405
Corporation	" 12	2,122	+ 222	†24	50,192	+ 5,597
ool Tramways	" 8	354	+ 48	36	9,937	+ 848
s Elec. Trams Co.	" 14	1,524	+ 189	11	16,232	+ 508
ong	" 16	$9,184	+ $201	..	..	..
sfield Corpn.	" 16	1,961	+ 244	24	48,253	+ 5,233
rporation	" 16	2,791	+ 226	24	69,162	+ 3,451
istrict Council	" 16	538	+ 13	25	13,745	+ 560
District Council	" 13	139	+ 4	24	3,273	+ 120
Corporation	" 23	517	+ 49	24	11,970	+ 829
hanet Co.	" 16	1,586	+ 398	50	35,396	+ 2,414
	" 8	153	+ 18	36	4,854	+ 364
Corporation	..	..	..	..	..	..
nster & District	" 8	161	+ 18	36	4,410	+ 307
ock Corporation	" 16	154	− 7	18	3,169	+ 311
ire Trams Co.	" 14	1,613	+ 112	37	52,439	+ 957
re United	" 13	1,444	+ 46	37	50,374	+ 1,755
ton	" 8	289	+ 118	36	6,561	+ 485
rporation	" 16	7,716	+ 651	24	185,733	+ 13,311
Corporation	" 16	2,467	+ 45	24	62,629	+ 5,237
poration	" 16	664	+ 55	‡18	12,691	+ 1,093
orporation	..	..	..	..	..	..
Corporation	" 9	11,780	+ 348	35	411,473	+ 11,505
Overhead Rly.	" 17	1,565	+ 170	11	17,047	+ 723
&ColwynBayRy.	..	..	..	..	..	..
ounty Council	" 6	43,921	+ 2,478	‡15	1,021,978	+ 61,302
lec. Ry. Co.	" 16	12,140	− 205	11	127,495	+ 1,415
nited	" 16	6,925	+ 258	37	243,552	+ 10,844
Corporation	" 16	373	+ 83	50	11,041	+ 885
r Corporation	" 16	16,134	+ 634	24	397,142	+ 23,118
ilway	" 16	1,912	− 68	11	19,733	− 1,760
	" 8	231	− 4	36	7,576	+ 123
n Dist. Railway	" 16	10,772	+ 473	11	115,253	+ 4,817
n Elec. Trams	" 8	10,633	+ 1,903	36	318,526	+ 50,185
	" 8	371	+ 30	36	12,608	+ 1,127
poration	" 16	208	+ 52	§24	4,631	+ 983
n-Tyne Corp.	" 16	4,107	+ 367	24	104,289	+ 7,558
lon.)	" 16	689	+ 14	24	17,828	+ 928
on Corporation	" 15	518	+ 55	24	13,620	+ 1,301
hton & Hyde	" 8	647	+ 21	36	20,753	+ 777
poration	" 17	1,957	+ 158	25	49,165	+ 1,974
Corporation	" 13	189	+ 13	17	3,444	+ 238
Elec. Trams	" 15	1,584	+ 487	37	59,317	+ 13,570
h	" 8	163	+ 39	36	4,676	+ 494
Corporation	" 16	2,395	+ 104	24	61,035	+ 6,015
	" 8	2,027	+ 181	36	65,163	+ 6,680
poration	" 13	831	+ 93	24	1?,440	+ 1,490
Corporation	" 14	696	+ 56	24	16,521	+ 1,477
	" 8	347	+ 30	36	8,790	+ 77
oration	" 18	4,697	− 316	§24	121,402	+ 5,842
	" 13	$12,500	+ $1,518	..	..	..
	" 8	72	+ 7	35	1,936	+ 81
poration	" 17	6,368	+ 355	24	161,498	+ 10,889
ams	" 16	$9,907	+ $84	..	..	..
olitan	" 8	1,057	+ 193	35	31,909	+ 1,999
	" 8	999	+ 83	36	32,509	+ 2,364
rporation	" 13	1,398	+ 213	24	31,398	+ 4,173
amways	" 13	1,032	+ 250	24	19,743	+ 3,067
de,&c., Jt. Bd.	" 8	398	+ 25	36	11,380	+ 512
orporation	" 16	781	+ 53	24	19,936	+ 1,807
istrict	" 17	1,341	+ 197	24	33,774	+ 4,477
ns	" 16	475	+ 20	46	21,547	+ 1,716
oration	" 8	1,249	+ 70	35	41,505	+ 2,518
	..	..	..	..	..	..
d District	" 8	50	+ 7	35	1,565	+ 35
ns Co.	" 8	402	+ 53	36	10,312	+ 455
oration	" 13	494	+ 77	11	6,267	+ 802
ration	" 16	1,160	+ 173	24	23,648	+ 4,471
rporation	" 16	569	+ 35	35	20,690	+ 854
rporation	" 11	403	+ 21	24	9,625	+ 220
Mare	..	..	..	..	..	..
on Co.	" 8	485	+ 148	36	6,982	+ 837
on Corpn.	" 8	468	+ 38	36	16,117	+ 791
	" 13	934	+ 78	24	24,540	+ 1,576
	" 8	381	+ 44	36	10,837	+ 551
Trams	" 8	115	+ 14	36	3,650	+ 175
ollen District	" 17	1,303	+ 99	38	49,039	+ 2,635
	" 8	1,145	+ 152	36	38,111	+ 2,799

(a) Comparisons are with the corresponding period last year. * Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 3 days. ¶ Plus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Share	Last Dividend	NAME.	Price Wed., Sept 20	*Rate per cent. Yielded. £ s. d.	Dividend Due.	Business Week to Sept. 20 Highest.	Lowest.
		Electricity Supply.					
10	5/0	Bournemouth & Poole Elec. Sup. Ord.	7½—8½	7 10 0	Mar, Sep	..	—
10	4/6	Do. 4½ per Cent. Cum. Pref.	8½—9½	4 17 3	Feb, Aug	..	—
10	6/0	Do. 6 per Cent. Cum. Second Pref.	10 —10½	5 17 0	Feb, Aug	10½	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101 —103	4 6 6	Jan, July	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	7½—8½	6 7 0	March....	..	..
5	3/6	Do. 7 per Cent. Pref.	7½—7¾	4 11 9	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Deb. Stock	99 —102	3 19 6	June, Dec	..	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	3½—4½	5 0 0	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	4½—5	4 12 3	Feb., Aug	..	—
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	94 —98	4 3 3	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	100 —102	4 8 3	..	..	..
5	2/3	Do. City Undertaking 4½% Cum. Pref.	3¾—4½	5 10 6	Jan, July	..	..
5	2/0	†Chelsea Electric Supply Ord.	3¾—4½	5 11 6	March ..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	98 —100	4 11 0	June, Dec	—	..
10	6/0	City of London Electric Lighting Ord.	12 —12½	4 18 0	Feb, Aug	12½	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11½—12½	4 18 0	Jan, July	..	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	119 —123	4 2 9	June, Dec	—	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	100 —103	4 8 6	Jan, July	..	—
St.	5%	County of Durham Elec. P. D. 5% 1st Mort. Deb. Stk	89½—91½	5 10 6	Jan, July	..	—
10	4/0	County of London Elec. Supply Ord.	7½—7¾	3 5 9	Feb, Aug	..	—
10	6/0	Do. 6 per Cent. Cum. Pref.	10½—11½	5 9 0	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Deb Stock (red.)	108 —110	4 2 6	Jan, July	108½	..
St.	4½%	Do. Second Deb. Stock	100½—103½	4 8 0	May, Nov	—	..
..	..	Edmundson's Elec. Corp. Ord.	½—¾	..	Jan, July	..	..
5	..	Do. 6 per Cent. Cum. Pref.	2 —2½	..	May, Nov	2½	..
St.	4½%	Do 4½ per cent. 1st Mort. Deb. (red.)	83 —86	5 6 6	July	..	..
5	4/0	Folkestone Electricity Supply Co. Ord.	4½—5	6 6 0	April, Oct	..	—
5	2/6	Do. 5 per Cent. Cum. Pref.	4½—5½	4 15 3	Mar, Sept	..	—
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	95 —98	4 13 3	Feb, Aug	—	..
5	5/0	Hove Electric Lighting Ord.	6½—7½	6 4 0	April, Oct	..	—
St.	4½%	Isle of Wight E. L. & P. Co. Deb. Stk.	88 —91	4 19 0	..	..	—
5	4/0	Kensington & Knightsbridge Ord.	6½—7½	6 18 6	Feb, Aug	—	—
5	6%	Do. 6 per Cent. 1st Pref.	5½—6	5 0 0	Jan, July	..	—
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	91 —93	4 6 0	..	..	..
St.	4%	Kensington & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	96 —99	4 1 0	April, Oct	—	—
St.	4½%	Kent Elec. Power Co. Irred Deb. Stk.	80 —84	5 10 0	Jan, July	..	—
3	1/2½	London Electric Supply Ord.	1½—2	3 8 0	Mar, Sept	..	—
5	3/0	†Do. 6 per Cent. Pref.	4½—4¾	6 8 0	Mar, Sept	—	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb	89 —92	4 8 0	Jan, July	—	..
5	2/0	Metropolitan Electric Sup. Ord.	3½—4½	6 0 0	April, Oct	—	..
5	2/3	Do 4½ per Cent. Cum. Pref.	4½—4¾	4 17 0	Jan, July	..	—
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	100 —105	4 8 0	June, Dec	..	—
St.	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	84½—87½	4 1 6	Jan, July	—	..
..	4½%	Midland Elec.Corp. for P.D. 4½ 1st Mort.Debs	96½—98½	4 12 6	—	—	—
5	2/0	Newcastle Elec. Supply Ord. (1-50,000 & 57,010-137,500)	3½—4	6 0 0	Feb, Aug	..	—
5	2/6	Do. 5 per Cent. non Cum. Pref.	4 —4½	5 17 6	Feb, Aug	—	..
100	4½%	Do. 4½ per Cent. 1st Mort. Deb.	97 —99	4 12 0	Jan, July	..	..
100	5%	North Metro. Elec. Power Sup. 5 Morts.	101 —101	4 17 6	..	..	..
1	6%	Northampton Elec. Lt. & P. Ord.	1¼—1 5/16	4 11 6	Feb, Aug	..	—
1	5%	Do. 5% Pref.	1 3/32—1 5/32	4 6 0	Feb, Aug	..	—
St.	4%	Do. 4% Debs.	99 —101	3 19 0	June, Dec	..	—
10	6/0	Notting Hill Electric Ord.	..	5 17 6	March	..	—
5	3/0	†Oxford Electric Ord.	6 —6½	5 9 6	March	..	..
St.	4%	Do. 4% Deb. Stk.	91 —94	4 5 1	..	..	—
5	5/0	St. James' & Pall Mall Elec. Ord.	8½—9½	5 11 0	Feb, Aug	8 11/16	8½
5	3/6	Do. 7 per Cent. Pref.	6½—7½	5 0 0	Feb, Aug	..	—
St.	3½%	Do 3½ per Cent. Deb. Stock (red.)	85 —87	4 1 6	Jan, July	..	—
5	..	Smithfield Markets Electric Sup. Ord.	1½—1¾	..	Feb.	..	—
5	4/0	South London Electric Supply Ord.	2¾—3	6 5 6	April	..	—
St.	5%	Do. 5% 1st Mort. Stock (red.)	93½—101½	5 0 6	..	..	—
1	0/8¾	South Metrop'n Elec. Lt & Power 7% 1st Pref	1 1/16—1 3/16	6 5 0	Feb, Aug	—	—
1	0/7½	Do. 6 per Cent. 2nd Pref.	¾—⅞	6 17 0	Feb, Aug	..	—
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	97 —100	4 11 6	April, Oct	—	—
5	1/3	Urban Electric Supply Ord.	½—1	..	April, Oct	—	—
5	1/3	Do. 5 per Cent. Cum. Pref.	2 —2½	11 2 3	April, Oct	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	87½—89½	5 1 9	April, Oct	..	..
5	5/0	Westminster Elec. Sup. Ord.	7½—8	6 15 6	Mar, Sept	..	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	4¾—5½	4 10 0	Jan, July	5 1/16	..
		Electric Railways and Tramways.					
1	..	Bath Elec. Trams Pref. Ord.	1/16—⅛	..	April	..	—
1	0/6	Do. 5 per Cent. Cum. Pref.	⅝—⅞	8 0 0	Jan, July	..	—
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	79 —83	5 8 6	April, Oct	..	—
St.	4½%	B'ham & Midland Trams 4½ 1st Deb. Stock.	91 —93	4 17 9	Jan, July	93	..
10	4%	Bristol Tramways & Carriage Ord.	5½—5¾	6 13 6	Feb, Aug	—	—
10	4%	Do. Cum. Pref.	7½—7¾	5 4 6	..	..	—
St.	4%	Do. 4 per Cent. Debs.	100 —101	3 19 2	Feb, Aug	..	..
10	..	British Electric Traction Ord.	¾—1¼	..	June, Dec	1¼	1 3/16
10	..	Do. 6 per Cent. Cum. Pref.	3½—3¾	..	Feb, Aug	3 1/16	3½
St.	5%	Do. 5 per Cent. Perpetual Debs.	93 —95	5 6 0	April, Oct	..	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	74 —78	5 18 0	May, Nov	..	..
St.	3%	Central London Ordinary Stock	65 —68	4 9 9	Feb, Aug	65	..
St.	4%	Do. 4 per Cent. Pref. Stock	85 —87	4 13 0	Feb, Aug	—	..
..	6/4	Do. 4½% Pref. Scrip 75% pd	87 —89	..	..	..	..
St.	2%	Do. Deferred Stock	49 —51	4 0 0	Feb.	..	..
100	4%	Do. 4 per Cent. Debs.	102 —104	3 16 11	Jan, July	103½	..
5	2/6	City of Birmingham Trams, 5% Cum. Pref.	4¾—5½	5 0 0	April, Oct	3½	—
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 11 9	April, Oct	..	—
St.	1½%	City & South London Rly. Con. Ord.	28½—29½	5 16 0	Feb, Aug	30	29½
St.	5%	Do. 5 per cent. Perp. Pref. (1891)	108 —110	4 11 9	Feb, Aug	..	—
St.	5%	Do. (1896)	104 —106	4 16 0	Feb, Aug	..	..
St.	5%	Do. (1901)	103 —105	4 17 0	Feb, Aug	..	..
St.	5%	Do. (1903)	102 —104	4 16 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	102 —104	3 17 9	May, Nov	..	..
10	6/0	Dublin United Trams, 6 per Cent. Pref	11 —12	5 4 0	Feb, Aug	..	..
10	12/0	Gateshead and District Trams Ord	8¼—9¼	6 19 0	..	..	—
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	⅞—1⅛	..	Feb, Aug	..	..
5	..	Hastings & District Elec. Trams, 6% C. P.	..	..	Mar, Sept	..	..
St.	4½%	Do. 4½ Deb. Stock	75 —80	5 10 0	April, Oct	..	..
10	..	Imperial Tramways Ord.	2½—3	..	Mar, Sept	..	..
10	..	‡Do. 6 per Cent. Pref.	4 —4½	..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Debs.	72 —74	6 3 6	Jan, July	..	—
..	2/0	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	2½—3	4 11 0	Mar, Sept.	..	—
St.	4%	Do. 4 per Cent. Deb. Stock	77 —82	5 1 0	Jan, July	80	—
10	5/6	Lanarkshire Tramways	9½—10½	5 15 0	Feb, Aug	—	—
St.	5%	Lancs Utd. Trams. 5% Prior Lien Deb. Stk.	79 —82	6 4 0	Jan, July	..	..
St.	4%	London Electric 4% Deb. St.	95 —98	4 2 6	—	97	95
St.	4%	Do. 4% Pref.	81 —83	4 16 0	..	82½	..
10	..	London United Trams, 5% Cum. Pref.	3 —3½	..	Jan, July	3	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	72 —76	5 8 0	Jan, July	73	72
St.	..	Mersey Con. Ord. Stock	6 —8	..	Feb, Aug	—	..
1	1/1½	Metropolitan Elec. Tramways Ord.	31/32—1 1/32	6 0 0	..	..	..
1	..	Do. Deferred	3/32—5/32	..	April	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	¾—1	5 8 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	99 —101	4 10 0	Jan, July	..	..
St.	5%	Do. 5 per Cent. Db. Stk	102 —104	4 17 0	—	103	..

* No allowance has been made for accrued interest or redemption.
† Ex Dividend ‡ The London Stock Exchange Committee have declined to quote these

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ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shares	Last Dividend	Name	Price Wed., Sept. 20.	*Rate per cent. Yielded.	Dividend Due	Business Week to Sept. 20. High-est.	Low-est.
		Electric Railways and Tramways—*Continued.*		£ s. d.			
St.	2%	Metropolitan Railway Consolidated	41 —41½	4 13 0	Feb, Aug	42½	40½
St.	3%	Do. Surplus Lands Stocks	64 —66	4 12 3	Feb, Aug	65	..
St.	3½%	Do. 3½ per Cent. Preference	86 —83	3 19 6	Feb, Aug	87½	86
St.	3½%	Do. 3½ per Cent. "A" Preference	84 —86	4 2 6	Feb, Aug	86½	84½
St.	3½%	Do. 3½ per Cent. Debenture Stock	85 —87	4 1 6	Feb, Aug	87	37½
St.	3½%	Do. 3½ per Cent. Convertible Pref.	89 —91	3 15 0	Jan, July	90	89½
St.	3½%	Do. 3½ per Cent. Debenture Stock	89 —91	3 17 0	Jan, July	..	..
St.	..	Metropolitan District Railway Ord.	85 —87	5 4 9	Feb, Aug	23½	21½
St.	4½%	Do. 4½% First Pref.	..	..	..	86½	64
St.	3½%	Do. Assnted 1st Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	74 —76	4 13 6	Feb, Aug	..	..
		Do. 3 per Cent. Consoltd. Rent-charge	76 —78	3 18 0	Jan, July	75	..
St.	3%	Do. 4 per Cent. Midland Rent-charge	102 —104	3 17 9	Jan, July	..	..
St.	4%	Do. 4 per Cent. Perp. Deb. Stock	145 —147	4 2 0	Jan, July	146	145
St.	6%	Do. 6 per Cent. Perp. Deb. Stock	96 —98	4 2 6	Jan, July	..	..
St.	4%	Do. 4 per Cent. Ditto	..	6 11 3	April, Oct	..	..
1	4½d.	Potteries Electric Traction Ord.	⅞ —1	8 9 6	Feb, Aug	89½	..
1	0/6	Do. 5 per Cent. Cum. Pref.	88 —91	5 0 0	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	..	10 2 0	..	..	..
1	1/2½	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	73 —78	5 6 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	..	8 4 0	Jan, July	..	..
100	5%	Sunderland Dist. Elec. Trms. 5% 1st Mt. Db.	..	..	..	1½	..
10	..	Underground Elec. Rys. Lon. Shares	1½ —1¾	..	..	99½	..
..	4½%	Do. 4½% Bonds with coup. 8	98 —100	4 11 0	..	60½	59½
..	15/0	Do. 6% In. bds. with coup. 8	59 —61	2 0 0	June, Dec	..	..
..	4%	Do. 4 per Cent. 1st Power Ho. Dbs.	101 —103	3 18 3	..	..	..
5	..	Yorkshire (W.R.) Elec. Trams. Ord.	⅛ —¼	..	March ..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	2⅛ —2½	..	..	..	..
St.	4½	Do. 4½ per Cent. 1st Debs.	80 —85	5 9 6	Jan, July	..	..
		Electric Manufacturing, &c.					
St.	4½%	Anchor Cable Co. 4½ % Deb. Stock	99 —101	4 10 0	..	..	..
1	1/2½	Aron Electricity Meter Ord.	⅜ —⅝	..	..	..	..
1	0/7½	Do. 6% Cum. Pf.	⅝ —¾	7 10 0	April, Oct	5⅛	5⅛
1	3/2½	Babcock & Wilcox Ord.	5⅛ —5½	4 14 6	April, Oct	..	..
1	0/7½	Do. Pref.	1⅛ —1½	4 0 0	..	7⅛	..
5	6/0	British Insulated & Helsby Cables Ord.	6½ —7½	6 15 9	July, Feb	6½	6
5	3/0	Do. 6 per Cent. Pref.	5½ —6½	5 0 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	102 —104	4 7 0	Jan, July	..	..
St.	..	Do. 5% Mort. Deb. Stock	101½ —106	..	..	..	..
St.	4½%	British Thom'n-Houst'n 4½% 1st Mt. Db.	94 —97	4 14 3	Mar, Sept	½	..
5	..	British Westinghouse 6 per Cent. Pref.	½ —⅝	..	Feb, Aug	..	..
100	6%	Do. 6 per Cent. Prior Lien Dbs. (red.)	102 —104	5 17 0	..	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	59 —62	6 6 6	Jan, July	..	..
St.	4½%	BrushE.Eng. Co. 4½% Perp. 1st Deb. Stock	55 —61	7 15 0	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	39 —44	10 10 0	Jan, July	..	..
5	10/0	Callender's Cable Con. Ord.	9 —9½	8 2 0	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅛ —5⅛	4 19 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort Debs. (red.)	101 —103	4 8 0	Nov, May	3⅛	3⅛
1	1/6	Castner-Kellner Alkali Co	3⅜ —3⅝	5 3 6	May, Nov	..	..
St.	4½%	Do. 4½ per Cent 1st Mort. Deb. (red.)	103 —107	4 5 9	Feb, Aug	..	..
1	1/0	Chadburn's (Ship) Telegraph Ord.	1⅛ —1⅜	5 19 0	March ..	..	..
1	0/8½	Consolidated Electrical Co.	⅛ —¼	7 8 9	August ..	..	..
1	0/6	Consolidated Signal Co.	⅛ —¼	8 7 6	April, Oct	..	..
1	0/7½	Do. 6 per cent. Cum. Pref.	⅛ —¼	7 6 6	April, Oct	..	..
3	..	Crompton & Co (Nos. 1 to 85,000)	⅛ —¼	..	Jan, July	..	..
100	5%	Do. 5 per Cent. 1st Mort. Debs. (red.)	57½ —67½	8 0 0	Jan. July	..	..
5	1/0	Dick, Kerr & Co. Ord.	⅛ —⅜	5 14 0	Sept ..	..	..
5	0/7½	Do. 6 per Cent. Cum. Pref.	95 —98	5 6 0	Sept ..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	95 —98	4 13 3	Jan, July	..	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	⅛ —⅜	..	Feb, Aug	..	..
	..	Do. (£5 paid)	1½ —2½	..	Feb. Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (red.)	67 —71	5 16 0	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	78 —31	6 3 6	Mar, Sept	..	..
2	2½%	Electric Construction Co.	½ —¾	6 6 0	Jan, July	..	..
2	2/7½	Do. 7 per Cent. Cum. Pref.	1⅛ —1⅜	7 4 6	July ..	8⅛	..
St.	4%	Do. 4 per Cent. Perp. 1st Mort. Debs.	7⅜ —7⅝	5 6 0	Jan, July	9⅛	..
10	5/0	General Electric (1900) 5% Cum. Pref.	8½ —9	5 14 0	June, Dec	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	88 —93	4 8 6	Mar, Sept	..	..
5	5/0	Henley's Telegraph Works Ord.	12 —12½	6 0 9	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	4⅛ —5⅛	4 9 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	103½ —105½	4 3 6	Mar, Sept	..	..
10	15/0	India Rubber, Gut. Per., &c., Works	13½ —15½	..	Feb, Aug	..	..
10	5/0	Do 5 per Cent. Cum. Pref.	9½ —10½	4 19 0	..	..	..
100	4%	Do. 4 per Cent. Debs. (red.)	95 —97	4 3 3	April, Oct	..	..
1	..	National Elec. Construction Co.	⅛ —¼	..	April ..	..	..
1	..	Richardsons, Westgarth & Co., Ltd. Ord.	⅛ —¼	..	Nov ..	..	..
1	..	Do. 6 per Cent. Cum. Pref.	⅛ —¼	..	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. Perp. Deb. Stock	75 —78	5 18 0	Jan, July	..	..
5	..	Simplex Conduits 6 per Cent. Cum. Pref.	4½ —5	..	..	..	..
12	12/0	Telegraph Construction & Maintenance	34½ —36½	6 9 9	Mar, July	..	..
100	4%	Do. 4 per Cent. Deb. Bonds (1901)	100 —102	3 19 3	Jan, July	2	..
1	1/0	Vickers, Sons & Maxim, Ltd., Ord.	1⅛ —2	5 1 0	..	1⅛	..
1	0/6	Do. 5 per Cent. non-Cum. Preference	1⅛ —1⅜	4 3 0	..	..	..
St.	5%	Do. 5 per Cent. non-Cum. Preferred	107 —111	4 11 6	..	9⅞	98½
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stk. (red)	93 —100	4 0 9	June, Dec	..	..
100	4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.)	103 —105	4 6 6	June, Dec	105½	105
100	5%	Do. 5 per Cent. 3rd Mort. Debs. Scrip	103½ —105½	4 15 6	..	..	..
10	12%	J. G. White & Co. 6% Cum. Pref.	14½ —15½	7 14 10	..	..	..
1	..	Willans & Robinson Ord.	⅛ —¼	..	Apr, Oct	..	..
5	..	Do. 6 per Cent. Cum. Pref.	⅛ —¼	..	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	55 —65	6 3 0	May, Nov	..	..
		Telegraphs.					
10	..	Amazon Telegraph	7⅛ —7½	..	June, Dec	..	..
100	5%	Do. 5 per Cent. Debs. (red.)	98½ —100½	5 0 6	Jan, July	67	..
St.	15/0	Anglo-American	67 —69	4 8 6	F,My,Ag,N	113	112½
St.	30/0	Do. Preferred	111½ —112½	5 7 6	F,My,Ag,N	..	..
St.	30/0	Do. Deferred	24½ —25½	5 19 0	F,My,Ag,N	25⅜	24⅜
St.	4%	Commercial Cable 4 per Cent. Deb. Stk.	87½ —89½	4 10 6	Jn,Ap,Jy,O	89	83½
10	6/0	Cuba Submarine Ord.	10½ —11	5 13 0	Feb, Aug	10½	10⅜
10	10/0	Do. Preference 10 per Cent.	17½ —18½	5 13 0	Feb, Aug	..	..
5	2/0	Direct Spanish Ord.	3½ —4	5 0 0	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	8½ —8½	5 16 0	April, Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	100 —102	4 9 0	Jan, July	..	..
10	3/0	Direct United States Cable	7⅜ —8½	6 2 6	Ja,Ap,Jy,O	8⅛	7⅞
100	4½%	Direct West India Cable 4½% Rg. Db. (red.)	99 —101	4 10 0	June, Dec	..	..
St.	25/0	Eastern Ordinary	137 —140	5 1 0	Ja,My,Jy,O	139	137
St.	17/6	Do. 3½ per Cent. Pref. Stock	84 —86	4 2 6	Ja,My,Jy,O	84½	84½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (red.)	102 —104	3 17 9	May, Nov	..	..
St	2/6	Eastern Extension	13½ —14	5 2 0	Ja, Ap, Jy, O	13⅜	13½
10	4%	Do. 4 per Cent. Deb. Stock	100½ —102½	3 19 0	Feb, Aug	103	..
25	4%	Eastern and S.Af., 4% Mauritius Sub. Debs	100 —102	3 19 0	May, Nov	..	..
10	5/0	G.N. (of Copenhagen), with Coupon 83	30½ —31½	5 16 0	Jan, July	..	..
25	52/6	Indo-European	56½ —59½	5 6 6	May, Nov	..	..
100	5%	†Mackay Companies Common	83 —85	5 15 0	Ja,Ap,Jy,O	..	..
100	4%	†Do. Preference	7¼ —7⅝	5 4 3	Ja,Ap,Jy,O	..	..
1	1/0	Marconi's Wireless Teleg. Co.	2⅞ —2½	..	April ..	2⅛	2½
1	2/9½	Do. 7% Partipg. Pref.	1⅛ —2	..	..	1⅛	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (red.)	99½ —101½	3 19 9	June, Dec	..	..
2½	1/3	West Coast of America	1⅛ —1½	5 0 0	May ..	..	..
100	4%	Do. 4 per Cent. Debs.	93 —100	4 1 0	Jan, July	..	..
10	1/6	West India & Panama	2½ —2½	4 16 0	May, Nov	2⅜	2½
10	6/0	Do. 6 per Cent. 1st Pref.	10½ —10½	5 16 6	May, Nov	..	..
10	6/0	Do. 6% 2nd Pref.	9½ —10½	6 0 0	May, Nov	..	..
100	5%	Do. 5 per Cent. Debs.	101 —103	4 18 0	Jan, July	..	..
10	3/0	Western Telegraph	13½ —13½	5 1 0	Mr,Jn,O,D	13½	13½
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	101 —103	3 18 6	June, Dec	101½	..
—	4%	Western Union Telegraph, $1,000 4% Bds	107 —110	3 13 9	..	..	..
—	4½%	Do. $1,000 4½% Fdg. & Rl. Est. Gl. Bnds	101 —104	4 8 0	..	..	..

Shares	Last Dividend	Name	Price Wed., Sept. 20	*Rate per cent. Yielded.	Dividend Due	Business Week to Sept. 20. High-est.	Low-est.
		Telephones.		£ s. d.			
100	2$	Amer. Telephn. & Telegh. Cap. St.	138 —140	5 15 0	..	..	..
	4%	Do. Coll. Trust $1,000 4 per Cent. Bds.	94 —96	4 4 0	Jan, July	..	..
	4%	Do. 4% Cons. Bonds 1936	108½ —110½	3 13 0	..	..	..
	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101 —103	4 18 0	Mar, Sept	..	..
	4/0	Chili Telephone	6½ —7½	4 5 9	August ..	..	..
	0/7½	Monte Video Telephone Ord.	⅛ —¼	6 0 0	Nov ..	..	..
	0/6	Do. 5 per Cent. Pref.	⅛ —¼	5 11 0	May, Nov	..	..
St.	6%	National Co. Pref. Stock	104 —106	5 14 0	Feb, Aug	..	..
St.	6%	Do. Def. Stock	114 —117	5 3 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	9½ —10½	5 12 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	9½ —10½	5 2 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.	5⅛ —5⅜	4 12 0	Feb, Aug	..	..
St.	3½%	Do Deb. Stock 3½ per Cent. (red.)	98½ —100½	4 0 6	June, Dec	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	102½ —103½	4 7 6	Jan, July	..	..
	4½%	New York Telephone Co. 30 yr. Bnds.	1⅛ —1⅜	5 2 0	April, Oct	..	..
	1/0	Oriental	1⅜ —1⅝	4 16 0	April, Oct	..	..
	0/7½	Do 6 per Cent. Cum. Pref.	88 —90	4 10 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Red. Deb. Stock	99 —101	4 10 0	Jan, July	..	..
	4½%	Telephone Co. of Egypt 4½% Db. Stk. (red.)	7⅛ —7⅜	5 13 6	July ..	..	..
5	5/0	United River Plate Ord.	5⅛ —5⅜	4 13 0	June, Dec	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	103½ —105½	4 6 0	Jan, July	..	..
St.	4½%	Do. 4½ Deb. St. Red.					
		Financial, Investment, &c.					
		Elec. & Gen. Investment 6% Cum. Pref.	4 —4½	7 1 0	Jan, July	..	..
5	3/0	Globe Telegraph & Trust	10½ —11	5 7 0	Sp,Dc,Mr,Jn	..	..
10	6/0	Do. 6 per Cent. Pref.	13 —13½	4 10 9	July ..	..	..
10	3/0	Submarine Cables Trust (Cert.)	133 —136	4 11 0	April, Oct	..	..
10	6%						
		Colonial and Foreign Electric Railways, Tramways, &c.					
		Anglo-Argentine 5½% Cum. 1st Pref.	5⅛ —5⅜	4 17 6	April, Oct	..	..
		Do. 5½% Cum. 2nd Pref.	4⅛ —5	5 12 9	Jan, July	..	..
5	2/9	Do. 4% Deb. Stock	93½ —95½	4 4 6	June, Dec	..	..
5	2/9	Do. 4% Deb. Stock	101 —103	4 8 3	..	..	..
5	4%	Do. 4½% Deb. Stock	101 —103	4 18 0	..	..	..
St.	4½%	Do. 5% Deb. Stock	102 —105	4 16 6	Jan, July	..	..
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)	6⅜ —7⅛	5 16 3	May, Nov	..	..
St.	5%	Brisbane Electric Trams. Invest. Ord	5 —5⅜	4 17 6	May, Nov	..	..
5	4/0	Do. 5 per Cent Cum. Pref.	102 —105	4 7 0	Jan, July	..	..
5	2/6	Do. 4½ per Cent. Db. Prov. Certs.	138 —142	5 14 0	Mar, Sept	..	..
St.	4½%	British Columbia El. Rly. Df. Ord.	119 —123	4 19 0	May, Nov	..	..
St.	8%	Do. Pref. Ord. Stock	106 —109	4 13 0	Jan, July	..	..
St.	6%	Do. 5% Cum. Perp. Pref. Stock	100 —103	4 7 6	April, Oct	..	..
St.	5%	Do. 4½ per Cent. 1st Mort. Debs.	101 —104	4 3 3	Jan, July	..	..
40	4½%	Do. Vancouver Power Debs.	101½ —103½	4 3 0	..	..	..
100	4½%	Do. 4½% Perp. Con. Deb. St.	98½ —100½	5 0 6	Mar, Sept	..	..
St.	4½%	Buenos Ayres Lacroze Trams 1st Mt. Db.					
St.	5%	Buenos Ayres Port & City Tram. 1st Mt. Deb. Stock	92 —96	6 8 0	Feb, Aug	..	..
St.	6%	Calcutta Tramways (1 to 137,610)	5½ —6½	4 19 6	Mar, Sept	..	..
3	3/6	Do. 5 per Cent. Cum. Pref.	5 —5½	4 17 6	Jan, July	..	..
10	2/6	Do. 4½% 1st Deb. Stock (red.)	102 —105	4 5 9	Jan, July	..	..
1	4½%	Cape Electric Tram Shares	⅛ —¼	..	..	..	..
St.	5%	City of Buenos Ayres Trams Co. (1904) Sh.	5⅛ —5⅜	4 8 0	F,My,A,N	..	..
5	1/3	Do. 4 per Cent. Deb. Stock	95 —98	4 3 0	June, Dec	..	..
St.	4%	Colombo Tr. & Ltg. 5% 1st Mt. Db.	95 —100	5 2 6	May, Nov	..	..
	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	100 —103	4 19 0	Feb, Aug	..	..
100	5%	Hong Kong Tramways Co. 5 per Cent. 1st Mort. Debs.	77 —81	6 6 6	June, Dec	..	..
		Kalgoorlie Elec. Trams Sh.	⅛ —¼	..	..	..	..
		Do. 5 per Cent. "A" Deb. Stock	92½ —95½	5 4 6	Jan, July	..	..
10	5%	Do. 6 per Cent. "B" Ditto	63 —67	8 15 0	July ..	..	..
5	6%	Lisbon Elec. Trams. Ord.	1 —1½	4 16 0	Jan, July	..	..
5	0/6	Do. 6 per Cent. Cum. Pref.	1 —1½	4 16 0	Jan, July	..	..
100	0/7½	Do. 5 per Cent. Rep. Mort. Debs.	97 —101	5 1 0	Jan, July	..	..
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	95 —98	5 3 6	..	..	..
St.	5%	Manaos Trams and Lt. Co. 5% Debs.	89 —92	5 11 0	Feb, Aug	..	..
100	5%	Manila Elec. Ry. $1,000 Gold Bonds	93 —100	5 1 0	..	..	..
100	$1½	Mexico Trams Co. Con. St.	115 —117	5 19 6	..	..	..
100	6%	Do. Gen. Con 1st Mort. 5% Gold Bds.	95 —98	5 3 0	..	..	..
St.	6%	Do. 6% 50 yr. Mort. Bds	97½ —99½	6 1 6	..	..	..
St.	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922) (Nos. 601 to 2,000)	100 —102	4 9 0	Feb, Aug	..	..
		Do. do. (Nos. 1 to 4,600)	102 —104	4 7 6	..	..	..
		Perth Elec. Trams Ord.	½ —1⅛	2 10 0	May ..	..	..
		Do. 1st Mt. Db. Stock	101½ —103½	4 17 6	Jan, July	..	..
100	5%	Rangoon Elec Trams & Supply Co. 6% Cum. Pf.	5⅛ —5½	5 8 0	..	..	..
		Do. 4½% 1st Mort. Deb. Stk.	98 —101	4 10 6	..	..	..
		Rio Janeiro Tram. Lt. & P. Co.	114½ —115½	4 5 0	..	..	..
100	$1½	Do. 30 yr. Gold Bnds.	101½ —102½	4 18 3	..	..	..
100	5%	Do. 50 yr. Mt. Bnds	97½ —99½	5 2 0	..	..	..
100	$2½	†Sao Paul: Tramway, Light & Power Co. $100 Stock	172 —175	5 14 0	June, Dec	..	..
		Do. 5 per Cent. 1st Mt. $500 Db.	102½ —104½	4 16 6	Feb, Aug	..	..
		Toronto Ry. Co 1st Mt. 4½% Ster. Bonds	97 —99	4 11 9	..	..	..
100	4½%	**Colonial and Foreign Electrical Supply, &c.**					
		Adelaide Elec S'ply Co. 6% Cu. Pr.	5½ —5¾	5 11 6	Mar, Sept	..	..
		Do. 5% Deb. Stk.	102½ —104½	5 9 0	..	..	..
St.	5/0	Bombay E.S. & T. 6% Cm. Pf.	10½ —11½	5 2 0	Jan, July	..	..
10	5/0	Do. 4½ per Cent. Deb. Stk. (red.)	96½ —98½	4 12 0	..	..	..
St.	4½%	Do. 5 per Cent. 2nd Mort. Deb. Stock	97 —99	5 2 0	April, Oct	..	..
St.	5%	Calcutta Elec. Supply Ord.	6⅜ —7⅛	5 19 6	..	..	..
		Do. 5% Cum. Pref.	5 —5⅜	4 15 0	..	..	..
		Calgary Power Co 5% 1st Mort. Bnd.	96 —98	5 2 0	..	..	..
100	5%	Canadian Gen. Elec. Co. Con. St.	105 —110	6 13 0	..	..	..
100	7/2½	Do. 7% Cm. Pf. Stock	121 —125	5 14 0	..	..	..
100	$3½	Castner Electrolytic Alkali Co (of U.S.A.) 1st Mort. Sd. Debs.	94 —99	5 3 6	Jan, July	..	..
100	5%	Elect. Development Co. of Ontario	85 —87	5 16 0	..	..	..
		Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St	84½ —87½	5 4 0	Jan, July	..	..
		Indian Elec. Sup. & Trac. Co.	1 —1⅛	..	..	..	..
		Kalgoorlie Elec. Power & Ltg. Co.	⅛ —¼	..	April, Oct	..	..
		Do. 6 per Cent. Cum. Pre.	8 —8½	8 6 6	..	..	..
		Kaministiquia Power Co. 5% Gold Bnds.	101½ —103½	4 17 6	..	..	..
5	5%	Madras E. S. Corp. Ord.	2⅛ —3⅛	..	..	..	..
		Melbourne E. S. Co. Cons. Ord. St.	43 —48	..	..	..	..
		Do. 5% 1st Mortg Deb. Stock	95 —97	5 4 0	..	..	..
		Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	85½ —88½	5 14 0	..	..	..
		Mexican Lt. & Power Co. Com. St.	85 —87	5 13 0	..	..	..
		Do. 7% Cum. Pref. St.	106 —108	6 6 0	..	..	..
		Do. 5% 1st Mort. Gold Bnds.	93 —95	5 6 0	..	..	..
		Monterey Rly. L. & P. Co. 1st Mort. Db. Stk.	83 —93	5 12 3	F,Mr,A,N	..	..
		Montreal Lt. Ht. & Power Co. Cap. St.	165 —170	5 18 6	..	..	..
		Northern Lt. Power & Coal 5% Gl. Bds.	38 —40	6 6 0	April ..	..	..
		River Plate Electricity Co. Ord. Stk.	218 —228	4 7 0	May ..	..	..
		Do. 6 per Cent. non-Cum. Pref. Stk.	107 —114	4 5 0	Jan, July	..	..
		Do. 5 per Cent. Deb. Stock	101½ —103½	4 17 6	..	..	..
		Shawinigan Water & Power Co. Cs.	114 —116	4 12 6	Jan, July	..	..
		Do. 5 per Cent. Bds.	107 —109	4 6 0	..	..	..
		Do. 4½ Per Con. Mt. Db. St.	103 —105	4 9 0	..	..	..
		Toronto Power Co. 4½% Db. St.	130 —132	..	Jan, July	..	..
	4½%	Victoria Falls Power Co. Pref.	.. —..	..	..	..	..

* No allowance has been made for accrued interest or redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote

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NOTES.

The Public and the Electrical Exhibition.

HOWEVER pleased the Executive Committee may feel at getting together such a fine collection of electrical manufactures at Olympia, and at acquainting the trade, through the technical Press, with the Exhibition, as a fact it has completely failed in whatever methods it adopted for bringing the public to the show. The Exhibition posters are indifferent, to say the least, and there have been no lay Press advertisements and few "write-ups" of the Exhibition. Such matter as has been published is quite inadequate to the needs of the Exhibition. Until Wednesday evening the Exhibition was innocent of a band. As we go to press we hear general complaints that the first week of the Exhibition has been wasted, and to many of the exhibitors this is a serious matter, as can easily be understood. Four days after the Exhibition had been opened an attempt was made to obtain the assistance of the technical Press in preparing articles of a popular nature which might be inserted in the daily papers. At considerable inconvenience we placed ourselves at the disposal of the authorities, and were joined by several contemporaries; but the originators around whom the movement was to have crystallised unfortunately failed to put in an appearance. It was also understood that the exhibitors were being approached to subscribe to a general fund from which suitable advertisements could be inserted in the daily papers. The co-operation of the technical Press was sought with a view to the placing of these announcements in the right quarter. This idea is a good one, and it seems a pity that it has not been carried further. The extraordinary part of the whole proceeding is that a week after the opening of the Exhibition the authorities have awakened to a fact which should have impressed itself upon them at least three months ago.

THE General Electric Co., with its usual enterprise, arranged a Press view of its exhibits last Monday, and a considerable number of the London dailies put in an appearance. From what we can gather, some of them became acquainted with the Exhibition and its objects for the first time on that occasion. Mr. HIRST explained the popular nature of the Exhibition, and the fact that there was an innumerable variety of electrical appliances which would interest the public if they could be brought to realise that such apparatus was on view. It certainly looks as if something has misfired in the arrangements, and, although it is not now too late, a valuable week has been practically thrown away, and this must reflect on the general success of the Exhibition at its close.

What Should the Exhibition Be?

THE management seem to have quite lost sight of the important fact that the object of such an Exhibition should be to attract and educate the public. There is an immense field for the domestic applications of electricity, and nowhere can these be so well demonstrated as at an exhibition. But, we need hardly remark, it is essential to get the public to attend if this object is to be attained; and it is well to remember that the public, when they do attend, require education to be of a free-and-easy kind. There is no subject that lends itself so well to popular demonstration as electricity. Admirable "side shows" can be made by lamp making, wireless telegraphy and telephony, high-tension

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discharges, radiography, electric furnaces, and electric cooking; also by short lectures and demonstrations at stated intervals, and in many other ways.

It is all very well to say that such side-shows are commonplace; they are to the engineer, but not to the layman, and so long as the public is attracted by them they should be provided. Visitors are amused thereby, and almost unawares they pick up the desirable seeds of knowledge in the intervals. True, there are already demonstrations of electric cooking, but we doubt if many visitors are aware of them, for there is no daily programme or other means of knowing easily what is going on. The visitor is also repelled by the unattractive appearance of most of the stands, many of which look like melancholy shelters from bad weather. Why should there not have been some preconcerted scheme to give a pleasing effect? Surely our Continental friends would not plan an exhibition in this way; the Turin Exhibition is indeed an example of the proper method. These various sins of omission do not speak well for the commercial instincts of the management, whose object, we presume, is to make money; and we fear that if immediate steps are not taken to alter the arrangements drastically the Exhibition will be a failure, instead of being a well-merited success.

Electric Locomotives for Shunting.

In discussing the features and advantages of railway electrification authors have generally confined their attention largely to the passenger traffic side of the question. Although this is the aspect of the subject with which the public are more particularly concerned, and is therefore of wider interest, the result has been that comparatively little regard has been paid to goods traffic; whilst the less conspicuous, but by no means unimportant, shunting operations have, we believe, rarely been made the main topic of a discussion on the merits of electrification. Elsewhere in the present issue will be found an abstract of a Paper on the use of electric locomotives for shunting, read by Mr. A. H. Marshall before the Cleveland Institution of Engineers, in which the author makes out a very good case for electrical plant.

Owing to the system adopted on steam railways of stating average costs per engine-mile, based on an estimated number of engine-miles in the case of shunting engines, the actual cost of shunting by existing means is probably not fully ascertained. A steam locomotive is particularly ill adapted for shunting work, and its operating costs under these conditions are much higher than those of normal running. This is evident from the fact that even in a busy yard a shunting locomotive is standing for more than one-half the time it is in service. Moreover, an electric locomotive can accelerate more quickly and therefore is able to maintain a higher average speed, whilst its stand-by and maintenance charges are less than those of the steam locomotive. The handling of heavy short-distance goods traffic certainly seems to offer a promising field for electric operation, and unless the railway companies take the initiative in this direction, private owners are not likely to make the change except in special cases. One of the most interesting installations in this connection is that of the Harton Collieries, to which Mr. Marshall refers, where six electric locomotives are in use for shunting and two more are on order. At these collieries some 15 miles of electrified track will shortly be in operation.

The author's remarks on underground haulage are particularly worth attention. The Cleveland ironstone mines are, we believe, very suitable for the introduction of either trolley or accumulator traction, as there is generally plenty of headroom, a good roof and practically complete absence of gas. The conservatism of the mine managers will doubtless require much time and persuasion to overcome, but as these mines are installing electrical apparatus for most purposes, the application to electric traction should not now be long postponed. English manufacturers, therefore, should certainly see that they are prepared to meet this demand for electric locomotives of the type required, and they should endeavour to hasten the conversion.

A Neglected Profession.

The numerous physicians who from time to time attempt to diagnose the ills of the electrical industry often hit upon "overcrowding" as a cause of the malady. But it has been left for Mr. T. E. Elder, in a letter to the "Daily Mail," to apply the above epithet to our profession. This letter is certainly not without its extraordinary side, for, after calling attention to the difficulty of obtaining properly trained young men (evidently with some practical experience) and to the possible necessity of importing assistants from the Continent if the present state of affairs continues, Mr. Elder concludes: "Electrical engineering still offers a much larger field for invention and discovery and personal advancement for merit than any other comparable career." Even if all this be conceded, there is one salient feature of the electrical engineering profession at the present time which more than off-sets all these advantages, namely, the poor financial outlook. The young engineer's education is lengthy and expensive (for instance, the firm with which Mr. Elder is connected charge £300 for allowing pupils to pass through their shops), and not only is the immediate return for this expenditure small, but it may be some years before a living wage is earned. This being the case, it is not surprising there should be a falling-off in the supply of young engineers for subordinate positions. For no array of other advantages, such as Mr. Elder details, can compensate the present commercially minded generation for those of a well-lined trouser-pocket. It seems to us to be high time that the heads of the electrical engineering profession recognised that to obtain good men, even in times of depression, they must offer adequate salaries; for a man of some initiative, even when trained as an electrical engineer, will not be deterred from changing his profession if he finds that he obtains a better position by so doing.

The 20-watt 200-volt Osram Lamp.

We announced exclusively in our Exhibition report last week that the General Electric Co. would be exhibiting a 16 c.p. 20-watt 200-volt lamp at Olympia. The technical and daily Press were given an opportunity on Monday last, on the special invitation of the Company, of examining this

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interesting lamp at their stand. It is a jointless filament lamp, and the makers claim for it a high efficiency and long life. The introduction of this lamp comes at an opportune moment, and, though it may not be welcomed by the station engineer, it is certain to result in an increase in the number of his consumers. The carbon lamp is still used to a considerable extent on the higher voltage circuits. The new Osram should displace these inefficient light units. The small size of the lamp is another feature in its favour. It can be used with shades intended for carbon lamps, also in watertight fittings, table lamps, brackets, standards, &c. The demonstrations of the lamp at the Exhibition are such as to show that it is in no way fragile—at any rate in the early stages of its life. The actual number of burning hours has yet to be proved, but we understand, from experiments made by the General Electric Co., that the life will be such as to encourage the wide use of the lamp. We must compliment the Company on the production of a lamp of this character at this particular period, because interest is being created in the drawn-wire lamp, and the new Osram will take its place prominently among these newer patterns.

Steam Turbine as a Monument.—It will be remembered that the 5,000-kw. steam turbines erected in 1903 in the Fisk-street station of the Commonwealth Edison Co., of Chicago, had a short life, being replaced a year or two ago by units of 12,000 kw. capacity. The "Electrical World" states that one of these 5,000-kw. turbines has now been erected in the centre of a park in the grounds of the General Electric Co. at Schenectady, to serve as a memorial of the rapid development of the steam turbine in central station service.

Experimental Electric and Gas Lighting in Manchester.—It is stated locally that the electricity and gas departments of the Manchester Corporation are about to undertake a series of comparative tests on street lighting. The gas department has arranged to light Moseley-street and St. Peter's Square, and the electricity department has in hand the lighting of Albert Square, Piccadilly and Portland-street. In the course of the next few months there will be a trial of the two systems of street lighting. The initial cost, the expense of upkeep, and the quality of the illumination will be recorded, and the City Council will then determine which system of public lighting has the advantage. As regards the electric lighting of Albert Square, sixteen of the 6 amp. Gilbert type of enclosed arc lamps have been replaced by a similar number of 10 amp. "Metro-Flam" arcs made by Messrs. Johnson & Phillips. The height of the new flame arcs is 22 ft. 6 in. from the ground level, instead of 17 ft. as at present. The maximum candle-power of each of the new "Metro-Flams" is not less than 2,500. The old and new lamps burn respectively for 80 hours and 130 hours without retrimming. They are all switched on from a central position, and the height of the lamps has been so arranged as to give the desired illumination without "glare." In Portland-street central lighting has been adopted as far as possible, arc lamps being suspended from duplicate cross-span wires attached to rosettes fixed on the fronts or corners of the buildings. Where this course has not proved feasible, side poles with long arms are fixed so as to bring the lamp central with the street. Provision is made for the raising or lowering of the lamps to suit the best conditions for illumination.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Assab—Perim	July 8, 1909 ...	—
Latakia—Palura	May 26, 1910 ...	—
Zanzibar—Mombasa	July 11, 1911 ...	Sept. 21, 1911
Kotonou—Grand Bassam	Aug. 23, 1911 ...	—
San Thiago—Bathurst	Sept. 4. 1911 ...	Sept. 23, 1911
Bathurst—Sierra Leone	Sept. 4, 1911 ...	—
Bissao—Bolama	Sept. 26, 1911 ...	—

Sharman System of Wireless Telephony.—Through the courtesy of the proprietors of the "Daily Mirror" our representative was enabled to be present on Wednesday last at a demonstration of wireless telephony between ship and shore given by Mr. A. W. Sharman and Mr. Thorne Baker, with the apparatus invented by the former and called by him the "Cymophone." The experimental stations were situated at Pegwell Bay near Ramsgate, one on shore and the other in a boat in the bay. The system employs two earth connections at either end, its chief novelty being the utilisation of energy stored in an inductance in the transmitter. Telegraphy and telephony are practicable with the same apparatus on switching over from the microphone to a buzzer. The instrument is extremely portable and of very low cost, and should, therefore, be useful in many cases where more complicated and expensive apparatus would not be suitable. At the demonstration speech was transmitted in both directions.

Electric Lighting of Trains.—The "Engineer" remarks that some interesting details regarding the electric lighting of the Great Western trains were given in a Paper recently read before the Great Western Railway Lecture and Debating Society. A special staff of 15 men is distributed throughout the system to supervise electric lighting matters, and reports are despatched daily to the head office as to the repairs carried out on the electrical equipment. An interesting system is adopted in connection with the accumulators. For this purpose an indicator board is used, divided into three sections, each representing a year. Each of these divisions is further subdivided into months, and a row of pins is affixed opposite the name of each month. Every coach in use carrying a battery of accumulators is represented on the board by a tab bearing its number, one side of the tab being painted red and the other green. When the battery is first put in use the green side is placed outwards, the tab being affixed in the row corresponding with the month when it was put in service. The accumulators on each coach are thoroughly overhauled every 11 months, and by this time the tab has been altered in position, so that it is 12 divisions away from its original place, each division representing a month. The red side of the tab is then turned outwards, and the inspector is notified that the accumulators of that particular coach require immediate overhauling.

Wireless Telegraph Developments.—"The Times Engineering Supplement" states that preliminary experiments have been conducted by Capt. Brenot with an equipment for wireless telegraphy, fitted on a Henri-Farman biplane. The energy is furnished by the Gnome motor of the aeroplane, which drives a special magneto and charges the antenna direct. The antenna consists of a bronze wire, 120 m.(400 ft.) long and 1 mm.(0·04 in.) in diameter, which passes through insulating tubes and is unwound behind the aeroplane. The wire can be cut in case of need, as, for example, if at the moment of landing there is no time to wind it up. With this apparatus it has been found possible to send messages regularly over distances of from 60 km. to 80 km. (37½ to 50 miles). The total weight of the equipment, including the wire, is 21 kg. (46 lb.).

Observant persons in the neighbourhood of St. Martin's le Grand may have noticed two masts which have recently been erected on the roof of the building known as G.P.O. West. We are informed by the Engineer-in-Chief to the Post Office that these masts, which are 50 ft. high, and stand about 240 ft. apart, support a system of bare copper wires forming the antenna or aerial of a wireless station in connection with the laboratory of the G.P.O. Engineering Department. The main purpose of this installation is experimental. Developments in the theory and practice of wireless communications are proceeding at a rapid rate, and in the projection of new stations as well as in the maintenance of existing stations much work of an experimental nature has to be undertaken. Traffic considerations permitting, it has often been necessary in the past to convert temporarily a commercial station into a laboratory or test room for experimental purposes. The wireless equipment referred to will allow experimental work to be carried out with greater facility and at less expense than heretofore, and at the same time will enable new devices which inventors sub-

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mit to the Postmaster-General from time to time, and which they claim to be improvements on the apparatus actually in use, to be placed under closer observation than formerly and to be tested under practical conditions.

The Westmorland and Cumberland Yeomanry have introduced for cavalry operations two portable Marconi wireless telegraph sets. These are carried on four pack saddles, and maintain communication over a distance of about 40 miles. Each station has two 60 ft. masts supporting horizontal aerial wires. Power is supplied by a small air-cooled petrol motor, permanently mounted on one side of a rigid but adjustable saddle, and the dynamo is mounted similarly on the other side. To bring them into action the complete saddle is taken from the pack animal and placed on the ground, when the dynamo and petrol motor are connected with a self-adjusting shaft. The wireless apparatus is contained in three weather-proof boxes, which are placed on top of each other, and are instantly ready for use. The earth system consists of a short length of tough metallic netting which is rolled out on the ground, and is plugged into a suitable socket in the receiver. The generator is connected to a transformer by a 50 ft. length of armoured flexible cable. These portable stations were specially designed by the Marconi Company that they should be capable of easy and rapid transportation and of effecting a ready means of communication between units of the main body. The time taken in erecting the sets ready for work is nine minutes, and for dismantling and repacking six minutes.

Rating of Electrical Machinery.—An interesting Report has been prepared by Mr. C. Le Maistre, General Secretary of the International Electrotechnical Commission, on the rating of electrical machinery. The Report contains extracts (set out in English and French, as is customary with all matters relating to the Commission) from the rules adopted in varous countries for the testing and rating of electrical machinery, and it has been drawn up to facilitate the work of the various Electrotechnical Committees in considering this question of rating. Since continuous-current machinery will probably be considered first, the Report is mainly confined to this class of apparatus. In an interesting preface, Prof. Elihu Thomson, president of the Commission, mentions that a study of this Report will show that the supposed difficulty in bringing about international agreement on the subject of the rating of electrical machinery is not really so great as in the case of nomenclature, symbols, &c., which problems have been successfully tackled by the Commission. The Rules from which extracts have been made are as follows: *Belgium.*—"Prescriptions normales" for the reception of electrical machines and transformers, issued by the "Chambre Syndicate des Electriciens Belges." *France.*—General instructions for the delivery and reception of electrical machines and transformers, issued by the "Union des Syndicats de l'Electricité," and the regulations for tenders, supply and testing of electrical machines and transformers, issued by the "Association Alsacienne des Propriétaires d'Appareils à Vapeur." *Germany.*—Standard Rules for the utilisation and testing of electrical machines and transformers, issued by the "Verband Deutscher Elektrotechniker." *Great Britain.*—Report of the Engineering Standards Committee on "Electrical Machinery." *Sweden.*—Rules for the testing and reception of electrical machines and transformers, issued by the "Association of Swedish Engineers." *United States of America.*—Standardisation Rules of the American Institute of Electrical Engineers. Copies of the Report may be obtained from the General Secretary of the Commission, 28, Victoria-street, Westminster, at a price of 4s. 2d. or 5 fr. or $1 per copy.

"The Electrical Conductivity and Constitution of Alloys."—At the annual autumn meeting of the Institute of Metals recently held at Newcastle, Dr. W. M. Guertler read a Paper on this subject. The aim of the Paper was to call attention to the property of electrical conductivity in its bearing upon the practical determination of the constitution of alloys. The so-called "equilibrium diagram" for alloys was, the author stated, now almost universally accepted as the basis for any systematic study of the properties of alloys, and hence it was of great importance to be able to construct it accurately, and to have a thorough knowledge of it. The relationship between concentration, temperature and any given property—electrical conductivity, specific volume, magnetism, &c.—was best and most clearly brought out by the employment of a co-ordinate system in three dimensions. Thus, taking concentration and temperature as the base, ordinates could be erected whose lengths were proportional to the numerical values of the property under consideration, and so a series of intersecting curved surfaces could be obtained, each of which corresponded to a particular phase-region of the equilibrium diagram. The converse problem, *viz.*, that of obtaining the equilibrium diagram (when it was unknown) by projection from these surfaces on to the basal plane, was one of great importance. The best known method and one which had been hitherto and was still most universally employed for the determination of the equilibrium diagram was that known by the name of "thermal analysis," in which special account was taken of the variations in the "total heat" of the systems under consideration. The author discussed at length the limitations of "thermal analysis," and in particular explained why it failed in those cases where, as so often happens in practice, a state of complete stable equilibrium was unattainable within a comparatively short interval of time. The respective merits of electrical conductivity and of specific resistance measurements were set forth and illustrated by numerous examples from practice.

Current Topics.

Subjects of current interest dealt with in this issue include the following:—

Mr. J. Rezelman contributes an article on "The Determination of Synchronous and Asynchronous Reactance."

Dr. R. A. Houstoun continues his series of "Studies in Light Production," considering this week "The Welsbach Mantle."

In an article entitled "Electric Tin Smelting" Mr. J. Hirlén describes what has recently been done in this direction in this country.

At the recent International Congress of the Applications of Electricity, at Turin, Prof. Silvanus P. Thompson presented a "Report on Motor-Generators, Converters and Rectifiers."

We give a complete account of the recent Turin meeting of the International Electrotechnical Commission.

We give a further instalment of Mr. T. F. Wall's British Association Paper on "The Single-Phase Repulsion Motor."

A volt-hour meter has been placed on the market by the British Westinghouse Electric & Mfg. Co. This enables engineers to keep a check on the average voltage of sections of their systems.

A digest of the revised scheme of examination for inspectors of mines is given in another column.

An abstract of the Board of Trade Report on Strikes and Lock-outs and on Conciliation and Arbitration Boards in 1910 is given in another column.

The Municipal Tramways Association has been registered, but the word "Limited" is omitted from the title by licence of the Board of Trade.

What seems like a boom in church lighting is in progress in many parts of the country. In the Stoke Newington (London) district four churches have been "converted" during the past three months.

At their meeting last week Shoreditch (London) Council approved the scheme for the extension of incandescent electric lighting to the portion of the borough north of Old-street. The southern portion is already illuminated by metal filament lamps.

We continue our account, in the "Industrial and Commercial Supplement," of the exhibits at Olympia. The need for greater publicity being given to the Exhibition is referred to in our Editorial Notes.

Companies' Meetings and Reports.—At the meeting of Cleveland & Durham Electric Power (Ltd.) on Tuesday the Chairman gave particulars of the progress of the Company, and announced that power contracts in hand amounted to 40,460 H.P.

The ordinary general meeting of Dick, Kerr & Co., held yesterday (Thursday), is reported in another column.

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APPOINTMENTS VACANT AND FILLED.

Test-room assistants, for adjusting and calibrating a.c. and d.c. instruments, are wanted; also assistants for photometry. See advertisement.

A working electrician is required for large works plant, with experience of motor repairs and wiring for lights. See advertisement.

A shift engineer is wanted for a power house with h.t. a.c. and d.c. plant. Salary £2. 5s., rising to £2. 10s. per week. See advertisement.

Messrs. Harland & Wolff, engineers and shipbuilders, Belfast, advertise for an electrical wiring draughtsman.

Mr. Wilfred S. Peake has been appointed assistant to the expert in wireless telegraphy in H.M.S. "Vernon."

Mr. Hubert Dobell, an engineer in the service of Marconi's Wireless Telegraph Co. (and for some years attached to Mr. Marconi's personal staff), has been appointed chief of the radio-telegraph service of the Turkish Government. He will shortly return to England from Spain, before proceeding to Constantinople.

EDUCATIONAL NOTICES.

University of London, University College.—The calendar of the University College for the 1911-12 session has been issued. Full particulars of the courses of instruction provided by the College are given, and among many new developments the following may be noted:—

In the faculty of engineering the institution of a new lectureship in heating and ventilating engineering, and the appointment of Mr. Arthur Barker thereto. A full course of instruction in heating and ventilating engineering and a course of public lectures on "The Real Nature of the Problems in Heating and Ventilation awaiting solution by the Engineer"; and courses suitable for those who have completed a diploma or degree course in engineering, occupying the whole session, are arranged in several branches of engineering, and facilities for research are provided to suit the needs of individual students. Among the courses of special lectures are those by Mr. E. Kilburn Scott on "Electrical Design," by Mr. W. J. Goudie on "Steam Turbines," by Mr. H. Deans on "Railway Engineering," by Mr. W. C. Clinton on "Illumination and Photometry," by Mr. A. R. Low on "The Design and Calculation of Aeroplanes," by Mr. W. N. Blair on "Roads, Street Paving and Tramways," &c. The post-graduate and special courses of lectures at University College are carefully arranged, and are under the control of experts. The number admitted to each course will be limited, and applications for admission should be addressed to the Secretary (Mr. W. W. Seton, M.A.), Gower-street, W.C.

University of London, King's College.—Complete courses of study, extending over three or four years, are provided in civil, mechanical and electrical engineering for engineering degrees of the University of London, and for the diploma and certificate of the college.

The four-years' course provides, in addition to the academic training, opportunity for practical training in works. Special advanced lectures and courses in civil and mechanical as well as electrical engineering, will commence in October. Among the lecturers in electrical engineering are Mr. W. H. Patchell, who will deal with "Electric Generating Stations" and "The Application of Electric Power to Mines and Heavy Industries"; Mr. F. Lydall, who will lecture on "Electric Traction, Direct and Alternating Current"; and Mr. Wm. Brew, who will deal with "Electric Lighting." Detailed syllabus and further particulars may be obtained from the Secretary, King's College, Strand, London, W.C.

University of Edinburgh.—The next session opens on Oct. 10. The University provides complete courses in civil, mechanical and electrical engineering, qualifying for the degree of B.Sc. in engineering, and extending over a period of three years. Particulars from the Matriculation Office, The University, Edinburgh.

University of Durham.—Armstrong College, Newcastle-upon-Tyne.—Courses of instruction are provided in mechanical, marine, civil and electrical engineering, naval architecture, mining, metallurgy, agriculture, pure science, arts and letters. Particulars from the secretary, Mr. F. H. Pruen, M.A.

Northampton Polytechnic Institute, Clerkenwell, London.—The full day courses in the theory and practice of mechanical and electrical engineering and in electro-chemistry commence on Oct. 2. The courses in mechanical and electrical engineering include periods spent in commercial workshops, and extend over four years, and they also prepare for the degree of B.Sc. in engineering of the University of London. There are also full and partial day courses in technical optics. Particulars from the Principal, Dr. R. Mullineux Walmsley.

University of Bristol.—A pamphlet setting out the record of the occupations of former engineering students of the Merchant Venturers' Technical College and the late University College (Bristol), has been issued by the Faculty of Engineering. The list is compiled alphabetically, and contains records of over 350 students, many of whom occupy responsible positions.

Finsbury Technical College.—The evening classes in electrical engineering at the City and Guilds Technical College, Finsbury, begin on Oct. 2. Prof. S. P. Thompson will give a course on "Alternating-current Work" and on "Dynamo and Motor Design," and Mr. Simmons will give a few lectures on "Transmission and Distribution of Electrical Energy." On Wednesday evenings Prof. Thompson will deal with "Magnetism, and the Design of Commercial Magnets," and Mr. Howgrave-Graham with "Electric Measurement," with "Illumination," and the more elementary principles of dynamos, transformers, &c. Special courses of lectures on "The Calorimetry of Fuels" and on "Petrol Engines" have also been arranged.

In the mechanical engineering department Mr. G. K. B. Elphinstone will give an inaugural lecture on the "Gyrostatic Compass." The chair will be taken by Mr. S. W. Luard at 8 p.m. on Tuesday next, Oct. 3.

Borough Polytechnic Institute.—Day and evening courses of instruction are given at this Institute. In addition to the engineering, building and technical trades and science classes, provision is made for instruction in commercial subjects and languages, &c.

The physics and electrotechnics department is under the control of Mr. John Henderson, D.Sc., A.M.I.E.E. The lecture theatre can accommodate 100 students, and there are two large well-equipped laboratories for practical work. The courses of instruction in electrotechnology are arranged to cover a certain period of years. There are also advanced and honours courses in pure electricity, and a three-years' course for electric wiremen. During the past year the governors have spent large sums of money in decorating, extending and improving the accommodation of the Institute, and they are contemplating the establishment of a special school for the ironmongery and hardware trades. Particulars from the principal (Mr. C. T. Millis), 103, Borough-road, S.E.

University Correspondence College.—The September issue (No. 59) of the "Matriculation Directory," which is published (at 1s. nett) by the University Correspondence College, of Cambridge and London, contains much useful information for candidates for the matriculation and other examinations of the University of London. The articles on text-books and courses of instruction are written by experts. At the University Tutorial College (32, Red Lion-square, W.C.), which is affiliated to the Correspondence College, there are day and evening classes in preparation for examinations of the University.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, September 29th (To-day.)

MUNICIPAL TRAMWAYS ASSOCIATION.

11 a.m. Excursion to Ayr and the Land of Burns, arriving back at Glasgow at 7:20 p.m.

MONDAY, October 2nd.

SOCIETY OF ENGINEERS.

7:30 p.m. Meeting at the Institution of Electrical Engineers, Victoria Embankment, W.C. Paper on "The Necessity for Safer, Quicker and Cheaper Railways, with Some Proposals Therefor," by Mr. C. R. Enock.

TUESDAY, October 3rd.

FARADAY SOCIETY.

8 p.m. Meeting at the Institution of Electrical Engineers, Victoria-Embankment. Papers on the "Paragon Electric Furnace and Recent Developments in Metallurgy," by Mr. J. Härdén; "Progress in the Electrometallurgy of Iron and Steel," by Mr. D. F. Campbell; and on "The Hering 'Pinch Effect' Furnace," by Mr. E. K. Scott.

THURSDAY, October 5th.

IRON AND STEEL INSTITUTE.

10:30 a.m. Meeting at the Institution of Civil Engineers, Great George-street, Westminster. A selection of Papers will be read and discussed. If necessary the meeting will be resumed in the afternoon.

THE LONDON ELECTRICAL ENGINEERS.

Officer Commanding, Col. H. M. Leaf.

The following orders have been issued:—

Drills for efficiency (1911-1912) will commence at head-quarters on Thursday, November 2, 1911, and head-quarters will be open as follows from that date: Daily (except Saturdays), 10 a.m. to 10 p.m. Saturdays (unless otherwise ordered), 10 a.m. to 12 noon.

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THE USE OF ELECTRIC LOCOMOTIVES FOR SHUNTING PURPOSES.*

BY ALBERT H. MARSHALL.

The object of this Paper is to direct attention to an important commercial application of electric power which, in the author's opinion, has not received the consideration and adoption it deserves. Shunting is taken to include: (1) The handling of heavy goods and mineral traffic in yards and sidings as now done by steam locomotives; (2) the haulage of minerals below ground as now done by stationary engines and horses—with particular reference to the Cleveland Iron Stone Mines.

The matter being one of costs and not of revenue—and the haulage costs being in most cases but a small portion of the total works cost—is probably the real explanation why the subject has not received more attention. There are, however, other reasons which may be advanced, such as the general objection to bare electrical conductors, difficulty as regards interchangeability of traffic, and the natural disinclination which usually exists to disturb a condition of things by which reasonably good practical results are obtained.

Shunting by steam locomotives differs from the rest of railway work in that the running costs of this particular work are relatively very much higher than those of other railway service; the shunting costs under electrical operation on the other hand should not be materially higher, and may even be somewhat lower than those of other kinds of work. The extent to which a saving in this respect is possible does not seem to be generally appreciated. Underground haulage by horses, and, in some cases, by cable, are also expensive modes of traction, and here again large savings can be effected.

The author will show that electric locomotives can be used with advantage for most shunting operations, and that it would be sound commercial policy to substitute them for the existing locomotives, horses and cable haulages.

Choice of System.—Speaking generally, the single-phase system only shows to advantage for long-distance main-line traffic, which will probably not be dealt with in the first instance; on the other hand, there is every inducement to railway companies at once to electrify their suburban services, for which the continuous-current system is cheaper and more suitable. It would seem, therefore, that commercial and practical reasons will lead to the continuous-current system being generally adopted.

A short discussion of the merits of the various electrical systems is given in an appendix, in which the author hopes he shows good reasons for his advocacy of the continuous-current system for the class of work under consideration.

Although "shunting" covers a very wide field, it is possible to draw up a general specification for a standard type of equipment capable of meeting all demands likely to be made on it. This specification would in brief be somewhat as follows:—

System.—Continuous current; 550 volt; negative side earthed; track rails as negative conductor.

Motors.—Series wound; 1, 2 or 4 per locomotive.

Control.—Series parallel with resistances.

Collector Gear.—Single overhead conductor with bows or trolleys. Provision for third-rail gear. For underground haulages, however, a lower voltage, say 250, would be safer, and where exposed conductors are inadmissible, the use of accumulator locomotives is suggested. These exceptions are dealt with under the section devoted to mining conditions.

Locomotives.—Typical electric locomotives are illustrated in the Paper, and the features of electric, as compared with steam, locomotives discussed. The power that can be got out of a steam locomotive depends upon the state of the boiler, the skill of the fireman and the quality of coal used; with electricity, so long as the voltage of the line is maintained and the motors are in any sort of running condition, the locomotive can always be relied upon to develop its rated horse-power. From the point of view of adhesion or grip of the driving wheels on the track rails, the electric motor has an advantage over the steam engine in that the torque exerted is quite uniform; for this reason there is not the same tendency to slip when starting under load. In the calculations herewith the adhesion of the electric locomotive has been taken at 0·235 and that of the steam locomotive at 85 per cent. of this figure, or 0·20. This effect is counterbalanced in practice owing to the steam locomotive being for other reasons made heavier than an electric locomotive of the same drawbar pull, but only at the cost of the power necessary to move the additional weight.

As regards ability to perform useful work, the electric locomotive has a distinct advantage over the steam locomotive in the following respects: (1) It loses no time on the road, coaling, watering, boiler tending and waiting for steam pressure to rise; (2) it accelerates more quickly and is more easily controlled; (3) it requires no shed day for boiler cleaning, &c.; (4) it needs fewer repairs and renewals. The first two points mean that more work can be done per loco per day, and the second two that fewer spare engines are necessary for the same service; the first two affect the wages question and all of them have to be taken into consideration in settling the proportion of electric to steam locomotives required for a given service.

The exact amount of time that can be saved in carrying out a series of operations is difficult to determine, as it depends a great deal on the class of work to be dealt with. In the case of shunting in a busy blast furnace yard (particulars of which are given) the average running speed of the engine was found to be a trifle over 4 miles per hour; the distance travelled per shift from 16 to 20 miles, and the percentage of standing time to running time over 50 per cent. If now, which does not seem unreasonable, the traffic arrangements could be improved to permit of the running time being lengthened by only 10 per cent., and of the average speed being raised from 4 to 4½ miles an hour, then four engines would do the work of five. This is a much lower estimate than that generally given in comparing the relative capacities of steam and electric locomotives, but it is the conservative one which will be taken in this discussion.

As regards spares, one engine over and above every 10 engines daily in commission should be an ample allowance; below 10 and above three a spare should also be provided; for three and under it would probably be sufficient to carry a stock of spare parts.

To facilitate a determination of the size of locomotive required for any particular duty, the author gives a number of tables showing how steam and electric locomotives compare as regards weight, tractive effort, cost and other essential features, based on equal brake-horse-power outputs for one hour. Some of the figures are summarised in Table I. herewith.

Table I.

B.H.P. rating.....	90		150		390	
Speed	6 m.p.h.		6 m.p.h.		9 m.p.h.	
	Steam. Tons.	Elec. Tons.	Steam. Tons.	Elec. Tons.	Steam. Tons.	Elec. Tons.
Total weight loaded	12·0	10·0	26·0	22·0	61·0	55·0
Available tractive effort	2·4	2·4	5·2	5·2	9·6	12·9
Approx. price.....	£700	£650	£1,200	£1,100	£2,250	£2,100

The steam engine designer is confronted with a serious problem when he has to produce an engine of more than about 26 tons. Up to this weight, the load can very well be carried on two axles; above that weight he has to add one or more axles in order to keep his axle load within limits and to carry the extended boiler necessary to supply the additional steam required. These axles have to be coupled together so as to make the total weight available for adhesion, thus increasing the rigid base from 6 ft. to 12 ft. or more. In heavier engines requiring greater fuel capacity, the framing has to be lengthened to provide sufficient coal and water accommodation, necessitating the use of a small bogie truck, or some form of radial axle to carry the extended portion. The weight so carried is not available for adhesion and in the tank engine corresponds in this respect to the tender which main-line goods locomotives have to drag after them. In the electric locomotive each axle is independently driven, and sizes up to 60 tons or thereabouts can be built with a rigid wheel-base not exceeding 6 ft., the whole of the engine weight being available for adhesion. The weight which has to be added for adhesion in the case of electric locomotives can be made use of in a variety of ways. For instance, a locomotive of full shunting capacity could be fitted with a crane capable of lifting heavier loads than the usual pattern of yard crane, thus saving in many cases the cost of a second machine and shift of men; it could be provided with a hopper for carrying paying load, or be adapted for other purposes of transportation.

Line and Track Equipment.—Except in some few special cases, the locomotives can be best supplied with power by means of overhead conductors, the track rails being used to complete the electrical circuit in accordance with standard tramway practice.

It is desirable to obtain as much headroom as possible in yards where locomotive cranes have to operate, but apart from the restriction imposed by the use of this type of crane, there appears to be no necessity to suspend the wires at a greater normal height than 16 ft. As, however, provision should in most cases be made for the use of cranes, it has been thought better to settle on a uniform height of 22 ft.

On sidings belonging to the North-Eastern Railway at Newcastle, the Harton Collieries and the Newcastle-upon-Tyne Electric Supply Co., 16 ft. or less has been considered sufficient. An increased height of trolley wire means an increased cost of the overhead structure, as the supports have not only to be lengthened but to be made corre

* Abstract of a Paper read before the Cleveland Institution of Engineers.

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Table II.

	A.	B.	C.	D.	E.	F.	G.
	Average (over 3 years).	Average (over 2 years).	For 1909.	For 1909.	Average (over 5 years).	For 1909.	For 1909.
Total number of engines	2	2	2	5	11	4	16
Average number of engines in daily use	1½	1	1	3½	7½	3	14
Gross ton-miles	171,100	188,000	248,000	1,780,000	3,620,000	6,250,000	7,610,000
Cost of coal	£237	£155	£145	£1,130	£2,470	£1,495	£2,765
Cost of water	30	12	12	80	130	105	145
Cost of wages (lighting up, standing-by, cleaning and driving)	335	370	223	1,550	2,788	1,040	3,905
Cost of stores and repairs	223	99	158	500	906	1,370	4,115
Depreciation at 4 per cent.	96	96	96	240	528	192	768
Total cost per annum	£921	£732	£634	£3,500	£6,822	£4,202	£11,698
Cost of fuel* per ton-mile	0·400d.	0·240d.	0·163d.	0·174d.	0·183d.	0·064d.	0·100d.
Cost of fuel per brake horse-power-hour	9·95d.	5·97d.	4·2d.	4·33d.	4·4d.	1·54d.	2·58d.

* Includes oil, coal and water.

spondingly stouter; in addition, the collector gear on the locomotive becomes more expensive.

As regards the method of suspension, there is no need with the low speeds incidental to shunting work to adopt an expensive construction. The ordinary span-wire construction with the conductor approximately in the middle of the track permits the use of the reversible type of bow collector and is quite satisfactory for the purpose.

Even with a 22 ft. height of trolley wire, there would still be trouble due to the fouling of the wires by the booms of long jib cranes such as are commonly used, and it therefore seems advisable to change the type of crane, using one with a fixed instead of movable boom. In this way a safe clearance can be got.

In equipping the yards and sidings of blast furnaces and steel works for successful electrical operation, the author realises that here and there difficulties have to be met, but these are not of a serious character, and are such as can be successfully overcome. Probably the most real difficulty is found in dealing with the jib type of crane. If, however, as suggested above, the solution lies in providing new cranes, advantage can be taken of the change to substitute electrical driving for steam, and so to effect a saving in operation proportionate to that obtained by the main conversion.

Wherever existing overhead wires interfered with the locomotive conductors, or an alteration in their position became desirable for the purpose of safety, they could be conveniently carried on extensions of the trolley wire supports.

Running Costs.—Table II. gives in detail the actual costs of shunting by means of steam locomotives at several works in this district.

Fuel Consumption.—By means of electricity, instead of a number of comparatively small and wasteful prime movers, energy can be obtained in a more advantageous manner from a few large and efficient machines in a central power station, whilst the supply of a number of varying loads from large machines improves the load factor.

The author illustrates this argument by particulars of a series of careful tests extending over several days taken on seven shunting engines at Newport Works. The following is a summary of the results obtained:—

Average gross load, including engine weight, 60·5 tons.
Average net load carried, 16 tons.
Average running speed, 4·09 miles per hour.
Percentage of total time running, 49 per cent.
Average miles run per shift, 17 miles.

He shows that if a power station were put down to deal with the service performed by these seven locomotives, one engine of a capacity less than that of three of them, running under much more efficient conditions, and fed from boilers using a cheaper quality of coal, would meet the requirements of the case. The saving effected thereby might be more than sufficient to cover the losses in converting from mechanical to electrical energy, transmitting from power house to locomotive, and converting back again. Moreover, advantage could be taken of the existence of the central station to supply power for other purposes, and thus to improve the load factor and decrease the capital charges. In the majority of cases, probably, the same end would be attained by driving the electric locomotives from a power station already in existence. Again, to pursue this policy to its logical conclusion, a greater saving can invariably be made by purchasing electrical energy from a large power supply company where such exists.

The author has not been able to discover any recorded results of the performance of steam shunting locomotives given in a form that admits of a fair comparison with what can be done by any other kind of motive power. He, however, compares the fuel costs of a non-condensing locomotive engine with the performance of a medium-sized turbo-generator, and then discusses the consumption of electrical energy per ton-mile and analyses it into its various constituents, a number of diagrams being given in this connection.

Repairs and Renewals.—Compared with street-tramway conditions, shunting conditions are less hard on the electrical equipment, as the motors, being further removed from the ground, are not exposed to the same extent to mud and wet; neither, as regards comparison with heavy suburban railway services, do the motors and other parts get covered with brake dust, which on underground railways especially is found to be a source of trouble. Judging from the very extensive experience derived from the use of similar electrical apparatus in other fields, it should be perfectly satisfactory for the work under consideration.

From a review of figures stated by Mr. Aspinall, Mr. Joshua Shaw and Mr. F. W. Carter it can be stated with some assurance that the maintenance of electric locomotives used for shunting work should not exceed from £20 to £50 per annum; also £30 per annum has been taken as an average figure to cover the cost of line and track equipment maintenance per single-track mile.

That electrical operation for this class of work has a beneficial effect on the life of the track rails is unquestionable; the ability of the electric locomotive, with its shorter wheel base, to negotiate sharp curves, reduces the wear and tear on points and crossings, while its lower rolling weight per axle is generally of advantage to the permanent way. Its better starting torque also reduces slipping at the driving wheels when starting under load.

Superintendence and Wages.—As regards superintendence the charges now allocated to steam locomotive operation will not be materially altered; much less supervision is required to keep an equivalent number of electric locomotives in working order, but, on the other hand, there is a responsibility for the maintenance of the overhead and track equipment to be assumed by someone.

The amount to be paid annually in wages for driving the electric locomotives should be somewhat reduced compared with the cost of driving a number of steam locomotives performing the same service, owing to the duties being very simple; moreover, as shown above, four electric locomotives could be taken as the equal of five steam locomotives (there would thus be a saving of one shift of men for every five steam locomotives displaced).

Comparative Estimates.—Taking the seven cases set out in Table II., the author next gives in a table a comparison of the operation of the shunting work in question by electric locomotives.

The cost per ton-mile and the annual saving by electrification for the seven cases considered are shown to be:—

A.	B.	C.	D.	E.	F.	G.
0·75d.	0·65d.	0·44d.	0·316d.	0·305d.	0·112d.	0·26d.
£413	£246	£202	£1,272	£2,454	£1,443	£3,887

Depreciation is allowed at the rate of 4 per cent. per annum on both the steam and electrical equipment, although the latter has perhaps some advantage in this respect. Interest at the rate of 5 per cent. per annum has also been charged on the cost of electrification, after deducting the scrap value of the steam locomotives.

Special Mining Conditions.—The great desideratum in mining is safety, and any system which on the whole tends to increase, in any

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degree, the present risks is inadmissible. It may be taken for granted that the employment of electric accumulators would not introduce any new danger; on the contrary, traffic conditions in this respect would be improved, in that the driver has complete control over his work, and, by the light which can be readily provided, is better enabled to see what he is doing. Braking will be more efficient than with rope or horse haulage, resulting in fewer runaway tubs—a frequent source of accident in mines. The principal disadvantage of the accumulator method of traction is its cost, but this is permissible where horse haulage is the only alternative.

As regards the overhead trolley system, the restrictions practically limit its application to metalliferous mines where the seams are 9 ft. or more in thickness. In the Cleveland Iron Mines there is, as a rule, plenty of headroom and a sufficiently sound roof to which overhead conductors could be attached. Under such conditions there can be no objection to the use of bare conductors, provided the voltage does not exceed 250 and the work is carried out in a proper manner. The wire can, if thought necessary, be guarded by boards fixed alongside. One important advantage this system has is the facility which it offers for the complete lighting of the whole of the workings.

As regards locomotive capacity, an engine capable of drawing two loaded trucks up a grade of 1 in 14 at a speed of 3 miles per hour should be suitable except for the main roads. This specification can be met by an accumulator locomotive of convenient dimensions and weighing not more than 3½ tons. Built with 15 in. wheels and a wheel base of 2 ft. 9 in., it would operate quite well on a 2 ft. 6 in. gauge around the sharpest curves and over any track suitable for horse traffic. It could also be fitted with collector gear, which would enable it to run over any electrically equipped track and to replenish its batteries while doing so. A two-motor equipment of standard type is proposed, the regulation being "series parallel" with one controller. A form of hand brake capable of holding back any number of tubs on any grade up which the locomotive could pull them would be fitted. The accumulator battery has a capacity of 16 kw.-hours and is capable of discharging at the rate of 14 H.P. for one hour or of 7 H.P. for three hours. This capacity would enable it to handle 100 ton-miles per shift with a sufficient margin.

For roads equipped with trolley wires and over which there is a considerable traffic, a heavier engine, say one of 6 tons, could be used with advantage; this size, if provided with a motor capable of slipping its wheels, would easily start and haul a set of six loaded tubs up a grade of 1 in 20 at 4 or 5 miles per hour. With suitable motor capacity the draw-bar pull of any locomotive deriving its power direct from a central station is proportional to its weight, so that the size of engine required for any particular work can be readily determined.

The collector gear proposed consists of a trolley arm, identical with that used on street tramways, instead of the sliding bow attachment recommended for general yard shunting. There is not room for the latter underground, nor is the trolley at the same relative disadvantage that it would be for above-ground use, as it is within easy reach of the driver, and can thus be more readily controlled.

The insulated conductors would be suspended from the roof timbers or road-sides. Solid copper wire of 0·10 sq. in. section is suggested as a convenient size of conductor. With this section at 250 volts sufficient power could be economically transmitted a distance of from a mile to a mile and a quarter, radially, from any distribution point. Distribution points would be situated in-bye to suit the geographical formation of the mine, and be fed from high-tension three-phase distribution mains through small motor-generators. The high-tension mains could also be used to convey power for pumping and ventilation.

As regards costs, the author has been favoured with details of the existing costs at some of the Cleveland mines, and has been enabled to examine the working conditions at these mines. In one case, which will serve for the purpose of illustration, horse haulage involves an annual expenditure, when everything is included, of almost exactly £10,000 per annum. The output of stone is a little over half a million tons per annum, and the average length of haul about a quarter of a mile. The total ton-miles (inclusive of tare and empties) works out at 320,000 per annum, each horse doing on an average 16 ton-miles per shift. Estimating on a very moderate basis a locomotive should be able to do the work of two horses in collecting and distributing at the face, and of four horses in hauling along sidings and branch roads. Allowing a battery efficiency of 50 per cent. and 25 per cent. for the cost of battery maintenance, the total of the annual charges, including interest and depreciation on new capital, assuming the whole of the work to be done by accumulator locomotives, should not amount to over £6,200. With the trolley system in use along the secondary roads and accumulators only on the locomotives at the face, there would be a still greater saving.

The success of accumulator traction depends mainly upon the cost of battery renewals; if, as accumulator manufacturers claim, this will not, all things included, exceed 25 per cent. of the first cost per annum, then a strong case can be made out for accumulator locomotives. The weight of the battery is not for this purpose a disadvantage as weight has to be provided to get sufficient adhesion. In Germany a large number of accumulator engines are in use for mining work, and in the United States a remarkable degree of success has been obtained with accumulator vehicles, used as delivery vans and the like.

It is difficult to make a fair comparison between electric locomotive haulage and rope haulage, and the author has not had sufficient time at his disposal to deal properly with the matter. In general, however, rope haulage is fairly economical under steady loads on straight track; it cannot, however, handle fluctuating loads so well nor does it admit of extension to branch roads and sidings without greatly increased wear and tear on longer ropes, or the provision of additional winding gear.

The accumulator method of electrical propulsion will, no doubt, appeal more strongly to mines managers than the trolley system, and until some experience has been gained with locomotives of the former type and a further stage of development reached in electrical matters, it is unlikely that the overhead trolley system will come into general use, although it has met with a very extended application in American and German mines.

From a humane point of view there is also something to be said for mechanical as against horse haulage, and the removal of the latter should improve the sanitary conditions of the mines somewhat. Electrical operation has also an advantage in that it facilitates the lighting arrangements, and, further, there seems no good reason why, where locomotives are available, the miners should not ride to and from the face and so be saved a certain amount of time and exertion.

Examples of Electrical Shunting.—The North-Eastern Railway Co. have had two 56-ton locomotives in use at Newcastle handling their quayside goods traffic for the past six years. These engines are individually capable of starting a 150-ton train on a grade of 1 in 27 and of hauling it on this grade at 10 miles per hour; they operate on track part of which is fitted with third-rail and part with overhead wires.

The Harton Collieries have six locomotives in use and 7 miles of track electrified; two other locomotives and the equipment of 8 miles of additional track are on order.

The Newcastle-upon-Tyne Electric Supply Co. and the Cleveland & Durham Electric Power Co. have locomotives for coal and ash traffic at their principal power stations.

The Consett Iron Co. at their Chopwell Colliery operate electric locomotives over 2¼ miles of track, the maximum gradient of which is 1 in 24 and the average 1 in 47; the locomotives are 14 tons in weight and haul a train of 36 tubs on a 2 ft. 2 in. gauge.

The Oakbank Oil Co. at Mid-Calder have two 11-ton engines running on a 2 ft. 6 in. gauge track and hauling some 600 tons of shale per day a distance of 2 miles.

A considerable number of powerful accumulator locomotives are in use for shunting purposes on the Prussian and Belgian railways.

Summary.—Perhaps the most striking outcome of this investigation is the indication it gives of the very small amount of useful work performed by steam engines in shunting operations. For instance, in the case of the Newport Works, it can be readily shown that the equivalent of the full amount of useful work done by the seven steam locomotives during the busiest 24 hours of the week, including that required to move themselves about, can be given out by any one of the comparatively small generators (1,250 kw.) at the waste heat power stations at these same works in 20 minutes.

In addition to the saving on fuel, there is a further large saving in locomotive repairs and renewals. Perhaps as good a case has not been made out in this respect for electrical driving as on its merits it is entitled to. Then, again, as regards the ease of operation and simplicity, too much cannot be said in favour of the electrical machine. A further advantage of the electric locomotive is that the driver has a clear view of his work, fore and aft, and so can more readily avoid collision, and, what is more important, accident to workmen. At night, too, very much more work can be done by the aid of the powerful head lamps with which each engine is fitted, while the dangers incidental to shunting operations are reduced. There is also something to be gained by reducing the output of smoke and steam in busy yards and thickly populated districts.

Large Hydro-Electric Plant in Brazil.—According to the "Electrical Review and Western Electrician" a contract has been let for the exploitation of the Paulo Alfonso Falls on the River San Francisco. At first 200,000 kw. will be developed, though the final capacity of the plant will be 1,000,000 kw.

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THE DETERMINATION OF SYNCHRONOUS AND ASYNCHRONOUS REACTANCE.

BY J. REZELMAN.

Summary.—The action of the rotor of a synchronous alternator with respect to the stator is, in part, of a single phase and, in part, of a polyphase nature. The article deals with the reactance under various conditions of speed, &c., of the various possible combinations of single and polyphase stators and rotors; the polyphase stator with single-phase rotor is in particular interesting. Machines with non-salient poles only are considered.

Introduction.—In every alternating-current electrical installation there are, in addition to the main currents of normal frequency, supplementary currents of the same frequency and others. Supplementary currents of *normal* frequency are produced between synchronous machines:

1. By over or under excitation of the one relatively to the other,
2. By a difference in the irregularity of their speeds.

The circulating currents of *higher* frequency are due to harmonics in the E.M.F. curves, or to disturbances on the system produced by variation in the load, short circuit, &c.

For the currents of *normal* frequency the total *synchronous* reactance, direct and transversal, must be considered, and for the currents of higher frequency the total *asynchronous* impedance.

Generalities.—It is true that the rotor of a synchronous alternator has a single phase winding; yet owing to the presence of masses of metal forming secondary circuits, its action with respect to the stator is of the nature part single, part polyphase, or mixed (that is to say, a mean between the two).

Let us establish the approximate diagrams of such a machine with non-salient poles, acting as an induction, that is to say, an asynchronous motor.

Let

E_o = voltage per phase applied to stator,
R_δ = reactance of main magnetic circuit,
R_s = reactance of magnetic leakage circuit of stator,
$R_o = R_\delta + R_s$,
R_r = reactance of magnetic leakage circuit of rotor, in terms of the stator,
$R_{cc} = R_s + R_r$,
I_m = magnetising current,
I_o = light load current,
I_{cc} = current on short-circuit,
I_s = stator current,
I_r = rotor current.

A. Stator *polyphase*, rotor *polyphase*.—At synchronism the current on light load is

$$I_o = I_m = E_o/(R_\delta + R_s) = E_o/R_o,$$

and at standstill the short-current is

$$I_{cc} = E_o/(R_s + R_r) = E_o/R_{cc}.$$

For an intermediate speed it is known that the primary current I_s, with its lag ϕ, is determined by the circle diagram I_{cc} (Fig. 1) (the resistance of the windings is assumed to be negligible).

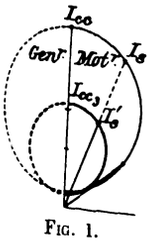

FIG. 1.

When the rotor is driven round in the direction of the rotating field at a speed above synchronism, the stator acts as a generator, following the continuation of the circle; and when the rotor is driven round in the *opposite* direction to the rotating field, the machine acts as a choking coil, the reactance of which is *constant*, independent of the speed, and equal to R_{cc}. The total impedance has then the limiting values of R_o and R_{cc}.

1. By placing an ohmic resistance r_s in series with the stator the current on light load becomes

$$I_{o_1} = E_o/\sqrt{R_o^2 + r_s^2},$$

and the short circuit current

$$I_{cc_1} = E_o/\sqrt{R_{cc}^2 + r_s^2};$$

however, the primary current I_{s_1} still follows the primitive circle I_{cc}.

2. By introducing an ohmic resistance r_r (reduced in terms of the stator winding) into the rotor circuit, the light-load current is not altered:—

$$I_{o_2} = I_o = E_o/R_o,$$

and the current on short circuit takes, as above, the value,

$$I_{cc_2} = I_{cc_1} = E_o/\sqrt{R_{cc}^2 + r_r^2};$$

the primary current still follows the same circle.

3. By placing a choking coil of reactance, R'_s, in series with the stator, the light load current becomes

$$I_{o_3} = E_o/(R_o + R'_s),$$

and the current on short circuit

$$I_{cc_3} = E_o/(R_{cc} + R'_s).$$

The primary current with its lag ϕ_3 is determined in the same manner, but by the circle I_{cc_3} (Fig. 1). The diagram is the same as if the supplementary reactance were part of the reactance of the stator winding itself.

4. By introducing a reactance into the rotor circuit, the light load current retains its value,

$$I_{o_4} = I_o = E_o/R_o,$$

and the short circuit current takes, as above, the value

$$I_{cc_4} = E_o/(R_{cc} + R'_r) = I_{cc_3},$$

when R'_r, reduced in terms of the stator winding, is equal to R'_s.

The light load current is then a little higher; otherwise the diagram is identical with the preceding one with the choking coil connected in the stator circuit.

B. Stator *single-phase*, rotor *polyphase*.—From the above it follows that to demonstrate that the circle diagram holds for this machine, it is simply necessary to show that the single-phase motor with polyphase rotor acts in reality as a polyphase motor with *a choking coil in series with the stator*.

To effect this we replace the single-phase winding by two equal polyphase windings, connected in series but in opposite directions. The current having the same intensity in the two windings at every instant, two rotating M.M.F.s are produced equal in magnitude, but rotating in opposite directions. The two rotating fields which are set up act upon the rotor as an alternating field, and their combined action will be the same since the resultant field attains the same maximum value. To obtain this equality let us see how the winding of such a machine can be realised.

(*a*) Take the case of a stator with r slots per pole, of which $r/2$ slots are wound single phase with s_n conductors; when a current of R.M.S. value I_s is passed through the winding the maximum value of the M.M.F. produced will be

$$= \frac{r}{2} \times s_n \times I_s \sqrt{2}.$$

Replace this single-phase winding by two two-phase windings, in which each of the r slots per pole contains s'_n conductors per winding ($2s'_n$ conductors per slot).

(*b*) In connecting the phases of the windings occupying the *same* slots in series, the *first* will be connected in the same sense, the others in the opposite sense.

The maximum value of the M.M.F. produced will be

$$2 \times \frac{r}{2} s'_n I_s \sqrt{2} = r s'_n I_s \sqrt{2}.$$

To obtain the same action it is necessary that $s'_n = \frac{1}{2}$ of s_n; in fact the M.M.F.s of the opposed phases counteract each other directly, and the other two remaining phases constitute quite simply a single phase winding identical to (*a*).

(*c*) By connecting the displaced phases in series, the maximum value of the M.M.F. produced will be

$$\sqrt{2} \times \frac{r}{2} s'_n I_s \sqrt{2}.$$

To obtain the same action it is necessary here that $s'_n = \frac{s_n}{\sqrt{2}}$.

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Let us verify the E.M.F.s produced, the resulting flux having the same value Φ in the three cases:

(*a*) $E_o = K \times \frac{r}{2} \times s_n \times c \times \Phi \times 10^{-8}$.

(*c*) $E'_o = \sqrt{2}K' \times \frac{r}{2} \times s'_n \times c \times \frac{\Phi}{2} \times 10^{-8}$,

per phase

$= K' \times r \times s'_n \times c \times \frac{\Phi\sqrt{2}}{4} \times 10^{-8}$.

The volt-amperes absorbed will be:

(*a*) $E_o I_s = K \times \frac{r}{2} \times s_n \times c \times \Phi \times 10^{-8} \times I_s$,

(*c*) $2E'_o I_s = 2 \times K' \times r \times s'_n \times c \times \Phi \times \frac{\sqrt{2}}{4} \times 10^{-8} \times I_s$.

In order that the V.A. shall be the same it is necessary that

$$K \times \frac{r}{2} \times s_n \times c \times \Phi \times 10^{-8} I_s = 2K' \times r \times s'_n \times c \times \Phi \times \frac{\sqrt{2}}{4} \times 10^{-8} I_s.$$

and since $K = K'$, it follows that $\frac{s_n}{2} = \frac{s'_n}{\sqrt{2}}$, whence $s'_n = \frac{s_n}{\sqrt{2}}$ as obtained above.

It follows that the reactance *per phase* of the main magnetic circuit of the two windings in series will be one-half of that of the single-phase winding. To have the same reactance it is necessary to employ $\sqrt{2} \times s'_n = s_n$ conductors per slot, and to apply a voltage per phase equal to $E'_o \sqrt{2} = E_o$ = that of the single-phase winding.

Thus the reactance per phase of *each* of the two windings is then one-half of that of the single-phase winding.

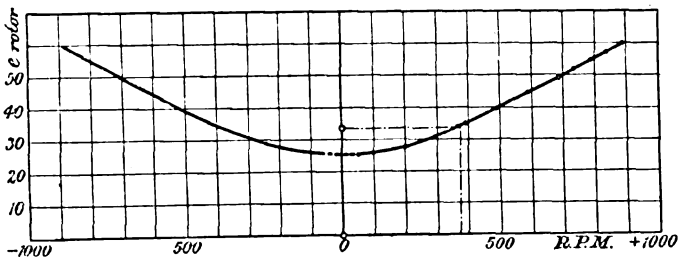

FIG. 2.—175 H.P. MOTOR, 3,000 VOLTS, 50 ∿, 750 REVS. PER MIN., WITH ROTOR OPEN.

Voltage between rings on rotor, the stator being magnetised single-phase, two phases in series, pressure being 250 volts. 25 ∿.

It follows from reasonings (*b*) and (*c*) that a single-phase winding can be replaced by two two-phase windings connected in series, the reactance per phase of the two windings in series being the same as that of the single-phase winding.

Let us now determine how this machine with the special equivalent winding operates. Assume the rotor to be open-circuited and driven at the speed of synchronism $+v_1$ it rotates then in the same sense as the one field and in the opposite sense to the other.

The field which rotates with the velocity $+v$ does not produce any induction in it, but the one rotating with the speed $-v$ produces an E.M.F. corresponding to the relative speed of $2v$, and hence of frequency equal to twice the normal (Fig. 2).

When the rotor circuit is closed, the latter, together with the winding I of the stator, constitutes a polyphase motor the rotor of which rotates at synchronous speed, and with winding II it constitutes a polyphase motor the primary field of which rotates in the opposite direction to the rotor.

At standstill, I and II both represent a polyphase motor on short circuit (rotor fixed).

It follows then, that I operates as a polyphase motor between the limits $+v$ and 0, whilst II is only a simply choking coil with constant reactance.

The windings I and II being connected in series, we can say that the *single-phase* motor acts like a *polyphase* motor having a *choking coil* in *series* with the stator.

By denoting the various reactances corresponding to each of the windings by $\frac{R_o}{2}$, $\frac{R_s}{2}$ and $\frac{R_r}{2}$ we have,

1. For the magnetising current,

$$I_m = \frac{E_o}{2(R/2)} = \frac{E_o}{R_o},$$

the voltage for each one of the windings in series will be $\frac{E_o}{2}$.

2. For the current on light load

$$I_o = E_o / \left(\frac{R_o}{2} + \frac{R_s}{2} + \frac{R_r}{2}\right) = E_o / \left(\frac{R_o}{2} + \frac{R_{cc}}{2}\right),$$

the voltage across I will be $I_o \times \frac{R_o}{2}$ and across II it will be $I_o \times \frac{R_{cc}}{2}$.

3. For the current on short circuit,

$$I_{cc} = E_o/2\left(\frac{R_s}{2} + \frac{R_r}{2}\right) = E_o/R_{cc}$$

the voltage for each phase will again be the same, *i.e.*, $\frac{E_o}{2}$.

The rotor constitutes a common secondary to the windings I and II; I induces a current I_{r_I} in it, displaced with respect to the primary current and varying in amount according to the circle diagram; II induces a current $I_{r_{II}}$, proportional and opposed to the primary current.

The resulting current in the rotor is $I_r = \sqrt{I_{r_I}^2 + I_{r_{II}}^2}$. Since I_{r_I} and $I_{r_{II}}$ are of different frequencies.

This explains at once the reason that the slip of a single-phase motor is not, as with a polyphase motor, determined by the total losses in the rotor; it is only the losses corresponding to $I_{r_1}^2$ which come into consideration.

(C) Stator *polyphase*, rotor *single phase*.—By replacing, as in the preceding paragraph, the single-phase winding of the rotor by two polyphase windings, we find in a fairly simple manner that the fundamental diagram of this machine is still a circle.

Consider what takes place at various speeds.

(*a*) *On light load at speed v.*—The rotor rotates in synchronism with the primary field, hence there is no E.M.F. produced in its windings; the stator consumes the light load current

$$I_o = I_m = E_o/R_o.$$

(*b*) *On load with a speed v, taken between v and* $\frac{v}{2}$.—The rotor slips relatively to the primary field, there is thus an E.M.F. and corresponding currents produced in its windings having a frequency $\sim_1$. The currents in winding I produce a field rotating in respect to, and in the same direction as the rotor, the actual speed being $v \times \frac{\sim - \sim_1}{\sim} + v \times \frac{\sim_1}{\sim} = v$ = constant, that is to say, the same speed as the primary field with respect to the stator.

The currents in the winding II produce a field which rotates relatively to the rotor, but in an opposite direction to it; this field thus rotates at a speed of $v \times \frac{\sim - \sim_1}{\sim} - v \times \frac{\sim_1}{\sim} = v\left(1 - \frac{2 \sim_1}{\sim}\right)$ relatively to the stator.

Since the speed of field II with respect to the stator decreases twice as quickly as the slip of the rotor, the field will be zero in space at half speed $v/2$. Below this speed the field II will rotate in a negative direction with respect to the stator. While the speed of the rotor varies from v to $v/2$, the frequency of the E.M.F.s induced by field II in the stator windings will vary from $\sim$ to 0, and for speeds from $v/2$ to 0 the frequency of the E.M.F.s will increase again from 0 to $\sim$. These E.M.F.s produce currents in the stator windings which complete their circuits by means of the distributing network.

The combined value of the ohmic resistance and reactance of the generators and motors operating in parallel across the mains is in general negligible in comparison with that of the motor; we can then consider that the stator winding constitutes a short-circuited secondary, so far as the rotor winding is concerned.*

* This depends upon the importance of the motor relatively to the network.

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We therefore conclude that the machine with polyphase stator and single phase rotor is similar in action to two polyphase motors, the rotors of which, fixed to the same shaft, are coupled in cascade in such a manner that the field of I rotates in the opposite direction to that of II (Fig. 3).

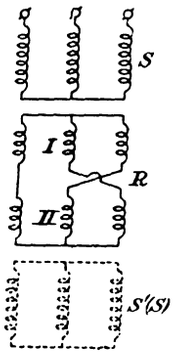

FIG. 3.

The table below shows the frequencies of the currents produced in the stator and rotor at various speeds.

Slip of the rotor R with respect to the primary field the stator S, per cent.	Frequency of the current produced in windings I and II of the rotor.	Frequency of the current produced by rotor winding II in the winding S (S') of the stator.	Electrical slip of the stator winding S (S') with respect to the field of the rotor winding II, per cent.	
10	5	40	800	
20	10	30	300	1
30	15	20	133	
33·3	16·65	16·65	100	
40	20	10	50	2
50	25	0	0	
60	30	10	33·3	
70	35	20	57	
80	40	30	75	3
90	45	40	89	
100	50	50	100	

The last column shows that the winding II of the rotor behaves:—

1. For a slip between 0 and 33·3 per cent. as a *choking coil.*
2. For a slip between 33·3 per cent. and 50 per cent. as an asynchronous *generator.*
3. For a slip between 50 per cent. and 100 per cent. as an asynchronous *motor.*

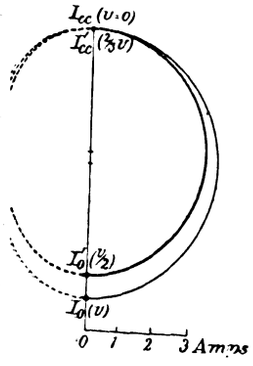

FIG. 4.

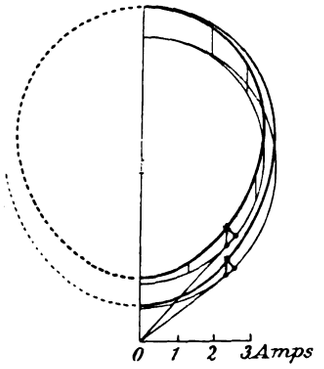

FIG. 5.

The rotor winding II constitutes for all slips from 0 to 100 per cent. the secondary of an asynchronous *motor*, of which the stator winding S is the primary: it follows then that the whole machine operates:—

Between v *and* $\frac{2v}{3}$, as a polyphase asynchronous *motor*, with reactance coil II in the *rotor* circuit.

Between $\frac{2v}{3}$ *and* $\frac{v}{2}$ as an asynchronous *generator* II, having *choking coil* S in series with the *stator.*

3. *Between* $\frac{v}{2}$ and 0, as an asynchronous motor II, having also a *choking coil* S in series with the *stator.*

In fact, it is well known that an asynchronous motor, with windings of small ohmic resistance, represents, for a slip well in excess of 33 per cent., a choking coil of approximately constant reactance of the same value as that of the motor at standstill.

It follows at once that for each of the three regions of speed 1, 2 and 3, the diagram will be a half-circle (Fig. 4).

The currents taken by the motor at the various characteristic speeds are:—

1. At speed v: $I_o = I_{cc} = E_o/R_o$.
2. At speed $\frac{2v}{3}$: $I'_{cc} = E_o/\left(R_s + R_r + \frac{R_r}{2} + \frac{R_s}{2}\right) = E_o/1{\cdot}5R_{cc}$.
3. At speed $\frac{v}{2}$: $I'_o = E_o/\left(R_s + R_r + \frac{R_o}{2} + \frac{R_r}{2} - \frac{R_s}{2}\right)$
$= E_o/\left(\frac{R_{cc}}{2} + \frac{R_o}{2} + R_r\right)$.
4. At speed 0: $I_{cc} = E_o/\left(R_s + R_r + \frac{R_r}{2} + \frac{R_s}{2}\right) = E_o/1{\cdot}5R_{cc}$.

The reactance of the first machine (stator with winding I of rotor as secondary) remains whole, whilst that of the second (winding II of the rotor with the stator as secondary) is halved. The current twice attains a maximum value I'_{cc} and I_{cc}. The voltages are composed as follows.

On the first machine.	On the second machine.
1. $I_o R_o = E_o$.	Zero.
2. $I'_{cc}(R_s + R_r) = I'_{cc} \times R_{cc} = \frac{2}{3}E_o$.	$I'_{cc}\left(\frac{R_r}{2} + \frac{R_s}{2}\right) = I'_{cc} \times \frac{R_{cc}}{2} = \frac{1}{3}E_o$.
3. $I'_o(R_s + R_r) = I'_o \times R_{cc}$.	$I'_o\left(\frac{R_o}{2} + \frac{R_r}{2} - \frac{R_s}{2}\right)$.
4. $I_{cc}(R_s + R_r) = I_{cc} \times R_{cc} = \frac{2}{3}E_o$.	$I_{cc}\left(\frac{R_r}{2} + \frac{R_s}{2}\right) = I_{cc} \times \frac{R_{cc}}{2} = \frac{1}{3}E_o$.

The stator winding constitutes at the same time the primary circuit of the first machine and the secondary circuit of the second: currents of different frequencies are therefore produced, and a hot wire ammeter will indicate the effective value of the resultant current, equal to the square root of the sum of the squares of the individual currents.

It is not the same with a wattmeter placed in the stator circuit; this indicates but little more than the power corresponding to the main watt current, since the voltage producing the secondary currents is very feeble.

It follows, therefore, that it is necessary to separate the two currents in order to find by experiment the real power factor of the main current. For this purpose it suffices to know that the secondary current produced in the stator is approximately one-half of the primary current; the main current is, therefore, $\frac{1}{\sqrt{1^2 + 0{\cdot}5^2}} = 0{\cdot}9 \times$ the current measured on test.

The circle diagram of the main currents is thus fixed by taking 0·9 of the limiting currents, that is to say, $0{\cdot}9 \times I_{cc}$ and $0{\cdot}9 \times I_o$. Similarly, the diagram of the resultant currents in the stator can be easily constructed from the fundamental circle; the diagram is then obtained in an oval form, as shown in Fig. 5.

It can readily be understood that the amperemeter should oscillate in the neighbourhood of synchronism at half and full speed, for then the frequency of the secondary currents in the stator is very small, corresponding to the slip. It should still further be remembered that ohmic resistance in the rotor completely alters the form of the diagram, the explanation of which can be seen above from paragraph A, sections (1) and (2).*

(To be concluded.)

* The analysis which we have just made also gives us all the elements necessary to establish the exact vector diagram; it is sufficient to consider the different regions of speed to obtain a continuous and complete diagram. We must be content with the above explanation without going at greater length into the matter.

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ELECTRIC TIN SMELTING.

BY J. HÄRDÉN.

Summary.—Very little is known, outside a limited circle, of tin-smelting. The author, after describing the smelting of tin in the reverbatory furnace, gives particulars of an extensive series of tests he has carried out, using an electric process. This method offers considerable advantages; and he shows that it deserves consideration where electric power is cheap.

Very little has as yet been said or published on the subject of electric tin smelting: all that has been done so far in this respect seems to refer to the de-tinning of tin-plate. Occasional references to electric tin smelting may have appeared from time to time, but the writer has not been able to find any literature on the subject worth referring to, though this may be due to lack of opportunity.

Even the smelting of tin in the orthodox way—by means of the reverbatory or the shaft furnace—is but scantily mentioned in text-books, &c., and very little is generally known about tin metallurgy outside the circle of those directly interested in the subject. It may therefore be of interest to metallurgists to learn that electric tin-smelting was carried out on a large scale as a commercial experiment in Cornwall during last summer (1910) in a plant designed by the author, the Grondal Kjellin Co., of London, being consulting engineers.

A brief report is here given of the work carried out, together with a few general remarks on tin smelting; these remarks are, of course, not intended to cover the whole scope of the subject.

Cornish Tin Smelting.—Tin smelting in the reverbatory furnace has been carried out in Cornwall since time immemorial, and the metallurgy of that process is, in a broad sense, very simple, though to make it efficient requires a good deal of attention to minor technical details, and long practice. Broadly speaking, the method is this:—

The tin ore, chiefly consisting of tin oxide (SnO_2), as mined in Cornwall, is dressed in streams or on tables at the mines so as to contain about 63 to 64 per cent. of tin. The ore is delivered in bags of about 3 cwt. each, in the form of a dense, red-brown, moist powder, ground fairly fine, say about 15 to 20 mesh. After allowing the ore to dry for some little time, depending upon the moisture, which may vary from 7 to 15 per cent., it is mixed with the reducing agent, a low grade anthracite called "culm," which contains a considerable quantity of slaty clay or aluminium-magnesium silicate, &c.

The quantity of culm to be used depends to a certain extent upon the character of the ore. A single ore is rarely used; indeed, the proper blending of different ores is one of the principal factors in producing an efficient melt. Bolivian or Straits tin ore is very often mixed with Cornish ore. Generally, about 20 to 25 per cent. of culm is used; for the first charges no other flux is added. It is customary to build a furnace so as to take a charge of 3 to 4 tons of ore and about ¾ of a ton of culm, some of the culm acting as fuel. A quantity of the ore is mixed with culm in various proportions and melted in a test crucible of graphite so as to ascertain the best yield.

It is essential to conduct the smelt so that the temperature is raised gradually, especially if the ore is of a silicious nature, because if the temperature rises too briskly, tin silicate and silicides will be formed; these go into the slag directly, causing a great loss. Also volatilisation must be guarded against, as the metal is comparatively very volatile. In very modern plants a condensing chamber is used to recover the losses. The charge is frequently turned over with iron rakes, so as to ensure an even distribution of the heat. In some plants a quantity of scrap iron is added to the charge before the melt is finished in order to cause impurities to be taken up by the iron rich slag formed.

The melt is finished after 6 to 8 hours, when the taphole is opened and the metal and slag are run off together into a hemispherical cast-iron pan, which is often provided with a special heating arrangement. Each pan will hold 4 to 5 tons of metal. The slag floats on the surface of the metal and is run off in iron boxes to solidify.

The first slag is generally rather rich in tint: it may sometimes contain 14 to 16 per cent. of tin in various combinations. It is therefore frequently used as an admixture to a subsequent smelt, or may be treated separately for tin. The final slag is said to contain about 6 to 7 per cent. of tin, and is therefore sometimes smelted together with lead refuse for solder tin. In more recent plants, however, the slag contains only 2·5 to 3 per cent. of tin.

The crude tin as first obtained is cast into large ingots, and still contains a considerable quantity of impurities. These ingots are placed on the sole of the reverbatory furnace and re-melted at slow heat and low temperature; this is the so-called liquation process. The pure tin is thereby run off and the impurities remain behind, forming the so-called "hardhead," which mainly consists of an alloy of tin with sulphides and arsenides of iron. The percentage of tin varies somewhat, but is always considerable, and this "hardhead" is a source of trouble to the smelters. One of the objects of electric smelting was to try to eliminate, if possible, the formation of this undesirable "hardhead," which is so difficult to treat separately.

After the tin has been liquated it is collected in a large pan or refining pot, heated from underneath. This tin is usually about 96 to 98 per cent. pure and still contains impurities of arsenic, tin sub-oxides, &c. For further purification so-called "tossing" and "boiling" are employed. The former consists in scooping the hot metal in thin broad streams through the air, whereby the impurities are oxidised and will float on the top. The "boiling," which is more common, consists in immersing a raw piece of wood of large dimensions in the metal, vigorously stirring the latter. (Formerly it was believed that only wood from apple trees would serve the purpose.) A violent agitation sets in, oxidising the impurities. In modern plants dry steam and air are blown through the metal for the same purpose.

A small sample is ladled out from time to time and poured into the groove of the "test stone," a porous, white sandstone. The behaviour of the solidifying metal, together with the fracture of the notched bar and the special sound of the "tin crying," tell the skilled smelter of the purity of his metal. Indeed, this test is so reliable that an experienced smelter can tell within 0·2 per cent the degree of purity of the tin. Refined tin should have 99·6 to 99·8 per cent. of tin.

The refined tin is usually cast into 28 lb. ingots and branded with the trade mark, or else into strips 18 in. long and about ½ in. thick.

Electric Tin Smelting.—At a first glance it would seem that the electric furnace would not adapt itself very well for the smelting of tin ore, since the temperature of the electric furnace would appear to be unnecessarily high for the reduction, and even injurious. However, this assumption is quite erroneous. The reduction of stannous oxide by carbon requires a comparatively high temperature, especially if a good separation from impurities is to be effected. Besides, tin is readily volatile at this high temperature, and in a reverbatory furnace with its wide hearth, communicating directly with the smoke stack, or else in the tin-blast furnace where air is forced through the charge, this volatilised metal is almost altogether lost, if complicated condensing devices are not provided for.

All the above can to a large extent be avoided with the electric furnace, if properly designed. Another feature is that the formation of "hardhead" can be greatly reduced if the process is carefully conducted. Finally, if the cost of power is not too high, decided economy compared with the reverbatory furnace is quite possible, as the experiments have shown.

As to the loss of tin in the slag, it has been conclusively proved that one can so conduct this operation that slags containing only 0·25 per cent. of tin may be produced in one melt; but it appears to be more economical so to conduct the process that a richer slag containing, say, 14 to 16 per cent of tin may be produced, and to treat this richer slag while white hot in a second furnace, thereby considerably increasing the output.

Theoretical Yield.—If tin oxide, SnO_2, is reduced by means of carbon, we may assume the ideal equation

$$SnO_2 + C = Sn + CO_2,$$

but that at least two-thirds of the reaction at the outset takes place according to the equation

$$SnO_2 + 2C = Sn + 2CO.$$

This is substantiated by the fact that a considerable quantity of CO can be seen burning at the mouth of the furnace. A certain amount of the CO will naturally serve as a reducer when passing through the charge in the shaft, and it is of importance for reasons given previously by the author,* so to conduct the charge that the reaction set out in the second equation above is predominant, though it will hardly be possible to realise this to a greater extent than 50 per cent. Also the packing of the charge in the shaft, owing to the weight and small size of the particles of ore, will prevent this to a certain extent. We may therefore assume that under proper conditions, and after some hours' run, the reactions set out in the two equations above take place in equal proportions.

Heat Energy Required.—According to Thomsen and other investigators, 118 grammes of tin will yield 145,300 gramme calories by combustion into tin oxide. This amount of energy will therefore be required for liberating 118 grammes of metallic tin. On the other hand, the combustion of 12 grammes of carbon into CO_2 will yield 96,960 gramme calories; and 24 grammes of carbon into 2CO will give (in round figures) 58,000 gramme calories.

Assuming, therefore, that the reaction takes place according to the first equation, the metal would require 474 kw.-hours, and if according to the second equation 855 kw.-hours, for 1 ton of metallic

* *See* "Electrochemical and Metallurgical Industry," Vol. VII., No. p. 16.

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Assuming an equal proportion of each reaction, we would therefore require 665 kw.-hours per ton of tin.

In addition to this, a certain amount of energy is required for heating up the charge to the temperature of reaction. No actual measurements of the temperature in the furnace were taken, but judging from the appearance of the slag and the metal tapped, it may be safe to assume that the average temperature of the whole interior of the reactive ozone was about 1,400 to 1,600°C.

Previous experiments have shown that to liquify one kilogramme of slag, such as that from the furnace, requires on the average 500 kg. calories, or about 0·6 kw.-hour. If we assume an average of 20 per cent. of slag from ore (naturally depending largely on the class of ore used) we would need 130 kw.-hours for the slag.

The radiation losses through the furnace walls, electrodes and water-jackets are naturally of such nature that no accurate figures can be obtained, but it seems safe to assume this loss to be equal to that in the slag, or 130 kw.-hours, while the escaping gases in the furnace used for our experiment, left the furnace mouth at a temperature of about 800°C. The losses through this source may therefore be set at about 150 kw.-hours for each ton of tin.

In summing up these items, we there find that in practice it should be possible to produce one ton of tin with an expenditure of power equal to :—

For the reaction	665	kw.-hours.
For slag	130	,,
For specific heat	65	,,
For radiation losses	130	,,
For losses through gases	150	,,
Total	1,140	kw.-hours.

In the experiments carried out, this theoretical figure was not obtainable, as the furnace was too small, and also for other reasons given below, but a very fair result was obtained.

Practical Tests.—At the request of Mr. A. F. Maclaren, of London, the author was asked to carry out some experiments on those lines late in 1909. Some difficulty was at first experienced in finding a suitable place for the preliminary trials on a laboratory scale, but early in 1910 Dr. Walmsley, of the Northampton Polytechnic Institute, courteously permitted the tests to be made in the Electrochemical Laboratory of the Institute. A furnace had been designed for 800 amperes and 50 volts alternating current, though only direct current of about 300 amperes and 100 volts was obtainable at the Institute. The direct current was particularly unsuitable for this class of work on account of the heating effect being greater at the positive electrode, which was fully borne out in the experiments. Also, electrolytic effects on the slag were to be reckoned with. In addition to this, the tests had to be carried out so as not to disturb the ordinary work of the laboratory; this naturally affected the results.

In spite of these difficulties, however, the following results were obtained. The furnace was built up in a manner somewhat resembling that designed by Harmet for iron-ore reduction. It was provided with a bottom chamber of magnesite bricks, rammed with calcined magnesite mortar, in the usual manner. A charging shaft rested on a vault or arch. The inner diameter of the hearth was about 5½ in. and the total height about 14 in. Two inclined carbon rods, about 2½ in. in diameter, were used as electrodes and reached into the centre of the hearth, about 2½ in. from the bottom. No cooling jackets were used, though they would have been of great assistance. The wear and tear of these electrodes, however, was so little, in spite of the primitive arrangement, that it could hardly be taken into account. This was also manifested during later experiments.

In a preliminary heat, on Jan. 27, 1910, the charge consisted of :—Tin ore (about 63 per cent. of tin) 20 lb., coke powder 5 lb., flux 5 lb. Of this only 12 lb. of ore was actually reduced, owing to lack of powder. Altogether about 40 kw.-hours were consumed, of which 15 were used for heating up, and 25 for the reduction proper. The melt yielded 5¼ lb. of pure bar tin and 1¼ lb. in the shape of shots, thus corresponding to about 85·5 per cent. yield from the ore. The slag was very irregular, as only one taphole was provided, so that some metallic tin remained in the slag. The power expenditure therefore amounted to about 4 kw.-hours per pound of metal or 8,960 kw.-hours per ton. As mentioned above, however, there was considerable loss of heat owing to the arrangement of the furnace.

In the next trial, the slag from the first melt was used as a flux. This proved to be a disadvantage, as it required a much higher temperature to be remelted and the taphole froze very readily. In a subsequent test, 16 lb. of ore were smelted, giving 6½ lb. of pure bar tin and 2⅓ lb. of shots, or a total of 9 lb. of metal, equal to about 90 per cent. of the metal in the ore. The maximum power taken was 8·4 kw., and the total duration of the melt was 2 hours. The total power consumption, including heating up, was 19·2 kw.-hours, that is, 2·15 kw.-hours per pound, or about 4,300 kw.-hours per ton of metal.

The tin obtained from the furnace proved to be well over 99 per cent. pure: it contained very little iron and no arsenic. The slag varied in appearance; if the run was smooth, it flowed freely and showed a greyish glassy lustre. Three average samples of this proper slag were analysed and found to contain an average 0·5 per cent. of tin. The stiff, black slag obtained in some melts contained, however, as much as 8 per cent. of tin. Thus, the best thermal efficiency obtained from this little furnace was about 25 per cent., while the metallurgical yield was as high as 90 per cent.

A test for electrolytic recovery of the tin in the slag was also made. Some slag and refuse containing an appreciable amount of metal was fused with soda (which may be carried out at once, while the slag is hot). The product was readily soluble in water and could be electrolysed direct, with iron plates as cathode. A good deposit of tin was obtained, though the efficiency was not very high. If, however, the oxide from the slag were converted into chloride of tin, the theoretical power consumption would be about 1,820 kw.-hour per ton of metal. Assuming an efficiency of, say, only 50 per cent., this recovery may be possible where the power price is low, with a rotating cathode and scrap tinplate as anode.

In view of the above promising metallurgical results, it was decided to carry on experiments on a very much larger scale, and on a commercial basis. A power supply of 100 kw. was secured and a suitable site acquired, where a galvanised iron building was erected, a tank for cooling water was built and every facility provided for a conclusive test.

Electrical Equipment.—Current was obtained from a Diesel engine plant, supplying power to a tin mine, and a condition was that no fluctuation should be caused which might endanger the regular working of the pumps in the mine. The supply was three-phase current at 50 cycles and 650–575 volts. A Berry three-phase oil-cooled transformer was installed, and was supplied at 660 volts on the primary side, in star connection, with only a lightning arrester and a main switch on the line. The secondary side, which was also connected in star, with earthed neutral, had four tappings, capable of giving either 30, 40, 50 or 60 volts. The terminals ended in copper 'bus-bars on a slate panel, provided with heavy copper screw plugs for obtaining the desired combinations. Each phase on the secondary side was provided with an ammeter, whilst a voltmeter with a change-over switch served for all three lines. The recording and indicating wattmeters were on the primary side.

The 'bus-bars were connected to the furnace electrodes by means of four flexible cables of suitable size, arranged so as to give the least possible induction. As, however, the current was as high as 4,000 amperes, a certain decrease in power factor was inevitable, the average power factor being about 0·90. During the whole test, no disturbance whatever was caused. The distance between the power house and the smelting plant was about 600 yds.

Furnace.—The furnace used was a shaft furnace of special design. Owing to pending patent applications a detailed description of this, as well as of the details of the actual smelting process employed, will have to be deferred to a later occasion when these matters have been settled. One of the principal features in an ordinary reverbatory tin furnace is that the metal, like mercury, will percolate into the lining and brickwork in large quantities and remain lodged there until the furnace is broken up. In a large plant with a number of furnaces this means the locking up of a considerable capital for a long period, which naturally is objectionable. This is successfully avoided in the new design of the electric furnace, where only a minimum quantity of metal is retained, all the metal being drawn off as soon as it is formed.

Three electrodes of carbon, 8 in. × 8 in. square and 4 ft. 6 in. long, cooled by water-jackets were used. The electrodes were supported by means of holders extending over half the electrodes, the holders being raised as the ends were worn off. The holders were suspended by means of flexible steel rope, and worm-gear winches permitted of fine adjustment.

No direct arc was allowed to form, as this caused a great variation of the yield and the working of the furnace. The charge formed a cone-shaped heap in the hearth, covering the reaction zone, permitting the electrodes to "burn free," forming a small space filled with incandescent gas round the ends, this acting as a resistance in which the reaction took place. This is, as is well known among furnace men, the only efficient way of working a furnace.

Arrangements were made to prevent the escape of volatilised metal; only about 0·5 per cent. or less of tin found its way out of the furnace. Tapholes on different levels were provided for drawing off the metal and slag separately. Sometimes the slaghole was frozen up with a hard slag crust, especially if the ore was rich in iron; all this went into the slag. In that case a small auxiliary electrode was used for

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burning the taphole open again. This could be done very easily, although it must be admitted that an oxy-acetylene jet would be even more handy.

The Smelting Process.—At the start of each series of tests, which usually lasted 10 to 12 days (there is no reason why the furnace should not be worked for months at a time), the empty furnace was warmed for about 4 to 6 hours by means of a small wood and coke fire; this was done to prevent cracks in the brickwork. In subsequent melts, this could be almost entirely dispensed with, since the lining had properly set. A charge of about 14 kg. of culm for each 100 kg. of ore, depending somewhat on the nature of the ore, was gradually filled in, while a current at 60 volts and of about 1,000 amperes per phase was switched on. As soon as the reaction commenced, the pressure was lowered gradually to the working condition of 40 volts and 2,500 amperes. This pressure and current were steadily maintained during the whole run. Only in the case of certain ores was a pressure of 30 volts used.

The current fluctuated considerably at the beginning whilst the cold charge was being thrown in, but as soon as the electrode commenced to burn free the fluctuations ceased. Within half an hour after the first charge the first tapping of metal could take place, while the first slag was drawn off after the furnace had been working for a couple of hours. The appearance of the slag rendered it possible for the experienced eye to judge if the charge was of the right composition or not; if of a glass-like, dark brownish-green colour, and freely leaving the taphole, the charge was right; if sluggish and light brown, it had to be altered.

After a few hours' run, certain re-agents were added at regular intervals. This successfully prevented the formation of "hard-head," causing the sulphides and arsenides of iron to enter into the slag instead of alloying with the tin. The result was that the metal as it left the taphole of the furnace was about 98 per cent. pure, if the right blend of ore, not too much contaminated with impurities, was used. In one test, ordinary Bolivian ore, with only 49·5 per cent. tin and about 15 per cent. of iron was smelted for about 10 days and yielded over 92 per cent. finally, and on some days even 97 per cent., of the metallic tin from the ore. The liquid metal was collected in the usual way in large pots of wrought-iron, heated from underneath and at the sides. By means of an air-pump, air was blown into the metal through a perforated iron pipe, the metal then being ladled into a second tank to set properly. With this simple operation, a metal of 99·75 per cent. purity, and even higher, was obtained. This is well up to the commercial standard. The metal was then poured into ingots of about 28 lb. weight, branded and stored in the usual way.

Output, Power Consumption and Loss in Slag.—These three factors were found to be in close relation to each other. It was found that a slag containing as low as 0·25 per cent. of metallic tin could easily be produced, but to do this in one operation proved to be less economical at the price charged for electric energy. The output was only about 6 to 8 cwt. per day and the power consumption correspondingly high, or about 3,000 kw.-hour per ton of metal.

Going to the other extreme, the operation could be conducted so that a slag containing 17 to 19 per cent. of tin was produced. In that case, the output increased to 1 ton 11 cwt. per day, with a power consumption of 1,300 kw.-hours per ton of metal. As only one furnace was provided, this method of operation with such high losses of tin in the slag was not commercial, although this slag could be treated again separately. It was found most economical under the prevailing conditions to operate the furnace so as to obtain a metallurgical yield of 96 to 98 per cent. with a higher power consumption.

The following report for the week July 28–August 4, 1910, is fairly typical.

Ore used: 21,056 lb. of 57 per cent. equals	..	12,003 lb. of metal.
Scrap metal and charge refuse equals	.....	2,324 lb. of metal.
Total	.....	14,327 lb. of metal.
Tin produced	.....	14,170 lb.

Net yield, 98·75 per cent.

Total number of kilowatt-hours, 15,113.

From this must be deducted for slag treatment (experimental) 678 kw.-hours, and for preparing furnace, &c., 500 kw.-hours.

Total number of units used for reduction, 13,935.

Units per ton, 2,220.

Electrode consumption, 28 lb. per ton of metal.

It should be noted that this figure for the power consumption was averaged over a single run of eight days, during which experiments with different charges were made. On single days the power consumption was only 1,760 kw.-hours per ton.

One other reason for the larger power consumption was also that the ore was very wet (it contained about 15 per cent. of water), so that the shaft could only be filled to about ⅓ of its height, on account of setting. Also the evaporation of the water wasted a considerable amount of energy.

Conclusions.—The above figures show that a considerable saving in tin can be effected by means of electric smelting. If the plant is so arranged, as is so often done in other metallurgical processes, that two furnaces are working in series, the first one producing metal continuously at a great rate and permitting the hot slag, rich in tin, to run direct into the second furnace for subsequent treatment, eventually with lead ore for solder in order to hasten the process, the power consumption should not exceed 1,400 kw.-hours per ton of tin in a sufficiently large furnace. Even this figure may be decreased if proper blending of ores is strictly attended to. In the above-mentioned cases single ores were mostly used on account of the high price of the ore; this prevented the laying in of a large stock of expensive material for experiments. Also, it should be remembered that in a large commercial plant, modern appliances for tin smelting could be applied, thus again helping to increase the yield and lower the cost.

Another feature is of importance: the electric furnace will commence to yield pure tin even during the first hour of operation, and it will continue to do so without interruption, while the reverberatory furnace is intermittent in its operation. Again, the formation of "hardhead" is materially minimised, whilst the amount of carbon necessary for the reduction is only 14 per cent. instead of 20 to 25 per cent. Less labour is also required, as three ordinary labourers per shift are quite capable of running the furnace. Much less space is necessary for the electric furnace compared with the reverberatory type. The consumption of electrodes is so small that it need not anywhere be regarded as an objectionable feature.

If the power can be obtained at a reasonable rate, it therefore appears to be quite feasible to smelt tin electrically: especially should this be the case in the Straits Settlements, where large quantities of good ore, but not very rich in tin, are mined, and where numerous waterfalls are said to exist, but only a low grade of coal and that in small quantities. The use of charcoal, which probably would be much cheaper, should not be objected to; in fact, with suitable flux, it would probably work even better than culm. Native labour could be employed under white supervision without hesitation, as practically no skilled labour at all is required. It is obvious that it would be much cheaper to ship metallic tin than an ore which, as a rule, only contains about 55 per cent. of tin.

The operations would at first naturally cause a considerable amount of trouble, and would require a good knowledge of metallurgical and chemical engineering, but on the whole one can say that the principles of the problem are solved.

The above experiments will probably be shortly resumed, in a somewhat modified way, by which an even greater saving is to be expected.

STUDIES IN LIGHT PRODUCTION.*

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(*Continued from page 938.*)

Summary.—In these studies the author deals with the theory of light production, the scope being briefly indicated by the following contents: (1) The distribution of the energy in the spectrum and the measuring of efficiency. (2) The importance of "black body" radiation and the experimental realisation of the black body. Comparison of the energy curves of a black body and of platinum, and the variation of the position of maximum energy with temperature. (3) Mechanism of flame, and the temperature, energy and efficiency of flames. (4) The Welsbach mantle and selective radiation. (5) Radiation and efficiency of the carbon glow lamp. (6) Physical properties and temperature of the arc. (7) Temperature and energy curves of the Nernst glower. (8) Efficiency of the metal filament. (9) The mercury arc and its difficulties. (10) The light of the future and the possibility of obtaining "cold light."

No. 4.—The Welsbach Mantle.

The incandescent gas light was invented by Karl Auer, Freiherr von Welsbach, in 1885. He had been a pupil of Bunsen at Heidelberg, and before the invention of the light had made a thorough study of the rare earths. The principle of the light is that a mantle of organic material is impregnated with a mixture of thorium oxide and cerium oxide in the proportion of about one part of the latter to 99 parts of the former; the organic material is then burned off, the oxides remain and are heated in the colourless Bunsen flame until they radiate

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light. It is known that Auer von Welsbach did not come upon the discovery suddenly, but that he experimented systematically with different earths in order to get a mixture which, when heated in the Bunsen flame, would give a stronger light than its components.

On its appearance the Welsbach mantle created quite a stir in the scientific world, and the cause of its brilliancy was very much discussed. It follows quite simply from the ordinary laws of temperature radiation, but at first this was not definitely known, and other explanations such as luminescence and catalysis were forthcoming.

It was assumed that the Welsbach mantle radiated more than a black body at the same temperature, and that, consequently, its radiation could not be pure temperature radiation. Nichols and Snow (Phil. Mag., 33, 1892, p. 19) had found that when platinum foil was covered with zinc oxide and heated electrically to incandescence its light was very strong at first, but that during the first 10 minutes it diminished considerably, although the temperature was kept constant. Afterwards the intensity became constant. Hence they assumed that the light was composed of two parts: one part which remained constant, consisting of temperature radiation, and another part which diminished rapidly, consisting of thermo-luminescence. The source of the energy of this latter part was to be found in a physical or chemical change in the incandescent body, such as one from the amorphous to the crystalline condition. If the Welsbach mantle were thermo-luminescent, we would thus have not only an explanation of its high luminosity but also of the diminution of its intensity with time.

But an experiment described by H. Bunte ("Uber die neure Entwickelung der Flammenbeleuchtung," Ber. d. Deutsch. Chem. Ges., 31, 1898, p. 5) showed that the Welsbach mixture did not radiate more than a black body at the same temperature, and that there was, therefore, no necessity to assume that it was luminescent. A tube of arc lamp carbon which could be heated electrically to over 2,000°C. was used. Magnesia prisms were taken, and faces which met in a sharp edge coated with different substances—carbon, magnesia, thorium oxide, cerium oxide and Welsbach mixture. The prisms were then heated in the tube, and the brightness of the two neighbouring surfaces compared by looking down the end. There was little difference. As the inside of the tube was almost closed, the radiation from its end was practically radiation from a black body, and there should have been little difference, provided that the radiation from the prism was pure temperature radiation. It would, however, have been otherwise had one of the substances been luminescent; hence it follows that the Welsbach mixture is not luminescent.

Killing had maintained that the high luminosity was due to catalysis, and Bunte took up and developed this idea. If platinum black is held over a gas jet, the issuing gas condenses in it and lights up immediately, although the platinum is only at the temperature of the room. A means of lighting the gas is founded on this. The platinum acts as a catalytic agent in facilitating the combination of the oxygen in the air with the coal gas. Bunte supposed that the Welsbach mixture has somewhat the same properties, that it causes the gases to combine more suddenly. A higher temperature is therefore produced, and this explains the increased luminosity. On this theory the diminution of the intensity with time was due to some of the oxide being carried away by the gas and to some of it sintering with dust particles.

Catalysis is, however, not the true explanation, for Le Chatelier and Boudouard (C.R., 126, 1898, p. 1861) showed that when the Welsbach mixture was heated in an atmosphere of the gaseous products of combustion it radiated quite as well as in the Bunsen flame. And Nernst and Bose (Phys. Zs., 1, 1900, p. 289) proved the same result by heating filaments of the mixture electrically and in the Bunsen burner, and showing that the radiation was the same in both cases when the temperature was the same, the latter being measured by the electric resistance of the filament.

The question was finally settled in an article by Rubens; but the true reason for the high luminosity had previously been indicated by Le Chatelier and Boudouard (loc. cit.) and also by Nernst and Bose (loc. cit.). Le Chatelier and Boudouard first showed that the radiation of the Welsbach mixture was less than that of a black body at the same temperature. They then took a thermo-junction, the junction itself being disc shaped and of a diameter of 1·5 mm., and covered it in succession with Welsbach mixture, thorium oxide, cerium oxide, platinum, magnetic iron oxide, uranium oxide and lanthanum oxide, and placed it each time in the same part of the same Bunsen flame. The temperature was then read by the thermo-junction and the brightness compared by means of a spectrophotometer with that of melting platinum for points in the red, green and blue. The results are given in the following table, the brightness of melting platinum being taken as 100 in each case.

——	Tem. perature.	Red.	Green.	Blue.
	Deg. Cent.			
Welsbach mixture	1,380	7·0	12·5	12·5
Thorium oxide.....	1,290	1·45	1·4	0·3
Cerium oxide	1,110	1·9	0·7	0·15
Platinum	1,290	8·5	4·0	1·4
Magnetic iron oxide.....	1,080	1·5	0·48	0·1
Uranium oxide.....	1,070	0·30	0·25	0·05
Lanthanum oxide	1,250	4·0	3·1	1·8

Two striking facts are brought out by this table. First of all the Welsbach mixture attains a temperature 300 deg. higher than a similar black body placed in the same circumstances, for magnetic iron oxide is approximately a black body. Then the relative brightness of the Welsbach mixture increases from red to blue, while it decreases for all the other substances. This high emission in the blue is also brought out by the measurements of Nernst and Bose.

Now the substance in the flame is in a state of thermal equilibrium. It receives, mainly by conduction, a certain fixed quantity of heat per second, and loses it by radiation. The quantity radiated increases with the temperature. Since the temperature of equilibrium of the Welsbach mixture is so much higher than that of magnetic oxide, the Welsbach mixture must radiate very much less when the latter is at the same temperature. In comparison with the other substances, the radiation of the Welsbach mixture falls off as we enter the infra-red. We are, therefore, led to the conclusion that the high luminosity of the Welsbach mantle is due to the fact that it radiates less than the other substances in the infra-red.

In the article above referred to, Rubens ("Uber das Emissionsspektrum des Auerbrenners," Ann. d. Phys. (4), 18, 1905, p. 725) took a complete energy curve (*a*) of a new Welsbach mantle, the glass funnel being removed to avoid absorption in the glass. The mantle was suspended from above in order to eliminate the radiation from the stick in the centre. About 70 points were taken on the curve. The apparatus used was a mirror spectroscope with thermopile; the prisms were of fluorite and sylvin. Then an energy curve (*b*) of the Bunsen alone was taken, and finally the energy curve (*c*) of a mantle that had been dipped in ink and thus covered with a thin layer of iron oxide. When heated in the Bunsen flame the latter mantle reached only a bright red heat. The three curves are given in Fig. 7.

The carbon dioxide bands at 2·8μ and 4·4μ are very prominent. From the curves it is evident that the mantle is practically transparent to the radiation of the Bunsen flame. Hence, by subtracting (*b*) from (*a*), we get the radiation from the mantle alone. This is represented by curve (*d*), in which, for the sake of clearness, the vertical scale is taken twice as large.

Rubens then determined the ratio of the emission of the Welsbach mantle to that of a black body of the same form which was at the same temperature. The result is represented by the curve (*f*), and we see at a glance from this curve why it is that the luminosity of the mantle is so high. Taking the limit of the visible spectrum at 0·7μ, Rubens finds the radiant efficiency of the mantle to be 2 per cent. This 2 per cent. is, of course, extremely effective in producing the sensation of light, owing to there being so much of it in the blue and green.

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It is necessary that the proportion of thorium and cerium oxide in the mantle should be exactly right; if it is slightly varied the luminosity of the mantle becomes much less. In order to discover the reason for this, and at the same time to investigate the respective roles played by the two oxides, Rubens took an energy curve for (*g*) a mantle in which there was pure thorium oxide alone, and (*h*) a mantle in which there was pure cerium oxide alone. These two curves, together with (*a*), are reproduced in Fig. 8. The only appreciable difference between (*a*) and (*g*) is in the visible spectrum; the shape of (*h*) is, however, quite different, the radiation in the infra-red being much greater than in the case of the other two curves. The addition of a little Ce_2O_3 to the ThO_2 seems, therefore, to move a

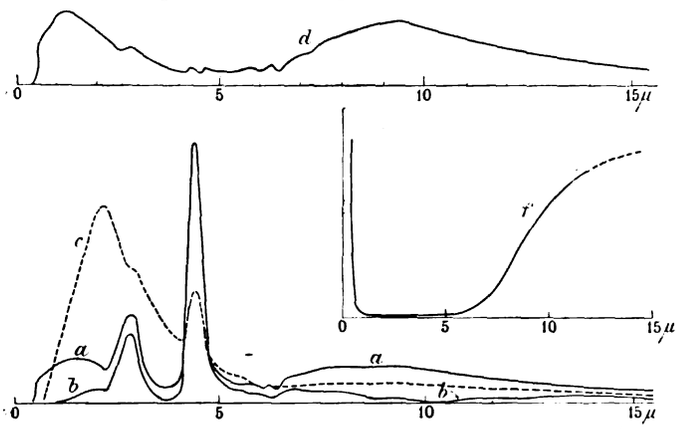

FIG. 7.

maximum into the visible spectrum without affecting the rest of the curve, and to act in somewhat the same way as the sensitising bath in the photography of the red end of the spectrum, while the addition of too much Ce_2O_3 increases the infra-red emission and lowers the temperature.

In a later article ("Emissionsvermögen und Temperatur des Auerstrumpfs bei verschiedenem Cergehalt," Ann. d. Phys. (4) 20, 1906, p. 593) Rubens found that for the mantles he used the best proportion of Ce_2O_3 was about 0·8 per cent.

Le Chatelier and Boudouard (loc. cit.) found by comparing the brightness of some Welsbach mixture on their thermopile with the brightness of a mantle burning normally that the temperature of the latter was 1,650°C. In the first article, referred to above, Rubens stated that the average temperature of the mantle for which the curve (*a*) was given was 1,527°C. As objection was raised to the accuracy of this figure by Lummer

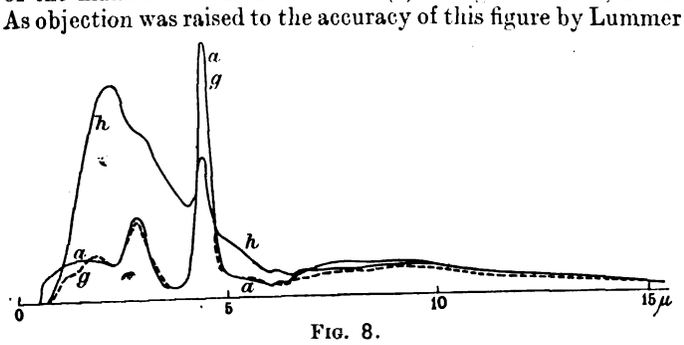

FIG. 8.

and Pringsheim (Phys. Zs., 7, 1906, p. 89; p. 189), he made a further determination (Phys. Zs., 7, 1906, p. 186), placing the mantle at the centre of a hollow sphere, the inside of which was silvered, and measuring the "black" temperature of the radiation from a hole in the side. The maximum values then found for a number of mantles varied from 1,560°C. to 1,590°C. It is interesting to compare this result with a value obtained recently by one of Rubens' students (Hans Schmidt, "Prüfing der Strahlungsgesetze der Bunsenflamme," Ann. d. Phys. (4), 29, 1909, p. 971) for the average temperature of the Bunsen flame itself 2·5 cm. above the edge of the burner. He obtained from about 1,597°C. for the centre to about 1,802°C. for the edge; this is in agreement with the fact that very fine platinum wire can be melted in the Bunsen. One of the previous best determinations had been that of W. J. Waggener (Ann. d. Phys. (3), 58, 1896, p. 579), who used thermopiles of different thickness and then extrapolated for an infinitely thin thermopile. His value was 1,785°C.

It is said that the diminution in intensity of the mantle with time is due to the cerium oxide volatilising more rapidly than the thorium oxide, and that in order to counteract this tendency makers are accustomed to put in rather too much cerium at first.

(*To be continued.*)

REPORT ON MOTOR-GENERATORS, CONVERTERS AND RECTIFIERS.*

BY SILVANUS P. THOMPSON, F.R.S.

1. This Report relates to a class of dynamo-electric machinery the object of which is to change or convert electric energy from one form or variety to another form or variety. From this class of machinery is excluded the apparatus called the transformer, which, though it also converts electric energy from one form to another, does so without employing any revolving parts. Also all those apparatus are excluded which, although they act as rectifiers of alternating currents, effect that operation by chemical means or by means of the electric discharge in vacuous bulbs.

2. *Problem of Conversion.*—The problem of converting electric energy of one form into electric energy of another form presents itself in many aspects, and the solution of it has resulted in many types of machinery. It is possible to consider the subject either by classifying the species of the conversion to be accomplished or by classifying the types of machine. Conversion may be required between any two of the following kinds of current: Continuous current, single-phase alternating current, two-phase alternating current and three-phase alternating current. It may also be required, without altering the kind of current, to convert it with respect to voltage, or frequency, or phase relation, or wave form. Further, the purposes for such conversion may be different, as, for example, for boosting, or balancing, or for gaining variable speed in motor work; and the combinations of machines required for the solutions of these problems are in many cases themselves involved in other problems, such, for example, as the production of a generator of constant voltage working at a variable speed.

As to types of machine, there is a transition of construction from type to type; but the following are the principal types: (*a*) motor-generators with two magnet systems and two armatures; (*b*) motor-generators with one magnet and two armatures; (*c*) motor-generators with one magnet and one armature carrying two windings; (*d*) converters (also called rotary converters) having one magnet system and one armature with one winding; (*e*) cascade converters (also called motor converters) having two interconnected systems (induction motor and continuous-current generator); (*f*) split-pole converters (also called split-pole converters); (*g*) rectifiers; and (*h*) frequency changers. As the machines of this last class are to be dealt with by themselves in a separate Report, they will be but slightly dealt with here. It is more convenient in the present Report to deal with the subject according to types of machine than to classify according to the kind of conversion to be effected. Hence the several types will be considered in systematic order.

3. *Motor-generators with Two Field-magnet Systems and Two Armatures.*—The crudest and most obvious method of conversion is to select a motor appropriate to the primary kind of current, and to couple it mechanically with a generator appropriate to the secondary kind of current. As we shall see, even in the most modern specialised machines to be considered, the apparatus can always be regarded as consisting of two parts, a motor part, with a generator part superposed upon it; and the two functions of the parts may be distinguished even if the parts themselves are so blended as to be mechanically indistinguishable. The mechanical union upon one shaft, or upon two shafts mechanically coupled together, of a motor and a generator is a very old device. Long-distance transmission of electric energy involved from the first high voltage, and also in practice involved the use of alternating currents. Distribution of electric energy in a local network for lighting, power, traction, &c., involved low voltage, and in the majority of cases involved the use of continuous currents. So the particular problem of conversion which presented itself earliest and on the largest scale to engineers was the problem of conversion from high-voltage alternating current (two-phase in earliest times, three-phase in recent years) to low-voltage continuous current. This kind of conversion still remains the dominant kind. An early example of machines so combined is furnished by the motor-generators installed in 1890 in the town of Cassel by Oscar von Miller, consisting of a synchronous monophase alterna-

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of 66 k.v.a., working at 2,000 volts, coupled mechanically at each end of its shaft to a bipolar continuous-current generator giving each 210 amperes at 110 volts, the two generators feeding the two sides of a three-wire network. Modern motor-generator sets almost always consist of high-voltage three-phase synchronous motors coupled to low-voltage continuous-current generators. All the chief constructive firms of Europe supply such motor-generators for traction and lighting, and they are in extensive use. A typical example is afforded by the motor-generators (six) supplied recently by Messrs. Dick, Kerr & Co., (Ltd.), of Preston, to the Calcutta Electric Supply Corpn., consisting of a synchronous three-phase 14-pole motor, rated at 500 k.v.a., running at 428 revs. per min., giving 6,000 volts at 50 cycles per second, coupled direct to a continuous-current generator with six poles, of 450 kw. output, shunt wound, working at 450 to 550 volts, and having commutating poles. Such machines have no electrical connection whatever between their two parts. The whole of the electrical energy supplied (save the inevitable losses) is converted into mechanical energy delivered to the revolving shaft, and is at once reconverted into electrical energy in the generator part. Such machines are not self-starting, but must be brought up to synchronism either by being temporarily supplied on their continuous-current side, or else by means of an auxiliary induction-motor used as starter. As there are in them two sets of electrical and magnetic losses, as well as mechanical losses, the efficiency is limited. But they have the advantage that the regulation of the power factor on the primary side and of the voltage on the secondary side can be independently effected by varying the respective excitations of the two field-magnet systems.

Such motor-generators can also be used for the converse problem of converting from continuous current to alternating current.

Motor-generator combinations can obviously be arranged in other ways. Instead of a synchronous motor, an asynchronous motor can be used, and in this case the machine is self-starting. Also the combination of two different alternating machines as motor and generator might be used to convert from single phase to two phase or three phase, or to change the frequency, or as a phase-shifter, or to alter the wave form or the voltage. Commutator motors for single-phase current do not appear to have yet been employed in motor-generators. They might even be used for the generator part as well as for the motor part. The combination of an asynchronous motor with a synchronous generator possesses special properties making it useful as a frequency changer.

4. *Motor-Generators with one Magnet and two Armatures.*—Such machines are the first stage toward the synthesis of the two parts. The same field magnet, made broad enough to embrace both armatures, is a possible type of construction, but it limits the applications of the machine in various ways. With this construction no synchronous alternating-current motor or generator is possible. Voltage regulation takes a different aspect, because any change in the excitation of the magnet affects both parts. Nevertheless, on this plan there have been at times constructed continuous-current converters.

5. *Motor-Generators with one Magnet and one Armature with two Independent Windings.*—The next stage toward fusion of the two parts is to provide a single armature core, but to wind it with two independent windings. If each winding is provided with its own commutator the machine becomes a continuous-current converter, suitable for receiving a current at one voltage and giving it out at another according to the ratio of the number of armature windings. Such a machine was indeed constructed by Gramme as early as 1874. If used as continuous-current balancer it is defective, since, as the magnetic field is common to both windings, there is no independent regulation of the voltage by changing the excitation.

By making one winding extend a longer distance than the other (axially) along the armature core, and applying to this extended part of the core an auxiliary field magnet, an independent regulation of the voltage may be obtained; and if this auxiliary magnet is excited by the (continuous) current entering or leaving the machine it will automatically vary the voltage as the load rises or falls. A continuous-current converter of this type may be arranged as a balancer by having two identical windings and two commutators, the E.M.F. of which are then put in series, the negative brush from one side and the positive brush from the other being joined to the neutral wire of a three-wire distribution. A further possible arrangement is to have at the motor side a high-voltage winding, with its appropriate commutator and at the generator side two independent low-voltage windings, each with its own commutator, these two secondary windings generating equal E.M.F. to supply the two sides of a three-wire distribution. One can imagine also a balancer for a five-wire distribution by providing the armature with four independent (equal) windings each with its own commutator, the four windings being put in series by connections at the brushes. If in a machine of this type any alternating-current winding designed in accordance with the number of poles, and connected down to the appropriate number of slip-rings for monophase, diphase, or triphase working, be wound on the armature, that side of the armature will serve for either synchronous motor or synchronous generator. If both windings are of this description this type may be used as phase changer, but not as frequency changer. With one such alternate-current winding, combined with a continuous-current winding the machine acts as a synchronous converter.

6. *Converters* (also called *Rotary Converters*). In this type there is but one field-magnet system, excited in shunt (from the continuous-current side), or independently, or compound-wound, and but one armature winding. This winding is connected at one side to an ordinary commutator, but is also connected, at the other side, at points symmetrically chosen, with respect to the windings and to the number of pole-pairs, to an appropriate number of slip-rings. The advantages and limitations of this type are very well known. The machine runs only as a synchronous machine. It is not self-starting from the alternating-current side. Except by special provision mentioned hereafter it does not permit of independent regulation of the voltage, the voltage between the brushes on the continuous-current side being practically in a fixed ratio to that between the slip-rings on the alternating side. Though such a machine can be used to convert from alternating current (of one, two, or more phases) to continuous current, or vice versa, it cannot of itself fulfil the condition of solving the dominant problem of changing from high voltage to low; therefore in all such cases step-down transformers are needed to reduce the voltage. Owing to there being but one armature winding, the sources of loss of energy are reduced, particularly if the number of phases by which the currents are introduced on the alternating side is great. Converters with six slip-rings wound for six-phase current are more efficient than those with but three; and it is easy to arrange the windings on the three-phase step-down transformer so that it yields six-phase current on its secondary side. The efficiency of transformers is so high that the total losses for transformer and rotary converter are less than those of a motor-generator set of equal output.

A long controversy has raged between the advocates of converters and those of motor-generators. All sorts of disadvantages have been attributed to converters; not only was their voltage fixed so that regulation was difficult, but when running in parallel they were apt to "hunt"; they were apt to reverse polarity; they were— at least unless designed for very low frequency, and with consequent wide pole-pitch—apt to flash over at the commutator. All these defects have been successfully combatted. Converters working at frequencies of 50 or even 60 cycles per second can be designed to give satisfaction, though undoubtedly frequencies of 33 or 25 are preferable. The addition of an amortisseur in the poles has eliminated "hunting." The problem of regulating the voltage has found several solutions. By using transformers having considerable self-induction in their secondary circuits, or by introducing into their secondary circuits between the transformer and the converter appropriate self-induction coils, it has been possible to regulate the voltage on the continuous-current side by merely varying the excitation of the field-magnet; increasing the excitation raises the voltage on the continuous side, and while it necessarily also raises the alternating voltage of reaction, it tends to put forward the phase angle and counteract the drop in the power factor due to the self-induction of the transformer. A second method of regulation is to add a synchronous booster on the shaft of the converter, the voltage of the incoming alternating currents being increased as the continuous-current output increases. A third method is to design the polar parts of the field-magnet so as to alter the wave-form of the alternating E.M.F. induced by the armature. The devices of Woodbridge for surrounding portions of each pole by coils for increasing or diminishing the magnetic flux in the pole-tips as compared with the flux in the central part of the pole afford a tolerable though not an automatic means of regulation. In a modification due to Burnham each pole is divided into two parts, the excitations of which can be independently controlled. A fourth method due to Miles Walker is to design the field-magnet of the converter to give a carefully graduated commutation zone, so that the voltage may be regulated by varying the lead given to the brushes.

Modern opinion seems to favour the use of converters in lieu of motor-generator sets, and the objections to them appear to have been largely overcome. They are occasionally designed with vertical shafts to economise space. Two rotary converters united together at their continuous-current sides might work as a frequency-changer, due regard being had to the number of poles and voltages.

7. *Cascade Converters.*—In these machines the two parts consist of an induction motor and a continuous-current generator interconnected electrically as well as mechanically. The motor part is an induction motor, into the stator of which the high-voltage three-phase current is brought. The rotor is on the same shaft as the armature of a continuous-current generator, and is connected to that armature electrically, the armature windings being connected back

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symmetrically to the windings of the rotor precisely as the armature windings are connected back to the slip-rings in a rotary converter. As a result the rotor runs synchronously, with a constant slip of 50 per cent., and half the power is transmitted electrically direct through the armature to the brushes, while the other half of the power drives the armature mechanically and generates the remaining half of the output delivered to the brushes. The efficiency of the machine is high, in general rivalling that of the combined rotary converter and transformer, and surpassing that of the simple motor-generator set of equal output. So much has been written upon the cascade converter by Arnold, Bragstad, La Cour and Hallo that no extended notice is here necessary. Cascade converters are now usually built as 12-phase machines in the rotor part, and with commutating poles on the field magnet. They also can be built with an alternating booster between rotor and armature for procuring independent voltage regulation.

8. *Revolving Field Converters.*—A curious type of machine is one in which the motor part resembles an ordinary alternator, the stator of which being, however, provided with two windings. One of these, an ordinary stator winding, receives the incoming high-voltage currents. The other winding, in the same slots, is an ordinary drum winding for the same number of poles, connected down to a commutator, which is stationary. The brushes revolve synchronously (pressing against the inside surface of the commutator), being carried round by the revolving field magnet, which runs synchronously. The poles of the field magnet need not be wound, being magnetised by the stator currents. In this case the electric energy is transformed and converted electrically. As thus described the machine is Arnold's modification of an earlier and more complex apparatus of Hutin and Leblanc, in which not even the iron of the field magnet revolved. The "Permutatrice" of Rougé and Fayet is esentially the same contrivance, but in it the brushes revolve externally to a fixed commutator of ordinary construction. The "Permutator" of Sahulka is of the same type.

9. *Rectifiers.*—From such machines as the foregoing, in which synchronously revolving brushes receive the continuous current, it is but a step to the much older rectifiers, by which it was sought to procure a uni-directional current from a simple alternating one by merely passing it through a synchronously revolving commutator or reverser. The rectifying commutator used in Wilde's alternators and later in those of Zipernowsky was an early example. Still later came the rectifiers of Pollak for accumulator charging, and of Ferranti for arc lighting. But none of these were satisfactory for rectifying large currents, since in the first place there was difficulty about sparking, and in the second the currents so rectified were pulsatory in character and not really continuous. Heyland's commutator for making a three-phase generator self-exciting belongs to the class of rectifiers, as the brushes on the commutator reverse the alternating currents synchronously without being provided with a magnetic field to procure sparkless commutation.

10. *Frequency Changers.*—Various combinations are possible. Two synchronous alternators with appropriate numbers of poles, coupled on one shaft, would form a motor-generator set suitable for this purpose. Steinmetz has suggested the combination of a synchronous and an asynchronous machine, but the latter cannot be used as the generator unless the system it supplies has other synchronous machines upon it to fix the frequency. The case of a pair of coupled rotary converters has already been mentioned; and a pair of cascade converters might also serve the same object. A more hopeful suggestion is to couple mechanically the rotors of a pair of ordinary induction motors of appropriate voltages and numbers of poles, the combined machine running at such a speed as to be below synchronism for the motor machine and above synchronism for the generator machine. Such a combination would serve for interconnection of the networks of two generating stations.

11. *Phase Shifters.*—For the infrequent purpose of changing or shifting the phase of an alternating current, machines are occasionally needed, and the principle of them is simple. Consider an ordinary induction motor. The currents coming into the stator there conspire to produce a progressive or rotatory magnetic field. If a coil be wound on the stator through two slots which are a pole-pitch apart there will be induced in that coil an alternating E.M.F. of the same period; but the phase of this E.M.F. will depend on the position of the slots with respect to the rest of the windings. If two such coils are wound in different positions the phase difference between their respective E.M.F.s will depend solely on the angle by which their positions differ. Hence one could easily wind a stator with two sets of windings, a primary or motor winding and a secondary or generator winding, the latter giving out alternating currents of the same frequency, but of different phase angle, or even with a different number of phases from that of the primary current. Thus a machine may be constructed to convert three-phase current into two phase or single phase, or to convert single phase into two phase or three phase. Such phase transformers were suggested independently by the author and by Arno. Another method is to couple together the revolving field magnets of a pair of ordinary synchronous alternators, one to serve as motor the other as generator. By shifting the stator of either machine through the appropriate angle any desired phase difference between their respective E.M.F.s can be obtained. Such a combination has been used to shift the load of a network from one generating station to another.

12. *Auto-Converters.*—The next recent type of converting machine is the auto-converter (also called the split-pole converter), the chief characteristic of which is the construction of the field-magnet with twice as many polar projections as there are poles in the winding of the armature, these magnet poles being arranged in pairs of the same polarity. As these machines seem destined to have an important future, some extended notice of them is desirable.

Consider Fig. 1 a two-pole armature with its ordinary windings and commutator. The windings span approximately across a diameter, and the two brushes stand at opposite ends of a diameter. There are two-pole pitches or regions, one usually occupied by the north pole, the other by the south pole of the magnet system. If the brushes are placed in the usual positions for collecting current ("neutral points,") the difference of potential between them (on open circuit) is then a maximum. If shifted through half a pole-pitch, that is, through a right angle, the difference of potential between them is reduced to zero. By adopting the modern method of compensating windings, current can be collected sparklessly, without giving the brushes any lead.

Suppose now we divide each of the poles of the field-magnet into two, so that the north pole N is replaced by the two poles N_1 and N_2, and that the south pole S is replaced by the two poles S_1 and S_2, as in Fig. 2. The pair N_1, S_1 may be considered as belonging to one magnetic circuit, the pair N_2, S_2 as belonging to a second and independent magnetic circuit at right angles to the first. If the first pair only is excited, the voltage between the brushes A_1, A_2 will be that due to N_1, S_1; if the second pair only is excited the voltage between the brushes A_1, A_2 will be that due to N_2, S_2. If both pairs are excited, the voltage between the brushes A_1, A_2 will be that due to the whole flux from N_1 and N_2, through the armature, to S_1 and S_2. Now suppose a second set of brushes B_1, B_2 placed in a position at right angles to A_1, A_2. It is obvious that if both pairs of poles are excited the voltage between these two will be that due to the difference between the two fluxes of the magnetic circuits. If we call the two fluxes F_1 and F_2 respectively, the voltage across A_1, A_2 will be proportional to F_1+F_2 and that across B_1, B_2 to F_1-F_2. (If we consider the partial voltages across from A_1 to B_1 and from B_1 to A_2, these will respectively be proportional to F_1 and F_2.) If now exciting coils are wound on these poles such that F_1 is made proportional to the sum of the A and B voltages, and that F_2 is made proportional to the difference of the A and B voltages, as can be effected by shunt coils which are wound summationally on the pair N_1, S_1 and differentially on the pair N_2, S_2, then the generated A voltage which is proportional to F_1+F_2 will depend on the A excitation only, and the generated B voltage which is proportional to F_1-F_2 will depend on the B excitation only; in other words each half of the machine will act as an independent self-excited shunt-wound machine. Each may, of course, be also compound wound, or might even be merely series-wound following an analogous plan. Fig. 3 depicts the combination arranged as a four-pole machine; but in reality it consists of a single armature acted upon by two independent two-pole field-magnets. The single machine so arranged becomes therefore the equivalent of two independent machines coupled together. So far, we have described it as a double generator, but obviously it can be used as a continuous-current converter. The term "auto-converter" is more descriptive seeing that there is only one armature winding. If a continuous current is applied to the brushes A_1, A_2 it will run as a motor, and an independent continuous-current will be generated in it, and delivered at the brushes B_1, B_2. If the pole-sections and windings are alike, the fluxes will be equal and the voltages equal. They can be made unequal by altering the pole sections or reluctances of the magnetic circuits, or the resistances of the exciting circuits, or by shifting the brushes to intermediate angles. With appropriate

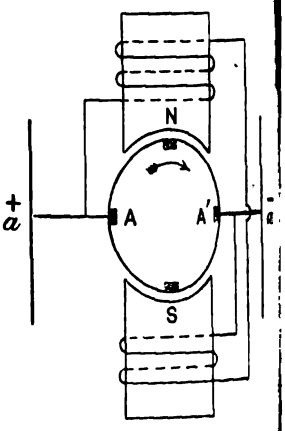

FIG. 1.

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modifications such a machine can be used as balancer, or booster, or as a three-wire generator.

If instead of adopting the method of excitation described above, one of the magnet pairs N_1, S_1 is independently excited and the second magnet pair N_2, S_2 is excited from the brushes pertaining to the field of the first pair, the machine then becomes a variable-speed generator and will furnish an approximately constant voltage at any speed, in either direction of rotation, as required for train lighting.

Now suppose the same armature to be connected at the appropriate symmetrical points to three slip-rings. The same machine will then be capable of being used as an alternating-continuous con-

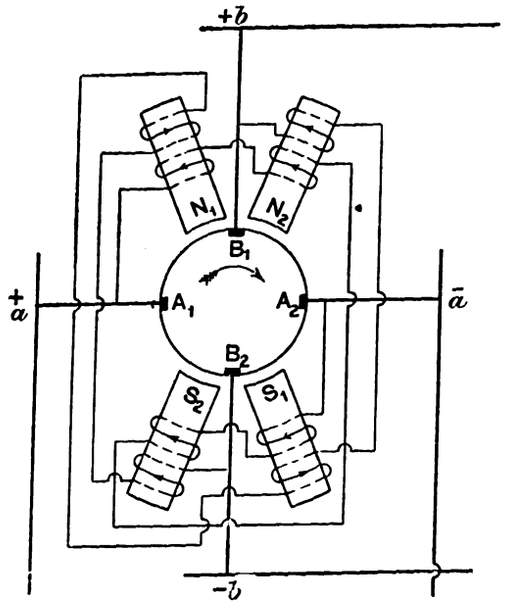


Fig. 2.

verter, and could furnish two different continuous currents at the same time, at equal or different voltages. It must, of course, run synchronously.

In the foregoing it has been assumed that armature reaction is absent or has been compensated. If instead of compensating armature reaction it is enhanced by short-circuiting one pair of brushes, fresh developments are possible; and on this procedure have been based a number of interesting machines such as: the train-lighting generators of Roenberg, Midgeley and others, and Woodbridge's exciter for three-phase systems. Of auto-converters that

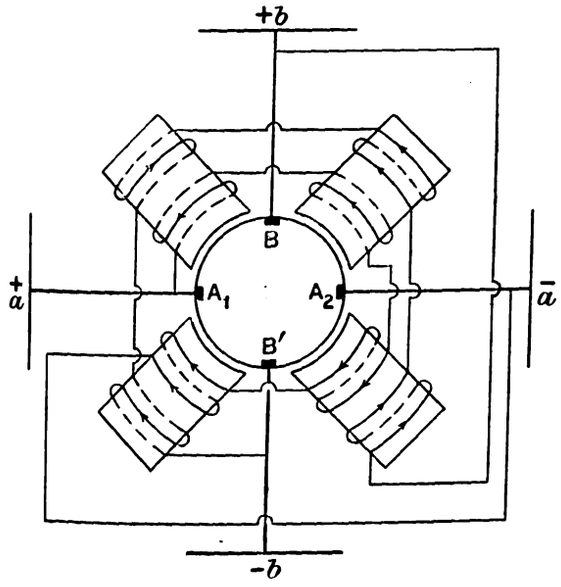


Fig. 3.

of Crompton-Macfarlane-Burge has obtained wide application. Considered in its bipolar form the generator E.M.F. is tapped off at the commutator between one of the A_1, A_2 brushes of the motor circuit and a pair of connected B brushes situated at equipotential points, not necessarily on a diameter at right angles to A_1, A_2. To make these B points equi-distant from the A brush as well as equi-potential, the two divided pole pairs are arranged in bilateral symmetry with respect to the A_1, A_2 axis, N_1 being the same size as S_2 and N_2 as S_1.

These machines are being used (1) as step-down continuous-current converters; (2) as voltage regulators; (3) as converters to convert from variable current at constant voltage to constant current within a limited range; (4) as rotary converters affording regulation of the continuous voltage without affecting the power-factor on the alternating side.

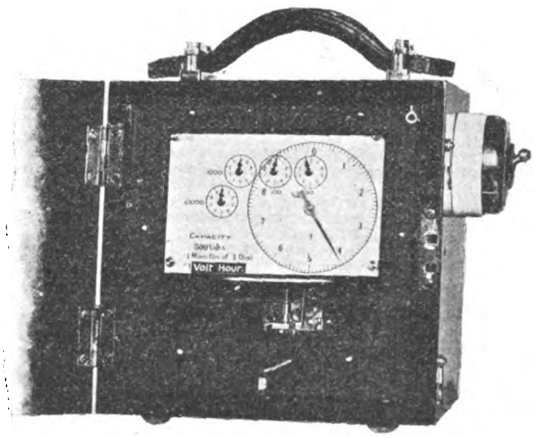
VOLT-HOUR METERS.

A new volt-hour meter, which, it is believed, will commend itself for use in various directions, but particularly in connection with tramway undertakings, has recently been suggested by Messrs. R. G. Cunliffe and J. G. Cunliffe (of the Manchester Corporation Tramways) and has been developed by the British Westinghouse Electric & Manufacturing Co.

This meter, of which a view is given herewith, is referred to in a Paper on "Tramcar Meters" read yesterday by Messrs. Cunliffe at the Annual Conference of the Municipal Tramways Association which is being held this week at Glasgow.

The new meter is, in principle, a direct-current motor in its simplest form, having a moving armature of a special and simple design; and it is designed so that the speed of the armature is proportional to the voltage. The meter is arranged to read in volt-hours; thus, at the end of one hour the average voltage of the circuit during that hour is indicated directly on the dial. As subsequent checking and recalibration is a simple matter, requiring little skill and no special apparatus, the high degree of accuracy with which the meter is originally calibrated can be easily maintained.

The importance to tramway managers and engineers of keeping a constant check on the average voltage of various sections of their



Volt-hour Meter of the British Westinghouse Co.

systems, both during normal working and under special service conditions, will undoubtedly be fully realised. Where the voltage becomes too low, owing to long feeders, long trolley lines, or heavy loading, serious losses are incurred; these include loss of energy in transmission, loss in the car equipment through inefficient working consequent on low voltage, and undue heating of feeders and trolley wires. Not only so, but low voltage means reduced speed, and that to keep to schedule time a driver may be compelled to use energy in driving where otherwise with higher voltage he would be able to coast.

Another direction where a knowledge of the average voltage on a circuit is desirable is in connection with tramway systems using ampere-hour meters on the cars. Conclusions based on readings taken in amperes only may be seriously misleading, and therefore the average voltage during the period of registration should be known, the readings in ampere-hours being corrected to represent the actual energy expended.

Up to the present time, instruments recording with a pen upon a paper chart have been used to determine average voltages. There is, however, with this arrangement a likelihood of errors resulting from the friction between the pen and the paper: moreover, when meters of this type are used on tramcars, a further and more serious error is introduced by the frequent stopping and starting causing vibration and jolting of the pen. The new meter has neither pen nor paper, and is therefore free from the drawbacks indicated. It can be used either in a stationary position or upon a car and has the advantage of recording directly upon a dial. Moreover, being exceedingly simple in construction it can be had at a comparatively low cost.

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With "THE ELECTRICIAN" for Sept. 14, 1906, was issued the first of a series of "Industrial Supplements," to be published from time to time with "THE ELECTRICIAN." The fifty-third issue of the Supplement published (Gratis) with the number of "THE ELECTRICIAN" for September 23, 1910, was the last of the monthly issues. "THE COMMERCIAL AND INDUSTRIAL SUPPLEMENT" to "THE ELECTRICIAN" is now issued weekly (Gratis). It will be found towards the end of the present issue.

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ELECTRICITY SUPPLY FOR RAILWAYS.

One of the objections sometimes put forward to the introduction of electrical working on a railway is the outlay necessary for the erection of a station for generating the required electrical energy. Yet advantage is seldom taken of an outside supply. In a Paper read a short time ago before the National Electric Light Association, Mr. F. DARLINGTON pointed out that in America only one electrically-operated trunk railway is supplied with energy from a public power station, it being the custom for the railways to instal independent generating plant. In glancing from time to time through the pages of our American contemporaries one cannot, indeed, help noticing the large number of comparatively small stations that have been constructed for supplying the numerous electric railways in that country. In many cases, no doubt, an alternative supply of power was not available, but with the exception of the Commonwealth Company, of Chicago, and a few other large concerns, little effort has apparently been made to deal with traction loads from existing power stations.

It is becoming increasingly recognised at the present time that generating electrical energy is a business in itself, and that it is best to leave this work in the hands of those who make it their primary object. Thus it is that numerous private plants have been superseded by a supply from public mains. With small private plants the saving that is possible by adopting this course is fairly obvious, and even in large concerns, such as mines, a saving is often effected. Only in a recent issue of THE ELECTRICIAN attention was

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drawn to the fact that by changing over from steam power to electric power obtained from the Victoria Falls & Transvaal Power Co. a saving was effected by one of the mines equal to 7·28d. per ton milled.

The position of a railway is somewhat special in regard to this question, because a large engineering staff must in any case be employed; also the district served is often large, and money is obtainable on easy terms. Nevertheless, the engineering problems on a railway are not the same as those occurring in the generation of electrical energy, and it is probably better that the energies of the staff should be restricted to the varied engineering problems of the railway proper rather than spread over a larger sphere obtained by including problems of electric generation. Of course, it may be that a suitable public supply is not available, for the power required by a railway is large; or, possibly, the distance for transmission is considerable, so that the conditions are unfavourable as compared with a generating station on the line itself. This state of things, however, with the growth of electric power, should become less and less prevalent.

In the event of extensive railway electrification in this country, the question of supplying the necessary power would probably give rise to considerable discussion. At present the Midland Railway Co. and the Lancashire & Yorkshire Railway Co. possess their own power stations for supplying current to the electrified sections of their tracks, whilst the North-Eastern Railway Co. and the London, Brighton & South Coast Railway Co. prefer to purchase power. Again, some of the underground railways of London have individual generating stations, although most of them are grouped together and obtain their power from a single station at Lot's-road, which is operated as a separate branch. It may be remembered that in connection with the recent Bill of the Metropolitan District and London Electric Railway Companies for sanction to purchase the Lot's-road power station of the Underground Electric Railways Co. of London, the future position of this station as regards the supply of power to other undertakings was raised a few months ago. It was decided to allow a supply of electrical energy to be given when required to the Central London, the City & South London, the Great Northern & City, the London & North-Western and the North London Railways respectively, the present capacity of the plant at Lot's-road—namely, 48,000 kw.—being capable of extension to 180,000 kw.

The advantages of combining the supply of energy for traction purposes near London in one station are, of course, many, particularly as regards load-factor and diversity-factor; but from the point of view of reliability such a course is scarcely desirable, since in the event of a breakdown, such as occurred a year or two ago at Lot's-road, the dislocation of traffic would be widespread and disastrous. From this point of view, as well as from that of undesirable competition with existing supply authorities, many of whom should be able to meet the demand of the railways, undue concentration of supply might prove not altogether advantageous. On the other hand, it would be undesirable for a number of independent generating stations to be erected about the country for this purpose. The present power supply companies should be particularly well adapted to deal with the requirements of the railways, and decided encouragement would be given to the business of electricity supply in bulk.

REVIEWS.

(Copies of the undermentioned works can be had from THE ELECTRICIAN Office, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.)

Electric Crane Construction. By C. W. HILL. (London, 1911: C. Griffin & Co.) Pp. xx. + 313. 25s. nett.

Probably in no branch of engineering are there fewer works of reference than in that which deals with the construction of lifting and hauling machinery. Not that the literature is scanty, but to the rank and file and to the busy engineer it is not an easy matter to search for the information. An enquiry comes into the office and no time must be lost in preparing preliminary drawings and estimates. Like Kipling's Midshipman, the designer "must do what he is told—not immediately but sooner, much sooner." Those familiar with the crane industry know that at the present time, on account of the keen competition, makers must be prepared to quote for any type of crane in order to keep their place in the market.

A book on the subject intended to be of any real use to designers must, therefore, deal with special cranes as well as with cranes of the ordinary type, and the matter must be presented in a sort of tabloid form arranged in such a way that the information required for the work in hand can be obtained without loss of time. Another difficulty which the writer of a book on electric crane construction has to face arises from the fact that crane designers are generally mechanical engineers with but an elementary knowledge of electrical engineering. This is to be deplored, and we hope that during the next decade the profession will be strengthened by a strong body of electro-mechanical draughtsmen. In the meantime it behoves writers of books on mechanical engineering subjects to make matters electrical as simple as possible.

Of the books on cranes which are available, many are, in the main, merely a collection of half-tone pictures, and badly-drawn illustrations combined with the necessary amount of padding culled from trade catalogues. The book under review is not of this kind. From an examination of the contents it appears that an attempt has been made to deal with the question of crane design from a scientific standpoint.

For purposes of review it will be best to divide the book into three sections. The first seven chapters deal with the principal types of crane. Chapters VIII. to XVII. deal with design, and Chapter XVIII. is devoted to the description of crane installations.

The first seven chapters, and the last chapter, are entirely sketchy, and it is doubtful whether, in a book of this kind, they serve any really useful purpose. The chapter on Overhead Cranes is most incomplete. There is still a demand for monomotor cranes, and for small capacity cranes having power-driven lifting mechanism and hand traversing and travelling mechanisms. Since cranes of the overhead-travelling type are the most widely used, it might reasonably be expected to find descriptions and drawings of the principal forms. But only the ordinary multi-motor crane is described, and much very important matter is omitted. A day or two ago the reviewer desired to know the probable weight and constants of a 40-ton three-motor crane of 50-ft. span. On turning to the book under review he found no mention of the weights of overhead cranes. With equal want of success he referred to the next chapter for the probable weight of a 5-ton low-truck portable jib crane of 40-ft. radius. In giving an approximate price and in many other ways, such information, in a convenient form, is invaluable.

In the chapter on Jib Cranes the author describes three cranes, namely: a 3-ton loco. crane, a 2½-ton portable crane,

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and a 4-ton harbour crane. It is well known that for discharging general cargo jib cranes provided with free-barrel lifting mechanism are in great demand, and it is equally well known that in engineering shops, where an ordinary crane service cannot be provided, mono-rail jib cranes have been used with conspicuous success. Moreover, jib cranes fitted with the Mitchell-Williams compensated derricking gear are rapidly coming to the front, and engineers are turning their attention to electric coaling cranes. None of these are mentioned. This laxity is common to other sections of the book. In vain will the reader look for descriptions of the many special cranes used in steel works, in shipyards and in stockyards. The absence of such information leads one to the conclusion that the author has given insufficient time to the preparation of the book.

Turning now to the part of the book which deals with design, the methods of determining the power required for crane driving are first described, and the analyses taken from test figures are good. For rapidly estimating the power required for lifting it is sufficiently accurate, in cranes of small and medium capacity, to multiply the load in tons by the speed in feet per minute and divide by 10; symbolically, B.H.P. = WS/10. Somewhat fuller treatment of the section on slewing would have been welcome. Thoughtful designers will read and re-read the chapter on starting torque and acceleration, and the many examples add materially to the value of the chapter.

Much of the elementary matter relating to struts and columns in the chapter on the Design of Crane Structures is rather out of place, for in books on Applied Mechanics and on Structures full discussions are already to be found. More examples on the design of struts would have been helpful. The section on girders is well written, and the examples are particularly good. In future editions it would, perhaps, be an advantage to describe the type of bridge much used for overhead cranes. This type consists of two single web plate girders braced to outrigger lattice girders. It gives a very rigid construction and is economical of material. A further advantage is that all parts are accessible for inspection and painting.

Chapters XI. to XIV. are devoted to the design of machinery and separate chapters are given to important details, such as brakes, gearing and so forth. Constructional details of worm gears would have added to the value of the chapter on gearing, as also would a table of strengths of wheel teeth, but the author's treatment of the subject is admirable, and will be of real use to designers. For very heavy cranes, hydraulic brakes cannot be improved upon, and a description of such a brake should have been included. It is unfortunate that certain important details such as pitch chains, transmission chains, clutches, ball bearings and motion screws are not considered.

Of the chapters on Electric Equipment those dealing with motors and controllers are praiseworthy. A chapter on Crane Wiring Diagrams would have appealed to many engineers. Differences of opinion exist on the value of model specifications in a work of reference, but there can be no doubt that such specifications are of great assistance to makers and users, and the book would have been improved by including specifications of the special cranes which are not described in the text.

We reiterate, that in a book intended to be of maximum use to engineers it is necessary to deal with special cranes. To find no such cranes described in an expensive book is certainly a sin of omission.

Das Kristallisationsmikroscop und die damit gemachten Endeckungen insbesondere die der flüssigen Kristalle. By Dr. O. LEHMANN. (Braunschweig: Vieweg & Son.) Pp. 112. M.3 net.

This book is a summary of the author's researches on crystalisation phenomena with the help of the microscope. Dr. Lehmann, who has been working on the subject for nearly 40 years, has certainly been a pioneer in the field, and in writing this book he has evidently wished to maintain his right of priority, especially in connection with the discovery of so-called "liquid crystals." Considerable space is devoted to a rather tedious argument on this question, and it is pointed out that the results of scientific research are apt to be readily taken as common knowledge without due credit being given to their authors. Dr. Lehmann suggests that text-books and similar works should be more strictly annotated with references to original publications. The present work certainly fulfils this requirement, as there are in the text over 150 references which should prove useful to those wishing to investigate the subject fully.

Attention is drawn to the growing importance of a chemical microscope arranged so that crystals can be examined as they separate and grow from solution, or as they solidify from a fused substance, and the practical use of such an instrument for analytical work is pointed out. In describing the development of his own instrument the author leads to a description of the most modern chemical microscopes. This part of the book is excellently illustrated, and gives details of arrangements, hitherto unpublished, for thermal measurements of the specimens, while methods of heating, lighting and photographing the objects are also dealt with.

The discoveries made by Lehmann with his instrument are fully treated in others of his works, and are only briefly surveyed in this book. The nature of the anomalous mixed, plastic and liquid crystals observed by him and others is considered, and the theoretical importance of their existence is discussed. It must be admitted, however, that these considerations prove rather unsatisfactory on account of their controversial nature, and the necessary scantiness of their treatment. Dr. Lehmann has striven to detect a link between inorganic matter and the lower organisms, and has made himself the centre for fierce criticism. The view that the solid, liquid and gaseous states of matter are all polymorphous modifications similar to those already recognised is also voiced.

A valuable asset is provided in the form of a long list of demonstration experiments serving to illustrate the various phenomena described.

Encyclopédie Electrotechnique. Part 48: ESSAIS DES MACHINES A COURANTS ALTERNATIFS. By G. FERROUX. (Paris, 1911: L. Geisler.) Pp. 184. Fr. 2·50.

This part of the encyclopædia forms in itself a useful little book on the testing of alternating-current machines. It gives a fairly complete description of the various tests in common use, and also goes at some length into such parts of the theory of the machines as are in use in working out the test results. For instance, the various methods in use for predetermining the full load excitation of alternators from a knowledge of the open and short-circuit characteristics are fully given: the Heyland diagram for induction motors is also discussed at some length.

Our chief criticism is that but little attention is paid to heating tests of alternators. Most firms at the present day make use of the Mordey or Behrend test, or one of its modifications, and it is to be regretted that the author has not included such tests in his work. The Hopkinson differential test is one that is sometimes used when two similar machines are available, and might well have been mentioned.

There are nine chapters in all. The first deals in a general manner with alternating-current measurements. The next three are devoted to alternators. The magnetic study and determination of the electrical characteristics are well treated: but the use of the oscillograph might well have been mentioned. The author too has overlooked the use of an under-excited synchronous motor in the testing of alternators on dead load.

Chapters V. and VI. give a very full treatment of the testing of transformers. A full description of the predetermination of the pressure regulation is given, and also of the various differential tests for two similar transformers.

The next chapter contains all that is necessary on the testing of synchronous motors. The testing of polyphase induction motors is also very thoroughly discussed. The method commonly used to determine the efficiency of large motors, *i.e.*, by loading them on a generator of known efficiency, might have been mentioned. The subject-matter is concluded with a short chapter on rotary converters and single-phase commutator motors.

There are but few typographical errors; the work is carefully written, and the diagrams, of which there are some one hundred and twenty, are clear. The book would be of use to all those who have to deal with the testing of alternating-current machinery, and for 2fr. 50c. it is a good investment.

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TURIN MEETING OF THE INTERNATIONAL ELECTROTECHNICAL COMMISSION.

At Turin, Italy, on Thursday, September 7th, Col. R. E. Crompton, C.B., the Honorary Secretary, declared open the first plenary session of the International Electrotechnical Commission. The meetings, which were held in the Palace of the Prefecture of Turin, kindly placed at the disposal of the Commission by the Provincial Council, consisted of a first plenary meeting, presided over by Prof. Elihu Thomson (U.S.A.), the then President of the Commission, two all-day unofficial meetings presided over by Prof. Luigi Lombardi, President of the Italian Committee, a second plenary meeting to consider and formally adopt the recommendations of the unofficial meetings and, finally, a meeting of Council to consider matters of finance and internal organisation. The Council Chamber, although somewhat magnificent, was at the same time so comfortably arranged as to make somewhat bearable the intense heat which prevailed during the greater part of the sittings.

Nineteen different countries were represented by 52 delegates, amongst whom were the official delegates of the British Government, Mr. Alexander Siemens, Major W. A. J. O'Meara, C.M.G., and Dr. Silvanus Thompson (Dr. R. T. Glazebrook, C.B., was also a Government delegate, but was unable to attend), and the official delegate of the Indian Government, Mr. J. W. Meares. His Excellency Signor T. Calissano, the Italian Minister of Posts and Telegraphs, on behalf of his Government extended a very warm welcome to the Commission, which he likened to a world's parliament of electricians.

Prof. Elihu Thomson in thanking His Excellency, in the name of the Commission, for his courteous welcome given in French, felt bound to use the same language in reply, which he did in a most able manner. Prof. Thomson then followed with his presidential address, and commenced by alluding to the profound influence of Italian genius upon the philosophy, science and art of the world, as exemplified by the immortal works of such men as St. Thomas d'Aquinus, Dante, Michael Angelo, Galileo and Leonardo da Vinci. He paid homage to those pioneers, Galvani and Volta, Galileo Ferraris, and Antonio Paccinotti, the last mentioned of whom the members had the pleasure of meeting at a special session arranged for the purpose, when an illuminated album was presented to him amidst much enthusiasm.

Prof. Thomson offered to the Italian nation on the fiftieth anniversary of its union, the most sincere congratulations of the Commission. He also complimented the various Local Committees upon their excellent work and more especially thanked them for their splendid co-operation with the Central Office. The delegates, he said, were no longer strangers, but comrades. He suggested the formation of several small International Committees so as to give the Local Sections a closer interest in the actual preparation of the work, and this suggestion was acted upon later. In closing his interesting address, of which the above is scarcely more than an epitome, Prof. Thomson, as the retiring President, expressed his deep appreciation of the honour conferred upon him by the members in having elected him as their President in 1908 and he thanked them most heartily for this evidence of their confidence.

Prof. Dr. Budde proposed a vote of thanks to Prof. Thomson, which was carried by acclamation.

Col. Crompton next gave a short report on the general progress made. He said that whereas in 1908 there were only 10 countries joining in the work, there were now 21 in which an Electrotechnical Committee was properly constituted, in most cases with the direct assistance of the respective Governments.

PHOTOGRAPH, TAKEN AT TURIN, OF THE DELEGATES AND OTHERS PRESENT AT THE RECENT MEETING OF THE INTERNATIONAL ELECTROTECHNICAL COMMISSION.

FRONT ROW.
1. His Excellency T. Calissano, Italian Minister of Posts and Telegraphs.
2. Prof. Dr. E. Budde, President of the I.E.C.
3. Prof. Elihu Thomson (U.S.A.), Retiring President.

SECOND ROW.
1. M. Emanuele Jona. (Italy).
2. Senator Vittorelli, Prefect of the Province.
3. M. de Chatêlain (Russia).
4. Prof. Luigi Lombardi (President, Italian Committee).
5. Prof. Absolon Larsen (Denmark).
6. M. R. V. Picou (President, French Committee).
7. Col. R. E. Crompton, C.B. (Hon. Sec. I.E.C.)
8. Prof. Dr. K. Strecker (Germany).
9. Mr. Alexander Siemens (President, British Committee, and Government Delegate).
10. M. Atsushi Oya (Japan).
11. M. E. Brunswick (France).
12. M. C. le Maistre (General Secretary I.E.C.).
13. M. Ch. David (Secretary French Committee.)
14. Signor Carlo Clerici (Italy).

THIRD ROW.
15. Major W. A. J. O'Meara, C.M.G. (Great Britain and Government Delegate).
16. Mr. Gano Dunn (U.S.A.), President A.I.E.E. and Government Delegate.
17. Mr. Leon Gaster (personally invited to attend).
18. Prof. Clarence Feldmann (President, Dutch Committee).
19. Mr. S. Faber (Denmark).
20. M. Paul Boucherot (France).
21. M. J. Blondin (France).
22. Dr. Silvanus P. Thompson (Great Britain. Government Delegate).
23. M. Blondin, fils (France).
24. M. O. De Bast (Secretary, Belgium Committee).
25. M. E. Gevaert (Belgium), behind Dr. Strecker.
26. Mr. C. O. Mailloux (President, United States Committee and Government Delegate).
27. Prof. Guido Grassi (Italy).
28. Prof. E. Morelli (Italy).
29. Comm. G. Duran (Rep. Italian Posts and Telegraphs).
30. Senor R. Muller (Ecuador).

FOURTH ROW.
31. Prof. Dr. Moritz de Hoor-Temres (Hungary).
32. Herr Georg Dettmar (Secretary, German Committee).
33. Prof. T. Mather (Great Britain).
34. Herr K. Tauber (Switzerland).
35. Senor Alfonso Castello (Mexico).
36. Prof. J. Landry (Secretary Swiss Committee).
37. Señor Luis de la Peña y Braña (Spain).
38. M. G. A. L'Hoest (Belgium).
39. M. H. Armagnat (France).
40. Dr. A. E. Kennelly (Secretary, U.S.A. Committee).
41. Dr. Clayton Sharp (U.S.A.)
42. Heer L. M. Barnet Lyon (Holland).
43. Mr. P. F. Rowell (Secretary, British Committee).
44. Signor Guido Semenza (Secretary, Italian Committee).

BACK ROW.
45. Mr. C. Ericson (Secretary, Swedish Committee).
46. Mr. C. A. Rossander (President, Swedish Committee).
47. Reporter (French).
48. Reporter, J. Perrott (English).
49. Mr. E. L. Litton (Assistant).
50. Mr. R. K. Gray (Great Britain).
51. Mr. G. A. Bona (Panama).

Prof. L. W. Gill (Canada).
Mr. J. W. Meares (British Indian Government).
The Portuguese Consul.
} Present.

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Having touched upon the various subjects under discussion, he reported what he considered a most valuable instance of co-operation and one which would, at any rate, be of great assistance to the British Section of the Commission. Through the good offices of Mr. Alexander Siemens, President of the British Committee, the British Engineering Standards Committee had been invited to and had appointed a joint Committee to deal with all electrical matters from the international point of view. The Committee would consist of members of the British Local Committee and of the Electrical Section of the Engineering Standards Committee, in addition to the usual Government representatives. This desire to co-operate for the good of the community, he felt sure the members would agree with him, was worthy of all praise.

The election of officers was then proceeded with and M. R. V. Picou, President of the French Committee, in a most charmingly courteous speech, proposed that Dr. Budde be elected to succeed Prof. Elihu Thomson. He said that, as everyone knew, Dr. Budde had taken the keenest interest in the Commission from its very inception; he was a great worker and his active assistance had been of immense advantage to the movement. Quite recently, in the matter of the symbols for Ohm's law, he had obtained from his compatriots the necessary sacrifice which had made international agreement possible. Finally, the leading part Dr. Budde had taken in the question of technical nomenclature and which had contributed in such a large degree towards a practical solution, rendered the Commission even more indebted to him. M. Picou, therefore, had the greatest confidence in proposing that, as a respectful homage to him for services already rendered, Prof. Dr. Budde be elected President of the Commission, and he felt that this election would be of the greatest benefit to the Commission as a whole. This proposal was seconded by Mr. C. A. Rossander, President of the Swedish Committee, and carried by acclamation, members rising in their seats.

Dr. Budde thanked the members for the honour they had done him and said he would do all in his power to further the aims and objects of the Commission.

Prof. Feldmann (Holland) said there were many present at this meeting who would remember the St. Louis Congress of 1904, where Col. Crompton had developed the idea of international co-operation in matters electrical. He was, in fact, the father of the I.E.C., and it was, therefore, with the greatest pleasure that he proposed the re-election of Col. Crompton as Honorary Secretary of the Commission. This was enthusiastically seconded by Prof. Lombardi (Italy) and carried by acclamation, members again rising in their seats.

Col. Crompton having expressed his thanks, on the proposal of Mr. Siemens, seconded by Mr. Faber (Denmark), it was carried unanimously that Prof. Lombardi be elected to preside over the unofficial meetings to be held.

The Minister of Posts and Telegaphs kindly consented to despatch a congratulatory telegram to His Majesty the King of Italy on behalf of the Commission. The meeting then adjourned and the members went into the Royal Gardens where the photograph here reproduced was taken, the list of names being given below.

The following morning at 9 a.m. Prof. Lombardi opened the unofficial meetings, the agenda for which had been in circulation amongst the various Committees for some months previously. The first question was that of nomenclature, and on behalf of the small Committee appointed at Brussels Dr. Budde presented a short report showing the work accomplished. He referred to the meeting held at Cologne in May last and stated that the modifications to the Cologne report which had been sent in by various National Committees had been given the most careful attention at a meeting held in Turin just before the present sitting of the Commission. He presented the result of this work in French and English. Some criticism at first arose as to the procedure adopted in this work, but after some discussion and explanations the report was adopted under the title "List of Terms and Definitions in the Official Languages, French and English, provisionally adopted by the I.E.C."

It was explained that the word "provisionally" was intended to imply that, at the next meeting, in two years' time, if it was found really necessary, modifications to the definitions would be considered. The List is to be published arranged in two methods, the one alphabetical, the other the logical order of sequence of ideas. The small International Committee consisting of one representative of France, Germany and Great Britain remains in being for two years, and Prof. Larsen (Denmark) is specially invited to attend the meetings. In view of the importance of the Spanish language the Spanish Committee is invited to send a delegate to follow the work; the Committee as originally appointed being alone empowered to vote.

An obviously necessary proposal was adopted that the National Committees be at liberty, and be invited to send delegates to attend the meetings of any and all special Committees.

The French Committee, through their President, M. R. V. Picou, presented their complete vocabulary in French, including a most useful affiliation table of the terms drawn up by Mr. P. Boucherot. Other Committees also presented their work on nomenclature.

The next question discussed was that of symbols, with the Brussels propositions as a basis. These, with small modifications as to form, were agreed to provisionally. The question as to the use of any particular type to represent magnetic quantities was left open. The following are the resolutions:—

1. Instantaneous values of electrical quantities which vary with the time to be represented by small letters.

2. Virtual or constant values of electrical quantities to be represented by capital letters.

3. Maximum values of periodic electrical quantities to be represented by capital letters followed by the subscript *m*.

4. Magnetic quantities, constant or variable, to be represented either by capital script, Gothic, heavy faced or any special type.

5. Maximum values of magnetic quantities to be represented either by capital script, Gothic, heavy faced any or special type followed by the subscript *m*.

6. The following quantities to be represented by the following letters:—

Electromotive force	E, *e*	
Electric quantity	Q, *q*	
Inductance*	L	See resolutions 4 and 5
Magnetic force	H	
Magnetic flux density	B	

Mass	M, *m*.
Length	L, *l*.
Time	T, *t*.

The letters I. E. R. were, on the proposition of Dr. Budde, seconded by Mr. Siemens, unanimously agreed to for the respective quantities in the simple representation of Ohm's law.

The term "reactive power" was also adopted to designate the quantity $V I \sin \phi$.

A special Committee consisting of one member from Belgium, France, Germany, Great Britain, Holland, Italy, Spain, Switzerland, and U.S.A., was appointed to continue the study of the international unification of symbols, and some additional propositions put in by the French as well as certain other suggestions by the Dutch, were referred to this Committee to be dealt with.

The good work of the A.E.F., the Pan-German Committee on symbols of the Elektrotechnischer Verein, of which Dr. Strecker is the able President, and which has done so much during the past 10 years towards the adoption of international symbols, was fully recognised by all present, and it is confidently hoped that, through the intermediary of the German Local Committee, the I.E.C. will enjoy the full benefit and advantage of the active co-operation of this important Association in the difficult subject of symbols generally.

The vexed question of the graphical representation of alternating-current quantities did not give rise to anything like the amount of discussion anticipated, and the following proposition

* Coefficient of self-induction.

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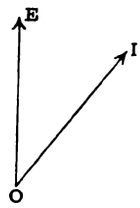
was agreed to without any difficulty whatever, beyond a question as to the utility of the note added by way of explanation:

In the graphical representation of alternating electric and magnetic quantities advance in phase shall be represented in the counter clockwise direction.

NOTE.—In consequence, the impedance of a reactive coil of resistance R and inductance L is $R + \sqrt{-1}L\omega$ and that of a condenser of capacity C is $\frac{1}{\sqrt{-1}C\omega}$, where ω is equal to $2\pi \times$ frequency. It follows also that the diagram herewith represents the phase relations in a simple alternating-current circuit containing an impressed E.M.F., O E, and a lagging current O I.



The rating of electrical machinery received detailed attention and not only were the three propositions referring to the rating of generators and motors in international watts put forward at Brussels adopted, but a Committee consisting of representatives from Belgium, France, Germany, Great Britain, Italy, Switzerland, Sweden and U.S.A., was appointed to study the subject from the international point of view. The work already carried out in various countries in reference to the rating of machinery was fully appreciated, and, through the National Committees, the co-operation of those bodies who have made it their business to study this particular problem is to be sought.

An interesting report on the question of prime movers for electrical purposes was presented to the Commission on behalf of the Italian Committee by Mr. E. Jona, and this was referred to the small Committee with instructions to give it their most careful attention.

A report on the different Standard Rules extant, prepared by the Central Office, was also referred to this Committee with a view to assisting its labours. This completed the definite work which had been before the National Committees during the past year and upon which decisions were desired. Mr. Leon Gaster, personally invited to attend as representative of the Illuminating Engineering Society of London, at the invitation of the President made a few remarks on the question of the nomenclature of illumination. Dr. Kennelly, President of the American Society of Illuminating Engineers, and Dr. Clayton Sharp, a past-President, also spoke on the subject and of its importance to the I.E.C. now that the question of electrical nomenclature generally was under consideration. The members, after a brief discussion, expressed themselves in favour of the idea of the National Committees communicating upon the subject with the Societies in their respective countries dealing with these matters.

The I.E.C. has decided to meet at Berlin in 1913, the exact date being decided later. The I.E.C. has also accepted the invitation of the American Institute of Electrical Engineers, so cordially presented by Mr. Gano Dunn, its new President, to hold a plenary meeting at San Francisco in 1915 on the occasion of the Great Exhibition to celebrate the opening of the Panama canal.

At the official request of the International Congress of the Applications of Electricity, the Council of the I.E.C. has decided, subject to the ratification of the Local Committees, to accept the task of organising all future Electrotechnical Congresses. It has also accepted the invitation transmitted through the American Local Committee in reference to an International Electrotechnical Congress at San Francisco in 1915.

At the second plenary meeting held on Monday, September 11th, the report of the work of the unofficial meetings was received and decisions officially adopted in the sense already outlined.

A council meeting was held on Wednesday, September 13th, at which the request of the Electrical Congress of Turin was discussed with the result above indicated. In addition to this important matter, questions of finance and internal organisation were dealt with.

Finally votes of thanks to the presiding officers, to M. Mailloux for his invaluable assistance in translating the speeches, and to the officers of the Commission, concluded the proceedings, which were voted by one and all a complete success. In view of the above report we feel sure our readers will share this opinion.

THE SINGLE-PHASE REPULSION MOTOR.*

BY THOMAS F. WALL, M.SC., M.ENG.

(*Continued from page* 923.)

Summary.—In the first part of this Paper expressions are deduced for the E.M.F.s induced in the stator and rotor windings, and curves are given which enable some of these E.M.F.s to be rapidly determined for any value of the displacement of the rotor brushes from the stator axis. In the second part of the Paper the results previously obtained are employed in developing the theory of the repulsion motor. A series of simultaneous equations enable expressions to be obtained for the speed, stator current, power factor and power of the motor. In the third part of the Paper the results of some tests on a 6 B.H.P. motor are given, and the values of the stator current, power factor and speed are shown to be in agreement with the theory. Finally, a method of calculating the open circuit characteristic of a single-phase motor is given.

PART II.

In order to present the method with the greatest possible clearness we shall neglect in the first place the resistance of the rotor winding, the resistance of the stator winding, the leakage of the rotor winding, and the leakage of the stator winding. The general case will then be examined and the effect of these different quantities on the final result will be ascertained.

If a current be passed through the stator winding, a flux will be produced which will be directly proportional to the current (if the limits of saturation be not exceeded). This flux will link both stator and rotor windings, the flux linkages being in each case the sum of the products—flux × number of coils linked—taken for all the coils. Similarly, if a current be passed through the rotor winding a flux will

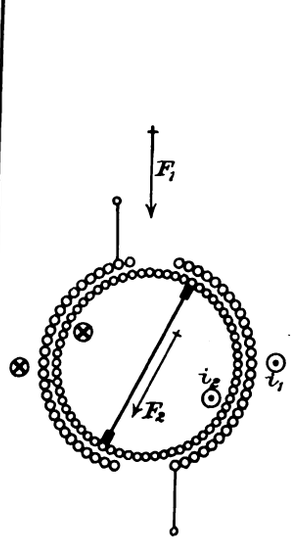


FIG. 10.

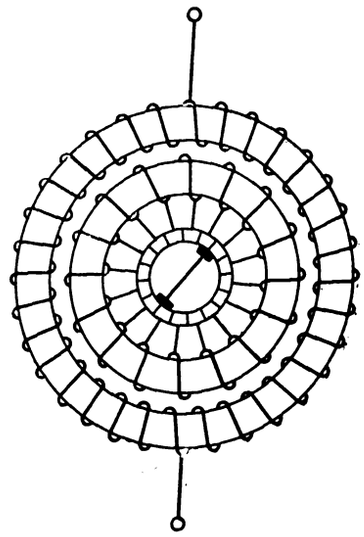


FIG. 11.

be produced which will be directly proportional to the current, and the flux linkages in this case also will be represented for both stator and rotor windings by the sum of the products—flux × number of coils linked.

For any given simultaneous values of the currents in the stator and rotor windings respectively, the flux linkages for both the stator and rotor windings will be simply the algebraical sum of the values of the flux linkages for each current.

Suppose the current in the rotor winding at any instant to be i_2 amperes. The flux distribution in the air-gap will be as shown in Fig. 8, for a smooth-cored armature and an indefinitely large number of conductors in the rotor winding.

The number of ampere-turns per pair of poles will be

$$= \frac{Z_2 i_2}{2P p_{2r}},$$

Z_2, P, p_{2r} having their previous signification. But the ampere-turns per pair of poles are $= 1{\cdot}6 B_{max} \delta$, in which δ is the length of the air-gap in centimetres. This expression holds for the case of smooth-cored rotor and stator. For slotted cores, the ampere-turns per pair of poles are $= 1{\cdot}6 k_1 B_{max} \delta$, in which k_1 is a coefficient which takes account of the fact that the maximum flux density over any small strip, measured in the direction of the circumference of the air-gap, is greater than the mean value (*cf.* previous references).

* Paper read before Section G of the British Association at Portsmouth.

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We may therefore write

$$\frac{Z_2 i_2}{2Pp_{2r}} = 1{\cdot}6k_1 B_{max.}\delta$$

or $$B_{max.} = \frac{Z_2 i_2}{2Pp_{2r}1{\cdot}6k_1\delta}$$

or $$B_{max.} = A_2 i_2,$$

A_2 being a constant of the machine and $= \frac{Z_2}{2Pp_{2r}1{\cdot}6k_1\delta}$.

Now, it has already been shown that the flux linkages of the rotor winding due to a current in that winding are

$$L''_R = \frac{B_{max.} lw_2 r^2 \pi^2}{3Pp_{2r}}$$

or $$L''_R = C_2 B_{max.},$$

in which $$C_2 = \frac{1}{3Pp_{2r}} lw_2 r^2 \pi^2,$$

and is a constant of the machine.

$$\therefore\ L''_R = A_2 C_2 i_2.$$

Again, the flux linkages of the rotor winding due to a current in the stator winding is (equation (2A) and Fig. 4)

$$L'_R = \frac{1}{3Pp_{2r}} B_{max.} lw_2 r^2 \theta_C$$

or $$L'_R = C_1 B_{max.},$$

in which $C_1 = \frac{1}{3Pp_{2r}} lw_2 r^2 \theta_C$, and is a constant of the machine for any given angle θ.

Now, $B_{max.}$ can be expressed as above in terms of the current i_1 in the stator winding, viz., $B_{max} = A_1 i_1$, in which $A_1 = \frac{Z_1}{2Pp_{2s}1{\cdot}6k_1\delta}$, and is a constant of the machine. Hence, the resultant flux linkages of the rotor winding for any current i_1 in the stator winding and any current i_2 in the rotor winding is

$$L_R = L'_R + L''_R = A_1 C_1 i_1 + A_2 C_2 i_2. \quad . \quad . \quad . \quad . \quad . \quad (6)$$

In order to avoid confusion it is desirable to agree upon a convention as to the meaning of positive and negative values of the flux linkages.

In Fig. 10 a current, i_1, in the stator winding flowing in the direction shown by the (⊗) and ⊙ is assumed to be positive, and produces a flux in the direction shown by F_1. The flux linkages of the stator and rotor windings respectively due to this current are taken as positive. A current, i_2, in the rotor winding flowing in the direction shown by the (⊗) and ⊙ is assumed to be positive, and produces a flux in the direction shown by F_2. The flux linkages of the stator and rotor windings respectively due to this current will also be positive.

For the flux linkages of the stator we may proceed in a similar manner.

The flux linkages of the stator winding due to any current i_1 in the stator winding is (equation 1A)

$$L'_s = A_1 D_1 i_1,$$

in which $D_1 = \frac{1}{3Pp_{2s}} lw_1 r^2(\pi - 2a)(\pi + 4a)$ and is a constant of the machine.

The flux linkages of the stator winding due to any current i_2 in the rotor winding is (equation 4A), $L''_s = A_2 D_2 i_2$, in which $D_2 = \frac{1}{Pp_{2s}} lw_1 r^2 \theta_D$ and is a constant of the machine.

Hence the resultant flux linkages of the stator winding for any current i_1 in the stator coils and any current i_2 in the rotor coils is

$$L_s = L'_s + L''_s = A_1 D_1 i_1 + A_2 D_2 i_2. \quad . \quad . \quad . \quad . \quad . \quad (7)$$

Expressions (6) and (7) allow the stator linkages to be immediately determined for any values of i_1 and i_2.

Now, if a sine wave form of pressure be applied to the stator terminals it at once follows that the stator flux linkages must vary as a cosine function of the time, and may be represented by the expression

$$L_s = L_{s\ max.} \cos 2\pi\nu t$$

for any time t, in which ν represents the frequency of the applied pressure and $L_{s\ max.}$ the maximum value of flux linkages. Since for the present the resistance and leakage of the stator winding are neglected we may write

$$L_{s\ max.}\ 4{\cdot}44\nu 10^{-8} = P,$$

P being the effective value of the applied pressure in volts.

$$\therefore\ L_s = \frac{P10^8}{4{\cdot}44\nu} \cos 2\pi\nu t.$$

Further, since the resistance and leakage of the rotor winding are for the present neglected, it follows that the E.M.F. induced in the rotor winding due to the pulsation of the rotor-flux linkages must be at every instant equal in magnitude and of opposite sign to the E.M.F. due to the rotation of the rotor winding in the field produced by the current i_1 in the stator winding, for it is evident that it is only the flux due to the stator current i_1 which can produce an E.M.F. of rotation in the rotor winding. It follows then that when i_1 is zero, the E.M.F. of rotation will be zero, and hence the E.M.F. of pulsation of the rotor linkages L_R must be zero when i_1 is zero. Hence, dL_R/dt must be zero when i_1 is zero—*i.e.*, L_R must be a maximum (as regards magnitude) when i_1 is zero. Therefore L_R and i_1 must be displaced relatively to each other by 90 deg. in time. In order to ascertain what sign must be given to L_R when i_1 is zero, we may consider the following: Referring to Fig. 11 it will be seen that when the short-circuited brushes are turned in a clockwise direction out of the stator axis the rotation will also be clockwise.* When the stator current is positive the E.M.F. of rotation, when the rotor turns in a clockwise direction, will also be positive. Hence, the E.M.F. of rotation in the rotor winding and the stator current are co-phasal, and therefore since the E.M.F. of pulsation of L_R in the rotor winding must balance the E.M.F. of rotation, L_R itself must be 90 deg. behind the stator current (since the E.M.F. dL_R/dt is 90 deg. behind L_R).

Fig. 12 gives the relative phase displacements of the different quantities for the ideal case of no resistance or leakage, and $\theta = 0{\cdot}2\pi$, $\nu = 50$, the speed n being assumed to be 1,000 r.p.m.

Now, let t_1 be the time at which the stator current passes through zero (from a positive to a negative direction). Then, since at the time $t = 0$, L_s has a maximum positive value, and the applied pressure at the stator terminals must be passing through zero from a positive to a negative value; *hence $2\pi\nu t_1$ will be the angle of lag ϕ of the stator current behind the applied pressure.*

Flux Linkage scale for L_S.	*Amps. scale for i_1.*	*Amps. scale for i_2.*	*Flux Linkages scale for L_R.*	*Scale for P. Volts*
$0{\cdot}5\cdot10^8$	50	100		100
$0{\cdot}4\cdot10^8$	40	80	$0{\cdot}2\cdot10^8$	80
$0{\cdot}3\cdot10^8$	30	60		
$0{\cdot}2\cdot10^8$	20	40	$0{\cdot}1\cdot10^8$	40
$0{\cdot}1\cdot10^8$	10	20		
				0

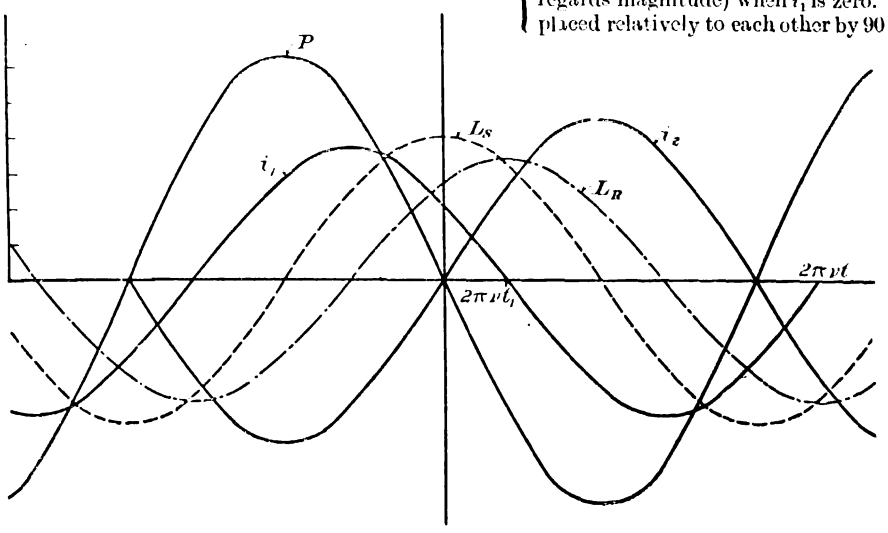

FIG. 12.

R.M.S. Value of Applied Pressure = 90 Volts.
" " Stator Current = 26·8 Amps.
" " Rotor " = 65·3 Amps.
Lag of I_1 behind P = 37°.
" I_2 " I_1 = 141·5°.

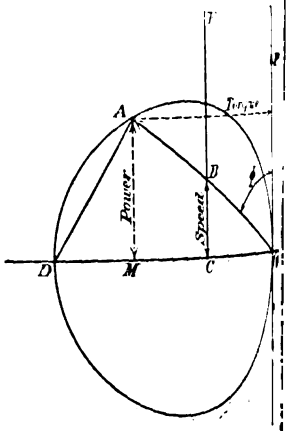

FIG. 13.

* If the brush-axis is perpendicular to the stator-axis when the motor is at rest, a movement of the brushes in a counter-clockwise direction causes the rotor to revolve in a clockwise direction.

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Further, since the stator current is zero at the time t_1 and is passing from a positive to a negative direction, the stator current must reach its maximum positive value at a quarter of a period earlier than the time t_1, that is to say, at the time $t_1 - 1/4\nu$, where ν represents the frequency of the supply (and consequently also the frequency of the current in the rotor circuit).

Let $\bar{I}_1$ represent the maximum value of the stator current.

The first part of the problem then resolves itself into a determination of the value of $\bar{I}_1$ and t_1. For, knowing the supply pressure, we shall have obtained both the magnitude and phase relationship of the stator current for all speeds, and we can thus draw the current diagram of the machine. It will then be shown how the performance of the motor may be accurately determined from the diagram as regards speed, torque and power.

From expression (3) we have: The maximum pressure due to the rotation of the rotor winding is

$$\bar{V} = \frac{1}{15 p_{2_r}} B_{max.} Z_2 n r l \pi \frac{\theta - \theta^2 - \alpha^2}{\pi - 2\alpha} 10^{-8} \text{ volts}$$

$$= E\bar{B}_{max.} n,$$

where $$E = \frac{1}{15 p_{2_r}} Z_2 r l \frac{\pi\theta - \theta^2 - \alpha^2}{-2\alpha} 10^{-8}.$$

But $$B_{max.} = A_1 i_1$$

$$\therefore \quad v = EA_1 i_1 n \text{ volts.} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

v being used to denote the instantaneous value of the E.M.F. of rotation.

The equations which must be satisfied are

$$L_R = A_1 C_1 i_1 + A_2 C_2 i_2,$$

$$L_s = A_1 D_1 i_1 + A_2 D_2 i_2,$$

$$L_s = \frac{P 10^8}{4{\cdot}44\nu} \cos 2\pi\nu t,$$

$$v = \frac{dL_R}{dt} 10^{-8} = EA_1 i_1 n.$$

It has already been shown that at the time $t_1 - \frac{1}{4\nu}$, i_1 is a maximum and equal to $\bar{I}_1$ and L_R is zero.

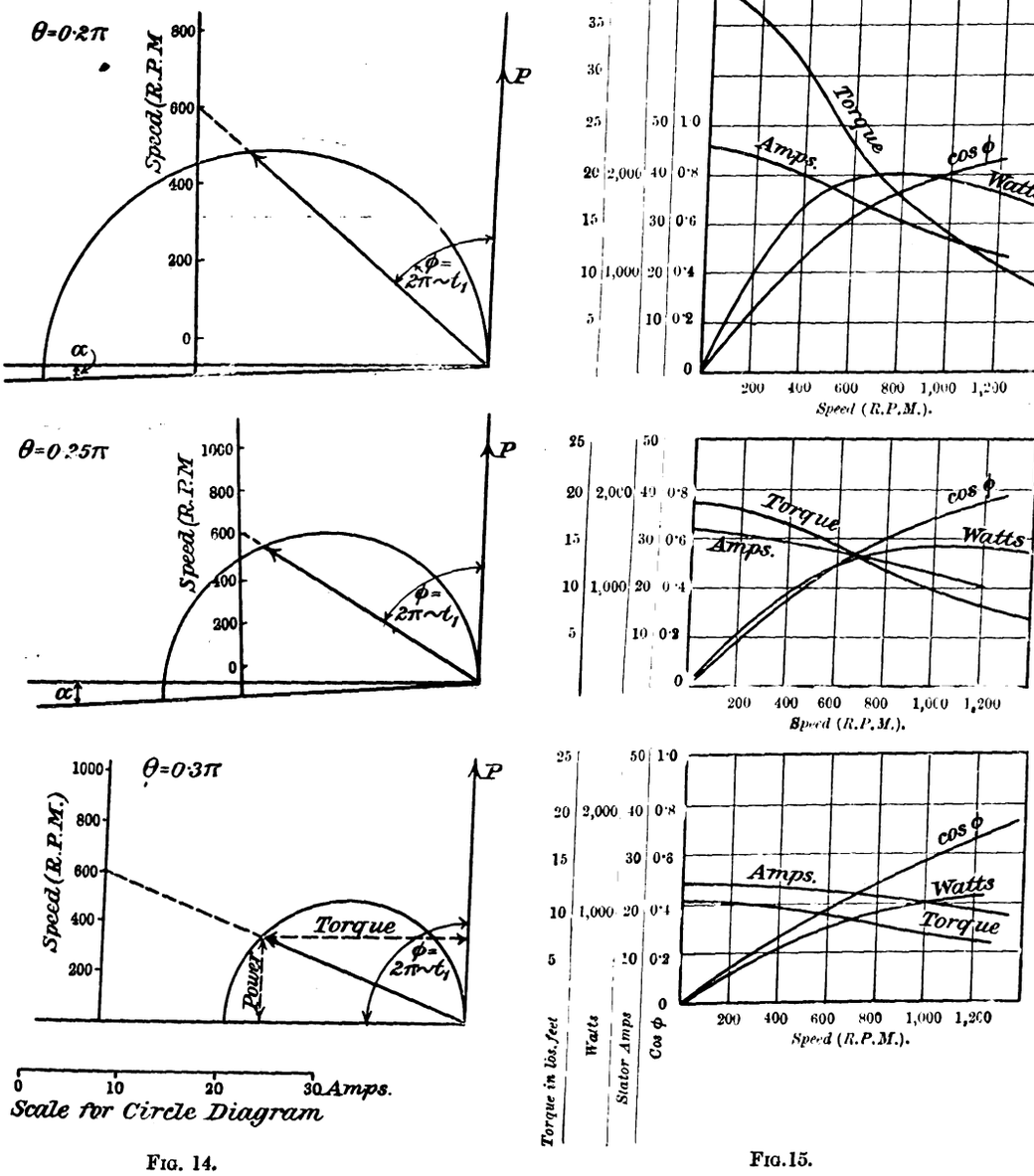

FIG. 14. FIG. 15.

Hence we may write for the time $t = t_1 - \frac{1}{4\nu}$

$$0 = A_1 C_1 \bar{I}_1 + A_2 C_2 i_2, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

$$L_s = A_1 D_1 \bar{I}_1 + A_2 D_2 i_2, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

$$L_s = \frac{P 10^8}{4{\cdot}44\nu} \cos 2\pi\nu \left(t_1 - \frac{1}{4\nu}\right), \quad . \quad . \quad . \quad . \quad . \quad (11)$$

$$v = \left[\frac{dL_R}{dt}\right]_{I_R=0} 10^{-8} = EA_1 I_1 n. \quad . \quad . \quad . \quad . \quad . \quad . \quad (12)$$

Now, by reference to Fig. 12, it will be seen that L_s can be represented by the expression $L_{R\,max.} \cos 2\pi\nu(t - t_1)$, in which $L_{R\,max.}$ denotes the maximum value of L_R. For $t = t_1 - \frac{1}{4\nu}$, *i.e.*, for $L_R = 0$ and increasing in a positive direction

$$dL_R/dt = -2\pi\nu L_{R\,max.} \sin (2\pi\nu)\left(t_1 - \frac{1}{4\nu} - t_1\right)$$

$$= -2\pi\nu L_{R\,max.} \sin\left(-\frac{\pi}{2}\right)$$

$$= 2\pi\nu L_{R\,max.} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (13)$$

But $L_R = L_{R\,max.}$ and $i_1 = 0$ for the time $t = t_1$.

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Let i'_2 be the rotor current at the time $t=t_1$. Then we may write for the time $t=t_1$

$$L_{R\,max.}=A_2C_2i'_2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (14)$$

$$L'_e=\frac{P10^8}{4{\cdot}44\nu}\cos 2\pi\nu t_1=A_2D_2i'_2$$

$$\therefore\quad i'_2=\frac{P10^8}{4{\cdot}44\nu A_2D_2}\cos 2\pi\nu t_1. \quad . \quad . \quad . \quad . \quad . \quad . \quad (15)$$

Hence from (13) and (14)

$$2\pi\nu A_2C_2i'_2=\frac{dL_R}{dt}\Big]_{L_R=0}. \quad . \quad . \quad . \quad . \quad . \quad (16)$$

From (12), (15) and (16) we get

$$2\pi\nu\frac{A_2C_2}{A_2D_2}\cdot\frac{P}{4{\cdot}44\nu}\cos 2\pi\nu t_1=EA_1I_1n. \quad . \quad . \quad . \quad . \quad (17)$$

From (10) and (11) we get

$$\frac{P10^8}{4{\cdot}44\nu}\sin 2\pi\nu t_1=A_2D_2i_2+A_1D_1I_1, \quad . \quad (18)$$

and from (9)

$$A_2C_2i_2=-A_1C_1\bar{I}_1. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (19)$$

From (18) and (19)

$$\frac{P10^8}{4{\cdot}44\nu}\sin 2\pi\nu t_1=A_1D_1I_1-A_2D_2\frac{A_1C_1}{A_2C_2}\bar{I}_1. \quad . \quad . \quad . \quad (20)$$

$$\therefore\quad \bar{I}_1=\frac{\dfrac{P10^8}{4{\cdot}44\nu}}{A_1D_1-\dfrac{A_1C_1D_2}{C_2}}\sin 2\pi\nu t_1. \quad . \quad . \quad . \quad . \quad (21)$$

From (17)

$$\bar{I}_1=\frac{2\pi\nu\dfrac{C_2}{D_2}\cdot\dfrac{P}{4{\cdot}44\nu}}{EA_1n}\cdot\cos 2\pi\nu t_1. \quad . \quad . \quad . \quad . \quad (22)$$

From (21) and (22) we get for the angle of lag $2\pi\nu t_1$ (usually denoted by ϕ)

$$\tan 2\pi\nu t_1=\frac{2\pi\nu(C_2D_1-C_1D_2)}{ED_2n10^8} \quad . \quad . \quad . \quad . \quad . \quad . \quad (23)$$

If we construct a diagram in which the pressure applied to the stator terminals is drawn along the ordinate axis, *the extremity of the current vector* $\bar{I}_1$ *will (according to equation* (21)*) move on a circle whose diameter lies on the abscissa axis, and has a magnitude*

$$\frac{\dfrac{P10^8}{4{\cdot}44\nu}}{\left(A_1D_1-\dfrac{A_1C_1D_2}{C_2}\right)}.$$

The circle represented by equation (21) *will be as shown in Fig.* 13.

Let any line such as CF be drawn perpendicular to the abscissa axis and let OA be any current vector. Join A to D and let B be the intersection of OA and CF. Then the triangles OBC and OAD are similar. Therefore

$$\frac{OB}{OC}=\frac{OD}{OA},$$

$$\therefore\quad OB.OA=OC.OD.$$

But OC.OD is a constant. Therefore OB.OA is a constant, say k. That is

$$I_1.OB=k.$$

$$\therefore\quad \frac{OB\cos 2\pi\nu t_1}{k}=\frac{\cos 2\pi\nu t_1}{\bar{I}_1}.$$

But from equation (22) $\dfrac{\cos 2\pi\nu t_1}{\bar{I}_1}$ is proportional to the speed n.

Therefore BC *is proportional to the speed* n.*

Since all resistances have been neglected the power of the motor must be $P.\frac{I_1}{\sqrt{2}}\cos 2\pi\nu t_1$, *i.e.*, $\frac{P}{\sqrt{2}}AM$.

Hence, the perpendicular distance from the extremity of the current vector to the abscissa axis is a measure of the power of the motor.

The torque of the motor is equal to the power divided by the angular velocity. Referring to Fig. 13, the torque is proportional to AM/BC—*i.e.*, proportional to MO/CO; and since OC is constant, *the torque of the motor is proportional to* MO, *the perpendicular distance of the extremity of the current vector from the ordinate axis.*

For a machine on which the author carried out some experiments to test the theory evolved in this Paper, it was found that the constants had the following values:—

$$A_1=183,\ A_2=89{\cdot}6,\ C_1=339\ \theta_C,\ C_2=3{,}350,$$
$$D_1=9{,}610,\ D_2=2{,}610.\theta_D,\ E=512.10^{-4}.\theta_E.$$

θ_C, θ_D and θ_E may be found for a brush displacement θ, from the curves of Figs. 5, 9 and 7 respectively.

In Fig. 14 the circles diagrams deduced from the equations (21) and (22) are shown for three different values of θ—viz., $\theta=0{\cdot}2\pi$, $0{\cdot}25\pi$, $0{\cdot}3\pi$ respectively. The applied pressure P is assumed to be 90 volts, and the frequency (ν) to be 50 cycles per second.* In Fig. 15 curves are shown which have been deduced from the circle diagrams, and show the relationship between speed and stator current, power factor, torque and power respectively, the speed having been plotted as abscissæ in each case.

(*To be continued.*)

* This may be proved at once by considering the circle of Fig 13 as the inverse of a straight line perpendicular to the abscissa axis, or, more correctly, the inverse of a straight line perpendicular to the diameter OD.

* The machine was built for 120 volts and 50 cycles, but in order to get rid of the influence of the variations of permeability of the iron the tests to be described later were made with an applied pressure P=90 volts. The curves of Figs. 14 and 15 respectively have been constructed for these values of the applied pressure and frequency, in order that they may be compared with those obtained when the resistances and leakages were not negligible.

CORRESPONDENCE.

OLYMPIA.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Would it not stimulate the visits of engineers from the provinces to this Exhibition if some arrangements could be made whereby, on some particular Saturday, half-day excursion tickets could be obtained at several of the leading provincial towns. At present, engineers in their several towns do not know what excursions are being run from other towns and do not know if they will meet engineers at the Exhibition that they would like to have an opportunity of meeting. If *some particular date*, or dates, could be arranged for such excursions, possibly many engineers might avail themselves of the opportunity and might arrange with one another to meet there.

Speaking for myself, I would have liked to have been at the Exhibition this Saturday (23rd inst.), but no excursion was running from Birmingham. I can hardly believe that if the Railway Companies were approached they would not grant special facilities for a particular date or dates, when they are continually running special excursions merely for the sake of football matches.—I am, &c.,

Birmingham, Sept. 23. ENGINEER.

A NEW SYSTEM FOR PROTECTING HIGH-TENSION CABLES.†

BY H. BIRRENBACH AND M. HÖCHSTÄDTER.

Summary.—The authors describe a new automatic protecting device for high-tension cable networks and mains invented by Mr. Hochstadter. Particulars of the installation at Cologne and the results of the tests are also referred to.

Since a previous Paper by M. Höchstädter on the "Dielectric Properties of Modern High-Tension Cables"‡ great advances have been made in Germany in the practical use of high-tension cables; thus, both the Siemens-Schuckert-Werke and Felten & Guilleaume-Lahmeyer-Werke have built and laid an asphalted lead-covered single-conductor cable for 60,000 volts alternating current. These cables were laid between the powerhouse Muldenstein and the Umformerstation Bitterfeld, a distance of about 7¼ miles, for the electrification of the main-line railway between Dessau and Bitterfeld.

Each cable of the system was tested to earth with 50,000 volts, *i.e.*, one against the other with 100,000 volts between conductors.

† Abstract of an article in the "E.T.Z."

‡ THE ELECTRICIAN, Sept. 2, 1910.

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Other large cable-networks are being installed in Cologne and Barmen for working pressures of 25,000 to 30,000 volts, and it is in consequence of the importance that such cables have obtained in the electrical industry that the greatest security for good working conditions must be guaranteed.

In order to obtain this necessary security in a network of high-tension cables, that is, to be able automatically to cut out that part of the network in which a fault occurs without interrupting the supply, the Siemens-Schuckert-Werke have worked out a system which will soon be installed in Cologne.

This system resembles somewhat the Merz-Price system of the A.E.G. The secondary cable of the Merz-Price system, however, is replaced by the special design of high-tension cable in the Siemens system.

A cable network on this principle has been laid down in the suburbs of Cologne where the automatic protecting device is to be used.

When using the connections in Fig. 1 the cables have in each core, concentric to the main conductor but insulated from it and from the lead sheath, an almost closed spiral copper sheath, C_1, C_2, C_3. With

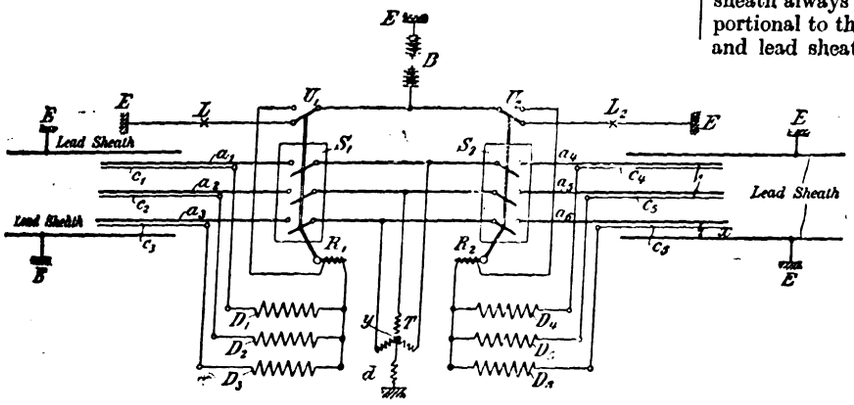

FIG. 1.—DIAGRAM OF CONNECTIONS OF ARRANGEMENT FOR CUTTING OUT FAULTY CABLE SECTION.

multi-core cables these sheaths are insulated from one another. The diagram of connections, Fig. 1, shows the arrangement in a switching chamber when using three-core cables with three-phase current. The same diagram can be used with single cables and for other current systems.

The chief point in this system is to obtain a momentary connection between the main conductor and the copper sheath, or between the latter and the lead sheath, or even between the copper sheaths themselves, by means of the spark caused by a breakdown in the insulation in any part of the cable. This is shown in the diagram at x.

In this way the circuit of a secondary battery, of which one pole is earthed, is closed through the relays R_1 and R_2 belonging to the switches S_1 and S_2 of the damaged cable, thus opening the switch.

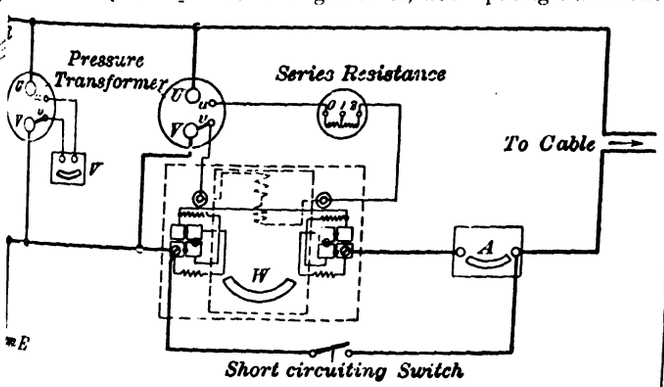

FIG. 2.—CONNECTIONS FOR THE ASTATIC WATTMETER.

The same operation occurs at the other end of the damaged cable and thus the damaged section is cut out of the network. The other switches remain closed.

In order to obtain this result with multi-core cables, in consequence of a short-circuit between two conductors, which has not affected the lead sheath, it is necessary to put one or different phases to earth, or if transformers (t) are used, the neutral point y^0 of the same, through choking coils in one or more of the switch chambers. The current from the battery then flows from the protecting sheath over the spark-gap to the conductor or conductors, and, in consequence of the earth connection, back to the battery.

In the connections between the sheaths C_1 to C_6 and the switch relays R_1, R_2, choking coils D_1 to D_6, are placed in star connection. These oppose only small ohmic resistances to the battery current, but reduce to a minimum the alternating current flowing through the relays, due to the normal voltage of the protecting sheath and also to a short-circuit, in case of breakdown.

The change-over switches U_1 and U_2 are coupled to the cable switches. The former connect the battery and the relays and operate the main switches. A signal lamp, L, is also placed in the battery circuit to show which switch in the station has operated.

The choking coils D_1 to D_6 can be built with secondary windings like testing transformers to which voltmeters are connected. These serve also to indicate the condition of the insulation of the different cable lengths, as they only show the same potential to earth when the insulation of each cable phase is equally good.

When using the above diagram with single cables, the earth at the neutral point y is not necessary, as all short-circuits must necessarily take place from the conductor to earth.

Characteristic of the arrangement in question is that the copper sheath always has a potential, relative to the working pressure, proportional to the distance between the conductor &c. copper sheath and lead sheath. This potential must be absorbed in the above-mentioned choking coils, whose star connections furnish us with a nullpoint to which the releasing coils and battery can be connected.

If one neglects the small differences of potential in the phases the releasing apparatus only have a continuous-current potential. In a normally perfect cable the copper windings have a continuous-current potential carried on the alternating-current potential.

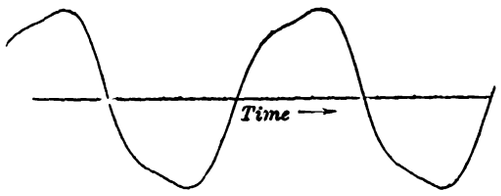

FIG. 3.—VOLTAGE CURVE.

A continuous-current battery is usually employed up to 250 volts and can be constructed of small elements which can bear a large overload and remain a long time without recharging, as the battery is usually at rest.

One of the main features of this system is that external injury to the cable—for example, piercing it with a pick-axe—cuts out that part of the system immediately, provided that the damage reaches the copper sheath.

For this reason the copper sheath is placed, in case of single cables, as near the lead sheath as possible. This makes it possible to build the choking coils with a very high factor of safety, as in single cables for high tension they have only to provide for a comparatively small part of the working pressure. And of course the apparatus for the protecting device must be so built that they themselves cannot cause any disturbance in the working of this system.

As a protection for multi-core cables against external damage an extra copper sheath under the lead sheath could be supplied. Experience shows that short-circuits seldom occur without the lead sheath being acted upon, and in this case the copper sheaths round the different cores could possibly be dispensed with.

The authors then give a description of the cable and boxes used for the Cologne network.

The cable was made in lengths of 750 m. and the weight per cable drum was about 6,500 kg. Multi-core cables can only be built in lengths of 250 m.

The size and electrical properties of the cable are as follows:—

Sectional area of copper conductor	95 sq. mm.
Diameter over lead sheath .....about	40 mm.
Diameter over asphalt covering ..... „	48 mm.
Thickness of insulation between conductor and copper sheath .....about	8 mm.
Thickness of insulation between copper and lead sheath	2·5 mm.
Total thickness of paper insulation	10·5 mm.
Radial thickness of lead sheath	3·0 mm.
Sectional area of copper sheath	26×0·07 mm.
Resistance of copper sheath .....about	30 Ω per km.
Weight of copper sheath ..... „	55 kg. per km.

The copper sheath is wound with only about 1 to 2 mm. between the spirals. It does not materially increase the price of the cable. Continuous tests have shown that the copper sheath in single, or

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the three copper sheaths in three-core cables, does not affect the quality of the cable with respect to impregnating, or the resistance to bending and testing; neither does it increase the dielectric losses or the capacity insulating values.

In the end dividing box used for the above single cable the copper sheath is connected as also in the straight through joint boxes, which are cylindrical and made in bronze on account of the Foucault currents, by means of tin-foil strips.

The principal dimensions of the end box are :—

Total length	about	930 mm.
,, breadth	,,	250 mm.
,, depth	,,	250 mm.
,, length of the porcelain insulators	,,	475 mm.
Length of the projecting part of the insulators	,,	280 mm.

The authors finally give a description of the terms drawn up for the guarantee to be given for the Cologne cables and the tests which have to be fulfilled before and after laying the same.

They also describe the special astatic wattmeters which have been especially built for use with this system. Fig. 2 shows the connections employed with these wattmeters; whilst Fig. 3 illustrates a diagram taken with an oscillograph of the tension of the phases with 10,000, 15,000, and 20,000 volts.

LEGAL INTELLIGENCE.

Electrical Inspectors.

At Clerkenwell (London) Police Court on Friday an electricity supply consumer in the St. Pancras area applied to Mr. Bros for the appointment of an electrical inspector. It was stated that applicant had had a dispute with the local authority as to the kind of fuse supplied by the Council, and there was *no* one to appeal to, as St. Pancras Council (and Chelsea Electricity Supply Co.) had electric lighting powers before the L.C.C. had general powers in the matter; they were excluded from the operation of the General Act by the Local Acts, and were not subjected to the inspection of the L.C.C., as was the rest of the metropolis. The Local Acts provided that in such a case an aggrieved consumer must apply to a stipendiary to appoint an inspector and the appointment remained a permanent one. The magistrate could appoint the London County Council. Applicant was informed that neither the Board of Trade nor the County Council could take action, and was referred to the magistrate to take the initiative.

Mr. Bros adjourned the hearing of the case until Thursday, Oct. 5.

Overhead Wires in Southwark.

At Lambeth (London) Police Court on Monday Mr. Hopkins sat as arbitrator to determine a difference between the Postmaster-General and Southwark (London) Council as to overhead telegraph wires in certain thoroughfares.

Mr. P. McIntyre, for the Postmaster-General, stated that when the solicitor to the G.P.O. asked the Council to waive their objection to overhead wires the Town Clerk replied that they were unable to do so, as they were firmly opposed to the principle of allowing overhead wires. It was not proposed to use the wires for any other purpose than that of connecting up the fire-alarm posts with the fire station. The cost of placing those lines overhead would be £90, but if they were placed underground the cost would be £339.

Evidence was given on behalf of the Council, and Mr. A. Harrison, borough engineer, said the Council objected to all overhead wires in their district. He considered the erection of the proposed posts and wires would be objectionable and tend to deteriorate the district.

Mr. Hopkins reserved his decision.

German Consular Service.—It is announced that the appointment of commercial experts to various important German Consulates having been found so advantageous in promoting German exports, it is now proposed to extend the principle by supplementing them with special experts for answering technical questions. Their field of activity will lie in following the progress of the industrial development of a foreign country and reporting about all technical and engineering novelties. At the outset, these new experts will be appointed to the German Consulates at London, Washington, Paris, St. Petersburg, Vienna, Constantinople and Tokio. Technical members, as salaried officials, will also be appointed to the Consulates at Christiania, Budapest, Bucharest, Sofia, Alexandria, Athens, Rome, Moscow, Manchester, New York, St. Louis and Peking.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

*NOTE.—The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application, an asterisk is affixed.*

August 11, 1911.

18,175 KING. Automatic electric switchgear.
18,203 BARBOUR. Electrical brushes or collectors.
18,204 BARBOUR. Homopolar electrical generators and motors.
18,212 BLACKETT & MOUNTAIN. Protecting coverings for conductors or cables.
18,231 THOMPSON. (Ges. fur Drahtlose Telegraphie m.b.H., Germany.) Electric oscillation circuits and their connections.*
18,235 GWOZDZ. Telephones. (Addition to 11,234/11. Convention date, 2/6/11. Germany.)*

August 12, 1911.

18,265 HECHT & DOWDELL. Electrically operated signs.
18,271 DITCHAM. Transmitter for wireless telegraphy.
18,280 LEHMANN. Automatic voltage regulation of alternators.*
18,284 MATTHEWS. Wireless telephony and wireless telegraphy. (Addition to 29,242/10.)

August 14, 1911.

18,322 MILNE. Electric controlling or synchronising pendulums.
18,324 RIPPINGILLE. Electrical heating and ventilating appliances.
18,334 JUDD. Electrical heating element.
18,351 GROTE. Metal filaments for electric lamps.
18,360 MORRISON. Reversible galvanic batteries. (10/10/10, United States.)*
18,375 KAESEN. Terminal clips for electric wires.*
18,392 HOGE & "Z" ELECTRIC LAMP MFG. CO. Filaments for incandescent lamps.

August 15, 1911.

18,462 SIEMENS BROS. & CO. (Siemens & Halske A.-G.) Mountings for wall telephone sets.*

August 16, 1911.

18,473 MCCLELLAND, JUN. Heating liquids by electricity.
18,487 MUNRO & R. E. T. CONSTRUCTION CO. Electric vehicles.
18,526 PRICE. Dynamos.

August 17, 1911.

18,575 SIEMENS BROS. DYNAMO WORKS & SCHUPP. Starting switches for motors.*
18,583 RAILING & MAURICE. Electric light fittings.
18,586 GWOZDZ. Telephones. (Addition to 17,363/11.)*
18,611 FIELD & FERRANTI LIMITED. Automatic starters for electric motors.

August 18, 1911.

18,630 KELVIN & JAMES WHITE, CLARK & CHETWYND. Magnetic compasses.
18,648 WESTERN ELECTRIC CO. (Western Electric Co., U.S.) Automatic telephone exchange systems.*
18,649 WESTERN ELECTRIC CO. (Western Electric Co., U.S.) Telephone exchange circuits.*
18,658 SIEMENS BROS. & CO. (Siemens & Halske A.-G., Germany.) Devices for supervising the effective working condition of power-operated railway points and signals.*
18,667 CRABB, PERL & HUTCHINSON. Switches.
18,674 NOBLE. Machines for covering or insulating wire. (18/8/10.)*
18,676 B.T.-H. CO. (G.E. Co., U.S.) Heat-storage devices.

August 19, 1911.

18,680 BULLERS LIMITED & CHAMBERS. Attachment of insulator carrying arms to poles.
18,692 WEEKES. Electrical indicating systems.
18,693 REYNOLDS. Electrical signal apparatus. (17/3/11.)*
18,733 PLANIAWERKE A.-G. FUR KOHLENFABRIKATION. Carbon electrode. (6/10/10.)*

SPECIFICATIONS PUBLISHED.

1910 SPECIFICATIONS.

11,154 FESSENDEN. Wireless signalling. (29/1/10.)
16,093 HALL. Magneto-electric ignition apparatus for internal explosion engines.
16,172 REEVE. Electrical apparatus.
18,470 JOHNSON & BILLINGTON. Electricity meters.
19,071 DAVIES, KENT & DAVIES, KENT & STEWART. Switches.
19,199 HERRDE. Regulating the closing of electric bell circuits.
19,449 MARTIN. Magnetic separation of zinc, copper and other sulphide ores.
20,040 ETABLISSEMENTS PAZ & SILVA. Socket for fixing electric lamps. (28/6/10.)
20,759 ALLGEMEINE ELEKTRICITAS GES. Apparatus for varying the mean potential of starting machines (distributing dynamo machines). (6/9/09.)
22,164 SMITH & LYON. Detectors for use with electromagnetic waves.
22,735 MITTELHAUSEN & WILLIAMS. Supporting and insulating overhead wires in electric tramways and railways.
22,775 HARRISON. Means for supporting electric lamps.
22,803 LEWIS. Electrodes for arc lamps.
23,639 SCHILLING. Manufacture of metallic filaments. (29/12/09.)
23,891 MEIGH. Terminal for high and low-tension conductors.
26,409 MERRYWEATHER. Driving magneto-electric machines for internal combustion engines.
27,247 GIRARDEAU. Apparatus for emission of Hertz oscillation. (26/11/09.)
27,725 BRUSH ELECTRICAL ENGINEERING CO. & LEECH. Motor supports for electric tramcar trucks.
27,857 BORN. Conversations-counter for telephones without crank handles.
28,179 GILES. Condensers for electrical systems. (4/12/09.)
28,536 RUTHENBURG. Electrodes for electric furnaces.
29,161 VICKERS, WILLIAMSON & BROWN. Commutators for electrical machines.
29,505 ALLGEMEINES CHEMISCHES LABORATORIUM OSKAR H. ARENDT & SCHLESINGER. Supports for metallic filaments in incandescent lamps. (18/12/09.)
30,166 & 30,167 GOLBY. (Draper-Latham Magneto Co.) Magneto generator.
30,233 B.T.-H. CO. (G.E. Co., U.S.) Dynamo-electric machines.

1911 SPECIFICATIONS.

320 ENGEL. Electrical contact devices. (Addition to 6,765/08.)
498 OTIS ELEVATOR CO. (Otis Elevator Co.) Controlling apparatus for electric motors.
1,907 RICHARDSON & CROWLEY. Incandescent lamps. (1/4/11.)
2,903 SIRE. Dynamo-electric machines. (14/2/10.)
4,397 OESTERREICHISCHE DAIMLER MOTOREN A.-G. Overhead trolley wire construction. (22/10/10.)
4,917 DAHL-JENSEN & AKTIESELSKABET BING & GRONDAHL'S PORCELLAENSFABRIK. Press moulds for the manufacture of insulators with more than one petticoat.
5,564 CROWE & BRITISH L. M. ERICSSON MFG. CO. Contact keys or the like.
6,983 BARNES. Lug joints for the lids of accumulator boxes.
7,631 SIEMENS BROS. DYNAMO WORKS. (Siemens-Schuckertwerke Ges.) Electrically braking polyphase series motors.
8,004 SCHWAB. Incandescing bodies for electric lamps and manufacturing same. (9/4/10.)
9,375 SIEMENS BROS. & CO. (Siemens & Halske A.-G.) Telephone intercommunication sets.
9,429 MENTEYNE & DEGAILLE. Automatic fire-arms.
10,156 BENKÖ. Voltaic cells.
11,339 BELLINI. Transmitters and receivers for wireless telegraphic and telephonic apparatus.
11,906 CHEMISCHE FABRIK GRIESHEIM-ELEKTRON. Depolarisers for galvanic cells or batteries. (10/10/10.)
12,024 BLONDEL. Manufacture of electrodes for arc lamps. (Addition to 6,060/03.)
12,735 SIEMENS BROS. DYNAMO WORKS. (Siemens Schuckert-Werke.) Arc lamps.

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COMMERCIAL AND INDUSTRIAL SECTION.

MUNICIPAL, FOREIGN & GENERAL NOTES.

BRITISH NOTES.

Alleged Theft of Electric Lamps.—At the Mansion House (London) Police Court on Tuesday, Jas. Wm. Waite, counterman, was charged on remand before Ald. Sir John Knill with stealing, and Thomas Powell, electrician, with receiving, 12 Tantalum lamps, value £1. 8s. 10d. Both were also charged with conspiracy to defraud Messrs. Siemens Bros. Dynamo Works (Ltd.), of 39, Upper Thames-street, E.C.

Mr. R. D. MUIR, who prosecuted, said Waite was in the employment of prosecutors as counterman in the electric lamp department, and Powell was a customer, but his legitimate transactions with the firm only amounted to a few pounds. In February last a serious shortage of lamps was discovered in the department, and that had increased by August. It was found on investigation that there had been a large exchange of old lamps for new with Powell, the number exchanged amounting to 37 per cent. of the total purchases. It was also found that lamps had been taken away by Powell, and that the transactions had not been entered in the books.

Evidence having been given, Sir JOHN KNILL expressed the opinion that a prima facie case had been made out, and he committed accused, who reserved their defence, for trial at the Central Criminal Court, admitting them to bail.

Battersea (London).—On Wednesday the Chairman of the Finance Committee reported to the Council that for the year ended March 31 last the electricity undertaking showed a net surplus of £3,118. The progress made during the past two years had been very satisfactory.

Bexley Heath.—As already announced the Council have adopted a revised scheme for carrying out wiring work on the deferred payment system.

Under the scheme forms of application and schedule for list of points proposed to be installed can be obtained from the electrical engineer (Mr. C. Mittelhausen), Car-sheds, Broadway, Bexley Heath. The installation is to be carried out by a contractor to the specification of the engineer. The Council's maximum contribution towards the cost of any installation is £1 per point installed, and no charge is made for supervision. If the cost of the installation exceeds the Council's maximum contribution, the difference between such contribution and the actual cost must be paid by the consumer (or the landlord) direct to the contractor. The installation remains the property of the Council until paid for as provided. The consumer (landlord or mortgagee) may purchase outright the whole of the wiring and fittings at any time on payment of the outstanding balance of the Council's contribution, plus 5 per cent. interest. The consumer (landlord and mortgagees) agree to refund to the Council the latter's contribution towards cost of installation by equal quarterly instalments of principal and interest and also undertake not to disturb or remove, or consent to the disturbance or removal of the wires or fittings without permission of the Council in writing until the same are fully paid for. The Council require no deposit or a guarantee of any fixed consumption of energy, except to the extent of the minimum charges payable by all consumers. These are: For quarters ending December and March respectively, 6s. per quarter, and for quarters ending June and September respectively, 3s. per quarter. Energy for lighting will be supplied at current rates, subject to usual cash discounts, and no meter rents will be charged. But for power, heating or cooking, the usual meter rent will be charged. In the event of the wires and fittings being destroyed or damaged beyond repair by fire or other cause, the balance then remaining unpaid of the value shall immediately become payable by the consumer (landlord or mortgagee). The installation includes wiring, fittings and the first supply of lamps. Lamps required subsequently may be purchased of the Council's electric lighting department. The Council's maximum contribution of £1 per point is estimated to include fittings of a plain character, and if more elaborate fittings are selected the excess cost will be paid by the consumer.

Bradford.—On Monday a deputation from Bingley Council waited upon the Tramways Committee to urge upon them the desirability of extending the tramways to Bingley.

Brighton.—Last week the Corporation adopted a report from the Lighting Committee recommending the re-construction of a turbine at the Southwick station.

Coun. Campbell, in moving the adoption of the report, said the committee were thoroughly convinced that the conversion would mean a very substantial saving. They were satisfied by the figures submitted by the engineer (Mr. John Christie) that they would at least save £1,000 a year on the cost of coal. By the suggestion now made the most recent turbine and No. 5, when transformed, would alone be sufficient to carry the maximum load on the present demand. The original cost of the set was £12,000, and the repayment of the capital was spread over 40 years. The alterations will cost £6,500.

Brumby and Frodingham.—The contractors for the laying of electric supply cables in this district (the British Insulated & Helsby Cables) are proceeding with the work, and it is anticipated that a supply of electric current will be available at the end of next month.

Bury (Lancs.).—At the last meeting of the Electricity Committee it was reported that the demand for power was increasing, and since the last meeting they had received applications from seven consumers for 100 H.P.

The engineer and manager (Mr. S. J. Watson) reported that the first day on which the machinery at the Chamber Hall station was connected up with the mains to assist the Rochdale-road station was Aug. 25. On the following Monday a regular supply was commenced, and the plant had since been in regular operation from 8 a.m. to 6 p.m., Saturdays and Sundays excepted, supplying up to about 800 kw. per day.

Church Lighting.—At the last meeting of the Stoke Newington (London) Borough Council the chairman of the Electric Lighting Committee (Coun. Savery) stated that there was a remarkable increase in the demand for electric current for church lighting, as during the past three months four churches in the borough had adopted electric lighting.

St. Nicholas Parish Church, Newbury, is now lighted electrically There are 127 lamps in all, including 78 25 c.p. Osrams in the nave, and 32 16 c.p. lamps in the chancel. The wiring was executed by Messrs. H. J. Cash & Co. to the specification of Mr. Pooley.

Clonakilty (co. Cork).—The Urban Council are considering a scheme for the erection of electricity works, and it is probable that a local company will be formed for the purpose of carrying out the scheme.

Croydon.—A new feeder cable is to be laid to the Drummond-road sub-station, at a cost of £1,700.

Dee Hydro-Electric Works.—Chester Corporation were recently recommended to adopt a scheme for utilising the water power available on the river Dee in the generation of electrical energy.

The scheme was drawn up by the borough electrical engineer (Mr. S. E. Britton), but before proceeding with it the Corporation decided to refer it to Mr. A. C. Hurtzig. In a report recently prepared by Mr. Hurtzig it is stated that the proposal is feasible. The plans provide for the erection of a power station on the site of the old Dee mills, and Mr. Hurtzig states that, assuming the weir to remain at the present height, the proposed scheme could not affect the navigation as much as did the mills when they were at work. With reference to the effect of the scheme on the fishery interests, he saw no objection to the erection of a fish pass at the weir, and generally speaking he considered that the authorities in charge of the fishery interests could not but be satisfied with the proposals of the scheme. He estimated the total cost at £12,500, while the yearly cost of working it would be £1,326, and the probable income £4,257. He was satisfied that the proposals contained in the power scheme were sound, and that by their adoption a certain and valuable source of electrical energy might be acquired for a comparatively small expenditure.

At the Council meeting on Wednesday Mr. John Owens said the Lighting Committee had not considered the report in detail, and when that had been done it would come before the Council with their recommendations.

The Deputy-Mayor said the committee could not proceed with the scheme until next spring, owing to the water and the tides.

Dorking.—The Council have obtained an order from the Board of Trade to extend the electric supply mains to Pixham and Mickleham.

East Ham.—The Finance Committee have decided that future applications for supply of current to clubs can only be acceded to on a substantial deposit being paid, and subject to agreement for the monthly payment of accounts.

Epsom.—Last week the Council further considered the report of the electrical engineer, Mr. A. C. Gilling, recommending the installation of a Diesel oil-driven set but, after discussion, it was decided to engage an electrical engineer at a fee not to exceed £25 to prepare a report upon the proposal, the engineer to be nominated by the President of the Institution of Electrical Engineers.

Gloucester.—It was reported to the Council on Wednesday that the use of meters for checking the electric current used by tramcars had resulted in a saving of £114, although there was an increase of 3,500 in the car-miles run. The cost of the 32 meters used was £ 00.

Heckmondwike.—The Electricity Committee have appointed a sub-committee to consider and report upon the terms submitted by the Yorkshire Electric Power Co. for supply of electricity in bulk.

Industrial Disputes.—An interesting report on Strikes and Lock-Outs and on Conciliation and Arbitration Boards in the United Kingdom in 1910, with comparative statistics for 1901-9, has been issued by the Labour Department of the Board of Trade. In a

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preface to the Report, which is supplied by Sir G. R. Askwith, K.C., it is stated that—

The year 1910 was marked by considerable industrial disturbance; the number of workpeople (515,165) involved in disputes commencing during the year was the highest since 1893, while the aggregate duration (9,894,831 working days) of all the disputes in progress during the year has been exceeded on only four occasions during the last 18 years. The high figures for 1910 were caused by disputes in the coal trade of Northumberland, Durham and South Wales, in the shipbuilding industry in the north of England and in Scotland, and in the cotton-spinning industry of Lancashire and Cheshire. These five disputes alone affected 265,100 workpeople, and caused a loss in working time of over 6,500,000 working days. The effect on other industries cannot be statistically measured, but must have been very considerable. Of all the workpeople directly affected by disputes in 1910, 39 per cent. were involved in disputes as to the employment of particular classes or persons, and 24 per cent. in disputes as to hours of labour, both percentages being exceptionally high. Questions of wages, which are usually the most frequent causes of disputes, involved only 20 per cent. of the workpeople directly affected by disputes in 1910. Compromises were arranged for about two-thirds of the total number of workpeople directly affected in all disputes. A few disputes still remain unsettled, and in the remainder about half the workpeople were successful and half unsuccessful.

As in other recent years, methods of conciliation and arbitration were extensively used in 1910 in the settlement and prevention of labour disputes. The number of workpeople directly involved in disputes settled by such means in 1910 was the highest recorded in the decennial period for which statistics are presented in the report, while the number of cases annually settled by permanent boards of conciliation showed a further increase in 1910.

The report contains much interesting matter relating to trades disputes, conciliation, arbitration, &c., and it gives clear testimony of the skill displayed by Sir G. R. Askwith and the officials of his department in the handling of labour disputes. During the year 1910, 59 such disputes were settled, involving 204,384 persons, against 63 disputes and 92,872 persons in 1909. It appears that, with the exception of the mining and quarrying industries, the metal, engineering and shipbuilding trades adopt conciliatory methods of settling disputes most frequently, and in 1901-10 63 disputes, directly involving 61,553 people, were settled.

Library Lighting.—The formal inauguration of the electric lighting installation at the Stoke Newington public library and accessory buildings took place in the presence of a numerous company on Thursday last week. The ceremony of switching on the current was performed by the Mayor (Coun. H. J. Beavis, J.P.). The installation was his worship's Coronation gift to the borough, and the entire cost, which Coun. Beavis has defrayed, is £210.

The Public Library Committee of the borough had had before them several times the question of the electric lighting of the library, but, having regard to the cost and to the fact that the library rate is a fixed amount, which cannot be exceeded, the matter was deferred from time to time. Aware of the desire of the committee and the difficulty in the way, the Mayor announced at the July meeting of the Council, that he would defray the whole cost of the installation, and, upon an estimate by the borough electrical engineer (Mr. S. Hann), promptly gave a cheque for £200 on account. Tenders were obtained and the work was executed by W. J. Fryer & Co., under Mr. Hann's superintendence. The scheme has allowed for the liberal treatment of the reading hall, lending and reference libraries and offices. There are 187 Osram lamps. In the library hall are five 400 c.p. lamps, besides footlights and wing lights for the stage, and there is a special plug for an electric lantern for lectures. The old gasoliers in the lending and reference libraries and reading hall have been retained and adapted for electric lighting, lamps of 32 c.p. and 50 c.p. having been fixed to the pendants. Current is taken from the Council's mains. To commemorate the occasion a mural tablet of statuary marble has been fixed at the entrance to the lending library recording the gift of the Mayor.

L.C.C. Tramways.—The Board of Trade have approved the proposals of the L.C.C. for the construction of the tramway from Poplar to Barking-road Bridge, on the conduit system, the track work being laid in such a manner as to enable a change-point to be fixed later should arrangements be made for through running between Poplar and Canning Town.

Mines Inspectorship.—The Home Secretary, with the advice of the Civil Service Commissioners, has revised the scheme of examination for inspectorships of mines. These appointments will now be filled after a competitive examination limited to candidates nominated by the Home Secretary.

Candidates must be between 23 and 35 years of age, must hold a first-class certificate under the Coal Mines Regulation Act and must have been employed for two years as manager or under manager of a coal mine or in some other responsible capacity requiring regular attendance underground in a coal mine. An examination to fill several vacancies will probably be held at the beginning of next year. Applications for examination must be sent in before Oct. 15, 1911. Forms of application from the Private Secretary, Home Office, London, S.W. The salaries are:—Divisional inspectorships £750, rising by annual increments of £50 to £1,000; senior £500, rising by annual increments of £20 to £700; junior £300, rising by annual increments of £15 to £450.

The following are the subjects of examination:—(i.) English 400 (maximum marks), (ii.) elementary mathematics 200, (iii.) elementary geology 200, (iv.) Coal mining 1,000, (v.) ore and stone mining 300, (vi.) electricity in mines 300, (vii.) law relating to mines and quarries 200, (viii.) oral examination 400, (ix.) chemistry 400, and (x.) physics 400. Candidates must qualify in each of the subjects numbered (i.), (iv.), (v.) and (vi.), and must also obtain such an aggregate of marks in all the subjects numbered (i.) to (viii.) taken together as to satisfy the Civil Service Commissioners. Subjects (ix.) and (x.) are optional, and only one of them may be offered. The fee for the examination is £6.

Municipal Tramways Association.—The tenth annual Conference of this Association is being held at Glasgow. The proceedings, which will extend over three days, were inaugurated on Tuesday evening, when a reunion of the members and their friends was held in the Grand Hotel. The guests, who numbered about 200, were received by the President of the Association (Mr. James Dalrymple) and Mrs. Dalrymple and by Bailie Russell (convener of the Glasgow Tramways Committee) and Mrs. Russell.

The formal opening of the conference took place in the City Chambers on Wednesday morning, when the delegates were received by Lord Provost Sir Archibald M'Innes Shaw and the convener and members of the Tramways Committee. After the presidential address of Mr. Dalrymple had been delivered, a Paper on "The Common Good of the City of Glasgow: its Origin, History and Present Position in Relation to the Tramways Undertaking," was read by Councillor W. Nelson, sub-convener of the Tramways Committee. Luncheon was served in the City Chambers at one o'clock, and in the afternoon Councillor J. H. Rodger, chairman of the Newcastle Corporation Tramways Committee, read a Paper on "Tramways Finances and Policy." In the evening the delegates were entertained at dinner in the City Chambers by the Lord Provost and the convener and members of the Tramways Committee.

A full report of the proceedings, together with abstracts of the Papers read, discussions thereon, &c., will appear in the next issue of THE ELECTRICIAN.

Popular Lectures on Electric Lighting.—Two special popular lectures will be given by Mr. F. H. Taylor, A.M.I.E.E., A.M.I.M.E., on "Recent Developments in Electric Lighting and other Applications of Electricity," on Oct. 4 and 6, commencing each evening at 8 p.m. Tickets from the secretary of the Willesden Polytechnic, Priory Park-road, Kilburn, N.W.

Portsmouth.—The appeal of the Electric Supply Committee against the assessment of the electricity works has been abandoned, as the parties have effected a compromise. The assessment now stands at £7,785, a reduction of £2,000.

Presentations.—Mr. C. W. Hill, late tramways manager at Bournemouth, has been presented by the staff with an illuminated address and leather writing case, and Mrs. Hill with two framed water colours.

On his marriage on Sept. 21, Mr. H. W. Angus, borough electrical engineer at Eccles, has been presented by the Chairman and members of the Electricity Committee with a silver coffee service, and by the Corporation officials with a silver salver.

Shoreditch (London).—At the meeting of the Council last week the scheme prepared by the borough electrical engineer (Mr. C. Newton Russell) for the extension of the incandescent electric lighting of the borough was adopted.

The Lighting Committee reported that, following on the completion of the street lamps south of Old-street from gas to incandescent electric lighting, they had had under consideration for some time the question of converting the lamps in streets north of Old-street from gas to electric incandescent lighting by means of metal filament lamps. The number of burners now illuminated by gas in the district referred to is 1,055. The capital cost of laying about 14 miles of cables, in 160 streets, of sufficient size to serve, not only for the street lamps, but to meet any reasonable demand likely to arise, was £8,385 (including excavation work and reinstating footways, &c.), and the cost would be charged to electricity works capital account, the money being raised by loan, for which sanction would be obtained from London County Council. The cost of converting the street lamps for electric lighting is estimated at £695. 5s. and would be borne by the electricity works revenue account, and the Committee are including a proportion of this sum in their revised estimates. The proposed charge to the general rate is 37s. per 50 c.p. lamp per annum, including lighting and maintenance of lamps, which compares with the present cost of 40s. 3d. per annum, or a saving (including reduction of charge on lamps south of Old-street) of about £230 per annum. It is proposed to lay mains in the ordinary side streets of sufficient capacity to supply power up to 25 H.P. or 350 50 c.p. lamps, and in the smaller streets, mains sufficient to provide for 6 H.P. or 84 50 c.p. lamps.

Skelmorlie (N.B.).—The Skelmorlie Electric Supply Co. are laying electric supply mains in this district, and current will be available by the end of October. For private lighting the initial charge will be 6d. per unit.

Stirling.—The charges for electric current for public and private lighting and power have been recently reduced.

Stoke Newington (London).—Last week the Council adopted a recommendation of the Electric Lighting Committee to give notice

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to the North Metropolitan Electric Power Supply Co. to terminate Schedule I. of their agreement with the Council at March 31 next.

The committee had reported that the accounts of the electricity department showed that had Schedule II. of the agreement been in operation during the past year a profit would have been made of £223. 8s. 2d., after payment of all working and management expenses and loan charges; and that the total repayment of loans at March 31, last amounted to £3,610. 13s. 1d.

Coun. White said that unless notice were given the Council would practically be presenting the company with something like £1,000. It was said that the recommendation was hardly fair, but he did not think the company were in need of sympathy. They had already received from the Council sums exceeding £5,000, and they were receiving yearly increasing sums which would be paid at a rate which the company themselves had asked.

Wakefield.—The Council have retained Mr. Ashton Bremner to advise them with regard to their destructor undertaking.

West Ham.—The Electric Light and Tramways Committee report having settled the claim of the Roland Hill Permanent Building Society, by payment of £275 (including costs), for injury to certain houses of the society, alleged to have been caused by noise, &c., at the generating station at Canning Town.

West Hartlepool.—Further negotiations have taken place between the Corporation and the local tramway company in regard to the municipalisation of the tramways in West Hartlepool.

The company were asked to pay 5 per cent. per annum on the Corporation capital expenditure, to establish a sinking fund and to contribute £150 per route-mile per annum for maintenance, and they were also to pay a rental. The company, however, say that such an agreement would involve them in heavy annual loss, and they offer to sell to the Corporation the remainder of the tramways in the borough, or to lease same on more favourable terms than the Corporation propose to them. Alternately, they offer to accept a lease of 42 years of all running powers on terms previously submitted.

Wireless Telegraph Note.—It is stated that from the time the Cunarder "Olympic" was in collision with H.M.S. cruiser "Hawke" until the former's safe arrival at Southampton, the Marconi wireless installation on board the "Olympic" was at work forwarding and receiving messages to and from all parts of the world. 150 messages were despatched to the account of the "Olympic" passengers, the total number of messages being a record.

Electric Supply Cricket League.—The following particulars of the points scored during last season by the clubs affiliated to this League have been issued and show that the St. James' Electric C.C. are the winners of the cup this year:—

St. James' Electric C.C. 17 points, City of London Electric C.C. 16, Kensington and Knightsbridge Electric C.C. 15, St. Pancras Electricity C.C. 8, Chelsea Electric C.C. 4, and Central Electric C.C. nil. The hon. secretary and treasurer (Mr. A. W. Seabright), 19, Cadogan-gardens, S.W., will be pleased to furnish any electricity supply cricket club with information in connection with the League.

B.E.A.M.A. Inaugural Dinner.—We are asked to announce that the British Electrical & Allied Manufacturers' Association (Incorporated) will celebrate their re-organisation by a dinner at the Hotel Cecil on Oct. 12. Applications for tickets should be made (by letter) to Mr. Hawes at Olympia, or 36, Kingsway, W.C., and from the following:—

London: Berry, Skinner & Co., 78, Upper Thames-street; General Electric Co., 71, Queen Victoria-street; Nalder Bros. & Thompson, 34, Queen-street, Cheapside; THE ELECTRICIAN Offices, 1, 2 and 3, Salisbury-court, Fleet-street, E.C.

Birmingham: Chamberlain & Hookham, New Bartholomew-street; Electric & Ordnance Accessories Co., Cheston-road, Aston.

Bradford: Phœnix Dynamo Mfg. Co., Thornbury Works.

Edinburgh: Bruce Peebles & Co.

Gateshead-on-Tyne: Sunbeam Lamp Co., Park-road.

Glasgow: Mavor & Coulson, 47, Broad-street, Mile End.

Manchester and District: Electromotors (Ltd.), Openshaw; Ferranti Limited, Hollingwood; Lancashire Dynamo & Motor Co., Trafford Park.

COLONIAL AND FOREIGN NOTES.

Argentina.—The "Review of the River Plate" says Messrs. Vega and Martinez have applied to Congress for a concession for a steam or electric railway from Port San Borombon to La Plata.

Mr. P. L. Pereyra has applied to the Buenos Ayres Provincial Government for a concession for electricity supply works in La Plata.

The Government of the Province of Cordoba have again invited tenders at an upset price of $150,000 (paper) for the purchase of their new electric power house in the City of Cordoba.

Punta Alta (Puerto Militia) Municipality recently received an offer from Messrs. Parcus & Co. to erect electricity works.

Australasia.—The Royal Commission on Melbourne Traffic has reported in favour of the electrification of the suburban railways and tramways and their management by a Greater Melbourne Council. The capital cost of the scheme (which includes the purchase of the Melbourne cable tramways) will exceed £5,000,000.

Mr. R. H. Harper, city electrical engineer, has just returned to Melbourne, after his visit to Europe and America.

Weymouth Proprietary (Ltd.) have presented a 10 kw. three-phase electric generator to the Working Men's College, Melbourne.

The Victorian State Legislative Assembly have passed a resolution moved by Mr. Watt, acting Premier of Victoria, for the appointment of a wages Board for tramway employes. Mr. Watt said the number of companies in Victoria was eight, and the men employed 1,518, with average earnings of 46s. 4d. a week. The males over 21 years of age numbered 1,450, earning 47s. 6d., and under 21 years 68, averaging 21s. 8d. The hours worked varied from 48 to 57½. The board was asked for by the Trades Hall Council and by the National Anti-Sweating League of Victoria.

Marsfield (V.) Shire Council has appointed Mr. G. B. L'reolre consulting engineer to report on a scheme for lighting the town by electricity.

Preliminary steps are being taken by the Turgamah (V.) Shire Council to secure electric lighting for that town.

Siemens Bros. Dynamo Works are supplying 30 motors (from 4½ to 23 H.P.) for Lysaght Bros. & Co.'s wire works at Pyrmont (N.S.W.). Current will be taken from Sydney Corporation.

Sydney Electric Light committee have adopted the suggestion of the city electrical engineer that the Council be recommended to duplicate the two 4,000 kw. sets recently supplied by Dick, Kerr & Co., at £17,285.

The adjacent local authorities are considering the desirability of carrying out a joint scheme for the erection of an electric power station to utilise the water power of the Barron Falls (Queensland).

The local Council have asked Manly (N.S.W.) Electric Light Co. to consider the question of erecting a refuse destructor.

Messrs. Younger & Howitt recently informed Prahran (Victoria) Council of their intention to abandon their contract for the construction of the Dandenong-road electric tramway in consequence of the strike of their workmen. The contractors, who are thus losing between £1,200 and £1,300, have handed over their plant to the Tramway Trust, and have offered to help the latter in any way possible.

Canada.—Prince Albert has resolved to spend £140,000 to develop power from La Colle Falls on the Saskatchewan River. 421 votes were cast, and only four were against the proposition. The original plans by R. H. and P. H. Mitchell are being inspected by Cecil B. Smith, the Winnipeg Power Scheme expert, and on receipt of his report contracts will be placed.

Port Arthur is an interesting city from many standpoints. Within a radius of comparatively few miles there are many waterfalls, capable combined of producing 145,000 H.P. Iron ore exists in enormous quantities in the district.

Dominion Statistics.—The "Canada Year-Book" for 1910, which was recently issued by the Dominion Government, gives the following statistics in regard to telegraph, electric lighting and traction companies:—

There are seven telegraph companies doing business in Canada, the Great North Western Co. (with 11,134 miles of line), the Canadian Pacific Railway Co. (12,257 miles), the Western Union (2,639 miles), Temiskaming & Northern Ontario Railway (265 miles), Algoma Central Railway (130 miles), Grand Trunk Pacific Railway (1,699 miles), and the North American Telegraph Co. (605 miles), total 28,729 miles.

The electric railways total 1,049 miles. The capital expended in Canadian electric railways totals $102,000,000. The annual revenue is $17,000,000, and operating expenses are $10,000,000.

The number of electric light companies registered under the electrical Inspection Act during the year ending March 31, 1910, totalled 398.

Hayti.—A concession has been granted for the erection of hydro-electric works to supply electric power to the railway which runs from Port-au-Prince to Piéton-Town (5 miles), and to the Port-au-Prince tramways (11 miles).

Hindu Temple Lighting.—It is reported that electric lighting is to be introduced into the Kalis Temple. This decision is the result of a recent conference of Brahmin pundits and scientists, who considered that there was "nothing objectionable in electric wires."

Panama.—A concession has been granted for the erection and equipment of electricity works and the construction of tramways in the town of David.

Prague.—The Municipal Council propose to issue a new loan of 2,000,000 crowns, 1,580,000 of which are to be devoted to the purchase of land for the erection of municipal electricity works.

Russia.—The Minister of Ways and Communications is preparing plans for the electrification of the railways round St. Petersburg. It is proposed to obtain the necessary electrical energy (about 28,000 kw.) by utilising the water power of the river Volkhoff, and 7,000 kw. will be available for industrial purposes after the railway supply is satisfied.

South Africa.—Pretoria Council have decided to extend the electric tramways at a cost of about £48,000.

Tokyo.—The Government have sanctioned the application of the Municipal Council to take over the electric tramways, and efforts will be made to complete the unfinished lines speedily and to improve the rolling stock. It is proposed to abandon 13 or 14 miles of existing track, and to build five new lines. The work will be finished by the end of 1914. The municipal authorities propose to build 500 new cars.

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ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Bath.—The minutes of the Electric Lighting Committee, which were presented at the Council meeting last week, contained the accounts of the electricity department for the year ended March last.

The accounts show total capital expenditure £168,364 (increase £3,420), of which £54,710 has been repaid. Revenue was £20,435, working and general expenses were £10,718, gross profit was £9,709, the nett result being a debit balance of £1,196. 1,973,280 units were generated, 427,789 supplied to public lamps, 10,596 by contract and 1,118,747 to private consumers by meter. The total maximum supply demanded was 1,058 kw. There are 164 arc and 195 incandescent lamps for public lighting.

The Chairman, in his remarks, said that in the previous year there was a loss of over £1,400, so they were showing some improvement, and whereas last year the revenue from lighting decreased by £431, this had been entirely wiped out by the increase of current for power, the nett increased revenue for the year being £574. With regard to the effect of the use of metal filament lamps, they had now turned the corner. They had made a larger number of connections this year than in any previous year. When he first became chairman of the committee, the revenue per 8 c.p. lamp was 5s. per annum; now (with the metal filament lamps) it had fallen to 2s. 5½d., which showed that consumers were now gettting the light at considerably less than half the cost some years ago. They had lost £300 less than last year, and after the introduction of the Diesel oil engine set they hoped to wipe out the loss altogether. If they could go on making both ends meet until 1918, they then liquidated one of their largest loans and established themselves in the position of being able to make a substantial profit.

Blackpool.—The quarterly report of the tramways department last week showed an increase of 265,431 passengers carried over the corresponding period of 1910, and of 3¾d. per car-mile in the receipts. The total receipts were £12,237, increase £2,247.

Bournemouth.—The accounts of the tramways department for the year ended March show capital expenditure £432,711 (increase £9,912), in addition to £130,330 spent on the Poole tramways, which are leased by the Corporation.

Revenue was £89,695, working expenses were £57,536 and gross profit was £32,159. The nett result, after crediting bank interest, &c., and paying capital charges, was a deficit of £130. Passengers carried were 14,686,368, car miles run 1,782,706 and units used 2,856,821. Total revenue per car-mile was 12·07d., working expenses (including power), were 7·74d.

Leicester.—At the meeting of the Town Council on Tuesday Ald. Smith, in moving the adoption of the report, of the Tramways and Electricity Committees, referred to the accounts of the Aylestone electricity undertaking for the half-year ended June 30.

It was, he said, the first balance sheet in connection with the undertaking since the transfer from the gas department. The half-year's revenue was £14,654, against £13,396. The disposable balance was £276, against £635. There had been an increase in expenditure of £1,534, as certain special expenses had had to be met during the half-year. There was now a steady increase in the consumption of electricity.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

GRIMSBY Corporation invite tenders for supply of paper-insulated lead-covered cables, house fuse and main service boxes. Specifications and forms of tender from the borough electrical engineer, Mr. W. A. Vignoles, M.I.E.E. Tenders must be in by first post Oct. 16. See an advertisement.

The Tramways and Electricity Committee of BELFAST Corporation invite tenders for the supply of 2,000 ampere switchboard apparatus, field regulating rheostat and change-over switch. Specification and form of contract from the city electrical engineer, Mr. T. W. Bloxam, East Bridge-street, Belfast. Tenders to the town clerk, Mr. R. Meyer, by 10 a.m. of Monday, Oct. 9. See also an advertisement.

Tenders are invited up to Nov. 8 for the supply of ironwork, measuring instruments and protectors, switchboards, switchboard parts and accessories, and up to Nov. 22 for the supply of cable to the Postmaster-General's Department in QUEENSLAND; and up to Nov. 15 for the supply of telephone cords and earpieces to the Postmaster-General's Department in SOUTH AUSTRALIA. Tender forms, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W. See also advertisements.

Tenders are invited up to Dec. 20 for the supply of one branching multiple magneto switchboard at Broken Hill to the Postmaster-General's Department in NEW SOUTH WALES. Tender forms and specification from the Commonwealth Offices, 72, Victoria-street, London, S.W. See an advertisement.

Tenders are invited up to Nov. 21 for supply of one automatic or semi-automatic switchboard and equipment to the Postmaster-General's Department in WESTERN AUSTRALIA. Tender forms and specifications may be obtained at the Commonwealth Offices, 72, Victoria-street, London, S.W. See an advertisement.

Tenders are invited by the City of MELBOURNE for the supply of 8,000 yds. three-inch fibre conduit, suitable for laying underground in concrete, and to be used for containing lead-covered cables. Specification, tender form and conditions of tender from the Agents for the City Council, Messrs. McIlwraith, McEacharn & Co. Pptv. (Ltd.), Billiter-square-buildings, London, E.C., to whom tenders by noon of Tuesday, Oct. 3. See also an advertisement.

LONDON County Council require tenders by 11 a.m. Oct. 24 for supply of hand-power overhead crane, h.t. and l.t. cables and switchgear, &c., rotary converters and static transformers, for sub-stations. Specifications, &c., from the Clerk.

HACKNEY (London) Borough Council require tenders by 7 p.m. Oct. 12, for supply of 100,000 pairs of white open type arc lamp carbons. Specification, &c., from the Town Clerk.

MANCHESTER Electricity Committee require tenders by noon Oct. 4, for supply and erection of a 4,000—4,500 kw. low-pressure exhaust type turbo-alternator. Specification from the Secretary.

HASTINGS Guardians require tenders by Oct. 18 for the electric lighting of the workhouse premises, Ore, Hastings. Specification from Mr. S. Bumstead, 11, Wellington-sq., Hastings.

MORECAMBE Council require tenders by 10 a.m. Oct. 10 for reconstruction of a portion of the Bare tramway route. Specification from Borough Surveyor.

PERTH (N.B.) Corporation want tenders by Oct. 14 for coal storage hoppers, conveyors, capstans, electric generating plant for stoking machinery and extension of coal elevator and hoist. Specifications &c., from the Gas Engineer.

CARLISLE Electricity Committee require tenders for water softening and purifying plant (4,000 gallons per hour) and a main to feeder switchboard. Tenders to City Electrical Engineer by Oct. 14.

Tenders are invited up to Oct. 18 for the supply of 20 coin-in-the-slot attachments to the Postmaster-General's Department in WESTERN AUSTRALIA; up to Oct. 25 for supply to the Postmaster-General's Department in SOUTH AUSTRALIA of cable and paper sleeves; and up to Nov. 1 for the supply of 5,000 porcelain (No. 8) insulators to the Postmaster-General's Department in SOUTH AUSTRALIA. Tender forms and specification from the Commonwealth Offices, 72, Victoria-street, London, S.W.

The Metropolitan Water and Sewerage Board, Albert-street, BRISBANE, Queensland, want tenders by noon Jan. 30 next for supply and erection of one, two or three complete units, each consisting of power generating plant and pump or pumps to lift not less than 6,000,000 gallons per day. Particulars from the Secretary, and forms from the Agent-General for Queensland.

DUNEDIN (N.Z.) Corporation require tenders by Nov. 1 for supply of (1) 500 B.H.P. vertical type gas engine or Diesel oil engine, suitable for rope driving an a.c. motor and d.c. generator; and (2) direct-coupled vertical type gas engine or Diesel oil engine and d.c. generator (800 kw. at 550 volts). Specification at 73, Basinghall-street, E.C.

TULCEA (Roumania) municipality require tenders by Nov. 19 for electric lighting of the town.

Tenders are invited by the Municipal Council of PELOTAS (Brazil) for a 40 years' concession for the supply of electricity for power and lighting and the establishment and working of electric tramways. Tenders to Senhor Luiz M. da S. Pennafiel, Intendencia Municipal, Pelotas, up to 1 p.m. Nov. 14. A deposit (about £300) is required with each tender, to be increased by the successful tenderer to 25,000 milreis (about £1,670). Further particulars (in Portuguese) can be seen by British contractors at 73, Basinghall-street, London, E.C.

Tenders will be received at the Town Hall, SYZRAN, Russia, on Oct. 14, for the construction of an electric tramway and the supply of electrical energy for lighting.

Tenders are wanted by noon Nov. 22 for supply of motor generators, accumulators, main switchboard, cable, &c., to the South African Government Posts and Telegraphs Department, PRETORIA. Particulars from G.P.O., Johannesburg, or Cape Town.

Tenders will be received until Nov. 28 at the Directoria Geral Ministerio de Viaçao e Obras Publicas, Rio de Janiero, for harbour works at JARAGUÁ (Alagoas State) (estimated to cost £80,000), including the supply of six movable 1½-ton electric cranes, a fixed 30-ton crane and an electric lighting installation. Particulars can be seen at 73, Basinghall-street, E.C.

BONA (Algeria) Municipality require tenders for supply and erection of electric pumping plant to pump water from the Bou-Gos

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water main to the Chateau d'Eau des Santons, nearly half a mile. The plant must lift 55 litres of water per second, and include a 440-volt c.c. motor. Prices must be submitted for two similar installations. Particulars from M. le Directeur du Service des Eaux, Hôtel de Ville, Bona, to whom tenders by Oct. 15.

TENDERS RECEIVED AND ACCEPTED.

East Ham Council have accepted the tender of the Ray Electric Co. for wiring the Manor Park Library, and that of Babcock & Wilcox for the installation of chain-grate stokers to two of the boilers at the generating station, at £325 per boiler. An order has been placed with W. Wood & Co. for two reels of figure eight trolley wire (about 2,700 lb.), at 7¾d. per lb.

Portsmouth Electric Light Committee have placed an order with W. T. Glover & Co. for cables at £331. 9s. 10d.

Sowerby Council have accepted the tender of the Northern Counties Electricity Supply Co. for supplying current to 74 lamps for 3 years at £105 per annum.

Cleethorpes Council have accepted the tender of the Western Electrical Co. for cables, and that of Ferranti (Ltd.) for meters.

Chelmsford Guardians have placed an order with F. H. Dennis for an electric fan at £14. 10s.

West Ham Council have accepted the tender of Willans & Robinson (at £11,384) for a 5,000 kw. turbo-alternator, and that of Babcock & Wilcox (at £9,790) for water-tube boilers.

Wood Green Council have entered into an agreement with the Chloride Electrical Storage Co. for the maintenance of the battery of accumulators at the baths for 12 years, at £16 per annum.

Southend Council have accepted the following tenders: Boydell & Co., nine feeder pillars, £114; John Spencer & Co., 53 traction poles, £241; Watlington & Co., 53 bracket arms and fittings, £195.

The Electric Light & Power Supply Corpn., Balmain (N.S.W.), have accepted the tender of Willans & Robinson (represented by Mr. T. K. Steanes) for a mixed-pressure turbine and G.E.C. 1,000 kw. generator.

The North British Rubber Co. have recently secured a further order for ebonite for the Admiralty.

Cleethorpes Council have placed an order with the Western Electric Co. for the supply and laying of vulcanised bitumen distributor and feeder cables, at £3,391, and with Ferranti Limited for meters, at £130.

Commonwealth Contracts.—The Postmaster-General's Department in New South Wales has accepted the tenders of R. Johnson, Clapham & Morris for 87 tons g.i. wire, at £11. 5s. per ton, and Thornton & Watson for wooden spindles, at 11s. per 100.

The Postmaster-General's Department in *Queensland* have accepted the tenders of W. T. Henley's Telegraph Works Co. for 1,760 yds. cable, at £112, 3,630 yds. at £172, 3,630 yds. at £224, 7,920 yds. at £276, and 1,540 yds. at £390 per mile; and the Western Electric Co. for 5,280 yds. cable at £462 per mile, 220 yds. at £525, 3,600 yds. at £634, and 1,800 yds. at £795 per mile.

BUSINESS NOTICES.

Mr. C. H. F. Muller, maker of X-Ray tubes, &c., is removing to 67, Red Lion-street, High Holborn, W.C. Telegraphic address "Florenzius London."

Mr. Wm. Scott Taggart, M.I.Mech.E., has taken an office at 22, Bridge-street, Manchester, where he will practice as a consulting engineer in general engineering and textile work.

The telephone No. of Mr. A. A. Campbell Swinton is now "Victoria 1506."

Wm. H. Gatley and J. Morehouse, electrical engineers and contractors, Water-street, Todmorden, have dissolved partnership. Debts by Mr. Gatley.

Manufacturers and Wiring Work.—Messrs. Johnson & Phillips announce that, owing to representations which have been made to them by some of their contractor friends, they have decided not to tender or accept orders for ordinary wiring work. Should any work of this nature be included in any orders they may receive for complete plant and cable installations, they propose, where possible, to sub-let and distribute the work among their contractor customers.

Plant for Sale.—Tenders are invited for the purchase and removal from the G.P.O., London, E.C., of some electric power plant which is being disposed of in consequence of the centralisation of the P.O. electric power supply. Specifications and forms of tender from the Controller of Stores, 17-19, Bedford-street, W.C. Tenders will be received up till 10 a.m. Oct. 31. See also an advertisement.

Mr. F. Lake, 132, Upper Thames-street, London, E.C., advertises for sale electrical sundries, cables, lamps, instruments, &c.

Agency.—A German firm of accumulator manufacturers advertises for a London firm with a connection among motor-car makers, &c., to take over the sole agency of their portable accumulators.

Business for Sale.—The business of an electric motor manufacturing company is advertised for sale in another column.

Patent Development.—The proprietor of patent No. 2,181/1905 for "Improvements relating to electric measuring instruments," desires to make arrangements for exploiting same in this country Applications to Messrs. Haseltine, Lake & Co., patent agents, 7 and 8, Southampton Buildings, Chancery-lane, London, W.C.

BANKRUPTCIES, LIQUIDATIONS, &c.

Wm. F. Flint, electrical engineer, 53, Jameson-street, Hull, has been adjudicated bankrupt. First meeting of creditors Oct. 5 at the O.R.'s, York City Bank Chambers, Lowgate, Hull, and public examination on Nov. 13 at the Court House, Hull.

A meeting of creditors of the Reno Electric Stairways & Conveyors (Ltd.) (in vol. liq.) will be held at the offices of T. F. Thorne, Lancaster, Farey & Co., 1, Basinghall-street, London, E.C., on Oct. 9.

Claims against the Howe Electrical Engineering Co. (Ltd.) to Mr. A. Thraves, 7, Victoria-street, Liverpool, by Oct. 11.

COMPANIES' MEETINGS AND REPORTS.

CLEVELAND & DURHAM ELECTRIC POWER (LTD.)—At the meeting on Tuesday Mr. Jas. Falconer, M.P., said the result of the past year's working was a gross profit of £20,973, compared with £12,942 in 1909-10. Contracts had been made with consumers this year amounting to 4,177 H.P. At the beginning of the year they had contracts amounting to 36,283 H.P., but now they amounted to 40,460 H.P. In addition, although the works to be supplied had not been completed, they had secured further contract for 12,500 H.P. Those figures showed a steady and satisfactory progress of the business, but they had been hindered considerably through the trade disputes of the past year. A satisfactory feature of the year's working was the fact that they had been able to secure arrangements for operating four additional waste heat stations, thus increasing the supply of electricity and affecting economies.

DICK, KERR & CO. (LTD.)—At the meeting of this company yesterday (Thursday), the chairman (Mr. John Kerr) in moving the adoption of the report and accounts (abstracted in our last issue), said that keen competition for orders had continued in all departments. The development of electric power in ironworks and the textile trades and in many other industries showed some progress. If this country did once lag behind Germany and America in the adoption of electricity it might fairly now be said that the greatest interest had been awakened. A considerable amount of plant had been ordered and quite a number of important installations were under consideration. At the company's Preston Works the highest grade of machinery could be turned out in an economical manner, by reason of good labour and the best modern equipment. Competition for business was acute enough between the home manufacturers, but it was increased by their market being an open one to Continental and American works. To any one who knew anything of manufacturing, the question of cost was largely one of output. To the working man, steady employment was better than intermittent work, even if the nominal wages were slightly higher per week. Work and plenty of it was equally essential to employer and employé. The directors were pleased to state that their efforts in the direction of the manufacture of steam turbines were meeting with satisfactory results. There could be no question but that development was on the right lines. In view of the enormous demand for metal filament lamps and the fact that the bulk of the lamps used of that class were of foreign manufacture, the directors, after careful investigation, decided to add a lamp factory. To avoid the danger of experimental work they had availed themselves of the experience of a Continental company. Their factory was now rapidly approaching completion and would very soon be in a position to turn out lamps second to none in the market. The prospects for the coming year were encouraging. As soon as international difficulties were settled, an amount of foreign work that was held in suspense would be proceeded with. Although they had been practically free from labour difficulties, there could be no doubt that strikes and threatened strikes all militated against business, by delaying work or causing postponement of orders. It was to be hoped that the Government would deal in no uncertain manner with "peaceful picketing," as the scenes that had recently taken place were a disgrace to the country and a source of public danger. Means could surely be found to deal with that clamant evil without inflicting any injury to the just rights of trade unions. The balance-sheet represented a rather uneventful year, although he was glad to say the result showed an improvement on the two previous years. The increase of £32,753 on capital expenditure was represented by the expenditure on the turbine business, the lamp factory and some additional plant at the Kilmarnock works. Debenture stock had been redeemed to the extent of £9,000. Since the issue of the debenture stock £46,570 has been paid off and a reserve fund of £150,000 created. It had always been the policy of the directors to strengthen the position of the debenture and preference shareholders. The contingent liability as co-obligants with the Edinburgh & District Tramways Co. in their liability to Edinburgh Corporation, under the lease of the tramways, would continue for about nine years. There need be no anxiety under that head, as the tramways were a remunerative undertaking of a first-class character. The company had

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experienced, like other concerns, the greatest depreciation in the securities recognised as gilt-edged, but that had been allowed for in adjusting the total valuation. The re-arrangement of the staff necessitated by the lamentable death of Mr. Geo. Flett last year had been carried out and Mr. Schultz had been appointed assistant managing director. There was a desire by the staff and directors to commemorate Mr. Flett's memory in a suitable manner; the money subscribed by them, in conjunction with a handsome donation by his daughter and one hundred guineas by the Company, had been the means of endowing a bed in the London Hospital.

Mr. T. HACKING asked whether it was not desirable that the amount at which the goodwill stood should be shown in the balance-sheet.

The CHAIRMAN said the question of putting the goodwill item in the accounts would have the directors' consideration. He did not think, however, there was any company where the directors had taken more care to guard the company than they had.

The report and accounts were adopted and the dividends approved, and, after certain routine business, a vote of thanks to the chairman, directors and staff closed the proceedings.

LLANELLY & DISTRICT ELECTRIC LIGHTING & TRACTION CO. (LTD.) At the meeting on Monday Mr. A. R. Holland referred to the improved prospects of the company, and attributed that to the skill and ability shown by the contractors and managers, Messrs. Balfour, Beatty & Co. The whole of the streets of Llanelly were lighted electrically. They had secured a large number of private consumers for both lighting and power, in addition to the supply of street lighting, and the directors thought it their duty to consider the extension of the present plant. The construction of the tramways was commenced in February last, and two-thirds of the system was carrying passengers by June 16, the remaining third being opened for traffic a few weeks later.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES & CHARGES, &c.

NEW COMPANIES.

H. DAKIN & CO. (LTD.) (117,703.)—Reg. Sept. 19, capital £10,000 in £1 shares, to take over the business of builders and contractors, electrical and gas engineers carried on as H. Dakin & Co. Private company. First directors, H. I. Dakin (chairman) and F. W. H. Dakin. Reg. office, 200, Upper Richmond-road, London, S.W.

GLAIS ELECTRICAL CO. (LTD.) (117,744.)—Reg. Sept. 21, capital £2,000 in £10 shares, to take over the electric light undertaking carried on by E. Lewis at Glais, Clydach, Glam. Private company. First directors, E. Lewis, E. Bevan and W. Bowen.

INDUSTRIAL PLANT CO. (LTD.) (117,763.)—Reg. Sept. 22, capital £40,000 in £1 shares, to carry on the business of manufacturers of machinery, apparatus, appliances, cables and all kinds of plant for use in connection with the generation and supply of electricity, &c. First directors, F. S. Newall and R. P. Sloan.

LEITNER ELECTRICAL CO. (LTD.) (117,708.)—Reg. Sept. 19, capital £27,500 in £1 shares, to acquire from H. Leitner a licence to work the patents relating to inventions for the automatic electrical lighting of trains, motor cars and boats, &c. Private company. First directors are Right Hon. Viscount Templetown, E. T. Sturdy and Capt. J. D. Walker. Reg. office, 7, Prince's-street, Westminster, S.W.

MUNICIPAL TRAMWAYS ASSOCIATION, INCORPORATED. (The word "Limited" is omitted from title by licence of Board of Trade). (117,780.)—Reg. with 300 members, each liable for £1 in the event of winding up, to promote, encourage and facilitate the construction, extension, working and interests of tramways, light railways, railless traction and motor omnibuses, and similar works and vehicles owned and worked by municipal corporations or other local authorities, and in particular of electric steam and other modes of mechanical traction, and with a view to bring together officials and others interested therein. The subscribers are:—J. Dalrymple, Glasgow; H. E. Blain, West Ham; C. J. Spencer, Bradford; A. L. C. Fell, L.C.C. tramways; J. Aldworth, Nottingham; H. Linsley, J.P., Salford; and A. R. Fearnley, Sheffield. The management is vested in a Council, the first members of which are:—J. Dalrymple, H. E. Blain, C. J. Spencer, A. L. C. Fell, J. Aldworth, H. Linsley, J.P., A. R. Fearnley, A. Baker, Birmingham; P. Fisher, Dundee; S. Flint, Leicester; J. B. Hamilton, Leeds; J. M. McElroy, Manchester; H. Morley, Burnley; W. F. Russell, Glasgow; L. W. Slattery, Traffic manager, L.C.C. tramways; and E. R. Pickmere, Town Clerk, Liverpool.

STATUTORY RETURNS.

CHESHAM ELECTRIC LIGHT & POWER CO. (LTD.)—Return to July 14 gives capital £25,000 in £1 shares. 15,007 shares taken up. £1 per share called up on 7. £7 paid, and £15,000 considered as paid on 15,000 shares. Mortgages and charges, £8,200.

CHILI TELEPHONE CO. (LTD.)—In return to Aug. 3 capital is £360,000 in £5 shares. 66,000 shares taken up. £5 per share called up on 44,000. £220,000 paid. £110,000 considered as paid on 22,000 shares. Mortgages and charges, nil.

CROMPTON & CO. (LTD.)—According to return to Aug. 14 capital is £300,000 in £3 shares. 85,000 shares taken up. £3 per share called up on 83,600. £249,000 paid. £6,000 considered as paid on 2,000 shares. Mortgages and charges, £175,000.

ECUADOR TELEPHONE CO. (LTD.)—According to return to Aug. 3 capital is £100,000 in £5 shares. 5,000 shares taken up. £25,000 paid. Mortgages and charges, nil.

ELECTRIC & GENERAL INVESTMENT CO. (LTD.)—In return to Aug. 10 capital is £200,000 in £5 shares (20,000 ordinary, 100 founders' and 19,900 preference). All shares taken up. £1 per share called up and paid on ordinary and £5 per share on the founders' and preference. Mortgages and charges at date of return, £10,000, since issued £22,500. Capital increased to £201,500 by the creation of 30,000 deferred shares of 1s. each, on Aug. 18, 1911. Return of allotments made up to Aug. 18 shows whole of deferred shares allotted for cash.

ELECTRIC CONSTRUCTION CO. (LTD.)—Return to Aug. 3 gives capital as £400,000 in £2 shares (50,000 preference). 112,100 ordinary and 31,390 preference shares taken up. £2 per share called up on 2,100 ordinary and 18,245 preference. £40,690 paid. £246,290 considered as paid on 110,000 ordinary and 13,145 preference. Mortgages and charges, £182,700.

MORTGAGES AND CHARGES.

INGLEBY & CO. (LTD.)—Particulars of £2,000 debentures, created Sept. 13, has been filed, the whole amount being now issued. Property charged: company's undertaking and property, present and future, including uncalled capital. No trustees.

"Z" ELECTRIC LAMP MFG. CO. (LTD.)—Particulars of £10,000 second debentures, created July 17 have been filed, amount of present issue being £4,700. Property charged: company's undertaking and property, present and future, including uncalled capital, but excluding certain patent rights, subject to £25,000 first mortgage debentures. No trustees.

CITY NOTES.

MEMORANDA (Sept. 28).—**Bank rate 4 per cent.** (since Sept. 21, 1911.) Price of silver, 24¼d. per oz. Consols 77¼—77½ for money and for account. Consols Pay Day, Oct. 5; Stock and Shares Continuation Days, Oct. 10 and 25; Ticket Days, Oct. 11 and 26; Pay Days, Oct. 12 and 27; Mining Shares Carry Over Days, Oct. 9 and 24.

PRICES OF METALS (London).—*Copper*, cash, 54⅞; three months, 55⅜. *Lead*, English, 15⅛—15⅜; Foreign, 14⅞—15. *Spelter*, 27¼—27⅜. *Tin*, English, 182—183; Foreign, cash, 176; three months, 173. *Iron*, Cleveland, cash, 46/4½, three months, 47/2½.

COMPAGNIE GENERALE AUXILAIRE D'ENTERPRISES ELECTRIQUES.—This Russo-Belgian company shows for the past year a gross profit of 2,571,519 fr. A dividend of 25 fr. per share will be paid on the preference and 3½ fr. on the ordinary shares.

COUNTY OF DURHAM ELECTRICAL POWER DISTRIBUTION CO. (LTD.)—A circular has been issued to the shareholders stating that, while the profits for the first six months of the current year, as shown by the revised sheets, are slightly better than those for the same period last of year, the directors, in view of the disturbed position of the labour world and the possible dislocation of local trades which may follow therefrom, do not think it advisable that an interim dividend on the preference shares should be paid.

DIRECT SPANISH TELEGRAPH CO. (LTD.)—The directors have decided to pay, in addition to the dividend at the rate of 10 per cent. per annum on the preference shares, an interim dividend at the rate of 4 per cent. per annum (tax free) on the ordinary shares, both for the half-year ended 30th June, payable 2nd prox.

EASTERN TELEGRAPH CO. (LTD.)—The company announce the payment on Oct. 16 next of dividend at the rate of 3½ per cent. per annum (less tax) on the preference stock for the quarter ending Sept. 30, and the second quarterly interim dividend of 1¼ per cent. on the ordinary stock (tax free) in respect of profits for the year ending Dec. 31, 1911. The transfer books of the ordinary stock will be closed from Oct. 7 to 14, both days inclusive.

The company also announce the payment by warrants on Nov. 1 of interest for the half year ending Oct. 31 on their 4 per cent. mortgage debenture stock. The transfer books of the debenture stock will be closed from the 27th to 31st prox. inclusive.

EASTERN EXTENSION, AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.)—The directors have declared an interim dividend for the quarter ended June 30 last of 2s. 6d. per share (tax free), payable Oct. 14. The share register will be closed from 6th to 13th prox. inclusive.

EASTERN & SOUTH AFRICAN TELEGRAPH CO. (LTD.)—The company announce the payment by warrants on Nov. 1 of interest for the half year ending Oct. 31 on their 4 per cent. Mauritius subsidy debentures. The transfer books will be closed from Oct. 27 to 31 inclusive.

ELECTRIC SUPPLY CO. OF VICTORIA.—This company's tramway and lighting receipts for June were £5,903.

KALGOORLIE ELECTRIC POWER & LIGHTING CORPN. (LTD.)—The directors have declared a dividend on the preference shares at the rate of 6 per cent. per annum for the six months ending 30th inst.

MEXICO LIGHT & POWER CO. (LTD.)—The directors have declared a dividend for the six months ending 31st prox. of 1 per cent. on the ordinary shares.

MEXICO TRAMWAYS CO. (LTD.)—The directors have declared a dividend of 1¾ per cent. for the quarter ending 30th inst.

REUTER'S TELEGRAM CO. (LTD.)—The directors have declared an interim dividend of 4s. per share, being at the rate of 5 per cent. per annum (tax free) for the half-year ended June 30.

RIO DE JANEIRO TRAMWAY, LIGHT & POWER CO. (LTD.)—The earnings of this company in August were £236,270 (increase £33,071). Aggregate from Jan. 1., £1,726,760 (increase £277,922).

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ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
erdeen Corporation	Sept. 20	1,535	+ 59	16	26,435	+ 1,659
drie	,, 15	241	+ 2	37	8,078	+ 51
gio-Argentine	,, 23	47,724	+ 1,452	38	1,851,122	+ 171,730
pton-under-Lyne	..	..	..	..	..	..
Corporation	,, 23	633	+ 349	19	8,179	+ .. 44
naisy	,, 15	196	+ 33	37	6,838	+ 474
row	,, 15	388	+ 107	37	11,465	+ 1,365
h Electric Trams, Ltd.	,, 20	870	— 56	38	32,740	+ 1,090
mingham Corporation	,, 23	9,014	+ 2,269	25	204,622	+ 34,657
mingham & Midland	,, 15	901	— 7	37	33,460	+ 1,944
ckpool & Fleetwood	,, 23	1,159	+ 144	..	..	..
ckburn Corporation	,, 20	1,160	+ 119	†26	30,921	+ 2,818
on Corporation	,, 24	2,395	+ 96	26	66,220	+ 4,659
bay	Aug. 25	2,819	+ 120	34	96,689	+ 5,947
rnemouth Corporation	Sept. 20	2,091	+ 126	25	49,596	— 1,202
lford Corporation	,, 23	5,480	+ 322	25	143,203	+ 11,534
hton Corporation	,, 24	1,137	+ 62	¶25	29,936	+ 2,107
tol Trams & Carriage	,, 22	6,523	+ 283	25	183,331	+ 19,290
ley Corporation	,, 23	1,365	+ 185	25	26,697	+ 3,472
on Corporation	,, 24	272	+ 20	25	7,592	+ 685
Corporation	..	..	..	..	..	..
rtta Tramways Co.	,, 23	R60,950	+ R6,090	12	R702,982	+ R57,770
orne-Redruth	,, 23	114	— 11	38	4,663	+ 11
ff Corporation	..	..	..	..	..	..
al London Railway	,, 23	4,705	— 983	12	52,023	— 11,270
am & Dist. Lt. Rys.	..	..	..	5	..	..
h South London Rly.	,, 24	3,205	+ 24	12	36,633	— 444
m Birmingham	,, 15	1,185	— 1,727	37	88,907	— 15,244
Electric Trams Co.	,, 21	504	+ 2	38	19,350	+ 603
on	,, 15	1,834	+ 109	24	45,789	+ 3,978
port & Dist. Trams	,, 15	564	+ 52	37	18,530	+ 2,751
Corporation	,, 23	289	+ 53	25	7,291	+ 1,160
& Lucan Railway	,, 22	170	+ 1	12	2,099	— 38
United	,, 22	5,532	+ 78	12	83,338	+ 10,493
-Stourbridge	,, 15	952	+ 68	37	31,955	+ 2,326
e Corporation	,, 20	1,211	— 3	¶18	22,337	— 289
dam Council	,, 23	1,099	— 16	25	27,987	+ 1,446
Corporation	..	..	..	..	..	..
ead & Dist. Trams	,, 15	1,085	+ 83	37	38,544	+ 2,206
w Corporation	,, 23	20,271	+ 1,842	§16	312,273	+ 20,903
Trams	,, 23	131	+ 12	38	4,745	+ 380
end-Northfleet	,, 15	243	+ 27	37	7,989	+ 269
Northern & City Rly.	,, 23	1,393	+ 23	12	16,217	+ 266
ck & Port Glasgow	,, 15	820	+ 120	37	27,055	+ 3,525
Corporation	,, 19	1,982	+ 139	†25	52,174	+ 5,737
ool Tramways	,, 15	324	+ 53	37	10,262	+ 902
s Elec. Trams Co.	,, 21	1,313	+ 54	12	17,595	+ 562
Cong	,, 23	$9,122	+ $617	..	..	..
nsfield Corpn.	..	..	..	..	..	..
rporation	,, 23	2,789	+ 171	25	71,951	+ 3,623
District Council	,, 23	531	— 18	26	14,276	+ 542
District Council	,, 20	139	— 6	25	3,412	+ 115
Corporation	,, 23	436	+ 26	25	12,457	+ 859
Thanet Co.	,, 23	1,162	+ 241	51	36,558	+ 2,655
	,, 15	126	+ 10	37	4,990	+ 374
y Corporation	..	..	..	..	..	..
minster & District	,, 15	144	+ 23	37	4,554	+ 331
ock Corporation	,, 23	161	+ 18	19	3,330	+ 329
dy Corpn.	,, 20	300	+ 30	..	..	..
shire Trams Co.	,, 21	1,567	+ 45	38	54,005	+ 1,001
ire United	,, 20	1,393	+ 35	38	51,771	+ 1,794
ston	,, 15	250	+ 37	37	6,811	+ 523
rporation	,, 23	7,525	+ 562	25	193,258	+ 13,803
Corporation	,, 23	2,584	+ 210	25	65,213	+ 5,497
rporation	,, 23	643	+ 26	‡19	13,335	+ 1,125
Corporation	,, 23	120	+ 1	25	3,334	+ 211
l Corporation	,, 16	11,773	+ 591	37	423,246	+ 12,097
l Overhead Rly.	,, 24	1,529	+ 136	12	18,576	+ 859
ao&ColwynBayRy.	,, 22	483	+ 55	§42	13,614	+ 487
County Council	,, 13	43,881	+ 2,154	‡16	1,065,859	+ 65,455
Elec. Ry. Co.	,, 23	12,635	+ 365	12	140,130	+ 1,780
United	,, 23	6,765	— 93	38	255,297	+ 10,751
ter Corporation	,, 23	294	+ 57	51	11,436	+ 1,042
Railway	,, 23	15,939	+ 843	25	412,981	+ 23,576
	,, 23	2,027	+ 17	12	21,765	— 1,743
	,, 15	230	— 5	37	7,807	+ 117
ltan Dist. Railway	,, 23	10,904	+ 340	12	126,157	+ 5,157
ltan Elec. Trams	,, 15	9,486	+ 1,426	37	328,012	+ 51,611
n	,, 15	361	+ 18	37	12,969	+ 1,145
rporation	..	..	..	..	..	..
son-Tyne Corp.	,, 23	4,162	+ 338	25	108,452	+ 7,907
(Mon.)	,, 23	678	+ 4	25	18,506	+ 931
pton Corporation	,, 22	554	+ 56	25	14,173	+ 1,357
Ashton & Hyde	,, 15	598	+ 22	37	21,352	+ 799
rporation	,, 24	1,857	+ 99	26	51,062	+ 2,073
B.) Corporation	,, 20	181	— 1	18	3,625	+ 237
A.) Elec. Trams	,, 22	1,577	+ 316	38	60,924	+ 13,912
ugh	,, 15	143	+ 28	37	4,820	+ 522
th Corporation	,, 23	2,247	+ 76	25	63,332	+ 6,122
	,, 15	1,937	+ 72	37	71,151	+ 6,751
orporation	,, 20	748	+ 27	25	20,188	+ 1,517
n Corporation	,, 21	684	+ 55	25	17,235	+ 1,533
	,, 15	318	— 9	37	9,109	+ 68
rporation	,, 25	5,019	+ 413	§25	125,452	+ 6,292
	..	..	..	..	..	..
orporation	,, 15	63	+ 4	37	2,000	+ 85
Trams	,, 21	6,357	+ 394	25	167,855	+ 11,285
ropolitan	,, 23	$10,327	..	..	..	..
ffs	,, 15	932	+ 45	37	32,841	+ 2,044
ton	,, 15	931	+ 23	37	33,440	+ 2,392
Corporation	,, 20	1,325	+ 186	25	32,723	+ 4,361
Tramways	..	..	..	..	..	..
Hyde,&c., Jt. Bd.	,, 15	346	+ 5	37	11,726	+ 516
Corporation	,, 23	710	+ 7	25	20,646	+ 1,802
District	,, 21	1,249	+ 200	25	35,022	+ 4,677
rams	..	..	..	..	..	..
orporation	,, 15	1,212	+ 76	..	42,706	+ 2,593
	..	..	..	..	..	..
and District	,, 15	47	+ 2		1,612	+ 36
rams Co.	,, 15	313	+ 6		10,625	+ 461
Corporation	,, 20	475	+ 71		6,742	+ 873
rporation	,, 25	1,031	+ 141	25	29,729	+ 4,612
Corporation	,, 23	564	+ 30	37	21,254	+ 884
Corporation	..	..	..	..	..	..
ser-Mare	,, 21	2,684	+ 147	25	69,547	+ 6,908
pton Co.	,, 15	361	+ 98	37	7,343	+ 985
pton Corpn.	,, 15	451	+ 27	37	16,569	+ 818
	,, 21	924	+ 29	25	25,464	+ 1,605
	,, 15	378	+ 64	37	11,215	+ 615
W.R. Trams	,, 15	118	+ 6	37	3,779	+ 181
Woollen District	,, 24	1,287	— 21	39	50,296	+ 2,614
	,, 15	1,062	+ 47	37	39,174	+ 2,846

Comparisons are with the corresponding period last year. * Partly electrical.
† Minus 3 days. ‡ Minus 2 days. § Plus 3 days. ¶ Plus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Nos. of Shs.	Last Dividend	NAME.	Price Wed., Sept 27	*Rate per cent. Yielded.	Dividend Due.	Business Week to Sept. 27 Highest.	Business Week to Sept. 27 Lowest.
		Electricity Supply.		£ s. d.			
10	5/0	Bournemouth & Poole Elec. Sup. Ord.	7¾—8¼	7 10 0	Mar, Sep	8¼	—
10	4/6	Lo. 4½ per Cent. Cum. Pref.	8¾—9¼	4 17 3	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Second Pref.	10 —10½	5 17 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101 —103	4 6 6	Jan, July	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	7⅛—8⅛	6 7 0	March	..	..
5	3/6	Do. 7 per Cent. Pref.	7¼—7⅝	4 11 9	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Deb. Stock	99 —102	3 19 6	June, Dec	..	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	3¾—4¼	5 0 0	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	4¼—5	4 12 3	Feb., Aug	4⅛	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	94 —98	4 3 3	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	100 —102	4 8 3	..	101⅛	..
5	2/3	Do. City Undertaking 4½% Cum. Pref.	3¾—4¼	5 10 6	Jan, July	..	..
5	2/0	†Chelsea Electric Supply Ord.	3¾—4¼	5 11 6	March	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	98 —100	4 11 0	June, Dec	..	..
10	6/0	City of London Electric Lighting Ord.	12 —12½	4 18 0	Feb, Aug	12¼	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11¾—12¼	4 18 0	Jan, July	..	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	119 —123	4 2 9	June, Dec	..	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	100 —103	4 8 6	Jan, July	102⅛	—
St.	5%	County of Durham Elec. P. D. 5% 1st Mort. Deb. Stk.	89½—91½	5 10 6	Jan, July	..	—
10	4/0	County of London Elec. Supply Ord.	7⅛—7¼	3 5 9	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	10¾—11¼	5 9 0	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Deb Stock (red.)	108 —110	4 2 6	Jan, July	..	..
St.	5%	Do. Second Deb. Stock	100⅛—103⅛	4 8 0	May, Nov	101⅛	..
..	..	Edmundson's Elec. Corp. Ord.	⅛—¼	..	Jan, July	..	..
5	..	Do. 6 per Cent. Cum. Pref.	2 —2½	..	May, Nov	..	..
St.	4⅜%	Do 4½ per cent. 1st Mort. Deb. (red.)	83 —86	5 6 6	July	85	—
5	4/0	Folkestone Electricity Supply Co. Ord.	4½—5	6 6 0	April, Oct	..	—
5	2/6	Do. 5 per Cent. Cum. Pref.	4½—5½	4 15 3	Mar, Sept	4⅛	—
St.	4½%	Do. 4½ 1st Deb. Stock (red)	95 —98	4 13 3	Feb, Aug	..	—
5	5/0	Hove Electric Lighting Ord.	6¼—7¼	6 4 0	April, Oct	..	—
St.	4½%	Isle of Wight E. L. & P. Co. Deb. Stk.	99 —101	4 19 0	..	..	—
5	4/0	Kensington & Knightsbridge Ord.	6½—7¼	6 18 6	Feb, Aug	..	—
5	6%	Do. 6 per Cent. 1st Pref.	5¾—6	5 0 0	Jan, July	..	—
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	91 —93	4 6 0	..	..	—
St.	4%	Kensington & Knstbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	96 —99	4 1 0	April, Oct	97⅛	—
St.	4½%	Kent Elec. Power Co. Irred Deb. Stk.	80 —84	5 10 0	Jan, July	..	—
3	1/2½	London Electric Supply Ord.	1¾—2	3 8 0	Mar, Sept	..	—
5	3/0	†Do. 6 per Cent. Pref.	4½—4¾	6 8 0	Mar, Sept	..	—
St.	4%	Do. 4 per Cent. 1st Mort. Deb	89 —92	4 8 0	Jan, July	..	—
5	2/0	Metropolitan Electric Sup. Ord.	3¾—4¼	5 14 3	April, Oct	..	—
5	2/3	Do. 4½ per Cent. Cum. Pref.	4¼—4½	4 17 0	Jan, July	4⅛	—
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	100 —105	4 8 0	June, Dec	..	—
St.	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	84½—87½	4 1 6	Jan, July	..	—
..	4½%	Midland Elec. Corp. for P.D. 4½ 1st Mort. Debs.	96½—98½	4 12 6	..	..	—
5	2/0	Newcastle Elec. Supply Ord. (1-50,000 & 57,010-137,500)	3¼—4	6 0 0	Feb, Aug	..	—
5	2/6	Do. 5 per Cent. non Cum. Pref.	4 —4¼	5 17 6	Feb, Aug	..	—
100	4½%	Do. 4½ per Cent. 1st Mort. Deb.	97 —99	4 12 0	Jan, July	..	—
100	5%	North Metro. Elec. Power Sup. 5 Morts.	101 —104	4 17 6	..	..	—
1	6%	Northampton Elec. Lt. & P. Ord.	1⅛—1⅛	4 11 6	Feb, Aug	..	—
1	5%	Do. 5% Pref.	1⅛—1⅛	4 6 0	Feb, Aug	..	—
St.	4%	Do. 4% Debs.	99 —101	3 19 0	June, Dec	..	—
10	6/0	Notting Hill Electric Ord.	..	5 17 6	March	..	—
5	3/0	†Oxford Electric Ord.	6 —5¾	5 9 6	March	..	—
St.	4%	Do. 4% Deb. Stk.	91 —94	4 5 1	..	..	—
5	5/0	St. James' & Pall Mall Elec. Ord.	8¾—9¼	5 11 0	Feb, Aug	8⅛	—
5	3/6	Do. 7 per Cent. Pref.	6¾—7¼	5 0 0	Feb, Aug	..	—
St.	3⅛%	Do. 3⅛ per Cent. Deb. Stock (red.)	85 —87	4 1 6	Jan, July	..	—
5	..	Smithfield Markets Electric Sup. Ord.	1⅛—1⅛	..	Feb.	..	—
5	4/0	South London Electric Supply Ord.	2¼—3	6 5 6	April	..	—
St.	5%	Do. 5% 1st Mort. Stock (red.)	98⅛—101⅛	5 0 6	..	..	—
1	0 8⅓	South Metrop'n Elec. Lt & Power 7% 1st Pref	1⅛—1⅛	6 5 0	Feb, Aug	1⅛	—
1	0/7½	Do. 6 per Cent. 2nd Pref.	⅛—¼	6 17 0	Feb, Aug	..	—
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	97 —100	4 11 6	April, Oct	..	—
5	1/3	Urban Electric Supply Ord.	¼—1	..	April, Oct	¼	—
5	1/3	Do. 5 per Cent. Cum. Pref.	2 —2½	11 2 3	April, Oct	..	—
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	87½—89½	5 1 9	April, Oct	..	—
5	5/0	Westminster Elec. Sup. Ord.	7⅛—8	6 15 6	Mar, Sept	..	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	4¼—5¼	4 10 0	Jan, July	—	..
		Electric Railways and Tramways.					
1	..	Bath Elec. Trams Pref. Ord.	¼—½	..	April	..	—
1	0/6	Do. 5 per Cent. Cum. Pref.	½—¾	8 0 0	Jan, July	..	—
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	79 —83	5 8 6	April, Oct	..	—
St.	4½%	B'ham & Midland Trams 4½ 1st Deb. Stock.	91 —93	4 17 9	Jan, July	91⅛	..
10	4%	Bristol Tramways & Carriage Ord.	5¾—6¼	6 13 6	Feb, Aug	—	—
10	4%	Do. Cum. Pref.	7¼—7½	5 4 6	..	..	—
St.	4%	Do. 4 per Cent. Debs.	100 —101	3 19 2	Feb, Aug	..	—
10	..	British Electric Traction Ord.	¼—⅜	..	June, Dec	..	—
10	..	Do. 6 per Cent. Cum. Pref.	3⅛—3½	..	Feb, Aug	..	—
St.	5%	Do. 5 per Cent. Perpetual Debs.	92 —95	5 7 6	April, Oct	92	—
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	74 —78	5 18 0	May, Nov	..	—
St.	3%	Central London Ordinary Stock	65 —67	4 9 6	Feb, Aug	65	—
St.	4%	Do. 4 per Cent. Pref. Stock	84 —86	4 12 0	Feb, Aug	—	—
..	6/4	Do. 4½% Pref. Scrip 75% pd	85 —88	..	..	..	—
St.	2%	Do. Deferred Stock	48 —50	4 0 0	Feb.	..	—
100	4%	Do. 4 per Cent. Debs.	102 —104	3 16 11	Jan, July	..	—
5	2/6	City of Birmingham Trams, 5% Cum. Pref.	4½—5½	5 0 0	April, Oct	—	—
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 11 9	April, Oct	—	—
St.	1⅛%	City & South London Rly. Con. Ord.	23⅛—29½	5 16 0	Feb, Aug	29½	28⅛
St.	5%	Do. 5 per cent. Perp. Pref. (1891)	103 —110	4 11 9	Feb, Aug	..	—
St.	5%	Do. (1896)	104 —106	4 16 0	Feb, Aug	102½	—
St.	5%	Do. (1901)	103 —105	4 17 0	Feb, Aug	..	—
St.	5%	Do. (1903)	102 —104	4 16 0	Feb, Aug	..	—
St.	4%	Do. 4 per Cent. Perpetual Debs.	102 —104	3 17 9	May, Nov	..	—
10	6/0	Dublin United Trams, 6 per Cent. Pref.	11 —12	5 4 0	Feb, Aug	..	—
10	12/0	Gateshead and District Trams Ord.	8¾—9¼	6 19 0	..	..	—
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	⅛—¼	..	Feb, Aug	..	—
5	..	Hastings & District Elec. Trams, 6% C. P.	..	..	Mar. Sept	..	—
St.	4½%	Do. 4½ Deb. Stock	76 —81	5 11 3	April, Oct	76½	—
10	..	Imperial Tramways Ord.	2½—3	..	Mar, Sept	..	—
10	..	‡Do. 6 per Cent. Pref.	4 —4½	..	Mar, Sept	..	—
St.	4½%	Do. 4½ per Cent. Debs.	72 —74	6 3 6	Jan, July	..	—
..	2/6	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	2½—3	4 11 0	Mar, Sept.	..	—
St.	4%	Do. 4 per Cent. Deb. Stock	77 —82	5 1 0	Jan, July	..	—
10	5/6	Lanarkshire Tramways	9¾—10½	5 15 0	Feb, Aug	..	—
St.	5%	Lancs Utd. Trams, 5% Prior Lien Deb. Stk.	79 —82	6 4 0	Jan, July	..	—
St.	4%	London Electric 4% Deb. St.	95 —98	4 2 6	—	96⅛	96⅛
St.	4%	Do. 4% Pref.	81 —83	4 16 0	..	80⅛	—
10	..	London United Trams, 5% Cum. Pref.	3 —3½	..	Jan, July	3⅛	—
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	72 —76	5 8 0	Jan, July	73⅛	72
St.	..	Mersey Con. Ord. Stock	6 —9	..	Feb, Aug	—	—
1	1/1½	Metropolitan Elec. Tramways Ord.	⅝—1⅛	6 0 0	..	..	—
1	..	Do. Deferred	⅝—¾	..	April	..	—
1	0/6	Do. 5 per Cent. Cum. Pref.	¾—1	5 8 0	May, Aug	..	—
St.	4½%	Do. 4½ per Cent. Deb. Stock	99 —101	4 10 0	Jan, July	100⅛	—
St.	5%	Do. 5 per Cent. Db. Stk.	102 —104	4 17 0	—	103⅛	—

* No allowance has been made for accrued interest.
§ Ex Dividend. ‡ The London Stock Exchange

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Share	Last Dividend	Name	Price Wed., Sept. 27	*Rate per Cent. Yielded £ s. d.	Dividend Due	Business Week to Sept. 27 Highest	Lowest
		Electric Railways and Tramways—*Continued.*					
St.	2%	Metropolitan Railway Consolidated	42½—43	4 10 0	Feb, Aug	43	40½
St.	3%	Do. Surplus Lands Stocks	64—66	4 12 3	Feb, Aug	65	64
St.	3½%	Do. 3½ per Cent. Preference	86—83	3 19 6	Feb, Aug	86½	..
St.	3½%	Do. 3½ per Cent. "A" Preference	84—86	4 2 6	Feb, Aug	84½	–
St.	3½%	Do. 3½ per Cent. Convertible Pref.	84—86	4 2 0	Feb, Aug	85	..
St.	3½%	Do. 3½ per Cent. Debenture Stock	89—91	3 15 0	Jan, July	89⅞	..
St.	3½%	Do. 3½ per Cent. "A" Deb. Stock	89—91	3 17 0	Jan, July	89	–
St.	..	Metropolitan District Railway Ord.	25—25½	..	Feb, Aug	25½	23½
St.	4½%	Do. 4½% First Pref.	85—87	5 4 9	Feb, Aug	85½	65
St.	3½%	Do. Assented 1st Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	73—75	4 14 0	Feb, Aug	74½	73
St.	3%	Do. 3 per Cent. Consoltd. Rent-charge	75—77	3 17 0	Jan, July	77½	..
St.	4%	Do. 4 per Cent. Midland Rent-charge	102—104	3 17 9	Jan, July	..	–
St.	6%	Do. 6 per Cent. Perp. Deb. Stock	145—147	4 2 0	Jan, July	–	–
St.	4%	Do. 4 per Cent. Ditto	97—99	4 1 6	Jan, July	..	..
1	4½d.	Potteries Electric Traction Ord.	[illegible]	6 11 3	April, Oct	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	[illegible]	8 9 6	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	88—91	5 0 0	May, Nov	–	..
1	1/2⅖	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	[illegible]	10 2 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	73—78	5 6 0	Jan, July	75	..
100	5%	Sunderland Dist. Elec. Trms. 5% 1st Mt Db.	.	8 4 0	Jan, July	..	..
10	–	Underground Elec. Rys. Lon. Shares	1⅜—1⅝	..	..	–	..
–	4½%	Do. 4½% Bonds with coup. 8	98—100	4 11 0	–	99½	99
–	15/0	Do. 6% In. bds. with coup. 8	58—60	2 1 6	June, Dec	60	59⅞
–	4%	Do. 4 per Cent. 1st Power Ho. Dbs.	101—103	3 18 3	..	..	..
5	–	Yorkshire (W.R.) Elec. Trams. Ord.	¼—⅜	..	March	–	..
5	–	Do. 6 per Cent. Cum. Pref.	2⅜—2⅞	..	..	..	..
St.	4½	Do. 4½ per Cent. 1st Debs.	80—85	5 9 6	Jan, July	83	..
		Electric Manufacturing, &c.					
St.	4½%	Anchor Cable Co. 4½% Deb. Stock	99—101	4 10 0	–	..	–
1	1/2⅖	Aron Electricity Meter Ord.	[illegible]	..	..	–	–
1	0/7⅕	Do. 6% Cum. Pf.	[illegible]	7 10 0	April, Oct	..	..
1	3/2⅘	Babcock & Wilcox Ord.	5⅛—5⅞	4 14 0	April, Oct	5⅛	[illegible]
1	0/7½	Do. Pref.	1⅛—1¼	4 0 0	..	..	..
5	6/0	†British Insulated & Helsby Cables Ord.	6⅞—7⅛	6 18 0	July, Feb	6	..
5	3/0	Do. 6 per Cent. Pref.	5⅞—6⅛	5 0 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	102—104	4 7 0	Jan, July	..	..
St.	..	Do. 5% Mort. Deb. Stock	104—106	..	..	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	94—97	4 14 3	Mar, Sept	..	..
5	..	British Westinghouse 6 per Cent. Pref.	¼—½	..	Feb, Aug	–	–
100	6%	Do. 6 per Cent. Prior Lien Dbs. (rd.)	102—104	5 17 0	..	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	59—62	6 6 6	Jan, July	..	..
St.	4½%	Brush E. Eng. Co. 4½% Perp. 1st Deb. Stock	56—61	7 7 9	Mar, Sept	–	–
St.	4½%	Do. Perpetual 2nd Deb. Stock	39—44	10 10 0	Jan, July	..	..
5	10/0	Callender's Cable Con. Ord.	9—9½	8 2 0	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4 13/16—5 3/16	4 19 0	Jan, July	–	–
St.	4½%	Do. 4½ per Cent. 1st Mort Debs. (red.)	101—103	4 8 0	Nov, May	..	..
1	1/6	Castner-Kellner Alkali Co.	3½—3⅞	5 3 9	May, Nov	3⅛	3½
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103—107	4 5 9	Feb. Aug	105	..
1	1/0	Chadburn's (Ship) Telegraph Ord.	1 1/16—1 3/16	5 19 0	March	–	–
1	0/8⅖	Consolidated Electrical Co.	[illegible]	7 8 9	August	[illegible]	[illegible]
1	0/6	Consolidated Signal Co.	7/16—9/16	8 0 0	April, Oct	..	..
1	0/7½	Do. 6 per cent. Cum. Pref.	[illegible]	7 6 6	April, Oct	..	..
3	..	Crompton & Co (Nos. 1 to 85,000)	[illegible]	..	Jan, July	..	..
100	5%	Do. 5 per Cent. 1st Mort. Debs. (red.)	57½—67½	8 0 0	Jan, July	..	..
5	1/0	Dick, Kerr & Co. Ord.	[illegible]	5 14 0	Sept.	..	..
5	0/7½	Do. 6 per Cent. Cum. Pref.	[illegible]	5 13 0	Sept	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	95—98	4 13 3	Jan, July	[illegible]	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	[illegible]	..	Feb, Aug	..	..
	..	Do. (£5 paid)	1¾—2¼	..	Feb. Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (red.)	67—71	5 16 0	June, Dec	67	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	78—81	6 3 6	Mar, Sept	..	..
2	2½%	Electric Construction Co.	½—¾	6 6 0	Jan, July	..	..
2	2/9¼	Do. 7 per Cent. Cum. Pref.	[illegible]	7 8 6	July	..	..
St.	4%	Do. 4 per Cent. Perp. 1st Mort. Debs.	73—78	5 6 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	8½—9	5 14 0	June, Dec	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	88—93	4 8 6	Mar, Sept	5 1/16	4 11/16
5	5/0	Henley's Telegraph Works Ord.	12—12½	6 0 9	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	4 13/16—5 3/16	4 9 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	103½—105½	4 3 6	Mar, Sept	..	..
10	15/0	India Rubber, Gut. Per., &c., Works	13½—15½	..	Feb, Aug	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	9½—10½	4 19 0	..	..	..
100	4%	†Do. 4 per Cent. Debs. (red.)	93—95	4 4 3	April. Oct	..	..
1	..	National Elec. Construction Co.	¼	..	April	..	..
1	..	Richardsons, Westgarth & Co., Ltd. Ord.	[illegible]	..	Nov	..	..
1	..	Do. 6 per Cent. Cum. Pref.	[illegible]	..	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. Perp. Deb. Stock	74—77	5 16 0	Jan, July	..	..
5	..	Simplex Conduits 6 per Cent. Cum. Pref.	4½—5	..	..	..	..
12	12/0	Telegraph Construction & Maintenance	34½—36½	6 9 9	Mar, July	34½	..
100	4%	Do. 4 per Cent. Deb. Bonds (1909)	100—102	3 19 3	Jan, July	..	..
1	1/0	Vickers, Sons & Maxim, Ltd., Ord	1 15/16—2	5 1 0	..	2	[illegible]
1	0/6	Do. 5 per Cent. non-Cum. Preference	1 1/16—1 3/16	4 3 0	..	1½	–
St.	5%	Do. 5 per Cent. non-Cum. Preferred	107—111	4 11 6	..	109	..
St.	4%	Do. 4 per Cent. 1st Mort. Db. Sk. (red)	99—101	4 1 0	June, Dec	100½	100
100	4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.)	103—105	4 6 6	June, Dec	..	..
100	5%	Do. 5 per Cent. 3rd Mort. Debs Scrip	104—106	4 15 6	..	105½	104½
10	12%	J. G. White & Co. 6% Cum. Pref.	14½—15½	7 14 10	..	14½	–
1	..	Willans & Robinson Ord.	[illegible]	..	Apr, Oct	–	..
5	..	Do. 6 per Cent. Cum. Pref.	⅞—1	..	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	55—65	6 3 0	May, Nov	..	–
		Telegraphs.					
10	..	Amazon Telegraph	7½—7¾	–	June, Dec	..	..
100	5%	Do. 5 per Cent. Debs. (red.)	99—101	5 0 0	Jan, July	100½	–
St.	15/0	Anglo-American	67—69	4 8 6	F,My,Ag,N	..	..
St.	30/0	Do. Preferred	111—112	5 7 3	F,My,Ag,N	112½	111½
St.	30/0	Do. Deferred	24½—25½	5 19 6	F,My,Ag,N	25	24½
St.	4%	Commercial Cable 4 per Cent. Deb. Stk.	87½—89½	4 10 6	Jn,Ap,Jy,O	89	83½
10	6/0	Cuba Submarine Ord.	10½—11	5 13 0	Feb, Aug	–	..
10	10/0	Do. Preference 10 per Cent.	17½—18½	5 13 0	Feb, Aug	..	..
5	2/0	Direct Spanish Ord.	3½—4	5 0 0	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	8½—8⅞	5 12 9	April, Oct	–	..
50	4½%	Do. 4½ per Cent. Deb.	100—102	4 9 0	Jan, July	..	..
10	3/0	Direct United States Cable	7½—8½	6 3 0	Ja,Ap,Jy,O	8	7⅞
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	99½—101½	4 9 6	June, Dec	..	..
St.	25/0	Eastern Ordinary	137—140	5 1 0	Ja,My,Jy,O	139	137½
St.	17/6	Do. 3½ per Cent. Pref. Stock	84—86	4 2 6	Ja,My,Jy,O	85½	84
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (red.)	102½—104½	3 18 0	May, Nov	104	..
St	2/6	Eastern Extension	13½—14	5 2 0	Ja, Ap, Jy, O	13½	13½
10	4%	Do. 4 per Cent. Deb. Stock	100½—102½	3 19 0	Feb, Aug	..	..
25	4%	Eastern and S. Af., 4% Mauritius Sub. Debs	100—102	3 19 0	May, Nov	..	..
10	5/0	G.N. (of Copenhagen), with Coupon 83	30½—31½	5 16 0	Jan, July	33½	.
25	52/6	Indo-European	56½—58½	5 6 6	May, Nov	..	..
100	5%	†Mackay Companies Common	83—85	5 15 0	Ja,Ap,Jy,O	..	..
100	4%	†Do. Preference	74—76	5 4 3	Ja,Ap,Jy,O	..	..
1	1/0	Marconi's Wireless Teleg. Co.	2 3/16—2 5/16	..	April	[illegible]	[illegible]
1	2/9⅗	Do. 7% Partipg. Pref.	1½—2	..	..	..	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (red.)	99½—101½	3 19 9	June, Dec	..	–
2½	1/3	West Coast of America	1½—1¾	5 0 0	May	..	..
100	4%	Do. 4 per Cent. Debs.	98—100	4 1 0	Jan, July	..	..
10	1/6	West India & Panama	2½—3	4 7 0	May, Nov	2½	[illegible]
10	6/0	Do. 6 per Cent. 1st Pref.	10½—10¾	5 16 6	May, Nov	10½	10½
10	6/0	Do. 6% 2nd Pref.	9½—10½	6 0 0	May, Nov	..	–
100	5%	Do. 5 per Cent. Debs.	101—103	4 18 0	Jan, July	102½	..
10	3/0	Western Telegraph	13½—13¾	5 1 0	Mr,Jn,O,D	13½	13⅛
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	101—103	3 18 6	June, Dec	–	..
–	4%	Western Union Telegraph, $1,000 4% Bds	107—110	3 13 9	–	–	–
–	4½%	Do. $1,000 4½% Fdg. & Rl. Est. Gd. Bnds	101—104	4 8 0	–	–	–

Share	Last Dividend	Name	Price Wed., Sept. 27	*Rate per Cent. Yielded £ s. d.	Dividend Due
		Telephones.			
100	2$	Amer. Telephn. & Telegh. Cap. St.	137—139	5 19 0	–
..	4%	Do. Coll. Trust $1,000 4 per Cent. Bds	94—96	4 4 0	Jan, July
St.	4%	Do. 4% Cons. Bonds 1936	107—109	3 12 0	..
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101—103	4 18 0	Mar, Sept
5	4/0	Chili Telephone	6⅞—7⅛	4 5 9	August ..
1	0/7½	Monte Video Telephone Ord.	⅞—1	6 0 0	Nov ....
1	0/6	Do. 5 per Cent. Pref.	[illegible]	5 11 0	May, Nov
St.	6%	National Co. Pref. Stock	104—106	5 14 0	Feb, Aug
St.	6%	Do. Def. Stock	119—122	4 19 0	Feb, Aug
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	9⅞—10⅛	5 12 0	Feb, Aug
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	9½—10½	5 2 6	Feb, Aug
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.	5⅜—5⅝	4 12 0	Feb, Aug
St.	3½%	Do Deb. Stock 3½ per Cent. (red.)	99—101	3 10 0	June, Dec
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	99—101	4 0 0	Jan, July
..	4½%	New York Telephone Co. 30 yr. Bnds.	102½—103½	4 7 6	..
1	1/0	Oriental	1⅜—1⅝	5 2 0	April, Oct
1	0/7½	Do 6 per Cent. Cum. Pref.	1 1/16—1 3/16	4 16 0	April, Oct
St.	4%	Do. 4 per Cent. Red. Deb. Stock	88—90	4 10 0	Jan, July
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. (red.)	99—101	4 10 0	Jan, July
5	5/0	United River Plate Ord.	7⅛—7⅜	5 7 9	July ....
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅜—5⅝	4 13 0	June, Dec
St.	4½%	Do. 4½ Deb. St. Red.	103½—105½	4 6 0	Jan, July
		Financial, Investment, &c.			
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4—4½	7 1 0	Jan, July
10	6/0	Globe Telegraph & Trust	10½—11	5 7 0	Sp,DcMr,Ju
10	3/0	Do. 6 per Cent. Pref.	13—13½	4 10 9	Sp,DcMr,Ju
10	6%	Submarine Cables Trust (Cert.)	133—136	4 11 0	April, Oct
		Colonial and Foreign Electric Railways, Tramways, &c.			
5	2/9	Anglo-Argentine 5½% Cum. 1st Pref.	5—5½	5 4 9	April, Oct
5	2/9	Do. 5½% Cum. 2nd Pref.	4½—5	5 12 9	Jan, July
St.	4%	Do. 4% Deb. Stock	93½—95½	4 4 6	June, Dec
St.	4½%	Do. 4½% Deb. Stock	101—103	4 8 3	..
St.	5%	Do. 5% Deb' Stock	101—103	4 18 0	..
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)	102—105	4 16 6	Jan, July
5	4/0	Brisbane Electric Trams. Invest. Ord	6⅞—7⅜	5 16 3	May ....
5	2/6	Do. 5 per Cent. Cum. Pref.	5—5½	4 17 6	May, Nov
St.	4½%	Do. 4½ per Cent. Db. Prov. Certs.	102—105	4 7 0	Jan, July
St.	8%	British Columbia El. Rly. Df. Ord.	138—142	5 14 0	Mar, Sept
St.	6%	Do. Pref. Ord. Stock	119—123	4 19 0	May, Nov
St.	5%	Do. 5% Cum. Perp. Pref. Stock	107—110	4 11 9	Jan, July
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	100—103	4 7 6	April, Oct
100	4½%	Do. Vancouver Power Debs.	101—104	4 3 3	Jan, July
St.	4½%	†Do. 4½% Perp. Con. Deb. St.	101½—103½	4 3 0	..
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	99—101	4 19 6	Mar, Sept
St.	6%	Buenos Ayres Port & City Tram, 1st Mt. Deb. Stock	92—96	6 8 0	Feb, Aug
5	3/6	Calcutta Tramways (1 to 137,610)	5½—6½	4 19 6	Mar, Sept
100	2/6	Do. 5 per Cent. Cum. Pref.	5—5½	4 17 6	Jan, July
1	4½%	Do. 4½% 1st Deb. Stock (red)	102—105	4 5 9	Jan, July
St.	..	Cape Electric Tram Shares	[illegible]	..	..
5	1/3	City of Buenos Ayres Trams Co. (1904) Sh.	[illegible]	4 8 0	F,My,A,N
St.	4%	Do. 4 per Cent. Deb. Stock	95—98	4 3 0	June, Dec
..	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.	95—100	5 2 6	May, Nov
1	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	100—103	4 19 0	Feb, Aug
100	5%	Hong Kong Tramways Co. 5 per Cent. 1st Mort. Debs.	77—81	6 6 6	June, Dec
1	..	Kalgoorlie Elec. Trams Sh.	[illegible]	..	..
100	5%	Do. 5 per Cent. "A" Deb. Stock	92½—95½	5 4 6	Jan, July
5	6%	Do. 6 per Cent. "B" Ditto	63—67	8 15 0	Jan, July
5	0/6	Lisbon Elec. Trams. Ord.	1—1½	4 16 0	July ....
100	0/7½	Do. 6 per Cent. Cum. Pref.	1—1½	4 16 0	Jan, July
St.	5%	Do. 5 per Cent. Reg. Mort. Debs.	97—101	5 1 0	Jan, July
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	95—98	5 3 6	Jan, July
100	5%	Manaos Trams and Lt. Co. 5% Debs	90—92	5 13 0	..
..	5%	Manila Elec. Ry. $1,000 Gold Bonds	93—100	5 1 0	Feb, Aug
100	$1½	Mexico Trams Co. Com. St.	116—118	5 2 6	..
..	5%	Do. Gen. Con. 1st Mort. 5% Gold Bds.	96½—98½	5 1 6	–
St.	6%	Do. 6% 50 yr. Mort. Bds.	97—99	6 3 0	–
St.	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922) (Nos. 601 to 2,000)	100—102	4 9 0	Feb, Aug
St.	4½%	Do. do. (Nos. 1 to 4,600)	102—104	4 7 6	..
1	0/6	Perth Elec. Trams Ord.	[illegible]	2 10 0	May ....
St.	5%	Do. 1st Mt. Db. Stock	101½—103½	4 17 6	Jan, July
5	3/0	Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	5⅛—5⅜	5 8 0	–
St.	4½%	Do. 4½% 1st Mort. Deb. Stk.	98—101	4 10 6	–
100	$1½	Rio Janeiro Tram, Lt. & P. Co.	115½—116½	4 9 0	–
..	5%	Do. 30 yr. Gold Bnds.	101½—102½	4 18 3	–
100	5%	Do. 50 yr. Mt. Bnds	97½—98½	5 6 6	–
..	$2½	†Sao Paulo Tramway, Light & Power Co. $100 Stock	172—175	5 14 0	..
..	5%	Do. 5 per Cent. 1st Mt. $500 Db.	102½—104½	4 16 6	June, Dec
100	4½%	Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	97—99	4 11 9	Feb, Aug
		Colonial and Foreign Electricity Supply, &c.			
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	5½—5¾	5 11 6	Mar, Sept
St	..	Do. 5% Deb. Stk.	102½—104½	–	..
10	6/0	Bombay E.S. & T. 6% Cm. Pf.	10½—11½	5 9 0	..
St.	4½%	Do. 4½ per Cent. Deb. Stk. (red)	96½—98½	4 12 0	Jan, July
..	5%	Do. 5 per Cent. 2nd Mort. Deb. Stock	97—99	5 2 0	..
5	5/0	Calcutta Elec. Supply Ord.	6⅛—7⅛	5 19 6	April, Oct
5	2/6	Do. 5% Cum. Pref	5—5½	4 15 0	..
100	5%	Calgary Power Co. 5% 1st Mort. Bnds.	96—98	5 2 0	–
100	7/2½	Canadian Gen. Elec. Co. Com. St.	103—108	6 12 0	–
100	$3½	Do. 7% Cm. Pf. Stock	121—125	5 14 0	–
100	5%	Castner Electrolytic Alkali Co. (of U.S.A.) 1st Mort. Stl. Debs.	94—99	5 3 6	Jan, July
500	5%	Elect Development Co. of Ontario	85½—87½	5 15 0	..
St. 5	5%	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	84½—87½	5 4 0	Jan, July
10s	..	Indian Elec. Sup. & Trac. Co.	1—1½	..	..
1	..	Kalgoorlie Elec. Power & Ltg. Ord.	[illegible]	..	Mar, Nov
..	0/7½	Do. 6 per Cent. Cum. Pref.	[illegible]	8 6 6	April, Oct
5	5%	Kaministiquia Power Co. 5% Gold Bnds.	101½—103½	4 17 6	..
St.	..	Madras E. S. Corp. Ord.	2½—2¾	..	..
St.	3/6	Melbourne E. S. Co. Cons. Ord. St.	43—48	..	..
500	5%	Do. 5% 1st Mortg Deb. Stock	95—97	5 4 0	Jan, July
St.	5%	Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	85½—88½	5 14 0	Jan, July
St.	$1	Mexican Lt. & Power Co. Com. St.	85—87	4 13 0	Ja,Ap,Jy,O
500	$3½	Do. 7% Cum. Pref. St.	106½—108½	6 13 6	May, Nov
St	5%	Do 5% 1st Mort. Gold Bnds.	92½—94½	5 10 0	Feb, Aug
100	5%	Monterey Rly. L. & P. Co. 1st Mort. Db. Sk.	88—93	5 12 3	..
100	8/2½	Montreal Lt. Ht. & Power Co. Cap. St.	167—172	4 15 3	F,My,A,N
St.	5%	Northern Lt. Power & Coal 5% Gd. Bds	35—38	6 7 6	..
St.	£10	River Plate Electricity Co. Ord. Stk.	218—228	4 7 9	April
St.	6%	Do. 6 per Cent. non-Cum. Pref. Stk.	107—114	5 5 0	May
100	5%	Do. 5 per Cent. Deb. Stock	[illegible]—103½	4 17 6	Jan, July
..	$1½	Shawinigan Water & Power Co. Ca[illegible]	[illegible]	4 7 9	[illegible]
St.	5%	Do. 5 per Cent. Bds.	[illegible]	4 12 6	Jan, July
St.	4½%	Do. 4½ Per Con. Mt. Db. St[illegible]	[illegible]	[illegible]	[illegible]
–	4½%	Toronto Power Co. 4½% Deb[illegible]	[illegible]	[illegible]	[illegible]
–	11·85	Victoria Falls Power [illegible]	[illegible]	[illegible]	[illegible]

* No allowance has been made for accrued interest or redemption. † Ex Dividend ♦ [illegible]

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NOTES.

The Olympia Exhibition.

EXCEPTION has been taken by the International Trade Exhibitions (Ltd.), managers of the Electrical Exhibition at Olympia, to some remarks which appeared in THE ELECTRICIAN last week on the subject of the Exhibition generally and the methods adopted for making it popular in particular. We think the International Trade Exhibitions (Ltd.) are quite unnecessarily perturbed. In the remarks we felt it our duty to make we believe we were voicing the general view of exhibitors and visitors alike. Certainly our own opinion is that the first week of the Exhibition—that is to say, from Saturday, September 23rd, to Friday, September 29th, inclusive—was a most unsatisfactory slice out of the four weeks' display at Olympia. Our object in calling attention to this matter in our last issue was to awaken the management in general, and not merely the International Trade Exhibitions (Ltd.), to a sense of the necessity for waking things up, and Saturday, September 30th, seemed to show some result. Whether cause and effect are as we assume them to be or not is of little import. How any remarks of ours could have been taken to reflect upon the management in any improper way we are at an entire loss to understand. It is, we presume, the object of everyone concerned, either in the management of the Exhibition or as exhibitors, to make money, directly or indirectly.

WITH a view to attract the public we are told that the Executive Committee have spent more on advertising the present than was spent on the last Electrical Exhibition at Olympia, and that more editorial comment in the lay Press has been obtained; also that the smaller attendance is due to the fact that tickets have not been purchased and distributed so freely as on the previous occasion. Be this as it may, there is a strong feeling that something more must be done. In support of this statement we need only allude to the action of exhibitors, to which we referred last week, and from which the executive officials did not hold aloof. As to what line any further effort should take, this question can, of course, only be decided by those who know all the facts of the case.

Now, as to the popular side of the show, a further acquaintance with the Exhibition only confirms our views. The lay visitor, if he does come, does not know what to look for, and is liable to become uninterested for want of direction. Why should there not be free or 1d. daily leaflet programmes distributed at the door, giving times of demonstrations and saying briefly what there is to be seen of popular interest, and where it is? The purely technical exhibits, intended for the technical buyer, are excellent, and we believe that satisfactory financial results therefrom are being obtained. But that is not enough. At the present day it is much more important to educate the public to the advantages of electricity in the home, the shop, and the small workshop than to make it a little easier for the technical buyer to place an order. Every manufacturer already has his showroom, where he can probably give a better display for the technical man than at Olympia. The

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education of the public, on the other hand, is a more difficult matter and the reward all round immensely higher. The lighting load is quite small compared with that which is possible from other domestic applications, and it must not be forgotten that this load for power, heating and cooking would be accompanied by an immense demand for domestic appliances.

It is because we think thus that we have ventured to express our views in THE ELECTRICIAN. Whatever reflections we have made are, of course, intended to stir the management (and by the management we mean everyone connected with the conduct of the Exhibition) to a wider activity. There is so much to see at Olympia that we regard it as the duty of the Press, both lay and technical, to call attention to any and every omission calculated to minimise its popularity. We take the opportunity to tender to the lay Press our sincere thanks for their efforts to bring the main features of the Electrical Exhibition to the notice of the public. We hope that the management of the Exhibition (we repeat that we include all concerned in its conduct) will even yet see the importance of a larger popular attendance, and make things more attractive and easy for the lay visitor than hitherto. Our only desire in criticising what has been done and left undone is that the Exhibition shall be a thorough success. If technical journals are to be precluded from expressing their views upon the management and conduct of such important events as great public exhibitions, in which the said journals are intimately concerned, it seems to us that the chief duty of the technical Press is in peril—namely, the right of fair and reasonable criticism of public events. Even exhibition managers must not be supersensitive, or their occupation may also be imperilled.

Finally, we suggest that the Tuesday 2s. 6d. admission be abandoned, that in its place 6d. per person be the entrance fee on, say, Monday and Thursday, and that the old charge for tickets (3d. each, with a graduated reduction on quantities) be resumed. If, in addition, the demonstrations and popular exhibits were strengthened up, and attention drawn to them, we are sure that the lay visitor would be gratified and the Exhibition would benefit. The cooking demonstration given last Tuesday by the Brompton & Kensington Electricity Supply Co. is an example of what is desirable from an educational point of view, and we hope that such demonstrations will become frequent.

The Atlantic Cable Merger.

Full reports of the meetings of the proprietors of the Anglo-American and the Direct United States Companies will be found in this issue. The proceedings mark the most important phase of submarine cable finance since the formation of our great submarine telegraph undertakings in the early seventies, when an enterprise destined to become of immense importance to the world in general and to the British Empire in particular first took definite shape and comprehensive organisation. Events have moved rapidly since then, and we have witnessed many changes and many developments. These changes have not, however, very materially affected the Atlantic Companies, which have gone the even tenour of their successful way, due mainly to the arrangements which the far-sighted men who have presided over their destinies have engineered from time to time. There has been keen competition for traffic between the Companies having community of interests and the Companies outside the "pool," but this rivalry has, in the main, only resulted in increasing the volume of traffic, by which all parties concerned have benefited, especially the public. But times also have changed. The proceedings which we report elsewhere show that drastic modifications of the old working arrangements between the pooled Companies have become necessary, and these modifications have now been accepted by the members of the two British Companies chiefly concerned. The remarks of Mr. F. A. Bevan and Mr. E. M. Underdown will be read with varied feelings, and some regret may be felt that the operating control of the British cables is passing into American hands; this regret will, however, be tempered by the arrangements which have been made to safeguard the financial interests of the proprietors of these British cables, as well as by the fact that the Western Union Company have taken over the entire working staffs of the two Companies. The directors are to be congratulated upon the completion of their onerous labours, and we sincerely trust that the new position will operate to the advantage of the pioneers of the great enterprise of Atlantic telegraphy.

Small Supply Stations.

The County of Surrey will soon be noteworthy for the number of small Diesel engine power stations that are in operation within its borders. The most recent addition to these plants is that of the Egham & Staines Electricity Co., which, it is hoped, will be running in about two months' time. Although the undertaking is small, it possesses a few features of more than local interest. In the first place it is interesting to notice that the Board of Trade have for the first time—so far as we are aware—sanctioned the earthing of one pole of the supply on the consumer's premises. This admits, without employing a transformer with double winding, of the use of concentric wiring in which a metal sheath serves as the return conductor; and in view of the general desire to minimise the cost of wiring, it is an important step in this direction. One terminal at the consumer's end of the main fuse box is earthed to the case of the box, to which the armouring and lead of the service cable is also bonded; and a removable link allows the wiring to be disconnected when a continuity test is required. Again, the Board have approved of distributing mains run on the fronts of the houses, metal sheathed conductors being employed. By this method the cost of services is reduced and many extensions are possible which would otherwise be unremunerative.

Some supply undertakers are possibly not aware of the change in the law as to the erection of electricity supply stations made by the Electric Lighting Act, 1909. By clause 2 of that Act it is provided that it shall not be lawful for undertakers, except with the consent of the Board of Trade, to construct any generating station unless the construction is authorised and the land specified in a special

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Act or Provisional Order, and it is also provided that the Board of Trade shall not give their consent until notice has been given to the local authority of the district in which the land is situate, and to owners and lessees of land within 300 yards of the proposed generating station. Usually, when there are objections by owners of property in the district a local inquiry is held by the Board of Trade into the circumstances of the case. This condition as to the erection of electricity works is an innovation introduced by the 1909 Electric Lighting Act, and, although it may be equitable to give residents in a district an opportunity of making reasonable objections to the erection of a power station, yet the clause may hamper the development of electricity supply in urban and rural districts. At all events, the necessity for holding an inquiry at Egham has resulted in considerable delay in the construction of the station. The objection to the station in the present instance may possibly have been due to lack of knowledge of the type of station proposed, as with a Diesel engine station a chimney and dust and dirt are absent. It might also be stated that at Egham the station is situated next door to the local gas works, so that no reasonable objection can, therefore, be made to it on the ground of the depreciation of local property or detraction from the amenities of the district.

Electrification of the Mont Cenis Tunnel.—The electrification of this tunnel, which has been worked by ordinary steam locomotives since its opening in 1861, is now in progress. The section which will be so worked reaches from Modane in France through the tunnel itself to Bardonnecchia on the Italian side, a total distance of about 15 miles. Single-phase current at a pressure of 3,500 volts and a frequency of 15 will be employed, and the overhead work on the open-air sections at each end is well forward. The supply will be obtained from the municipal generating station at Chiomonte where a power of 3,500 kw. at 50,000 volts and a frequency of 50 is available. A transformer station is being erected at Bardonnecchia. Owing to a variety of causes the proper ventilation of this tunnel has always been a matter of some difficulty, a state of affairs which should be made much easier by the proposed alteration.

"The Necessity of Safer, Quicker and Cheaper Railways, and Some Proposals Therefor."—In a Paper on this subject, read by Mr. C. R. Enock before the Society of Engineers, the author discussed the possibility of evolving an altogether new type of railway, and brought forward a scheme for light overhead railways on which single electric vehicles travelling at high speeds, with special provision against derailment by employing additional horizontal wheels, were to be used. If such a type were found practicable the present great cost of railway construction would be lessened, as land on the right of way would not be rendered useless for agricultural purposes, and embankments, cuttings, bridges, tunnels, drainage, ballast, sleepers, telegraph poles, and other similar equipment would no longer be necessary. He urged that national experiments for the solution of these problems should be carried out on a specially equipped site, in order to give greater scope to inventors and to evolve improvements, of d suggested that enquiry might be made into the possibility ana combination of railway and aeroplane.

Cable Interruptions.	Date of Interruption.
Assab—Perim	July 8, 1909
Latakia—Palura	May 26, 1910
Kotonou—Grand Bassam	Aug. 23, 1911
Bathurst—Sierra Leone	Sept. 4, 1911
Bissao—Bolama	Sept. 26, 1911
Malta—Tripoli	Oct. 2, 1911

Nature of Light Action in Selenium.—A recent issue of the "Physical Review" contains an article on this subject by Mr. F. C. Brown. The conclusions reached by the author are as follows: (1) Llight produces two changes of opposite sign in the conductivity of all selenium sensitive to light. (2) The amount of the change is a function of the time of illumination, as well as of the intensity and character of the illumination. (3) The selenium in the Giltay cell shows the same two changes under the action of high P.D.s that it does under the action of light. (4) The character of the conductivity curves for the four known varieties of light-sensitive selenium can be explained by assuming the existence of three components in dynamic equilibrium, under given illumination, temperature, pressure and electrical P.D.'s. (5) The effect of any agency that affects the conductivity of selenium is of the nature that it alters the rates of interchange between the components. (6) The experimental results can be explained to a first order of approximation on the assumption that of the three components which are in equilibrium according to the reaction $A \rightleftarrows B \rightleftarrows C$ only the B kind is conducting. (7) If we accept the view here proposed, the failure of Ohm's law becomes only an apparent and not a real failure.

Electric Traction in Sweden.—In dealing with this subject, the "Manchester Guardian" mentions that the State authorities hope to have the line between Gellivare-Kiruna-Riksgränsens, a distance of about 130 km. (80 miles), completed by 1914, and if the hopes of its success prove justified the general electrification of the entire State system will doubtless follow quickly. A special board to investigate the question as to the best method of exploiting the water-power and an electrical power bureau were recently appointed, and these bodies are now dealing with the economic and technical problems which would be involved in the electrification of the stretch between Gôteberg and Alingas, a distance of 46 km. (28 miles). A large generating station is to be erected near Elfkarleby, 145km. (90 miles) from Stockholm, and the State authorities are pushing the matter forward as much as possible. About 40,000 H.P. will be generated here. Over a thousand men are at present engaged on the Gellivare-Riksgränsens line, the generating station for which is being built near Porjus. This line is really part of the projected Inland Railway, which will run from Oestersund to Gellivare, a distance of 900 km. (550 miles). The southern portion (Oestersund to Ström) is also in actual construction, this stretch being 110 km. long (70 miles). The water-power already secured by the State represents, according to conservative estimates, 750,000 H.P.

"The Mechanical Properties of Hard Drawn Copper."—At the annual autumn meeting of the Institute of Metals recently held at Newcastle, Mr. D. R. Pye read a Paper on this subject in which he deplored the lack of any satisfactory definition of standard hard drawn copper. Although the Post Office specification was highly satisfactory for the sizes of wire used in telephone and telegraph construction, it was quite unsuitable for larger sizes. The various definitions adopted from time to time were reviewed, and it was suggested that the one at present adopted by the Engineering Standards Committee, viz., "the term hard drawn copper wire shall apply to copper wire which does not elongate more than 4 per cent. on a gauge length of 10 in. when broken by tension," though not contradictory of the properties of hard drawn copper, was unsatisfactory, since a specification should preferably fix a *minimum* elongation as a safeguard against the wire becoming brittle. An important point was that tensile strength per square in. and elongation at fracture both depended on the diameter of the wire. Experiments were described confirming a suggestion made by Mr. A. P. Trotter that this tensile strength per square in. diminished with increase in diameter according to a linear law. It was also shown that the elongation at fracture for similarly manufactured wires depended very much on the diameter, being considerably greater for larger sizes of wire. In view of these experiments it was suggested that a satisfactory definition of hard drawn copper wire would fix a minimum tensile strength per square inch given by the formula $T = 30 - 20D$, and a minimum elongation per cent. at fracture given by the formula

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$e = 5D$, where D was the diameter in inches. This specification would hold good for all sizes up to 0·5 in. diameter. Finally, this suggested definition was compared with the specifications of the American Society for the Testing of Materials, and in an appendix was given the results of some recent experiments in America showing the effect of hard-drawing upon the electrical properties of copper.

Railway Electrification.—It is stated that the North Eastern Railway Company are considering the adoption of electric traction for their goods and mineral traffic on those sections of the track which are already electrified. In this connection we understand that Mr. V. L. Raven, chief mechanical engineer of the company, Mr. C. H. Merz, and other officials have recently left for the United States to investigate the question.

Electrically Worked "Stair Lift" on the Underground.—A new moving stairway, which connects the Earl's Court stations of the District Railway and Piccadilly tube, was opened to passengers yesterday. The vertical height which the staircase traverses is 40 ft., and the passengers first step on to a platform moving at 90 ft. per minute. This platform is level for some distance with a stationary platform alongside, but then it is formed into a series of steps, whose tread increases until a proper stairway is formed. This stairway moves upwards to the higher level, where the passenger steps off on to another stationary platform. Moving hand rails are provided at the side, and when the passenger arrives at the top there is no possibility of his remaining too long on the moving platform, for at a certain point a travelling belt on a level with his feet quietly and safely edges him off. In a similar way the journey can be made from the upper to the lower level, the trip in each case taking 160 seconds. Both "escalators" are driven by a motor through chain gearing. It is claimed for this arrangement that it has a greater traffic capacity than the ordinary lifts, owing to the elimination of waiting, and that it can deal with 10,800 passengers per hour, a number which would require five lifts working at full pressure.

Large Testing Outfit.—The "Electrical World" gives an account of a large portable testing outfit which has recently been put in commission by the Edison Electric Illuminating Co. of Boston. The apparatus consists of the following equipment: An 800 k.v.a. 2,200/30,000-volt transformer, an 850 k.v.a. 2,200-volt reactance and a 100 kw. four-bearing motor-generator set, consisting of a 100 kw., 1,200-2,200 volt generator, a 100 H.P. 1,200-2,300/4,000-volt motor, and a 125-volt exciter mounted on a wooden base and connected together by a flexible coupling, together with a starting compensator and two field rheostats. Other apparatus consists of two motor-driven blower sets, two 2,200-220 volt transformers, 12 lifting jacks, ammeters, voltmeters, portable current and potential transformers, and a frequency meter. The weight of this outfit is about 10 or 11 tons. As it is too heavy to go on one vehicle, it was decided to erect it on two 5-ton electric trucks, with battery equipment sufficient to make the run from a central point to any of the Company's stations at a reasonable speed in any sort of weather. The motor-generator set is installed on one of the cars and the rest of the apparatus on the other. Each truck will have a clear loading space 6 ft. wide, 15 ft. long and 6 ft. high. The weight without battery and load will be 7,500 lb., the weight of the battery, which is of the 60-cell Edison type, being about 2,400 lb. The rated speed of the car, on a hard, level, asphalt road, will be 7 miles per hour, and the estimated mileage on one charge on the same sort of road, is 30 miles. The outfit is intended to have sufficient capacity to test 5 miles of underground cable consisting of 34/0 conductors, lead-sheathed cable, built for 15,000 volts working pressure.

Electrically Operated Pumping Stations.—According to "Engineering News" four sewage pumping stations have been installed at Grand Rapids, Mich., to handle the entire sewage of that city during the times the Grand River, into which all the sewers empty, is in flood. The normal flow of the river is such that it can be forded at any place, but during flood periods, which generally occur in the spring, the river rises 15 to 20 ft. in a few hours. The small drop between Grand Rapids and the lake allows this water to back up and flow into the sewers, thus causing serious damage in the basements in the low section of the city. To prevent the constant recurrence of this damage the river has been dredged and enclosed between concrete walls 20 ft. in height. The water is prevented from entering the sewer outlets by special valves. During the normal flow periods the sewage is discharged into the river as before, but at flood periods the sewage is discharged into a sump pit, from which it is pumped over the wall by centrifugal pumps. Four pumping stations are required for the four sewer outlets. One station is equipped with two 18 in. centrifugal pumps operating under a normal head of 3·1 ft. with a capacity of 12,000 gals. per min., driven by 30 H.P. electric motors direct connected. Two stations are each equipped with two 24 in. and one 12 in. centrifugal pumps, with a capacity of 17,000 gals. per min., driven by 60 H.P. motors direct connected. The fourth station, which is at the terminus of the east side main sewer, has four 40 in. centrifugal pumps operating under a normal head of 6·7 ft. with a capacity of 47,000 gals. per min. These pumps are driven by 175 H.P. motors direct connected. Each station is also equipped with a priming pump belted to their driving motors. The power is supplied by the Grand Rapids Muskegon Power Co. No attendance is needed at the stations except during flood stages of the river, when an attendant goes to the station, closes the main line switch and also the valve on the sewer outlet. The sewage then flows through a by-pass into the sump pit. When the water reaches a fixed level the operator starts the pumps and runs them as long as is necessary.

Electric Traction in Vienna.—The report on the working of these tramways for the year 1910, as published in our Austrian contemporaries, shows that 271,584,931 passengers were carried, as compared with 267,449,171 passengers in the year 1909. This represents an increase of 1·5 per cent., as compared with 9·1 per cent. for the preceding year. The unfavourable result was due partly to an increase in fares and partly to poor weather. There were operated 49,822,147 car-miles, an increase of 5·84 per cent. The gross earnings were £1,713,066, an increase of 13·9 per cent. On the electrically operated lines of the system the operating expenses, exclusive of "welfare" work, constituted 60·9 per cent. of the gross earnings, as compared with 61·1 per cent. in 1909. The average earnings were 7·7d. per car-mile, an increase of 7·6 per cent. The average receipts per passenger were 1·61d., compared with 1·45d. in 1909. The total mileage of the system, measured as single track, was 312 miles. The 9,786 employés of the company received £693,198 in 1910, an increase of 14·5 per cent. over the year before. This sum was equivalent to 40 per cent. of the gross earnings. In addition 6 per cent. of the gross earnings was set aside for employés' welfare purposes, such as pensions and sick benefits. The use of car meters has produced a steady decline in the current consumption per car-mile. In one case the clocks showed a difference of 68 per cent. in the efficiency of two motormen who were operating under the same speed conditions over a given route. In another test it was found that a good motorman maintained the schedule for 312 days with 33,200 current-minutes, whereas a poor motorman required 55,070 current-minutes. Premiums for current saving were awarded to the amount of £2,305 for a total of 6,433 cases. The improvement of the motormen is shown by the fact that 28 per cent. received premiums in 1910 as compared with 15 per cent. in 1909. The car-meters on the cars are supplemented by clocks which have been installed at 48 time points. These clocks have been found very effective in spurring the motormen on to maintain their schedules and reducing energy consumption, and in aiding statistical work such as mileage determinations. At the end of the fiscal year there were 1,201 motor cars and 1,348 trailers in service. The latest rolling stock, numbering 99 motor cars and 205 trailers, is of the vestibule type with separate passages for entrance and exit, as in the American prepayment cars. These cars

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have reduced the length of stops by some 25 per cent. The new motor cars use interpole motors which are large enough to haul two trailers. The running and braking resistance grids are placed under the seats for use as heaters.

urrent Topics.

Subjects of current interest dealt with in this issue include the following:—

Mr. J. Rezelman concludes his article on "The Determination of Synchronous and Asynchronous Reactance."

Mr. J. Härdén contributes an article entitled "Notes on Electric Furnaces."

We give an account of the proceedings at the annual conference of the Municipal Tramways Association last week. The Paper by Messrs. R. G. and J. G. Cunliffe on "Tramcar Meters" is referred to in our Leading Article, and a lengthy abstract will be found on another page of this issue.

A joint Committee of the Municipal Electrical Association and the Municipal Tramways Association has drawn up a report on "Charges for Electrical Energy Supplied for Traction Purposes from Combined Stations."

The foundation stone of a generating station to supply Egham and Staines was laid last Saturday by the Lord Mayor of London. This supply undertaking contains several features of interest.

We analyse the accounts for the year ended February 28, 1911, of the Melbourne Corporation electricity supply undertaking.

A further instalment is given of the Paper read by Mr. T. F. Wall before the British Association, entitled "The Single-phase Repulsion Motor."

We continue our account of the exhibits at the Olympia Electrical Exhibition.

A difference has arisen between Bermondsey Council and London County Council in regard to the granting of loans for electricity supply.

The deputation from Edinburgh Council who inspected the Leeds and Bradford rail-less traction system have now prepared their report on the subject.

Rotherham Council have received permission for a loan of about £2,000 for tramways.

Worthing Council have received sanction for a loan of £4,532 for extensions to station buildings and plant.

Barrow-in-Furness Corporation have decided to substitute electric for gas lighting in over 2 miles of thoroughfares, the number of electric lamps being 162.

PERSONAL NOTE.

Mr. F. W. Wilson is to hold the position of Government electrical inspector, Bombay, for a further term of four years, the extension of the period of service having been sanctioned by the Secretary of State.

APPOINTMENTS VACANT AND FILLED.

The Governing Body of the Northampton Polytechnic Institute, London, invite applications for a part-time appointment as day lecturer in mathematics in the engineering day courses. Salary £20 per session for eight hours' attendance per week. Further particulars, conditions with forms (which should be returned by 14th inst.) can be obtained from the principal, Dr. R. Mullineux Walmsley.

A meter inspector is required to repair, test and read slot and flat-rate meters, and to take charge of test room. See advertisement.

Mr. R. Lawson, formerly lecturer at Manchester Technical School, has been appointed instructor of telegraphy and telephony at the evening classes of East Ham Technical College.

Mr. A. Campbell, senior assistant superintendent, has been appointed by the Great Indian Peninsula Railway Co. as telegraph superintendent, in succession to the late Mr. J. E. Neale.

Mr. Fred Farrar has been appointed demonstrator and lecturer in electric wiring at Fleetwood technical school.

Mr. E. Meigh, M.Sc., has been appointed demonstrator in physics at the Battersea Polytechnic.

Mr. A. J. Maloney, A.R.C.Sc. (Dublin), has been appointed to the assistant lectureship in physics at St. Andrew's University.

INSTITUTIONS AND SOCIETIES.

International Congress of Applied Chemistry.—The eighth International Congress of Applied Chemistry will be held at Washington on September 4, 1912, and at New York from September 6 to 13, 1912. At the opening meeting the President of the United States, who is patron of the Congress, will welcome the delegates. The organising committee have already prepared notices calling on secretaries of Chambers of Commerce and of Educational Institutions in the United States to co-operate so as to give delegates opportunities of inspecting the commercial and educational facilities which are available in that country. Great interest is being taken in the affairs of the Congress by the United States Government, and it is therefore hoped that chemists all the world over will assist to make the gathering a success. All communications should be addressed to the secretary, Mr. B. C. Hesse, at 25, Broad-street, New York City.

Students' Section of the Institution of Electrical Engineers.—The honorary secretary desires to call the attention of such members of this section as wish to read Papers, to the fact that it is necessary for notice of their intention to be sent him *immediately* in order that an announcement may be embodied in the programme which is now being drawn up. Students intending to read Papers should therefore communicate with Mr. D. Betts, 3, Fordwych-road, London, N.W.

EDUCATIONAL NOTICES.

University of Durham.—Armstrong College, Newcastle-upon-Tyne.—Courses of instruction are provided in mechanical, marine, civil and electrical engineering, naval architecture, mining, metallurgy, agriculture, pure science, arts and letters. Particulars from the secretary, Mr. F. H. Pruen, M.A.

Scholarship Award.—In the competition for the entrance scholarship to the Faculty of Engineering at University College (of the value of 120 guineas) C. H. Avery (Southend Secondary School) and G. G. Dawson (Tollington School) were bracketed equal for the scholarship.

ARRANGEMENTS FOR THE WEEK.

SATURDAY, October 7th.

ASSOCIATION OF ENGINEERS-IN-CHARGE.

1:55 p.m. Leave Liverpool-street Station for Chelmsford. Visit to the Works of the Marconi Wireless Telegraph Co.

MONDAY, October 9th.

GRADUATES' ASSOCIATION OF THE INSTITUTION OF MECHANICAL ENGINEERS.

8 p.m. Meeting at Storey's Gate. Paper on "The Advantages of the Steam Turbine as compared with the Reciprocating Engine," by Mr. W. A. Hatch.

WEDNESDAY, October 11th.

ASSOCIATION OF ENGINEERS-IN-CHARGE.

8 p.m. Meeting at St. Bride's Institute, Bride-lane, Fleet-street, E.C. Presidential Address by Mr. W. H. Maw.

THURSDAY, October 12th.

BRITISH ELECTRICAL AND ALLIED MANUFACTURERS' ASSOCIATION.

2:30 p.m. Council Meeting at Olympia.

FRIDAY, October 13th.

JUNIOR INSTITUTION OF ENGINEERS.

6:30 p.m. Visit to the "Model Engineer" Small Power Engineering and Scientific Exhibition at the Royal Horticultural Hall, Vincent-square, Westminster.

THE LONDON ELECTRICAL ENGINEERS.

Officer Commanding, Col. H. M. Leaf.

The following orders have been issued:—

Drills for efficiency (1911-1912) will commence at Head-Quarters on Thursday, November 2, 1911, and Head-Quarters will be open as follows from that date: Daily (except Saturdays), 10 a.m. to 10 p.m.; Saturdays (unless otherwise ordered), 10 a.m. to 12 noon.

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MELBOURNE ELECTRIC SUPPLY ACCOUNTS.

The Report of the Electric Supply Committee of the City of Melbourne shows that, for the year ended February 28, 1911, the Corporation electric supply undertaking made a profit of £19,532, after paying capital charges, &c., and setting aside £20,766 for depreciation and renewals. It should be noted, however, that the contribution to the sinking fund was only at the rate of 1 per cent. on the capital. As an offset to this low rate of repayment, we notice that the Committee recommended the setting aside of a further sum of £5,000 for depreciation and renewals, whilst the "Town Fund" only benefited to the extent of £9,500.

The diagrams attached to the Report indicate considerable activity in electrical matters in Melbourne. Thus, the number of units sold for private lighting increased by 149,028, in spite of the growing use of metal filament lamps. Whilst the power sales increased by no less than 537,969 units. The total output for all purposes was 8,920,489 units, as follows:—Private lighting 3,803,091 units, power and heating 3,098,960 units, street lighting 1,736,695 units, municipal buildings 281,743 units.

In connection with the private lighting load it is interesting to notice that the Electricity Department provide free lamp renewals to consumers using carbon lamps. The growing use of metal filament lamps, however, has led the Committee to consider how far consumers using these lamps can be given an equivalent benefit. The main difficulty arises in the case of consumers who have installed both types of lamps; but the Committee hope to evolve a satisfactory scheme.

The total number of consumers connected to the mains was, on February 28 last, 3,758, 1,530 of these taking a supply for power and heating. The number of consumers added during the year was 546, as against 359 in the previous year. A considerable proportion of the new connections were for power and heating, 175 motors, representing 887 H.P., having been added, bringing the total number of motors connected to 1,616, and the total horse-power to 5,571. Of these motors, 394 have been installed by metal and wood workers, 317 by clothing and boot manufacturers, 271 by printers, and 189 for elevators and hoists. The return of the Government statist shows that at the end of 1909 the power employed by factories was as follows:—

Steam.		Gas.		Electricity.
1,192	.....	797	.....	802

Six years previously (that is in 1903) the respective figures were—

1,316	.....	724	.....	195

It is interesting to notice the smaller use made of steam, the practically stationary position of gas engines, and the development of the electric drive.

During the past year the question of making provision for the anticipated load of the winter of 1912 has been under consideration in regard to an extension of the plant. The relative merits of a battery erected on a central site in the city and additional generating plant at the power station have been discussed, the Council finally deciding in favour of the installation of a battery. The cost of this battery is estimated at £21,000.

Further points of interest in the Report are that increasing attention is being given to canvassing, with very satisfactory results; and that in future the electric supply accounts of the Corporation are to be made up to December 31 instead of the end of February, so that they may be brought into line with the General Accounts of the Corporation.

From our analysis of the Accounts below; it will be seen that there is little change to record in the cost per unit sold. All surplus steam from the city refuse destructor was, as in previous years, used at the power station. The Council have during the year entered into a contract with the State Mines Department for a supply of slack coal at 10s. 7d. per ton, as against 16s. 10d. paid under a previous contract with a company. The relative calorific value of the new fuel is from 80 to 85 per cent. that of the old supply.

As to the revenue, this has increased by some £7,000; but in this connection it must be remembered that a reduction in the price per unit came into force in August of last year, and its full effect has not yet been experienced. The average price received for private lighting was 4·1d. per unit; and for power and heat 1·88d.

In the following analysis of the Accounts for the year ended February 28, 1911, the amount of each item per unit sold is set out, together with the figures for the previous year to facilitate comparison:—

		Per unit sold. 1910-11.	1909-10
Generating Costs.			
Coal	£14,741	0·43d.	0·43d.
Steam supplied by destructor	1,136		
Water and stores	901	0·02d.	0·02d.
Wages	6,898	0·19d.	0·21d.
Repairs and maintenance	3,350	0·09d.	0·12d.
Total Generating Cost	£27,026	0·73d.	0·78d.
Distribution Costs.			
Wages	£827	0·02d.	0·02d.
Repairs and maintenance	5,724	0·15d.	0·15d.
Total Distribution Costs	£6,551	0·17d.	0·17d.
Management, &c.			
Salaries	£5,812	0·16d.	0·17d.
Rent	1,240	0·03d.	0·04d.
Insurance	372	0·01d.	0·01d.
Advertising	88	0·00d.	0·00d.
Printing and stationery	403	0·01d.	0·01d.
Miscellaneous	1,009	0·03d.	0·02d.
Total Management Costs, &c.	£8,924	0·24d.	0·19d.
Special charges	£299	0·01d.	0·01d.
Public lamps (attention, &c.)	£7,468	0·20d.	0·21d.
Private lamps (attendance and renewals)			
Labour £3,149			
Material 3,012			
	6,161	0·17d.	0·19d.
TOTAL COSTS (*ex* Capital charges)	**£56,429**	**1·52d.**	**1·54d.**
Capital Charges.			
Interest	£17,533	0·47d.	0·50d.
Sinking fund	5,260	0·14d.	0·15d.
Provision for depreciation and renewals	20,765	0·56d.	0·58d.
Loans, flotation, &c.	844	0·02d.	0·03d.
Total Capital Charges	£44,402	1·19d.	1·25d.
TOTAL COSTS (*inc.* Capital Charges)	**£100,831**	**2·71d.**	**2·79d.**
Revenue			
Sale of current, lighting	£64,944		
Sale of current, power and heating	23,571		
Rent of meters	3,311		
Rent of arc lamps	921		
Miscellaneous	380		
Boundary lighting	475		
Public lighting, streets	21,665		
Public lighting, markets	3,040		
Public lighting, Town Hall	1,124		
Public lighting, other public places	932		
TOTAL REVENUE	**£120,363**	**3·23d.**	**3·33d.**
Balance	£19,532	0·52d.	0·54d.

A feature of the supply is the large output for street lighting, the revenue from this source being nearly equal to that from the power and heating sales; indeed, including the lighting of the markets and public buildings, the public lighting provides over 22 per cent. of the total revenue.

The capital expenditure during the year was £29,[illegible], bringing the total expenditure to February 28, 1911, to £605,023. £166,736 of this is on account of machinery, and £180,695 for mains.

Testing of Dirty Insulators.—The "Schweizerische Bauzeitung" states that the testing laboratory of the Swiss Electrotechnical Association has recently carried out a number of tests on porcelain insulators of different forms which had become blackened by locomotive smoke and soot after a considerable period of service. The insulation resistance showed a very appreciable reduction, but the breakdown voltage for a disruptive discharge was found to be reduced only 10 per cent. for dry insulators and 15 per cent. for those subjected to rainy conditions. As a result of these tests it is considered that particular precautions against soot are necessary.

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TRAMCAR METERS.*

BY R. G. CUNLIFFE, M.SC.TECH., AND J. G. CUNLIFFE, M.SC.TECH.

Summary.—The authors show the importance of obtaining absolute values of the energy consumption of tramcars, and discuss the scope and behaviour under working conditions of watt-hour meters, ampere-hour meters and time-meters. The results of extensive investigations on the Manchester and other tramways are given, and finally the effect on the maximum demand of current, and the importance of brake setting and limitation of the motormen are considered.

It is now over 10 years since the first attempts were made to check and, in some degree, control the consumption of energy by the installation of meters on electric tramcars, and the failure, through structural weaknesses, of the early forms of watt-hour meter has, in the meantime, led to the widespread adoption of other types of meter which are not true energy meters, with the consequent desertion of readings of absolute, in favour of others of purely relative, accuracy. This relative measurement is, at the best, a compromise, and has given rise to considerable discussion.

Before deciding on the adoption of meters at Manchester, a careful study was made of the literature of the subject, and it was found to be impossible to determine, from this source, the type of meter likely to prove most useful. Experiments have accordingly been conducted with large numbers of each of the more important types of meter, and in this Paper comparisons are based upon the results of careful measurements carried out under actual working conditions.

True Functions of the Meters.—The result of a long series of investigations into the relationship between energy consumption and maintenance costs, carried out during the past few years at Manchester, has been to demonstrate clearly that in the case of certain

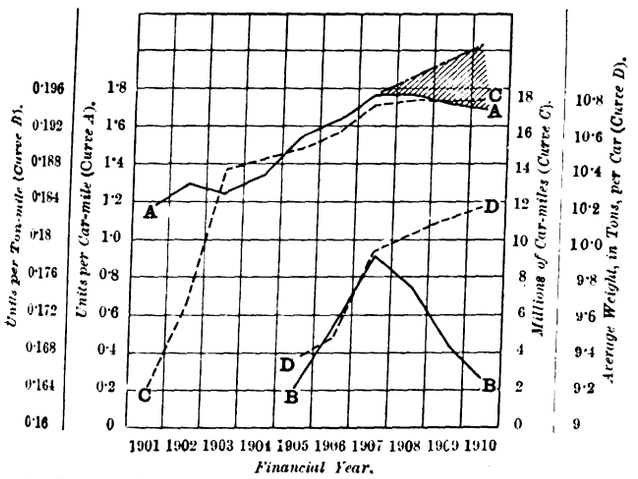

FIG. 1.—ENERGY CONSUMPTION STATISTICS (MANCHESTER CORPORATION TRAMWAYS).

Curve A. B.O.T. units per car-mile. Curve C. Car-mileage run.
" B. " " ton-mile. " D. Average weight per car.

wearing parts of the equipments, in which the energy losses increase with wear, the economical life is determined by the energy loss rather than by the extent of the wear. The methods employed at Manchester have been briefly referred to in the authors' Paper† presented at the Nottingham Conference of this Association. At that time the methods were still of too recent application to permit of results being given; but in the three years which have since elapsed savings have been made which have proved their efficacy and vindicated the somewhat increased maintenance costs.

Curves A and B, Fig. 1, show that the rate of energy consumption commenced to fall from the time that the methods were applied in 1908, the saving increasing as the equipments were gradually brought to a state of increased efficiency. The whole of the large increase in rate of energy consumption prior to 1907 was not due to the increasing inefficiency of the equipments, as the proportion of large bogie cars in use was steadily increasing whilst the covering of cars was proceeding at a rapid rate; but curve B shows that the units per ton-mile also increased to a considerable extent, and the effect of increasing weight ought to have been slightly to diminish this, since weight added to a car does not proportionately increase its rate of energy consumption, so that there was no doubt as to the importance of the increasing losses.

From curve C it is evident also that the mileage run was increasing rapidly, and the transmission losses, being roughly proportional to the square of the mileage, were becoming of relatively greater importance.

* Abstract of a Paper read at the Conference of the Municipal Tramways Association last week.

† *See* THE ELECTRICIAN, October 9, 1908, p. 1003.

The actual saving effected is shown approximately by the shaded area in curve A, and would have been greater but for the fact that the proportion of bogie cars has continued to increase, as also has the covering of existing cars, so that the average weight per car is much in excess of the 1907 value, as is shown by curve D.

It is difficult to obtain an exact knowledge of either the value of the saving effected or the cost of obtaining it, but although the first cost of renewing faulty field coils, worn gearing, &c., and adopting a heavier gauge of trolley wire where necessary, was comparatively heavy, it has already been balanced by the saving in energy, which, in addition, is cumulative over a number of years, during which the increase in manitenance charges will be very slight. The lost mileage due to defective equipments has fallen considerably from 1908 to 1910, and is still rapidly decreasing, thus indicating the state of increased efficiency of the equipments.

On the whole, therefore, by keeping down the losses it is possible to maintain the equipments in a better condition, with increased public safety and comfort, and, at the same time, to effect a saving, but this necessitates as exact a knowledge as possible of the values of the various losses, and one of the principal functions of the meters ought to be to supply this information. This, however, can only be done by meters capable of giving absolute values.

Another of the most important functions of the meters is to afford a means of measuring the comparative care and skill exercised by the motormen in the handling of their controllers. This can only be done, in the case of meters giving relative readings, on the assumption that every meter, working under similar general conditions, has the same percentage error; an assumption of the accuracy of which no proof has as yet been offered.

Types of Meter.—The watt-hour meter survived its early failure, and, by continued improvement, has been able, in many cases, to hold its own against its rivals, of which the only important ones are the ampere-hour meter and the time meter.

Electrical energy is a product of three components, viz., voltage, current and time, all of which, in traction work, are subject to simultaneous and rapid fluctuation over a wide range. The watt-hour meter measures all three components and is therefore theoretically complete. The ampere-hour meter measures current and time and assumes constant voltage; it is therefore partially complete; whilst the time-meter assumes both current and voltage constant and is therefore incomplete.

As an auxiliary meter the authors have developed a volt-hour meter,* the readings of which, when divided by the time, give the average value of the fluctuating voltage along a route, and in addition have used graphical recording instruments and measuring instruments of many kinds for checking purposes.

Accuracy of Meters.—Great pains have been taken in checking the accuracy of the meters by actual measurement from the following standpoints, viz. (1) As a means of measuring the energy component or components which each meter is specially designed to measure. (2) As true energy meters having regard to the simultaneous and rapid fluctuation of the three components. (3) As true energy meters when assisted by an auxiliary meter.

The authors have employed several forms of time-meter, and have found the most successful to consist of a clock having a small electric motor of peculiar design in place of the main spring, governing being obtained by means of a hair-spring and balance wheel, the motor providing the motive power and driving the clock when the current flows.

Experiments conducted with a contact maker rotating at a known constant speed, and completing the circuit for a predetermined part of each revolution, have shown the accuracy of the meter, at frequencies of operation corresponding to the quick handling of a controller, to be that inherent to clockwork generally, which, so far as meters are concerned, represents practical perfection.

Lord Kelvin checked his most delicate current-measuring instruments by means of the copper voltameter, and the authors have made use of the same method in order to check the actual error of the ampere-hour meter when in operation on the car. The apparatus itself is not susceptible to any of the peculiar conditions obtaining in traction work, vibration, if anything, assisting its action by causing circulation of the electrolyte. Care is required in the preparation and use of the cell, and, since this measurement forms the real basis of the Paper, the voltameter designed, and used with perfect success by the authors, is described in an appendix. It affords a means of measuring the ampere-hours to an accuracy of within half of 1 per cent.

Meters whose percentage error had been carefully determined in the test room were operated in series with the cell on service cars, and their error was found to be almost exactly as predetermined, showing that there was no appreciable error due to vibration and to the rapid

* Described on p. 971 of last week's issue of THE ELECTRICIAN.

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fluctuation of the current. This is of great importance and proves the test-room calibration to be reliable.

Vibration reduces the friction, causing the meter to run slightly fast, but this is balanced by a slight retardation due to inertia effects. Both ampere-hour and watt-hour meters have the great advantage that they are not called upon to operate with currents lower than 30 per cent. of the normal full load for which they are designed, thus avoiding the inaccuracies frequently encountered in these meters at light loads, and enabling full advantage to be taken of the flat part of the calibration curve.

Ampere-hour meters of both mercury and commutator types, by various makers, have been tested and found to be capable of accurate operation within limits of 2½ per cent. over the whole of the working range, whilst, if accurate when installed, they have been found to be still accurate within 1 per cent. when tested after six months' continuous operation.

As the volt-hour meter is merely an ampere-hour meter designed for a very low current, and with a suitable series resistance in place of the shunt, its accuracy is that of the ampere-hour meter working at the most favourable parts of the load range.

Experiment shows that the average voltage on a route, as determined by the volt-hour meter, is practically independent of the car on which the volt-hour meter is installed, so that a single volt-hour meter will give the true average voltage for a route. Evidently, then :—

1. Every ampere-hour meter on the same route fails to register energy by the same definite percentage, and hence ampere-hour meters may be employed without correction for the purpose of placing drivers or cars in their correct order of merit as regards consumption of energy, although such readings could not be accurately used to determine the percentage difference between the values of the various men or cars.

2. The readings of the ampere-hour meters, when corrected for the true average voltage, give the actual energy consumption. This correction need only be applied to average daily, weekly, or monthly values for either each separate car or for the whole route, as desired, in order to estimate the value of the line losses by comparison with the station meters, or to compare the consumptions of cars on different routes.

There is no direct method of checking the accuracy under service conditions of the watt-hour meter, but numerous readings have been taken of watt-hour meters operating in series with ampere-hour meters, checked by volt-hour meters, both of known accuracy, and it has been found that watt-hour meters do not work very accurately on a line with wide voltage variation.

In Manchester, owing to high-tension transmission to a network of over 20 sub-stations, each having a number of short, heavy, low-tension feeders, radiating in all directions, the voltage regulation is within 10 per cent., especially as every section is fed from the centre, and unusually heavy trolley wires are used and parallelled for mutual assistance. On the Salford lines, however, owing to low-tension transmission over large distances, a voltage variation of some 30 per cent. or more was available for tests with the meters. On one route, of practically 22 miles per complete journey, the watt-hour meter appeared to read high at the lower voltages, the error, as compared with the corrected ampere-hour meter, exceeding 10 per cent. on a 35 per cent. voltage variation.

In order to check this error under more favourable conditions, the instrument was taken to the Polygon Testing Department of the Manchester Electricity Works, and tested by Mr. H. A. Ratcliff at various values of the current and voltage. The results, set out in a Table in the Paper, show that, at working values of the current, the range of error as measured in the test room may exceed 6 per cent. on a wide voltage variation, and, under the more severe practical conditions, the fluctuations of current and voltage being simultaneous and rapid, this range was exceeded. Evidently, if these results are typical of the watt-hour meter, it fails under the very conditions which would render its use desirable, and, whilst the above represent difficult conditions, they are, nevertheless, to be encountered on numerous tramways in this and other countries.

In the opinion of the authors it is better that one such widely fluctuating component alone should be measured by each meter, when there will be no mutual interference and the whole attention of the designer can be concentrated on the already sufficiently involved conditions.

If the time-meter is to be of any use as a means of obtaining absolute values, *i.e.*, as an energy meter, there must be a direct proportionality between its readings and the energy consumption, whilst, if it is even to be used as a means of comparison between drivers or cars, there must still be some definite relationship, although it need not necessarily be a direct one. In order to investigate this relationship whole routes have been equipped with both energy meters and time-meters, and the analysis of thousands of daily averages has proved that, for reasons discussed later, the time-meter cannot be made to give absolute values and, further, that it cannot be even employed with fairness to the men as a means of comparison between them, although the general tendency of a reduction in controller time is to cause saving of energy.

Diagrams given in the Paper show that there is no simple relationship between energy consumption and controller time ; in a typical case the drivers, second and third in order of merit as determined by energy consumption, were respectively 11th and 14th on the time-meter basis.

Influence of Meters on the Motorman.—Car meters are generally supposed to effect a saving in energy by promoting careful and skilful handling of the controller. They tend to prevent waste of energy by running with the brakes on, running on the resistance notches, approaching stopping places too rapidly, with consequent loss in braking, &c., and, whereas without meters the motorman might like to have his brakes so tight that he would only require to switch off the controller in order to stop his car, he will now complain if they are set too tightly and will watch jealously the state of the equipments of each car he may be called upon to drive, testing this by coasting down well-known inclines.

This increased care is what is really meant by the "moral effect" of meters, and in itself may result in fairly considerable economy, but skilful driving is a very different matter, and no amount of coercion, whether by meters or otherwise, can make a man drive skilfully if he does not know how to do so. The ordinary course of instruction teaches a man how to handle his car in a general way, and after some months of experience he becomes far more conversant with the equipments than is generally believed, but if the full measure of economy is to be effected, some supplementary training becomes necessary which will emphasize the effects of various methods of driving from the point of view of consumption of energy.

Results of Manchester Investigations.

Numerous experiments have been carried out in Manchester with a view to determining the effect of various methods of driving, and although the knowledge gained is by no means complete, many interesting results have been obtained.

It has been shown that there is no simple relationship between energy consumption and controller time, and various drivers can obtain the same value of units per car-mile with very different controller-minutes per car-mile. This is explained by the curves A, B and C in Fig. 2, which illustrate various relationships between the two quantities, These are curves actually given by three men on the Palatine route with exactly similar cars. The working range is from 2·6 to 4 controller-minutes per mile, as indicated, and it is evident that with the same value of the energy consumption these three men would have very different time-meter readings.

As is shown in Appendix II., there is an infinite number of curves varying in shape between these three, or having the same general shape but different heights, and a driver may work during part of a month along one curve and then change over to a totally different one. He may even drive in so haphazard a manner that his results plot out a large number of curves, suggesting, to a more superficial analysis, that there is no relationship at all. In the majority of cases, however, it is found that the man keeps to a certain general method of driving, giving points lying fairly close to a smooth curve which can be drawn and analysed. This is invariably the case when the man covers a wide range of controller-time per mile. It is men who maintain approximately the same value of controller-time from day to day whose results do not give any curve, and they are few in number.

Fig. 3 shows the theoretical relationship for each controller notch, and every man must work up and down all these curves and from one to another, remaining on particular curves for different proportions of the time according to his method of driving ; and when it is considered that each of the daily averages from which the actual curves in Fig. 2 are built up is compounded of a great number of such instantaneous values covering the whole range of Fig. 3, the complexity referred to is obvious, especially as each of these daily averages may fall anywhere within the rectangle of A, B, C, D, which represents their working range.

Further diagrams in the Paper show the great economy of parallel as compared with series operation and indicate the desirability of getting on to the running notches as quickly as possible consistently with the comfort of the passengers, which latter consideration can be trusted to restrain the drivers, owing to fear of complaints, from too quick starting.

The economy of parallel running is shown in the accompanying Table, which gives the average results of a series of observations taken on the Palatine route and is based on hundreds of journeys.

It is evident that series operation entails a comparatively long

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PALATINE ROUTE.

Section.	Units per car-mile.	Controller min. per car-mile.	Units per controller min.	Av. speed (miles per hour).	Remarks.
All Saints' to Town, return.	2·26	5·28	0·429	5·39	Heavy City route. All series running, very frequent stops.
All Saints' to Birch Villa and back.	1·99	3·35	0·592	8·52	Urban route. Frequent stops. Mainly mixed series and parallel running.
Birch Villa to Terminus and back.	1·395	2·99	0·467	10·9	Suburban route. Good opportunity for parallel running.

of the controller, a comparatively low average time-rate of energy consumption as shown by the units per controller-minute, and a high distance-rate of consumption as shown by the units per car-mile.

Parallel running, on the other hand, necessitates a greatly reduced use of the controller, a slightly greater time-rate, and a much smaller distance-rate of consumption, and it is in this distance-rate, the units per car-mile, that economies are to be effected.

Returning to the curves in Fig. 2, it would appear that the use of the controller is mainly series in curve A, mixed in curve B, and parallel in curve C. The characteristic upward tendency is shown in curve C, which is evidently a much purer curve than the other two, where there is a greater proportion of mixed driving.

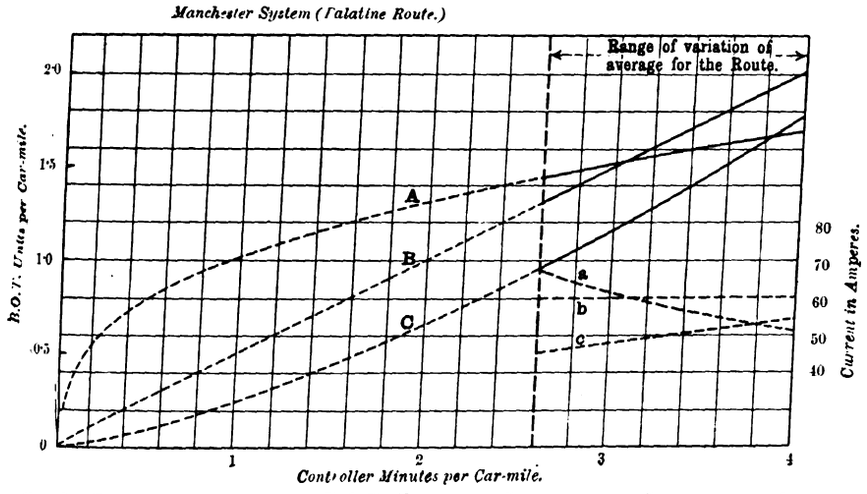

FIG. 2.—RELATIONSHIP BETWEEN B.O.T. UNITS PER CAR-MILE AND CONTROLLER MINUTES PER CAR-MILE. (Three typical cases obtained in practice.)

Maximum Demand.—If the installation of meters becomes general, e station engineer is threatened with a reduction of revenue in uch the same way, though not to the same extent, as that caused / the advent of the metal filament lamp, with the added disadvan-ge that the increased economy will not bring him an increase in the mber of his connections in the shape of cars, since the schedule opted is fixed by other than energy considerations. It is of interest consider the probable effect of this saving on the maximum de-nd, as there appears to be every probability of traction energy rges in the future being based upon a maximum demand rate.

The current taken by a car is shown in Appendix II., to be propor-nal to the average energy demand of the car in units per controller-nute; and current curves *a*, *b* and *c*, there obtained are shown by broken lines on Fig. 2. These correspond respectively to the ves A, B and C on the same figure, and their shape is accounted in the Appendix.

t is evident that as the controller-time diminishes, *i.e.*, as improve-nt continues, the average demand increases for a driver working ng curve A, remains constant for curve B, and diminishes for ve C. In the case of curve A, however, it will be observed that proportionate increase of average demand, as measured by current mall compared with the reduction in the time during which the nand continues, and hence, owing to the lesser probability of ny cars simultaneously requiring a supply of energy, the station ximum demand would be reduced even if every driver worked ng the curve A.

s a matter of fact, however, it is observed that any marked im-vement in driving is effected, not by working lower down a given ve, whether A, B or C, but by falling bodily on to a lower curve consuming less energy at very similar values of the controller-time, and this, if it became general, would proportionately reduce the maximum demand, being equivalent to a reduction in the value of the constant "a" (*see* Appendix II.).

Limitation of the Motorman.—The ideal method of driving, as regards energy consumption, would be to get fairly quickly into parallel, remaining there at full speed until approaching a stopping place, then to switch off at such a distance that the car would just come to rest without application of the brakes; but this long coasting would be wasteful of time and is prevented by the fixed schedule time, which is important in so far that it hinders the men in obtaining the best results and should be taken into consideration in comparing the records of men on different routes.

The Table given above shows the predominating influence of "Type of Route," the values given in the city part being much higher than for pure series running on account of the great number of stops, and the authors are of opinion that it is not possible to effect much saving on such routes, as there is practically only one way in which a man can drive, his whole attention being taken up in getting his car along at all.

Low-line pressure, due to bad feeding arrangements, compels the driver to remain longer on the controller in order to maintain a given schedule, but, as is evident from Appendix II., the average demand is reduced in practically the same proportion, so that the effect is to alter the relationship between energy consumption and controller-time without materially increasing the former. It is very difficult, therefore, to make a fair comparison between drivers or cars on different routes; and in a city like Manchester, where large numbers of part-day cars are run at the rush hours, separate comparisons must be made even between cars on the same routes.

Brakes.—One result of the installation of car meters is to call attention to the great importance of brake setting, and, however careful the supervision, cases of tight brakes are very common, causing great waste of energy. This difficulty is being met by the use of brake gear fitted with a conical drum, giving a large initial movement of slack chain and brake blocks with a leverage gradually increasing to a maximum when the block is on the wheel. This permits of an increased clearance between the blocks and the tyres.

Meter-Registering Dials.—In order to facilitate correct reading of the meters by unskilled men, the dials ought invariably to be of the cyclometer type with spring figures, and a tenths dial ought to be provided, the figures being painted red, whilst the other dials bear figures in black.

Clock-face dials invariably lead to confusion, and in the case of cyclometer dials without spring figures, it is possible to have two figures, each half exposed when a driver is being relieved, with the result that each driver, takes the figure most favourable to himself, and, as this generally occurs at the units dial, one unit is lost. If a tenths dial is provided, an error of reading in the last figure will be unimportant, whilst the other figures can always be corrected by a comparison of meter cards.

Results obtained from the use of Meters.—An analysis of the schedule recently compiled by Mr. Goodyer* shows that on 19 systems which have furnished complete replies the average saving amounts to £22·66 per meter per annum. The authors have had an opportunity of verifying the saving effected at Bury, and it may be accepted as a bona-fide example of the results to be obtained from the use of meters under the most favourable conditions. A reduction of 21·79 per cent. was made in the energy consumption corresponding to a saving of £41·6 per meter per annum.

This result, however, has only been obtained by the most unremitting attention on the part of Mr. Clough and his staff, supervision and time being devoted to the subject to an extent which would be impossible on much larger undertakings. It is quite out of the question to expect such results on a large city tramways; but, although comparatively little can be done in the driving, there is no reason why the full saving resulting from efficient equipments should not be realised, and so, in the case of such undertakings, the absolute values become proportionately of greater importance.

It is important to notice that the methods of employing the meters should be such as to exert a continual pressure on the men, as otherwise their improvement will not only gradually cease, but they will actually slip back into the old values. It has been found profitable in Manchester to fix a limiting value, slightly better than that ob-

* *See* THE ELECTRICIAN, July 7, 1911, p. 487.

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tained by the best driver, for each route, and to encourage the men to aim at reaching that value.

Conclusions.—The authors are satisfied as a result of their numerous experiments that :—

1. The ampere-hour meter can, with proper supervision, be made to operate with an accuracy of within 1 per cent., and that its uncorrected values may be employed for the purpose of placing motormen and cars in their correct order of merit, whilst, when corrected for variation of average voltage by the volt-hour meter, its readings give the true energy consumption.

2. If percentage differences between the results of various men are required the corrected values must be used.

3. The watt-hour meter, owing to its greater complexity, more fraglie construction, susceptibility to lightning discharges, and greater inaccuracy, is not so desirable or valuable an instrument as is the corrected ampere-hour meter.

4. The time-meter, although very accurate in its measurement of time, cannot be trusted to measure energy within 10 per cent., and, if used at all, should only be employed, in conjunction with the energy meter, for purposes of investigation, in which connection it is very valuable.

5. The volt-hour meter is indispensable for many purposes, and ought to be employed on all tramway undertakings for the purpose of measuring average voltages.

6. On small undertakings, with light traffic, approximately equal savings may be effected in the driving and in the detection of faulty equipments, but, as the congestion increases, the state of the equipments becomes of increasing importance, more especially as regards the feeding and distributing system where the losses are a fraction of the total energy consumption, and do not merely affect the consumption of individual cars.

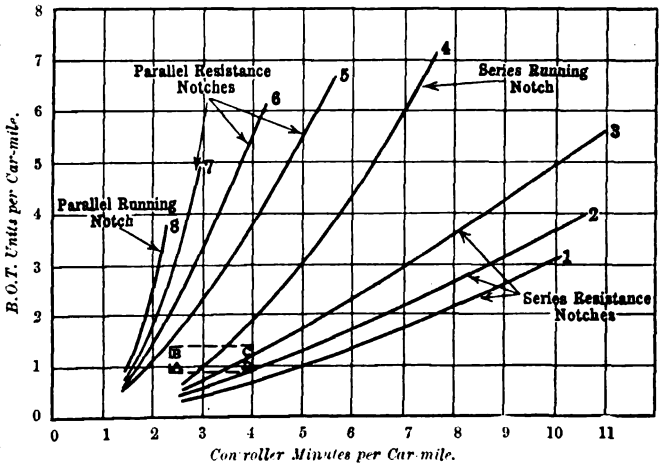

FIG. 3.—RELATIONSHIP BETWEEN UNITS PER CAR-MILE AND CONTROLLER MINUTES PER CAR-MILE FOR EACH CONTROLLER NOTCH OF A CAR EQUIPPED WITH TWO G.E. 52-27 H.P. MOTORS. (Monthly average for the Stockport route falls in the rectangle A B C D.)

In Appendix I. the authors describe a copper voltameter for use on tramcars. This was designed with special regard to the heavy rushes of current, liberal allowance being made in order to avoid loosening of the deposit. Temperature rise and facility for accurate weighing were also taken into consideration. In order to avoid a high temperature rise the voltameter was divided into four parts, each in a separate glass cell with air space on every side, the four cells being carefully parallelled by heavy copper strip in order to ensure equal division of the current. For accurate weighing a large number of plates were used, each weighing about 200 grammes. The plates were of soft drawn copper strip, and each of the four cells contained 6 anodes and 5 cathodes, each plate being 8 cms. wide by 20 cms. deep. A close, firmly adherent deposit was obtained of about 115 grammes weight per cell from each day's run, and a correction at the rate of $\frac{1}{200}$ mmg. per hour per square centimeter was made for solution of copper, from the plates in the electrolyte.

Appendix II. contains a discussion of the mathematical relationship between energy consumption and controller time. The theoretical curves, given in Fig. 3, show by their shape that the distance-rate of consumption of energy is an exponential function of the distance-rate of duration of controller time.

Thus, $U = a M^n$, where U = B.O.T. Units per car-mile, M = Controller-minutes per car-mile, and a and n are constants for any particular curve. This exponential form, with its inverse, the logarithmic function, is characteristic of the series electric motor, and its influence is evident from the shape of the practical curves, given in Fig. 2.

Differentiating this equation we get $\frac{dU}{dM} = naM^{n-1}$. From this it is evident that, with increasing values of the specific controller-time the curve will have an upward tendency if $n > 1$; a downward drop if $n < 1$; and will be a straight line of slope a if $n = 1$. This is illustrated in Fig. 2, where the actual equations to the curves are as follows, viz. :—Curve (A)—$U = 1{\cdot}02\ M^{0{\cdot}364}$; Curve (B)—$U = 0{\cdot}513M$; Curve (C).—$U = 0{\cdot}247\ M^{1{\cdot}422}$.

The influence of the value of the index n on the shape of the curve is of interest for several reasons. In the first place it accounts for the large number of possible working relationships since on the various controller notches widely different values of n are obtained, and the practical curves are composed of large numbers of these component values, which may be compounded in an infinite number of ways. In the second place the value of n is of interest from the point of view of station maximum demand. The value of the coefficient a determines the height of the curve.

Station maximum demand has been treated, in the text, from a consideration of the average energy demand per car; this during the time that current is flowing, being given by the ratio U/M; i.e., the energy units consumed per controller-minute.

From the first equation above, it is evident that $\frac{U}{M} = aM^{n-1}$, whence it appears that, with improvement, *i.e.*, with diminishing values of the controller-time per mile, the average demand per car will increase if $n < 1$, will remain constant if $n = 1$, and will fall if $n > 1$.

This is shown by the broken lines *a*, *b*, *c* in Fig. 2, these representing the variation in average demand, corresponding to the curves A, B, C, respectively. These curves, *a*, *b*, *c*, really represent the variation of the average current which has been employed as being more familiar than the ratio U/M, to which it may be shown to be directly proportional. Thus, $\frac{U}{M} = \frac{E.C.}{1{,}000 \times 60}$ kw. hours per controller-minute, or $C = k\ U/M$, whence $C \propto U/M$, where E = average line pressure in volts, C = average current in amperes, and k = constant for any given value of E. (120 at 500 volts).

The value of the average current is $C = kaM^{n-1}$.

THE DETERMINATION OF SYNCHRONOUS AND ASYNCHRONOUS REACTANCE.

BY J. REZELMAN.

(*Concluded from page 963.*)

Summary.—The action of the rotor of a synchronous alternator with respect to the stator is, in part, of a single phase and, in part, of a polyphase nature. The article deals with the reactance under various conditions of speed, &c., of the various possible combinations of single and polyphase stators and rotors; the polyphase stator with single phase rotor is in particular interesting. Machines with non-salient poles only are considered.

The above study will serve to explain various phenomena which will be met with in the following :—

Reactance of three-phase asynchronous motor, 175 *H.P.*, 8 *poles*, 3,000 *volts*, 50∼, 750 *revs. per min.*

The reactance of this motor has already been determined in the preceding article on "The Reactance of Asynchronous Motors."

1. *Stator three-phase, rotor three-phase.*—The leakage reactance per phase of the three-phase *stator* winding is :—

$$R_s = x_{ss} + x_{sk} + x_{sd} = 2{\cdot}72 + 0{\cdot}98 + 3{\cdot}1 = 6{\cdot}8w.$$

and of the *rotor* winding, reduced in terms of the stator :

$$R_r = 1{\cdot}5 + 0{\cdot}73 + 1{\cdot}6 = 3{\cdot}83w.$$

whence $$R_s + R_r = 10{\cdot}63w.$$

The fields due to the higher harmonics produce a reactance of *mean* value $0{\cdot}004R_o$. The main reactance per phase corresponding to the air-gap, $R\delta = 195w$. The current measured on light load is $I_o = 5{\cdot}22$ amperes for a voltage of 1,500 between phases, whence $R_o = \frac{867}{5{\cdot}2} = 167w$; hence there is a diminution $(195 + 6{\cdot}8^*) - 167 = 34{\cdot}8w$, corresponding to the reluctance of the stator and rotor iron.

* For the reactance of the stator alone it is, in reality, necessary to take $R_s + 0{\cdot}002R_o$, but this correction is negligible for the light load current.

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The air-gap has relatively but a small influence upon the leakage reactance R_s+R_r, but the reactance R_o depends directly upon the air-gap.

The ratio $R_o/(R_s+R_r+0{\cdot}004R_o)=\frac{167}{11{\cdot}3}=14{\cdot}8$ (Fig. 6).

In general, alternators have much larger air-gaps, and consequently much smaller ratios.

By making the air-gap of our machine four times as large, *i.e.*, by increasing it from 1·5 mm. to 6 mm., we find :

$k_1=32{\cdot}7/(2\times27{\cdot}7+\sqrt{6}(5+3))+19{\cdot}5/(2\times16{\cdot}5+\sqrt{6}(5+3))$
$=0{\cdot}525+0{\cdot}488$
$=1{\cdot}013,$

whence $R_\delta=195\times\frac{1{\cdot}1\times0{\cdot}15}{1{\cdot}013\times0{\cdot}6}=52{\cdot}8w,$

and $I_\delta=\frac{867}{52{\cdot}8}=16{\cdot}4$ amperes.

The leakage reactance of one phase of the stator becomes :—

$R_s=2{\cdot}98+0{\cdot}25+3{\cdot}1=6{\cdot}33w,$

and of the rotor, in terms of the stator :

$R_r=1{\cdot}67+0{\cdot}18+1{\cdot}6=3{\cdot}45w,$

whence $R_s+R_r=6{\cdot}33+3{\cdot}45=9{\cdot}78w.$

The current on light load for a pressure of 1,500 volts between phases will have the value :

$I_o=16{\cdot}4\times52{\cdot}8/(52{\cdot}8+6{\cdot}33)+5{\cdot}22\times34{\cdot}8/(195+6{\cdot}8)=14{\cdot}7+{\cdot}9$
$=15{\cdot}6$ amperes,

whence $R_o=867/15{\cdot}6=55{\cdot}5w.$

It follows that by quadrupling the air-gap the current on light load is augmented by $\frac{15{\cdot}6}{5{\cdot}22}=3$, and the short-circuit current by $\frac{86{\cdot}7}{76{\cdot}6}=1{\cdot}13$.

The ratio $R_o/(R_s+R_r+0{\cdot}004R_o)$ becomes 5·55 instead of 14·8 (Fig. 6).

We have already remarked in the previous article that the leakage reactance of the stator with the rotor removed is $10{\cdot}7w$, by chance the same value as with the rotor in position and short-circuited, the air-gap being 1·5 mm. We can, therefore, conclude that for this machine the short-circuit current at first increases with the air-gap, attains a maximum value, and then decreases so as to approach the original value with the rotor removed.

For an air-gap of 20 mm. we calculate :

$R_s=3{\cdot}21+0{\cdot}07+3{\cdot}1=6{\cdot}38w,$
$R=1{\cdot}785+0{\cdot}055+1{\cdot}6=3{\cdot}44w,$
$R_s+R_r=9{\cdot}82w.$

Our formulæ thus enable us to establish a minimum value for the reactance (λ_n increases more rapidly than λ_k decreases) but within these limits a great accuracy cannot be depended on, the permissible application depending upon the ratio $\frac{\tau}{\delta}$; since, for machines developed logically, the air-gap increases with the pole pitch, the formulæ can be applied in an almost general manner.

2. *Stator connected single-phase, two phases in series, rotor three-phase.*

The leakage reactance of the two phases of the stator in series is :—

$R_s=2\times6{\cdot}8=13{\cdot}6w.$

and of the rotor :—

$R_r=2\times3{\cdot}83=7{\cdot}66w,$

whence $R_s+R_r=13{\cdot}6+7{\cdot}66w,$
$=21{\cdot}26.$

The main reactance per phase corresponding to the air-gap :

$R_\delta=390w.$

The measured value of the magnetising current for a voltage of 1,740 was $I_m=5{\cdot}22$ amperes, whence $R_m=\frac{1,740}{5{\cdot}22}=334w$: there is thus a diminution of $(390+13{\cdot}6)-334=69{\cdot}6w$ corresponding to the reluctance of the stator and rotor iron. The current measured on light load with the rotor running at synchronous speed was $I_o=1$ 0·35 amperes for a voltage of 1,740 at the terminals, whence $R_o=168w$.

When the rotor is running at synchronism the alternating field of the stator is replaced by a rotating field, fixed relatively to the rotor.

By applying, then, 1,740 volts between phases at light load, the voltage per phase will be $\frac{1,740}{1{\cdot}73}=1{,}010$ volts instead of $\frac{1,740}{2}=870$ volts during magnetisation ; nevertheless, the flux has the same value in the two cases, the winding factors being 0·96 and 0·83, and $\frac{0{\cdot}83}{0{\cdot}96}=\frac{1{\cdot}73}{2}$.

By calculation we find for the light load current

$I_o=E_o/\left(\frac{R_m}{2}+\frac{R_s}{2}+\frac{R_r}{2}\right)$
$=1,740/(167+6{\cdot}8+3{\cdot}83)=1,740/177{\cdot}6=9{\cdot}8$ amperes,

in place of 10·35 amperes measured, including the watt component.

The current in the rotor, produced by the inverse field II., and hence of double frequency, will have the value :

$I_{r\pi}=10{\cdot}35\times\frac{552}{2\times80}\times\frac{2}{\sqrt{3}}\times\frac{1}{\sqrt{2}}=29{\cdot}2$ amperes ;

the measured value, including the watt component is 39 amperes.

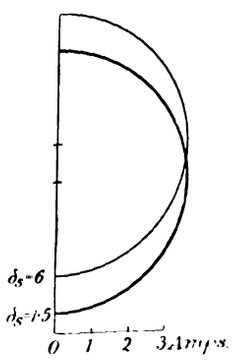

FIG. 6.

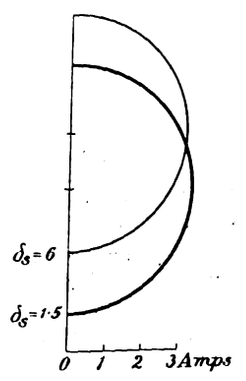

FIG. 7.

Here the ratio $R_o/(R_s+R_r+0{\cdot}004R_m)=168/22{\cdot}6=7{\cdot}5$ (Fig. 7).

By again increasing the air-gap from 1·5 to 6 mm. we find :

$R_\delta=105{\cdot}6w$ and $I_\delta=1,740/105{\cdot}6=16{\cdot}4$ amperes.

The leakage reactance becomes :

$R_s=12{\cdot}55w$ and $R_r=6{\cdot}38w$, whence $R_s+R_r=18{\cdot}93w.$

The magnetising current for a pressure of 1,740 volts will be

$I_m=16{\cdot}4\times105{\cdot}6/(105{\cdot}6+125{\cdot}5)+5{\cdot}22\times69{\cdot}6/(390+13{\cdot}6)$
$=15{\cdot}6$ amperes,

whence $R_m=1,740/15{\cdot}6=111w.$

With such an air-gap the increase in the reactance due to R_s, is more important than the diminution corresponding to the reluctance of the iron.

The light load current will have the value

$I_o=1,740/(55{\cdot}5+6{\cdot}27+3{\cdot}145)=1,740/64{\cdot}9$
$=26{\cdot}8$ amperes,

and $R_o=1,740/26{\cdot}8=65w.$

Thus, by quadrupling the air-gap the light load current is augmented in the ratio of $\frac{26{\cdot}8}{10{\cdot}35}=2{\cdot}58$, and the short-circuit current in the ratio $\frac{99}{77}=1{\cdot}17$; the ratio $R_o/(R_s+R_r+{\cdot}004R_m)$ becomes 3·4 instead of 7·5 (Fig. 7).

3. *Stator three phase, Rotor single phase, two phases in series.*

Readings were taken with various positions of the rotor, the two phases, II.-III. in series, being short-circuited.

These measurements give rise to the following interesting observations :—

1. By changing the position of the rotor the reactance per phase varies between that of the main circuit R_o and that of the leakage paths R_σ.

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Table of Results.

Readings with a pressure of 250 volts between phases I.–II.	Stator.									Rotor.		
	$e_{I.-II.}$	$e_{I.-III.}$	$e_{II.-III.}$	$e_{o\,I.}$	$e_{o-II.}$	$e_{o-III.}$	$I_I.$	$I_{II.}$	c.	$I_r.$	$e_{o-I.}$	$e_{I.-II}$
	250	248·2	249·4	142·5	144·2	143·5	0·92 min.	11·55	50·5	83 max.	20·5	31
	250	250·6	250·2	144	144	145	12·2 max.	10·6	50·5	80·5	20·5	31
	250	252	250·2	145·8	143·8	144·8	11·6	5·9	50·5	73·4 min.	20·5	31
	250	251	251	144·9	145	145·1	8·85	8·9	50·5	77	rotating slowly	

2. Although the current in phases II. and III. of the stator reaches the same maximum value I_{cc}, whilst the third phase I. is traversed by the magnetising current, the voltages per phase remain the same in value and in consequence retain a displacement of 120 deg.

3. The experiment shows that the E.M.F.s induced in the rotor phases are *independent* of its position with respect to the stator.

The distribution of the voltages over the various phases is explained as follows :—

(*a*) *Stator.*—We have already found that, on single phase one phase only with the rotor open, there is a mutual induction of 39 per cent. between neighbouring phases (Fig. 8). Now the magnetising current I_m is divided into equal parts between the phases II. and III., whence Fig. 9 and Fig. 10; by superposing Fig. 11 is obtained.

We thus deduce that the main flux induces in phases II. and III. E.M.F.s in phase with that of phase I., but of one-half the value; these E.M.F.s are thus displaced by 90 deg. with respect to the voltage $e_{II.-III.}$ applied to the terminals (Fig. 12). It follows that the short-circuit current corresponding to the leakage reactance of phases II. and III. in series, is displaced by 90 deg. with respect to I_m.

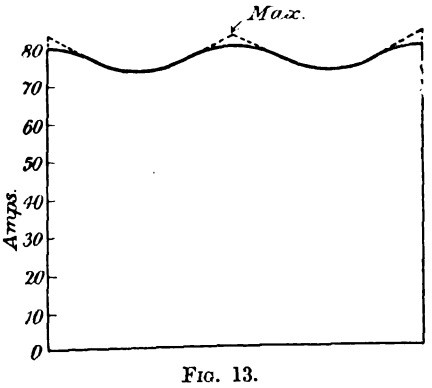

Fig. 13.

(*b*) *Rotor.*—In position (2), where the two short-circuited phases of the rotor are opposite two phases of the stator, the open phase of the rotor is opposite the third phase of the stator, which is then traversed by the magnetising current; the E.M.F. induced is therefore :

$$e_{o-I}=144\times\frac{40}{276}=20{\cdot}8 \text{ volts.}$$

The E.M.F.s induced in phases II. and III. will have one-half the value :

$$e_{o-II.}=e_{o-III.}=72\times\frac{40}{276}=10{\cdot}4 \text{ volts.}$$

and are in phase with the E.M.F. induced in phase I. The combined voltages will, therefore, have the value

$$e_{I.-II.}=e_{I.-III.}=20{\cdot}8+10{\cdot}4=31{\cdot}2 \text{ volts.}$$

Currents.—We have already found that the main reactance, single phase one phase only, corresponding to the air-gap, is $R_\delta=130w$. The current measured is $I_m=0{\cdot}92$ amperes for a pressure of 104 volts (Fig. 8), whence $\frac{104}{0{\cdot}92}=113w$; hence there is a decrease of $(130+6{\cdot}6)-113=23{\cdot}4w$ due to the reluctance of the iron.

The leakage reactance of two phases in series: $R_r+R_r-0{\cdot}004R_m=22{\cdot}6w$ whence $\frac{250}{22{\cdot}6}=11{\cdot}1$ amperes; the measured value was 11·55 for position (2) with the rotor and stator phases opposite each other. ($I_m/2=0{\cdot}46$ amperes is negligible

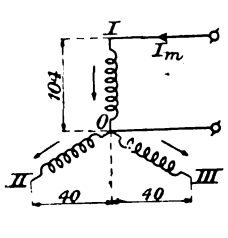

Fig. 8.

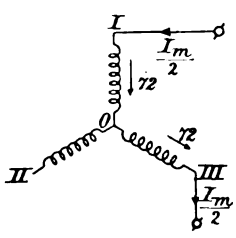

Fig. 9.

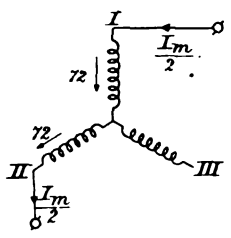

Fig. 10.

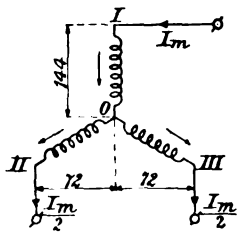

Fig. 11.

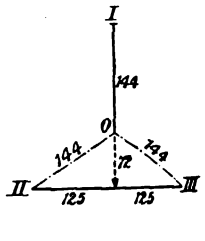

Fig. 12.

with respect to the short-circuit current I_{cc}, these two currents being displaced by 90 deg.)

We find for the rotor current

$$I_r=11{\cdot}55\times\frac{2\times276}{40}=80 \text{ amperes.}$$

Let us further verify the effective value of the currents when the rotor is slowly turned. The intensity of the current in each phase of the stator varies between 0·92 and 12·2 amperes, assuming that the variation is symmetrical and sinusoidal.

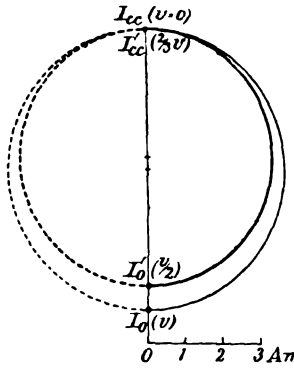

Fig. 14.

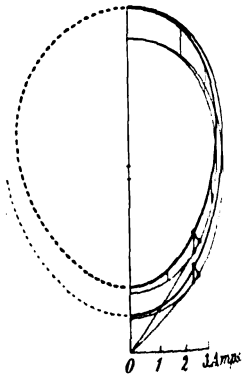

Fig. 15.

the mean value will be $\frac{1}{2}(0{\cdot}92+12{\cdot}2)=6{\cdot}56$ amperes, and the effective value

$$\sqrt{6{\cdot}56^2+\left(\frac{12{\cdot}2-0{\cdot}92}{2}\right)^2}=\sqrt{6{\cdot}56^2+5{\cdot}64^2}=8{\cdot}65 \text{ amperes.}$$

The effective rotor current is by experiment 77 amperes; this value is even inferior to the mean $\frac{1}{2}(73{\cdot}4-83)=78$ amperes. It follows that the variation is not sinusoidal and that the maximum values only occur momentarily (Fig. 13).

We now come to the diagram of operation at different speeds; we will utilise the formulæ already obtained to determine, as a check, the reactances, using the *mean* values found in the experiment—three phase

$$R_o=867/5{\cdot}2=167w;\quad R_{cc}=115/10=11{\cdot}5w.$$

(1) At speed v, $I_o=I_m=E_o/R_o=144/167=0{\cdot}86$ amperes; the value measured was 1 ampere.

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(2) At speed $2v/3$, $I'_{cc}=E_o/1{\cdot}5R_{cc}=144/(1{\cdot}5\times11{\cdot}5)=8{\cdot}3$ amperes and $1{\cdot}11\ I'_{cc}=9{\cdot}2$ amperes; the value measured was 8·85 amperes.

3. At speed $\frac{v}{2}$:

$$I'_o=E_o/\left(\frac{R_{cc}}{2}+\frac{R_o}{2}+R_r\right)=144/\left(\frac{11{\cdot}5}{2}+\frac{167}{2}+0{\cdot}83\right)=\frac{144}{93.1}$$

$=1{\cdot}55$ amperes; and $(1{\cdot}11$ to $1{\cdot}5)I'_o=1{\cdot}72$ to $2{\cdot}32$ amperes the measured value was 2·05 amperes.

4. At speed $v=0$, $I_{cc}=I'_{cc}=8{\cdot}3$ amperes as with (2).

The rotor voltages have been measured between phases and between the terminals of the open phase; their variation in terms of the speed is interesting to notice. They diminish in a straight line law with increase of the speed as if the rotor were completely open, except between the speeds of 250 and 500 revolutions, where the voltages rise again and attain at 375 revolutions, a maximum value exactly the same as at standstill.

In fact, it is experimentally verified that at the synchronism of half-speed two fields show themselves in the rotor, each having the main value Φ; they rotate at a speed $v/2$ with respect to the rotor, the one in an opposite direction to the other. So far as the stator is concerned one of these two fields remains fixed and the other rotates in space at the speed v. It is this latter which produces the E.M.F. at the terminals.

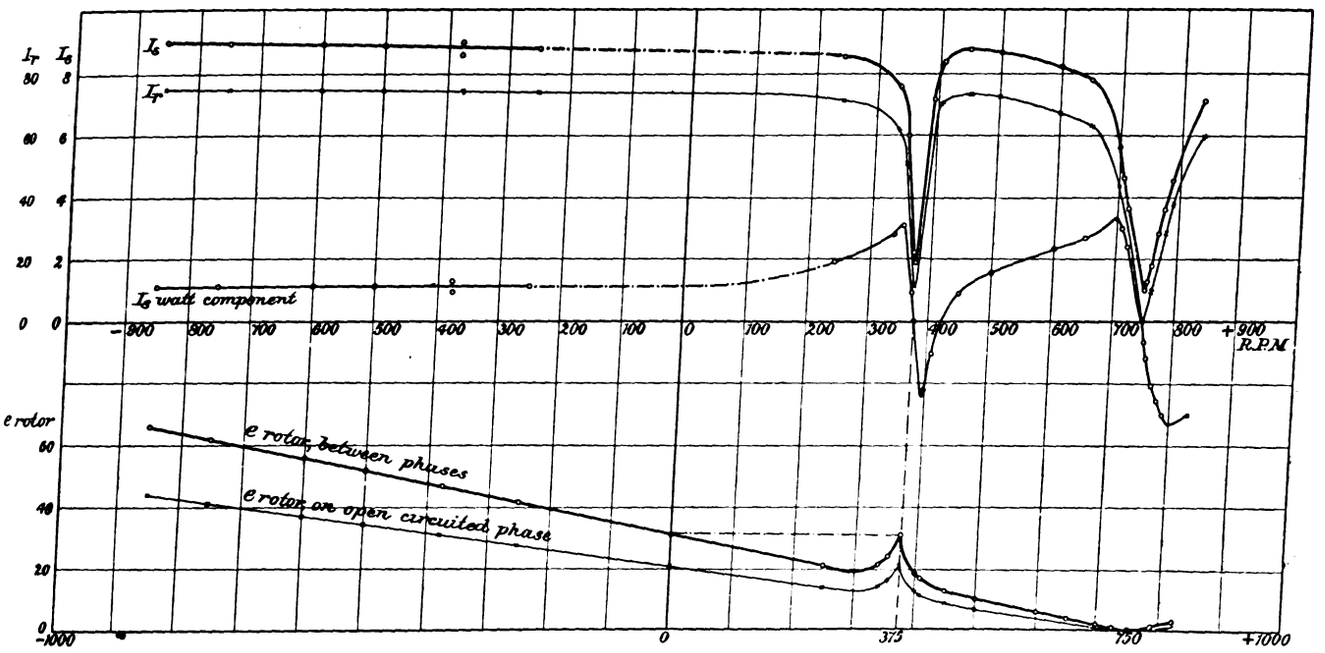

FIG. 17.

With these values we can draw the circles of the main currents and then construct the oval diagram of the resultant currents in the stator winding (Figs. 14 and 15).

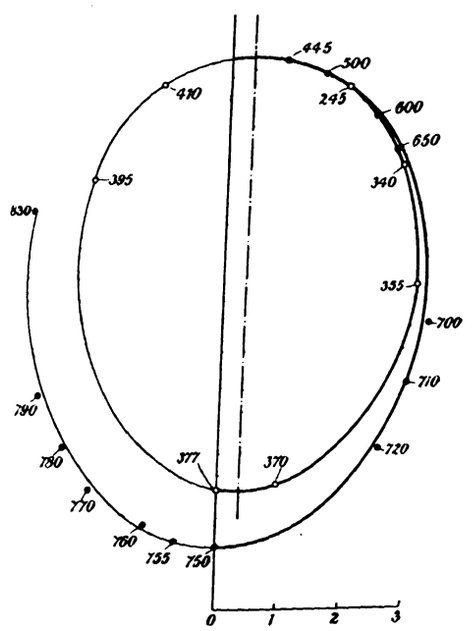

FIG. 16.

Experiments.—Complete measurements have been made on ie 175 H.P. motor with 250 volts between phases 50 ∽, the peed being varied progressively from −850 to +850 revs. per in. (Fig. 16); the voltage per phase retains the value $250/\sqrt{3}$ =145 volts at all speeds. The currents were measured simultaneously in two phases, also the watts per phase and the total atts; the readings have given entirely concordant results.

CHARGES FOR ELECTRICAL ENERGY SUPPLIED FOR TRACTION PURPOSES FROM COMBINED STATIONS.*

The joint Committee of representatives of the Incorporated Municipal Electrical Association and the Municipal Tramways Association (Messrs. J. Christie, S. L. Pearce, Thos. Roles, C. E. C. Shawfield, H. Talbot, S. J. Watson, T. P. Wilmshurst, and Messrs. H. E. Blain, J. Dalrymple, A. R. Fearnley, J. B. Hamilton, J. M. McElroy, Chris. J. Spencer) have very carefully considered the above question in all its aspects, and have come to the conclusion (subject to the reservations and general notes which follow) that the following broad principles should be adopted as the basis for the charge for electrical energy supplied for traction purposes from combined stations—viz.:

1. That the charge should be based upon the actual cost of production.
2. That in order to ascertain the actual cost of production it is necessary that the "standing costs" and the "running costs" should be properly

* Report drawn up by a joint Committee of the I.M.E.A. and M.T.A., and adopted by the I.M.E.A.

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separated, and the following allocation is suggested subject to the general observations subsequently made in this report, viz. :—

	Standing costs. per cent.	Running costs. per cent.
Coal	25	75
Oil, waste and water	25	75
Repairs :—		
(*a*) Building	100	—
(*b*) Steam boilers, piping, &c.	75	25
(*c*) Engines and generating plant	50	50
Repairs of joint mains in case of high-tension stations	100	—
Wages at generating stations	50	50
„ sub-stations	100	—
Salaries of operating officials	100	—
Rents, rates and taxes on joint assets (not including income tax)	100	—
Management expenses (salaries of administrative officials)	50	—
Interest in respect of all capital which is used in common for the various classes of supply	100	—
Depreciation in respect of all assets used in common for the various classes of supply	100	—

3. That the tramways department's proportion of the standing costs should be the ratio which the maximum demand for traction purposes at the generating station bears to the total maximum demand on the generating station, such maximum being arrived at in the same manner in each case as hereinafter set forth.

4. That the tramways department's proportion of the running costs should be the ratio which the total number of units delivered to feeders at the station for traction purposes bears to the total number of units delivered to feeders at the station for all purposes.

5. That the traction maximum demand should be taken to be the mean of the figures representing: (1) The maximum traction demand at any time of the year, and (2) the average of the daily maximum traction demand (Sundays excepted) taken over a period of a month coincident with the maximum demand on the station.

The method of ascertaining the traction maximum shall be taken as the maximum observed load, deducting therefrom 20 per cent.

6. That in cases where storage batteries are in use the figure to be adopted as the traction maximum demand and used for allocating to the tramways department their proportion of the standing costs under the headings of (*a*) rents, rates and taxes, and (*b*) management expenses, should be the generating plant maximum plus the battery; and for the purpose of allocating the remaining standing costs—*i.e.*, (*a*) coal, (*b*) oil waste and water, (*c*) repairs, (*d*) wages at generating and sub-stations, and (*e*) salaries of operating staff—the maximum demand to be adopted should be the maximum demand of the generating plant only.

That the two-hour rating of any storage battery should be deemed to be its kilowatt capacity, and that all repairs to the battery which could be used for the dual purpose of lighting and traction should be dealt with in the same manner as repairs to engines and generating plant. If, on the other hand, it is put in for purely traction purposes, it should be dealt with under the heading of repairs to exclusive traction plant.

7. That the total costs in respect of traction feeders and any other apparatus connected exclusively with traction distribution should be wholly allocated to the tramways department, such costs to include interest, depreciation and repairs.

8. That it is desirable, as a matter of ordinary commercial prudence, that there should be established in connection with electrical undertakings a suitable reserve fund for meeting any extraordinary expenditure in any year, and that the tramways department should bear their proper proportion of the annual sums to be set aside for establishing such reserve fund, but it should be an understading that the tramways department should be a party to the fixing of the annual amounts to be so set aside.

9. That the total actual cost of production of current for traction purposes may be summarised under the following heads—viz. :

(*a*) Proportion of standing costs (ascertained as per paragraphs 2 and 3)
(*b*) Proportion of running costs (as per paragraphs 2 and 4).
(*c*) Total cost of traction feeders, &c. (as per paragraph 7).
(*d*) Proportion of reserve fund (as per paragraph 8).

10. That the question as to what amount of profit (if any) should be paid to the electricity department by the tramways department is a matter which each municipality should settle for itself. The joint Committee have only endeavoured to lay down what they consider to be the correct method of ascertaining the actual cost of production, and upon which they suggest the charge should be based.

General Notes made by the Joint Committee.

Coal Allocation as between Standing and Running Costs.—The question as to the proper proportion of coal to be allocated to the standing costs received careful consideration by the joint Committee. From the evidence in their possession it would appear that the amount of coal which is consumed to make up for radiation losses differs somewhat in the various stations. The general information obtained showed that it averages from 4 lb. to 5 lb. per kilowatt of plant usefully employed per day. It is suggested by the joint Committee that each municipality should carefully go into this matter, with a view to ascertaining, as far as possible, the actual figure for their particular station. If, however, it is not thought worth while in any particular case to go into this detail, it is suggested that the division suggested by the joint Committee should be adopted—viz., 25 per cent. to standing costs and 75 per cent. to running costs.

Oil Waste and Water.—The joint Committee, after considering the allocation under this head, suggests that it should follow the division proposed in the case of coal. They recognise that this may not be strictly accurate, but they think that the smallness of the figure does not justify a different allocation.

Repairs to Steam Boilers, Piping, &c.—The figures suggested as the allocation under this head are not less than 75 per cent. to standing costs, the balance going to running costs. The joint Committee suggest that the figures should be settled for each station having regard to local conditions.

Salaries of Operating Officials.—Under this head it is suggested that only the salaries of those officials should be included whose services are devoted to generation and transformation of electrical energy.

Management Expenses (Salaries of Administrative Officials).—Under this head the proposal is to include the salaries of the administrative staff as apart from the staff engaged at the generating station. It would include the salary of the chief engineer, the secretary, the accountant and officers of that class. It will be observed that it is proposed to allocate only half of the management expenses to standing costs, the remaining half having no connection with the traction supply is eliminated from the calculations.

Interest and Depreciation.—The capital, it is suggested, should be that which is used *in common* for the various classes of supply, and should be ascertained by taking the total capital expenditure of the undertaking and deducting therefrom all items which are *not* used in common—as traction feeders, lighting feeders and distributing networks and services, meters, &c., motors (for hire), any other plant not used for the common supply.

In calculating the depreciation charges it is suggested that the "lives" of the various portions of the assets should be fixed in accordance with the actual provision made by the electricity department.

Method to be adopted for Accurately Measuring the Current Supplied for Traction Purposes.—The joint Committee suggest that all direct-current meters should be of the watt-hour type. When fixed in position where they are liable to be affected by stray magnetic fields they should be astatic, and of a type containing no iron or permanent magnets, and should not be affected by momentary overloads or short-circuits. Where meters containing permanent magnets or iron are used it is advisable that they should be shielded as much as possible.

It is further desirable that all meters should be calibrated for the temperature of the surrounding medium in which they will be located. For loads up to 2,000 amperes the total current type is recommended, and above this output the shunted type—each with its own shunt.

Where polyphase currents have to be measured "dynamometer" or "induction" type of meters may be used.

It is suggested that the two-wire wattmeter method should be employed as being the most satisfactory way of metering three-phase electrical energy.

The joint Committee recommend, having regard to the importance of reliable measurements being obtained, that in all generating stations three wattmeters should be arranged in series. One meter being the property of the tramways department.

In all important sub-stations they consider two wattmeters will suffice, one of which would also be the property of the tramways department.

Provision should be made for reference to an independent authority in the event of any dispute arising as to the accuracy of any or all of the meters installed.

Reservations Made by the Joint Committee.

Traction Maximum Demand.—The joint Committee in paragraph 5 have suggested a method of ascertaining the traction maximum which they are of opinion could be equitably applied to the majority of tramway undertakings in the kingdom; they consider, however, that it might not be applicable in every case where the "peaks" are accentuated or where the ratio of $\frac{\text{sustained maximum demand}}{\text{average maximum demand}}$ is of an abnormally high value, due to (*a*) geographical or (*b*) service conditions. As an instance of the former, they cite the case of those towns having very severe gradients on their system, and as an instance of the latter the case of those towns having to deal with football or other abnormal rush traffic.

Capital Charges.—The joint Committee have set forth in paragraphs 2 and 3, and further amplified in the "General Notes," what they consider the most practicable method of treating the question of the capital charges in the ascertainment of the costs of traction supply. They are aware, however, that circumstances may arise in connection with the development of electrical undertakings which might properly justify some departure from the method suggested.

They have had under their notice the case of stations where the principle of dealing with the capital charges on the "common plant" basis or the "pooling system," as it may be termed, would *not* be in the best interests of either the electricity or the tramways undertakings. They therefore suggest the following as an alternative basis which might be applied in cases which come within this category—viz. :

(*a*) That the tramways department's proportion of the charges for interest on capital expenditure in respect of generating and transforming plant and boilers should be based upon the cost per kilowatt for such plant at the time of its installation, the amount of such plant to be ascertained on the maximum demand principle already described, plus a reasonable allowance for reserve or spare plant to be determined in accordance with the local conditions.

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(*b*) That the tramways department's proportion of the interest on the capital in respect of land and buildings should be based upon the proportion which the kilowatt capacity of the traction plant bears to the total kilowatt capacity installed.

(*c*) That the depreciation charges should be determined in accordance with the paragraph under the heading of "General Notes" contained in this report.

The joint Committee cannot make any recommendations as to which of the two methods outlined should be applied in any particular instance. Each case should be settled on its merits, having regard to the local conditions, and, in the event of any dispute arising, the joint Committee suggest that provision should be made for referring the matter to an independent engineer for settlement.

The joint Committee desire to take this opportunity of acknowledging the special assistance which they have received in the work of drafting the report on this difficult matter from the sub-committee, consisting of Mr. S. L. Pearce (Manchester) and Mr. T. Roles (Bradford), representing the I.M.E.A.; and Mr. J. M. McElroy (Manchester) and Mr. C. J. Spencer (Bradford), representing the M.T.A. These gentlemen have devoted a considerable amount of time to the question, and it is largely owing to their efforts that your Committee are able to report at this date.

SOME NOTES ON ELECTRIC FURNACES.

BY J. HÄRDÉN.

The valuable contributions by Mr. Carl Hering, which have appeared from time to time in THE ELECTRICIAN on the subject of the design of furnace electrodes, have no doubt been welcomed by designers. Many difficulties, indeed, confronted the designer in the early days of electric furnaces, both as regards the best size of electrodes and the most efficient way of arranging them, and also, last but not least, where to get them.

Some 12 years ago the author had to design a graphitising furnace for carbon rods in Russia. The electric power available was direct current, about 3,000 amperes at 65 volts, no alternating current being obtainable at the works in question. The furnace was to be operated in series with a row of electrolytic cells and intended to absorb surplus power in a useful way. The carbon rods to be graphitised were about 3½ in. diameter by 4ft. long. Owing to these two facts the operation could not be carried out "in bulk," as is the practice at Niagara, but had to be a continuous operation. It was found subsequently that the best method under the circumstances was to pass three rods at a time slowly through the furnace.

At first, attempts were made to produce a large arc in a carbonaceous atmosphere. This method had, for obvious reasons, to be abandoned very soon. The arc behaved very well for 6 to 8 hours, but as soon as the interior of the furnace got well heated the furnace walls became part of its path, being conductive at that temperature, and even directing magnets had no beneficial influence owing to the irregular paths taken by the arc. Also, the rods to be treated got scorched and injured by the action of the arc.

In this connection it might be mentioned that the suggestion made by A. Mahlke, in "Met. and Chem. Eng.," Vol. IX., No. 1, p. 42, to broaden the active ends of the electrodes, so as to obtain a better distribution of the arcs and the heat in the furnace is not likely to be successful. Anyone who has had an opportunity to observe the arc, even in a furnace of the largest size, will have noticed how the base of the arc is always concentrated on a comparatively small area, which wanders about on the surface of the electrode. This is no doubt due to the fact that the arc requires carbon vapour of high temperature (or any other ionised medium of high temperature), and as this cannot take place at the same instant over the whole surface of the electrode, the arc will always be concentrated at its base. The same may also be observed in a mercury-vapour lamp; the arc forms only a comparatively small spot on the surface of the mercury cathode.

Reverting again to the graphitising furnace a further attempt was made to convert it into a resistance furnace in the following way: Two electrodes, about 6½ in. square, were placed inclined on opposite sides in the furnace chamber of firebrick. The bottom consisted of electrode stumps and stamped coke. The furnace was partly filled with granular charcoal, in which the electrodes were embedded about 7 in. or 8 in. Due provision was taken to prevent the current passing through the furnace walls, an arrangement similar to that used in the pig iron smelting furnace by Gronwall & Stalhane.

This arrangement would work satisfactorily for about a day or so; after that period, however, trouble began. In spite of the air being excluded as far as possible from the electrode collars the electrodes were consumed very rapidly just inside the furnace, while the active ends grew in thickness by the deposit of carbonaceous matter to such an extent that the electrode took the shape of an irregular mushroom, causing great difficulties in the regulating.

A final alteration was then made, which proved successful. The bottom of the furnace was built up on a hollow cast-iron plate, similar to that in a carbide furnace, two of which were also in operation at the works. Electrode stumps about 8 in. high were placed in carbon cement on the iron plate and the brickwork erected to form the furnace chamber. This bottom plate formed the positive electrode, while the negative one consisted of a 6½ in. by 6½ in. carbon suspended from above, by means of a water-cooled holder, through an opening in the furnace roof. The furnace chamber was filled with granular charcoal as before, in such a manner as to reach the upper electrode and sloping down at the sides, which prevented the current passing through the walls. The rods to be graphitised were passed three by three slowly through the glowing mass of charcoal, and allowed to cool in coal dust on a gantry. The rods were examined as to the degree of graphitising by tapping with a steel bar; the sound emitted gave a good idea of the process. Also the polishing effect was ascertained by rubbing.

One difficulty remained to be solved; the roof was soon destroyed in each case, and we may assume that this difficulty is still a great stumbling block, even to-day, in all electrode furnaces. In the above instance, the problem was solved in this way: The roof of the furnace was protected by means of scrapped or curved carbon electrodes, separated and held by means of wedge-shaped high-grade fire bricks, to prevent leakage of current. After some adjustment this type of roof could be made to last for 8 or 9 months, even when run continuously day and night at a very high temperature, and despite the fact that the furnace was emptied and recharged every 24 hours, a considerable fall in temperature taking place during this process; in fact, this refilling was the primary cause of the rapid breakdown of the original brick roof. One top electrode would, under these circumstances, last four to five days, its dimensions being, as already stated, 6½ in. by 6½ in by 4 ft 6 in., and the current 3,000 to 3,500 amperes at 40 to 45 volts. As far as known to the author the bottom needed no repair at all during four years.

A curious incident during the trials with the arc design led to a number of further experiments and also some patents. When the large arc was started, violent rushes of current took place, the whole furnace being cool. This was strongly objected to at the power station, as it caused considerable surging between the large engines running in parallel—the regulating device of the steam engines was of such nature as to be particularly sensitive in this respect.

While awaiting the construction of a suitable starting resistance (an iron band immersed in running water) a makeshift was employed to start the arc, and also to prevent it extinguishing. This consisted of a spark coil, made to discharge between the electrodes. In order to prevent the spark taking any other way than was intended, a condenser was connected to the sparking circuit and a primitive inductance in the power circuit. By this means it was possible to start the arc without any serious current rush, and the tendency of the arc to go out before the furnace was heated ceased, if the spark was kept going.

This device was first tested with a smaller arc and narrower electrodes. It was then observed that the tips of the electrodes got more quickly graphitised and that the graphite formed was of a more flaky appearance when the spark had been in operation for some time, but only under certain conditions. The whole phenomenon was at first thought merely to be accidental, but on further investigation it was found that the graphitising could, under favourable conditions, be somewhat

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accelerated by introducing condenser discharges of practical magnitude. A specially made spark coil and a suitable condenser were, therefore, installed and put into permanent use. The workmen were protected from the discharge by means of thick mica shields surrounding the auxiliary electrodes through which the discharges were introduced into the furnaces.

Other and more pressing work prevented a more systematic and exhaustive investigation as to the efficiency of the methods. It may be said, however, that its use appeared to be justified. The workers, a man and a boy per shift, were paid by piecework for a minimum number of rods, passed by the foreman after each shift, and an additional bonus for each extra rod passed. It was regularly found that if the spark coil had been out of operation for some time during a shift the number of rods passed decreased, and the rejected rods had to be sent through the furnace again, therefore the workmen showed a keen interest in keeping the coil in working order.

As there was no alternating current available at the works, the coil had perforce to be operated by direct current at 125 volts. Anyone who has had the task of keeping a large coil, giving a heavy 12 in. to 14 in. spark in operation day and night without breakdown for several months at a time will testify that the finding of a suitable interrupter is by no means an easy problem. At first, the ordinary mercury make-and-break, consisting of two motor-driven vertical pins was tried, but it was soon found that this did not answer. The pins were rapidly worn out, regardless of the metal used; besides, the mercury soon clogged in spite of a thick strata of oil over it. Carbon rods lasted longer, but the spark was greatly diminished, owing to insufficient rapidity of break.

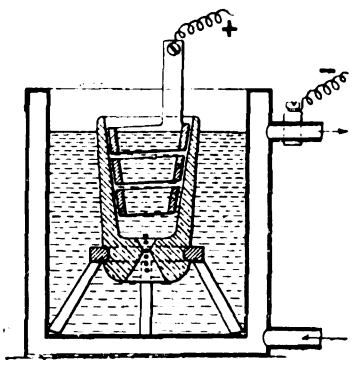

FIG. 1.

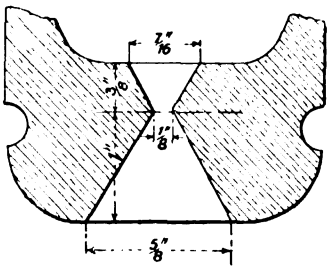

FIG. 2.

A turbo-interrupter was then tried in which a mercury jet was projected in the well-known manner against a toothed iron wheel, moving in oil or cooling liquid. Even this proved futile, as the teeth of the wheel were soon worn off by the sparking, and the mercury got so clogged in three to four days that it had to be replaced. To prevent this latter nuisance a jet of coal gas was introduced into the vessel, so as to prevent oxidation; but even this measure, though it did some good, did not sufficiently reduce breakdowns.

The electrolytic interrupter was finally resorted to and, in spite of its low electric efficiency, proved to be more satisfactory than the others. A platinum point, as introduced by Dr. Wehnelt, was first tried, but was soon destroyed by the current. After a good deal of experimenting it was found to answer the purpose best if a large porcelain insulator drilled through the top, without any metal point at all, was used.

As indicated in Fig. 1 the insulator was suspended in a double-walled vessel of lead, cooled by running water. A lead spiral formed the inner, or positive electrode; the active liquid was sulphuric acid of about 1·14 specific gravity. The paper condenser in the base of the coil was not in circuit while this interrupter was at work.

With this device it was found quite possible to keep the coil going day and night for many months, only stopping about every fifth day for cleaning and replacing of the acid, which was gradually vaporised, but such stoppage only required about 15 to 20 minutes. The hole drilled in the insulator was gradually widened by the action of the current. It had to be replaced about every three months, for which purpose a spare one was always kept.

At first some difficulty was found in the tendency of the apparatus to act as a pump. In some cases the acid was driven out through the bottom hole into the outer vessel, causing the working to be irregular and producing much heat. Again, with another insulator substituted, the acid rose in the inner room so as to overflow and cause a short-circuit. It was soon found that the shape of the hole was responsible for this behaviour. If the hole sloped too much upwards the gas bubble causing the interruption exploded upwards, thus driving the pile of liquid up into the inner vessel, causing a surging from underneath, so that the liquid in the outer vessel rushed inwards. If this happened rythmically, as was often the case, the insulator was soon filled to overflowing. On the contrary, if the boring widened too acutely downwards the bubbles burst outwards and drove the liquid into the outer vessel.

In Fig. 2 is indicated the correct shape of the boring, with which no surging took place. The hole should be well polished, or preferably glazed, when the action is much minimised. The period of interruption was adjusted by means of a variable inductance in the primary circuit, so as to give the best effect. Large glass condensers were used in the secondary circuit to produce the oscillations necessary. With this arrangement the breakdowns were very rare, and the whole apparatus could be left for four to five days without inspection.

NEW ELECTRICITY SUPPLY STATION FOR EGHAM AND STAINES.

The laying of the foundation stone of the power station by the Rt. Hon. Sir T. Vezey Strong (Lord Mayor of London), on Saturday last, marks the inception of the last stage in the provision of a public supply of electricity in the districts of Egham and Staines, two small county towns on the banks of the Thames some 20 miles from London.

The history of the supply really starts in the year 1904, when Mr. Powell erected a small power station on premises in the rear of High-street. From this station current has been supplied down to the present time to a number of the principal shops and places of amusement in Egham. In 1907 statutory powers were obtained, subject to the undertaking, within a period approved by the Board of Trade, being transferred to a limited company.

At this juncture Messrs. Handcock & Dykes were retained to advise on the development of the undertaking; and as the question of a public supply of electricity in Staines was becoming a pressing matter, and it was obviously to the advantage of both districts that their supply should be from one source, a further provisional Order to cover the Urban District of Staines was obtained in 1909.

All the powers obtained were then transferred, with the consent of the Board of Trade, to the Egham & Staines Electricity Co., as the new company is called.

A suitable site for the generating station having been found nearly midway between Egham and Staines, Messrs. Handcock & Dykes were instructed to complete their plans, which were for a high tension scheme and a Diesel-engine station, and to apply for the approval of the Board of Trade to the system proposed, the latter as mentioned below, containing some novel features entailing special consideration on the part of the Board. On this approval being obtained, specifications were prepared, and early in 1911 tenders were invited for the necessary works.

Under the new Electric Lighting Act, notices were served on owners of property in the neighbourhood of the proposed site of the generating station, and unfortunately some objections were made, thus rendering it necessary for the Board of Trade to hold an inquiry. This could not take place before July 19, and, meantime, neither the building of the station nor the erection of the machinery could be proceeded with, thus rendering it impossible for the station to be erected in time to supply current, as hoped, early in September. The result of the inquiry was, however, favourable, and immediately on receiving the authorisation of the Board of Trade in August, not a moment was lost in commencing the erection of the buildings. It is expected that the station will be complete, ready to commence the supply of current some time in December next.

The station, far from being a detriment to the surrounding

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property, will be a distinct addition from an architectural point of view. The absence of any chimney shaft and of any dust and dirt, secured by the use of Diesel oil engines, gives the whole an appearance which compares very favourably with that of the gas works that are on an adjacent site.

The first instalment of plant will consist of two Diesel-type crude oil engines, each direct coupled to a 100 kw. 2,000-volt single-phase Crompton alternator with direct-coupled exciter. The engines are of the vertical three-cylinder type, running at 250 revs. per min., and have been made at Messrs. Mirrlees, Bickerton & Day's works. The circulating water for cooling the cylinders will be passed through one of Little's patent water coolers.

The main switchboard, which is now on view at the Electrical Exhibition at Olympia, is of the most modern high-voltage cellular type, made by The Electric & Ordnance Accessories Co., and consists of six enamelled slate panels carrying the necessary instruments and handles for operating the high-tension switchgear fitted in fireproof cubicles behind the panels.

The system of distribution consists of paper-insulated lead-covered and armoured high-tension concentric cables laid in the ground, some seven miles having already been laid. At central positions in both Egham and Staines transformer kiosks have been erected in which the high-tension current will be transformed down to a pressure of 100 volts, and distributed throughout the principal streets by about 4 miles of low-tension three-wire cables.

Under the system approved by the Board of Trade the low-tension mains may either be ordinary armoured cables laid underground or special metal-sheathed conductors fixed on the fronts of the houses, thus obviating the necessity for opening up and disturbing the foot-paths whenever a new service is required, and enabling a supply to be given in certain cases where otherwise the demand would not be sufficient to warrant the cost of extending the underground mains. In other portions of the district houses will be supplied direct through transformers fixed in the houses themselves.

One of the most interesting features of the supply is that with the special permission of the Board of Trade one pole of each consumer's supply is "earthed" in the house fuse box, so that if desired the "earthed concentric" or "single wire" system of wiring can be adopted without having to interpose a double-wound transformer between the consumer's installation and the supply mains. By adopting this system only one insulated wire is required instead of two, and only single-pole main switches and distribution fuses are necessary, thus admitting of a considerable reduction in the cost of house wiring.

In accordance with the Board of Trade requirements a removable link is fitted in the house fuse boxes to connect one pole of the main service cable to the "earthed" terminal of the fuse box (this terminal is fixed direct on to the case of the fuse box), and thus to the lead and outer armouring of the mains, so that by removing this link the continuity of the return can be tested at any time exclusive of any leakage through earth.

A flat rate of 6d. per unit has been adopted, and there is also an alternative method of charging which is expected to prove very popular. For a slight additional meter rent, a special two-rate meter will be fitted and current supplied at the low price of 2d. per unit for all purposes whether the energy be used for lighting, heating or power, except during three hours per day, when the price will be 7d. per unit. The time when the three-hour period commences, varies from about 5:30 p.m. on the shortest day to 7:30 p.m. on the longest.

The feature of this system of charging is that separate wiring is not required when it is desired to connect up heating and cooking utensils, whilst the low rate of 2d. per unit encourages the long use of lights in bedrooms, passages, &c., during the night time, and also outside shop windows until a late hour in the evening. If desired also, a fixed price per lamp will be quoted, the charge for small installations of only a few lights being approximately 2½d. per lamp per week.

At the present time the applications for supply represent about 60 kw., so that by the time the station is completed the plant should be well loaded. Mr. F. W. Strickland has been appointed engineer and manager, and has already taken up his duties.

At the laying of the foundation stone last week, Mr. A. H. Dykes explained the main features of the scheme. The presence of the Lord Mayor of London attracted a considerable number of sightseers, and in spite of the stormy weather, the ceremony was a great success.

The Lord Mayor, in responding to a vote of thanks moved by Mr. W. A. Schultz, J.P., said that in his opinion an undertaking such as that at Egham should be run at the expense and risk of the individual, and not of the State. He also considered that in an enterprise of this character the best results are obtained, and the largest economies effected, when it is controlled by individuals who are prepared to take considerable financial risks.

THE BALLOON AS A WIRELESS TELEGRAPH RECEIVING STATION.*

BY P. LUDEWIG.

As very little has been published regarding the wireless stations which are fitted on balloons, the author determined to describe some tests on this subject made by him at the beginning of the year. The object of these tests was to pick up with the simplest arrangement of apparatus the waves sent out from wireless land stations.

The crux of the problem lay in the arrangement of the antenna, which was made in two parts, between which the receiving apparatus was connected. As regards the receiving apparatus itself, a choice was made of those employed in practice.

The following was the arrangement employed: When the balloon was half filled a wire was wound round the equator of the gas bag, being interwoven through the protecting cordage; and the end of the wire was placed in the basket. This wire formed the upper half of the antenna. To form the lower half a heavy wire was dropped from the basket after the balloon had risen. Fig. 1 shows the completed arrangement.

As the object of the tests was to discover with how simple means picking up of messages was possible, a very simple apparatus was chosen. A Schlömilch cell was used as receiver, and this was connected direct to the antenna, as shown in Fig. 2, in order that the room taken up should be as little as possible. With this arrangement accurate tuning was, of course, impossible. Approximation

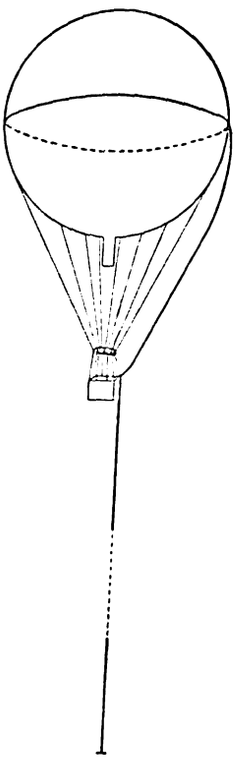

FIG. 1.

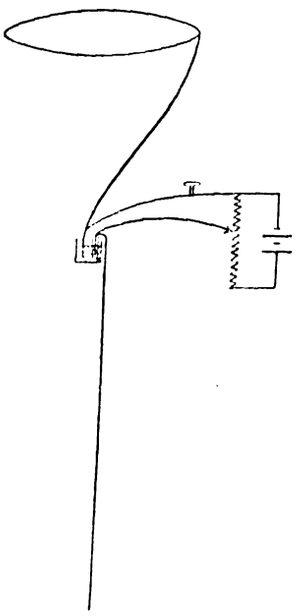

FIG 2.

to the wave length of 500 metres at the sending station was obtained when the wire from the basket was 125 metres long, or equal to $\lambda/4$.

The choice of some simple receiving station also solved the problem as to whether damped or undamped waves should be used for sending, the small tuning capacity of the receiving station making the use of the first-named a necessity. As sending station the 30 m. (100 ft.) high "T" antenna at the Electrotechnical Institute of the Frankfort Physical Society was used. This station employs the Braun method, highly damped waves with close coupling being used.

During the first tests in March, 1911, which lasted two hours, the balloon was 50 km. (31¼ miles) away at a maximum height of 600 m. (2,000 ft.) from the ground. At this height the signals received were not so clear as when the balloon was lower down.

During a second test on March 23rd three balloons were used, the stations at Göttingen, Darmstadt, Karlsruhe and Frankfort being employed for sending. The first three of these transmitted singing sparks, the latter working on the Braun system with a frequency of 50. The signals from Frankfort and Darmstadt were heard quite easily, but the other two could not be heard. During the time Göttingen was sending, signals with a frequency of 50 were received, and a message was received so quickly as to be unintelligible. Subsequent inquiries show this to have been transmitted from the balloon belonging to the Telegraph Battalion at Coblentz.

* Abstract of an article in the "Physikalische Zeitschrift."

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With "THE ELECTRICIAN" for Sept. 14, 1906, was issued the first of a series of "Industrial Supplements," to be published from time to time with "THE ELECTRICIAN." The fifty-third issue of the Supplement published (Gratis) with the number of "THE ELECTRICIAN" for September 23, 1910, was the last of the monthly issues. "THE COMMERCIAL AND INDUSTRIAL SUPPLEMENT" to "THE ELECTRICIAN" is now issued weekly (Gratis). It will be found towards the end of the present issue.

SPECIAL NOTICE

The present number of "THE ELECTRICIAN" completes Vol. LXVII. The Index to the Volume will be issued (Gratis) on October 20th.

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CAR METERS.

Central station engineers on the introduction of the metal filament lamp consoled themselves with the prospect of obtaining additional consumers by means of its economy compared with the lamps previously in use. Experience has shown that in this they were not disappointed. The reduction in energy consumption brought about by the recent extensive adoption of car-meters by tramway undertakings does not offer, however, any compensating prospect of increased business for the supply authority. Indeed, it is possible in some cases that a worse load-factor may have to be faced as well as a smaller output. Where a flat rate of charging for energy is in force, the changed state of affairs may necessitate a reconsideration of the method of charging. In this connection, attention may be called to the Report, which will be found set out elsewhere in this issue, by a Joint Committee of the Municipal Electrical Association and the Municipal Tramways Association.

That the installation of meters on the cars has a beneficial effect in reducing the energy consumption, by making the motorman more careful in handling his controller and brakes, has now been decisively proved, although a few tramway managers, among whom is Mr. J. B. HAMILTON, may possibly dispute that the advantages thereby obtained

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are material. Recent discussions have, in fact, centred more round what is the most satisfactory type of car-meter to adopt than on whether any advantage is obtained by using meters. Ampere-hour and time meters have each their advocates, whilst watt-hour meters have of recent years gone out of favour, largely owing to troubles with the pressure coils. Although the main features and advantages of each type of meter have been discussed on numerous occasions, the Paper presented by Messrs. R. G. and J. G. CUNLIFFE at the Annual Conference of the Municipal Tramways Association last week is by far the most careful examination of the subject that has been published. The electric tramway industry is already indebted to the above members of the staff of the Manchester Corporation Tramways for several important contributions to the technical side of tramway operation, and the present Paper is likely to remain a standard of reference for some time to come.

As will be seen from our abstract of Messrs. CUNLIFFE'S Paper elsewhere in the present issue, the subject is more complicated than appears at the outset, and apart from errors depending on the type of meter employed, the variation in voltage of the overhead line and local conditions prevent reliable comparisons being made between the energy consumption of cars on different routes, or even sections of the same route. This last feature is clearly shown by the readings taken on the Palatine route in Manchester. In the centre of the city where, as the authors remark, motormen have their attention fully taken up in getting their cars through the traffic, the energy consumption averages 2·26 units per car-mile, the motors being run on the series notches of the controller. On passing into less crowded thoroughfares the energy required decreases to 1·99 units per car-mile, the running being mixed series and parallel; whilst on the suburban part of the route only 1·395 units per mile are taken, the motors running in parallel for considerable periods. The average speeds at which the above sections of the route are traversed are 5·39, 8·52 and 10·9 miles per hour respectively, whilst the periods during which current is taken from the overhead line are 5·28, 3·35 and 2·99 minutes respectively per mile traversed. The above figures repay careful study, since they embody the characteristics of each type of running. Another feature which must not be lost sight of in making comparisons, is that the necessity of maintaining schedule time may prevent, on some routes, the motormen from economising current as they would under other circumstances.

One of the most valuable parts of the Paper describes the investigation of the accuracy of various meters under working conditions. In this connection the liability to considerable error in watt-meter readings on varying pressure and current will probably come as a surprise to many engineers; whilst the ampere-hour meter is found to measure the two components—current and time—with great accuracy. In order, however, to obtain reliable information from its readings, since the authors show that an exact determination of the power consumption is desirable, it is necessary to ascertain the average pressure during the period in question. For this purpose the authors have introduced a volt-hour meter (which was described in our columns last week). This instrument should also prove of considerable utility to other than tramway engineers. If it were necessary to instal this instrument on every car, in addition to another meter, we think that the additional cost and complication would prevent its general adoption; but it should be possible to obtain sufficient information as to the pressure from readings taken at the end of each journey, from a single car fitted with a volt-hour meter on each route. It has, we think, generally been admitted that the time meter is not in itself a sufficient check on the motormen, but its readings in combination with those of energy meters are of much interest. Though these readings may be very misleading as regards the relative power consumption, there is no doubt that where time meters have been installed considerable benefit has resulted, for the fact that the motormen are aware that some record is being obtained of their operations is sufficient to bring about more careful running of the cars. The extra regard thereby paid to the condition of the brakes is a case in point. We regret that Messrs. CUNLIFFE have apparently confined their attention to energy consumption, and that particulars have not been given as to the effect on various parts of the car equipment of installing meters. Thus, it would be interesting to know whether controller repairs are increased where time meters are employed, owing to the tendency of these meters to encourage too rapid handling of the controller.

An inspection of the annual reports of tramway managers issued during the past few months shows the widespread satisfaction at the results of using meters, as typical of which we may draw attention to the remarks of Mr. A. BAKER, general manager of the Birmingham Corporation Tramways, at the meeting last week. On his tramway system, with 300 meters in use, a saving in current equivalent to £5,000 has been made in nine months, in spite of an increase of a quarter of a million car-miles. Such experience is sufficient argument for the use of meters even where a tramway department possesses its own generating station, although, of course, the fact that any diminution in output increases the capital charges and wages per unit reduces the advantage in the latter case. This consideration is certainly an argument in favour of a combined station, so that the whole of the plant may be utilised to the best advantage.

OBITUARY.

WILLIAM SHUTER.

We regret to announce the death of Mr. William Shuter, which occurred at his residence, 22, Belsize-grove, London, N.W., on October 3rd. Mr. Shuter, whose name was for so many years associated with the Telegraph Construction & Maintenance Co., was born on September 11, 1829. He commenced business life as an accountant with the firm of Deloittes, leaving them in 1856 to join Messrs. Glass, Elliot & Co., who had just taken over the business of W. Kuper & Co., wire rope makers, and were about to embark in the enterprise of making submarine telegraph cables. In 1864 Messrs. Glass, Elliot & Co., who had so far shared with Messrs. Newall almost all the contracts for telegraph cables constructed up to that time, amalgamated with the Gutta Percha Co. of

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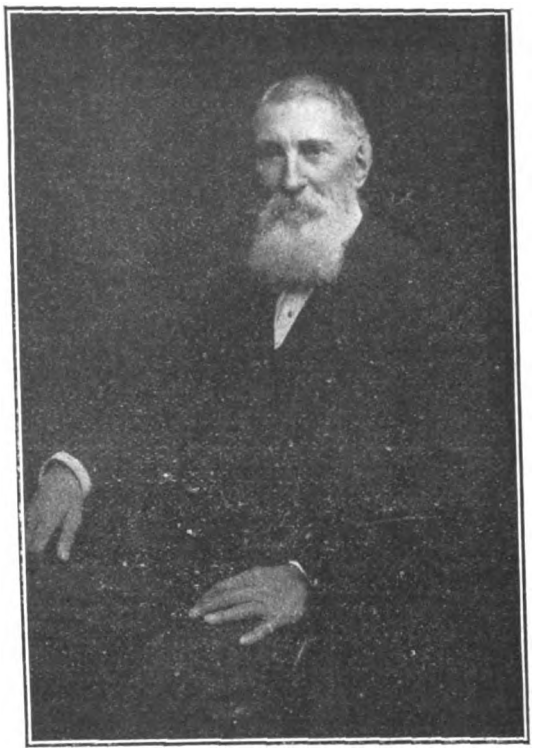
City-road, London, under the title of the Telegraph Construction & Maintenance Co., and Mr. Shuter was its first secretary. In 1882 he was appointed manager, and in 1894 managing director. On the death of Sir Robert Herbert in 1905, Mr. Shuter was elected chairman of the Company, which office he held until he resigned in 1909.

This Company has, during the 45 years that Mr. Shuter was associated with it, been engaged in the construction and submergence of more than two-thirds of all the telegraph cables in the world; he was in this way connected with the progress of submarine telegraphy from its inception; he saw many great contracts carried out successfully, including the one for the Imperial Pacific Cable, and when, in 1909, he terminated his long and valued services to the Company it was with the general regret of his colleagues, the staff, and all who came



WILLIAM SHUTER, BORN SEPT. 11, 1829—DIED OCT. 3, 1911.

into personal contact with him, to whom he endeared himself by his kindly manner and amiable nature. He was a strong personality, a shrewd man of business, and, like most successful men, a decided optimist—never afraid of taking risks or of accepting responsibility; and it is largely due to his wise financial guidance in years gone by that the Telegraph Construction & Maintenance Co. is the powerful corporation which it is to-day.

Mr. Shuter's funeral takes place to-day, Friday, at 12:30 p.m. at the Parish Church of St. John, Hampstead.

REVIEWS.

Manuale del Ingegnere Elettricista. By A. MARRO. 2nd edition. (Milan, 1911: Ulrico Hoepli.) Pp. xxv. + 862.

To most engineers, in spite of memory training systems, a good pocket-book is indispensable. The data and formulæ contained in it should be conveniently arranged, concise, and, above all things, reliable. It should not aim at supplanting the student's text-books or the specialist's treatises, but it should afford such information to the operating or constructing engineer as to enable him to use his practical knowledge quickly and efficiently, and without the brain-fag of memorising lists of formulæ. The present little work very fairly fulfils these conditions. In the first place its size is convenient—reasonably a pocket-book—yet its scope is wide, and its information exact and up to date. A good beginning is made in the three opening chapters, which give the fundamental principles of electrostatics, magnetism and the electric circuit. With the increasing development of extra-high-tension transmission frequent reference has to be made to electrostatic principles, and in this section the reader will find what he requires, with just sufficient explanation to render the formulæ intelligible. In fact, this attribute is characteristic of every section in the book.

Chapter IV. deals with instruments for and methods of measuring current, E.M.F., resistance, capacity, inductance and power, with the addition of useful notes on magnetic and photometric tests.

The next three chapters provide extensive data on central station plant: dynamos, alternators, prime-movers, transformers and converters. The notes on relative efficiencies, and the other factors that determine the choice of prime-mover, are all based on the most modern practice, as instanced by the figures given for Diesel engines.

Consuming devices—motors, incandescent and arc lamps—occupy the next two chapters. The summary of the theory of A.C. motors, including Heyland's diagram, is clear and helpful.

Chapters X. and XI. are devoted to systems of distribution which are treated with exceptional fulness and accuracy for a book of this kind. The comparative figures of merit for iron, aluminium and copper as conductors, are given, as also the simpler formulæ and methods of calculating cables and networks.

The installation of aerial lines, underground cables, batteries, transformers, motors and lamps is discussed in the next two chapters. The calculation of tramway systems has a chapter to itself, while the remainder of the book is nearly all taken up by a reprint of the regulations of the Verband Deutscher Elektrotechniker, and extracts from the Italian laws relating to electrical installations. In the final chapter some of the more recent applications of electricity are briefly described, such as copper and silver refining, the production of ozone, carbide of calcium, carborundum, with notes on the power taken by cooking appliances and machine tools. The mathematical tables, including logarithms, squares and cubes, standard differentials and integrals, form a useful appendix.

The book is essentially one for the engineer dealing with heavy work. No reference is made to telegraphic or telephonic instruments, and little or no data are given on house-wiring or the lighter accessories, such as switches and fuses. To the Italian engineer of experience, unable to consult his office records, this little book would be a helpful guide; to the average British engineer, the language and the metric system would probably prove insuperable barriers. J. R. D.

Enclycopédie Electrotechnique. Vol. V. INDUCTION ET COURANTS ALTERNATIFS. By EUGENE VIGNERON. (Paris, 1910: L. Geisler.) Pp. 147.

This book, which forms the fifth volume of an Electrotechnical Encyclopædia, though hardly corresponding with our English ideas of an alphabetically arranged series, is another example of the remarkably erudite and elegant theoretical treatises with which French engineers frequently present us and which one would hardly have expected from practical men. The author makes an attempt to develop in a clear and logical form, the theory of induction and of alternating currents starting from the experimental basis of Faraday's discoveries. While, however, the mathematical reasoning is brief and clear if somewhat academic, we confess to some difficulties over the logic or basis of the theory. After mentioning that the theory of induction must have an experimental basis, and stating that this is afforded by the experiments of Faraday, the author proceeds to mention some experiments which are practically similar, and then builds up the general expression for the current as depending upon the difference between the impressed E.M.F. and the time rate of change of the flux. But we are then told that Faraday's discovery was simply that this formula holds good even when the impressed E.M.F. is zero, and that there is therefore no discontinuity in the formula. Surely it would be more correct to say that the whole basis of the theory of induction lies in Faraday's experiments, and that the complete formula is a generalisation from them by logical reasoning, and which is found to be in conformity with experiment.

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in all cases. We are sorry also to see that the author constantly speaks of extra *currents* instead of induced E.M.F.

One other point which seems open to criticism is the treatment of certain discharge problems by energy principles. It is certainly true that the mathematical working is thereby greatly simplified, and that correct results are obtained in the special case selected; but there is just the same fundamental error as in attempting to solve dynamic problems on the basis of energy rather than momentum, and the student might be led to apply these methods in absolutely unsuitable cases.

But, apart from these somewhat debatable points, we can cordially recommend this book as presenting its subject in as simple and clear a manner as orthodox mathematical methods will permit. One of the best features is the extremely neat and simple proof of Neumann's mutual induction formula from elementary principles, a clear understanding of which is much needed, even by the majority of mathematical physicists.

The alternate-current section does not call for much comment, except to mention that it puts the ordinary theory clearly and concisely, that the vector diagrams are good and well explained, and the vector theory of Steinmetz well developed. C. V. D.

Electric Wiring, Fittings, Switches and Lamps. By W. Perren Maycock. 4th edition. (London, 1911 : Whittaker & Co.) Pp. x. + 628. 6s. net.

This comprehensive work has been brought up to date in this—the fourth—edition. The author has in some measure defeated his object by attempting too much. We ventured upon this criticism in our review of the previous edition, and the present volume confirms the opinion which we then expressed—namely, that there are sections of the book which might with advantage be developed as separate volumes. However, the author has adhered to his original plan of crowding the largest possible amount of information within the compass of a single volume, which numbers over 600 pages. The book is mainly divided into sections, which deal with wiring and wiring methods, circuit accessories of every description, illuminating units, electric signs and electric heating, small motors, bells, telephones, fire-alarms and clocks. As a complete repository on the subject of wiring from the main terminals to the electricity consuming devices the book has everything to commend it. As a publication of this nature it lays itself open to criticism, being of the catalogue order. The book is intended to serve as a wiring text book for students, but we cannot help thinking that the multiplicity of subjects dealt with by the author in his efforts to produce a comprehensive work will lead to some confusion. This particularly applies to the great variety of wiring diagrams. In practice so few of these are required that the wireman seeks the information which he needs at the moment from the pages of a switchmaker's catalogue.

We think the scheme of indexing the numbered paragraphs in the book is clumsy and misleading. It would have been far more convenient to index the items by the pages on which they appear.

Compulsory Working of Letters Patent. By F. W. Beney. (London : W. Clowes & Sons.) pp. 15. 3d.

Much has been written on the effect of sec. 27 of the Patents and Designs Act, 1907, which is commonly known as the compulsory working clause, but few writers have studied the question from the imperial point of view, and therefore we are glad to see that Mr. F. W. Beney, who has made a special investigation into the subject of the feasibility of unifying the patent law and practice of the different parts of the Empire, has published a general review of the situation as it presents itself to him after three years' working of the Act. In the "Empire Review" for January the author pointed out the difficulties to be overcome before uniformity could be attained throughout the Empire. The subject is, indeed, an important one from the industrial and economic points of view. It came before the recent Imperial Conference at one of its sittings, but nothing tangible was done, though there was general agreement as to the need for uniformity in the patent laws of the various parts of the Empire. In his interesting pamphlet on "The Compulsory Working of Letters Patent in its Imperial and Economic Aspects" Mr. Beney pleads for the abolition of the working conditions in the case of patents granted to imperial citizens, and for the exoneration of foreign patentees from the obligations of sec. 27 where they reside in a State that is willing to grant us reciprocal advantages. Like ourselves, the author thinks the form of sec. 27 too drastic; it is useful for certain purposes, but when applied universally it has serious disadvantages. We do not intend again to detail these drawbacks, but we recommend those of our readers who are interested in this question to read Mr. Beney's pamphlet, which is clearly and cogently written.

TENTH ANNUAL CONFERENCE OF THE MUNICIPAL TRAMWAYS ASSOCIATION.

The Municipal Tramways Association held their annual conference last week at Glasgow, under the presidency of Mr. J. Dalrymple, general manager of the Glasgow Corporation tramways. The proceedings opened on Wednesday (September 27th) in the Council Hall of the Glasgow City Chambers. The Lord Provost (Sir Archibald McInnes Shaw, LL.D.) welcomed some 180 members of the Association to Glasgow in his usual racy, military style, and dwelt upon the mutual support such an Association could give to individual members, tending to develop, as it did, the exchange of ideas and the further improvement of electric traction for the common weal. He instanced Glasgow as having probably the cheapest tramway fares in the world; but some of the community still wanted a further reduction. The 1½d. two-stage fare had, he considered, been a huge success. Bailie Russell (Glasgow) also spoke, and said the Association had justified its existence.

Mr. Blain (West Ham), on behalf of the Association, thanked the Corporation of Glasgow for their welcome. Glasgow was, he said, considered the Mecca of all tramway experts, on account of the ideal manner in which the system was there organised and conducted.

Mr. Dalrymple then took the chair and delivered his presidential address, of which the following is a brief abstract:—

PRESIDENTIAL ADDRESS.

In his address Mr. Dalrymple said that, although their Association was one of the youngest and smallest connected with municipal work, it was among the most vigorous. He thought it a pity that the tramwaymen of this country should be divided into two camps; and it looked as if the two Associations were to drift further apart, seeing that the Municipal Tramways Association had just got their charter of incorporation. He hoped, however, it would be possible for the two Associations to work together.

In regard to the Papers that had from time to time been read and discussed, he was anxious that members should take up what might be called the small change of tramway management. Thus "track construction and maintenance" was too comprehensive a subject for one Paper. The track might be subdivided into 10 or 12 sections, each of which provided sufficient material for a Paper and discussion. Similarly with rolling stock. His object was to put in a strong plea for careful detail work.

At the present time they were watching very carefully the operation of rail-less cars in Leeds and Bradford, and developments in America in connection with storage batteries. Nearly all the large American street railway companies were collecting the fares of passengers on the platform before they entered the car.

The President next referred to the changes in Glasgow rolling stock of recent years, and finally mentioned what was being done as regards investigating the cause of rail corrugation and a basis for fixing the charge for current supplied to tramway departments.

Mr. C. J. Spencer (Bradford) moved a vote of thanks to Mr. Dalrymple, who, in replying, said the Executive of the Association were at present negotiating with the Board of Trade for small tramway systems to obtain powers at a reasonable cost to run trackless trolley cars.

Councillor W. Nelson (sub-convenor of the Glasgow Cor-

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poration tramways) then read a Paper (of which the following is a summary), entitled :—

"The Common Good of the City of Glasgow, its Origin, History and Present Position in Relation to the Tramways Undertaking."

The "common good" originally commenced with the common lands belonging to the community, and has developed until the total revenue from all sources last year amounted to some £175,000; whilst the expenditure, including over £6,619 donations to charities, was £119,000. To this revenue the tramways, which by a recent Act of Parliament are deemed to have always been part of the Common Good, contributed last year £68,678. Part of the balance in 1910 was used to reduce the parks rate—a rate falling wholly upon occupiers—by 2d. in the £1. This year the balance is to go to a suspense account for the removal of undesirable property in congested districts within the city.

At the conclusion of the Paper the author was asked a number of questions, and in replying Councillor Nelson said that, apart from the trams, the Common Good Fund was substantial, and on its security they had borrowed some £2,000,000 for tramway purposes. Undoubtedly, considerable inroads had been made on the funds in former times, but he thought a more enlightened policy would give even greater benefit to the community.

Members then adjourned for lunch, which was provided by the Corporation of Glasgow (out of the Common Good Fund, by the way). On resuming, Councillor J. H. Rodgers (chairman of the Newcastle-on-Tyne Tramways Committee) presented a Paper, of which the following is a summary, on

"Tramways Finances and Policy."

The author surveys the policy of many municipally owned tramway systems. His ideas are: (1) A system should be made financially sound by ample reserve funds; (2) proper travelling accommodation and service should be made for the public; (3) sufficient and adequate conditions of service for the employés should be provided; (4) there should be some recompense to the ratepayers who footed the bill by an adequate contribution to the relief of the rates.

No fewer than 28 out of 88 municipal tramway systems referred to by the author had no reserve fund. Many gave a contribution to the relief of rates with considerable *éclat*, but, in his opinion, on an unsound basis, as they robbed their renewals funds. No fewer than 34 systems made a loss last year, and he feared this number would increase if Committees knuckled under to the agitation for further concessions to ratepayers and employés.

In only 10 places where ½d. fares were in force was the system successful; and four of these systems (including Glasgow) were in Scotland. But Glasgow had one million inhabitants, who were carried on the average over 200 times per annum, as against a town of which he knew with 30,000 to 40,000 inhabitants, who were only carried on the average 40 or 50 times per annum. Glasgow had a relatively dense population, whilst the other town was sparsely populated and very scattered, a point usually ignored.

He was also against cheap fares at certain hours of the morning and evening.

The recent tramway employés strikes were, he considered, due to a misconception on the part of the men—that the trams were a co-partnership concern, more for their own betterment, and not the communal benefit. He thought that, as a class, the tramway employé was considerately dealt with, and had no long term of apprenticeship to serve; and he deprecated the cheap notoriety gained by some committeemen who were for granting undue concessions, not only to the employés but to the public clamouring for extended ½d. and workmen's fares and other quagmires leading to disastrous financial results.

The greater part of the afternoon was taken up in discussing this Paper. In the evening, the Corporation (again out of the Common Good Fund) entertained the members to dinner, the Lord Provost being in the chair. Among the speakers were Sir John Ure Primrose, Bart., Mr. Whitaker Thomson (London County Council), Bailie Russell, Mr. Niessen (Amsterdam), and Alderman Bowes (Manchester).

Thursday, September 28th.

To-day's meetings took place in the men's hall at Newland's depot. Messrs. R. G. Cunliffe and J. G. Cunliffe read a Paper* on "Tramcar Meters."

Mr. T. B. Goodyer (Croydon), in opening the discussion, confessed to being a very strong advocate of the use of meters. He instanced Berlin's saving of £21,000 per annum, and said that the adoption of meters on the Cape Town cars had also proved a financial success.

Mr. W. Clough (Bury) said his concern was what type of meter to adopt. The ampere-hour meter neglected the voltage, and he could not accept it as being the scientific solution. He would agree to accept the watt-hour type as satisfying all the conditions, and he knew of such types proving quite satisfactory. He had had 50 in use on his system for the past 18 months at maker's risk. They were under a guarantee of keeping accurate within 3 per cent., and complete maintenance was provided for 6s. per meter per annum. He expressed surprise at the results given in the Paper. While 1 per cent. accuracy was quite good for laboratory tests, still, taken in conjunction with the running conditions, he thought the percentage error would be increased to 3 per cent. He considered the authors were not quite consistent, for first they advocated accurate values and later advocated average values. Average values would not suit him. With regard to the influence on the motorman, he found in Bury that the introduction of meters led to great improvement, not only in the saving of current, but by a more regular spacing of the cars along the routes. This latter effect probably meant that less time was being lost at the various termini. The approximate saving to Bury was £2,000 per annum.

Mr. R. S. Pilcher (Aberdeen) referred to his Paper* read in London two years ago. Rapid progress had been made since then, and he was of opinion that the use of meters was becoming universal. He found his saving during the last three years to be 13 per cent. It was important to warn motormen not to get on to parallel running until they saw a clear roadway ahead. He frequently found the tendency was to get over the series notches as fast as possible in accelerating speed. He also advocated the grouping of men to cars.

Mr. A. Baker (Birmingham) confessed to looking upon meters now as a necessary part of a car's equipment. Last year they had installed 300 meters, and the saving in nine months was some £5,000, even with an increase of 250,000 car-miles. The use of meters had also reduced the consumption of brake shoes by 30 per cent. It further raised the standard of efficiency among the men by forming an incentive in the way of friendly rivalry. Any increase in the number of accidents was probably due to sudden starting and stopping, with the object of accelerating as quickly as possible.

Mr. J. B. Hamilton (Leeds) said he was no ardent supporter of meters. Probably their use was advocated more by tramway departments not generating their own current; but for those with their own power stations he could not see what improvement it could possibly make. The mania for "reduction of current" was, he thought, being overdone. The use of meters reminded him of the story of the Irishman who found his blanket did not cover his feet, so he cut a bit off from the end near his head to sew on to the foot.

Mr. C. J. Spencer (Bradford) thought that Mr. Hamilton's objections to meters were probably due to inexperience. He thought Bradford was the first town to adopt them. Whilst there were undoubted differences in types, there were other more important differences. He was no advocate of the grouping of men to any particular car, as advocated by Mr. Pilcher. Apart from the clerical work involved——

Mr. Pilcher here said that there was no additional clerical work. The men took their own readings.

Mr. Spencer, continuing: There was the difference in the men themselves. When meters were first used he found even 30 per cent. difference between the best and worst drivers, but now the difference had been reduced to 5 per cent.

Mr. Dalrymple asked whether the worst men improved that much.

Mr. Spencer replied that some did and others left.

Mr. A. Ellis (Cardiff) said his department not only generated the power current but sold it to the lighting department. The works cost to the trams was 0·4d. per unit. They had 130 meters in use, and thought they could still reduce the current consumption with benefit. He tried the system of adjustment of wages on current consumed, and made it subject to revision every six months. He could not agree to grouping, as in Aberdeen. His men checked their own readings. His meters had been in use some six months.

Mr. R. G. Cunliffe, in reply, said he was glad to hear of so many in agreement as to the use of meters. Their adoption showed up the faults of a car very much sooner than where they were not used. Cars with faulty coils were very quickly indicated, thus reducing maintenance costs. The average values referred to were only for use as relative values to show the differences between careful and careless men. The maximum period taken for this purpose was one month. His reason for advocating ampere-hour meters was due to the absence of the very fine wire in the pressure coil. In the ampere-hour meter there was no such coil, with its frequent breakdown. Besides that, it was a stronger instrument and much simpler for the average man to connect up. Traffic conditions did not make a very material difference. In Manchester it was found 0·5 unit per car-mile.

Mr. Hamilton wished to deny Mr. Spencer's insinuation regarding lack of experience. As a matter of fact, he had several meters in use experimentally, but this did not alter the opinion expressed.

After Mr. Dalrymple had moved a vote of thanks to Messrs. Cunliffe, Messrs. J. Grierson (Glasgow), H. Mattinson (Manchester) and R. B. Holt (Leeds) presented reports on "Tramway Track: Methods of Construction and Maintenance."

These reports were based on tabulated replies to queries in

* An abstract of this Paper is given on p. 997 of this issue.

* *See* The Electrician, September 24, 1909, p. 952.

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respect to present practice in permanent way work. As the authors had found it impossible to come to a unanimous agreement for a first report, they had agreed to draw up individual reports. (We regret that owing to pressure on our space it has been necessary to hold over our abstract of these reports until next week.—ED. *E.*)

Mr. H. MOZLEY (Burnley), in opening the discussion, gave a long dissertation on the history of rail welding, and was frequently interrupted.

Mr. J. M. MCELROY (Manchester) said the silicon rail showed an increase in life of 33⅓ per cent. He was surprised the experience at Glasgow should have been contrary to that at Manchester. In Manchester there were some 7,000 welded joints, and cracks or breakages only amounted to 0·3 per cent., not 3 per cent., as printed in the report. The whole matter depended on the weld, whether made by experienced men or inexperienced labour. If by the latter, nothing but disappointment could be expected. His three years' experience convinced him that the thermit weld could not be improved upon, provided it was made by the Thermit Co.'s experienced men. This was the course he adopted, and a bonus was further given for every joint which did not break.

Mr. R. L. ACLAND (Chesterfield) thought that the best way of arriving at a conclusion was to appoint a commission of enquiry, and he submitted one or two subjects which might be considered by such a commission: (1) Section and composition of the rails, with a standard specification; (2) foundations; (3) a standard joint; (4) use of anchors; (5) to report fully on the question of manganese. He pleaded strongly for standardisation. Large Corporations could afford to do as they were doing at present, but the smaller concerns could not afford to experiment.

Mr. J. F. SIMPSON (Preston) also asked for more information. It was agreed that the Executive Committee should decide what action to take.

Mr. KNOWLES (Sheffield) said it would be interesting to more than himself to learn what kind of steel was used at Glasgow.

Mr. DALRYMPLE, in reply, said it was open hearth steel, a kind which the Thermit Co. would not undertake to make joints on.

Members then adjourned for lunch, again provided by the Corporation out of the Common Good Fund. Thereafter a photograph of the company was taken and the annual business meeting was held. Mr. H. E. Blain, of West Ham, was unanimously elected president of the Association for the ensuing year, and it was decided to hold next year's Conference at West Ham.

The other office-bearers elected were:—*vice-president*, Mr. A. R. Fearnley (Sheffield); *hon. secretary and treasurer*, Mr. C. J. Spencer (Bradford); *members of council*, Alderman White (West Ham) *ex-officio*, Alderman Flint (Leicester), Alderman Rodgers (Newcastle-on-Tyne), Messrs. T. B. Goodyer (Croydon), J. B. Hamilton (Leeds), W. Clough (Bury), P. Fisher (Dundee), and J. Aldworth (Nottingham.)

Alderman Hunt (Birmingham), in proposing a vote of thanks to the Lord Provost and Glasgow Corporation Tramways Committee for the hospitality extended to the Association, said that he had been on many deputations, but they had never been entertained in the princely fashion that the Association had been in Glasgow.

A hearty vote of thanks was also accorded Mr. Dalrymple for his services as president.

A trip was then made to Rouken Glen on reserved cars, the day's proceedings finishing up with the Annual Association dinner in the Grosvenor Restaurant. At this dinner a large company of ladies and gentlemen were present. Mr. J. Dalrymple occupied the chair, whilst the Lord Provost and Lady McInnes Shaw were amongst the guests. The main toast, that of "The City and Corporation of Glasgow," was proposed by Mr. H. E. Blain and acknowledged by the Lord Provost.

Friday, September 29th.

To-day was spent in an excursion to the Burns country round about Ayr, on the invitation of the Ayr Corporation. Good weather prevailed, and altogether the Conference was an undoubted success.

An interesting feature, in the form of a side show, at the Newland's depot was the specially arranged exhibition of tramway material, from the latest type of covered top deck, 7 ft. wheel base, end-screened Glasgow car to the latest idea in overhead trolley wire insulation. Many well-known firms exhibited material, including car trucks, controllers, trolley arms, rail sections, rail cross-overs and junctions, speed indicators, brakes, signs, &c.

THE SINGLE-PHASE REPULSION MOTOR.*

BY THOMAS F. WALL, M.SC., M.ENG.

(*Continued from page* 980.)

Summary.—In the first part of this Paper expressions are deduced for the E.M.F.s induced in the stator and rotor windings, and curves are given which enable some of these E.M.F.s to be rapidly determined for any value of the displacement of the rotor brushes from the stator axis. In the second part of the Paper the results previously obtained are employed in developing the theory of the repulsion motor. A series of simultaneous equations enable expressions to be obtained for the speed, stator current, power factor and power of the motor. In the third part of the Paper the results of some tests on a 6 B.H.P. motor are given, and the values of the stator current, power factor and speed are shown to be in agreement with the theory. Finally, a method of calculating the open circuit characteristic of a single-phase motor is given.

We shall now consider the general case in which the resistances and leakage inductances of the stator and rotor windings respectively, are taken into account.

Let r_1 be the resistance of the stator winding.
Let r_2 be the resistance of the rotor winding.
Let S_1 be the leakage inductance of the stator winding (in henries).
Let S_2 be the leakage inductance of the rotor winding (in henries).
Let the pressure applied to the stator terminals be a sine function of the time and represented at any time t by

$$p = -P \sin 2\pi\nu t.$$

Then the following equations must hold:—

$$-\frac{dL_s}{dt}10^{-8} - r_1 i_1 - S_1 \frac{di_1}{dt} + p = 0, \quad . \quad . \quad . \quad . \quad . \quad (24)$$

$$L_s = L_{s\max.} \cos(2\pi\nu t + \beta_s), \quad . \quad . \quad . \quad . \quad . \quad . \quad (25)$$

$$L_s = A_1 D_1 i_1 + A_2 D_2 i_2, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (26)$$

$$L_R = A_1 C_1 i_1 + A_2 C_2 i_2, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (27)$$

$$EA_1 i_1 n - S_2 \frac{di_2}{dt} - r_2 i_2 - \frac{dL_m}{dt}10^{-8} = 0. \quad . \quad . \quad . \quad (28)$$

$(90-\beta_s)$ is the angle of displacement of the stator flux linkages relatively to the applied pressure at the stator terminals. Suppose at the time $t=t_1$, i_1 passes through its zero value in a direction from positive to negative. Then at the time $t=t_1-\frac{1}{4\nu}$, i_1 attains its maximum value $\bar{I}_1$, and $\frac{di_1}{dt}=0$.

Therefore, from (24) and (25)

$$2\pi\nu L_{s\max.} \sin\left[2\pi\nu\left(t_1-\frac{1}{4\nu}\right)+\beta_s\right]10^{-8} - r_1\bar{I}_1 - \bar{P}\sin 2\pi\nu\left(t_1-\frac{1}{4\nu}\right)=0.$$

or $$-2\pi\nu L_{s\max.}\cos(2\pi\nu t_1+\beta_s)10^{-8} - r_1\bar{I}_1 + \bar{P}\cos 2\pi\nu t_1 = 0, \quad ; \quad (29)$$

$$L_{s\max.}\cos\left[2\pi\nu\left(t_1-\frac{1}{4\nu}\right)+\beta_s\right] = A_1D_1\bar{I}_1 + A_2D_2 i_2$$

or $$L_{s\max.}\sin(2\pi\nu t_1+\beta_s) = A_1D_1\bar{I}_1 + A_2D_2 i_2, \quad . \quad . \quad . \quad (30)$$

$$EA_1\bar{I}_1 n - S_2\frac{di_2}{dt} - r_2 i_2 - A_2C_2\frac{di_2}{dt}10^{-8} = 0. \quad . \quad . \quad . \quad (31)$$

At time $t=t_1$, $i_1=0$. Therefore,

$$2\pi\nu L_{s\max.}\sin(2\pi\nu t_1+\beta_s)10^{-8} - S_1\left[\frac{di_1}{dt}\right]_{i_1=0} - P\sin 2\pi\nu t_1 = 0. \quad (32)$$

$$L_{s\max.}\cos(2\pi\nu t_1+\beta_s) = A_2D_2 i'_2 \quad . \quad . \quad . \quad . \quad . \quad (33)$$

$$-S_2\frac{di'_2}{dt} - r_2 i'_2 - A_2C_2\frac{di'_2}{dt}10^{-8} - A_1C_1\left[\frac{di_1}{dt}\right]_{i_1=0}10^{-8} = 0. \quad . \quad . \quad (34)$$

$$\left[\frac{di_1}{dt}\right]_{i_1=0} = -2\pi\nu\bar{I}_1. \quad . \quad . \quad . \quad . \quad . \quad . \quad (35)$$

Again, from (25) and (26) we get

$$L_{s\max.}\cos(2\pi\nu t+\beta_s) = A_1D_1 i_1 + A_2D_2 i_2.$$

Differentiating with respect to t we get

$$-2\pi\nu L_{s\max.}\sin(2\pi\nu t+\beta_s) = A_1D_1\frac{di_1}{dt} + A_2D_2\frac{di_2}{dt}.$$

* Paper read before Section G of the British Association at Portsmouth

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At the time $t=t_1-\frac{1}{4\nu}$, i_1 is a maximum, $\therefore \frac{di_1}{dt}=0$ and

$$-2\pi\nu L_{s\max.}\sin\left[2\pi\nu\left(t_1-\frac{1}{4\nu}\right)+\beta_s\right]=A_2D_2\frac{di_2}{dt},$$

i.e.,
$$2\pi\nu L_{s\max.}\cos(2\pi\nu t_1+\beta_s)=A_2D_2\frac{di_2}{dt}. \quad . \quad . \quad . \quad . \quad (36)$$

From (31) and (36) we get

$$EA_1I_1n-\left(\frac{S_2+A_2C_2\cdot10^{-8}}{A_2D_2}\right)2\pi\nu L_{s\max.}\cos(2\pi\nu t_1+\beta_s)-r_2i_2=0. \quad (37)$$

From (29), (30) and (37) we get:

$$0=EA_1\bar{I}_1n+\left(\frac{S_2+A_2C_2\cdot10^{-8}}{A_2D_2}\right)(r_1\bar{I}_1-P\cos2\pi\nu t_1)10^8 - r_2\left[\frac{L_{s\max.}\sin(2\pi\nu t_1+\beta_s)-A_1D_1\bar{I}_1}{A_2D_2}\right]. \quad (38)$$

From (32), (35) and (38) we get

$$0=EA_1\bar{I}_1n+\left(\frac{S_2+A_2C_2\cdot10^{-8}}{A_2D_2}\right)(r_1\bar{I}_1-P\cos2\pi\nu t_1)10^8 - \frac{r_2}{A_2D_2}\left[\frac{-S_1\cdot2\pi\nu\bar{I}_1\cdot10^8+P\sin2\pi\nu t_1\cdot10^8}{2\pi\nu}-A_1D_1\bar{I}_1\right]. \quad (39)$$

Re-writing (39) as follows:

$$EA_1\bar{I}_1n+\left(\frac{S_2+A_2C_2\cdot10^{-8}}{A_2D_2}\right)r_1\bar{I}_1\cdot10^8-\left(\frac{S_2+A_2C_2\cdot10^{-8}}{A_2D_2}\right)P\cos2\pi\nu t_1\cdot10^8 - \frac{r_2}{A_2D_2}\cdot10^8\frac{\bar{P}\sin2\pi\nu t_1}{2\pi\nu}+\frac{r_2}{A_2D_2}S_1\bar{I}_1\cdot10^8+r_2\frac{A_1D_1}{A_2D_2}\bar{I}_1=0$$

or
$$\bar{I}_1\left[EA_1n+r_1\left(\frac{S_2\cdot10^8}{A_2D_2}+\frac{C_2}{D_2}\right)+\frac{r_2S_1}{A_2D_2}\cdot10^8+r_2\frac{A_1D_1}{A_2D_2}\right] = \frac{S_2\cdot10^8+A_2C_2}{A_2D_2}P\cos2\pi\nu t_1+\frac{r_2}{A_2D_2}\frac{P\sin2\pi\nu t_1}{2\pi\nu}\cdot10^8$$

$$=P\sqrt{\left(\frac{S_2\cdot10^8+A_2C_2}{A_2D_2}\right)^2+\left(\frac{r_2\cdot10^8}{A_2D_2\cdot2\pi\nu}\right)^2}\cos(2\pi\nu t_1-a),$$

where* $\tan a=\frac{r_2\cdot10^8}{2\pi\nu(S_2\cdot10^8+A_2C_2)}$,

$$\therefore \quad \bar{I}_1=\frac{\bar{P}\sqrt{(S_2\cdot10^8+A_2C_2)^2+\left(\frac{r_2\cdot10^8}{2\pi\nu}\right)^2}\cos(2\pi\nu t_1-a)}{\left[EA_1A_2D_2n+r_1S_2\cdot10^8+r_1A_2C_2+r_2S_1\cdot10^8+r_2A_1D_1\right]}. \quad (40)$$

If we put $r_1=0$, $r_2=0$, $S_1=0$, $S_2=0$, we get $a=0$, and noting that $\bar{P}=\sqrt{2}P$

$$\bar{I}_1=\frac{PA_2C_2}{EA_1A_2D_2n}\cos2\pi\nu t_1 = \frac{\sqrt{2}PC_2}{EA_1D_2n}\cos2\pi\nu t_1,$$

which is the same as equation (22), page 980.

Again, from (25) and (26), by differentiation, we have

$$-2\pi\nu L_{s\max.}\sin(2\pi\nu t+\beta_s)=A_1D_1\frac{di_1}{dt}+A_2D_2\frac{di_2}{dt}. \quad . \quad . \quad (41)$$

From (35) and (41) we get, for time $t=t_1$,

$$-2\pi\nu L_{s\max.}\sin(2\pi\nu t_1+\beta_s)=-2\pi\nu\bar{I}_1A_1D_1+A_2D_2\frac{di'_2}{dt}. \quad (42)$$

From (34), (35) and (42)

$$-2\pi\nu L_{s\max.}\sin(2\pi\nu t_1+\beta_s)=-2\pi\nu\bar{I}_1A_1D_1 + A_2D_2\left[\frac{2\pi\nu\bar{I}_1A_1C_1\cdot10^{-8}-r_2i'_2}{S_2+A_2C_2\cdot10^{-8}}\right]. \quad (43)$$

From (33) and (43)

$$-2\pi\nu L_{s\max.}\sin(2\pi\nu t_1+\beta_s)=-2\pi\nu\bar{I}_1A_1D_1 + A_2D_2\left[\frac{2\pi\nu\bar{I}_1A_1C_1\cdot10^{-8}-r_2\frac{L_{s\max.}}{A_2D_2}\cos(2\pi\nu t_1+\beta_s)}{S_2+A_2C_2\cdot10^{-8}}\right]. \quad (44)$$

From (29) and (44)

$$-2\pi\nu L_{s\max.}\sin(2\pi\nu t_1+\beta_s)=-2\pi\nu\bar{I}_1A_1D_1 + A_2D_2\left[\frac{2\pi\nu\bar{I}_1A_1C_1\cdot10^{-8}+\frac{r_2\cdot10^8}{A_2D_2}\left(r_1\bar{I}_1-\frac{P\cos2\pi\nu t_1}{2\pi\nu}\right)}{S_2+A_2C_2\cdot10^{-8}}\right]. \quad (45)$$

* The letter a has been used in the first part of this Paper in a different sense, namely, in connection with the unwound portion of the stator.

From (32), (35) and (45)

$$[P\sin2\pi\nu t_1-2\pi\nu\bar{I}_1S_1]10^8=+2\pi\nu\bar{I}_1A_1D_1 + \frac{\left[r_2\frac{P\cos2\pi\nu t_1\cdot10^8}{2\pi\nu}-\frac{r_2r_1\bar{I}_1\cdot10^8}{2\pi\nu}-A_1C_1A_2D_2\bar{I}_1\cdot2\pi\nu\cdot10^{-8}\right]}{S_2+A_2C_2\cdot10^{-8}}. \quad (46)$$

Simplifying (46) we get

$$\bar{I}_1=\frac{P\cdot10^8\sqrt{1+\left[\frac{r_2}{2\pi\nu(S_2+A_2C_2\cdot10^{-8})}\right]^2}\sin(2\pi\nu t_1-a)}{\left\{2\pi\nu A_1D_1+2\pi\nu S_1\cdot10^8-\frac{\left[A_1A_2C_1D_2\cdot2\pi\nu\cdot10^{-8}+\frac{r_1r_2}{2\pi\nu}\cdot10^8\right]}{S_2+A_2C_2\cdot10^{-8}}\right\}}, \quad (47)$$

$$\tan a=\frac{r_2}{2\pi\nu(S_2+A_2C_2\cdot10^{-8})}$$

as before.

Equation (47) is the equation of a circle the diameter of which makes an angle $(\pi/2+a)$ with the ordinate axis—*i.e.*, the axis along which the pressure P is drawn.

Equation (47) *gives the circle diagram of the repulsion motor.*

The circle represented by equation (47) is shown in Fig. 16, in which OA is a current vector and $\phi=2\pi\nu t_1$ is the angle of lag of OA. Let CB be any line drawn at right angles to the diameter OD of the circle.

From equation (40) we have: The speed n is proportional to

$$\left[\frac{\cos(2\pi\nu t_1-a)}{\bar{I}_1}\right]-\text{a constant.}$$

But
$$\frac{\cos(2\pi\nu t_1-a)}{\bar{I}_1}=\frac{BC}{OB.OA}=\frac{BC}{OC.OD}=\frac{BC}{\text{a constant}}.$$

Therefore, the speed is proportional to CB minus some constant quantity, which constant may be represented by CE. *Hence the speed of the motor is given by the distance from a fixed point, E, of the intersection of the current vector on a line drawn perpendicular to the diameter of the current circle.*

Dividing equation (47) by equation (40) we get

$$\tan(2\pi\nu t_1-a)=\frac{2\pi\nu A_1D_1+2\pi\nu S_1\cdot10^8-\frac{A_1A_2C_1D_2\cdot2\pi\nu\cdot10^{-8}+\frac{r_1r_2}{2\pi\nu}\cdot10^8}{S_2+A_2C_2\cdot10^{-8}}}{10^8\times\left(\frac{EA_1A_2D_2n}{S_2\cdot10^8+A_2C_2}+r_1+\frac{r_2(S_1\cdot10^8+A_1D_1)}{S_2\cdot10^8+A_2C_2}\right)}. \quad (48)$$

Substituting for $\tan a$ its value as given above, we get for the angle of lag $2\pi\nu t_1$ of the current behind the applied pressure. (If Δ be used to represent the right-hand side of 48.)

$$\tan2\pi\nu t_1=\left[\frac{r_2}{2\pi\nu(S_2+A_2C_2\cdot10^{-8})}+\Delta\right]\Big/\left(1-\frac{r_2\Delta}{2\pi\nu(S_2+A_2C_2\cdot10^{-8})}\right).$$

It is to be noticed that the equations (40) and (47) give the maximum values of the current, and in order to obtain the effective values they must be divided by $\sqrt{2}$. When drawing the current circles the diameter of the circle as obtained from equation (47) should, therefore, be divided by $\sqrt{2}$.

The Representation on the Circle Diagram of the Power and Torque of the Motor.—The torque of the motor is equal to the power divided by the angular velocity.

The power of the motor will be given by the product of the R.M.S. value of the E.M.F. of rotation, the R.M.S. value of the rotor current and the cosine of the angle between them.

Let $i_2=I_2\sin2\pi\nu(t-t_2)$ be the equation for the rotor current. Then we have, as before,

For the time $t=t_1$, $i_1=0$, $\frac{di_1}{dt}=-2\pi\nu\bar{I}_1$.

Therefore from equations (25) and (26)

$$L_{s\max.}\cos(2\pi\nu t_1+\beta_s)=A_2D_2\bar{I}_2\sin2\pi\nu(t_1-t_2). \quad . \quad . \quad (49)$$

From equations (24) and (25)

$$2\pi\nu L_{s\max.}\cdot10^{-8}\sin(2\pi\nu t_1+\beta_s)+2\pi\nu\bar{I}_1S_1-\bar{P}\sin2\pi\nu t_1=0. \quad (50)$$

For the time $t=t_1-\frac{1}{4\nu}$, i_1 is a maximum and $\frac{di_1}{dt}=0$.

From equations (24) and (25)

$$2\pi\nu L_{s\max.}\cdot10^{-8}\sin(2\pi\nu t_1-\pi/2+\beta_s)-r_1\bar{I}_1-P\sin2\pi\nu\left(t_1-\frac{1}{4\nu}\right)=0.$$

i.e.,
$$-2\pi\nu L_{s\max.}\cdot10^{-8}\cos(2\pi\nu t_1+\beta_s)-r_1\bar{I}_1+\bar{P}\cos2\pi\nu t_1=0. \quad (51)$$

From equations (25) and (26)

$$L_{s\max.}\cos(2\pi\nu t_1-\pi/2+\beta_s)=A_1D_1\bar{I}_1+A_2D_2\bar{I}_2\sin2\pi\nu\left(t_1-\frac{1}{4\nu}-t_2\right).$$

i.e.,
$$L_{s\max.}\sin(2\pi\nu t_1+\beta_s)=A_1D_1\bar{I}_1-A_2D_2\bar{I}_2\cos2\pi\nu(t_1-t_2). \quad (52)$$

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Therefore from (52) and (50)

$$A_2D_2\bar{I}_2\cos 2\pi\nu(t_1-t_2)=A_1D_1\bar{I}_1+\frac{(2\pi\nu_1S_1\bar{I}_1-\bar{P}\sin 2\pi\nu t_1)10^8}{2\pi\nu}. \quad (53)$$

The R.M.S. value of the pressure induced between the rotor brushes by rotation is (*see* above)$=\frac{EA_1\bar{I}_1n}{\sqrt{2}}$ volts.

Since the pressure due to rotation is in phase with the stator current, the angle of phase displacement of the rotor current relatively to the pressure of rotation is

$$[\pi-2\pi\nu(t_1-t_2)].$$

Therefore, the power is

$$=\frac{EA_1\bar{I}_1nI_2}{2}\cos[\pi-2\pi\nu(t_1-t_2)]$$

$$=-\frac{EA_1\bar{I}_1I_2n}{2}\cos 2\pi\nu(t_1-t_2).$$

The negative sign denotes the motor action.

Substituting for $I_2\cos 2\pi\nu(t_1-t_2)$ from equation (53) we have—Power (in watts)

$$=\frac{EA_1I_1n}{2A_2D_2}\left[A_1D_1I_1+S_1I_1108-\frac{\bar{P}\sin 2\pi\nu t_1}{2\pi\nu}10^8\right]$$

$$=\frac{EA_1n}{2A_2D_2}\left[(A_1D_1+S_1108)\bar{I}_1^2-\frac{PI_1\sin 2\pi\nu t_1 10^8}{2\pi\nu}\right]. \quad . \quad . \quad (54)$$

The torque is obtained by dividing the power by the angular velocity of the rotor—*i.e.*, by $2\pi\times$ speed (in revs. per second).

Hence the torque is

$$=\frac{60EA_1}{4\pi A_2D_2}\left[(A_1D_1+S_1108)I_1^2-\frac{\bar{P}I_1\sin 2\pi\nu t.10^8}{2\pi\nu}\right]. \quad . \quad . \quad (55)$$

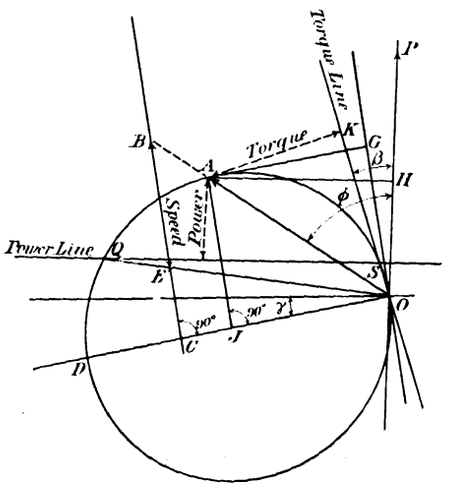

FIG. 16.

NOTE.—In this figure the angle γ is the angle α referred to in the calculations.

In Fig. 16 let the line OG be drawn as a tangent to the circle at O. Then we have

$$\frac{OA}{OJ}=\frac{OD}{OA'}$$

Therefore $OA^2=OD\,.\,OJ=$ constant $\times$ AG.

Therefore $\bar{I}_1^2$ is proportional to AG.

Further, $AG=I_1\sin(2\pi\nu t_1-a)$,

$AH=I_1\sin 2\pi\nu t_1$.

Now we have $AG=\bar{I}_1^2/OD$, therefore the torque is

$$=\frac{60EA_1}{4\pi A_2D_2}\left[(A_1D_1+S_1108)\bar{I}_1^2-\frac{PI_1\sin 2\pi\nu t_1 10^8}{2\pi\nu}\right].$$

It is generally more convenient to deal with R.M.S. values of the current, in which case we get

$$\text{Torque}=\frac{2EA_1(A_1D_1+S_1108)OD\,AG60}{4\pi A_2D_2}-\frac{2PEA_1108AH60}{8\pi^2A_2D_2\nu}$$

$$=kAG-k'AH$$

$$=kI_1\sin(2\pi\nu t_1-a)-k'I_1\sin 2\pi\nu t_1,$$

in which $k=\frac{2EA_1(A_1D_1+S_1108)OD60}{4\pi A_2D_2}$ and $k'=\frac{2PEA_1108\cdot60}{8\pi^2A_2D_2\nu}$.

Now the expression $kI_1\sin(2\pi\nu t_1-a)-k'I_1\sin 2\pi\nu t_1$ may be written in the form $KI_1\sin(2\pi\nu t_1-\beta)$, in which

$$K=\sqrt{(k\sin a)^2+(k\cos a-k')^2}$$

and $$\tan\beta=\frac{k\sin a}{k\cos a-k'}.$$

But $I_1\sin(2\pi\nu t_1-\beta)$ is equal to AK. *Therefore, the torque is* K . AK = K × [*the perpendicular distance of the extremity of the current vector from the line* OK].

It may be shown that the power may be represented by the perpendicular distance of the extremity of the current vector from another line drawn at a certain angle to the ordinate axis. This line may be found in a similar manner to that in which the torque line was found. The following considerations, however, lead to a simpler solution. The power must be zero in the two following cases: (1) When the torque is zero; (2) when the power is zero. Hence the power line must pass through the points SQ in Fig. 16.

The results deduced by the aid of the foregoing theory will now be compared with some experimental results.

(*To be continued.*)

ERRATUM.—We regret that Fig. 14 was incorrectly reproduced in last week's issue. We therefore give herewith the correct Fig. 14,

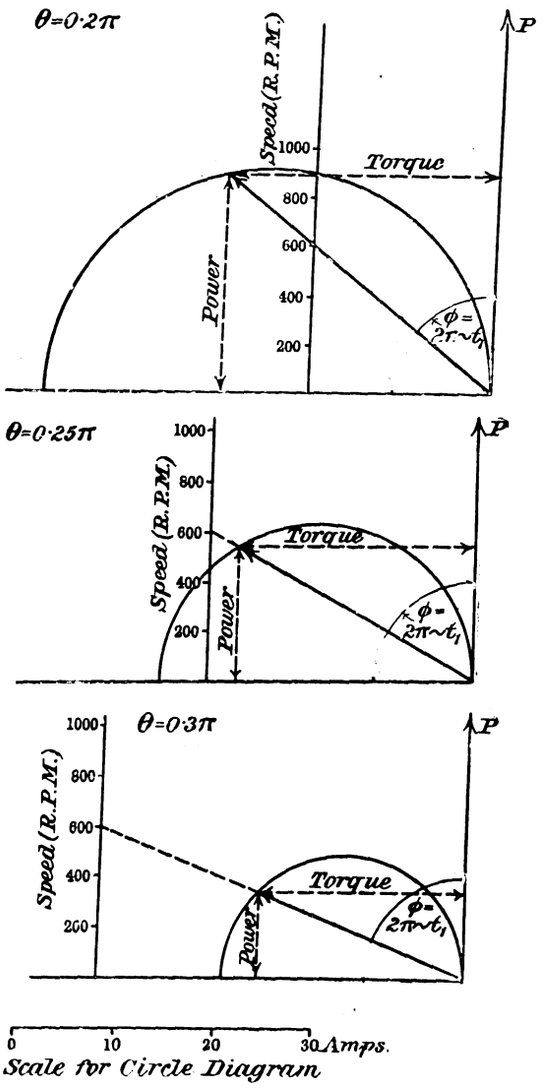

FIG. 14.

and must ask our readers to substitute this figure for that given last week.—ED. *E.*

Proposed Railway under the Lagoon at Venice.—According to the "Journal" of the Royal Society of Arts, it is now proposed to connect Venice with the island of Lido by a tunnel under the lagoon. This island, a favourite summer resort of the Venetians on account of its unrivalled beach and excellent sea-bathing, is situated on the Adriatic, about two miles from the city. The terminus of the line would be in a central position, close to the Piazza di San Marco, and the Riva degli Schiavoni, at about 26¼ ft. below the sea level. The tunnel, 2¼ miles in length, would pass in a straight line, under the islands of La Giudecca and San Georgio, to the terminus at Lido, a spot called the Quattro Fontane. The line and lifts would be worked by electricity, and trains could perform the journey in five minutes.

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CORRESPONDENCE.

THE PUBLIC AND THE ELECTRICAL EXHIBITION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I must congratulate you on your ability in fault-finding. At the first attempt you have discovered the leak where the current is running to earth, rendering somewhat inefficient a machine which, for the past 10 days, should have been working continuously on full load without excessive temperature rise.

To forsake metaphor (which teems with pitfalls for the unwary) and to come to ordinary language, the promoters of the Olympia Exhibition do not appear sufficiently to have differentiated between the two classes to which an electrical exhibition must be made to appeal, viz., engineers and the general public. The former regard Olympia in the light of a glorified showroom where they may see the various examples of modern electrical equipment with a minimum of trouble. In providing for their wants, the promoters have succeeded. Technical visitors, who 12 months ago knew all about the Exhibition and where it was being held, have appeared in fair numbers, and are satisfied with what they have seen, for though there is not anything startlingly new, there is plenty of interest and the exhibitor is satisfied in that respect.

But there has not been the same success as regards the general public. Many of the exhibitors wish to appeal to the public, quite apart from the technical man, for it is to the public as a purchaser that we must look largely in the future if the electrical industry is to be kept busy. So far, however, the attendance of the layman has been very much smaller than at the last electrical exhibition at Olympia, which is to be regretted, and shows a lack of organisation somewhere. In addition, it is to the interest of *all* classes of exhibitors that the public should be attracted to Olympia in large numbers. The cost of exhibiting is a heavy item at any time, but in these days of excessive competition it can ill be afforded by many. Therefore, we standholders look to a good "gate" to help to recoup us for our outlay; but as things are at present, I am afraid we shall be disappointed.—I am, &c.,

London, Oct. 3. EXHIBITOR.

INTERNATIONAL COMPETITION IN PRACTICAL TELEGRAPHY AT TURIN.

As announced in THE ELECTRICIAN, there has been held, in connection with the Turin Exhibition, an international competition in practical telegraphy, which was open to British telegraphists and others in the service of administrations which are members of the Telegraph Union. The competition took place from Aug. 22 to 28. The full regulations governing the competition were given in THE ELECTRICIAN for Oct. 21, 1910, and will also be found in "The Electrician" Electrical Trades' Directory and Handbook for 1911, pp. 642-4.

There were 226 competitors, of whom 114 were employed by the Italian Telegraph Administration and 112 by foreign departments. There were 31 from Austria, 24 from Germany, 15 from France, 8 from Spain, 7 from Hungary, 6 from Belgium, 5 from Switzerland, 4 from Roumania, 2 each from Brazil, Greece, Turkey, Servia and Sweden, 1 from Great Britain and 1 from the South African Union. Among the competitors were 9 females (5 Italians, 2 Swedish, 1 French and 1 Austrian). On Aug. 18 the jury (an international one) assembled, and after an address by Comm. G. Greborio, Inspector-General of Italian Posts and Telegraphs, it was decided to leave to a sub-committee, presided over by Ing. Mirabelli, certain points raised by the delegates as to the use of particular types of instruments, &c. On Aug. 20 the jury approved the instructions as to the performance of the tests and also the conclusions of the sub-committee as to the apparatus to be employed. On Aug. 21 the competitors were received at the Turin central telegraph office, which was beautifully decorated for the occasion. Comm. Greborio welcomed the visitors, and Prof. C. Montu delivered an interesting address on telegraphy. On the morning of Aug. 22, after the apparatus was tested and found to be in good working order, the first test was commenced.

In the *Morse trial* there were 117 competitors, 43 of whom were classified and 40 received rewards. The winners of the two Grand Prizes were Italians—viz., MM. Schinetti (cup given by the Italian Minister of War and 1,000 frs. by the Minister of Posts and Telegraphs) and Padroni (cup and 1,000 frs. by the State Railway Administration). Gold medals were awarded to the following: MM. d'Agostino (Italy) (and gold watch), Garonimi (Italy) (and 500 frs.), Ironci (Italy) (and 500 frs.), Malasoma (Italy) (and gold chronometer), Baldaro (Italy) (and 400 frs.), Landini (Italy) (and 300 frs.), Woettki (Germany) (and 200 frs.), Staffa (Italy) (and 200 frs.), Balsamo (Italy) (and 200 frs.), Donot (France) (and bronze statuette), Ledrus (Belgium) (and 100 frs.), Dalcero (Italy) (and 100 frs.), Schuwerack (Germany) (and 100 frs.), Cannas (Italy) (and 100 frs.), Scaglioni (Italy) (and 100 frs.), Eichholz (Germany) (and bronze statuette), Testi (Italy) (and clock), Mdlle. Planck (Sweden) (and 50 frs.), Bernand (France) and de Rooy (Belgium). In addition, 10 silver and 8 bronze medals were awarded.

For the *Hughes trial* there were 76 competitors, of whom 67 were classified and 28 received a reward. Grand Prizes were awarded to MM. Martens (of Belgium) (cup given by the Foreign Minister and 1,000 frs. by the Minister of Posts and Telegraphs) and Zillig (of Germany) (cup given by Naples Municipal Council and 800 frs. by the Minister of Posts and Telegraphs). Gold medals were given to MM. Fleyel (Germany) (and silver knives and forks), de Rooy (Belgium) (and 500 frs.), Kubelka (Austria) (and 400 frs.), Bradl (Austria) (and 300 frs.), Schindler (Austria) (and 200 frs.), Haussmann (Germany) (and gold watch), Krumm (Germany) (and 100 frs.), Pernt (Austria) (and 100 frs.), Hienke (Germany) (and 100 frs.), Bontez (Belgium) (and 100 frs.), Czinte (Hungary) and Boixeda (France). There were also 8 silver and 6 bronze medals.

In the *Baudot test* 80 competitors entered, 76 of whom were classified and 22 received awards. Grand Prizes were given to two Frenchmen, MM. Chapius (cup and 1,000 frs.) and Maurel (cup and 800 frs.). Gold medals were given to MM. Sol (France) (and 500 frs.), Constant (France) (and 400 frs.), Rocca (Italy) (and 300 frs.), Berti (Italy) (and gold watch), Valente (Italy) (and 200 frs.), Mdlle. Aymar (Italy) (and 100 frs.), Batocchi (Italy) (and 100 frs.) and Pernt (Austria) (and 100 frs.). Six competitors obtained a silver medal and six a bronze medal each. The prize which was reserved for the groups of competitors belonging to the State taking part in the tests with three competitors, one for each system and winning a prize in each of them, has been obtained by Italy. It is a bronze work of art (1m. 50 high on a 80m. diameter) by Zanelli.

There was no competition for the championship prize, as none of the competitors obtained prizes in each of the trials.

It is stated that certain competitors attained a very high speed, largely exceeding 1,000 words an hour, both in transmitting and receiving. This high speed, however, was obtained at the expense of accuracy, for it appears that errors made (signals altered, badly made or insufficiently spaced) prevented them from reaching the position they hoped to attain. With the Hughes apparatus, M. Martens, of Belgium, who was classed first with 122 points above his nearest competitor, succeeded in transmitting in one hour, without any trouble and without error, a total of 1,502 words, the words having an average length of 7¼ characters, and 12,767 characters or signals being transmitted.

With the Baudot apparatus the results were also very good, and the winners in the competition attained almost the highest possible points.

On the evening of the distribution of prizes a banquet was given at which the organisers, the members of the jury and of the committee, as well as the competitors, were present. The Minister of Posts and Telegraphs, Signor Calissano, presided.

LEGAL INTELLIGENCE.

Appointment of Electrical Inspectors.

At Clerkenwell (London) Police Court yesterday (Thursday) Mr. Bros resumed the hearing of the application by Mr. C. S. Sayer, of Messrs. Macdonald, Sayer & Co. (Ltd.), for the appointment of an electrical inspector for the St. Pancras District. Applicant's firm was taking current from the Borough Council for power and lighting, and a dispute had arisen between the parties as to a particular type of fuse which the Council desired consumers to adopt. There was no other complaint against the efficiency of the Council's supply. A good deal of discussion arose as to the legal position and as to the authority of the magistrate to appoint an electrical inspector. The application was ultimately adjourned to enable applicant to obtain legal advice.

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from *The Electrician* office, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published under 2s., and 5 per cent. for books published nett. Add 10 per cent. for abroad on foreign books.]

"Transactions" of the Royal Society of Edinburgh. Vol. XLVII. Part IV. Session 1910-11. 27s. 6d.

"A Handbook on the Gas Engine." By Herman Haeder. Translated from the German and edited by W. M. Huskisson. Pp. xii. 2[illegible] (London, 1911: Crosby Lockwood & Son.) 18s. nett.

"The Electrical Nature of Matter and Radioactivity." By Harry Jones. Second edition. Completely revised. (London, 1911: Constable & Co.) 8s. nett.

"The Post Office and Its Story." An interesting account of the activities of a great Government Department. By Edward Hemmer. Pp. 356. (London, 1912: Seeley, Service & Co.) 5s. nett.

"Proceedings of the Incorporated Municipal Electrical Association, 1911." 5s.

"Proceedings of the American Institute of Electrical Engineers, September, 1911." Vol. XXX., No. 9. $1·00.

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COMMERCIAL AND INDUSTRIAL SECTION.

MUNICIPAL, FOREIGN & GENERAL NOTES.

BRITISH NOTES.

Associated Municipal Electrical Engineers (Greater London).—At the last meeting the Association elected the following officers for the year 1911-12:—

President: Mr. W. C. P. Tapper (Stepney); *Vice-presidents:* Messrs. F. A. Bond (Battersea), L. L. Robinson (Hackney) and A. H. Shaw (Ilford); *Hon. Treasurer:* Mr. G. G. Bell (Hammersmith); *Hon. Auditors:* Messrs. J. G. Bruce (Willesden) and E. Calvert (Finchley); *Hon. Secretary:* Mr. Norman Staniland, Electricity Works, Hornsey, N.; the Council is composed of Messrs. S. W. Baynes (St. Pancras), J. H. Bowden (Poplar), H. H. Couzens (West Ham), C. S. Davidson (Barnes), A. J. Fuller (Fulham), F. Hill (Hammersmith), W. Innes (Poplar), C. Newton Russell (Shoreditch), P. E. Rycroft (Heston), E. Sayer (Hampstead), A. H. Seabrook (St. Marylebone) and W. C. Ullmann (East Ham).

By kind permission of the Institution of Electrical Engineers, the Association meetings are now held at the new Institution buildings, and the dates of the meetings will be fixed in advance. The Association had under consideration at their meeting various matters of interest, including the question of a defensive combination between the power and light authorities (including gas companies) in times of general strikes. The Association visited the Electrical Exhibition at Olympia on Oct. 4.

Barrow-in-Furness.—At the monthly meeting of the Corporation on Monday it was decided, on the recommendation of the Highways & Lighting Committee, to replace existing gas lighting in Abbey-road, from the central station to the Furness Abbey tram terminus, and also in Roose-road, from Salthouse Bridge to the tram terminus, by electric lighting. The electric lighting is to be by means of metal filament lamps from span-wires fixed between the tram poles on either side of the road.

The total length of road over which gas lighting is to be displaced is over two miles, and the number of electric lamps to be erected 162. This decision has been arrived at as a result of a prolonged test between the two illuminants, in which the superiority of electric lighting along the roads planted on both sides with trees has been very marked.

Extensions of mains at an estimated cost of about £990 are being carried out, in connection with the supply of power to Messrs. Burt, Boulton & Haywood's sawmills at Devonshire Dock, where motors aggregating about 165 H.P. are being installed.

Bedford.—The new highway depot of the Beds County Council is to be supplied with electrical energy for light and power, and the supply mains are also to be extended to the Isolation Hospital.

A new coal bunker has been erected at the electricity works.

Belfast.—An unopposed inquiry was held on Tuesday into the application of the Corporation for sanction to borrow £40,000 for extensions of the electricity undertaking, including £12,850 for plant, £9,560 for mains, £6,100 for feeders, £8,550 for services, and £2,000 for meters, time switches, &c. The city electrical engineer (Mr. T. W. Bloxam), supplied technical details.

Bermondsey.—Friction has arisen between the Council and London County Council in regard to loans for extensions of the electricity undertaking.

It was reported to the Borough Council on Tuesday that although the contracts for additional plant had been let the County Council declined to sanction the loan for the purpose. The County Council asked for certain information as to the financial position, &c., of the undertaking, but the Borough Council thinks that London County Council is not entitled to the information. In a recent letter the Comptroller of London County Council reported that he noted that the Borough Council had accepted tenders for the proposed plant and buildings, and he reminded them that it was the opinion of the Finance Committee that no liability for expenditure which was to be made the subject of a loan should be incurred until the loan sanction was obtained.

Reporting upon the position, the Electricity Committee of the Borough Council states that they have no alternative, in view of the liability having been incurred, but to recommend the amount for payment, and in doing so they warn the Council that should the County Council refuse their sanction to the loan (£18,563), and an appeal to the L.G. Board fail, any liability incurred by the Council in the matter will have to be met out of the general fund, probably involving a heavy increase of the rates.

Birmingham.—The work of laying supply mains in Moseley is proceeding apace.

Mains have been laid and supply is available in several streets, and work is in progress in other thoroughfares. A show-room has been opened in Alcester-road to meet the convenience of residents in Moseley and King's Heath, who will be able to see a display of electric motors, lighting fittings, ovens, radiators, hot-plates, kettles, irons, &c. The current for the supply of Moseley will be supplied from Summer-lane station through the sub-station at Balsall Heath. The Electric Lighting Committee have secured a site for a sub-station at Harborne for the general supply of Harborne, and also to provide a duplicate bulk supply to Selly Oak. The question of a sub-station for the supply of King's Norton and Yardley is also engaging the attention of the committee.

A tramcar accident took place on the Dudley-road route on Sunday night, resulting in the death of one and injuries to 15 passengers.

One of the late cars from Birmingham to Bearwood was ascending Cape-hill, and when half-way up it stopped to pick up several passengers. On attempting to re-start the driver found that he could not make any progress, and the car began to run back. The brakes were applied, but they refused to act, and in a short time the car was running at high speed down the steep hill. It came into collision with another car which was coming up the hill, and the two were partially telescoped. Some passengers jumped and others were thrown off. The two interlocked cars rushed down the incline, and at the bottom ran into a stationary car.

Col. Yorke will hold an inquiry into the circumstances of the accident to-day (Friday).

British Electrical & Allied Manufacturers' Association (Incorporated).—Next meeting of Council at Olympia, W., on 12th inst., at 2:30 p.m.

Carluke.—At a public meeting last week it was decided to petition the Clyde Valley Electric Power Co. to extend their mains to the district. Great dissatisfaction is expressed at the charges made by the local gas company.

Caversham.—Over 100 of the street lamps are now converted to electric lamps, and the work of substituting electric for gas lighting in the remainder of the district is making rapid progress.

Electric current is supplied by the Reading Electric Supply Co. In each of the old lanterns two electric globes are being placed, in addition to a reflector, and the light thus obtained is much superior to that provided by the gas lamps. The members of the Council estimate the saving in the cost of lighting by electricity at £100 a year.

Cheltenham.—Application is to be made to the Board of Trade for a provisional order amending the Cheltenham Electric Lighting Orders of 1890-1900 by extending the area of supply to the parishes of Leckhampton, Swindon, Prestbury, Bishop's Cleeve, Southam, Brockhampton, Woodmancote, Badgeworth, Shurrington and Up Hatherley.

Eastbourne.—Messrs. R. H. & J. Pearson, who are organising an electrical exhibition in November, are to be supplied with electrical energy at 1½d. per unit for exhibition purposes.

Ellesmere Port.—The Urban Council have unanimously resolved to apply for a provisional electric lighting order. A special committee has been appointed to deal with electricity supply.

Fleetwood.—The L. & Y. Railway Co. has asked for a reduction in the price of electrical energy supplied by the Council.

About four years ago the Company agreed to pay 3d. per unit for lighting and 1½d. for power, but the units consumed have risen from 41,376 to 114,957. Owing to the unsettled state of the coal trade and the possibility of an increase in price, the Council have decided not to grant an immediate reduction, but if the cost of coal does not increase a rebate will be granted of ¼d. per unit for power and ¼d. for light between Sept. 30 and March 31.

Fulham (London).—A new coal bunker, with a capacity of approximately 1,000 tons, is to be erected at the electricity works.

Halifax.—The Tramways Committee have reorganised the duties of the various officers of their department. Mr. W. M. Rogerson has been relieved of his appointment as general manager of the tramways, so that, on account of developments in prospect, he will be able to give his whole time to his other work as electrical engineer. Mr. Caird and Mr. Galloway, traffic superintendent and tramways engineer respectively, have been selected as dual managers of the tramways in his stead.

Heston and Isleworth.—Experiments are being made in the lighting of High-street with Jandus arc lamps.

Hornsey.—On Tuesday an unopposed enquiry was held into the application of the Council for sanction to borrow £500 for the purchase of land for extensions of the electricity works.

Hospital Lighting.—Bedford Council have decided to wire the isolation hospitals.

Crossley Hospital (Mirfield) is to be wired, and electric current will be supplied by Mirfield Council by overhead wires.

Johnstone.—The Council are considering the question of extending their gasworks; also the Council are ascertaining the cost of erecting electricity works.

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ELECTRICITY SUPPLY TABLES AND DATA.

This Valuable Set of Tables and Engineering Data relating to Electricity Supply and to Electric Traction on Railways and Tramways in the United Kingdom, the Colonies, and some important places abroad, is now ready, and can be obtained complete in handy book form, price 6s. 6d. post free, or on very hard paper for rough or constant use, price 8s. 6d. post free. A complete Index is included.

Kingsbury (London).—At the last meeting of the Council the chairman (Mr. J. Diaz) announced that a supply of electricity was now available in the district.

The North Metropolitan Electric Power Supply Co. had, he said, built a sub-station in the parish, and in his opinion and in the opinion of many experts, electricity was the best for either public or private lighting and power. He hoped that Hendon Council would see their way to light up the west side of the Edgware-road, beginning at the northern boundary, all along Collindale and West Hendon, the Broadway, Cricklewood, Cricklewood-lane, Child's Hill, and even to introduce it within the whole of their principal district, including Golders Green and the Garden Suburb. If they did that it would be more efficient and cheaper in the long run than the incandescent gas mantles, the electricity being more reliable and possessing greater illuminating power. He also stated that their electric lamps in Kingsbury and on the Kingsbury side of Edgware-road cost less than the incandescent gas lamps in Hendon area.

L.C.C. Tramways.—London County Council have applied to the City Corporation for consent to the construction of a tramway in Bishopsgate as far as Middlesex-street, and from Charles-street to a point near Ludgate-circus, via Farringdon-road and Farringdon-street.

Stepney Council decided on Wednesday to oppose the proposal of the County Council to reconstruct the present horse tramways from West India Docks to Victoria Park on the overhead system.

Manchester Smoke Abatement Exhibition.—Everything points to a success for this exhibition. Apart from the good work of the organisers, the fact that the exhibition will be held in a district where the need for smoke abatement is pressing, and at the time of year when the evil effects of a smoky atmosphere are most apparent, coupled with the movement for cleaner cities, will help materially in securing the attendance of large numbers of factory and works managers and also of the general public. The exhibition will be held in the City Hall, Manchester, from Nov. 10 to 25 next.

Newport (Mon.).—At a private meeting of the Electricity and Tramways Committee on Monday it was decided to recommend the Council to appoint a general manager to take supreme control of the tramways undertaking, Mr. Collings Bishop to retain the position of electrical engineer. The committee did not fix the remuneration for the new manager, but some members said they were desirous of getting a first-class man, and £1,000 per annum was mentioned.

Poplar and Stepney Electricity Supply Agreement.—Poplar (London) Council have approved the following heads of an agreement with regard to reciprocal and stand-by supplies of electricity between the two councils:—

(1) Stepney to afford supply to Poplar under the present agreement, pending Poplar extensions, to the year 1913; (2) Poplar to afford supply to Stepney from 1913 to 1917, or until such time as the maximum demand of Stepney reaches, say 7,270 kw.; (3) Stepney not to complete extensions until 1916 at the earliest date, or until the aforesaid demand of 7,270 kw. is reached; (4) after the period of supply by Poplar to Stepney, Poplar to be under obligation to take from Stepney equal bulk supply as Stepney has taken from Poplar, before Poplar makes further extension, Stepney, however, to have preference of extension at such time; (5) three weeks' supply of coal, based on winter consumption, to be kept by each party immediately at hand.

The Electricity Committee, reporting on the agreement to the last meeting of the Council, stated that the proposals would involve the laying down in 1913, at an approximate cost of £20,000, of a further 3,000 kw. generating set for the accommodation of which provision had been made in the scheme for extending the station buildings. It would be necessary to provide mechanical means of unloading and conveying coal, in order to safeguard the coal supply as well as to reduce the cost of handling, and they recommended that Poplar should provide stand-by for Stepney until 1917.

P.O. Wages.—Last week the Postmaster-General (Mr. H. Samuel) received a deputation from the National Joint Committee of Postal and Telegraph Associations.

Mr. W. Davis, chairman of the Association, said the deputation represented 70,000 organised employés of the Post Office service, who were unanimous in their demand for a Select Committee of the House of Commons to consider their grievances. The result of the interpretations placed upon the findings of the Hobhouse Committee by the Department had been to embitter the Post Office servants. The engineer linesmen and stores employés complained of long hours, low pay and the preponderating percentage of unestablished force.

Mr. Samuel, in reply, said that he had declined requests from various Associations to reopen on his authority the main scales of Post Office wages laid down by the Hobhouse Committee; but they came now with a different request—namely, that the Government should invite the House of Commons to appoint another Select Committee to review the decisions arrived at by the Hobhouse Committee. He himself was not opposed to another Committee of the House of Commons enquiring generally into the conditions of Post Office service, but it was a question of what interval should be allowed to elapse between the holding of one enquiry and the holding of another. He could not give a definite reply, either affirmative or negative, to their request at that moment without consultation with his colleagues.

Rail-less Trolley Traction.—Failing other means of communication between Southall and Twickenham via Hounslow, it has been decided by Heston and Isleworth Council to include in their general bill clauses to confer powers to equip routes on the rail-less trolley system.

St. Helens Corporation have appointed a committee to report upon the question of utilising the rail-less trolley system for projected extensions of the local tramways.

Dundee Council have decided to equip the Clepington-road route on the rail-less trolley system.

The Tramways Committee are to consider the question of the existing tramway along Cranbrook-road or the equipment of the route on the rail-less trolley system.

The Northampton Tramway Committee have instructed their manager (Mr. J. Gottschalk) to report as to the working of the Leeds and Bradford experiments in rail-less trolley traction.

Rotherham Corporation have ordered the Maltby route to be equipped on the rail-less system.

The deputation recently appointed by Edinburgh Council to visit Leeds and Bradford rail-less systems of traction in those towns have issued their report, which states that the extended trial of the system has now confirmed the favourable opinion formed in July last as to the reliability, simplicity and economy of the system.

The report further states that the road formation over which the present equipment at *Bradford* operates is partly paved with granite setts, but for the greater part of the road is ordinary macadam. No special treatment was given to the road, and the deputation could trace no evidence of any extraordinary wear upon the road. It was not anticipated that the surface would suffer from the running of the trolley car. Electric current was supplied by the Corporation at 1d. per unit, and the current used in the driving of the car was about 0·95 unit per car-mile, about one-half the current used on an electric tramcar. The capital cost of 1¼ miles had been at the rate of £1,734 per mile, the two cars costing £700 each. The deputation did not experience any discomfort from vibration. The manager of the Bradford tramways puts the cost of operating at less than 5½d. per car-mile.

At *Leeds* the new line was opened in the middle of June last. It commences right in the centre of the city, and proceeds thence in a radial direction for a distance of four miles (one mile along a busy street crowded with vehicular traffic) until it reaches the Farnley outskirts. So far, the experience of Leeds Corporation in the working of the new line had been in every way encouraging. There had been no interruption in the working of the line, and there had been no accidents, notwithstanding the congestion of the traffic on portions of the route. The surface of the road over which the cars run is paved partly with wood and partly with granite within the city, whilst in the outskirts it is ordinary macadam formation. The running of the car is smooth and unattended by any abnormal vibration. The capital cost of the four miles route on the new system was £1,246 per mile, and the cost of the cars to hold about 56 passengers £700 per car. The actual revenue per car-mile in Leeds is 8·78d., and the total operating costs 5½d. per car-mile (exclusive of interest and redemption of capital).

In summarising the information obtained, the Edinburgh deputation thought it right to say that, notwithstanding that the system had only been on trial for a comparatively short period in this country, they had formed the opinion that that method of conveyance was capable of satisfying the requirements of many districts in and around Edinburgh, not already provided with public transit, in a practical and economical manner. It offered the great inducement of being able to provide an excellent service at a minimum cost, enabling routes to be equipped that might under other systems prove quite unprofitable. The financial advantages compared with overhead trolley tramways were the reduced cost of equipment (being not more than one-seventh part of the cost of constructing and equipping the overhead tramway), a saving in maintenance of permanent way, and the reduced costs of operating. The pre-eminence of the trolley car in comparison with the motor bus, on the other hand, was proved by the easy running, its freedom from smoke or odour, the reduced vibration of the car in motion, and its freedom from shock in starting and stopping, and, above all, its reliability. Therefore, they consider it eminently suitable for new districts which cannot be expected to provide a profit upon the capital cost of tramways. Whilst providing for the development of new districts, the system could be readily transformed into, and completed, as a regular overhead tramway, should the traffic increase so as to exceed the relatively limited capacity of the trolley car. At what stage the transition from the one to the completed tramway should take place was a matter to be determined by experience still to be acquired, by the development of the conditions of trade, and by the amount of traffic which the system was capable of overtaking. Further, the alleged objection to tramways being laid along suburban roads was done away with, because the roads were [illegible]

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free from rails, and its overhead equipment was so unobtrusive that one speedily became unaware of its presence. The deputation direct special attention to the policy adopted at Bradford of creating a circular route, bearing such similarity, as Bradford did, to the radial routes of the Edinburgh system, stretching out from a common centre in diverse directions, but quite unconnected at or near to the extremities, the object in view being the uniting of those divergent routes by a new circular route.

The deputation, confining themselves to the terms of their reference, do not suggest any specific route or roads suitable for the introduction of the rail-less system into Edinburgh, but there are many suburban streets and roads within the city boundary where the system would be eminently suitable.

The report contains several photographs of street scenes in Leeds and Bradford in connection with the working of the system.

In reply to a question, the chairman of the Leeds Tramways Committee (Ald. Tetley) stated at the Council meeting on Wednesday the total capital cost of the rail-less system of traction had been £7,600, the amount set aside for interest and sinking fund would be £690, and the average receipts per car-mile were 8·3d. A period of three months was quite an insufficient time for any reliable information on the question of profit to have been obtained.

Dronfield Urban Council have applied to Derbyshire County Council for the approval of a system of rail-less trams between Sheffield and Dronfield, but the County Council have asked for further particulars.

Reigate.—The Council have received sanction to the following loans for electricity supply :—

£1,292 to defray excess expenditure on transformers, services and armoured mains (for 13 years), £530 for excess expenditure on mains in conduits (23 years), £142 for excess expenditure on meters (three years), £4,859 for new engines, switchboard, &c. (17 years) and £1,118 for prospective expenditure on mains, services and transformers (15 years).

Application has been made to the L.G. Board for authority to defray the £423. 4s. 10d. deducted from the sanction for the new switchboard, out of renewals and contingencies fund account. The sum of £36. 4s. for sundries in connection with house services, &c., deducted from the sanction for extensions already carried out, will be defrayed out of the same account. In future a separate account will be kept of the expenditure under each sanction for loans.

Rotherham.—Sanction has been received to the following loans for tramway purposes :—

Land at Rawmarsh-road, £327 (repayable 60 years); buildings, £550 (20 years); machinery, £6,287 (16 years); cables, £14,780 (25 years); total, £21,944.

The Broom tramway route is to be extended to the borough boundary, and the Dalton line to Tarybergh.

Salford.—Mr. C. D. Taite has been retained by the Council, at a fee of 50 guineas, to report upon the proposal to instal an additional turbo-generator, &c.

Southborough (Kent).—The Council will apply for a provisional electric lighting order.

Southwark.—The Electric Lighting Committee have had under consideration a report from the borough electrical engineer (Mr. J. M. Kinghorn) on the hiring out of motors.

Mr. Kinghorn states that the system appears to appeal to a large number of consumers, and there was a probability of its being largely extended in the future. At present the practice of the Council was to depreciate arc lamps and other apparatus on the basis of a life of five years, which worked satisfactorily for such apparatus, as fittings, lamps, radiators, &c., which were always being superseded by improved apparatus. The case was different with motors, the useful life being not less than 15 years, and it was not possible to obtain for hire from the consumer a sum sufficient to cover depreciation and maintenance at that rate, so that, with every probability of the hire system increasing, there would be a serious deficit to be met on the hire account for at least five years unless the period was extended. The usual rate for hire was 10 to 12½ per cent. of the cost of the motor, and Mr. Kinghorn suggested that the cost should be written off in 10 years, thus making the scheme self-supporting. The Committee have decided to extend the time from 5 to 10 years.

Stepney (London).—The Electricity Committee have expended the £500 advanced to them for wiring customers' premises on the hire purchase system, and another sum of £500 has been voted for the same purpose. £2,500 is also to be expended on meters, &c.

Stoke-on-Trent.—The Electricity Committee report that the aggregate amount of the accepted tenders in connection with the new electricity works is about £55,000, made up as follows :—

Jas. Howden & Co., turbo-generators, £8,905; British Westinghouse Co., rotary converters, £3,800, transformers, £384, and switchgear, £651; Bruce Peebles & Co., motor converters, £2,250, and motor-generators (D.C.), £225; Siemens Bros. Dynamo Works, motor generators, £2,385; Callender's Cable & Construction Co., mains and cables, £3,093. 10s. 10d.; Stirling Boiler Co., boilers, £5,040; Davenport Engine Co., cooling towers, £1,053; Grants (Ltd.), Burslem, buildings, £5, and power house buildings, £5,745; J. Meiklejohn, Stoke, buildings, £5; Acton & Co., steam pipes, &c., £1,128. 12s.; New Conveyor Co., coal bunkers, &c., £1,426; G. & J. Weir, steam feed pump, £113; D.P. Battery Co., storage battery, £91; Herbert Morris & Bastert, 15-ton crane, £229; British Westinghouse Co., electric feed pump, £180.

Submarine Telegraph Cable Capacities.—Mr. Gilbert Rosenbusch (who presumably writes as an expert), in the course of a letter appearing in "The Times" for Oct. 4, writes as follows :—

For years transmitting and receiving instruments have been available having a speed immeasurably greater than that of the cables on which they operate. It must be evident, therefore, that if some form of cable were available which would have a greater speed of transmission than those at present in use, the laying of such a cable would be justified, as the far lower rate per message possible would force the cable companies to meet this competition.

The inherent peculiarity of existing submarine cables, known as electric capacity, has been the stumbling-block, and for many years the engineers of the cable companies have pooh-poohed the idea of counteracting this by electric inductance.

Were a cable so constructed that these electric difficulties were overcome, not only would a much greater speed be possible, but telephoning across the Atlantic might be practicable. This latter feature is of particular interest at this juncture, owing to the impending nationalisation of the telephone system in this country.—GILBERT ROSENBUSCH.

Another writer in "The Times," described as "An Engineering Correspondent," writes on practically the same subject, and with almost the same absence of knowledge of what has been done of late in connection with submarine telegraph cables. The editor of "The Times," in commenting upon this latter correspondent's letter, makes the remarks following :—

The above correspondent appears to have overlooked the fact that the suggestion to compensate the effect of capacity by adding inductance is due to Mr. Oliver Heaviside [the correspondent referred to credits Prof. Cuntz, of America, with this discovery]. He has also omitted to mention that the idea of continuous "loading," as opposed to "loading" by coils, has long been known, and that it has been successfully applied in the case of several telephone cables. Further, it is necessary to observe that the statement [by this correspondent] that "the speed of this (Cuntz) cable is at least five times that of existing cables" must be accepted with the utmost reserve. It possibly relates to a laboratory test, but it is obviously incorrect as applied to an Atlantic cable.

We may add that, taken in conjunction with Mr. Rosenbusch's letter, it is clear that the schoolmaster is abroad. Mr. Rosenbusch evidently has a poor opinion of the capacity of the consulting and chief engineers of the cable companies. Those who are more intimately acquainted with the subject do not altogether share his views.

Teignmouth.—The Council are to consider in committee an application by Dr. J. W. Purves for their assent to a proposed application for an electric lighting order.

The Telephone Purchase.—The "Daily Mail" states that the priced inventory (which our contemporary describes as "the greatest sale catalogue ever compiled") of the trade assets of the National Telephone Co. is nearing completion. We are told that this is the work of 650 experts. According to this estimate the total amount the Post Office will require to hand over to the company is between £14,000,000 and £15,000,000. We have no means of checking these stupendous figures.

Walthamstow.—The Council will maintain and repair electric light installations at the various schools at actual cost plus 5 per cent. for establishment charges.

Sanction has been received to the borrowing of £6,634 for feeder cables and spare stoneware conduits.

West Hartlepool.—The Council further considered on Friday the proposal to purchase the local tramways.

The Tramways Committee recommended the purchase of the section of the Hartlepool line within the West Hartlepool borough boundary; and also recommended the Council to obtain the necessary powers for working the line as well as the Park and Foggy Furze lines, and for constructing certain additional lengths of routes.

Mr. Martin moved, as an amendment, that the Council negotiate with the tramway company with a view to the company accepting an extended lease of 42 years. He declared that the Corporation could not carry out the scheme of municipalisation under £120,000. Tramways (he said) never had paid, and never would pay in that district.

Ultimately the amendment was defeated, and the recommendations of the committee adopted.

Worksop.—St. Cuthbert's College is to be wired, and electric current will be supplied by the Council.

Worthing.—Sanction has been received to a loan of £4,532 for the extension of the electricity station, buildings and plant.

G.E.C. Athletic Club.—The G.E.C. athletic club opened their football season on Saturday last on their new ground at Willesden with a stirring game between head office (Osram F.C.) and Queenhithe branch (Magnet F.C.).

The game was a very fast one, and after a hard fight the result was a win for the Osram team by 3 goals to 2. The secretary would be pleased to hear from any club connected with the industry with a view to fixing up matches for the coming season.

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COLONIAL AND FOREIGN NOTES.

Australasia.—The "Australian Mining Standard" says a satisfactory agreement has been arrived at between Shepparton (Victoria) Water Trust and Shepparton District Council for a joint pumping and electricity scheme. Mr. Crossle (of F. A. McCarty & Co., Melbourne) has compiled a list of 60 intending consumers, mostly occupiers of large stores and shops. The District Council will erect the works and supply current to the Water Trust. The total annual revenue is estimated at £2,240 and the gross profit at £825.

Amongst his criticisms of the Sydney telephone system, Mr. H. W. Ramsay Sharp, who was appointed to enquire into the efficiency or otherwise of the service, says the electrical engineers have too much routine work, with the result that important technical matters cannot receive proper attention, and the salaries of some of the officials are out of proportion to their responsibilities; for instance, the salary of the chief electrical engineer of the Commonwealth is only £750 (£50 more than he received when State engineer of Queensland), and that of the telephone mechanician, Sydney, with a staff of 200 permanent and an average of 500 temporary men under him, is £252. Mr. Sharp further states that the majority of switchboards at branch exchanges and the present central switchboard are out of date, and recommends that sufficient additional junctions, B positions and order wires be promptly installed, that every branch exchange with over 500 subscribers be fitted with multiple switchboards, and that the erection of new switchboards be hastened by the employment of larger erecting staffs.

Canada.—The U.S. Consul at Winnipeg, says the City of Winnipeg will be prepared within a few months to sell electrical energy.

The great plant at Point du Bois, costing £450,000, and capable of generating 100,000 H.P., is nearing completion. While the city is contemplating purchasing the street car system, it may also arrange to take over the power plant of the street railway company, which supplies power for the railway, and electricity for private lighting and for power. The rates for power at present: 6 cents per unit up to 50 H.P.; 4 cents from 50 to 100 H.P., and 3 cents over 100 H.P. Current for private lighting costs 10 cents per unit and for cooking 6 cents. Public lighting costs 11 cents per arc lamp per night, the total cost in 1910 being $42,977.

International Rubber Exhibition.—Mr. A. S. Manders, organising manager of the Rubber and Allied Trades Exhibition recently held in London, states that a rubber exhibition will be held in New York in September, 1912.

Italy.—The Soc. Anon. di Tramvie Elettriche Briantee has obtained a concession for construction and working of an electric tramway from Meda to Cantu. The Soc. Anon. per la Tramvia Elettrica Lucca-Pescia-Monsummano a concession for construction and working of an electric tramway from Lucca to Maggiano.

Peru.—The Soc. Electrica del Cuzco (Ltda.), the board of which is composed of Alquipa business men, has been formed to supply electric light and power in Cuzco. It is proposed to use water power from Lake Chincheros or from the river Vilcaiota for generating electrical energy.

South Africa.—The report of the Rhodesia Chamber of Mines for 1910 states that the imports into Southern Rhodesia included: Electrical machinery, £11,822; mining machinery, £182,502; electrical materials, £11,661; manufactures of iron and steel, £89,023; detonators and fuses, £18,995.

Sweden.—An electric power station is being constructed at Elfkarleby, and temporary plant is expected to be working by December.

Switzerland.—M. A. Palaz, of Lausanne, has secured an 80 years' concession for the construction and working of a rack and pinion electric railway from Villars-Chesières to Bretaye, at an estimated capital cost of £34,000.

The Telephone in War Time.—For the first time since its introduction, we think, effective control of the telephone has been organised. Italy, in connection with the political troubles which have arisen between that country and Turkey on the Tripoli question, has succeeded in effectively "bonneting" both the telegraph and the telephone, so far as concerns the leaking out of any news concerning the mobilisation of the Italian fleet and army during the past week or two is concerned. The efficiency of the Italian wireless telegraph arrangements is said to have been of material assistance in this connection. The Italians pride themselves upon the completeness of their wireless telegraphic equipments, thanks to Signor Marconi.

Wireless Telegraph Notes.—It is stated that a still further extension of the wireless telegraph station at the Eiffel Tower, Paris, has been decided upon. In 1910 large extensions were made, and these have pointed the way to a still further enlargement of the powers of the station. "The Times" of Oct. 4 gives the following additional information on this subject:—

The existing installation consists of three sections, placed in an underground depot on the Champ de Mars. The first of these, which employs solitary sparks at 10 kw., is an early system, now used only for short distances; the second, which emits discharges at 40 kw., serves for long-distance purposes; and the third is adapted for the use of musical vibrations at 10 kw. This last method has proved excellent in practice, and it is the one which is to be increased in power. The musical discharge has been found, even with the present limited conditions, to attain a wide range of action, and to enable messages to be transmitted at times when the state of the atmosphere induces electric perturbations which paralyse the emission of isolated sparks. The plant is now sending telegrams to a distance of 3,100 miles. The new station, which is to be put in hand at once, will have 225 H.P. available. The current will be provided by a Diesel motor, which will drive an alternator on the Bethenod system at 500 volts, with 1,000 periods, and the station will serve as the starting point for a vast network of wireless telegraphy, destined to link up the French colonial possessions with the metropolis. The Minister for the Colonies has propounded a scheme which will involve the creation of at least 10 high-power stations, and this project will be carried out if the installation on the Eiffel Tower proves to be satisfactory.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

The directors of the GREAT WESTERN RAILWAY Co. invite tenders for one year's supply of telegraph instruments, telegraph apparatus (insulators, &c.), electrical wires and cables, telegraph ironwork and tools, telegraph dryselteries, electric light carbons, glass, acids, oils, paints, leather, indiarubber goods, zinc, antimony, brass, tin plates, iron and steel wire, sundries, &c. (tenders by 10 a.m. Oct. 16); also for three years' supply of baskets, waste, brasswork for carriages, &c., locks, ironmongery, tools, varnish, &c. (tenders by 10 a.m. Nov. 7. Specifications and forms of tender (on and after Oct. 23 in the case of the second group) from the Stores Superintendent, Swindon. Tenders to the secretary, Mr. A. E. Bolter, Paddington Station, London. See also an advertisement.

Tenders are invited up to Nov. 15 for supply of magneto switchboards, millammeters, relays, repeaters, copper wire and an electric motor to the Postmaster-General's Department in SOUTH AUSTRALIA, and up to No. 28 for the supply of ebonite ear-pieces, calculagraphs and brown stoneware insulators to the Postmaster-General's Department in VICTORIA. Specifications, forms of tender, &c., from the Commonwealth Offices, 73, Victoria-street, London, S.W. See also advertisements.

HAMMERSMITH (London) Borough Council invite tenders for the supply of various a.c. and d.c. motors. Specifications, form of tender, &c., from the borough electrical engineer, Mr. G. G. Bell, St. Fulham Palace-road, London, W. Tenders to the town clerk, Mr. H. Thompson, by 4 p.m. of Wednesday, Oct. 11. See also an advertisement.

GRIMSBY Corporation invite tenders for supply of paper-insulated lead-covered cables, house fuse and main service boxes. Specifications and forms of tender from the borough electrical engineer, Mr. W. A. Vignoles, M.I.E.E. Tenders must be in by first post Oct. 10.

The Tramways and Electricity Committee of BELFAST Corporation invite tenders for the supply of 2,000 ampere switchboard apparatus, field regulating rheostat and change-over switch. Specification and form of contract from the city electrical engineer, Mr. T. W. Rhodes, East Bridge-street, Belfast. Tenders to the town clerk, Mr. R. Meyer, by 10 a.m. Oct. 9.

Tenders are invited up to Nov. 22 for the supply of cable to the Postmaster-General's Department in QUEENSLAND; and up to Nov. 15 for the supply of telephone cords and earpieces to the Postmaster-General's Department in SOUTH AUSTRALIA. Tender forms, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W. See also advertisements.

Tenders are invited up to Dec. 20 for the supply of one branching multiple magneto switchboard at Broken Hill to the Postmaster-General's Department in NEW SOUTH WALES. Tender forms and specification from the Commonwealth Offices, 72, Victoria-street, London, S.W. See an advertisement.

Tenders are invited up to Nov. 21 for supply of one automatic or semi-automatic switchboard and equipment to the Postmaster-General's Department in WESTERN AUSTRALIA. Tender forms and specifications may be obtained at the Commonwealth Offices, 72, Victoria-street, London, S.W. See an advertisement.

LONDON County Council require tenders by 11 a.m. Oct. 24 for supply of hand-power overhead crane, h.t. and l.t. cables and switch gear, &c., rotary converters and static transformers, for sub-stations. Specifications, &c., from the Clerk.

HACKNEY (London) Borough Council require tenders by 7 p.m. Oct. 12, for supply of 100,000 pairs of white open type arc lamp carbons. Specification, &c., from the Town Clerk.

HASTINGS Guardians require tenders by Oct. 18 for the electric lighting of the workhouse premises, Ore, Hastings. Specification from Mr. S. Bumstead, 11, Wellington-sq., Hastings.

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PERTH (N.B.) Corporation want tenders by Oct. 14 for coal storage hoppers, conveyors, capstans, electric generating plant for stoking machinery and extension of coal elevator and hoist. Specifications, &c., from the Gas Engineer.

CARLISLE Electricity Committee require tenders for water softening and purifying plant (4,000 gallons per hour) and a main l.t. feeder switchboard. Tenders to City Electrical Engineer by Oct. 14.

DUNDEE Council require tenders by Oct. 9 for material required in the erection of overhead tramway equipment at Clepington-rd. Specification, &c., from the City Electrical and Tramways Engineer.

Tenders are invited up to Oct. 18 for the supply of 20 coin-in-the-slot attachments to the Postmaster-General's Department in WESTERN AUSTRALIA; up to Oct. 25 for supply to the Postmaster-General's Department in SOUTH AUSTRALIA of cable and paper sleeves; up to Nov. 1 for the supply of 5,000 porcelain (No. 8) insulators to the Postmaster-General's Department in SOUTH AUSTRALIA; and up to Nov. 18 for the supply of ironwork, measuring instruments, switchboards, &c., to the Postmaster-General's Department, in QUEENSLAND. Tender forms, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W.

The Metropolitan Water and Sewerage Board, Albert-street, BRISBANE, Queensland, want tenders by noon Jan. 30 next for supply and erection of one, two or three complete units, each consisting of power generating plant and pump or pumps to lift not less than 6,000,000 gallons per day. Particulars from the Secretary, and forms from the Agent-General for Queensland.

DUNEDIN (N.Z.) Corporation require tenders by Nov. 1 for supply of (1) 500 B.H.P. vertical type gas engine or Diesel oil engine, suitable for rope driving an a.c. motor and d.c. generator; and (2) direct-coupled vertical type gas engine or Diesel oil engine and d.c. generator (800 kw. at 550 volts). Specification at 73, Basinghall-street, E.C.

TULCEA (Roumania) municipality require tenders by Nov. 19 for electric lighting of the town.

Tenders are invited by the Municipal Council of PELOTAS (Brazil) for a 40 years' concession for the supply of electricity for power and lighting and the establishment and working of electric tramways. Tenders to Senhor Luiz M. da S. Pennafiel, Intendencia Municipal, Pelotas, up to 1 p.m. Nov. 14. A deposit (about £300) is required with each tender, to be increased by the successful tenderer to 25,000 milreis (about £1,670). Further particulars (in Portuguese) can be seen by British contractors at 73, Basinghall-street, London, E.C.

Tenders are wanted by noon Nov. 22 for supply of motor generators, accumulators, main switchboard, cable, &c., to the South African Government Posts and Telegraphs Department, PRETORIA. Particulars from G.P.O., Johannesburg or Cape Town.

Tenders will be received until Nov. 28 at the Directoria Geral Ministerio de Viaçao e Obras Publicas, Rio de Janiero, for harbour works at JARAGUÁ (Alagoas State) (estimated to cost £780,000), including the supply of six movable 1½-ton electric cranes, a fixed 30-ton crane and an electric lighting installation. Particulars can be seen at 73, Basinghall-street, E.C.

PORT ELIZABETH (Cape Colony) Municipality require tenders by Oct. 19 for the supply of electric motors and starting switches. Particulars from the Town Clerk.

The Bulgarian Directorate-General of Posts, Telegraphs and Telephones, SOFIA, require tenders by Oct. 23 for supply of telegraph and telephone material. Specification (in Bulgarian) at 73, Basinghall-street, London, E.C.

PLEVNA (Bulgaria) Municipality require tenders by Nov. 17 (from firms who have carried out similar contracts) for electrically lighting the town. Deposit of £1,000 required. Specifications from the Municipal Offices on payment of £1.

SYSRAN (Russia) Town Council require tenders by Oct. 14 for the construction of an electric tramway and the equipment of electricity works.

TENDERS RECEIVED AND ACCEPTED.

The following tenders were received by Poplar (London) Council for (*a*) one overhead bunker and (*b*) one combined coal elevator and conveyor:—

New Conveyor Co. (*accepted*) (*a*) £1,188, (*b*) £699, 10s.; Tickle Bros. (*a*) £1,076, (*b*) £490; Ed. Bennis & Co. (*a*) £1,270, (*b*) £610; John Spencer, Ltd. (*a*) £1,212, (*b*) £865; Edgar Allen & Co. (*a*) £1,730, (*b*) £918; Barry, Hendry & Co. (*a*) £2,050, (*b*) £475; Babcock & Wilcox (*a*) £2,100, (*b*) £760; Dempster & Sons (*a*) £1,654, (*b*) 1,015. The specification of the lowest tender was incomplete and no drawings were submitted.

Launceston (Tasmania) were recently recommended by the Electricity Committee to accept the following tenders for plant to supplement the power now available at the electricity works: Australian Metal Co., turbo-alternator, condenser and switchgear, £3,480, with an addition of £258 for spare parts; Babcock & Wilcox, for boilers, £2,859; total, £6,597; and that the Australian Metal Co. be allowed six months and Babcock & Wilcox 18 weeks for delivery.

Poplar (London) Council recently received tenders for a 3,000 kw. turbine alternator and condenser. Twelve firms sent in tenders, and many of them submitted several alternative quotations for different types of alternators, condensers, &c. We give below the highest and lowest tender of each firm:—

Willans & Robinson (G.E.C. alt.) (*accepted*), £7,581; E.C.C. alt., £8,364. 14 tenders.

Richardsons, Westgarth & Co. (G.E.C. alt.), £7,522; Siemens alt., £9,375. 6 tenders.

Dick, Kerr & Co. (Mirrlees, Watson cond.), £7,617; Allen cond., £7,652. 3 tenders.

C. A. Parsons & Co. (B. West. alt.), £8,306; Parsons alt., £8,832. 21 tenders.

Bellis & Morcom (G.E.C. alt.), £8,456; Siemens alt., £8,877. 3 tenders.

Brush Co., £8,728 and £8,460.

British Westinghouse Co., £8,776 and £9,269.

Jas. Howden & Co. (B. West. alt. and Mirrlees, Watson cond.), £8,970; Vickers alt. and Mirrlees cond., £9,339. 12 tenders.

John Musgrave & Sons (G.E.C. alt.), £9,267; Siemens alt., £10,011. 3 tenders.

Fraser & Chalmers (G.E.C. alt. and Mirrlees cond.), £9,925; Vickers alt. and Worthington cond., £10,605. 18 tenders.

British Thomson-Houston Co. (Mirrlees cond.), £9,854 and £9,728.

Five firms submitted quotations for the condensers only, viz.: I. Storey & Son (£3,195), Cole, Marchent & Morley (£2,865 and £2,695), Mirrlees, Watson Co. (£3,200), Worthington Co. (£3,180 and £2,930), and W. H. Allen, Son & Co. (£3,069 and £2,543).

After analysis of the tenders by the borough electrical engineer (Mr. J. H. Bowden) the Electricity Committee recommended the acceptance of Messrs. Willans & Robinson's tender at £7,581.

Hackney (London) Guardians received tenders from six firms for the extension of the telephone systems at their buildings at Homerton. The quotations varied from £252. 10s. (by the Private Telephone Co.) to £672. 10s. (by the British Home & Office Telephone Co.), and the lowest tender has been accepted.

Wigan Council have accepted the tender of the Rees Roturbo Co. (at £261) for supply and erection of two electrically-driven centrifugal pumps for the water department.

Rugby Council have accepted the tender of the British Thomson-Houston Co. for three transformers.

Swindon Guardians have accepted the tender of Rye & Co. for cotton-covered electric cable at 1¼d. and 1⅝d. per yard, and flexible electric cord at 1½d. per yard.

Bermondsey (London) Council have accepted the tender of S. Pontifex & Co. for supply of 50 electric street lanterns at £48.

The tender of the Automatic Electric Co. (Sydney) has been accepted for the installation of the automatic telephone system at Geelong (Victoria).

Southwark Council have accepted the tender of the British Insulated & Helsby Cables, at £231. 15s., for supply of 440 yds. of 0·3 l.t. t.c. cable, and, (at £40), for an eight-way feeder pillar.

Haslingden Council have placed an order with Ferranti Limited for a switchboard, and with the British Westinghouse Co. for station transformers.

Eccles Council has accepted the tender of Ferranti Limited (at £709) for supply of a h.t. single-phase switchboard.

Plant for Sale.—Mr. F. Lake, 132, Upper Thames-street, London, E.C., advertises for sale electrical sundries, cables, lamps, instruments, &c.

Agency.—A German firm of accumulator manufacturers advertise for a London firm with a connection among motor-car makers, &c., to take over the sole agency of their portable accumulators.

Business for Sale.—The business of an electric motor manufacturing company is advertised for sale in another column.

Patents Development.—The proprietor of patent No. 2,181/1905 for "Improvements relating to electric measuring instruments," desires to make arrangements for exploiting same in this country. Applications to Messrs. Haseltine, Lake & Co., patent agents, 7 and 8, Southampton Buildings, Chancery-lane, London, W.C.

The owners of British patent No. 23,778/1907, for "Improvements in the manufacture of electric resistances," desire to sell their patent rights or to grant licences thereunder. Particulars from Messrs. Day, Davies & Hunt, patent agents, 321, High Holborn, London, W.C.

The proprietor of British patent No. 20,746/1908, for "Lamp shades, globes and reflectors," desires to enter into arrangements

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with British manufacturers with a view to the exploitation of same. Further particulars from Mr. H. Skerrett, chartered patent agent, 24, Temple-row, Birmingham.

BUSINESS NOTICES.

The North Western Electrical Appliance Co., formerly of Catheart, Glasgow, have removed their works and offices to Railway Appliance Works, Darlington.

Arthur Paxton and Sydney C. Fifast, electrical engineers and electric supply merchants, Fynyeod-street, Cardiff, have dissolved partnership. Debts by Mr. Paxton, who continues.

BANKRUPTCIES, LIQUIDATIONS, &c.

An application for the discharge of Joseph A. Bauer (trading as the Electrical & General Engineering Co.), 17, Gracechurch-street, London, E.C., will be heard on Oct. 25 at Bankruptcy-buildings, London, W.C.

A meeting to receive an account of the winding-up of Havana Telephone Securities Co. (Ltd.) will be held on Oct. 31 at New Broad-street House, London, E.C.

The Winchester Electric Light & Power Co. (Ltd.) is being wound up voluntarily. Messrs. F. E. Gripper and A. R. Dyer are liquidators.

COMPANIES' MEETINGS AND REPORTS.

Direct United States Cable Co. (Ltd.)

The sixty-eighth ordinary general meeting was held on Friday last, under the presidency of Mr. E. M. UNDERDOWN, K.C.

The SECRETARY (Mr. W. Miles) read the notice convening the meeting and the auditors' report.

The CHAIRMAN said: In view of the meeting that is to follow, I do not propose to detain you long. The outstanding feature in the accounts for the past half-year is the decrease of £12,326 in revenue, due to the Western Union Co. having ceased, since March 1 last, to hand over to us or to the Anglo Co. the proportion of the eastward traffic that up to that time, since the year 1882, had always been dealt with by us. The increase of £2,471 in the working expenses is entirely due to the establishment of the Harbour Grace station consequent upon the diversion of the cable to Newfoundland, which, as I have previously informed you, has resulted in an acceleration of the speed at which messages are transmitted over the cable, equal to 70 per cent. upon its previous speed. I do not propose now to refer to the provisional agreement with the Western Union Telegraph Co. that we have entered into, as the proposal before you is simply to adopt the Directors' report and accounts. The reason for the delay in the issue thereof is explained in the report. In the middle of July, when the accounts have usually been circulated, we were entering upon the final stage of the protracted negotiations that have resulted in the agreement, and we thought it undesirable to publish the accounts at that time. Those negotiations have now been brought to a conclusion, and, as you will see, if the agreement is approved by you, the Western Union Co. will be required to hand us a sum of £10,800 in respect of the traffic withheld since March 1, to which I have previously referred, so that the diminution in our revenue will be practically covered. Some explanation may be looked for as to the payment of a dividend of 2s. and a bonus of 1s. for the quarter to June 30 last. It was, from a diplomatic point of view, desirable to maintain the usual rate of dividend for the final quarter of the year, and looking to the fact that our reserve fund stood at a sum well over £500,000, which had been deemed a sufficient amount to provide for the replacement of the cable should that be necessary, while it had been increased during the year by some £18,000, we considered ourselves justified in using some £7,000 of that increase of £18,000 in paying a bonus to the shareholders. I may also add that your Directors were fully alive to the strength of the position of our undertaking, and were confident that the Western Union Co. would concede terms that would be regarded as satisfactory by the shareholders. I appeal very confidently for your approval of what we have done, and move the adoption of the report and accounts.

Sir JAMES PENDER, Bart., seconded the motion, which was carried unanimously.

The retiring directors (Mr. E. M. Underdown and Mr. H. C. B. Underdown) and the retiring auditors were then re-elected. This terminated the proceedings of the ordinary general meeting.

An extraordinary meeting followed, when the heads of the agreement with the Western Union Co. were read by the Solicitor (Mr. T. G. Cowan, of Messrs. Slaughter & May).

The SECRETARY then read the resolutions to be put before the meeting, which expressed acceptance of the agreement by the shareholders of the Company, and effected the necessary alterations in the Articles of Association.

The CHAIRMAN, in proposing the adoption of the resolutions, said: You have doubtless all received a copy of the Secretary's communication of Sept. 15 giving in a summarised form particulars of the more salient provisions embodied in the provisional agreement for leasing the cables of this Company to the Western Union Co., and this your Directors recommend you to-day to adopt. In proposing the resolutions that have just been read I will relate the circumstances which have necessitated our entering into this proposed agreement and our reasons for recommending you to approve of our action so far, and formally to sanction the arrangement by your vote. You are probably all aware that since the year 1882 this Company has been working with the Anglo-American Telegraph Co. and the Western Union Telegraph Co. under agreements entered into with a view not only to secure and maintain the successful carrying on of this Company's cable business, but also to give to the public an efficient cable service between this country and the United States and Canada founded upon the mutual support and facilities existing between the cables for all purposes, it being conceded that there is a necessity for a fair number of lines across the Atlantic if steady communication is to be secured. Under that arrangement the bulk of the cable business was, up to 1882, conducted over the cables of the Anglo- and Direct Companies. The Anglo possessing four cables to our one, it will be obvious to you that the proportion of traffic dealt with by us was small as compared with that dealt with by the Anglo Co. In 1882 the Western Union Co. joined the combination with two cables, while the land lines and communications on the other side were conducted by the Western Union. In order that you may properly appreciate the position of the Western Union Co. in America I must explain that it is a company possessing, in addition to cables across the Atlantic, an independent telegraph system, in many respects comparable with that of the telegraph system in this country, which, as you are aware, is now in the hands of the Government. The Western Union Co. has not, indeed, a monopoly of the telegraph system in America, but its only serious competitor is the Postal Telegraph Co., an ally of the Commercial Cable Co. The Western Union Co. is, without doubt, in a predominant position as regards telegraphic communication in the United States, the postal system being a less extensive one. In the year 1910 the Western Union Co. had 24,825 offices in the United States, operating 1,429,049 miles of wire, and 214,360 miles of poles and cables. The total receipts of the Western Union Co. for the year 1910 amounted to the huge sum of $33,889,202, equal to nearly £7,000,000, and after paying all expenses, interest, and dividends for the year, a balance of revenue remained of $2,597,373, or over £500,000. These figures will give you some idea of the magnitude of the Western Union Co.'s operations, and I have no doubt will satisfy you that the payment of the rental for our cables is well secured by the undertaking of that company. Although the Anglo and Direct companies have hitherto maintained separate offices in New York and other centres, under the working arrangement that existed between the three companies, the Western Union Co. acted in America, to all intents and purposes, as collectors of cable messages passing over the cables of the three companies, and these messages were distributed and dealt with in agreed proportions. In the early part of 1910 a controlling interest in the Western Union Co. was obtained by the American Telegraph & Telephone Co., and a change in the management of the former company followed. About the same time the Government of the United States proceeded to put in force an Act of Congress known as the "The Sherman Anti-Trust Act," which prohibited combinations characterised as being in restraint of trade, and in view of this the Western Union Co. was advised that the agreement then existing between that company and the two English companies involved a contravention of the Sherman Act, and that the only method of avoiding it was to enter into some fresh agreement which would do away with the objectionable features of the combination. In May, 1910, negotiations were commenced with the Anglo and Direct companies to this end, and certain proposals were then submitted to us which we were reluctantly compelled, in your interests, to decline. So far as this Company was concerned, this was the position of matters when, in February last, the Western Union Co. gave notice that, in view of the agreement being considered as a violation of the provisions of the Sherman Act (and the Directors and officials of that company feared they would, in the event of the Government taking action, incur penalties of a severe kind), after March 1, 1911, the agreement that had been in existence between the three companies since 1882 would no longer be recognised. Your Directors meanwhile had obtained the highest legal advice in America and on this side, and it was at once intimated to the Western Union Co. that this Company could not accept that notice, and that we adhered to and held them, to the 1882 agreement. The Western Union Co. therefore gave notice cancelling the convention of 1882. The advisers of the Western Union Co., who, after all, are the people chiefly interested, are satisfied that the proposed lease is not a contravention of the Act. It must be admitted that our own advisers were not so confident, while an American counsel, consulted by the Anglo Co., has expressed the view that while it is not possible to pronounce with certainty upon the validity of the agreement, in his opinion the proposed lease is good under American common law, and would not be held to be in violation of the Anti-Trust law. We have, therefore (although a recent judgment of the Supreme Court has considerably modified the views of the Government as to the effect of the Sherman Act, and a statement has been made with authority that the United States authorities would be prepared to take all circumstances into consideration in connection with these matters), had to bear in mind the possibility that the proposed lease might be regarded as within the meaning of the Sherman Act. This aspect of the question has, you may be sure, been most closely and carefully considered by your Directors, and, while they appreciate that there is a risk, it is believed to be a distant one. With full knowledge of the position we have taken every step to effectually safeguard your interests and ensure that, even should the lease be broken, or even, which is quite possible, modified with our consent, you will be certainly in no worse position, than you were when the Western Union Co. repudiated the 1882 agreement. Then, on March 1 last, the Western Union ceased to hand over either to us or to the Anglo Co. any portion of the Eastward traffic collected by them on the other side. This represented nearly 50 per

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cent. of the messages transmitted over the cables. That statement will make clear to you the enormous loss that resulted to the English companies. This, put into figures, brought about a reduction in our revenue for the four months to June 30 last from £42,500 to £28,290 as compared with the corresponding four months in 1910, or a decrease of £14,210, and this on the assumption that our original agreement with the Anglo Co., entered into in 1877, prior to the admission of the Western Union Co., would still have held good, and that we should receive our full proportion of the traffic of the two companies, Anglo and Direct, as provided under that agreement. In the intervening months we were from time to time informed that negotiations were proceeding between the Anglo and Western Union companies, and it was intimated to us that when these were contemplated the Western Union Co. would approach us with a view to entering into a similar arrangement. In the early part of July we were informed that these two companies had come to an agreement, and the Western Union Co. then approached us. This was the position in the month of July, when it had been usual to issue our half-yearly accounts and to hold the annual meeting, and, as I informed you just now, we considered that in the circumstances that was not a suitable time for calling you together. Now, you may doubtless be disposed to ask me whether the arrangement before you might be broken by one of the parties or is or is not capable of being held invalid for the above-mentioned reasons, and whether, if so, the existence of the proposed contract might be endangered. I think we may look upon this in the light of the attitude and intention of the parties, and especially of the Western Union Co. I am convinced that the latter company will loyally endeavour to substantially uphold this agreement, even should legal necessity require some modification not of a vital character. It is clear that both parties will endeavour to exclude anything of an illegal nature. Our negotiations with the Western Union Co. have resulted in the arrangement which has been communicated to you and which your Directors recommend you to accept. We carefully studied the possible alternatives—namely (1), to revert to the original 1877 agreement with the Anglo Co.; (2), to endeavour to work alone. The latter alternative seemed an impossible one, seeing that we have only one cable across the Atlantic, and that interruption thereto would result in complete cessation of revenue; while as regards the other alternative, we have had four months' working with the Anglo Co. (without the Eastern traffic coming from the Western Union Co.'s system), and the result has conclusively demonstrated that our receipts under the 1877 agreement would probably have been little more than sufficient to meet our working expenses. Again, the question might be asked whether the two English companies could not have combined and established their own land line connections in America. I can only say that the institution of any such system by the English companies would have been a most costly undertaking, beset with such difficulties including the strenuous opposition of existing telegraph companies in America, as to make it practically impossible of accomplishment, at any rate with the capital at the disposal of the English companies. I am bound to state that the Anglo Co. proceeded with their negotiations and came to their agreement without consulting your Directors in any way thereon, and we had therefore to take care of ourselves. I now hear that the arrangement between that company and the Western Union Co. has been unanimously approved to-day at the extraordinary general meeting of the Anglo Co. That agreement is not identical with our agreement, but, of course, it is analagous to it. The assent to the agreement as between us and the Western Union Co. is not governed by that agreement, but it is satisfactory that it has been approved, as it shows that these great companies will all act together practically under the same regulations and conditions. It was, however, obvious that we could not count upon the co-operation of that company in attempting to provide our own means of communication between the cable ends and the interior of America. As I said just now, the only course open to us was to come to the best arrangement possible with the Western Union Co., and I have no hesitation in saying that we have, after many months of anxious negotiation, succeeded in doing this and have secured terms which we can honestly recommend for your acceptance.

Mr. UNDERDOWN proceeded to refer to the chief points of the new agreement and to the old arrangements which the agreement displaces. Their old cables were, he said, working admirably. The arrangements to limit the dividend to 4 per cent. was quite as much in the Direct Company's interest as in that of the Western Union, as it ensured that any balance remaining out of the interest of the reserve fund, after paying for repairs to the cable, would be added to the reserve fund, so that if a new cable should be required the Direct Company would have the means to purchase it. The policy of the Board in the future would be to pay quarterly dividends, as hitherto, at the rate of 4 per cent., to take into account the expenditure upon repairs and renewals of the cable, and to declare or not to declare the bonus as the circumstances warranted. The whole of the Company's staff, with the exception of the secretary and his assistants, who naturally remained with the Direct Company, are to enter the services of the Western Union Company under all the conditions of their present employment, and the Western Union Company undertakes to contribute an annual sum sufficient to maintain the pension scheme for the entire staff. The Postmaster-General, he understood, had stipulated that the stations of the English companies should be staffed by British subjects. Everything had, therefore, been done for the staff, of whose loyalty and devotion to duty the Directors desired to express their warm appreciation. He then proposed the adoption of the resolution assenting to the terms of the arrangement with the Western Union Company.

Sir JAMES PENDER seconded.

In reply to questions, the CHAIRMAN said that each company, the Anglo and the Direct, made their own agreements, and these agreements did not stand or fall together in any way. The arrangements of the old so-called "pool" disappeared altogether. With regard to the operation of the Sherman Act, should any difficulty arise they were in no worse position than they would be otherwise. They had their reserve fund, their interest upon this, their property, and their goodwill for what it might be worth. They had given up nothing but whatever rights they might have under the 1882 agreement. Under the new arrangement they not only retained their own property, but they had rights over the Western Union Company's land lines in the United States. The Chairman then asked for a show of hands, and declared the resolution carried unanimously.

The amendments to the Articles of Association were then approved, and a vote of thanks to the Chairman and Directors was agreed to with acclamation.

The CHAIRMAN, in reply, expressed the thanks of the Board to the officials of the Company for the assistance they had rendered, and said the shareholders were much indebted to the Secretary for the manner in which he had conducted the negotiations.

The proceedings then terminated.

Anglo-American Telegraph Co. (Ltd.)

An extraordinary general meeting of this company was held on Friday last, under the presidency of Mr. F. A. BEVAN, for the purpose of passing three resolutions: (1) approving the conditional agreement dated Aug. 22, 1911, between the company and the Western Union Telegraph Co., and authorising the directors to carry the agreement into effect in due course, subject to such modifications (if any) as they may from time to time approve; (2) altering the provisions of the memorandum of association of the company; and (3) providing that, upon the conditional agreement becoming operative and any present directors retiring within three calendar months after it becomes operative, there be paid out of the funds of the company to the said directors so retiring £4,000, to be divided amongst such retiring directors as they may agree.

The SECRETARY (Mr. T. H. Wells) having read the notice convening the meeting,

The CHAIRMAN proposed the resolutions. He said the circular which had been sent to the stockholders embodied all the principal points of the provisional agreement with the Western Union Co. He need hardly say that the proposal came from the other side. The Anglo-American Co. would have been quite satisfied to continue to work under the pooling agreement between themselves, the Direct United States Co., and the Western Union Co., but those who had the management of the Western Union Co. were of opinion that if the three companies could be brought under one management it would be easier to effect improvements which they had in contemplation in working the cables and to save expenses. With that object the negotiations for the agreement were commenced, and when they had made considerable progress the Western Union Co. discovered that the pooling agreement under which they had been working so satisfactorily, as far as the Anglo-American Co. was concerned, for many years, was in contravention of the Sherman Anti-Trust Act. In this country we were no judges of what that Act was, and therefore the directors had thought it right to consult the best legal opinion they could obtain on the other side, and they invited over here one of the most eminent lawyers in the United States, a gentleman of remarkable acumen and experience, and the directors had every reason to think that the advice he gave them was thoroughly sound. He told them that the matter could not be absolutely settled without going to a court of law, but he had no doubt that if it were brought to the notice of a court of law they would declare the pooling agreement to be illegal. Whether they would have done better to go into a legal fight, which would have taken a long time and cost a good deal of money—and during the time the contest lasted the stockholders would have received considerably less—he could not say, but the directors thought that the better way was to assume that the advice they had received was correct. The Western Union Co. at once stated that, believing the advice to be correct, they would terminate the pooling agreement as from March 1 last, which meant that instead of the earnings being divided, as before, in certain proportions between the three companies, each company would do its best to get traffic and would be entitled to the earnings it made. Therefore, whether they got more or less depended upon their own unaided work—a totally different matter from having the traffic pooled as hitherto. It must also be borne in mind that there was a slight, although not more than slight, advantage to the Americans as compared with themselves—that was to say, that the traffic from America was rather larger than the traffic to America. In addition to that, the Western Union Co. had enormous inland business on the other side, and it was only natural that they would be able to get hold of the traffic on their side in a way the Anglo Co. could not possibly do, having only their own line on this side. In the directors' opinion those were strong additional reasons why they should enter into the agreement. What might have been the issue had they gone into a fight he could not say, but the directors were of opinion that under the proposed agreement the company would be much safer than if they had gone into a regular stand-up fight with their former colleagues and friends.

Those were the principal reasons why the directors had thought fit to submit the agreement to the stockholders, and why they strongly advised the stockholders to approve it. The stockholders knew what the principal points of the agreement were. It was a lease for 99 years, and it guaranteed 3¾ per cent. on their ordinary stock, which meant 6 per cent. on the preferred and 1½ per cent. on the deferred—an amount which they had only once exceeded since 1884—that was, since they had had the present tariff. If they took that 3¾ per cent. on £7,000,000, it seemed to him that it was a very good return, because if they looked at the

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market price of their stock, it was something like £4,500,000—rather over. Therefore 3¾ per cent. on £7,000,000 represented a much higher rate of interest than 3¾ per cent. on the market price of the stock. Besides that the Western Union Co. had to maintain this company's cables and plant. They had also to keep up the Anglo Co.'s renewal fund until it reached £1,000,000, just as it was under the previous arrangement; and they took over all this company's liabilities and relieved them of the management of the cables. On the other hand, the Anglo Co. had to purchase from the Western Union Co. the cable which the latter laid a few months ago. The amount would come out of the renewal fund, which would thus be diminished by a very large amount, and the Western Union Co. would have to continue adding to the fund a considerable sum in order to make it up to £1,000,000. The Western Union Co. were bound under the agreement to maintain five cables, but in the case of the failure of two of the old Anglo cables they could substitute a new cable equal in power to the two old ones, and then they would have to maintain four cables, including the one to be purchased from them by the Anglo Co. There were never to be fewer than four cables, and the Anglo Co.'s plant was to be maintained and their dividend to be secured, whatever happened. There were certain contingencies under which the lease might terminate. If the Western Union Co. were to fail in paying the guaranteed dividend the Anglo Co. could give them notice to terminate the contract. On the other hand, if by the action of either the British or the United States Government it was found practically impossible to carry on the traffic, then the Western Union Co. would be released from their obligations. It appeared to him, however, that those contingencies were most unlikely when they thought of the magnitude of the Western Union Co. and its earning powers. Over and above the dividend it paid there remained a very large amount. He also thought, taking into account that the traffic itself, from natural causes, was likely to increase, that their 3¾ per cent. was about as safe as it was possible to be, and that, in fact, instead of having, as the deferred stockholders had, what he might call a speculative stock, judging by the fluctuations in its price, they would have really a gilt-edged stock, which would not be subject to such fluctuations. He saw that it had been hinted in the newspapers that some difficulties might occur. It had been suggested that the new agreement was a violation of the Sherman Anti-Trust Act. He need not tell the stockholders that the directors had taken counsel's opinion on the point, and they were assured that, as far as they could tell, the agreement was not in violation of that Act. It seemed to him that there was this difference, that instead of there being, as now, a combination of three companies to maintain certain rates—for neither of them could alter the rates without the consent of the others—it was now in the power of the Western Union Co. to vary their rates as they pleased without consulting the Anglo Co. or the Direct Co. They could put the rate up or down so far as the Anglo Co. was concerned, but they would have to pay the latter 3¾ per cent., whatever the rate might be. It was difficult to prophesy, but as far as he could foresee there was no reason why the agreement should not last. He desired to say, in conclusion, that if from any unforeseen cause the agreement came to an end, the position of the Anglo-American Co. would be that they would resume their five cables in certain contingencies or four cables as a minimum, they would have all their plant that was not perishable handed back to them, they would have their renewal fund at whatever amount it might have reached, and, in addition, they would have the assurance, as would be found by an article in the agreement, that the Western Union Co. would do their utmost to restore them, as far as traffic was concerned, to the position which they occupied in the year 1910. He thought the stockholders would agree with him that the directors had in every way possible guarded the interests of the company, and in asking them to pass the resolutions the board believed that they were doing that which was best and safest for the interests of the stockholders.

Sir GERALD FITZGERALD seconded the motion.

The MANAGER (Mr. J. H. Carson), in answer to Mr. CHESTER, said the traffic was nearly divided equally between east and west; about 52 per cent. from America and 48 per cent. from this side.

The CHAIRMAN, in reply to other questions, said that, in exchanging their money for a new cable the Anglo Co. were not in any way damaging themselves. They were getting a very fine new cable, and they would in any case have had to lay a new cable a few years hence. What was the position under the agreement? They would have five cables to the Western Union Co.'s two, and the cables were the property of the Anglo Co., not of the Western Union, to whom they were only leased. Therefore, in the event of the agreement breaking down, they would be in a very much better position having the cable already laid, even than if they had the money instead. They had the 1873 and the 1874 cables, and they had had considerable trouble with one of them lately, and if they had not come to the proposed agreement with the Western Union Co., it would probably have been prudent for them, in the next two or three years possibly, to have laid a new cable. The Western Union Co. did not disclose what their reserve fund was, but they kept what they called a surplus account which last year amounted to $2,597,000. They always carried forward a very large surplus and did not divide at all closely. Their net revenue last year was $7,274,900, whereas a few years ago it was $5,700,000. Their capital stock issued was close upon $100,000,000 (£20,000,000).

The SOLICITOR (Mr. Carslake), in reply to a stockholder, said the contract was an English contract, and they could therefore sue the Western Union Co. here as well as in America. They could get judgment against them here and put in a receiver of all the receipts on this side. Again, if they broke the contract the Anglo-American Co. could determine the lease and resume possession of their property. With respect to the position if the Sherman Anti-Trust Act were put into force and the lease were declared invalid, the company would again have all their cables back; and the lease contained a provision that the Western Union Co. were in that event to give the Anglo Co. the same facilities in the United States for the transmission of their traffic over the land-lines which they enjoyed up to the end of 1910. The new cable would belong absolutely to the Anglo Co.; it would only be leased to the Western Union.

The CHAIRMAN then put the resolutions to the meeting, and declared them carried unanimously.

A vote of thanks to the chairman and directors terminated the proceedings.

DRAKE & GORHAM (LTD.)—The directors' report for the year ended June 30 states that, after payment of all charges, including bonuses due to staff, there remains a nett profit of £7,184. 7s. 6d., added to £1,242 4s. 9d. brought forward. Dividend of 4½ per cent. requires £5,625 and £1,500 is written off underwriting commission, leaving £1,301. 12s. 3d. to be carried forward. The improved results are mainly due to the increasing popularity of the electric light, especially in view of the large reduction in first cost and running expenses. The wholesale department has been further extended and an additional warehouse will shortly be ready for occupation.

WESTERN UNION TELEGRAPH CO.—The report of this company for the quarter ended Sept. 30 states that there was a surplus at March 31 of $9,313,702.36, and net revenue for the quarter ended June 30 was $1,982,493.17. After appropriating $747,886.50 for ¾ per cent. dividend paid July 15, and $433,953.05 for interest on bonded debt, there was a surplus at June 30 of $10,114,355.98. Net revenue of the quarter ended Sept. 30, based upon completed returns for July, partial returns for August and estimating the business for September, will be about $2,220,200.00, interest on bonded debt will require $434,062.00, and dividend of ¾ per cent. $747,887.00, leaving a surplus of $11,152,606.98.

WILLANS & ROBINSON (LTD.)—The directors' report for the half-year ended June 30 states that after writing off £4,428. 12s. 9d. depreciation, paying £4,173. 18s. 5d. interest on debenture stock and £348. 9s. 7d., the cost of the upkeep of the Queen's Ferry works, the result of the half-year's trading shows a loss of £7,692. 14s. 7d., compared with £10,811. 3s. for the previous six months. Added to the balance £26,079. 19s. 9d. brought forward from the previous half-year, this brings up the total of the debit standing against profit and loss account to £33,772. 14s. 4d. Although the company is securing its fair share of orders, the prices obtainable, due to the continued excessive competition, render these largely unremunerative. The company's area of operations is being judiciously extended. The economies referred to at the last half-yearly meeting, and which are only partially operative in the current balance-sheet, should materially assist in meeting the severe conditions at present existing. The regrettable lawsuit (referred to at previous meetings), involving a claim for £10,000 damages, has now been concluded, a verdict of £3,411 damages (with costs) being given against the company. The total cost to the company of the action amounts to £23,519. 8s. 11d. Provision against this liability to the extent of £3,863. 8s. 2d. has already been made, leaving £19,656. 0s. 9d. still to be dealt with. The matter concludes the liabilities arising out of the Queen's Ferry works, prior to their being closed in 1908, and is in no way attributable to the business carried on at Rugby.

CITY NOTES.

MEMORANDA (Oct. 5).—**Bank rate 4 per cent.** (since Sept. 21, 1911). Price of silver, 24¼d. per oz. **Consols** 77¼—77½ for money, 77¼—77⅝ for account. **Consols Pay Day**, Nov. 3; Stock and **Shares Continuation** Days, Oct. 19 and 25; **Ticket Days**, Oct. 11 and 26; **Pay Days**, Oct. 12 and 27; **Mining Shares Carry Over** Days, Oct. 9 and 24.

PRICES OF METALS (London).—*Copper*, cash, 54½; three months, 55. *Lead*, English, 15⅞—15½; Foreign, 15⅛—15¼. *Spelter*, 27½—27. *Tin*, English, 190—192; Foreign, cash, 183; three months, 183. *Iron*, Cleveland, cash, 46/9½, three months, 47/4.

ANGLO-AMERICAN TELEGRAPH CO. (LTD.)—The board of directors have resolved to declare an interim dividend for the quarter ended Sept. 30 of 15s. per cent. on the ordinary stock and £1. 10s. per cent. on the preferred stock (less tax) payable Nov. 1.

CALCUTTA TRAMWAYS CO. (LTD.)—An interim dividend of 2s. 3d. per share has been declared on the ordinary shares (at the rate of 5 per cent. per annum, tax free), on account of the year to Dec. 31 next.

FOLKESTONE ELECTRICITY SUPPLY CO. (LTD.)—The directors have declared an interim dividend at the rare of 6 per cent. (3s. per share) less tax, on the ordinary shares for the half-year to June 30.

LISBON ELECTRIC TRAMWAYS (LTD.)—The directors have declared an interim dividend of 3 per cent. (tax free) on account of current year.

SUBMARINE CABLES TRUST.—Notice is given that on the 16th inst. the coupon due on that date will be paid by Messrs. Glyn, Mills & Co. Coupons should be left four clear days before payment.

WINCHESTER ELECTRIC LIGHT & POWER CO. (LTD.)—At an extraordinary meeting last week it was resolved to wind up the company voluntarily; and Mr. F. E. Gripper (Broad Sanctuary Chambers, Westminster) and A. R. Dyer (Palm Hall, Winchester) were appointed liquidators.

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ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
deen Corporation	Sept. 27	1,563	+ 66	17	27,988	+ 1,725
rie	,, 22	231	+ 4	38	8,308	+ 54
o-Argentine	,, 30	48,092	+ 2,198	39	1,899,214	+ 173,928
on-under-Lyne	.. ..	..	..	..	..	..
Corporation	,, 30	306	+ 5	20	8,486	+ 49
sley	,, 22	191	+ 22	38	7,030	+ 495
w	,, 22	349	+ 81	38	11,815	+ 1,446
Electric Trams, Ltd.	,, 27	895	— 25	39	33,635	+ 1,065
ngham Corporation	,, 30	9,750	+ 2,366	26	214,373	+ 37,023
ngham & Midland	,, 22	918	+ 63	38	34,383	+ 2,011
pool & Fleetwood	,, 30	962	+ 114	..	..	..
burn Corporation	,, 27	1,092	+ 39	1	1,092	+ 39
n Corporation	Oct. 1	2,451	+ 24	27	68,672	+ 4,683
ay	Sept. 1	2,656	— 78	35	99,345	+ 5,869
emouth Corporation	,, 27	1,921	+ 46	26	51,517	— 15
rd Corporation	,, 30	5,370	— 301	26	148,573	+ 11,233
on Corporation	Oct. 1	1,043	— 20	¶26	30,979	+ 2,087
Trams & Carriage	Sept. 29	6,422	+ 102	26	189,753	+ 19,392
y Corporation	,, 30	1,344	— 60	26	28,041	+ 3,412
Corporation	Oct. 1	283	— 157	26	7,875	+ 527
orporation	,, 1	1,254	— 34	¶26	35,098	+ 3,208
a Tramways Co.	Sept. 30	R66,426	+ R10,536	13	R769,408	+ R68,306
ne-Redruth	,, 30	122	— 7	39	4,786	+ 5
Corporation	,, 23	2,440	+ 121	25	64,554	+ 5,543
London Railway	,, 30	4,819	— 618	13	56,842	— 11,888
n & Dist. Lt. Rys.	.. ..	..	..	..	..	..
South London Rly.	Oct. 1	3,116	+ 88	13	39,749	— 355
Birmingham	Sept. 22	1,139	— 1,782	38	90,046	— 18,026
ctric Trams Co.	,, 28	495	— 7	39	19,845	+ 597
	,, 23	1,776	+ 58	25	47,555	+ 4,037
rt & Dist. Trams	,, 22	518	+ 74	38	19,048	+ 2,825
orporation	.. ..	..	..	..	..	..
Lucan Railway	,, 29	163	— 3	13	2,252	— 41
nited	,, 29	5,477	— 392	13	88,815	+ 10,274
Stourbridge	,, 22	899	+ 92	38	32,854	+ 2,418
Corporation	,, 27	1,186	— 89	¶19	23,494	— 379
n Council	,, 30	1,022	— 26	25	29,298	+ 1,652
orporation	,, 29	363	+ 17	26	9,722	+ 815
d & Dist. Trams	,, 22	1,017	+ 54	38	39,592	+ 2,260
Corporation	,, 30	21,020	+ 1,145	§17	333,292	+ 22,258
Trams	,, 30	124	+ 7	39	4,869	+ 387
d-Northfleet	,, 22	230	+ 12	38	8,219	+ 288
rthern & City Rly.	,, 30	1,426	+ 23	13	17,643	+ 289
& Port Glasgow	,, 22	762	+ 154	38	27,817	+ 3,679
orporation	,, 26	1,944	+ 80	†26	54,118	+ 5,817
d Tramways	,, 22	297	+ 34	38	10,559	+ 937
Elec. Trams Co.	,, 23	1,264	— 76	13	18,859	+ 826
g	,, 30	$9,581	+ $458	..	..	..
eld Corpn.	,, 30	2,271	+ 151	26	52,855	+ 6,241
oration	,, 30	2,842	+ 88	26	74,794	+ 3,711
rict Council	,, 30	520	— 17	27	14,796	+ 525
District Council	,, 23	130	— 5	26	3,542	+ 109
orporation	,, 30	468	+ 1	26	12,924	+ 860
net Co.	,, 30	810	+ 167	52	37,368	+ 2,822
	,, 22	130	+ 15	38	5,120	+ 390
Corporation	,, 28	178	— 1	26	5,165	+ 401
ster & District	,, 22	114	— 3	38	4,668	+ 327
Corporation	,, 30	163	+ 5	20	3,493	+ 334
Corpn.	,, 27	288	+ 6	..	..	..
e Trams Co.	,, 28	1,619	+ 58	39	55,655	+ 1,059
United	,, 27	1,352	+ 24	39	53,132	+ 1,829
	,, 22	185	— 39	38	6,996	+ 484
oration	,, 30	7,659	+ 259	26	200,924	+ 14,265
orporation	,, 30	2,457	+ 28	26	67,680	+ 5,525
oration	,, 30	652	+ 25	‡20	13,988	+ 1,151
poration	,, 30	123	— 1	26	3,456	+ 210
orporation	,, 25	11,493	+ 475	38	434,739	+ 12,572
verhead Rly.	Oct. 1	1,557	+ 134	13	20,133	+ 993
Colwyn Bay Ry.	Sept. 29	322	+ 35	§43	13,936	+ 522
nty Council	,, 20	43,232	+ 833	‡17	1,102,091	+ 67,338
Ry. Co.	,, 30	12,760	+ 610	13	152,890	+ 2,120
ted	,, 30	6,547	— 209	39	261,844	+ 10,547
orporation	.. ..	..	..	..	..	..
Corporation	,, 30	16,692	+ 237	26	429,673	+ 24,256
way	,, 30	2,106	+ 55	13	23,871	— 1,698
	,, 22	219	+ 11	38	8,026	+ 128
Dist. Railway	,, 30	11,253	+ 604	13	137,410	+ 5,761
Elec. Trams	,, 22	9,142	+ 905	38	337,154	+ 52,516
	,, 22	333	+ 14	38	13,302	+ 1,160
oration	,, 30	175	+ 26	§26	4,990	+ 1,042
-Tyne Corp.	,, 30	4,249	+ 365	26	112,944	+ 8,221
n.)	,, 30	694	+ 696	26	19,190	+ 919
n Corporation	,, 29	523	+ 13	26	14,698	+ 1,371
ton & Hyde	,, 22	578	+ 21	38	21,930	+ 820
oration	Oct. 1	1,962	+ 87	27	53,024	+ 2,160
Corporation	Sept. 27	170	— 26	19	3,796	+ 211
Elec. Trams	,, 29	1,528	+ 255	39	62,452	+ 14,137
	,, 22	132	+ 13	38	4,952	+ 535
Corporation	,, 30	2,162	+ 11	26	65,493	+ 6,132
	,, 22	2,072	+ 219	39	73,222	+ 6,971
oration	,, 27	807	+ 112	26	23,996	+ 1,629
orporation	,, 23	672	+ 28	26	17,878	+ 1,562
	,, 22	232	+ 14	38	9,341	+ 82
oration	Oct. 2	4,731	— 126	‡25	131,243	+ 6,155
	Sept. 20	$13,000	+ $1,422	..	..	..
oration	,, 22	55	+ 1	38	2,055	+ 85
ams	Oct. 1	6,451	+ 249	26	174,316	+ 11,558
olitan	Sept. 30	£10,688	+ $933	..	..	..
	,, 22	893	+ 23	38	33,734	+ 2,066
	,, 22	954	+ 101	39	34,394	+ 2,493
poration	,, 27	1,305	+ 186	26	34,029	+ 4,555
ramways	,, 27	802	+ 131	25	21,435	+ 3,390
de, &c., Jt. Bd.	,, 22	315	+ 14	38	12,041	+ 530
rporation	,, 30	743	— 1	26	21,389	+ 1,801
istrict	Oct. 1	1,270	+ 73	26	36,292	+ 4,755
a	Sept. 27	470	+ 31	48	22,485	+ 1,786
oration	,, 22	1,202	+ 73	38	43,939	+ 2,667
	,, 27	180	+ 26	26	4,312	+ 516
d District	,, 22	47	+ 4	38	1,659	+ 41
ns Co.	,, 22	232	+ 19	38	10,918	+ 491
oration	,, 27	474	+ 70	13	7,216	+ 942
ration	,, 30	1,095	+ 136	26	30,826	+ 4,749
rporation	,, 30	580	+ 17	38	21,834	+ 901
rporation	,, 23	413	+ 27	26	10,431	+ 269
Mare	.. ..	..	..	..	..	..
n Co.	,, 22	229	+ 31	38	7,572	+ 1,016
n Corpn.	,, 22	482	+ 30	39	17,051	+ 848
	,, 27	1,015	+ 51	26	26,479	+ 1,656
	,, 22	334	+ 22	38	11,551	+ 622
Trams	,, 22	111	+ 17	38	3,889	+ 198
llan District	Oct. 1	1,224	— 50	40	51,520	+ 2,564
	Sept. 22	1,121	— 4	38	40,295	+ 2,842

parisons are with the corresponding period last year. * Partly electrical.
Minus 3 days. ‡ Minus 2 days. § Plus 3 days. ¶ Plus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Par	Last Dividend	NAME.	Price Wed., Oct 4	*Rate per cent. Yielded.	Dividend Due.	Business Week to Oct. 4. Highest.	Lowest.
		Electricity Supply.		£ s. d.			
10	5/0	Bournemouth & Poole Elec. Sup. Ord.	7¾—8¼	7 10 0	Mar, Sep	—	—
10	4/6	Do. 4½ per Cent. Cum. Pref.	8¾—9¼	4 17 3	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Second Pref.	10¼—10¾	5 16 0	Feb, Aug	10⅞	—
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101 —103	4 6 6	Jan, July	..	—
5	4/6	Brompton & Kensington Elec. Sup. Ord.	7¾—8¼	6 7 0	March	..	—
5	3/6	Do. 7 per Cent. Pref.	7¾—7¾	4 11 9	Mar, Sept	—	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Deb. Stock	99 —102	3 19 6	June, Dec	..	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	3¾—4¼	6 1 6	Feb, Aug	3¾	—
5	2/3	Do. 4½ per Cent. Pref.	4¼—5	4 12 3	Feb., Aug	4¼	—
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	94 —98	4 3 3	Jan, July	..	—
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	100 —102	4 8 3	..	101½	100½
5	2/3	Do. City Undertaking 4½% Cum. Pref.	3¾—4¼	5 10 0	Jan, July	4	3¾
5	2/0	Chelsea Electric Supply Ord.	3¾—4¼	5 11 6	March	4	—
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	98 —100	4 11 0	June, Dec	—	—
10	6/0	City of London Electric Lighting Ord.	12 —12½	4 18 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11¾—12¼	4 18 0	Jan, July	11¾	—
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	119 —123	4 2 9	June, Dec	—	—
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	100 —103	4 8 6	Jan, July	102½	102
St.	5%	County of Durham Elec. P. D. 5% 1st Mort. Deb. Stk.	89½—91½	5 10 6	Jan, July	—	—
10	4/0	County of London Elec. Supply Ord.	7¾—7⅞	3 5 9	Feb, Aug	7⅞	—
10	6/0	Do. 6 per Cent. Cum. Pref.	10¾—11¼	5 9 0	Mar, Sept	—	—
St.	4½%	Do. 4½ per Cent. Deb Stock (red.)	108 —110	4 2 6	Jan, July	..	—
St.	4½%	Do. Second Deb. Stock	103½—103¾	4 8 0	May, Nov	..	—
..	..	Edmundson's Elec. Corp. Ord.	¼—¾	..	Jan, July	..	—
5	..	Do. 6 per Cent. Cum. Pref.	2 —2½	..	May, Nov	..	—
St.	4½%	Do 4½ per cent. 1st Mort. Deb. (red.)	83 —86	5 6 6	July	..	—
5	3/0	†Folkestone Electricity Supply Co. Ord.	4¼—5	6 6 0	April, Oct	4¼	—
5	2/6	†Do. 5 per Cent. Cum. Pref.	4¾—5¼	5 2 6	Mar, Sept	..	—
St.	4½%	Do. 4½ 1st Deb. Stock (red)	95 —98	4 13 3	Feb, Aug	..	—
5	5/0	Hove Electric Lighting Ord.	6¾—7¼	6 4 0	April, Oct	—	—
St.	4½%	Isle of Wight E. L. & P. Co. Deb. Stk.	88 —91	4 19 0	..	..	—
5	4/0	Kensington & Knightsbridge Ord.	6¾—7¼	6 18 6	Feb, Aug	—	—
5	6%	Do. 6 per Cent. 1st Pref.	5¾—6	5 0 0	Jan, July	—	—
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	91 —93	4 6 0	..	..	—
St.	4%	†Kensington & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	95 —98	4 3 0	April, Oct	..	—
St.	4½%	Kent Elec. Power Co. Irred Deb. Stk.	80 —84	5 10 0	Jan, July	..	—
3	1/2½	London Electric Supply Ord.	1⅝—2	3 8 0	Mar, Sept	..	—
5	3/0	Do. 6 per Cent. Pref.	4¼—4¾	6 8 0	Mar, Sept	4¾	—
St.	4%	Do. 4 per Cent. 1st Mort. Deb	89 —92	4 8 0	Jan, July	—	—
5	2/0	Metropolitan Electric Sup. Ord.	3¼—4	6 13 6	April, Oct	3⅛	—
5	2/3	Do 4½ per Cent. Cum Pref.	4¼—4¾	4 17 0	Jan, July	—	—
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	100 —105	4 8 0	June, Dec	—	—
St.	3½%	Do. 3½ per Cent. Mort. Deb. Stock (red.)	94½—87½	4 1 6	Jan, July	86½	—
..	4½%	Midland Elec. Corp. for P. D. 4½ 1st Mort. Debs.	96½—98½	4 12 6	..	—	—
5	2/0	Newcastle Elec. Supply Ord. (1-50,000 & 57,010-137,500)	3¼—4	6 0 0	Feb, Aug	—	—
5	2/6	Do. 5 per Cent. non Cum. Pref.	4 —4¼	5 17 6	Feb, Aug	—	—
100	4½%	Do. 4½ per Cent. 1st Mort. Deb.	97 —99	4 12 0	Jan, July	..	—
100	5%	North Metro. Elec. Power Sup. 5 Morts.	101 —104	4 17 6	..	..	—
1	6%	Northampton Elec. Lt. & P. Ord.	1¼—1⅜	4 11 6	Feb, Aug	..	—
1	5%	Do. 5% Pref.	1⅜—1⅝	4 6 0	Feb, Aug	..	—
St.	4%	Do. 4% Debs.	99 —101	3 19 0	June, Dec	..	—
10	6/0	Notting Hill Electric Ord.	..	5 17 6	March	..	—
5	3/0	Oxford Electric Ord.	6 —5¾	5 9 6	March	..	—
St.	4%	Do. 4% Deb. Stk.	91 —94	4 5 1	..	..	—
5	5/0	St. James' & Pall Mall Elec. Ord.	8¼—9	5 14 0	Feb, Aug	..	—
5	3/6	Do. 7 per Cent. Pref.	6¾—7¼	5 0 0	Feb, Aug	..	—
St.	3¼%	Do. 3¼ per Cent. Deb. Stock (red.)	85 —87	4 1 6	Jan, July	..	—
5	4/0	Smithfield Markets Electric Sup. Ord.	1¾—1¾	..	Feb.	..	—
5	1/3	South London Electric Supply Ord.	2¾—3	6 5 6	April	..	—
St.	5%	Do. 5% 1st Mort. Stock (red.)	93¼—101½	5 0 6	..	..	—
1	0 8½	South Metrop'n Elec. Lt & Power 7% 1st Pref	1⅛—1⅜	6 5 0	Feb, Aug	—	—
1	0/7½	Do. 6 per Cent. 2nd Pref.	⅝—¾	6 17 0	Feb, Aug	9⅞	—
St.	4½%	†Do. 4½ 1st Deb. Stock (red.)	95 —98	4 13 3	April, Oct	..	—
5	1/3	Urban Electric Supply Ord.	¾—1	..	April, Oct	—	—
5	1/3	Do. 5 per Cent. Cum. Pref.	2 —2½	11 2 3	April, Oct	..	—
St.	4½%	†Do. 4½ per Cent. 1st Mort. Deb.	85½—87½	5 4 0	April, Oct	87½	—
5	5/0	Westminster Elec. Sup. Ord.	7½—8	6 15 6	Mar, Sept	—	—
5	2/3	Do. 4½ per Cent. Cum. Pref.	4½—5½	4 10 0	Jan, July	—	—
		Electric Railways and Tramways.					
1	..	Bath Elec. Trams Pref. Ord.	⅛—¼	..	April	..	—
1	0/6	Do. 5 per Cent. Cum. Pref.	¼—⅜	8 0 0	Jan, July	—	—
St.	4½%	†Do. 4½ 1st Mort. Deb. Stock (red.)	77 —81	5 14 0	April, Oct	—	—
St.	4½%	B'ham & Midland Trams 4½ 1st Deb. Stock.	91 —93	4 17 9	Jan, July	91½	—
10	4%	Bristol Tramways & Carriage Ord.	6 —6½	6 8 0	Feb, Aug	—	—
10	4%	Do. Cum. Pref.	7½—8	5 3 0	..	..	—
St.	4%	Do. 4 per Cent. Debs.	100 —101	3 19 2	Feb, Aug	..	—
10	..	British Electric Traction Ord.	½—1⅛	..	June, Dec	1⅛	—
10	..	Do. 6 per Cent. Cum. Pref.	3¼—3½	..	Feb, Aug	3⅜	—
St.	5%	†Do. 5 per Cent. Perpetual Debs.	90 —93	5 9 6	April, Oct	92½	—
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	74 —78	5 18 0	May, Nov	—	—
St.	3%	Central London Ordinary Stock	65 —67	4 9 6	Feb, Aug	—	—
St.	4%	Do. 4 per Cent. Pref. Stock	64 —35	4 12 0	Feb, Aug	—	—
..	6/4	Do. 4½% Pref. Scrip 75% pd	85 —37	..	..	—	—
St.	2%	Do. Deferred Stock	48 —50	4 0 0	Feb.	—	—
100	4%	Do. 4 per Cent. Debs.	102 —104	3 16 11	Jan, July	—	—
5	2/6	City of Birmingham Trams, 5% Cum. Pref.	4¼—5¼	5 0 0	April, Oct	—	—
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 11 9	April, Oct	—	—
St.	11%	City & South London Rly. Con. Ord.	28½—29½	5 16 0	Feb, Aug	29½	28¾
St.	5%	Do. 5 per cent. Perp. Pref. (1891)	103 —110	4 11 9	Feb, Aug	—	—
St.	5%	Do. (1896)	104 —106	4 16 0	Feb, Aug	—	—
St.	5%	Do. (1901)	103 —105	4 17 0	Feb, Aug	—	—
St.	5%	Do. (1903)	102 —104	4 16 0	Feb, Aug	103½	102½
St.	4%	Do. 4 per Cent. Perpetual Debs.	102 —104	3 17 9	May, Nov	—	—
10	6/3	Dublin United Trams, 6 per Cent. Pref.	11 —12	5 4 0	Feb, Aug	—	—
10	5/0	†Gateshead and District Trams Ord.	8¼—8¾	7 4 0	..	—	—
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	¼—1⅛	..	Feb, Aug	—	—
5	7½	†Hastings & District Elec. Trams, 6% C. P.	⅜—⅞	..	Mar. Sept	—	—
St.	4½%	†Do. 4½ Deb. Stock	74 —79	6 4 0	April, Oct	—	—
10	..	Imperial Tramways Ord.	2½—3	..	Mar, Sept	—	—
10	..	‡Do. 6 per Cent. Pref.	4 —4½	..	Mar, Sept	—	—
St.	4½%	Do. 4½ per Cent. Debs.	72 —74	6 3 6	Jan, July	—	—
..	2/6	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	2½—3	4 11 0	Mar, Sept.	3	—
St.	4%	Do. 4 per Cent. Deb. Stock	77 —82	5 1 0	Jan, July	80	—
10	5/6	Lanarkshire Tramways	9¾—10½	5 15 0	Feb, Aug	10	—
St.	5%	Lancs Utd. Trams, 5% Prior Lien Deb. Stk.	79 —82	6 4 0	Jan, July	..	—
St.	4%	London Electric 4% Deb. St.	95 —98	4 2 6	..	97½	96
St.	4%	Do. 4% Pref.	80 —82	4 18 9	..	81½	81
10	..	London United Trams, 5% Cum. Pref.	3 —3½	..	Jan, July	..	—
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	72 —76	5 8 0	Jan, July	71½	—
St.	..	Mersey Con. Ord. Stock	6 —3	..	Feb, Aug	—	—
1	1/1½	Metropolitan Elec. Tramways Ord.	⅝—1⅛	6 0 0	..	⅞	—
1	..	Do. Deferred	⅜—⅝	..	April	..	—
1	0/6	Do. 5 per Cent. Cum. Pref.	⅝—1	5 8 0	Feb, Aug	1⅛	—
St.	4½%	Do. 4½ per Cent. Deb. Stock	99 —101	4 10 0	..	..	—
St.	5%	†Do. 5 per Cent. Db. Stk	100 —102	4 19 0	..	..	—

* No allowance has been made for expenses
† Ex Dividend ‡ The London Stock Exchange

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ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Share	Last Dividend	Name	Price Wed., Oct. 4	*Rate per Cent. Yielded £ s. d.	Dividend Due	Business Week to Oct. 4 Highest	Lowest
		Electric Railways and Tramways—*Continued.*					
St.	2%	Metropolitan Railway Consolidated	41 —41½	4 17 0	Feb, Aug	43⅜	40¾
St.	3%	Do. Surplus Lands Stocks	64 —66	4 12 3	Feb, Aug	65⅞	64⅜
St.	3½%	Do. 3½ per Cent. Preference	86 —88	3 19 6	Feb, Aug	87½	86
St.	3½%	Do. 3½ per Cent. "A" Preference	84 —86	4 2 6	Feb, Aug	84½	–
St.	3½%	Do. 3½ per Cent. Convertible Pref.	84 —86	4 2 0	Feb, Aug	85	84
St.	3½%	Do. 3½ per Cent. Debenture Stock	88 —90	3 18 9	Jan, July	89½	88½
St.	3½%	Do. 3½ per Cent. "A" Deb. Stock	88 —90	3 18 9	Jan, July	..	–
St.	..	Metropolitan District Railway Ord.	24¼—24¾	..	Feb. Aug	25½	24½
St.	4½%	Do. 4½% First Pref.	85 —87	5 4 9	Feb, Aug	86½	85½
St.	3½%	Do. Assented 1st Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	73 —75	4 14 0	Feb, Aug	74¾	–
St.	3%	Do. 3 per Cent. Consoltd. Rent-charge	75 —77	3 17 0	Jan, July	..	–
St.	4%	Do. 4 per Cent. Midland Rent-charge	102 —104	3 17 9	Jan, July	–	–
St.	6%	Do. 6 per Cent. Perp. Deb. Stock	144 —146	4 2 9	Jan, July	145	144½
St.	4%	Do. 4 per Cent. Ditto	97 —99	4 1 6	Jan, July	97½	..
1	4⅛d.	Potteries Electric Traction Ord.	7/32—11/32	6 11 3	April, Oct	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	17/32—[illegible]	8 9 6	Feb, Aug	17/32	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	88 —91	5 0 0	May, Nov	90	..
1	1/2⅖	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	13/32—15/32	10 2 0	..	–	..
St.	4%	Do. 4 per Cent. Deb. Stock	72 —77	5 7 6	Jan, July	73⅛	..
100	5%	Sunderland Dist. Elec. Trms. 5% 1stMtDb.	•	8 4 0	Jan, July	–	..
10	–	Underground Elec. Rys. Lon. Shares	1⅜—1⅝	..	..	–	..
–	4½%	Do. 4½% Bonds with coup. 8	98 —100	4 11 0	–	99⅝	99¼
..	15/0	Do. 6% In. bds. with coup. 8	57 —59	2 1 6	June, Dec	58¾	57½
–	4%	†Do. 4 per Cent. 1st Power Ho. Dbs.	100 —102	3 19 0	..	–	–
5	–	Yorkshire (W.R.) Elec. Trams. Ord.	¼ —¾	..	March	..	..
5	–	Do. 6 per Cent. Cum. Pref.	2⅜—2⅞	..	..	..	..
St.	4½	Do. 4½ per Cent. 1st Debs.	80 —85	5 9 6	Jan, July	..	..
		Electric Manufacturing, &c.					
St.	4½%	Anchor Cable Co. 4½ % Deb. Stock	99 —101	4 10 0	–	..	..
1	1/2⅖	Aron Electricity Meter Ord.	9/16—11/16	10 0 0	..	–	–
1	0/7⅕	Do. 6% Cum. Pf.	11/16—13/16	7 10 0	April, Oct	..	..
1	2/4⅘	†Babcock & Wilcox Ord.	5½—5¾	4 17 6	April, Oct	..	..
1	0/7½	†Do. Pref.	1⅜—1½	4 0 0	..	..	..
5	6/0	British Insulated & Helsby Cables Ord.	6¾—7¼	6 18 0	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	5¾—6¼	5 0 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	102 —104	4 7 0	Jan, July	102¼	..
St.	..	Do. 5% Mort. Deb. Stock	104 —106	..	..	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt.Db.	94 —97	4 14 3	Mar, Sept	..	–
5	..	British Westinghouse 6 per Cent. Pref.	¼ —⅜	..	Feb, Aug	..	..
100	6%	†Do. 6 per Cent. Prior Lien Dbs. (rd.)	99 —101	6 0 0	..	..	–
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	59 —62	6 6 6	Jan, July	59¼	..
St.	4½%	BrushE.Eng. Co. 4½% Perp. 1st Deb.Stock	55 —61	7 7 9	Mar, Sept	–	–
St.	4½%	Do. Perpetual 2nd Deb. Stock	39 —44	10 10 0	Jan, July	–	–
5	10/0	Callender's Cable Con. Ord.	9 —9½	8 2 0	Jan, July	9 1/32	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4 15/16—5 3/16	4 19 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort Debs. (red.)	101 —103	4 8 0	Nov, May	102¾	–
1	1/6	Castner-Kellner Alkali Co.	3½—3⅝	5 3 9	May, Nov	3 9/16	3 7/16
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	104 —108	4 5 0	Feb. Aug	..	–
1	1/0	Chadburn's (Ship) Telegraph Ord.	1 1/16—1 3/16	5 19 0	March ..	–	..
1	0/8⅗	Consolidated Electrical Co.	11/32—15/32	7 8 9	August ..	–	..
1	0/6	Consolidated Signal Co.	¼—½	13 6 8	April, Oct	–	–
1	0/7½	Do. 6 per cent. Cum. Pref.	¾—⅞	7 6 6	April, Oct	..	..
3	..	Crompton & Co (Nos. 1 to 85,000)	⅛—⅜	..	Jan, July	..	..
100	5%	Do. 5 per Cent. 1st Mort. Debs. (red.)	55 —65	8 6 0	Jan, July	..	..
5	1/0	Dick, Kerr & Co. Ord.	13/16—15/16	5 14 0	Sept.	..	..
5	0/7⅕	Do. 6 per Cent. Cum. Pref.	15/16—1 1/16	5 13 0	Sept	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	95 —98	4 13 3	Jan, July	..	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	9/16—11/16	..	Feb, Aug	..	..
..	..	Do. (£5 paid)	1¾—2¼	..	Feb. Aug	–	–
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (red.)	67 —71	5 16 0	June, Dec	..	..
St.	5%	†Do. 5 per Cent. 2nd Deb. Stock	77 —80	6 7 0	Mar, Sept	..	..
2	2½%	Electric Construction Co.	½—¾	6 6 0	Jan, July	..	..
2	2/9⅗	Do. 7 per Cent. Cum. Pref.	1 13/16—1 15/16	7 8 6	July	1⅞	..
St.	4%	Do. 4 per Cent. Perp. 1st Mort. Debs.	73 —78	5 6 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	8¾—9	5 14 0	June, Dec	..	..
St.	4%	†Do. 4 per Cent. 1st Mort. Debs	86 —91	4 10 6	Mar, Sept	..	..
5	5/0	Henley's Telegraph Works Ord.	12 —12½	6 0 9	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	4 15/16—5 3/16	4 9 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	105½—108½	4 3 6	Mar, Sept	..	..
10	15/0	India Rubber, Gut. Per., &c., Works	13½—15½	..	Feb, Aug	14⅞	14½
10	5/0	Do. 5 per Cent. Cum. Pref.	9⅞—10⅜	4 19 0	..	..	..
100	4%	†Do. 4 per Cent. Debs. (red.)	95 —97	4 3 3	April. Oct	..	..
St	5 %	†Johnson & Phillips 5% 1st Mt. Deb. Stk.	78½—83½	..	..	80½	..
1	–	National Elec. Construction Co.	¼	..	April	..	..
1	..	Richardsons, Westgarth & Co., Ltd. Ord.	3/16—¼	..	Nov	..	..
1	..	Do. 6 per Cent. Cum. Pref.	½—9/16	..	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. Perp. Deb. Stock	74 —77	5 16 0	Jan, July	..	..
5	..	Simplex Conduits 6 per Cent. Cum. Pref.	4⅞—5	..	..	..	..
12	12/0	Telegraph Construction & Maintenance	34½—36½	6 9 9	Mar, July	..	..
100	4%	Do. 4 per Cent. Deb. Bonds (1909)	100 —102	3 19 3	Jan, July	..	..
1	1/0	Vickers, Sons & Maxim, Ltd., Ord.	1 13/16—2	5 1 0	..	2	1 15/16
1	0/6	Do. 5 per Cent. non-Cum. Preference	1 1/16—1 3/16	4 3 0	..	..	–
St.	5%	Do. 5 per Cent. non-Cum. Preferred	107 —111	4 11 6	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Db. Sk. (red)	99 —101	4 1 0	June, Dec	..	..
100	4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.)	103 —105	4 6 6	June, Dec	..	..
100	5%	Do. 5 per Cent. 3rd Mort. Debs Scrip	104 —106	4 15 6	..	105½	105 3/16
10	12%	J. G. White & Co. 6% Cum. Pref.	14½—15½	7 14 10	..	..	–
1	..	Willans & Robinson Ord.	[illegible]	..	Apr, Oct	–	..
5	..	Do. 6 per Cent. Cum. Pref.	¼—½	..	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	55 —65	6 3 0	May, Nov	..	–
		Telegraphs.					
10	..	Amazon Telegraph	7¼—7¾	..	June, Dec	..	..
100	5%	Do. 5 per Cent. Debs. (red.)	99 —101	5 0 0	Jan, July	–	–
St.	15/0	Anglo-American	67 —69	4 8 6	F,My,Ag,N	..	..
St.	30/0	Do. Preferred	111½—112½	5 7 6	F,My,Ag,N	112	111
St.	30/0	Do. Deferred	24⅝—25⅛	5 19 6	F,My,Ag,N	24 15/16	24 11/16
St.	4%	Commercial Cable 4 per Cent. Deb. Stk.	86½—88½	4 11 6	Jn,Ap,Jy,O	88	85⅞
10	6/0	Cuba Submarine Ord.	10¼—11	5 13 0	Feb, Aug	–	..
10	10/0	Do. Preference 10 per Cent.	17½—18½	5 13 0	Feb, Aug	..	..
5	2/0	†Direct Spanish Ord.	3¾—4	5 0 0	April, Oct	..	..
5	5/0	†Do. 10 per Cent. Cum. Pref.	8⅝—9⅞	5 12 9	April, Oct	–	..
50	4½%	Do. 4½ per Cent. Deb.	100 —102	4 9 0	Jan, July	..	..
10	3/0	Direct United States Cable	7¾—8¼	6 3 0	Ja,Ap,Jy,O	8	7¾
100	4½%	Direct West India Cable 4½%Rg.Db.(rd.)	99½—101½	4 9 6	June, Dec	..	..
St.	25/0	Eastern Ordinary	137 —140	5 1 0	Ja,My,Jy,O	138½	–
St.	17/6	Do. 3½ per Cent. Pref. Stock	84 —85	4 2 6	Ja,My,Jy,O	85½	–
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (red.)	102½—104½	3 18 0	May, Nov	..	..
St	2/6	†Eastern Extension	13½—14	5 2 0	Ja, Ap,Jy,O	13⅞	13 9/16
10	4%	Do. 4 per Cent. Deb. Stock	100½—102½	3 19 0	Feb, Aug	102	..
25	4%	Eastern and S.Af., 4% Mauritius Sub.Debs	100 —102	3 19 0	May, Nov	..	..
10	5/0	G.N. (of Copenhagen), with Coupon 83	30½—31½	5 16 0	Jan, July	–	.
25	52/6	Indo-European	56½—58½	5 6 6	May, Nov	..	..
100	5%	Mackay Companies Common	83 —85	5 15 0	Ja,Ap,Jy,O	..	..
100	4%	Do. Preference	74 —76	5 4 3	Ja,Ap,Jy,O	..	..
1	1/0	Marconi's Wireless Teleg. Co.	2 3/16—2 5/16	..	April	2 7/32	2 3/16
1	2/9⅗	Do. 7% Partipg. Pref.	1¾—2	3 10 0	..	1 27/32	1 25/32
100	4%	Pacific & Europe'n Tel.4%Guar.Dbs.(red.)	99½—101½	3 19 9	June, Dec	..	–
2½	1/3	West Coast of America	1⅛—1⅜	5 0 0	May	..	..
100	4%	Do. 4 per Cent. Debs.	98 —100	4 1 0	Jan, July	..	..
10	1/6	West India & Panama	2½—2⅞	4 10 6	May, Nov	2⅝	2½
10	6/0	Do. 6 per Cent. 1st Pref.	10⅛—10⅝	5 16 6	May, Nov	..	..
10	6/0	Do. 6% 2nd Pref.	9½—10½	6 0 0	May, Nov	..	–
100	5%	Do. 5 per Cent. Debs.	101 —103	4 18 0	Jan, July	..	..
10	3/0	Western Telegraph	13¼—13½	5 1 0	Mr,Jn,O,D	13½	13 5/16
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	101 —103	3 18 6	June, Dec	–	..
–	4%	Western Union Telegraph, $1,000 4% Bd	107 —110	3 13 9	–	–	–
–	4½%	Do. $1,000 4½% Fdg. & Rl. Est.Gd.Bnd.	101 —104	4 8 0	–	–	–

Share	Last Dividend	Name	Price Wed., Oct. 4	*Rate per Cent. Yielded £ s. d.	Dividend Due
		Telephones.			
100	2$	†Amer. Telephn. & Telegh. Cap. St.	135 —138	5 17 0	..
..	4%	Do. Coll. Trust $1,000 4 per Cent. Bds.	93 —95	4 5 0	Jan, July
St.	4%	Do. 4% Cons. Bonds 1936	107 —109	3 12 0	..
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101 —103	4 18 0	Mar, Sept
5	4/0	Chili Telephone	6 5/16—7 1/16	4 5 9	August ..
1	0/7⅕	Monte Video Telephone Ord.	⅞—1	6 0 0	Nov ....
1	0/6	Do. 5 per Cent. Pref.	[illegible]	5 13 0	May, Nov
St.	6%	National Co. Pref. Stock	104 —106	5 14 0	Feb, Aug
St.	6%	Do. Def. Stock	118 —121	5 0 6	Feb, Aug
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	9⅞—10⅜	5 12 0	Feb, Aug
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	9½—10¼	5 2 6	Feb, Aug
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.	5⅜—5⅝	4 12 0	Feb, Aug
St.	3½%	Do Deb. Stock 3½ per Cent. (red.)	99 —101	3 10 0	June, Dec
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	99 —101	4 0 0	Jan, July
..	4½%	New York Telephone Co. 30 yr. Bnds.	103 —104	4 7 0	..
1	1/0	Oriental	1 3/16—1 5/16	5 6 8	April, Oct
1	0/7½	Do 6 per Cent. Cum. Pref.	1 3/16—1 5/16	4 16 0	April, Oct
St.	4%	Do. 4 per Cent. Red. Deb. Stock	88 —90	4 10 0	Jan, July
St.	4½%	Telephone Co. of Egypt 4½%Db.Stk.(red.)	99 —101	4 10 0	Jan, July
5	5/0	United River Plate Ord.	7 3/16—7 7/16	5 8 0	July ....
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼—5½	4 13 0	June, Dec
St.	4½%	Do. 4½ Deb. St. Red.	103½—105½	4 6 0	Jan, July
		Financial, Investment, &c.			
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4 —4¼	7 1 0	Jan, July
10	2/0	†Globe Telegraph & Trust	10⅜—11⅛	5 10 0	Sp,DcMrJu
10	3/0	†Do. 6 per Cent. Pref.	12⅞—13⅜	4 11 6	Sp,DcMrJu
10	6%	Submarine Cables Trust (Cert.)	133 —136	4 11 0	April, Oct
		Colonial and Foreign Electric Railways, Tramways, &c.			
5	2/9	Anglo-Argentine 5½% Cum. 1st Pref.	5 —5¼	5 4 9	April, Oct
5	2/9	Do. 5½% Cum. 2nd Pref.	4¾—5	5 12 9	Jan, July
St.	4%	Do. 4% Deb. Stock	93½—95½	4 4 6	June, Dec
St.	4½%	Do. 4½% Deb. Stock	101 —103	4 8 3	..
St.	5%	Do. 5% Deb' Stock	101 —103	4 18 0	..
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)	102 —105	4 16 6	Jan, July
5	4/0	Brisbane Electric Trams. Invest. Ord	6⅝—7⅛	5 16 3	May ....
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5⅜	4 17 6	May, Nov
St.	4½%	Do. 4½ per Cent. Db. Prov. Certs.	102 —105	4 7 0	Jan, July
St.	8%	British Columbia El..Rly. Df.Ord.	140 —144	5 12 6	Mar, Sept
St.	6%	Do. Pref. Ord. Stock	121 —125	4 17 6	May, Nov
St.	5%	Do. 5% Cum. Perp. Pref. Stock	108 —111	4 11 3	Jan, July
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	100 —103	4 7 6	April, Oct
100	4½%	Do. Vancouver Power Debs.	101 —104	4 3 3	Jan, July
St.	4½%	Do. 4½% Perp. Con. Deb. St.	101½—103½	4 3 0	..
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	100 —102	4 19 0	Mar, Sept
St.	6%	Buenos Ayres Port & City Tram, 1st Mt. Deb. Stock	92 —96	6 8 0	Feb, Aug
5	3/6	Calcutta Tramways (1 to 137,610)	5¾—6¼	4 19 6	Mar, Sept
100	2/6	Do. 5 per Cent. Cum. Pref.	5 —5¼	4 17 6	Jan, July
1	4½%	Do. 4½% 1st Deb. Stock (red)	102 —105	4 5 9	Jan, July
St.	..	Cape Electric Tram Shares	1/16—⅛	..	..
5	1/3	City of Buenos Ayres Trams Co. (1904) Sh.	5 5/16—5 11/16	4 8 0	F,My,A,N
St.	4%	Do. 4 per Cent. Deb. Stock	95 —98	4 3 0	June, Dec
..	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.	95 —100	5 2 6	May, Nov
1	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	100½—103½	4 18 0	Feb, Aug
100	5%	Hong Kong Tramways Co. 5 per Cent. 1st Mort. Debs.	77 —81	6 6 6	June, Dec
1	..	Kalgoorlie Elec. Trams Sh.	1/32—5/32	..	..
100	5%	Do. 5 per Cent. "A" Deb. Stock	92½—95½	5 4 6	Jan, July
5	6%	Do. 6 per Cent. "B" Ditto	62 —65	9 0 0	Jan, July
5	0/6	Lisbon Elec. Trams. Ord.	1 —1¼	4 16 0	July ....
100	0/7⅕	Do. 6 per Cent. Cum. Pref.	1 —1¼	4 16 0	Jan, July
St.	5%	Do. 5 per Cent. Reg. Mort. Debs.	96 —100	5 2 0	Jan, July
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	95 —98	5 3 6	Jan, July
100	5%	Manaos Trams and Lt. Co. 5% Debs	90 —92	5 13 0	Feb, Aug
..	5%	Manila Elec. Ry. $1,000 Gold Bonds	93 —100	5 1 0	..
100	$1¼	Mexico Trams Co. Com. St.	119 —121	5 15 6	..
..	5%	Do. Gen. Con. 1st Mort. 5% Gold Bds.	97½—99½	5 1 6	–
St.	6%	Do. 6% 50 yr. Mort. Bds.	97 —99	6 2 0	
St.	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922) (Nos. 601 to 2,000)	100 —102	4 9 0	Feb, Aug
St.	4½%	Do. do. (Nos. 1 to 4,600)	102 —104	4 7 6	..
1	0/6	Perth Elec. Trams Ord.	13/16—1 1/16	2 10 0	May ....
St.	5%	Do. 1st Mt. Db. Stock	101½—103½	4 17 6	Jan, July
5	3/0	Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	5⅜—5½	5 8 0	–
St.	4½%	Do. 4½% 1st Mort. Deb. Stk.	98 —101	4 10 6	–
100	$1½	Rio Janeiro Tram, Lt. & P. Co.	116¾—117¾	4 5 3	–
..	5%	Do. 30 yr. Gold Bnds.	101¼—102¼	4 18 3	–
100	5%	Do. 50 yr. Mt. Bnds	95½—96½	5 4 0	–
–	$2½	Sao Paulo Tramway, Light & Power Co. $100 Stock	173 —176	5 14 6	June, Dec
..	5%	Do. 5 per Cent. 1st Mt. $500 Db.	102½—104½	4 16 6	Feb, Aug
100	4½%	Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	97 —99	4 11 9	
		Colonial and Foreign Electricity Supply, &c.			
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	5⅛—5⅜	5 11 6	Mar, Sept
St.	..	Do. 5% Deb. Stk.	102½—104½	–	..
10	6/0	Bombay E.S. & T. 6% Cm. Pf.	10¼—11¼	5 9 0	Jan, July
St.	4½%	Do. 4½ per Cent. Deb. Stk. (red)	96½—98½	4 12 0	..
..	5%	Do. 5 per Cent. 2nd Mort. Deb. Stock	97 —99	5 2 0	April, Oct
5	5/0	Calcutta Elec. Supply Ord.	6⅜—7⅛	5 19 6	..
5	2/6	Do. 5% Cum. Pref	5 —5¼	4 15 0	–
100	5%	Calgary Power Co. 5% 1st Mort. Bnds.	96 —98	5 2 0	–
100	7/2¼	†Canadian Gen. Elec. Co. Com. St.	104 —108	6 12 0	–
100	$3½	†Do. 7% Cm. Pf. Stock	118 —122	5 16 0	Jan, July
100	5%	Castner Electrolytic Alkali Co (of U.S.A.) 1st Mort. Stl. Debs.	94 —99	5 3 6	..
500	5%	Elect. Development Co. of Ontario	85½—87½	5 15 0	Jan, July
St.	5%	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	84½—87½	5 4 0	..
5		Indian Elec. Sup. & Trac. Co.	1 —1¼	..	May, Nov
10s	..	Kalgoorlie Elec. Power & Ltg. Ord.	⅛—3/16	..	April, Oct
1	0/7⅕	Do. 6 per Cent. Cum. Pref.	14/32—[illegible]	8 6 6	..
5	5%	Kaministiquia Power Co.5% Gold Bnds.	101½—103½	4 17 6	..
St.	..	Madras E. S. Corp. Ord.	2⅜—2⅝	..	..
St.	..	Melbourne E. S. Co. Cons. Ord. St.	50 —55	..	Jan, July
500	5%	Do. 5% 1st Mortg Deb. Stock	95 —97	5 4 0	Jan, July
St.	5%	Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	85½—88½	5 14 0	Ja,Ap,Jy,O
St.	$1	Mexican Lt. & Power Co. Com. St.	86 —88	4 12 0	May, Nov
500	$3½	Do. 7% Cum. Pref. St.	108 —110	6 8 6	Feb, Aug
St	5%	Do 5% 1st Mort. Gold Bnds.	93½—95½	5 6 6	
100	5%	Monterey Rly. L. & P. Co. 1st Mort.Db.Sk.	89 —91	5 9 0	F,My,A,N
100	8/2½	Montreal Lt. Ht. & Power Co. Cap. St.	167 —172	4 15 3	..
St.	5%	Northern Lt. Power & Coal 5% Gd.Bds	35 —38	6 7 6	April ....
St.	£10	River Plate Electricity Co. Ord. Stk.	218 —228	4 7 9	May ....
St.	6%	Do. 6 per Cent. non-Cum. Pref. Stk.	107 —114	5 5 0	Jan, July
100	5%	Do. 5 per Cent. Deb. Stock	101½—103½	4 17 6	–
..	$1½	Shawinigan Water& Power Co.Ca ex rights	115 —117	3 17 6	Jan, July
St.	5%	Do. 5 per Cent. Bds.	107 —109	4 12 6	–
St.	4½%	Do. 4½ Per Con. Mt. Db. St.	103 —105	4 6 0	–
–	4½%	Toronto Power Co. 4½% Db. St.	100 —102	4 9 0	Jan, July
–	11·85	Victoria Falls Power Co. Pref.	1/16—1	6 0 0	

* No allowance has been made for accrued interest or redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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THE ELECTRICIAN COMMERCIAL AND INDUSTRIAL SUPPLEMENT.

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STANDARDS IN TRADE LITERATURE.

We recently received some leaflets from the Engineers Standardized Publications which remind us of the movement now being made to bring manufacturers into line in the size and style of certain of their literature. As far as we are aware, nothing has been done to include complete catalogues—bound trade volumes so to speak—in this new scheme of standardization. There are, naturally, difficulties in the way of any such attempt. The only arrangement approaching to standardization is that in which a very large number of loose leaflets are held together in a file; also all these sheets can be of uniform size, and the file will conveniently hold a hundred or so of them.

Some manufacturers who are now inseparable from the card index system and have adopted loose leaf ledgers, &c., will not object to the building up of a catalogue of loose leaves in an imposing file. On the other hand the majority, representing probably 75 per cent. of the total, are averse to adopting any such suggestion. When the subject is looked into in the most cursory manner by those who handle big budgets of trade literature, as we ourselves do, the first impression gained is that a maker's catalogue is something in which he takes a peculiar pride. The catalogue is an index of the *personnel* and management of a trade or industrial organisation. The larger the concern the more imposing as a rule is its trade literature. The heads of departments usually decide the contents of the particular piece of literature, and the directors select the quality and colour of the binding, the result is a reflection of the particular ideas of the management of what a good list (in their opinion, of course) should be. In other words the compilation and general appearance of the catalogue are as much to the company as the education of a traveller in the selling of their goods. In many instances the production of a new catalogue gives genuine pleasure and satisfaction to the staff. We have on our trade bookshelf volumes, brochures and booklets which we were delighted to receive; the sight of the cover, gold embossed or emblazoned, maybe in colours, sent a thrill through us as we carefully turned back the tissue paper in which they were wrapped. We were also overwhelmed with longing to have a quiet half-hour to go carefully through the contents. The object of the manufacturer with the production of such a list is achieved many times over when such feelings are aroused in the recipient of his literature.

It is just here that the literature standardising specialist will find his difficulty. The average manufacturer is not attracted to the loose leaflet and file idea for his main catalogue, no matter how imposing the cover of the file is made. He gets so accustomed to compiling his ponderous trade tome at stated intervals that it appears little short of sacrilege for him to do the work on the "unit" system, building up slowly or quickly, as the case may be, a page or a few pages at a time.

And in great measure he is not to blame. Specialist businesses almost compel uniformity in trade literature, but even with them the desire to standardise in everything but the main catalogue is very strong. We think that as long as manufacturers must appeal to the buyer through the medium of the printed page they will retain the right to handle their literature in their own way.

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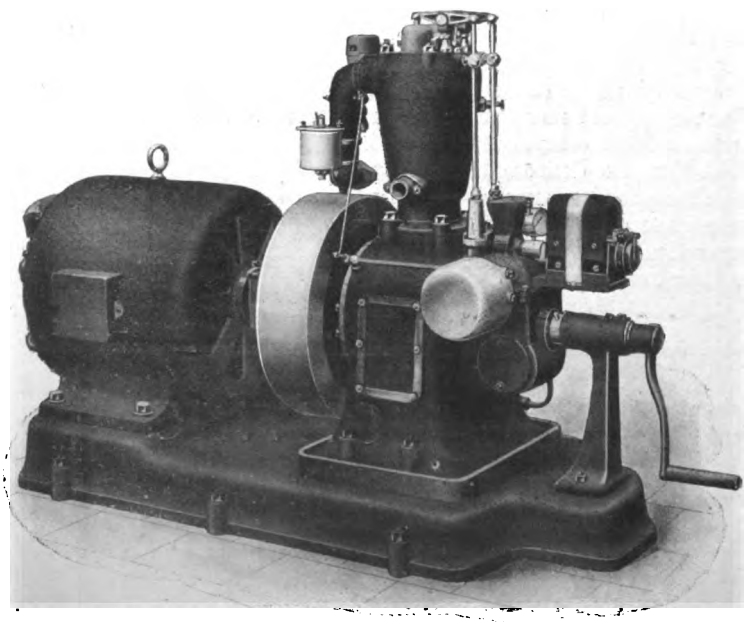
PRIVATE LIGHTING PLANT.

The petrol paraffin high speed vertical engine has been developed considerably during the past few years by makers of motor car and motor boat engines. The experience in the



BOULTON & PAUL PETROL DYNAMO SET.

manufacture of internal combustion engines which firms of this class derived from their motor car work must be of exceptional value in dealing with small engines intended for stationery work, and for direct coupling to dynamo electric machines. Messrs. Boulton & Paul, Norwich, are well known in the industry as makers of motor boat equipments, and we notice in their latest catalogue of marine motors that they include a special section on petrol paraffin engines intended for country house lighting plants or for direct coupling to centrifugal pumps, and similar high speed machinery. The list contains descriptions of several types of plant, and we understand that the company is prepared to supply complete electric lighting equipments comprising the engine and generator, accumulators and main switchboard. The engines are made to operate either on the Otto cycle or 2-cycle principle. In each case they are watercooled. The 2-cycle engine has the advantage of operating with a minimum of moving and wearing parts. There are no valves, springs or gears. The construction employed is fairly well known, the crank case being utilised as a compression chamber. Air and gas are drawn into the crank case on the upward stroke of the piston, and on the down stroke this mixture is slightly compressed. There are ports in the cylinder walls, and at the bottom stroke of the piston the inlet port is opened and the mixture is then forced up into the compression space by the rising piston. The charge is exploded, and at the extreme limit of the outward stroke the exhaust portion of the cylinder wall is uncovered. The gases pass out into a water-jacketed expansion box, into which a continuous spray of water is passed. This moisture reduces the temperature and pressure of the exhaust, and the gases pass away into the atmosphere in the form of steam at the pressure only slightly above atmosphere. This cycle of operations is repeated with the continuous rotation of the engine.

The use of a two-stroke engine for country house lighting or isolated plant of any description where the supply of skilled labour is naturally limited, will be appreciated by users of this class of plant.

The ignition in these engines is by high-tension magneto as a standard fitment, but coil and battery ignition can be fitted if desired. The governing is done on the throttle, and the speed can be adjusted while the engine is running. A feature of the catalogue in question is the listing of complete generating sets with battery and switchboard for the supply of 16 c.p. lamps, varying in number from 50 to 600. The price of the 50 16 c.p. equipment for operating at 25 volts is £95, or for 50 volts £105. This appears to be extremely moderate, and is for the Otto cycle engine. For the two-stroke engine the equipment is priced at £70. The catalogue contains a quantity of useful information regarding the application of these engines to various industrial purposes.

ELLIOTT MICROMETERS.

Interchangeability is now the accepted order of things in most engineering products, consequently it is necessary to employ accurate gauges to check off both small and large work. For small pieces the hand micrometer gauge is commonly used, and it is now obtainable in extremely accurate patterns. Hitherto the call was mainly upon foreign makers of these gauges because the British manufacturer had not stirred himself sufficiently to produce anything of the kind. Messrs. Elliott Bros. who are well known as makers of electrical instruments have now on the market a line of micrometer gauges which they are anxious to bring to the notice of British users of such devices, as an absolutely indigenous product. After considerable experiment and experience in the construction of tools and appliances, they have produced a micrometer which they claim can compete successfully with foreign patterns, both on the score of accuracy

OSRAM-LAMPS

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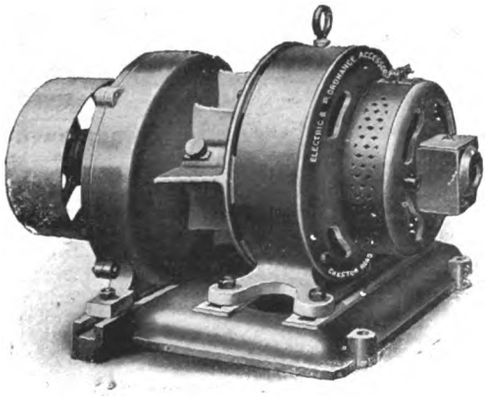


Back geared "EOA" Motor. Gearing enclosed.

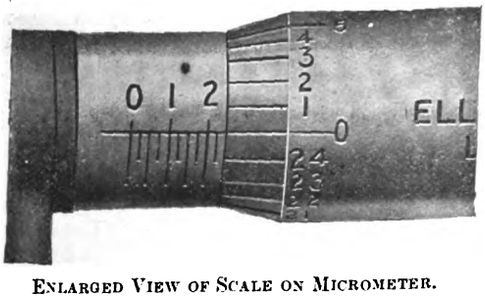
"EOA" Motors in all sizes up to 50 H.P., with back gear enclosed as illustrated, or of the usual open type.

"EOA" Motors give satisfactory service under all working conditions, as their great feature is Reliability.

Quick Delivery. *Competitive Prices.*

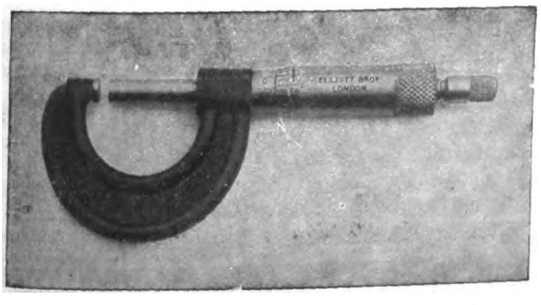
The Electric & Ordnance Accessories Co., Ltd., Aston, Birmingham.

and selling price. They vouch for the precision of the gauges on account of keeping closely in touch with the National Physical Laboratory throughout the process of making the



ENLARGED VIEW OF SCALE ON MICROMETER.

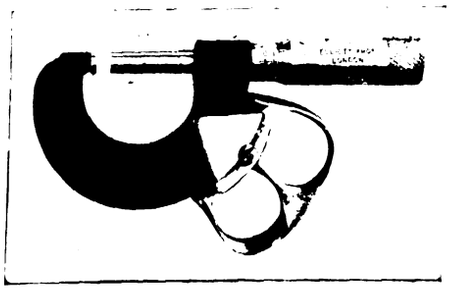
standard screws from which the micrometer threads are originated. These standards were brought into agreement with those at the Laboratory.



1 IN. ELLIOTT MICROMETER.

A special arrangement has been adopted for the figures round the measuring head, so that each division is numbered and can be easily read. The longitudinal scale on the frame is also provided with long and short lines, enabling the intermediate divisions between the numbers to be clearly distinguished.

From a brochure just brought to our notice we gather that 1 in. and 2 in. patterns of micrometer are offered, there being two styles of each pattern. Readings are in thousandths of an inch, and there are adjustments for taking up wear in the measuring screw, and also for adjusting the zero. Numerous handy accessories are also provided for making the micrometer more convenient to use.



ELLIOTT MICROMETER, SHOWING FINGER GRIP WHICH ADMITS OF THE USE OF THE MICROMETER WITH ONE HAND.

ELECTRIC CHARGING MACHINE.

Messrs. Babcock & Wilcox recently received an order for a charging machine from Messrs. Steel, Peech & Tozer, Sheffield. The machine is of the low ground type, and is electrically-driven by four separately controlled motors. The machine picks up the charging boxes and carried the contents into the hearth of the open hearth furnaces in the usual way. It would deal with a load of 3 tons in the charging box. The machine is arranged upon the makers' special design, several

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STERLING TELEPHONES
The Sterling Telephone & Electric Co., Ltd., 200, Upper Thames Street, London, E.C. Works: Dagenham, Essex.

improvements in detail being introduced over older forms of charging machines, and it will be constructed in the already extensive and rapidly extending crane department of Messrs. Babcock & Wilcox, who have started a special branch of their crane department for dealing with steel works special cranes and charging machines. It is the intention of the firm to take up the manufacture of any handling and transporting machines and apparatus for handling the raw material or finished products in steel works.

A PORTABLE BRIDGE AND FAULT LOCALISER.

Although the location of artificial faults in cables can be carried out with considerable precision under laboratory conditions, a mains engineer frequently experiences no little difficulty in obtaining reliable measurements in practice. The liability of introducing errors due to the connecting-up leads, the resistance of temporary joints, &c., in a Murray loop test is well known, so that any means for rendering such allowances unnecessary and for increasing the accuracy of the measurements will be welcomed by mains engineers.

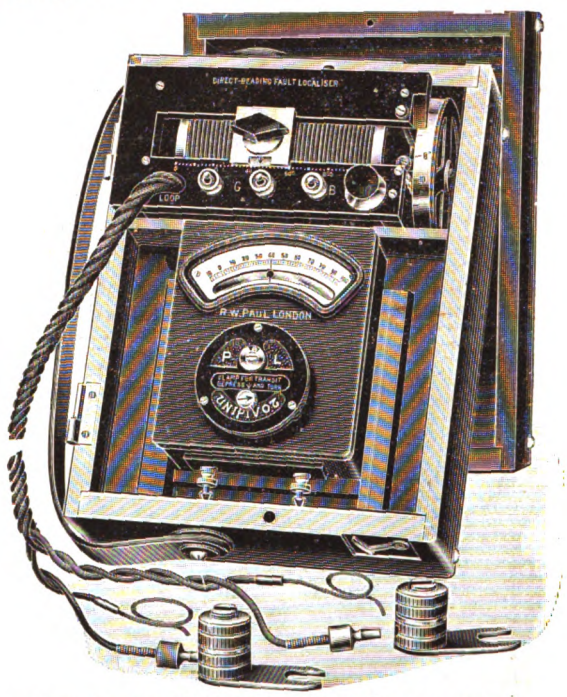

Fig. 1.—New Portable Bridge and Fault Localiser of Mr. R. W. Paul.

Mr. Robt. W. Paul has just placed on the market what is undoubtedly one of the most compact and at the same time reliable portable Wheatstone bridges and fault localisers that we have seen. An idea of its portability and compactness can be obtained from Fig. 1, which shows a general view of the apparatus.

First, as to the use of the instrument for resistance measurements. The bridge wire is about 10 metres long, and is wound on a screw threaded insulated metal drum, mounted in a frame of aluminium and ebonite (see Fig. 2). The bridge wire is connected to the terminals by flexibles, thus eliminating moving contacts, and increasing the accuracy of the measurements.

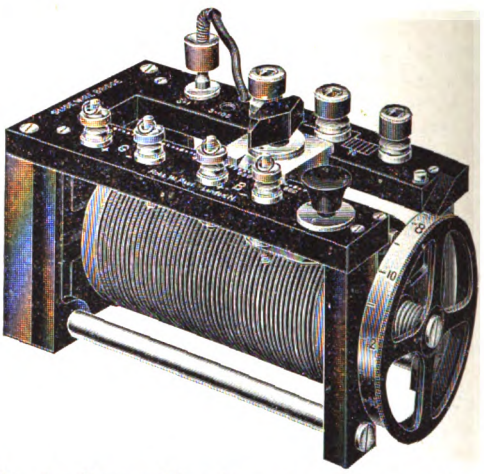

Fig. 2.—Bridge Wire Mounted on Insulated Drum.

Two standard coils are contained in a shallow box at one end of the instrument, and either 1 or 100 ohms may be brought into the circuit by means of a plug. The sliding contact, which acts as a key, is joined in the galvanometer circuit and may be adjusted to any position on the slide wire, firstly by moving the slider which has a device for registering the contact point exactly on the wire, and secondly by rotating the drum. The spindle of the drum is screw threaded to the same pitch as that of the wire and its movement is limited to one turn. The disc is divided into 20 parts; and as there are 50 turns of wire on the drum and the position of the contact may be read to one-tenth of a division, readings may be determined to one ten-thousandth part of the slide-wire length.

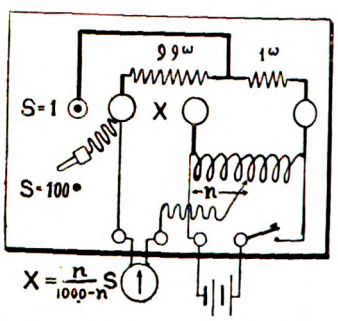

Fig. 3.—Connections when used as Wheatstone Bridge.

All the parts are visible and the wire is easily cleaned. Extra large terminals are provided for connection to the resistances to be

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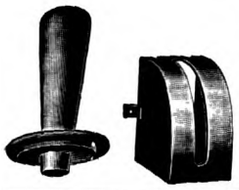
Manufacturer of Presspahn and Insulating Material.

Grand Prix: Marseilles, 1908.



PRESSPAHN in sheet, rolls and tapes. Presspahn tubes and stampings.

CORNITE, high tension Material. Handles for Switchgear and Heating Apparatus. Controller Insulation. Moulded parts of all kinds.

ASBESTOS CEMENT in Plates, Arc Shields for Controllers, &c.

AMIANITE, Vulcanised Asbestos. Coil Frames. Spools for Dynamos, Motors and Transformers. Boxes, &c. Insulating Blocks, Tubes, Plates.

Insulators for Electric Furnaces, Tramways, &c.

Insulating Pearls, MICA and Substitutes. Transformer Spools.

Japanese Paper in Rolls and Tapes. Oil Varnished Linen, Silk and Paper, &c.

measured. The useful range of this instrument when used as a Wheatstone bridge is from 0·02 to 5·000 ohms, and it may obviously be used as a fine adjustment rheostat or potential divider as well as a bridge.

When arranged for fault localising by the loop test, the terminals joined to the end of the slide wire are replaced by flexible leads permanently fixed to the instrument; their resistance being allowed for in the adjustment of the slide wire. The ends of the leads terminate in plugs (see Fig. 1) which may be inserted in terminals adapted for clamping on to the cable or bolting to a switch pillar. The ease with which the connection can be made and the good contact obtained are certainly features of the apparatus. With these leads are laid up two wires for connection to the galvanometer, each of which wires terminates in a short length of bare flexible, for direct attachment to the cable beyond the localiser terminals. Thus the resistance of the joint is not included in that of the loop.

This localiser is illustrated in Fig. 1 in combination with a low resistance unipivot galvanometer, which is particularly adapted for the loop test.

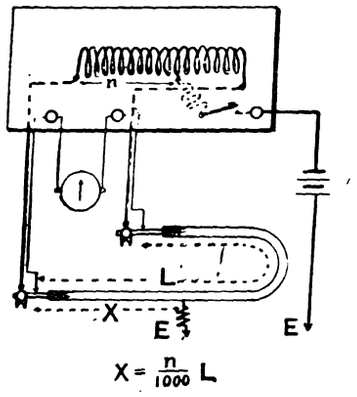


Fig. 4.—Connections when used as Fault Localiser.

The slide wire is capable of carrying 5 amperes without injury, and the current for the test may be taken from the mains by using a lamp in series, or from a small portable accumulator, 1 ampere being usually sufficient.

It will be seen that if the fault were *very close* to one end of the cable it would not be possible to obtain a balance, on account of the resistance of the flexible leads; in such a case a coil of nine times the resistance of the slide-wire may be inserted at the end of the flexible, thus extending the range of the slide-wire.

Fig. 3 shows the connections when the apparatus is used as a Wheatstone bridge, whilst Fig. 4 indicates its application for fault localisation. Even before this apparatus had been placed on the market, its good points were quickly appreciated by those who were privileged to see it in its unfinished form, so that Mr. Paul should be assured of a considerable demand when the capabilities of this fault localiser are more widely known.

Extract from an Electrical Catalogue

RUBBER MATS.

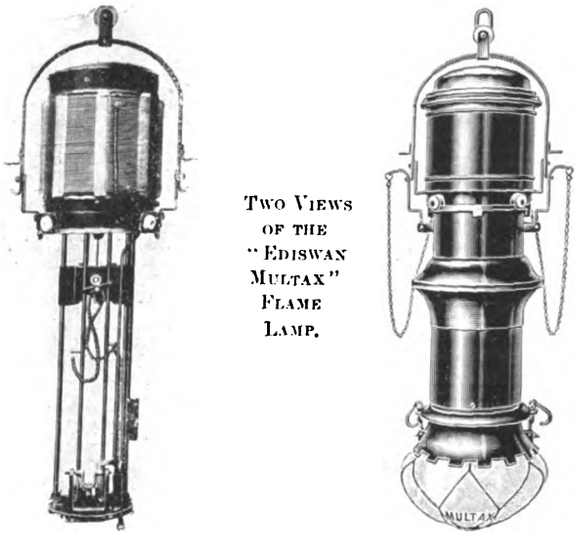
Canto XI.

Where Switchboards stand in Tombstone-like array,
'Tis frequent that their Users need to pray
(When shocks to earth are felt on switching off)
For Rubber Mats, St. Helens type alway.

published by St. Helens Cable & Rubber Co., Ltd., *Warrington.*

"EDISWAN MULTAX" LAMPS.

Details have reached us of a pattern of arc lamp which the Edison & Swan Co. are putting on the market. It is known as that under the above title, and embodies the "bridge-core" principle for the carbons. By the use of this system of carbons the burning hours of the lamp are doubled without any increase in length of the lamp. This is an advantage where shop-window lighting and low interiors have to be dealt with. The bridge core carbon is also stronger than the ordinary single carbon, consequently breakages are reduced considerably. The working parts of the lamp are carefully enclosed and protected from the fumes given off by the burning carbons. There is no magazine and the lamp is of simple construction. The



Two Views of the "Ediswan Multax" Flame Lamp.

"Ediswan Multax" long burning flame lamp is at present supplied for 20 and 36 burning hours. The 20-hour pattern is recommended because it is only 33 in. in overall length, for all ordinary lighting purposes, and in particular for shops and public buildings. The 36-hour pattern is suitable for street lighting purposes, docks and goods yard illumination, and generally where trimming considerations outweigh the slight disadvantage of somewhat increased overall size.

IFS AND QUERIES.

If the use of gas as an illuminant were made a criminal act.

Does Mr. Bale want any help from The London Electrical Engineers in quelling the electrical riots at Callan, Kilkenny Co.?

Will Mr. Ferranti referee at a football match between the mercury and commutator meter stalwarts?

At Messrs. Elliott Bros.' social evening a farce entitled "Facing the Music" was presented. But in the electrical industry, surely this is no farce?

The Electrical Engineer at Worthing has a balance to the good of £8 on the year's working. Can we help him "blue" it?

When will orders for turbines be placed on steam consumption and not on price?

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ALVA A.C. WATTMETERS.

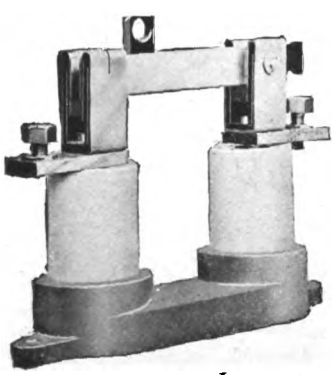
The following general details of Alva wattmeters have been supplied by Messrs. Gillespie & Beales. The "Alva" wattmeter works on the induction principle and possesses the mechanical advantages of the induction type of meter, with the sensibility and accuracy of a wattmeter of the dynamometer type. It can be used for the measurement of single-phase, two-phase or three-phase power consumption, and can be employed as a fixture on switchboards and also as a portable instrument for the testing of dynamos, transformers, motors, &c. The "Alva" wattmeter has a uniformly divided scale and is stated to be accurate at all loads.

The principal difference between the Alva wattmeter and other wattmeters consists in an optical arrangement enabling the indications on a horizontal scale to be read vertically, and thus the moving element can be mounted on a vertical axis, thus rendering the instrument free from any frictional troubles.

The "Alva" wattmeter is made for single-phase circuits, three-phase circuits with balanced loads, three-phase three-wire circuits with unbalanced loads or for two-phase circuits with common return, three-phase four-wire circuits, and for three-phase four-wire circuits (on two-phases and the neutral wire). The torque on the wattmeter disc at full load is from 40 to 50 gramme-millimetres, and the shunt loss of the wattmeter varies from 0·6 watts to about 4 watts according to type. The weight of the disc is about 25 grammes, and the insulation of the meter is tested at 2,000 volts. The accuracy of the wattmeter is said to be independent of the wave form of the alternating current, and is not appreciably affected by considerable variations in the pressure and frequency of the supply.

ISOLATING SWITCHES.

The illustration shows a single-pole isolating switch manufactured by Siemens Brothers Dynamo Works. The standard types are either single or triple-pole, and are slow-break switches mounted on porcelain insulators suitable for pressures up to 6,600 volts. Single-pole switches are arranged for operation by means of an insulated pole and hook. They are made in two designs: For fixing to iron framework, &c., the switch being provided with a cast-iron base, the terminals being arranged for front connection. For cementing directly into brickwork or concrete, this design of switch has no base, and can be supplied either for front or back connection, or with one terminal in front and one behind.

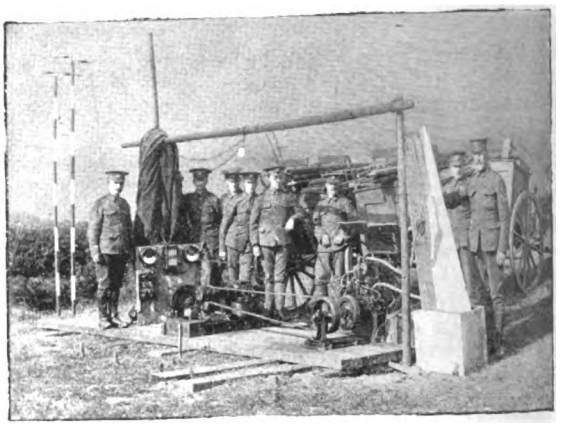


General View of Isolating Switch.

Triple-pole switches consist of six porcelain insulators carrying switch contacts, cemented into a cast-iron base, the connecting blades being also mounted on porcelain insulators, and fixed to a common wayshaft, which can be operated directly by means of a double-armed handle, or indirectly through a system of levers and links. In triple-pole switches the terminals are always arranged for front connection.

OSRAMS ON ACTIVE SERVICE.

The Osram lamp has been responsible for many revolutions in lighting methods, and we have had occasion to deal with these from time to time in our columns. The most recent example to come to our notice is that of camp illumination, Osram lamps being installed at the Bexhill summer camp of the Royal Engineers. The plant comprises a portable 4 H.P. petrol dynamo set, complete with battery. This equipment is used in the daytime to charge the cells for wireless service, and at night provides current for groups of Osram lamps in officers.

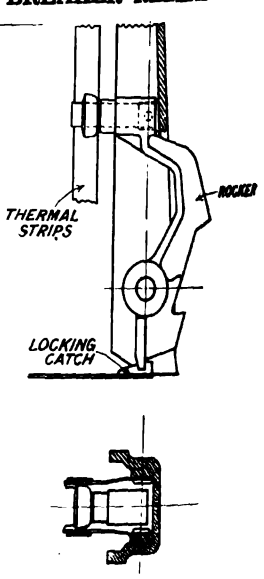


Osrams at Bexhill Camp.

mess, sergeants' mess, orderly tent, men's canteen, &c. Overhead lines attached to service poles are used for distribution purposes. The average distance of the lamps from the plant is 300 yds., and they are run on a 50-58-volt circuit. The interior of the waggons carrying the wireless apparatus (as shown in the illustration) are lighted with Osram motor car lamps. This interesting installation affords yet another instructive example of the efficiency and durability of the Osram lamp. The plant was first put into service in August, 1910, and was fitted up by the members of the wireless and airline companies of the London Army Corps, R.E.

A SIMPLE CIRCUIT-BREAKER RELEASE.

In our last issue we gave some preliminary details of a pattern of circuit-breaker manufactured by Morris & Lister, Coventry. We have now been supplied with a drawing showing the details of the release employed in this circuit-breaker, and we think it of sufficient interest to reproduce. Fitted to the breaker is a casting known as "the rocker." In closing the breaker this casting is driven in positively by the handle. The lower end of the casting is fitted with a locking catch which engages as soon as the breaker is home. The top end of the rocker casting carries a turned plunger



Arrangement of Circuit Breaker Release.

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catch which engages two flat catches connected to the main arm of the breaker; these two catches are kept in position by tension on the thermal strips. When the breaker is overloaded these strips expand and allow the flat catches to spring outwards, thus releasing the main arm of the breaker, which flies out away from the rocker. The bottom end of the breaker arm is fitted with cam surfaces which release the bottom locking catch. The breaker is immediately ready for closing. For the various attachments such as no-voltage, minimum and reverse current the bottom locking catch is operated on. For instance, in an overload and no-voltage breaker this catch is sprung down so that it will not engage unless there is voltage on the magnet system. Should the voltage fail the catch is released and the breaker opens.

CELL OR SELL?

A Birmingham traveller in the hardware trade was on business in a cathedral city recently. In the office of an ironmonger there he found a derelict dry cell, and as he wanted something of that kind to make a simple experiment, he asked if he might have it. The ironmonger agreed with pleasure. As the traveller had only a few minutes to catch his train he carried away the cell under his arm, without wrapping it up. As he approached the station he became aware of something unusual, and was suddenly pounced upon by an inspector of police, who snatched the worn-out battery from his arm, placed it on the ground, and hustled the unoffending traveller into the station-master's office. A body of police were told off to watch that nobody approached the place where the traveller was confined; indeed, when the whisper went round that an anarchist with a live bomb had been discovered, people scarcely needed telling. In the meantime the poor commercial traveller was subjected to a long string of searching questions. He put his foot in it at the beginning by saying he had no idea the King and Queen were expected to pass through the station. The officials smiled incredulously. Of course, nobody in the city could possibly be ignorant of such a thing. Nor did the traveller mend matters by saying that he knew nothing about the "bomb" except that he believed it to be quite harmless. If it was harmless, what were those curly bits of wire sticking out from it? And when he declared that he had only just had the thing thrust into his hand by a friend, he simply ran himself in. People don't allow friends to thrust bombs into their hands without their knowledge. It was not until the erstwhile owner of the "bomb" had been brought to the scene to corroborate the traveller's statements, and prove the truth of his assertions by taking the battery to pieces, that the traveller was allowed to go free. Even now, he fears, he will be a marked man in the city in question for the remainder of his days.—*From "The Ironmonger."*

EXCELLO

FLAME ARC WITH UNIQUE TWO YEARS' WARRANTY

THE GAS STOVE OF ADOLPHUS BROWN.

Adolphus Brown was very proud,
He moved above the common crowd;
And yet his ways were very loud.

He said his blood was old and blue,
But not a word of this was true;
He was a low-down *parvenu*.

For "common things" he cared no jot,
And therefore he indulged in what
His friends and neighbours had not got.

Now Jones, who was his *ris-a-ris*,
Had told him that, for cooking, he
Believed in electricity

And so had bought a useful stove
That smells and dirt from kitchen drove;
He said it was a treasure-trove.

But Brown turned up his Cockney nose.
He said: "That really only shows
How little everybody knows."

For his conceit was very crass.
He said: "The smart set cook with gas."
He really *was* a stuck-up ass.

He thought such men as Jones were dirt,
Their customs low, their manners pert.
And yet his dignity was hurt.

That Jones should try to do the grand
With stove of the electric brand
Was really *more* than he could stand.

The Gas Co.'s showroom wasn't more
Than twenty minutes from his door.
He bought a stove for five pounds four.

They said it was the *very* best
By London County Council test.
He turned his back upon the rest.

He said: "Please send it very soon;
I'm sure that it will be a boon."
They promised it that afternoon.

He stood beside his garden gate,
He hadn't very long to wait;
He'd bested Jones, at any rate.

They fixed it up that very day:
He said he'd try it, come what may
He'd have his dinner cooked that way.

* * * *

That night when Jones was at his door
He heard a loud and deaf'ning roar,
And something hit him on the jaw.

Although no longer in his youth,
Jones had a strict regard for truth;
He swore it was Brown's wisdom tooth.

And, probably, Jones was quite right.
There fell from out th' Empyrean height
Small bits of Brown throughout the night.

For here they found a lump of fat,
A hand, an ear, his new silk hat;
They even found his old tom cat.

And eke an arm, a nose all hacked;
They found his braces and, in fact,
They found his trousers quite intact.

But of the gas stove ne'er a trace;
No bits were found about the place—
It was projected into space.

And now among the asteroids,
Converted into alkaloids,
It floats, unregistered at Lloyds.

Thus Brown, he proved to you and me
The worth of gas, and paid the fee.
Electric stoves are best, you see.

V. Z.

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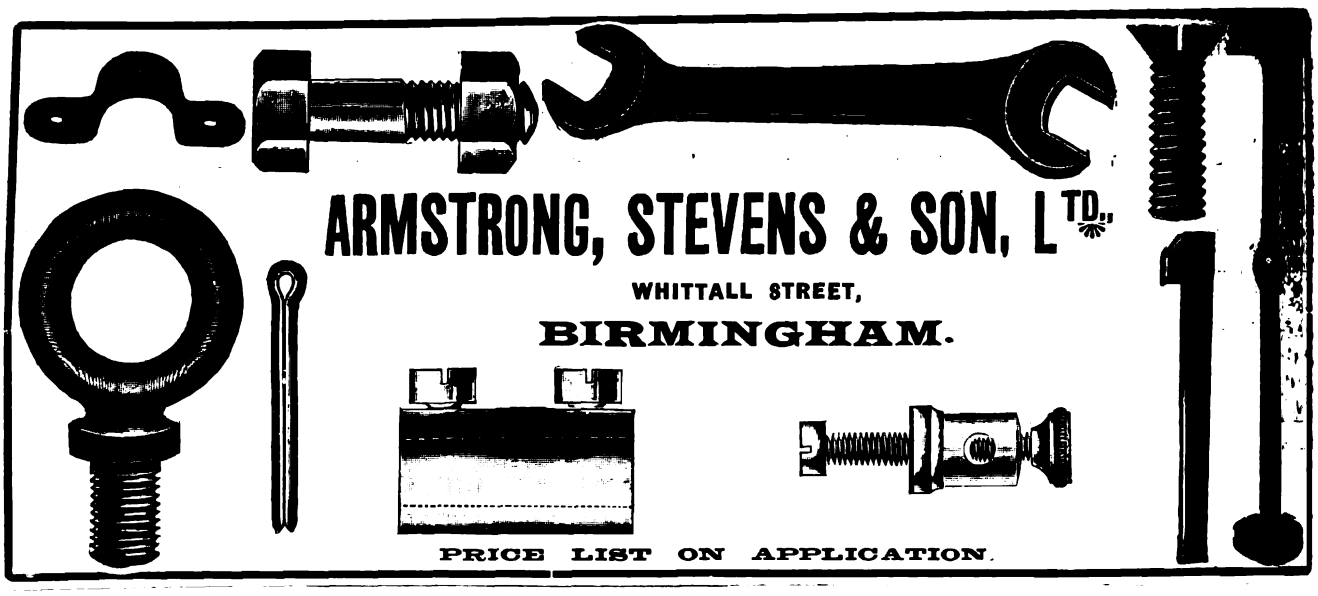


NEW TURBO SET AT ST. HELENS.

The official opening of the latest addition to the plant in the generating station of the St. Helens Corporation took place on April 5. The new unit consists of one British Westinghouse 1,000 kw. steam turbo-alternator which runs at a speed of 3,000 revs. per min. and supplies energy at a pressure of 6,600 volts.

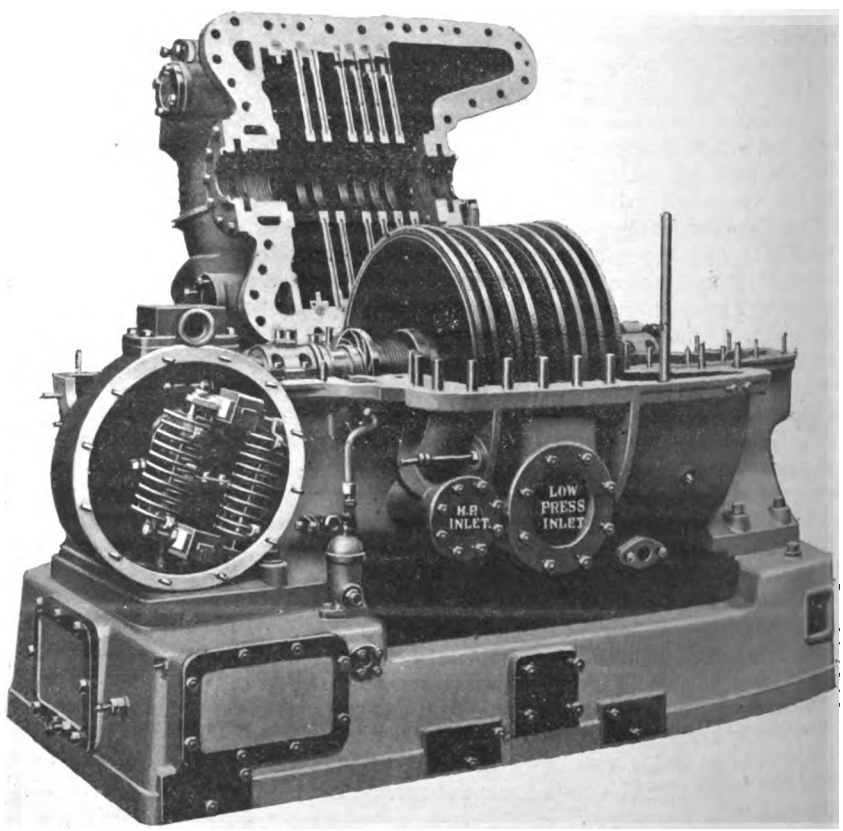
The turbo-alternator takes steam from the boilers at 160 lb. per square inch, and the steam consumption guaranteed was 15·9 lb. of steam per kilowatt-hour at full load; the actual consumption on test came out at 15·64 lb. per kilowatt-hour, which is 1·63 per cent. better than the guarantee. This result is most satisfactory from the Corporation's point of view. The condenser is of the low-level jet type, manufactured by The Mirrlees Watson Co., with Westinghouse motors driving the various pumps.

The illustration shows the Westinghouse turbine opened for inspection. The steam enters at the left-hand side of the turbine and is expanded through the various nozzles placed in each stage until the exhaust pressure is reached. Each stage consists of a diaphragm fixed in the cylinder and a moving wheel on the shaft. The velocity of the steam after it passes through the diaphragm nozzles is used up on the blades of the moving wheel.

The bearings are supplied with oil under pressure from the oil pump shown in the bedplate of the turbine, which is driven by means of a vertical shaft through bevel gear from the governor shaft, which in turn is driven from the main turbine shaft by means of the worm and gear wheels shown. An emergency governor is fixed on the extreme end of the shaft to prevent the turbine reaching a dangerous speed should anything go wrong with the ordinary governor gear. The blades rivetted on the various wheels are machined out of the solid steel bar. The main shaft is made of high-quality steel, and stepped in diameter from the centre towards each end to take the blade wheels. Water glands are provided on each end of the cylinder to keep air from leaking into the cylinder and steam from passing out. The steam chest, which receives the steam from the main boilers, contains the necessary stop valves and governor valves for operating and controlling the turbine. It will be seen that the turbine is covered with planished steel, and all moving parts are totally enclosed so that no dust or dirt can reach the bearings. The alternator is totally enclosed, and in order to keep the windings cool, air is drawn in at each end of the machine and discharged at the top.

Before the installation of the 1,000 kw. turbo-alternator, the whole of the alternating current generated was supplied by two Westinghouse rotary converter equipments, of 250 and 550 kw. capacity. Now that the turbo set is installed, these rotary converters will form a very flexible and most efficient link between the direct-current and alternating-current systems of supply. Each rotary is reversible, that is, it can supply a.c. or d.c. energy as required.

The whole of the switchgear equipment was also supplied by the British Westinghouse Co.



WESTINGHOUSE STEAM TURBINE AT ST. HELENS, SHOWN OPEN FOR INSPECTION.

Printed and Published by GEORGE TUCKER, at the Editorial, Printing and Publishing Offices, 1, 2 and 3, SALISBURY COURT, FLEET STREET, in the City of LONDON, FRIDAY, APRIL 14, 1911.

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THE ELECTRICIAN COMMERCIAL AND INDUSTRIAL SUPPLEMENT.

C. & I. Supplement No. 81.] APRIL 21, 1911. [Gratis to Subscribers.

HIGH C.P. METAL LAMPS AT LOWER PRICES.

Shopkeepers, tradesmen and central station engineers will read with satisfaction the announcements of most of the metal lamp makers this week to the effect that the high candle-power lamps are to be again lowered in price. This move will materially assist the electrical industry in its campaign against gas, because the inverted mantle when grouped in suitable lanterns is a most powerful competitor of the metal lamp when used in the same manner. The high candle-power metal lamp should, in the light of its new price, be capable of competing even more successfully with gas than it has already done. In every sphere of trade, commerce and industry, there is a demand —and a big demand—for a unit of light between that of the highest candle-power lamp in general use—the 50 c.p. lamp—and the smallest arc lamp. The most successful high candle-power metal lamp is rated at 600 c.p., and a light unit of this standard is of immense value for the illumination of shops, yards and open spaces. Its selling price is therefore of more than ordinary importance. The action of the lamp makers in reducing prices should be supported by the trade in every possible way.

As far as the central station engineer is concerned his support can no doubt be counted upon for high candle-power metal lamps for street lighting. This is a field in which the gas advocates fear the competition of the metal lamp more than in any direction. The electricity supply authorities have kept up a constant fight with gas for the last few years, and they have succeeded in removing to some extent the popular impression that gas is a cheaper and better illuminant than electricity for streets and public thoroughfares. Already the metal lamp shows a remarkable life when used in this field of illumination, but its initial cost has prevented many undertakings launching out on a big scheme for the conversion of existing gas lanterns or for the fitting out of new posts. The effect of the new prices will be watched with interest, and we hope that both the industry and the manufacturer will benefit by it.

The announcements of the various lamp makers are given below.

MAZDA.

The British Thomson-Houston Co. state they have decided to amend the list prices of high candle-power Mazda lamps, and the following are the new prices :—

Watts.	British candle-power.	Volts.	Dimensions.	List price of clear parallel lamps.
80	53	100/260	6″×3¼″ straight side	4s. 6d.
100	90	100/260	7″×4⅜″ spherical ,,	4s. 9d.
200	180	100/260	9⅛″×6⅝″ ,, ,,	9s.
300	270	100/260	9⅛″×6⅝″ ,, ,,	17s.
400	360	100/260	11¼″×8″ ,, ,,	17s.
600	540	100/260	11¼″×8″ ,, ,,	20s.

Contractors, &c., who have any Madza lamps of the above varieties still in stock, which were purchased since March 15, 1911, and who advise the company of the number and type immediately, will receive a credit for the difference in price.

OSRAM.

The General Electric Co. announce that they have been very successful in the sale of high candle-power lamps, from 100 c.p. to 600 c.p., with a corresponding effect of cheapening the production. They announce that from April 15, 1911, prices will be reduced as follows :—100–260 volt 100 watt, approx. 100 c.p.,

See important announcement, page xv.

OSRAM

LAMPS.

The General Electric Co., Ltd. Head Office 67, Queen Victoria St., London, E.C.

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PROTECT YOUR HOUSE SERVICES WITH

"ZED" FUSES.

Specially suitable for use as

COMPACT HOUSE SERVICE CUT-OUTS.

SIEMENS BROTHERS DYNAMO WORKS LIMITED.
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Telephone: LONDON WALL 8270. Telegrams: "SIEMOTOR, LONDON."
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BIRMINGHAM	GLASGOW	SHEFFIELD	CALCUTTA	SINGAPORE	SYDNEY
BRISTOL	MANCHESTER	JOHANNESBURG	BOMBAY	PENANG	MELBOURNE
CARDIFF	NEWCASTLE	CAPE TOWN	MADRAS	RANGOON	TORONTO

4s. 9d. each; 100–260 volt 200 watt approx., 200 c.p., 9s. each; 100–260 volt 400 watt approx., 400 c.p., 17s. each; 100–260 volt 600 watt approx., 600 c.p., 20s. each.

They hope by these reductions to largely increase the sale of the higher candle-power lamps which have an exceedingly long life, as shown by a recent test by the National Physical Laboratory. Further, the Official Records of the Borough of Hammersmith Electricity Department also show that an average life of over 3,600 hours has been attained with Osram lamps.

"ONEWATT."

Messrs. Siemens Brothers Dynamo Works Limited, Tyssen-street, Dalston, London, N.E., have reduced the list prices of their well-known "Onewatt" lamps of 200 c.p. and 400 c.p. The prices of these in all voltages are, as from the 15th inst., 9s. and 17s. each respectively. It is expected that the lower prices will enable contractors to do an even larger trade in these lamps than previously. We may remind our readers that the price of their 100 c.p. lamp remains unchanged at 4s. 6d. A new price list has been printed containing the above alterations, and quantities will be forwarded, over-printed with contractor's name and address, on receipt of application accompanied by trade card.

AEGMA.

The Electrical Co. lamp department are making reductions in the price of their high candle-power lamps as follows: 100 c.p., 100–135 volts, from 5s. 6d. to 4s. 6d.; 100 c.p. 200–260 volts, from 6s. to 4s. 6d.; 200 c.p. 100–260 volts, from 12s. 6d. to 9s.; 400 c.p. 100–260 volts, from 20s. to 17s.; 600 c.p. 100–260 volts, from 22s. 6d. to 20s. The same company also make an important announcement in the reduction of their 25 c.p. and 32 c.p. pear-shaped 200-volt metal lamps. These are both reduced from 4s. to 3s. 9d. These prices are, of course, subject to the usual trade discounts, and we understand that the company is in a position to make prompt delivery. They also state that they can give special terms for street lighting.

BRIMSDOWN.

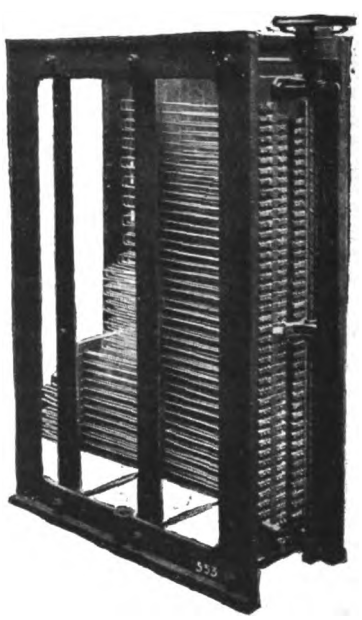
Imperial Lamp Works (Brimsdown), Ltd., announce reductions in the price of their lamps. These affect the lamps from 53 to 540 British c.p., and are as follows: 53 c.p. 4s. 6d., 90 c.p. 4s. 9d., 180 c.p. 9s., 270 c.p. and 360 c.p. 17s. each, and 540 c.p. 20s. These are list prices for clear lamps, and are, of course, subject to the usual trade discounts.

PHILIPS.

Messrs. G. M. Boddy inform us that the prices of their Philips high-candle metal lamps, 100 c.p. to 1,000 c.p., will be reduced to the same level as that of the Osram lamps. Mr. Boddy has been identified with the metal lamp trade for many years past, and has always endeavoured to associate his business with all improvements and developments as they occur.

LARGE CAPACITY RHEOSTATS.

A new line of rheostats for controlling the field circuits of large generators and for other purposes is being made by the Electric Construction Company. They describe it as their straight line type, and the illustration shows a regulator with an operating hand wheel. They are, however, designed also with the view to being placed away from the switchboard and operated by gearing and rods, or by chain.



E.C.C. RHEOSTAT.

The rheostats have a large number of ways, and the resistance conductor consists of a number of strips or wires in parallel, so that the continuity of the circuit does not depend on one strip or wire, and it also enables the ohmic resistance to be readily altered. The hot air rising from the resistance material is not obstructed in any way by the framework, and the ventilation is consequently efficient, enabling a large amount of heat to be dissipated in comparatively small dimensions.

THE SALESMAN'S CREED.

1. To respect my Co. and myself. To be honest and fair with my Co., as I expect my Co. to be honest and fair with me; to think of it with loyalty, speak of it with praise, and act always as a trustworthy custodian of its good name.

2. To make a study of my business or line; to know it in every detail; to mix brains with my efforts and to use system and method in my work. To find time to do everything needful by never letting time find me doing nothing. To make every hour bring me dividends in commissions, increased knowledge or healthful recreation.

3. To believe in my proposition heart and soul; to carry an air of optimism into the presence of possible customers; to dispel ill-temper with cheerfulness, kill doubts with strong

OSRAM-LAMPS

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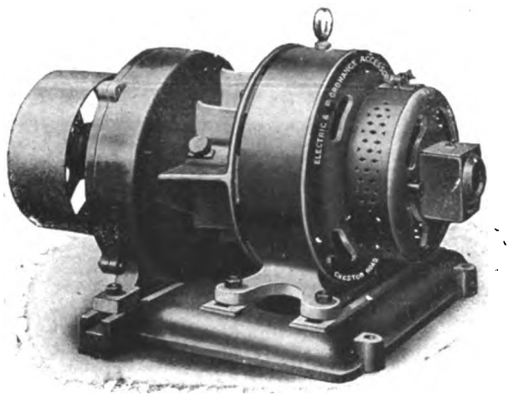

Back geared "EOA" Motor. Gearing enclosed.

"EOA" Motors in all sizes up to 50 H.P., with back gear enclosed as illustrated, or of the usual open type.

"EOA" Motors give satisfactory service under all working conditions, as their great feature is Reliability.

Quick Delivery. *Competitive Prices.*

The Electric & Ordnance Accessories Co., Ltd., Aston, Birmingham.

(Proprietors, VICKERS LIMITED.)

convictions and reduce active friction with an agreeable personality.

4. To remember that success lies within myself, in my own brain, my own ambition, my own courage and determination. To expect difficulties and force my way through them; to turn hard experience into capital for future struggles.

5. To base my expectations of reward on a solid foundation of service rendered; to be willing to pay the price of success in honest effort. To look upon my work as opportunity to be seized with joy and made the most of and not as painful drudgery to be reluctantly endured.

6. To keep my future unmortgaged with debt; to save money as well as earn it; to cut out expensive amusements until I can afford them; to steer clear of dissipation, and to guard my health of body and peace of mind as my most precious stock-in-trade.

7. Finally, to take a good grip on the joy of life; to play the game, and to endeavour to grow as a salesman and as a man with the passage of every day of time. This is my creed.

The foregoing has been sent in to us by the St. Helens Cable Co. who are making a distribution of them to applicants (strictly in rotation). Mr. J. C. H. Brooking, the manager of the company in question, is responsible for this *credo*.

We have numbered the items for purposes of comment. It will be noticed that there are seven. The author evidently believes in the biblical number.

Nos. 1 and 2. Rather difficult with a man who sells turbines, condensers, metal lamps, varnish, rubbers, telephones and electric winders, all in the space of about 18 months. He makes his own creed as he goes along.

No. 3. Not recommended for salesmen of steam turbines.

No. 4. This should be a boon to salesmen of magazine arc lamps.

No. 5. Borough electrical engineers in small towns with salaries from £150 a year downwards should frame this item in solid oak, or, better still, have it perpetually reeled off on a phonograph.

No. 6. Impossible for electrical contractors and advertisement solicitors. Simply can't be done.

No. 7. Electrical men generally might omit the repetition of this the next time they go to church.

We suggest as a substitute: Finally, to get a good grip of the other man's prices, to cut like blazes, and to endeavour to get the job (*for the works' sake*) every time and all the time.

COLOUR CAPS.

Electrical contractors and central station engineers who have in hand illumination schemes for the Coronation will be interested in a device for illuminating the tips of lamps which is being put forward by an American firm, Messrs. Betts & Betts, of New York. This company has sent us a number of bulletins in which this interesting device is described. It is a celluloid cap which is clipped on to the lamp bulb by wire fasteners which encircle a flange at the base of the cap. A stock series of colours is listed, and we understand that a supply can be given at short notice. The makers claim that the cap has an advantage over a dipped lamp, in that it cuts off a minimum of light, and, in fact, enables a lower candle-power to be used with the same effect as a higher candle-power with a dipped lamp. The company have supplied a large quantity of these caps to the big sign firms in America, and the literature supplied contains illustrations of a number of these signs.

EXCELLO

FLAME ARC WITH UNIQUE TWO YEARS' WARRANTY

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"EMPIRE"

A.C. Lift Controllers

FOR POLYPHASE CIRCUITS.

Unsurpassed for
RELIABILITY,
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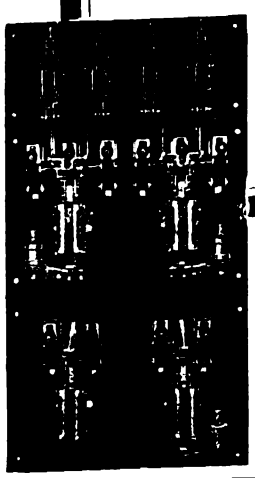
SILENCE IN ACTION.

Liberal Design.
Conservative Action.

BRITISH MADE.



10 H.P. 3-phase Lift Controller
Push Button Type (four floors).

Write for full Particulars and Catalogue "E."

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GLASGOW.

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OSRAMS FOR STREET LIGHTING.

In a recent issue we reviewed a publication which the General Electric Co. had issued relating to the application of the Osram lamp for street lighting. This booklet contained a page from the log book kept by Hammersmith Borough Council of the street lighting lamps, all of which are Osrams. We have now received an extract from this log relating to the life of 75 lamps, and the figures are of sufficient interest to publish in full.

No.	Hrs.	Mins.	No.	Hrs.	Mins.	No.	Hrs.	Mins.
1	3,462	40	26	3,552	10	51	2,776	5
2	8,480	55	27	5,725	20	52	2,142	20
3	2,497	30	28	5,441	15	53	1,640	15
4	8,134	...	29	4,572	40	54	3,705	45
5	8,698	15	30	4,408	5	55	953	30
6	7,893	30	31	3,888	15	56	4,027	15
7	793	25	32	2,167	30	57	3,969	50
8	8,012	5	33	1,881	...	58	1,760	5
9	7,693	20	34	1,250	55	59	799	25
10	7,512	35	35	4,122	...	60	1,585	25
11	6,264	15	36	2,760	20	61	3,764	20
12	4,799	45	37	2,821	20	62	3,962	20
13	2,894	25	38	4,537	45	63	1,276	1
14	5,199	40	39	3,221	20	64	1,276	10
15	5,282	10	40	2,215	35	65	1,104	20
16	5,939	5	41	929	35	66	3,234	5
17	5,804	25	42	2,671	50	67	3,742	45
18	5,987	25	43	1,295	45	68	3,335	35
19	5,541	25	44	4,001	...	69	3,176	35
20	3,102	50	45	3,874	55	70	2,429	45
21	5,691	35	46	1,124	25	71	1,514	35
22	2,792	50	47	4,218	...	72	2,061	...
23	6,400	30	48	1,004	35	73	877	15
24	1,398	5	49	3,944	45	74	1,667	40
25	5,272	25	50	1,224	35	75	1,902	10

Total number of lamps ..... 75.
Total burning hours ..... 270,988½.
Average life per lamp ..... 3,613 hours.

The following are a few instances of existing large street lighting installations :—

The Corporation of Torquay have replaced every arc lamp previously on circuit by 1,000 c.p. Osrams, 80 of the latter now being in use. At Acton 64 400 c.p. Osrams have replaced a similar number of 10-ampere open-type arc lamps. In Hammersmith a considerable number of 400 c.p. Osrams have replaced arc lamps in one of the most important thoroughfares. According to figures now to hand, we understand this change has been the means of effecting a saving of £2. 16s. per lamp per annum. Yarmouth Corporation have installed over 300 400 c.p. Osrams which replace both arc and gas lamps. West Hartlepool have a number of 200 c.p. Osrams now in use, these having displaced 10-ampere open-type arc lamps. Wimbledon have already installed 49 300 c.p. Osrams, most of which have replaced 550-watt small enclosed arcs, whilst over 1,100 50 c.p. Osrams are being used in this district for side street lighting. Cardiff have already replaced over 60 arcs with 400 and 600 c.p. Osrams. Bury St. Edmunds have 200 Osrams in use for street lighting and a further 200 posts are being fitted. The lamps are of the 63-watt 200-volt type and their average life is found to be about 2,500 hours. A life of 2,000 hours is also reported from King's Lynn, where there are 600 Osram lamps in service for street lighting. We may also mention that a contract has been placed for the supply of 4,000 Osrams for the entire equipment of the incandescent lamp street lighting scheme for Johannesburg. On the Underground Electric Railways, London, some thousands of high candle-power Osrams have been installed, entirely replacing the arc lamps which previously provided illumination for their various stations.

IFS AND QUERIES.

If the writer of the "Electricity Memoranda" in the "Journal of Gas Lighting" were not a Scotchman.

With the new electric train service will the I.E.E. Conversazione be held at the Crystal Palace this year?

How much longer will metal lamp makers resist the temptation to reduce prices all round?

If the miners succeeded in prohibiting the use of electricity in mines what would all the gas works do?

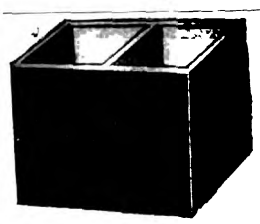
Will the additional 54,000 c.p. in the street lighting at Watford adversely affect the dividends of the local breweries?

Carnarvon Castle is to be lighted electrically for the investiture of the Prince of Wales; will the castle electrician arrange for the necessary leek?

If Mr. Killingworth Hedges were made Comptroller of the P.O. Telephone System.

After the events in Holborn, will the Street Lighting Committee of the Corporation of London now ask for a scheme of public lighting to be submitted by the gas and electricity supply companies jointly?

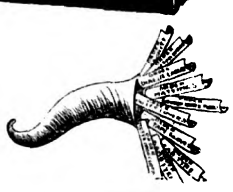
Extract from an Electrical Catalogue



EBONITE.

CANTO XII.

Where Insulation's needed, strong but thin,
Then Ebonite is used, as Black as Sin,
But Good and True St. Helens make the kind
For Volt detention thro' or o'er its skin.



ORDERS.

CANTO XIII.

And when THYSELF with inked pen shall pass
THY Bounteous Orders, singly or en masse,
For merchandise of kind as shewn herein,
Remember us, or THOU may'st cry "Alas!"

published by ST. HELENS CABLE & RUBBER CO., LTD., *Warrington.*

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SPECIFY AND USE

FERRY RESISTANCE WIRE.

No Temperature Coefficient. Wire will not Rust or Perish.
Contains no Iron.
The only Material of its kind Manufactured in England.
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Used also by the Italian and Japanese Admiralties.

Write for List giving Electrical Particulars of Ten Grades of Wire.

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Agent : LIONEL ROBINSON,
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Telephone : 6323 HOLBORN.
Telegrams : "FERRYDOM, LONDON."

IF WEATHER-PROOF CABLE—WHY CONDUIT ?

One of the leading cable companies has recently introduced a Rust and **Weather-proof Cable,** specially recommended for use in Screwed Steel Tube ; a **Conduit Company** advises that **Weather-proof Cables** be used in their conduits. Why ? Because it is impossible to have steel or iron tubes without condensation.—It means that **no** cable ordinarily used for indoor work should be drawn into steel tubes. The Weather-proof Cables are certainly more suited to the conditions, but they don't eliminate the condensation—the trouble is still there.

And yet **"Conduit wiring without condensation" is possible,** and easy of attainment—but only with the **Kalkos System** (taped only wires are all that are required). That is why a constantly increasing number of consulting engineers are specifying, and contractors adopting it as their standard practice. Write now for full particulars of the Kalkos system which is guaranteed free from condensation by The Sun Electrical Co., Ltd., 118-120, Charing Cross Road, London, W.C.

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STERLING TELEPHONES
The Sterling Telephone & Electric Co., Ltd., 200, Upper Thames Street, London, E.C. Works: Dagenham, Essex.

"STANNOS" AT RHYL.

RESULTS OF 12 WEEKS' CAMPAIGN.

Towards the end of last year, the Rhyl Urban District Council wished to increase the load on their mains, and Mr. E. H. Wright, the electrical engineer, approached Messrs. Siemens Brothers & Co., as it was considered that Rhyl would

EXTERIOR OF "STANNOS" SHOWROOM AT RHYL.

offer an excellent field for the O.S. wiring system. Eventually the Council fitted out a showroom, which was wired throughout with "Stannos" and opened early in January. The necessary advertising was undertaken by means of signs, lighting, showboards, literature, newspapers, &c. Simultaneously an energetic canvass of the town was made by the two local contractors, Messrs. D. T. Jones & Co. and Mr. Barker, who have obtained between them, a large number of orders for new installations with "Stannos" (including "Tantalum" lamps and "Zed" fuses). The additional load secured to the undertaking by the 12 weeks' campaign is represented by the equivalent of over 1,100 30-watt lamps.

The importance of these figures must be considered, however, in relation to the size of the undertaking. Taking as a basis the latest published data (THE ELECTRICIAN Tables of Electric Lighting, &c.), the lamps connected represent an increase of about 11 per cent. We understand that Messrs. Siemens Brothers & Co., Ltd., are prepared to discuss "Stannos" showroom schemes with station engineers who are desirous of providing the necessary facilities much on the same lines as at Rhyl.

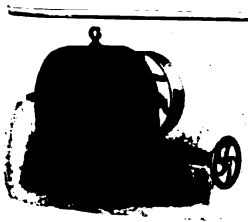
Since Messrs. Siemens Brothers & Co. first introduced the wiring about two years ago, one of their claims has always been that "Stannos" wires provided a means for increasing the number of consumers. With that object indirectly in view, they instituted a publicity campaign, which was applied at both ends of the retail scale, viz., the contractor and the consumer, and the results continue to afford the greatest satisfaction. This is particularly the case in localities where prejudice or conservatism is not allowed unduly to influence progress, and where the station engineer is able, or enterprising enough, to assist. The foregoing shows how it can be done.

NEW TRADE LITERATURE.

A budget of trade publications has reached us from various sources during the past week.

The British Thomson-Houston Co. has sent particulars of their arc lamp winches, high torque alternating-current watt-hour meters, pressure governors, radiator lamps, automatic starting compensator, automatic starting rheostats for direct-current non-reversing motors above 15 H.P., and oil-immersed switches for induction motors. We shall give details of one or two of these specialities in our next issue.

The General Electric Co. have issued several catalogues which relate to their engineering supplies and arc lamps and accessories. The former describes a variety of small type Witton motors, and shows the application of these to machine tools, small pumps, sewing machines, coffee mills, vacuum cleaners, &c. There is also a section dealing with accumulators, dynamo supplies and traction overhead equipment accessories. The arc lamp list is replete with information on the subject of Angold and Butt arc lamps, and practically every description of lamp manufactured by the company. There is a section on accessories and flame and ordinary carbons. Accompanying these catalogues is a loose leaflet describing the Jackson semi-automatic door switch and Hileach patent shade carrier. Particulars of these will be given next week.



PELTON WHEELS for Hydro-Electric Plants.
Patent Hydraulic Speed Governors.

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Garrison Lane, BIRMINGHAM.
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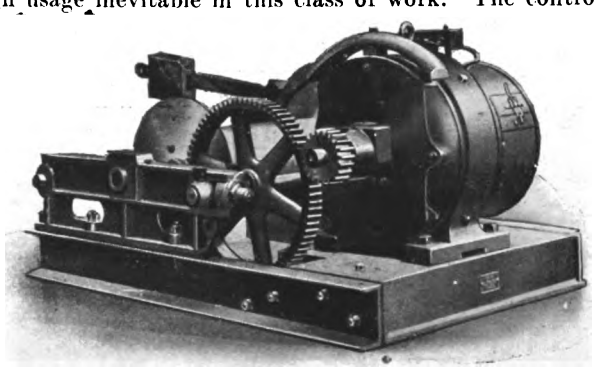
"UNION" FRICTION HOISTS.

These hoists have been designed to meet a general demand for a cheap and reliable electrically-driven winch, especially in connection with building construction. They are constructed with a view to compactness and portability, but at the same time are proportioned to withstand the hard wear and rough usage inevitable in this class of work. The control of



UNION ELECTRIC FRICTION HOIST.

the hoist is effected by a single lever, operated by a rope from any convenient position. The hoists are listed for use on direct-current circuits or three-phase circuits of 50 cycles. In the case of direct-current hoists, the motor is a shunt wound enclosed ventilated machine of suitable speed and output, and the switchgear an ironclad combined switch and fuses, together with a semi-enclosed motor-starter fitted with a "no-volt" release. For three-phase circuits the motor is a squirrel cage enclosed ventilated machine, controlled by an iron-clad combined switch and fuses, and an enclosed star-mesh controller.

The hoists consist of a protected electric motor, driving by means of spur gearing, an intermediate shaft, which carries a small steel friction wheel. The rope drum and a large cast-iron friction wheel are mounted on a second shaft, which is bushed at one end in a swivel bearing, and at the friction wheel end in an eccentric block, capable of being moved through a small angle by means of the operating lever. This lever is weighted so as to bring the large friction wheel into contact with a wooden brake block in its normal position. On lifting the control lever the large friction wheel is first brought clear of the brake block, in which position the rope drum is left free to revolve under the weight of the load, and so lower it; while, if the lever is lifted still further, the large and small friction wheels are brought into contact, and the load is consequently lifted.

The usual method of employing these hoists for building purposes is to instal the machine on the ground level, the wire cable being brought up to the top of the scaffolding, where it is passed over a suitable head wheel. The controlling rope is also led up and over a small pulley, and terminates in a loop into which the operator places one foot. This enables him to keep the hoist under perfect control, and ensures that the friction wheels will be engaged quickly and without slipping, thus reducing wear to a minimum. The Union Electric Co. will furnish additional particulars on request.

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THE ELECTRICIAN COMMERCIAL AND INDUSTRIAL SUPPLEMENT.

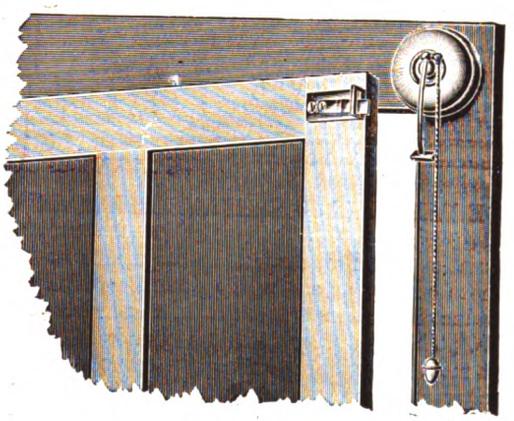
C. & I. Supplement No. 82.] APRIL 28, 1911. [Gratis to Subscribers.

"SIMPLEX" FOR THE POCKET.

A 400-page quarto catalogue compressed into a pocket edition of 130 pages; it sounds almost impossible, but Messrs. Simplex Conduits have managed it, and we hope that the trade will appreciate their effort by getting and keeping the list, the while, of course, they act upon its many admonitions to purchase. There are no less than 18 sections, and they cover the entire range of wiring and electricity using devices. A most valuable section is that of some 6 pages devoted to a numerical index of the items in the catalogue. The list is 4 in. by 8 in., and can easily be slipped into the catalogue. The illustrations are on a small scale of course, but perfectly clear and distinct. The adjoining specimen is taken from the electric fixtures section, and shows a line of illuminated mirrors for shaving and hairdressing purposes. The mirror is adjustable and can be placed either on the table or hung on the wall.

SEMI-AUTO DOOR SWITCH.

The ordinary automatic door switch is usually under the disadvantage of being switched on every time the door is fastened, whether it is required or not. With the "Jackson" type the light is on only when actually required after entering room, the closing of door and subsequent pulling of cord places the switch in the "on" position. The action of opening the door to leave automatically throws the switch to the "off" position. A considerable saving in current consumption is effected, as during the hours of daylight the switch need not be used. The illustration shows the method of fixing the switch. The device is made by the General Electric Co., who supply the switch for right or left hand doors. There is also included a bolt with 3 ft. cord and acorn-shaped knob.



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Full particulars free on application.

The General Electric Co., Ltd. Head Office 67, Queen Victoria St., London, E.C.

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B.T.H. AUTO-STARTING COMPENSATOR.

Automatic starting compensators are recommended for the remote control or automatic operation of two and three-phase induction motors with squirrel-cage rotors of 5 H.P. and upwards. These compensators are particularly adapted for use with motors in connection with pumping systems.

The compensator method of starting the squirrel-cage type of induction motor presents advantages over the system in which resistance is used in series with the stator for reducing the current taken from the line. In starting a motor with this latter type of device, the line current is at all times the same as the motor current, and since the starting current will probably be several times greater than the normal load current, serious disturbance may be caused in the line voltage.

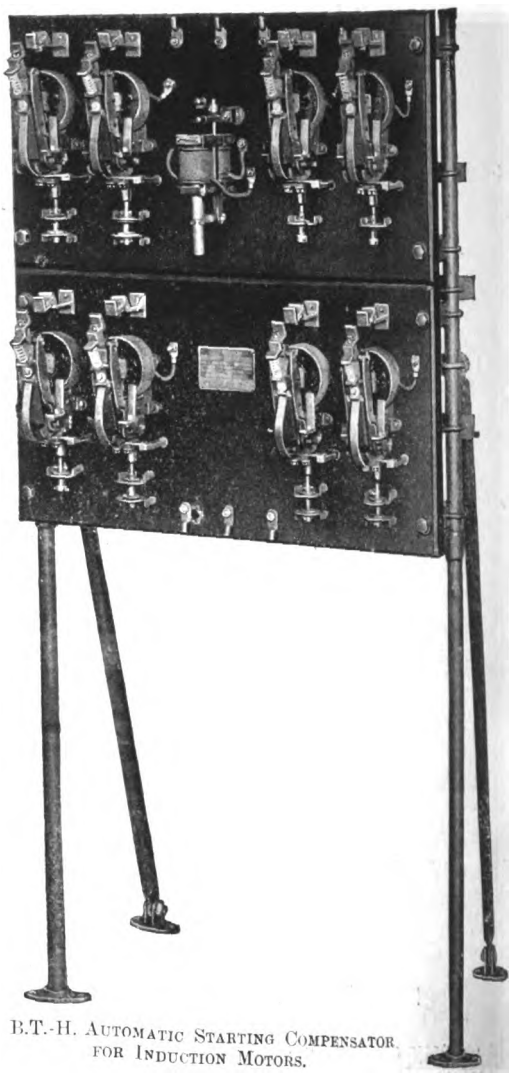
With an automatic compensator the line current during the period of starting is about the same as the motor current at full load, owing to the transformer action of the compensator. In addition, the compensator is provided with tappings which can be adjusted to suit the starting conditions.

The automatic compensator is operated by an improved type of a.c. solenoid, which ensures positive action. In addition, it is possible to instal the apparatus where continuous current is not available, and without the use of batteries or other auxiliary appliances. The only solenoids in circuit after the motor has attained full speed are those on three contactors, and they use a very small amount of energy. Automatic compensators protect the motor if the voltage fails; external enclosed fuses also are provided, which are in circuit only when the motor is across the running side of the automatic compensator.

The B.T.-H. compensator, shown herewith, consists of a current limit relay, contactors, compensator coils and fuses mounted on a panel supported by pipe frame work. The contactor will carry its rated current continuously with a large factor of safety. It opens and closes with a quick positive action, thus preventing fusing at the contacts. It will open the circuit on heavy overloads, arcing being dispersed by means of a powerful magnetic blow-out. Special attention has been given to these contactors in order to eliminate the noise and vibration often experienced with alternating current magnets.

Fuses for overload protection are supplied and mounted on the panel. As they are not connected in circuit during the period of starting, fuses of the running capacity of the motor can be used. All the parts have been designed and constructed to meet the requirements of the severest service, and to enable replacements to be effected with the greatest ease and in the shortest time.

The motor can be controlled either by opening and closing the circuit of the solenoids by means of a small lever switch, or by leaving this circuit closed, and using instead a double or triple pole switch (preferably of the oil type) for opening and closing the line circuit. When the operation of the motor depends upon the rise or fall of a liquid in a tank, a single pole float switch is used to open and close the exciting circuit of the controlling solenoids.



B.T.-H. AUTOMATIC STARTING COMPENSATOR FOR INDUCTION MOTORS.

Starting compensators are supplied in voltages 110 to 550, but they can be supplied for circuits of 2,200 volts. The general construction of high voltage is similar to that of low voltage compensators, excepting that in the former the contractors and the whole of the lower part of the panel are totally enclosed in a tank of oil, thus ensuring perfect insulation and disruption of the arcs at the contacts. Tube expulsion fuses are supplied and a transformer is furnished to reduce the line voltage to the voltage at which the solenoids are operated.

OSRAM-LAMPS

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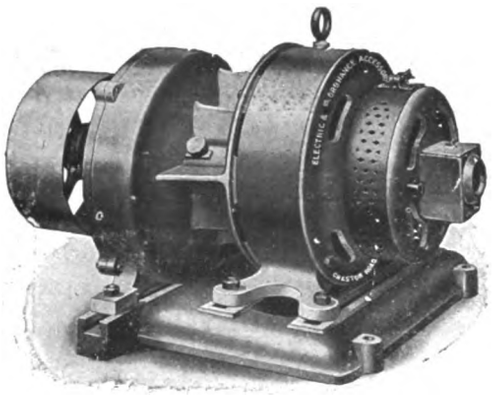

Back geared "VICKERS" Motor. Gearing enclosed.

"VICKERS" Motors in

all sizes up to 50 H.P., with back gear enclosed as illustrated, or of the usual open type.

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Quick Delivery. *Competitive Prices.*

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NEW ACCESSORIES.

An insulated switch lampholder specially designed by Messrs. Siemens Brothers Dynamo Works (Ltd.) to meet the requirements of the Home Office, is shown herewith. It complies in every respect with the regulations governing the use of pendant switch lampholders in factories and workshops (*see* Regulation No. 13, Factory and Workshop Acts). The lampholder consist of a fireproof insulating case enclosing the porcelain interior of a switch lampholder.

The following advantages are claimed by the makers: When the lamp is in place neither the lamp cap nor any metal part of the holder can be touched. The metal shade is insulated from the lampholder, and therefore cannot become charged. The metal pin which passes through the centre of the switch handle is insulated from the current-carrying parts, so that, in the event of this handle becoming broken, it is impossible for anyone to receive a shock. The insulating covers form an integral part of the lampholder, making it impossible for the lampholder to be used if any portion of the protecting devices is omitted. The lampholder is constructed to take the standard size of shade with 1⅛ in. hole.

The essential function of a gallery is to securely hold the glass shade or reflector or pendant or electric light fitting, and it should be of neat appearance and well finished. The new "screwless" gallery has advantages owing to its simplicity of fixing, and it should appeal to contractors. It is specially deep in order to bring metal filament lamps into correct position in the glass shades, and, in the case of stiletto and household holophane reflectors, brings the lamps into the true focus of the glassware. The "screwless" gallery is a brass spinning drilled and slotted to obtain the necessary amount of spring, having a curved lip which just grips the glassware. A ring slides on the outside and this is pulled up whilst the gallery is sprung on to the lip of the glassware; the ring can then be pressed down to ensure security. To release, the ring is simply pushed up and the glass pulled out. Former types of gallery in which screws are employed are often a cause of breakage because the screws hold the reflector too tightly, and the reflectors crack through expansion. It will also be noticed that the "screwless" gallery is well ventilated, and thus the cap end of the lamp is kept cool. Owing to the shape of the gallery itself, the ring cannot be removed except by force, and the gallery may be considered as far as all practical purposes are concerned as a single piece, rendering the loss of parts, so common in ordinary screw galleries, absolutely impossible. Large stocks of these are being held at all the branches of Messrs. Siemens Bros. Dynamo Works (Ltd.), from whom they can be obtained at the price of 6s. per dozen, list.

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For Portable Machines, Lights, &c.

Pamphlets 114, 122, 88 and 45 give all particulars

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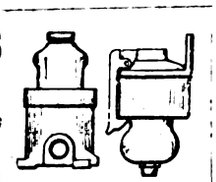

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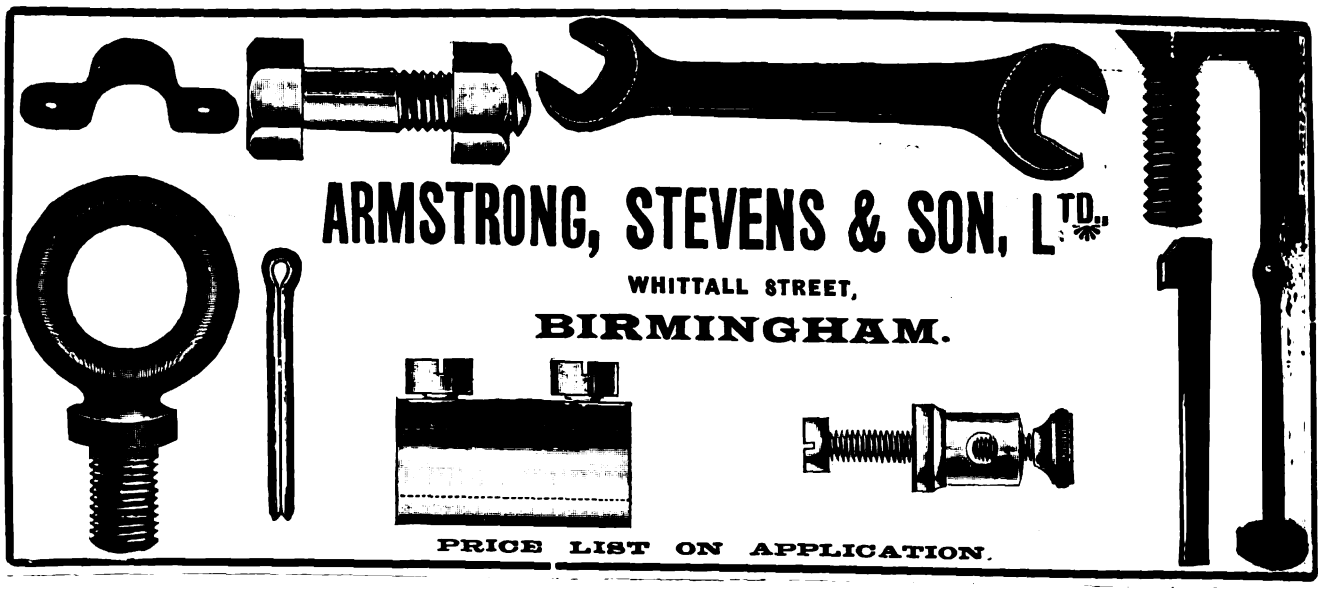

SIMPLEX CORONATION ILLUMINATIONS.

There are many and varied devices in connection with illuminated decorations which will, in some shape or other, be used at the Coronation.

The illumination strip already sold by various makers might probably encompass the world, even a few times.

The general public have just begun to think about how much they will spend on decorations, and from the last week in May to the second in June there will be a big rush of orders, which, we understand, Messrs. Simplex Conduits (Ltd.) will be ready to meet with immediate delivery.

They are putting on the market temporary lighting material in the form of strip lighting following on the usual design which is suitable for festoon purposes and outlining buildings (Fig. 1). The holder consists of a galvanised steel case enclosing the usual form of china interior. This is mounted on an insulating base which forms a batten that may be screwed to the face of the building, so that there is no strain on the wire. The wire is twin 7/22's of a high grade, and the insulating base is treated with black enamel, thus protecting it against the attacks of moisture. The wiring is rendered watertight by bitumen filling.

In addition to the wired illuminating strip, a cheap and effective holder is being introduced; this is illustrated in Fig.2.

The method of wiring is extremely simple; the illustration shows the holder apart. The cap is first fixed by an ordinary wood screw, thus securing the insulating piece of fibre shown. The twin wire is then laid in the two grooves provided in the gap, and the lampholder assembled in the usual way. Instead of having to insert a bight of the wire into the lampholder terminals, as is usual, these terminals are threaded, and a brass screw with a spiked end provided. When the lampholder is in position the screw is turned home so that the sharp end pierces the insulating covering of the wire and makes contact with one of the conductors. The holder is accurately shaped, the wire fills the hole in the case exactly, and a practically watertight joint is made without the use of any filling. It is undoubtedly one of the simplest, and at the same time most effective, types of quick wiring holder on the market we have yet seen.

Suitable grouped designs have also been got out in connection with illuminating devices, and one pattern is illustrated in Fig. 3. It is built of wire and sheet metal, and obviates any special constructional work in fixing to buildings. The letters are made in one size, 36 in. high, and require a total of 50 lamps to illuminate the complete device consisting of G.R. and a crown The reflectors behind the lamps give a pretty effect at night. It is recommended that the lamps be pip obscured, and the reflectors can be painted any colour, in which case it is advisable to lacquer the lamps the same colour.

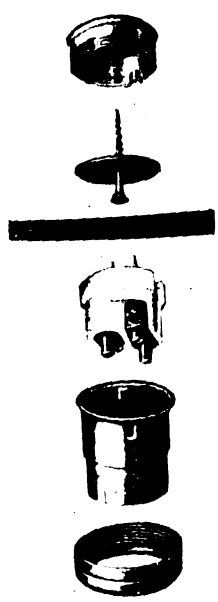

Fig 1.—Simplex Strip Lamp. Fig 2.—Simplex Quick Wire Holder

Simplex Conduits are also introducing illuminated wood letters in various sizes with crowns to match.

For purely decorative purposes, or for use in connection with shade carrier temporary lighting holder, coloured gelatine lanterns are offered. These are in a collapsible form, readily stored or sent through the post, and may be obtained in various colourings as required. With a low candle-power elec-

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Western-Electric TELEPHONES.

WORKS: NORTH WOOLWICH

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tric lamp inside they are very effective. Two sizes are supplied: No. 1 pattern, 4½ in. by 4½ in., and No. 2, 6 in. by 5½ in.

The attention of contractors and station engineers is also directed to Simplex electric signs. These are now well known, and require no further description. They are being fitted with a coloured device representing the King or Queen's head, combining both a day and night effect. These signs are 12 in. in diameter, and the price includes lamp, flexible cord, plug and combination wall plug and lampholder adaptor. The sign may, of course, be subsequently used to advertise tradesmen's own goods at the cost of a few pence for a stencil after use in connection with Coronation illuminations.

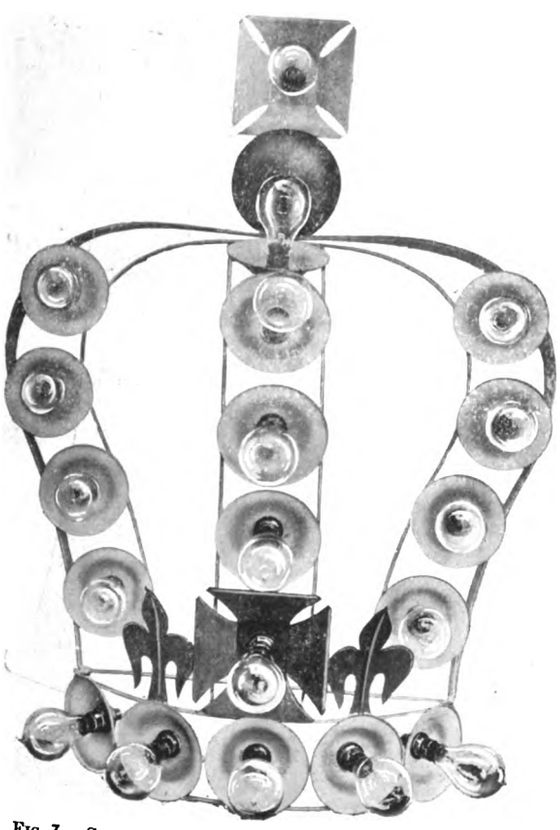

FIG. 3.—SIMPLEX CROWN WITH LAMPS AND REFLECTORS.

The Simplex flagstaff should be very popular among the electrical fraternity. It may be erected or dismantled in a few minutes, and it is not necessary to dig a hole in the ground to secure a firm fixing. It is made up of Simplex steel tubing, and includes lower and top mast, flanged cross trees, rope rigging, truck, flag halliards and Union Jack or Red Ensign. We must congratulate the company on this smart idea.

A NEW AUTOMATIC WATER EJECTOR.

The Ejecta Valve has been designed to overcome the water difficulties encountered in connection with the use of compressed air. It is designed to automatically eject the accumulation of water from the pipe-lines, thereby insuring the delivery of dry air to the machinery which is being operated thereby. The valve is actuated when sufficient water is accumulated in the valve chamber, thereby lifting a float and opening the outlet valve against the pressure of the unbalanced piston. As soon as the water is ejected by the pressure on the line, the float falls and the valve is closed by means of the unbalanced piston, thereby making it impossible for any air to escape after the accumulated water has been discharged.

The advantages claimed for the valve are its automatic action, exceedingly small size (being only 6½ in. × 4½ in. over all) and its light weight; it can be inserted in the pipe line without any special fixing, and is, in consequence, inexpensive to fit. It is constructed of gun-metal throughout, with a copper float, and in such a manner that it can be opened for examination as necessity arises; and its wearing parts are reduced to a minimum. It will work under any pressure without any adjustment whatever. It is already in use on several railways, and we understand is giving every satisfaction. It is made by the Ejecta Valve Co., 110, Cannon-street, E.C.

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STERLING TELEPHONES

The Sterling Telephone & Electric Co., Ltd., 200, Upper Thames Street, London, E.C. Works: Dagenham, Essex.

B.T.H. OIL IMMERSED SWITCHES.

A squirrel-cage induction motor when thrown directly on the line will take a starting current of from 4½ to 7 times full load current, and will develop a starting torque of from full load to 1½ times full load. From these figures it will be seen that on large motors this starting current is excessive, while the torque for most requirements is unnecessarily high.

To reduce this starting current it has been the practice to use an auto-transformer or compensator, or else to bring out six terminals on the motor, so that in starting up the three phases may be connected first in star and then in mesh. The star-mesh switch gives the same results as a relatively expensive compensator with a tap at about 58 per cent. voltage, and the starting current and starting torque are reduced to one-third the value corresponding to full voltage.

Motors with the star-mesh switch will therefore start with about 1¾ times full load current, and give approximately one-half load torque. Hitherto the equipment necessary for controlling a motor started on this principle has consisted of a main switch with a low voltage release, three fuses, a special starting switch, and in some case an ammeter.

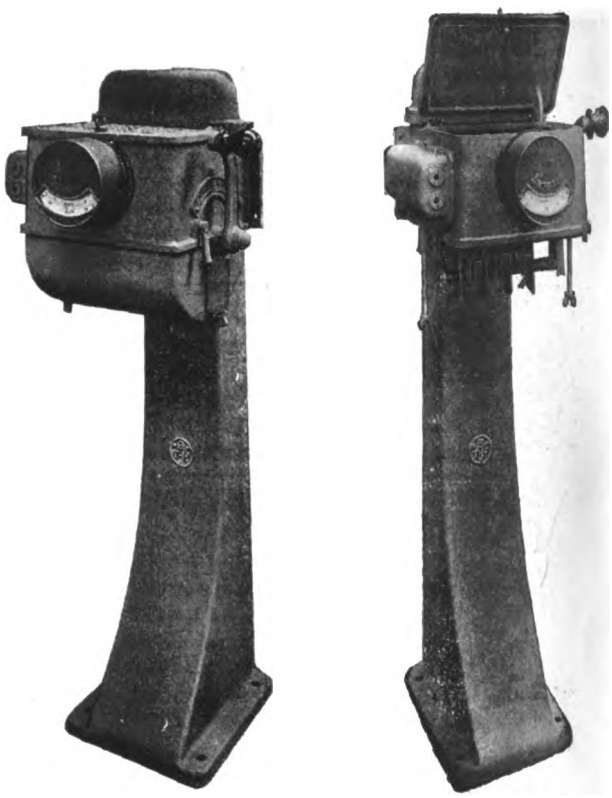
The "O T" switch, made by the B.T.-H., combines in one ironclad unit these devices, and thus provides a maximum of simplicity in the controlling gear as well as in the motor.

All the parts are enclosed in a cast-iron casing, the upper portion of which is fitted with a hinged lid and contains the terminals and fuses; the lower portion is fitted with a semi-circular oil tank which contains the contacts of the oil switch. The joints between the hinged lid and the frame, and between the oil tank and the frame, are so constructed that the whole switch is dust-tight and weather-proof.

All live parts of the switches are of wrought copper. The main blades of the switch are of the lever type, entering U-shaped contacts. Copper beading contacts are provided, so that the circuit is not made or broken on the main contact itself.

The terminals and contacts are mounted on an oiled slate base with a liberal leakage surface between contacts. A removable insulating barrier is provided on the top of the slate base to cover all the terminals, so that there is no possibility of touching live metal when replacing fuses. Punched metal terminals with ⅜ in. diameter tinned holes are provided inside the switch casing, into which the incoming cables may be soldered. If "O T" switches are to be installed in positions where the use of solder is objectionable, they can be furnished with terminals fitted with set screws for clamping the cable. The use of soldered terminals is strongly recommended wherever possible. If clamp terminals are used, they should be carefully tightened up, taped and varnished, both to prevent corrosion at the joint and to provide against the set screws working loose.

The switches are operated by a handle on the right-hand side. This handle is arranged so that when it is in the central position the switch is open; when the handle is pulled towards the operator it is in the starting position, and when it is pushed away from the operator it is in the running position. A quick make-and-break are obtained, and an interlock is provided to prevent the switch being thrown into the running position unless it is first thrown into the starting position. This interlock also ensures the switch being thrown quickly from the starting to the running position.



TWO VIEWS OF THE B.T.-H. OIL IMMERSED SWITCHES.

The switch can be operated with one hand, as the low voltage device is so arranged that it automatically sets itself when current is thrown on to the coil. The fuses can be replaced by opening the hinged lid at the top of the switch. This lid is interlocked with the switch mechanism, so that it cannot be opened unless the switch is in the off position, and when the lid is open, the switch mechanism is interlocked with it, so that the switch cannot be moved from the off position until the lid has been closed. It is, therefore, impossible for an operator to get a shock whilst replacing fuses.

H. WEIDMANN, RAPPERSWIL, SWITZERLAND.

Manufacturer of Presspahn and Insulating Material. Grand Prix: Marseilles, 1908.

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Black Presspahn if specially ordered.

Presspahn Coils and Sheets for Transformers, Armatures, Slots and Moulded Articles.

Varnished Presspahn. Mica-Covered Presspahn, &c.

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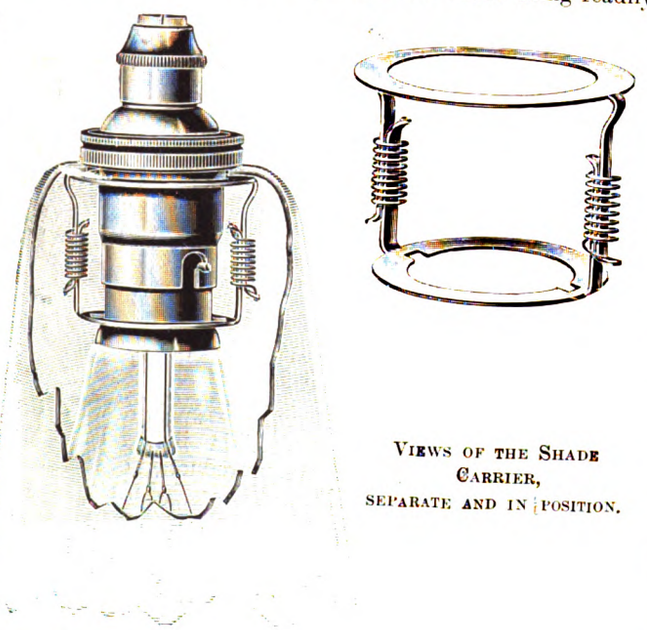
THE ELECTRICIAN COMMERCIAL AND INDUSTRIAL SUPPLEMENT.

C. & I. Supplement No. 83.] MAY 5, 1911. [Gratis to Subscribers.

THE "HILEACH" SHADE CARRIER.

The "Hileach" Patent Shade Carrier is a spring device enabling the shade to be fixed on to lampholder in a remarkably short space of time. It also permits the shade being readily removed for cleaning without unscrewing a shade ring, a necessary operation before the introduction of this ingenious time-saving device. The illustrations show the device itself, and the method of fixing for the shade. There can be nothing more trying than the removal or attachment of an ordinary shade ring, this being the cause of frequent breakages and much spoiling of good temper. The G.E. Co. will supply details of prices.



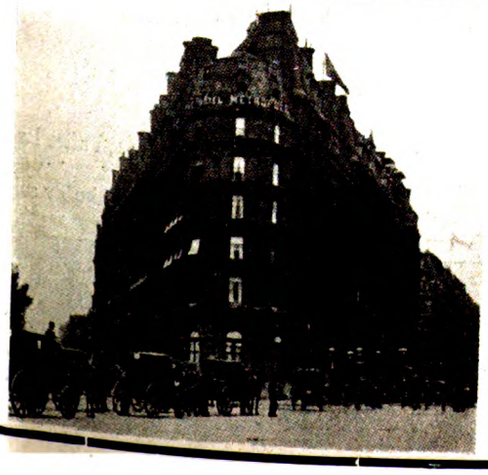
VIEWS OF THE SHADE CARRIER, SEPARATE AND IN POSITION.

"ZED" PROGRESS.

The success of the "Zed" fuses as a reliable protection for electric lighting and power installation is emphasized by a communication to the "Electrical Contractor" from Mr. Sydney W. Baines, which reads as follows:—"With reference to the enclosed fuse regulation, will you please make known to the contractors of the Association the following:—That, provided the fuses are protected in a similar manner to the 'Zed' fuses—with porcelain—and that no metal parts charged with current are exposed, we do not intend requiring any further protection; that is to say, the teak box lined with asbestos will not be asked for."

An extract from Rules reads as follows:—"On and after January 1, 1911, all main fuses should be of the enclosed cartridge type, built up of porcelain."

The essential feature of the "Zed" fuse is the enclosure of all live contacts, and also the complete enclosure in a sealed chamber of the fusible portion. This construction is a safeguard from fire. Some tests recently carried out by the Burma Electric Tramways & Lighting Co., Ltd., of Mandalay, also illustrate the reliability of "Zed" fuses under severe conditions, and their suitability for tramway work. A "Zed" fuse placed in a feeder circuit behaved perfectly whether under a normal overload in actual practice, under a gradually increasing load or under a dead short. These fuses are made by Siemens Bros. Dynamo Works.



THE HOTEL METROPOLE,
LONDON,
illuminated throughout by
OSRAM
LAMPS.
The General Electric Co., Ltd.
Head Office 67, Queen Victoria St., London. E.C.

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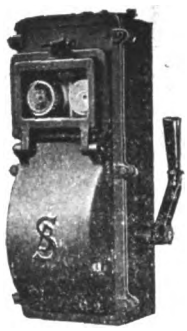
SIEMENS

WEATHER-PROOF SWITCHBOXES



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PRESCOT WELDERS.

The progress made in electric welding has been recorded in these columns from time to time, and we are pleased to note that the Prescot welder is being rapidly developed along practical commercial lines. A pamphlet has just been issued in which new and interesting applications of the Prescot welder are illustrated and described. This pamphlet deals with spot and seam welding. A spot welding machine is suitable for welding together two or more plates of iron or steel ranging in thickness from 0·015 in. or 28 S.W.G. to 0·5 in. or 7 S.W.G. The electrodes in the welder are water-cooled, and in the general construction of the machine the operator is safe-guarded from shock.

The general appearance of a spot welding machine at work is illustrated in Fig. 1. This also shows the great variety of

FIG. 1.—PRESCOT SPOT WELDER.

metal utensils and other articles to the assembly of which the welder can be applied. Fig. 2 is a striking illustration of the strength of spot welding. This is a reproduction of some test pieces from Lloyds' proving house. The welded plates shown have been forced apart when cold with a hammer and chisel.

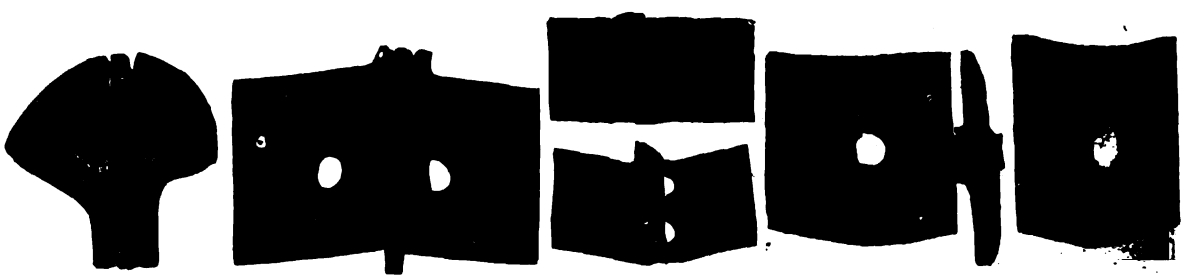

FIG. 2.—EXAMPLES OF PRESCOT SPOT WELDS AFTER OPENING WHEN COLD.

The mechanical effect of the weld is equivalent to that of rivetting. The diameter of the spots will vary from $\frac{1}{8}$ in. to $\frac{1}{2}$ in., according to the gauge of the plate. One phase A.C. current is employed, and if a D.C. or polyphase supply are available they must be converted to one-phase. Standard Prescot welders are wound for 200 volts 50 periods. We understand that the energy consumption is very low; 1,000 $\frac{1}{8}$ in. diameter welds can be made on 28 S.W.G. plate with an energy consumption of $\frac{3}{4}$ unit. In 7 S.W.G. plate 1,000 $\frac{1}{2}$ in. welds can be made with an energy consumption of 70 units. It will be seen that the separation was only effected after large holes had been torn in one or other of the plates.

For seam welding the Prescot welder is also admirably suit-

OSRAM-LAMPS

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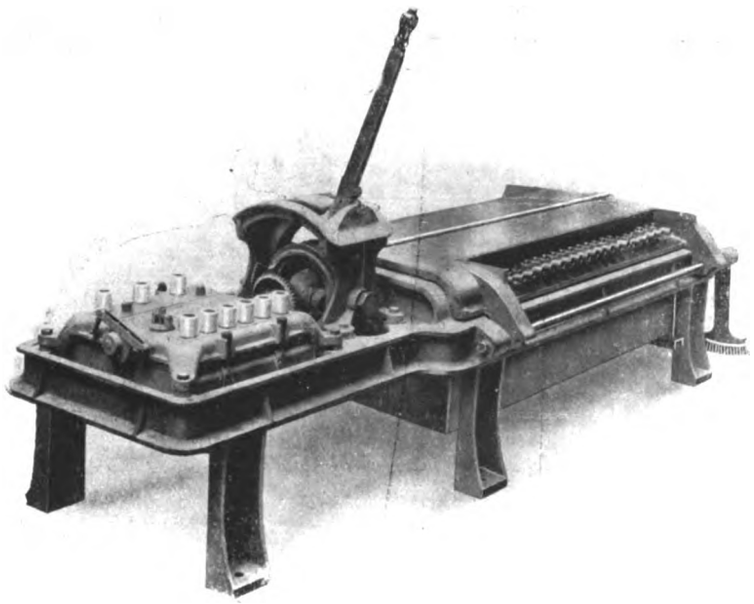

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able. In this process thin plates of wrought iron or mild steel are welded along the edge by a continuous lap weld. Scale and rust are removed because these offer a high resistance to the passage of current. Sand blasting or rotary cleaners must be used to clean the edges of the plate. Plates of 28 S.W.G. and up to 10 S.W.G. gauge can be successfully seam welded at the rate of 1 ft. in 1½ minutes with an energy consumption of 0·2 to 0·3 unit per foot. Fig. 3 shows one pattern of Prescot seam welder which has been adapted from spot welding by replacing the electrode with a pair of rollers. The machine is intended for short welds such as small jugs or for fixing the spouts to jugs. The rollers are closed by a foot pedal, and the top roller can be rotated by hand through a ratchet gear, while the bottom roller is carried round by friction. Cylinders and cones can be successfully welded, and there are also machines for lap welding mild steel tapes such as are used for cable armour and also for the welding of the ends of band saws. The Prescot welder is made by the British Insulated & Helsby Cables, and the booklet referred to above can be obtained from them on application.

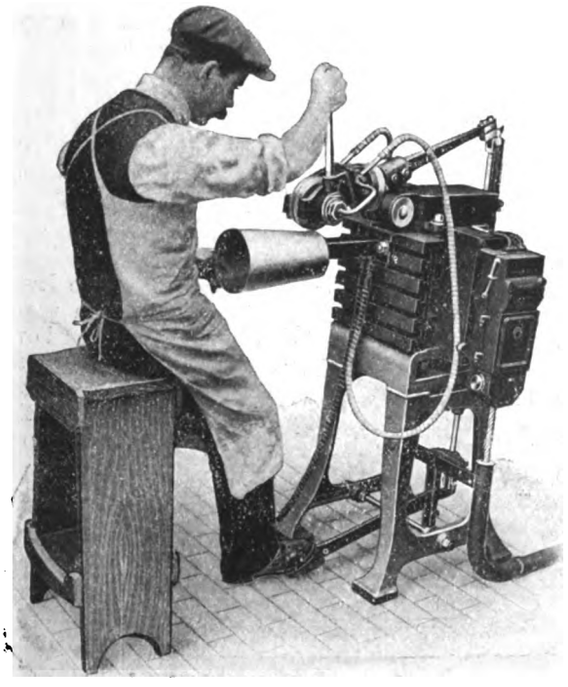

FIG. 3.—PRESCOT SEAM WELDER.

ADAMS DIMMERS.

The dimmer is now universally employed for theatre stage lighting, and it is interesting to note how the metallic dimmer has gradually taken the place of the liquid dimmer. This fact is emphasised in a pamphlet just issued by the Adams Mfg. Co., in which they compare their Igranic metallic dimmer with the liquid dimmer, in opposite columns. On the points of safety construction, size, interlocking, upkeep, installation and lighting effects they make out a good case for the metallic dimmer. This is practically iron clad, and it can be installed to occupy a minimum of space both in regard to the moving contacts and the arrangement of the connecting cables. The resistances are enamel embedded, and they can be divided into a large number of steps so as to obtain almost imperceptible degrees of change in the strength of the light. The resistance is practically fireproof, so that it can be installed close to the operator without danger. The booklet is interesting from a comparative point of view, and should be in the hands of every theatre manager.

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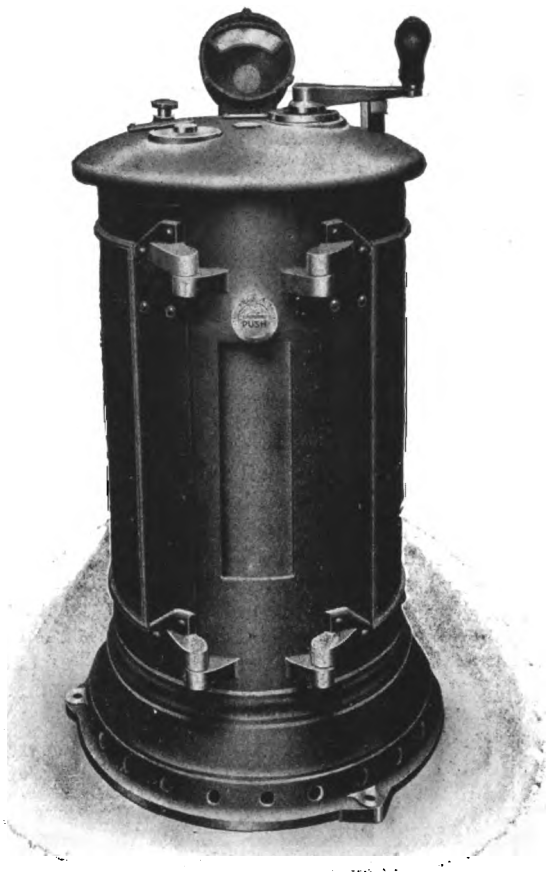
THE "EOA" CONTROL PILLAR.

Motor control panels do not always prove satisfactory in actual practice where the service is at all severe. For certain duties the flat type of starter has been replaced by the barrel or drum type controller, owing to the unreliability of the former on heavy duties. The "EOA" control pillar has been designed as a substitute for the ordinary motor control panel. It contains the necessary apparatus for starting, regulating and protecting the motor against overload and interruption of the supply. It consists of: (1) D.P. overload and no-voltage circuit-breaker, (2) drum type starter, (3) shunt regulator for variable speed motors, (4) resistances for starter and shunt regulator, (5) D.P. switch fuses, all enclosed in a weather-proof case and operated by one handle.

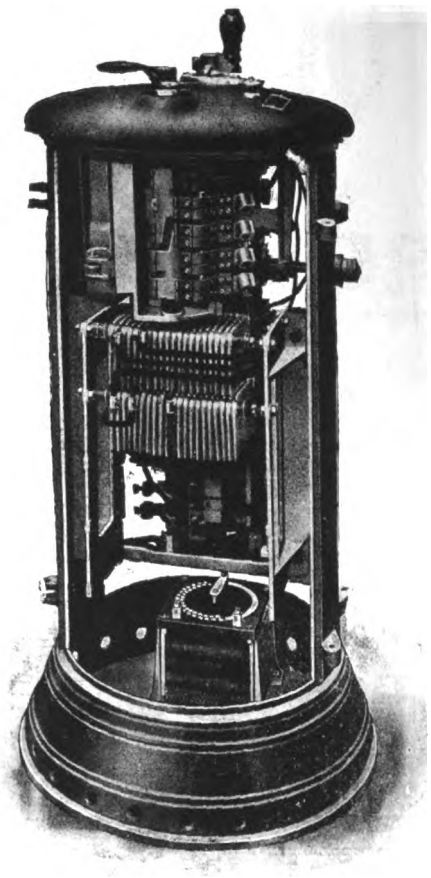
It is specially suitable for the control of motors operating printing presses, calendering machines, machine tools, or any machines which require to be frequently started and stopped. Where necessary, it can be arranged to release the circuit-breaker, and so stop the motor from distant points by means of push buttons, as is required for printing presses, &c. In starting, the press button on top-plate is pushed down and held down while handle is moved slowly to the running position. Should the button be released before this position is reached, the circuit-breaker will open, but after this point, and when



"EOA" Control Pillar, closed.

returning handle to "off" position, the button need not be touched. Further movement of the handle, after reaching the running position, inserts resistance in the shunt field, and speeds up the motor. The control pillar is fool-proof, and any attempt to open the doors while the motor is running releases the breaker and stops the motor.

The barrel consists of cast-iron spiders mounted on but insulated from a steel spindle. A ball thrust bearing is provided, which takes the weight of the barrel, thus ensuring ease of operation and preventing wear of the seating which would otherwise cause the contacts to get out of alignment with the fingers. The contacts are of hard-drawn copper, screwed to the barrel, and easily and cheaply replaced. The fingers are of hard-drawn copper, carried by laminated steel springs and connected to the terminals by flexible copper leads. The springs carry practically no current, and consequently retain their elasticity, even after heavy overloads. These springs are fixed to brass finger brackets, which are insulated from the finger bar by mica.



The "EOA" Control Pillar, open, showing Starting Resistance and Shunt Regulator.

A double-pole circuit-breaker is provided and is fitted with both overload and no-voltage releases. It is so interlocked with the main barrel that when it is opened the starting barrel has to be brought to the "off" position before the motor can be re-started. The starting resistance is contained in the same carcase. The standard resistance is one-minute rated, and is for starting only. A push button is fitted for stopping the motor at any position of the starting handle. This push button releases the no-voltage coil, and then mechanically operates the circuit-breaker, so that, should the latter tend to stick, it is forced open. The control pillar can be made reversible, the reversing barrel being operated by a separate lever. This reversing barrel is, however, interlocked with the starting barrel so that the connections can only be changed over when the starting handle is in the "off" position. A shunt regulator can be provided in the same case, and, being operated by the same handle as the starting barrel, all possibility of the motor being started under light field is avoided. Double-pole fuses are fitted inside the carcase. The pillar is of substantial construction throughout, and contains no wood or other combustible material. The "EOA" pillar is made in four sizes to deal with motors ranging from 5 to 150 H.P., there being three voltages per size of 115, 230 and 460 volts.

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Will the suggested lunar-tidal electric power scheme prove ultimately to be all moonshine?

Will the new Thames auto-tumbler successfully walk the tight-rope of competition?

AN ANSWERED QUERY.

In our issue of December 30, 1910, we asked: "Will Mr. Ferranti again occupy the Presidential Chair of the Inst.E.E.? If not why not?" Enough said.

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Presspahn and Insulating Material.
(See larger Advt. last week.)

WESTINGHOUSE LOOM MOTORS.

Considerable interest has been taken recently in the individual driving of looms by small electric motors specially designed for high efficiency. Some few months ago, the British Westinghouse Co. secured an order for the equipment of a weaving shed on these lines from Messrs. Edward Hibbert & Co., of Hyde, through their consulting engineer, Mr. Robert Blackmore, of Stalybridge. This installation is now at work, and we understand that the looms are running much quicker and steadier than they did under the ordinary system, and the operatives are well satisfied with the alteration. The motors are so arranged as to use a short belt, and the drive ensures smoothness of running and prevents slips.

ALLEN WEST CONTROLLERS.

A large variety of switchgear in the shape of motor starters, controllers and resistance grids is made by Allen West & Co., Lewes-road, Brighton. In a new pamphlet and folder which the firm has just issued are to be found a number of illustrated particulars of these devices. Among these we notice a self-aligning fuse which has sundry novel features. The fixed contact jaws for the fuse are of the rigid type, and the contacts in the ends of the porcelain handle are capable of adjusting themselves to the surfaces of the fixed contacts. There is ample ventilation provided by the use of a hard asbestos tube and this ensures that the handle will always remain cool under working conditions. There is no expansion of the fuse contacts, so that the porcelain will not burst, as frequently happens when cemented ends are employed. The list referred to also contains details of an interesting line of liquid controllers and drum type controllers, the latter for crane service. The list has been well arranged and is carefully printed.

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STERLING TELEPHONES
The Sterling Telephone & Electric Co., Ltd., 200, Upper Thames Street, London, E.C. Works: Dagenham, Essex.

IMPROVED TESTING SETS.

Users of multi-range instruments will have experienced the difficulty of ensuring that the winding is not "burnt out" through the application of a high pressure to one of the lower ranges of the instrument. A fruitful source of danger in this respect lies in the plug and socket arrangement frequently employed as a means of changing from one range to another. Even with the arrangement formerly adopted by Messrs. Everett, Edgcumbe & Co., namely, to provide a separate ebonite cover terminal for each range, whereby the risk was minimised, there was always a chance that accidental contact might be made with the wrong terminal.

In their latest sets, herewith illustrated, this danger has been eliminated by the provision of a circular switch, and any required range can be instantly selected. Moreover, this switch is so arranged that it has always to be brought back to the position corresponding with the highest range before the case of the instrument can be closed. By this means it is ensured that the highest range is the one left in circuit and a "burn out" is almost impossible.

FIG. 1.—MODEL 1, COMBINED INSTRUMENT.

Figs. 1, 2 and 3 show three distinct types of testing sets, the first being known as Model 1, which consists of two moving coil instruments, an ammeter and a voltmeter, each provided with a number of ranges. Model 2. (Fig. 2) consists of a single instrument fitted with a change-over switch, by which it can be instantly used either as a voltmeter or an ammeter, as may be required. This change-over is accompanied by an ingenious switch, which is entirely contained within the instrument, and is actuated by two ebonite knobs marked in "amperes" and "volts" respectively. The exposed switches so often provided for the purpose of changing from the current to the pressure measurements, and vice versa, are a source of constant danger, and should certainly never be used by any unskilled person. Model 3 (Fig. 3) consists, as will be seen, of two distinct instruments in one case, and is of Messrs. Everett, Edgcumbe & Co.'s "Universal" pattern of moving iron.

One of the main features of these instruments is that for alternating-current work the indications are entirely unaffected by change of frequency and, which is often quite as important, of wave form also; as a consequence the same instrument can at any time be used with very fair accuracy for continuous-current measurements, should this be desired.

FIG. 2.—MODEL 2, SINGLE INSTRUMENT WITH CHANGE OVER SWITCH.

The dimensions of these instruments, complete with current shunts and pressure resistances, are as follows:—Model 1, $13 \times 8\frac{1}{4} \times 5\frac{1}{2}$ in.; model 2, $8 \times 7 \times 5\frac{1}{4}$ in.; model 3, $13 \times 8\frac{1}{4}$ [illegible]. All three are provided with the above-mentioned multi-range switches for changing the pressure ranges. This makes them practically "fool-proof."

As the result of experience with various forms of finish for cases, Messrs. Everett, Edgcumbe & Co. have adopted the practical course of having the instruments in plain unpolished light oak cases.

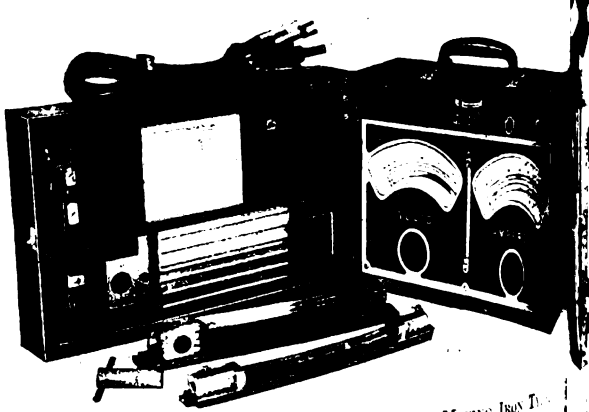

FIG. 3.—MODEL 3, COMBINED INSTRUMENT, MOVING IRON TYPE.

Of the various other features possessed by these instruments we need hardly speak, as they are already well known to engineers. Each instrument is provided with an external zero adjustment, with rubber shock absorbers, with knife edge pointers and anti-parallax mirrors, and last, but by no means least, with an efficient damping arrangement.

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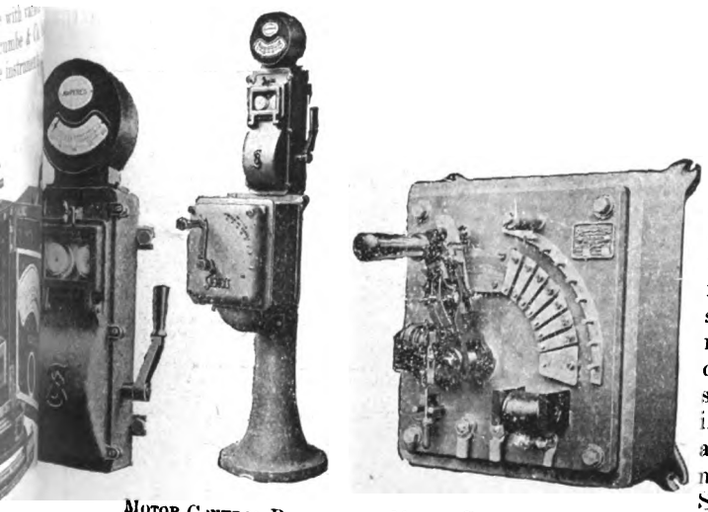
SWITCHBOXES AND MOTOR CONTROL PANELS.

We illustrate herewith some compact types of switchboxes and motor control panels. The former will be seen to consist of a cast-iron case and contain a double or triple-pole switch and cartridge fuses, mounted on porcelain. An ammeter



Motor Control Panels and Motor Starter.

can be supplied, if desired, mounted on the top of the case. All joints are made so that the box is completely weatherproof and the complete apparatus is solid in construction. The window for the fuses is hinged and is so interlocked in the 100-ampere size, and above, that it cannot be opened whilst the switch is closed and, conversely, the switch cannot be closed while the window is open. The fuses are of the now well-known "Zed" type, provided with an indicating device which shows at a glance when a fuse has blown. All live parts are completely enclosed, making it impossible to receive a shock accidentally when replacing a cartridge and no "arcing" or "flashing" occurs when a fuse burns out.

The switch has a quick-break action and each pole is mounted on a separate porcelain. The boxes are so arranged that 2, 4 or 6 cables can be led into the box from above or below, except when an ammeter is used, in which case only two cables can be led in from the top. The boxes are stocked undrilled and are drilled to suit customers' requirements and cable glands and packing can be supplied.

In the motor starters the contacts are renewable and of ample area and cross section, and overload and no-voltage release are fitted. The centre spindle is provided with a ratchet and the overload release with a pawl, and these two come into operation if the motor is switched on too rapidly, and prevent further movement of the brush. A patent step-by-step slow motion gear can be fitted to these starters. In this gear the switch is moved sharply from one contact to the next, but retained at each step for a short time to enable the motor to come up to speed. The advantages of such a device as this scarcely need to be pointed out. This gear is shown in the illustration. The motor control panels, mentioned above, are a combination of the switchbox and starter already described, mounted on a cast-iron pillar. These controllers are made by Siemens Bros. Dynamo Works, who specialise in motor-control gear of every description.

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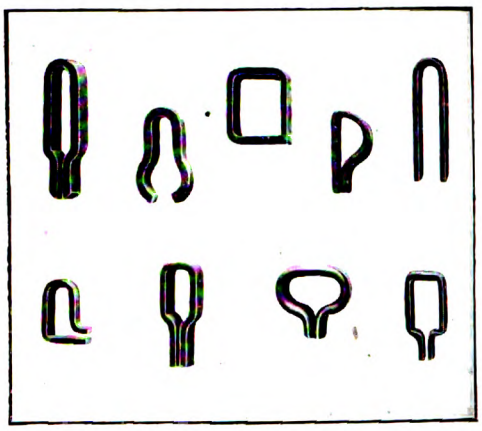

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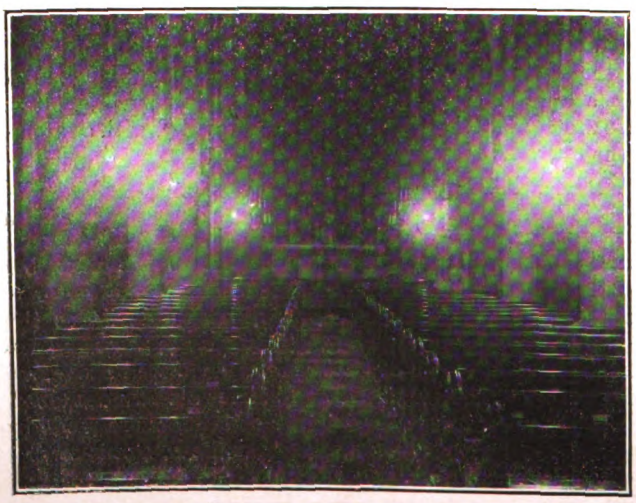
MORE TANTALITING.

We reproduce two untouched photographs illustrating the interior of a church illuminated by gas and electricity respectively. The clear outline of the architectural details of the church interior is a testimony to the efficiency of the electric lighting which was, in this case, accomplished by Siemens "Onewatt" lamps. Apart from the fact of a better illumination, the actual lighting bill has been considerably less than with gas, whilst money will be saved in the cost of redecoration and cleaning. These advantages, together with the fact that the initial cost of high candle-power "Onewatt" lamps is now lower, should encourage similar installations.

Messrs. Siemens Bros. Dynamo Works (Ltd.) inform us that they are now placing upon the market a further range of "Tantalum" candle lamps. Hitherto these lamps have not been supplied in higher voltages than 60, in 5 and 10 c.p. sizes, but the new types will be supplied in 10 and 16 c.p. for 70 to 120 volt circuits. The filaments will be of drawn tantalum and the efficiency will be precisely the same as that of the ordinary "Tantalum" lamps at present on the market. These lamps will be listed at the price of 2s. 9d. each, and it is anticipated that there will be a large demand for series burning candelabra fittings on high voltage circuits. The lamps are approximately 5 in. long and $1\frac{7}{8}$ in. in diameter.



CHURCH LIGHTING BY GAS.

CHURCH LIGHTING BY "ONEWATT" LAMPS.

Printed and Published by GEORGE TUCKER, at the Editorial, Printing and Publishing Offices, 1, 2 and 3, SALISBURY COURT, FLEET STREET, in the City of LONDON, FRIDAY, MAY 5, 1911.

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THE ELECTRICIAN COMMERCIAL AND INDUSTRIAL SUPPLEMENT.

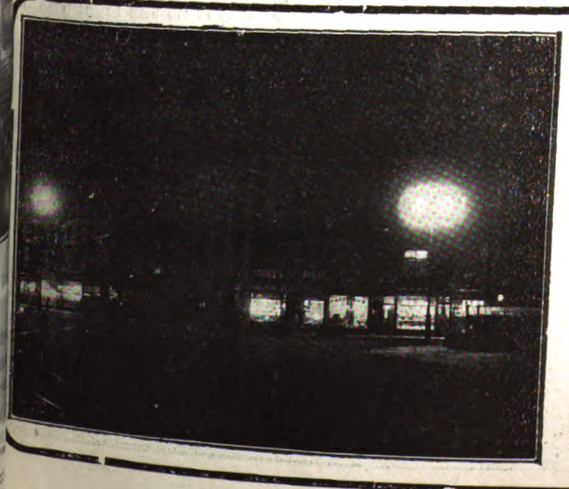
C. & I. Supplement No. 84.] MAY 12, 1911. [Gratis to Subscribers.

MINE SIGNALLING AND TELEPHONY.

Amongst the accessories of general interest particular to mining work should certainly be mentioned telephones, bells, signalling keys, relays, generators and exploders. In the latest types of mining telephones the care is of cast iron and carries the watertight receiver, induction coil, and spring jacks, mounted securely on it, while the cast cover, with the speaking transmitter fitted to it, is secured to the base by means of set screws. The cover is recessed for fitting to the case, and the whole station is made gas and waterproof by means of a packing cord soaked in paraffin wax fitted into the recess in the cover.

On the left of the case is the ear-piece for the listener, attached to the case by a length of flexible metal tubing, which, whilst adding to the comfort of the operator when listening, still conforms to the necessary substantial character of the station. On the right is the ringing and speaking key used by the operator, which, passing through the case, operates the necessary springs for the ringing and speaking connections, and is kept watertight by means of a packing gland and socket. In an installation using this type of instrument, the main or central set, including the calling indicator and central battery, would be fitted at the pit head, whilst other sets would be fitted at the different galleries or working levels. The indicator box consists of a cast-iron case carrying the apparatus, and the cover carrying the three indicators and three bells. The indicator box is fitted with three visual indicators and bells, so that while the main set is speaking to another set the remaining stations can ring up and draw attention at the main set without interrupting the conversation. Connections to the indicator and terminal box are brought through packing glands at the bottom, so that the whole set can be kept watertight. Each of these stations is fitted with a signalling bell, and terminals are provided for an extension bell to be fitted away from the station should it be required. A station of similar design, but fitted with hand generator for magneto working, can be used equally well if desired.

Mention may now be made of an installation for an alarm circuit for a constant water supply, or to show the fall of water in a working. It comprises a watertight key with a water buoy attachment, and alarm bell of the watertight iron bell type, together with a relay and necessary battery. Upon the water falling, the buoy falls and operates the pull, connecting the circuit through the bell and battery, when the alarm bell rings. The attendant's attention is drawn to the fact of low water level, and he presses a key which breaks the bell circuit and puts the battery through a relay until the water rises, when the relay armature is released and the apparatus is re-set. A more elaborate system of signalling may be used when it is required to maintain a constant level, or to signal when a rise or fall takes place. A double battery is essential in this case, and is connected up, as shown, with an additional polarised indicator, in circuit, the mining pull being also fitted with Morse contacts. Upon the water level rising, the alarm circuit is completed and the bell rings, whilst at the same time the coils of the indicator are energised by the current in a forward direction, and the armature is attracted so that the indicator registers a high level. For a fall in the water level the current through the indicator is reversed, and a low level indication is made. The alarm and restoring is done in a similar manner



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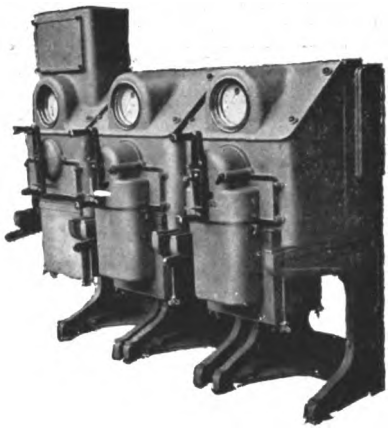
SIEMENS

MINING SWITCHGEAR



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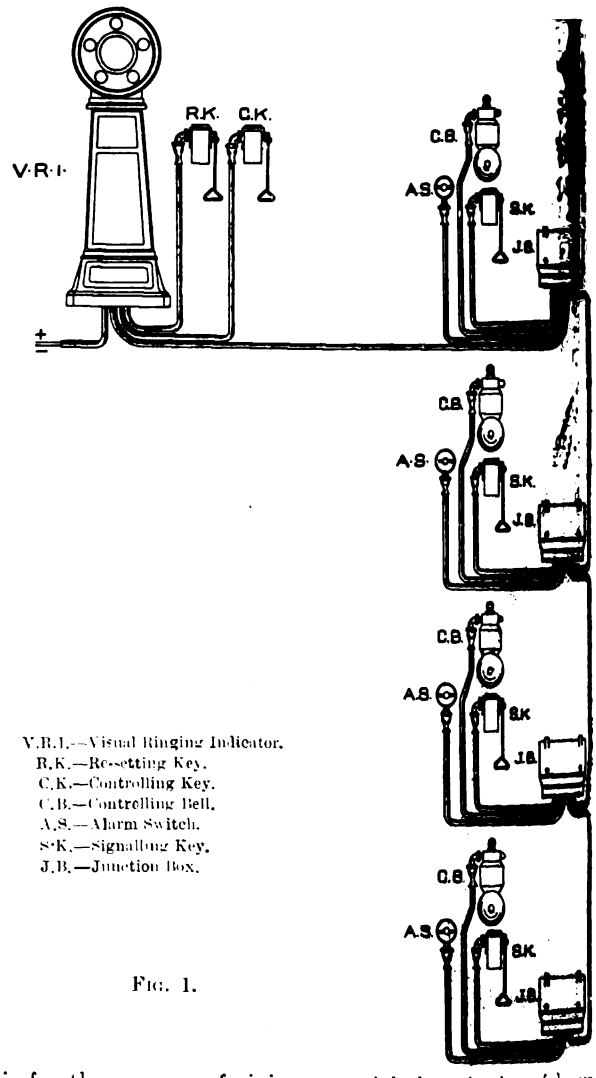
as in the first instance. Installations of a similar nature can be designed and carried out to suit individual requirements for any type of work requiring constant supervision of the water supply, and will be found a great advantage owing to their low cost and certainty of action.

One of the latest types of signalling installations for a mine winding gear, with visual and oral signals, is shown in Fig. 1. The main set—at the pit head, for example—consists of two watertight keys, together with a large pedestal indicator, whilst the bank and different levels are each equipped with one watertight iron bell with single stroke action, one mining pull, one simple alarm switch, and a junction box of simple pattern but of watertight construction. This system is purely a signal system with code ringing for the signals, the signals from any one station being heard at all the others, as the bells are connected in series. Should an operator at one level desire to signal the winding room and bank, he simply pulls his mining key, and at each pull the bell gives one stroke; the operator can thus give the code ring he desires, and this is transmitted to all the other stations, so that they know according to the code who is speaking and what is wanted, and do not interfere until the line is clear. These signals are transmitted to the winding room pedestal indicator, and here the bell moves in unison, thus giving the oral signal required. The indicator has a face like a clock, with a large centre and five small circles outside, each with a lamp behind, one for each outside set of apparatus—that is, each level and bank. Immediately the level rings up, besides the bell ringing, the particular small lamp for that level lights up as well, whilst the centre of the indicator is also illuminated. The lamps remain alight, and as the level rings the code, so for each ring, the mechanism of the indicator causes a dash to appear on the centre face of the indicator; thus for three short rings three short dashes are obtained, and for three long rings three long dashes, these dashes remaining upon the face of the indicator whose face is lighted by the lamp behind, thus giving a certain index of what calls have been transmitted, until the operator in the winding room answers the call, whilst at the same time the small indicator lamp round the face shows the origin of the call. The winding room then answers by ringing back the same call on their mining pull, and this answer is transmitted back to all stations. The calling station then signals his call as correct, and the winding room re-sets the indicator by simply pulling his re-setting key RK, which breaks the relay circuits that keep the lamps glowing, and the lamps in consequence go out. Thus the operator in the winding room gets the signals from the bell and also sees them down in black and white, whilst the levels know they are not being attended to unless they get their ring back again, when they give the "all right" signal and everything proceeds. By this means it is claimed to be practically impossible for mistakes and accidents to occur, and the indicator system speaks for itself as regards utility and certainty of operation. The additional alarm switch provided at each level



V.R.I.—Visual Ringing Indicator.
R.K.—Re-setting Key.
C.K.—Controlling Key.
C.B.—Controlling Bell.
A.S.—Alarm Switch.
S.K.—Signalling Key.
J.B.—Junction Box.

FIG. 1.

is for the purpose of giving a special alarm in time of danger, and is simply switched over by the operator at the level before he rings, when a special danger lamp, A, in addition to the other lamps, lights up on the face of the indicator, and the signals then appear in the ordinary way. The diagram of connections for this system of signalling is shown in Fig. 2.

Another very useful piece of apparatus for mining work is the mining exploder. It consists of a small hand generator in a portable case, and is fitted with two line terminals, the generators being made in three different sizes. A bell for use in conjunction with this set, or for working direct from alternate current mains, is the polarised bell. It is of similar design to

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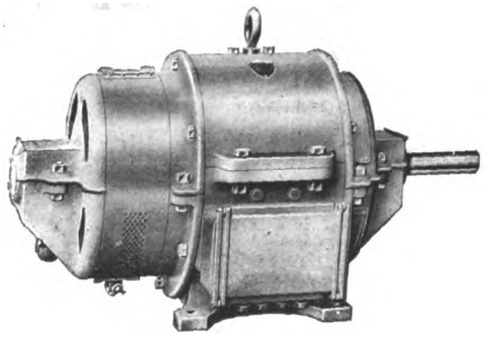
ALL SIZES UP TO 50 H.P.



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the watertight bell, but has in addition an extra gong and the permanent magnet surrounding the coils. These bells give a loud and powerful ring, and are perfectly gas and watertight.

To mine owners, inspectors and others interested in the subject, the International Electric Co., whom we have to thank for the above information, will be very pleased to forward a copy of their latest catalogue, showing the prices of the apparatus described in this article, and giving much more in addition of interest to the mining and electrical engineer.

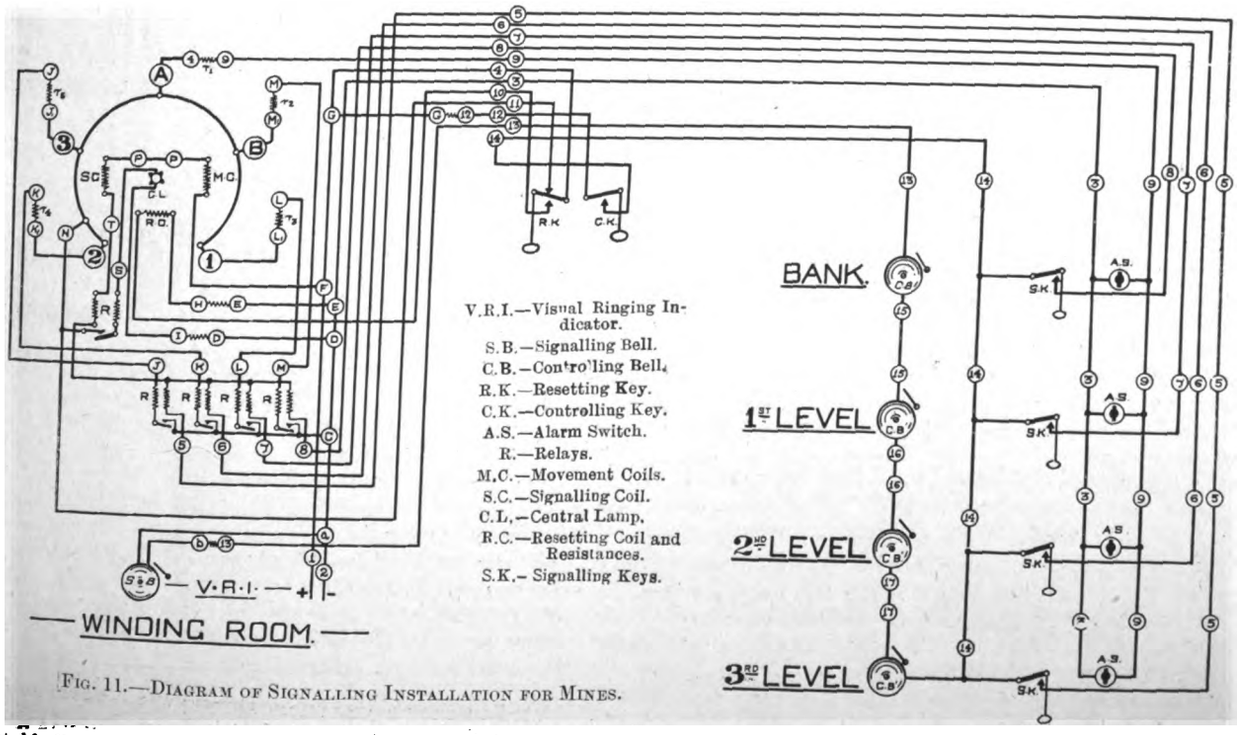

FIG. 11.—DIAGRAM OF SIGNALLING INSTALLATION FOR MINES.

A portable line tester much appreciated for mining purposes is supplied with satchel and strap, and will be found very useful for testing lines.

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A USEFUL MINING SWITCHGEAR PUBLICATION.

Many manufacturers fail to take advantage of the opportunity which is frequently presented to them of making the publications describing their standard products of permanent value and utility. A publication just issued by the British Westinghouse Co. is noteworthy as an example of how attention can be directed to the latest products of a company, while at the same time a quantity of useful information is also supplied. The publication in question is entitled "Electricity in Mines," and it is mainly devoted to the Report of the Committee re Electricity in Mines, the proposed new special rules, the proposed official notification forms, and the memorandum of the Committee on the proposed new rules. As a supplement to this matter there are 16 pages of carefully prepared and well illustrated descriptions of the latest pattern of Westinghouse switchgear for mine service. The articles in our Special Mining Section this week will be found to contain some account of this new switchgear, but limitations of space quite naturally prevent us going as fully into the subject as does the pamphlet before us. At the same time, the issue of the publication at the present moment, coinciding as it does with our Special Mining Number, will certainly increase the interest which must attach to its perusal. We can only recommend every mining electrical engineer who has not already received a copy of this interesting piece of literature to make application to the company for the same.

NICLAUSSE AUTOMATIC STOKERS.

In a previous issue we published some particulars of the Niclausse boiler. We now gather that the British Niclausse Boiler Co. have ready a catalogue describing their automatic mechanical stoker. The elements of this stoker consist of two steel plates or bearers about 8 ft. long, bolted together at the end with distance pieces, leaving an inch wide channel between the two plates. Each element carries a number of cast-iron stepped firebars about 6 in. wide. The tang of the bars is inserted in the groove between the two plates, and they are kept in position by toggle joints. The grate is built up of a number of these elements, according to the width desired, and sufficient space is left for air passages without fouling; the elements are set with an inclination of about 9 deg. to the horizontal. The elements rest on small rollers at the front and back, and are reciprocated by cams on a shaft placed at the front outside the boiler. Each element is reciprocated alternately, and every few seconds all the elements are simultaneously moved from front to back. This action mixes the fuel, spreads it evenly over the grate, prevents air holes, detaches the clinker and works the burnt products to the back of the grate.

The main frame of the stoker is independent of the boiler, and it may be withdrawn so as to leave a space under the tubes for the inspection of the brickwork.

The fire bars at the front of the grate do not admit any air, and act as a dead plate. The next set of bars forward are of extra hard cast iron, and have air passages between them. They are short in length and the upper faces are stepped. Only a small surface of the bar is in actual contact with the fire, but there is a large surface exposed to the cool air ascending from the ashpit. This prevents burning of the bars and ensures against the formation of clinker.

Natural, induced or forced draught can be used with this stoker, but the latter is preferable, because combustion can be made independent of atmospheric influences, the flues or the height of the chimney.

THE FOSTER DIMMER.

Some weeks ago we asked in our query column what the name of the next dimmer switch would be. The title above supplies the answer. The switch is made by the Foster Engineering Co. in two types, one for direct-current and the other for alternating-current circuits. The switch is specially recommended for use in connection with metal lamps, and the following table shows the current economy at various positions of the switch :—

Stop.	Per cent. saving.	Watts used.
1	Full on	200·0
2	16·0	168·0
3	48·5	103·0
4	82·0	36·0
5	95·8	8·4
6	97·8	4·4

The switch is connected to a variable choke coil, from which a number of tappings are brought out to the contacts of a multipoint switch. The apparatus is enclosed in an iron cover and occupies a minimum of space.

A CROMPTON CONVERSAZIONE.

A pleasant evening was spent last Friday by the members of the Arc Works Engineering Society, Chelmsford. Col. R. E. Crompton, C.B., was in the chair, and a good programme of music and song was gone through. The Colonel presented prizes to both the pupils and apprentices for Papers read during the session. They were all of equal value and presented by Crompton & Co. The recipients were (pupils) E. A. Boyd for a Paper on "Synchronous and Asynchronous Converting Machinery," and Lieut. Mehmed Ichssan, of the Turkish Navy, for "Oil Fuel for Marine Use": the lieutenant is evidently a popular man judging by the ovation he received. The apprentices were E. Hughes ("Electricity as a Motive Power in Coal Mines"), and S. P. Trounson ("Gold Mining on the Rand"). In handing the prizes to the above gentlemen the Colonel addressed a few appropriate words to each.

The entertainment was contributed mainly by the Works staff, and included quartettes by Messrs. Parker, Brown, Auger and Gainsborough; the last-named also rendered several songs with effect. Mr. G. L. Williamson has considerable command of the 'cello and Mr. C. Lucy was in form as a dramatic reciter; Mr. Phillips was the humorous songster of the evening, and had to respond to repeated calls, and Mr. W. G. Smith, in addition to presiding at the piano, displayed his ability as an accomplished pianist. The party included a number of visitors from London, of whom Mr. T. E. Gatehouse contributed to the programme. During the interval an inspection was made of a number of electrical experiments set out by the students.

We had the pleasure of attending at this delightful fete gathering of Cromptonians, and while in Chelmsford had an

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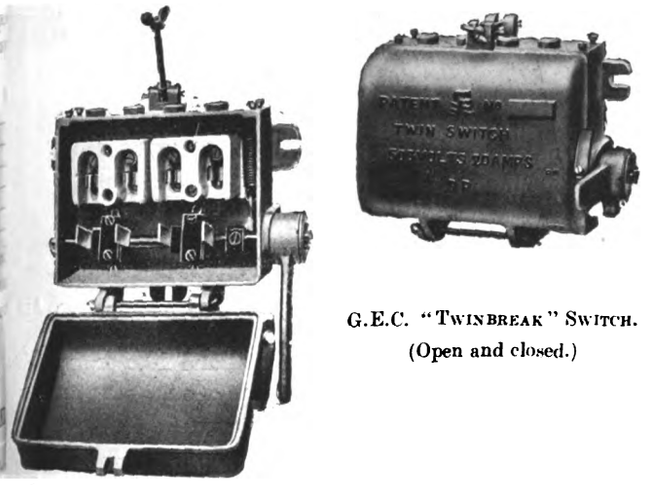
opportunity of a walk through the shops with Mr. Macfarlane, the genial co-designer, with Mr. Burge, of the now well-known C.M.B. converter. The dynamo shops showed signs of plenty of work in both a.c. and d.c. machines. Mr. Macfarlane pointed out what an influence efficient ventilation had had on the size of modern dynamo electric plant, and in particular, with the up-to-date Crompton machines. We were particularly struck by the extremely small diameter of the armatures for quite large outputs, these looking almost ridiculously small by the side of the old medium-speed dynamos which furnish power for the driving and lighting of Arc works. By the use of thinner core plates and by adopting what is known as the "up and down" placing of the plates, this being simply the use of adjacent plates of slightly different diameter, a greater radiation surface for the heat is obtained. The ends of the windings also admit of the free passage of air between them from the interior of the armature.

"TWINBREAK" IRONCLAD SWITCH.

In this switch both contacts and poles open and close simultaneously, thus meeting a demand for an ironclad switch in which the hinge does not form one contact, but in which two separate breaks per pole are used. The break is long and the contacts are entirely surrounded by porcelain, making a short circuit between opposite poles practically impossible. Mica



G.E.C. "TWINBREAK" SWITCH.
(Open and closed.)

under compression is used as insulation between the metal parts carrying current and earth. The switch complies with the Home Office Regulations as to earthing terminals for the case, and an indicator is provided for denoting whether the switch is open or closed. It is impossible to only partially open the switch, whilst at the same time, the case cannot be opened until the switch itself is open. The handle does not project through a slot in the cover and it is not possible to get a shock due to the handle being accidentally alive nor to be burned due to flame coming through the slot. The spring which gives the quick action to the break operates through a curved link so constructed that when the contact is full home it is just over the dead centre, consequently there is no tendency for the switch to spontaneously pull off and open circuit. On first pulling forward the handle, the spring controlling this is brought into tension; and should the switch not be opened, the handle immediately flies back to its first position. The maximum tension of operating spring is reached just at the point when the switch blade leaves the contact, so that the break is very rapid. The switch is being made and marketed by the General Electric Co.

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THE MILLIWATT LAMP.

Since the publication of our last note on the Milliwatt lamp another remarkable instance of its durability has been brought to our notice by the makers. A case of lamps was being taken from the works by monoplane carrier to a customer in the Midlands when for some unexplained reason the aviator found that the case had come unshipped. He saw it hanging by its packing cord from the frame of the machine, and one by one the 100 lamps were shaken out of the case, falling in their cartons 1,000 ft. to the ground below. The aviator continued on his course until the last lamp had been dislodged by vibration, and finally the case itself sped earthwards, falling into a hen roost and causing much consternation among the feathered inmates. As the aeroplane was travelling at a high speed the 100 lamps were distributed over a wide tract of country. The makers, however, now write informing us that the 100th lamp has been traced and recovered. They assure us, without blushing (though they write on pink note paper), that none of the lamps were damaged, and they are all burning brightly as if nothing had happened. The 13th lamp (doubtless with a view to maintaining the reputation of the number for ill luck) suffered most out of the consignment, for the stem supporting the filament was snapped by the shock of the fall. The filaments themselves (the lamp was 250 volts 100 c.p.) refused to follow suit, and glowed merrily when the lamp was carefully placed in a holder and switched on. We understand that this size of lamp will be known in future as the Aerowatt.

IFS AND QUERIES.

If a profit could only be made on the sale of Coronation illuminating material.

If Mr. Merz ran the "Daily Mail."

Has the Institution organised a trip to Constantinople yet, with calls at Paris and Vienna en route?

What is the consumption of standard bread among the members of municipal electricity committees?

Is Mr. Christie preparing special triple concentric sticks of Brighton rock for the I.M.E.A. members to take home after the convention?

Will the G.E.R. run a late special to town for the Arc Works dinner and smoker next year, or will C. & Co. short-circuit the railway by C.M.B. monoplanes?

Will the N.E.M.A. take for the subject of its next discussion the electrical aspect of the Aliens Bill?

Queen Mary I. said that when she died the word Calais would be graven on her heart; will disappointed electrical engineers also notify their expectations in similar circumstances?

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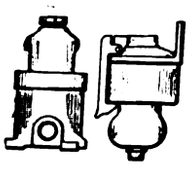

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REAVELL COMPRESSORS AND MINING HOISTS.

Among the compressed air plant in use in underground mines the Reavell quadruplex compressor is now very well known among mining engineers. The compressor has four cylinders arranged in an annular casing. This casing forms a water jacket which surrounds all the cylinders. There is also a circumferential belt running round the casing, into which each cylinder delivers its air. The water, in addition to surrounding the cylinder bodies, has access to the cylinder heads, enveloping that part in which the valves are situated, and also the pilot cylinders. It will thus be seen that an excellent cooling effect is obtained which extracts a correspondingly large amount of heat from the air during compression, and therefore results in a very low power consumption for driving the machine.

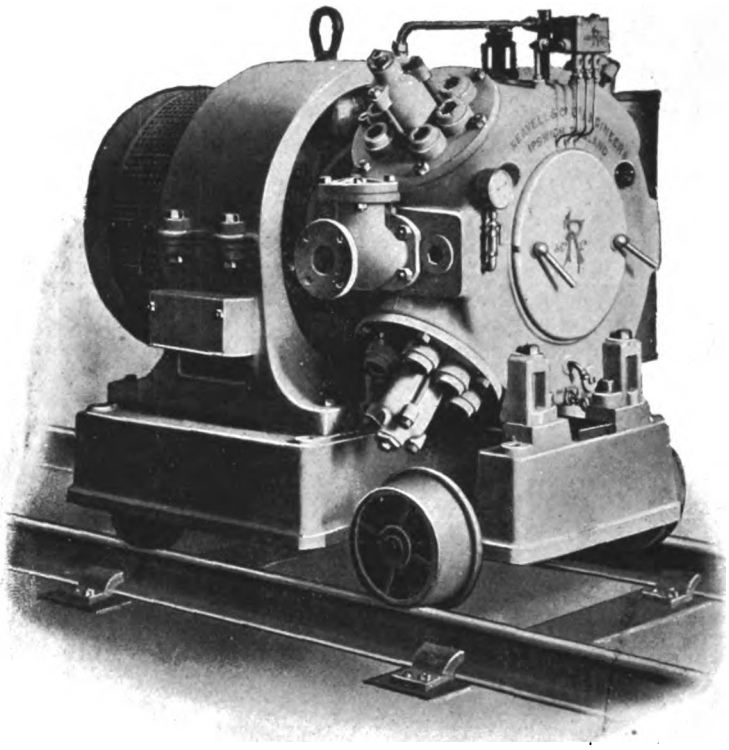

FIG. 1.—GENERAL VIEW OF PORTABLE COMPRESSOR.

All the four pistons are actuated by connecting rods, bearing upon a crankpin common to all. Air is admitted to the cylinders through ports arranged in the connecting rod gudgeons, and corresponding ports in the pistons which are opened and closed by the axial motion of the gudgeons. This does away with the need for spring loaded suction valves, and effects, it is claimed, a gain in volumetric efficiency of at least 5 per cent., as compared with compressors having spring loaded suction valves. The arrangement of the four cylinders also results, we understand, in an even turning moment, thus rendering the machine quite suitable for electric driving, and especially for direct coupling to electric motors. Another great advantage of the machine is the fact that all the pistons and connecting rods can be withdrawn in a few minutes, by simply removing the tap bolt fixed in the end of the crankpin. As an example of this class of plant we may mention a direct coupled electrically-driven machine, which is arranged upon wheels so as to be run on a tram line. This machine is illustrated in Fig. 1. Gear-driven compressors too are manufactured in large numbers, and can be arranged to run on tram-lines when necessary.

Messrs. Reavell & Co. also manufacture a compact little motor-driven compressor suitable for use in collieries, and other power stations, for the purpose of blowing dust from switch-gear, armatures, &c., which they term their "sub-station" Cleaning Set.

The same firm manufacture a useful mining hoist (*see* Fig. 2). This is driven by a pneumatic engine constructed on a similar principle to the compressor, and so arranged that it is entirely without valves. A winding drum is arranged through the centre of which the engine crankshaft passes, and actuates the epicyclic gearing contained in a casing at the outer side of the drum, thus making the whole extremely compact, while everything being enclosed danger of breakage through falling rubbish, &c., is avoided. The hoist is shown mounted on a pillar, and can be arranged for any position and at any angle. One of the feet of the pillar is adjustable, so as to render the hoist capable of being wedged between roof and floor or any other convenient position.

FIG. 2.—MINING AIR H[illegible]

THE REDUCTION OF COAL DUST IN MINES.

The danger of coal dust in mines is a question which has been engaging the attention of mining experts for some considerable time, and it is now generally acknowledged that when allowed

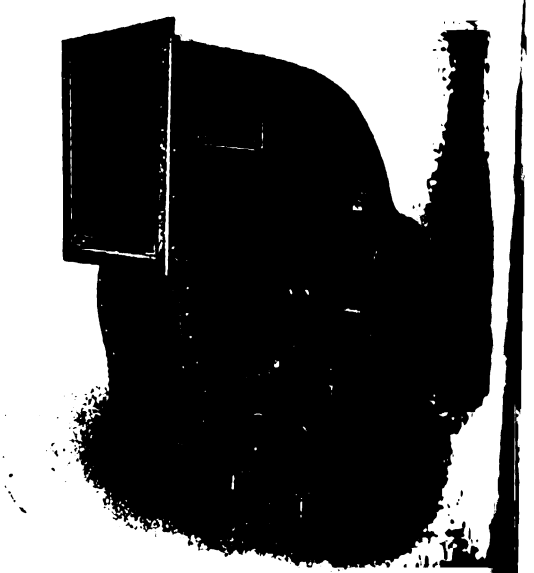

FIG. 1.—CYCLONE EXHAUSTER.

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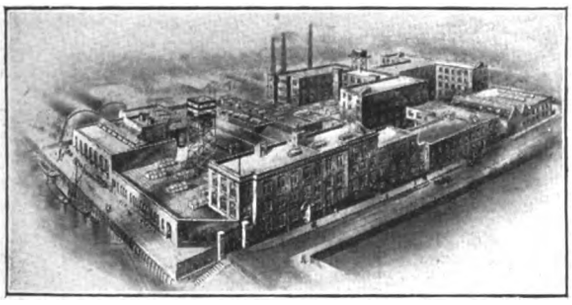

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to accumulate in the workings, it becomes a serious menace to the safety of the personnel and plant on account of its extreme liability to explode. In fact, it is considered that several recent colliery explosions have been due to this cause, and in the proposed new regulations for the Coal Mining Industry, which are shortly to come before Parliament, there is a clause which reads as follows :—" Arrangements shall be made to

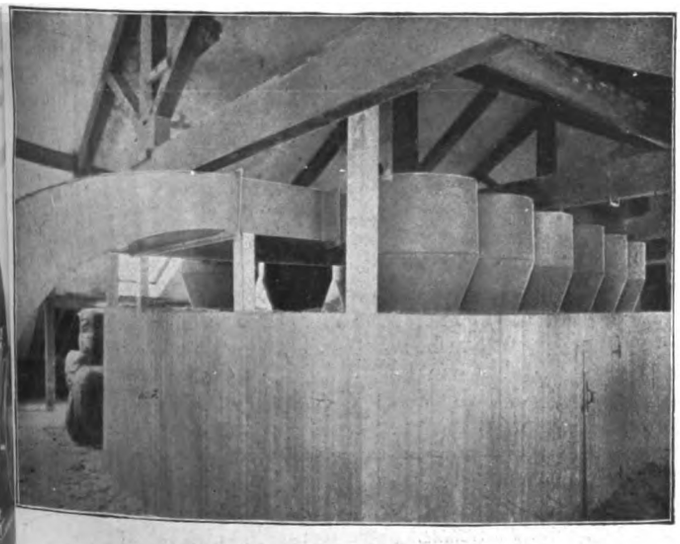

FIG. 2.—SEPARATOR PLANT.

prevent as far as possible coal dust from the screening entering the down cast shaft."

Down in the mine itself the dust question is a difficult subject to handle, on account of the dust arising at so many points in contradistinction to the conditions on the surface where this is not the case. The screens and tipplers are undoubtedly responsible for creating a large proportion of the dust on the surface, and owing to their close proximity to the pit mouth, this dust is drawn into the workings by the action of the

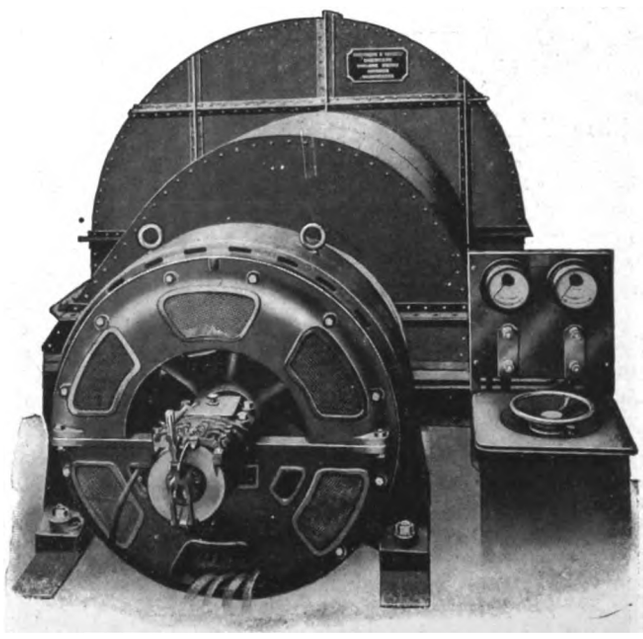

FIG. 3.—INDUCED DRAUGHT CYCLONE FAN.

ventilating fans. To overcome this difficulty the Cyclone dust collecting plant has lately been introduced by Messrs. Matthews & Yates, Ltd., who claim to have installed the first plant for this purpose.

A typical plant consists of an electrically-driven Cyclone exhauster, and a battery of the firm's lately patented Cyclone

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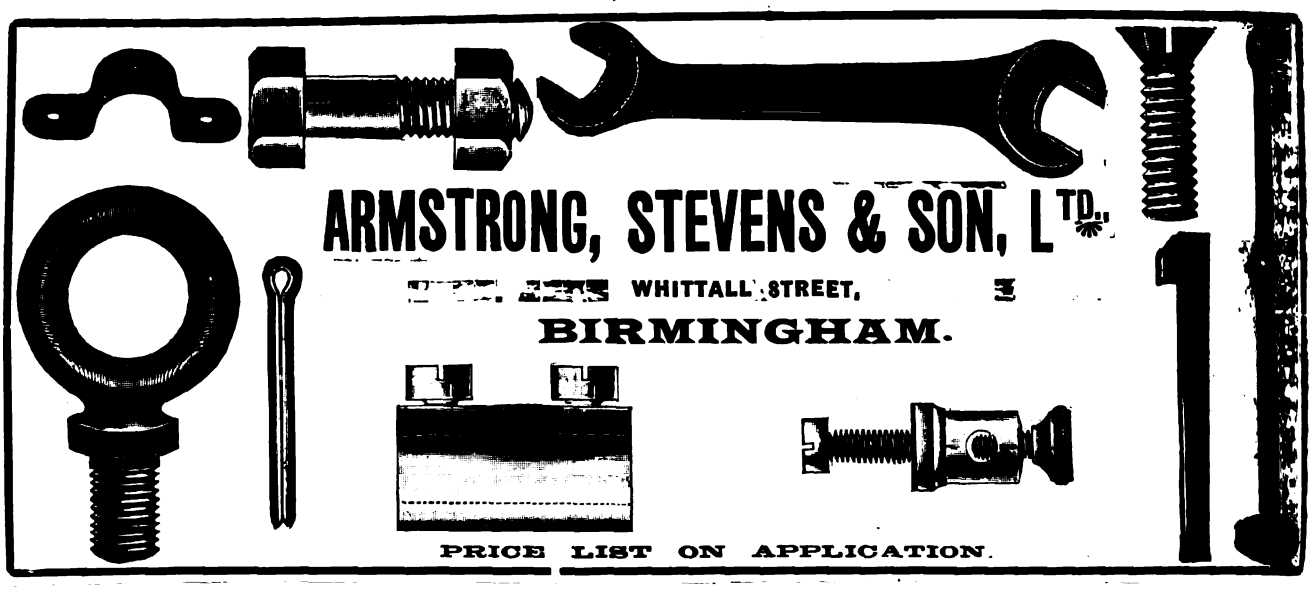


separators, such as is shown in Figs. 1 and 2, which may be fixed in any convenient position. The suction side of the fan is then connected with the screens, &c., by means of hoppers, hoods and trunking, through which the fans draw the dust-laden air, delivering it into the separators, where by centrifugal action, the dust is caused to fall into suitable receptacles, while the air escapes at the top. Fig 3 will give a general idea of the plant.

The advantages of such a plant are twofold; first, in preventing the coal dust from being drawn down the shaft into the workings by the ventilating fans, and secondly from a commercial point of view, as the dust collected when kept dry is a saleable article, and one that will find a ready market.

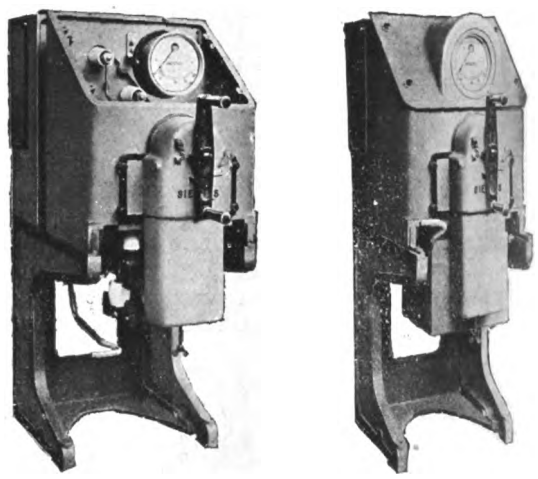
The Cyclone blower and exhauster (Fig. 2) is also highly suitable for mine ventilation, not only as the main ventilator, usually on the pit brow, but also when, coupled to electric motors, it can be used as an auxiliary to the main fan, for supplying ventilation to remote workings. Fig. 3 shows a combined motor-driven induced-draught set. A plant of this description guarantees a plentiful supply of steam, an absence of black smoke, and enables the user to burn the refuse from the coal.

MINING PILLARS.

The mining pillars illustrated are designed for three-phase circuits up to 300 amperes at 3,300 volts. The frame-work and outer casing of the pillar are of cast iron, the whole being arranged for floor fixing. Various combinations of apparatus are possible, but in each case two triple-pole isolating switches and a triple-pole automatically operated oil switch are included.

The oil switch may be provided with one, two or three over-load releases with or without "air vane" time limits, or a similar number of no-voltage releases or any combination of these not exceeding three releases to each switch. If desired, the releases can be arranged for operation from an auxiliary circuit. These pillars can be fitted with a special buffer resistance to prevent an abnormal rush of current when the switch is first closed. The isolating switch is operated by the movement of a carriage carrying the oil switch and other apparatus.

The oil switch is of the "free handle" type, and it is impossible to withdraw the carriage unless the switch is in the "off" position. The oil tank or the cover cannot be removed until the carriage has been withdrawn, and the carriage cannot be pushed in to close the isolating switches until the tank and the cover have been replaced and the oil switch put into the "off" position. All live parts are completely protected from accidental contact. For pressures above 650 volts the no-voltage coil and voltmeter, when fitted, are operated through a pressure transformer mounted below the cover, which is then of special design. The pillars can be supplied with ammeter and voltmeter if required.



MINING PILLAR WITH AMMETER.
With cover removed. With cover on.

These pillars can be used singly or combined in any required number to form a totally-enclosed switchboard, in which case 'bus bars are arranged in the upper portion of the pillars and fixed in such a way as to prevent accidental contact. The cables can be led in from the top or bottom, and suitable bifurcating boxes can be supplied for this purpose. If preferred, porcelain bushes can be supplied for single-core cable. The pillars are made by Siemens Bros. Dynamo Works, who will furnish full details and prices on request.

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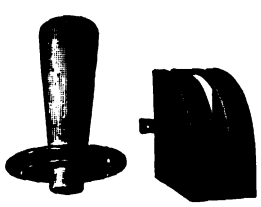

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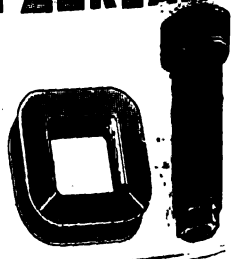

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THE ELECTRICIAN COMMERCIAL AND INDUSTRIAL SUPPLEMENT.

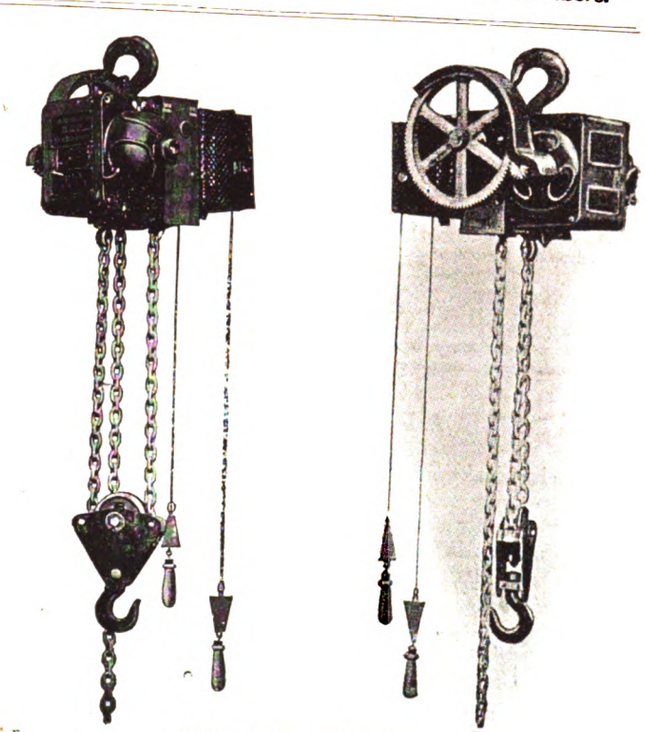
C. & I. Supplement No. 85.] MAY 19, 1911. [Gratis to Subscribers.

ELECTRIC PULLEY BLOCKS.

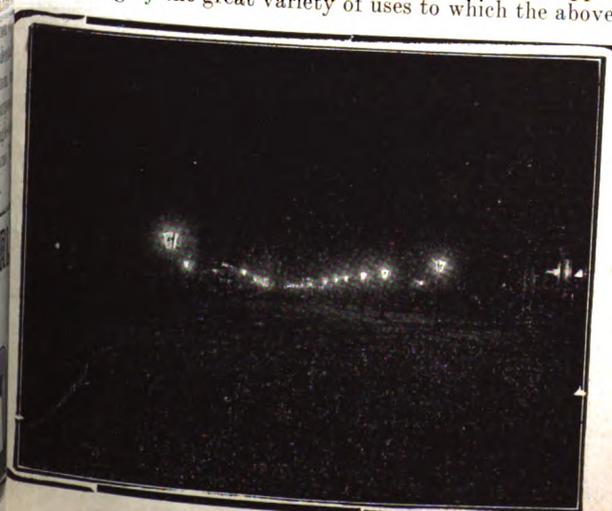
The electric lifting appliance in the shape of the massive crane is a recognised institution in almost every sphere of industry. It is an accepted fact, and to such an extent that the claims of the smaller electric lifting device are often overlooked. The electric pulley block and small electric runway is of immense value in every branch of engineering trade and commercial work. We illustrate two views of a handy pulley block which is self contained, and can be hung on a crane hook or any other convenient support, and operated from a local light or power circuit. The block takes up no more room than a hand pulley block, and the load hook hangs in a vertical plane with the suspension hook whether loaded or not. We understand that the saving in labour quickly pays for the cost of the electric pulley block.

The pulley block is made in standard sizes for loads from 10 cwt. to 5 tons, and the motor can be supplied for d.c. or three-phase circuits. The block is silent in operation, and as will be seen from the illustrations is controlled from the floor level. The controller, motor gearing and chain wheels comprise a self-contained unit, and the operation of the controller is simplicity itself. These blocks are made by the Electric Pulley Block Co., 47, York-street, Westminster, London, S.W., and Messrs. A. W. Pocklington & Co., at the same address, are the sole selling agents. They also supply electric runways and overhead travelling cranes for use in specially cramped positions. They inform us that their lifting devices are widely used and appreciated, and they will be pleased to supply catalogues or other details on request.

The advantages of electric pulley blocks are evidently appreciated judging by the great variety of uses to which the above-mentioned pattern has been put. The makers have on hand a number of illustrations which depict actual installations of the device.



ELECTRIC PULLEY BLOCKS.



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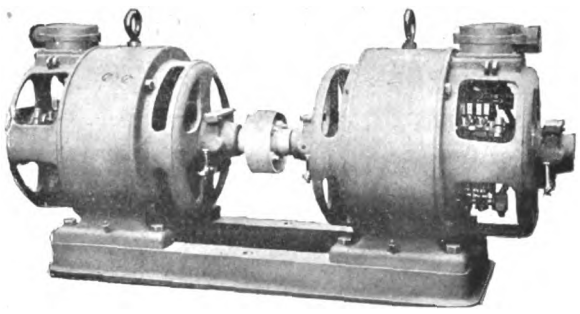

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A NEW PUNKAH FAN.

The electrical operation of a punkah proved to be for some time a troublesome problem, principally because of the peculiar "flick" which was the speciality of the expert punkah puller, and which was difficult to reduce to mechanics. This "flick" practically gave the punkah its reputation as a cooling device, and until it could be faithfully reproduced the electrically-operated punkah was not considered worth its salt. We were given an opportunity last week of inspecting a new electric punkah which seems to fill the desired requirements and by simple and efficient means. The device in question was shown in operation at the London offices of Messrs. Hogan & Wardrop, who are well known as the agents for E.M.I. electric fans.

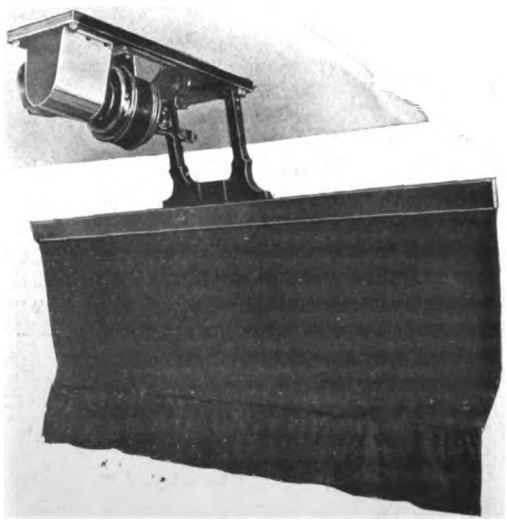

FIG. 1.—E.M.I. PUNKAH FAN.

A general view of the punkah is shown in Fig. 1, which illustrates the complete device as designed for ships' cabins, and also for use in residences, offices, &c., in tropical climates. It comprises a horizontal motor and a worm-reducing gear, both mounted complete on a substantial sole plate. The same plate carries the bearings in which the metal frame for the punkah is free to swing. This frame is mechanically and rigidly coupled by a connecting rod to a crank on the reduction gear of the motor. The rotation of this crank at a speed 12 times less than that of the motor causes the punkah to swing slowly from side to side. The flick is obtained by the slight hesitancy of the connecting rod in passing the dead centres of the crank. The effect is very real, and the resultant "puff" of air, far from being a draught, is quite pleasant to sit under. This, of course, is as it should be, because the "live" punkah gives just such a result.

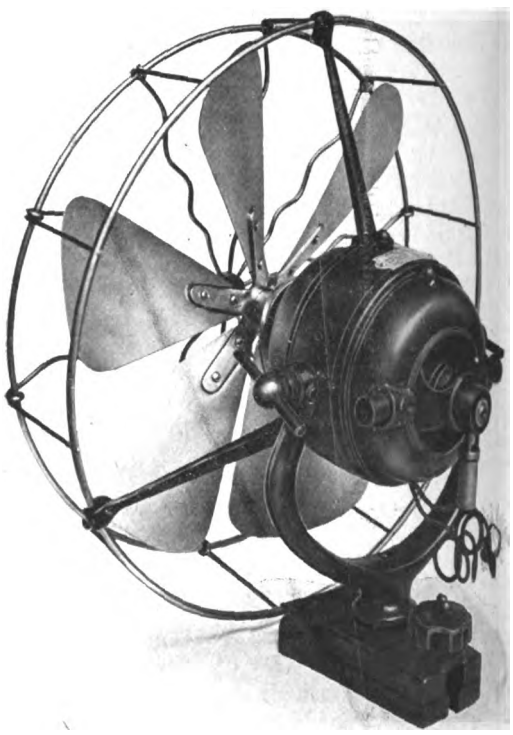

FIG. 2.—E.M.I. NEW SEASON'S FAN.

The motor can be supplied for both alternating-current and direct-current circuits, though for ship service only the latter would be used. It will be seen that the gear is completely enclosed, and both worm and wheel run in a continuous bath of graphite grease, which causes efficient lubrication and practically eliminates noise. We could not detect any sound above that of the soft purr of the motor itself. The punkah shown in Fig. 1 is 6 ft. wide, but widths up to 12 ft. can be driven by a single motor. The punkah is neat and compact, and is well worth the inspection of interested engineers, export agents, &c.

We also illustrate a new season E.M.I. fan in Fig. 2, and would remind our readers that Messrs. Hogan & Wardrop are now ready to supply to the requirements of the summer trade. They also hold stocks of ceiling, porthole and bracket fans suitable for operation in foreign climates. The firm's address is 2, Gresham Buildings, Basinghall-street, London, E.C.

OSRAM-LAMPS

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VICKERS MOTORS.

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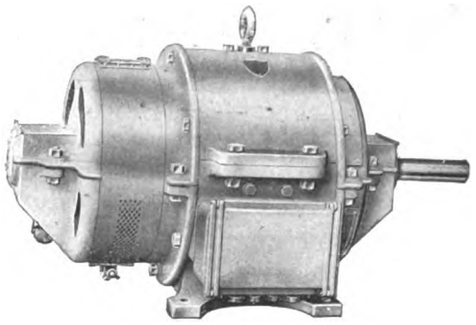

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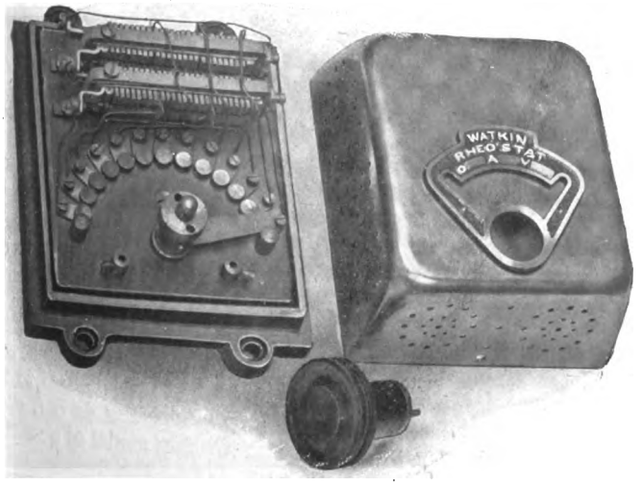
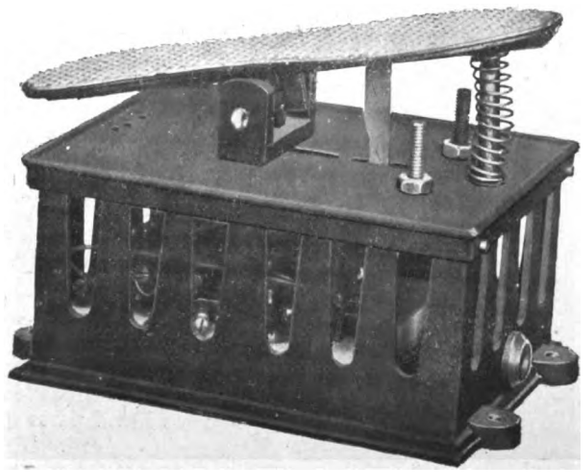
NEWPORT (Mon.)—C. R. HOUGH, 7, Summerhill Avenue.
YORKSHIRE—F. MACCALLUM, Austhorpe Road, Crossgates, Leeds.
IRELAND—The Hurst Electric Manufacturing Co., Clokey's Buildings, King Street, Belfast.

WATKIN MOTOR STARTERS.

The Watkin switch is well known in the electrical trade and amongst users of electric light as a convenient device for reducing the candle-power for incandescent lamps. The Adams Watkin Co. have taken steps to develop the switch for the control of small motors and also for regulating groups of incandescent lamps. The original type of switch has been followed closely in the motor starter pattern as far as the details of the resistance are concerned. The resistance elements are made up of a number of graphite blocks which are held on a suitable frame by clamping screws. Leads are brought out from this frame from points which subdivide the elements into groups each having a definite resistance value. These leads are connected to the stops of a multipoint switch over which a radial arm is arranged to sweep. The illustration will explain the details of this. A suitable cover is provided to enclose the moving contacts and through a hole in this cover the operating handle projects. The resistance is made up in a number of different sizes and for voltages from 50 to 250. The capacity ranges from 65 to 500 watts. A no-volt release can be supplied if required.



WATKIN MOTOR REGULATOR.



PEDAL REGULATOR.

We also illustrate the Watkin switch made up as a pedal switch and motor regulator. This is intended for small motors from $\frac{1}{8}$ to $\frac{1}{4}$ H.P. It should prove useful for the control of motor-driven sewing machines, dental engines, jewellers' lathes, polishing bobs, &c.

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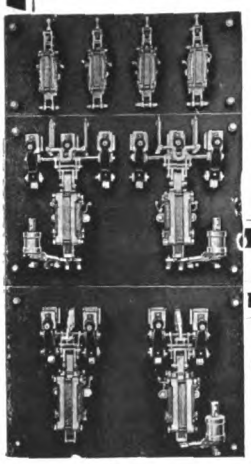

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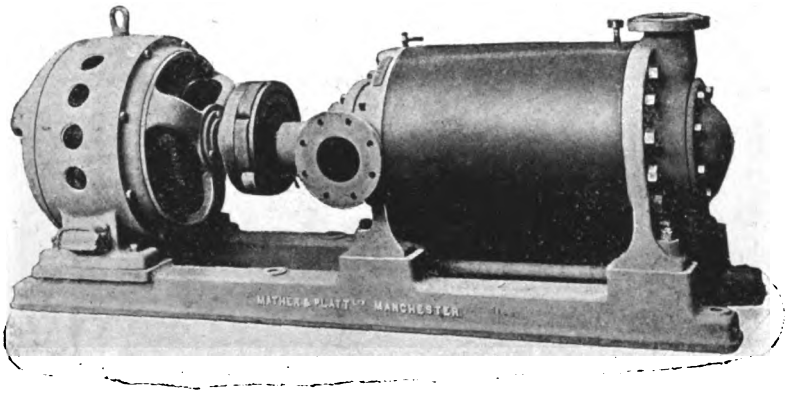
COLLIERY EXHIBITION IN MANCHESTER.

On Friday last the City Exhibition Hall, Deansgate, Manchester, was the scene of the opening of an important Colliery and General Mining Exhibition. Three years have elapsed since the mining industry of this country was represented at an exhibition, this having been held at Olympia, in July, 1908. The opening of the present exhibition in the Midlands should create a greater amount of interest than a show in the Metropolis, because Manchester is an industrial centre which is more closely in touch with the mining districts in all parts of the country, not excepting South Wales and Cornwall. The exhibits, though not large in the matter of numbers, are fully representative, and indicative in every way of the importance of mining interests in this country.



MATHER & PLATT MULTI-STAGE MINING PUMP.

In the unavoidable absence of Sir William Bailey, the exhibition was declared open by Sir T. Holland, who was introduced to the company by Mr. A. E. L. Chorlton, of Mather & Platt.

The exhibition has no particular display of electrical apparatus, but this may be regarded as a sign of progress rather than otherwise. Electric power is now taken for granted as an indispensable adjunct of mining operations, and it is no longer necessary for electrical manufacturers to urge the design of their products on the attention of mining engineers. On this account it seems in every way appropriate that electric motors and control gear should fill a natural and unobtrusive place in the machinery displayed at the exhibition.

Coming to the exhibits themselves, we may first refer to that of Mather & Platt on stand No. 79. In addition to the original Mather-Reynolds turbine pump, which is interesting as the first multi-stage pump ever constructed and which was designed for a 60 ft. head and a capacity of 800 gallons per minute, this firm shows its most recent types of high-lift turbine pumps. One of these has a capacity of 1,800 gallons per minute under 950 ft. head at 970 revs. per min., or 2,500 gallons per minute under 2,000 ft. head at 1,450 revs. per min. This pump is intended for direct driving by electric motor, and is of the seven-stage type, each stage forming a separate section, and the sections are bolted together to make up the complete pump. It is stated that this construction obviates the trouble of dismantling due to the rusting of the internal parts, such as is required when the working parts are placed in an outer casing. Each chamber is provided with separate feet, and the bedplate is extended to allow support to the end chamber while this is being withdrawn. Renewable bronze guide passages are fitted, and these are of substantial construction, being carried from the periphery of the propeller to the outside of the pump casing. A forced lubrication pedestal bearing is included, which is independent of the pump itself, being carried from the bedplate so as to give ample support to the shaft. This pedestal bearing is fitted at the driving end of the pump. At the opposite end the bearing is internal, and is cooled by the water passing through the pump. Grease lubricant is supplied to the bearing under pressure. A further interesting item in this exhibit is a high-lift turbine pump direct coupled to Mather & Platt's "Zoelly" steam turbine. This has an output of 1,500 gallons a minute and a 400 ft. head at 3,000 revs. per min. The turbine develops 200 B.H.P. with steam at 160 lb. pressure and a vacuum of 27 in. The pump is designed for high duty and high speed, and the impeller is of the double-suction type, with special passages equalising the pressure on each side. The pump is connected to the turbine through a semi-flexible coupling. In another portion of the stand may be seen a special form of vertical pump and motor, suitable for shaft sinking and unwatering.

A number of electrically-driven coal cutters are shown, and in this branch of the industry the exhibit of Messrs. Alfred Hopkinson is one of considerable extent and importance. It includes one three-phase longwall coal cutter, one direct-current machine of the same type and a number of parts, such as motor armatures, rotors and electrical accessories for use in connection with coal cutters. In this latter respect we may refer to specimens of cab tyre insulated cables, which have been recently developed for use in connection with portable electrical apparatus of all kinds in mines.

Messrs. A. Hirst & Son, of Dewsbury, also show a number of electrically-driven three-phase and direct-current disc coal cutters. The largest of these is fitted with a 3 ft. 6 in. cutter wheel of the loose box type. The controller and cable connections to the motor are carefully enclosed in steel piping. In fact, both motor and controller are totally encased. The same firm also exhibit a 24 in. shot hole drill for holes up to 2 in. diameter, 4 ft. 6 in. deep. This is electrically driven, and is shown in operation. A complete working model of a standard

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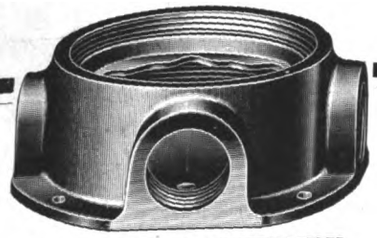

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coal cutter is among the other interesting exhibits on this stand. The Harland Engineering Co., who are the Lancashire agents for Messrs. Hirst, combine their exhibit with the above firm, and show a turbine pump direct coupled to a 500-volt direct-current motor, and a quantity of high-tension ironclad switchgear designed in accordance with the Home Office regulations.

A purely electrical exhibit is that of the Jandus Arc Lamp & Electric Co., who have a stand upon which they are showing their well-known regenerative lamp. This is particularly suitable for the illumination of pithead works, and should especially commend itself to mining engineers. It is a high efficiency flame lamp with a long life, 70 to 100 hours on one pair of carbons, and has the advantage of operating at a low cost—namely, 10 hours for 1d. The candle-power is 4,000 maximum at 15 degrees from the horizontal, and the makers claim that it will replace four to eight ordinary type arc lamps, giving a better light for less cost. Mining engineers visiting the exhibition should take an opportunity of inspecting this exhibit.

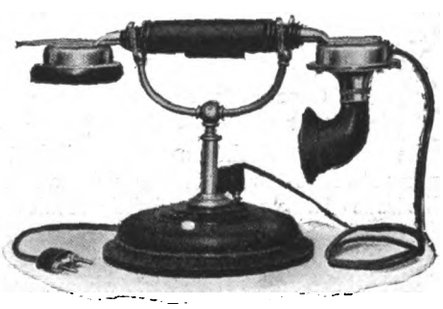
The British Westinghouse Co., who have fitted up the Engineers' Club with "Auriga" metal lamps, have appropriately decorated the club with a number of large framed photographs of electrical plant and machinery which they have installed in mines and collieries. These installations include turbines, generators, motors and switchgear, and the pictures are both instructive and of more than ordinary interest. They indicate the rapid strides made in the applications of electricity to mining operations.

An exhibition which is not without interest is that of the Great Central Railway, who show a massive cabinet in which views of G.C. locomotives and steamers are mounted. These are illuminated at night. High up on the wall of the Exhibition and facing the main cross aisle is a wash drawing of Immingham Dock, which is in process of construction, and is being equipped with the most modern dock and harbour plant. This view has been prepared by the Great Central Railway, and shows the extensive character of the undertaking. We may remind our readers that the company are offering special facilities for reaching the Exhibition in Manchester both from London and the Midlands.

The Exhibition has been organised by the "Engineering Review," and during the past two days the annual meeting of the National Association of Colliery Managers, under the presidency of Mr. G. H. Winstanley, has been held in connection with the Exhibition.

"WESTOPHONES."

There should now be a brisk demand for domestic telephones, judging by the literature which the various telephone manufacturers are distributing on the subject. The Western Electric Co. send us particulars of their private telephone instruments, to which they have given the trade name "Westophone." These instruments are intended for connection to existing bell circuits and can be supplied as wall or table sets. An illustration of the latter is given herewith. The instruments are extremely reasonable in price, and the makers state that they are "not a toy but a well-constructed telephone, built to last." They are finished in ebonised wood with nickel-plated fittings.



WESTOPHONE TABLE SET.

The Western Electric Co. also send us particulars of their interphones for commercial and industrial use. We have referred to the general excellence of these instruments on a previous occasion.

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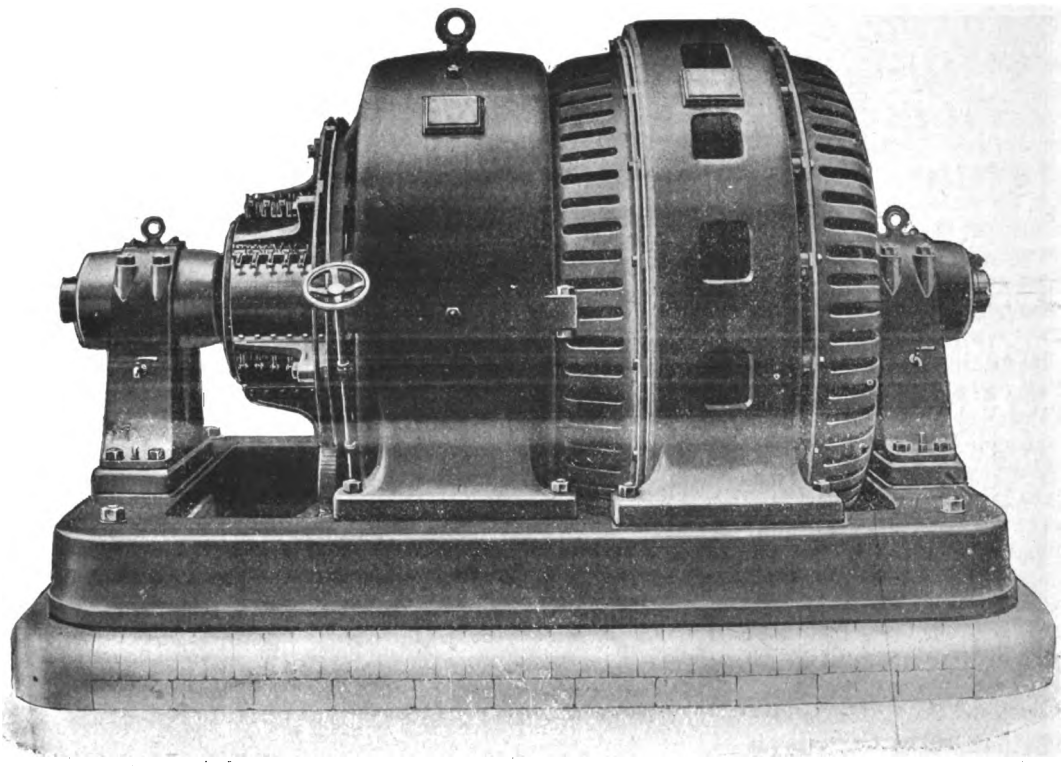
STERLING TELEPHONES

The Sterling Telephone & Electric Co., Ltd., 200, Upper Thames Street, London, E.C. Works: Dagenham, Essex.

PEEBLES MOTOR CONVERTERS.

The controversy which raged some years ago around the question of the respective merits of motor generators, rotary converters and motor converters has now practically subsided, and each class of machine has filled its own particular niche in electrical working. The motor converter practically revived interest in the controversy by placing an entirely different aspect upon it. The machine possessed such a variety of novel features that it appealed largely to station engineers who were engaged in the extension of their supply for industrial power purposes among the type of consumer requiring a direct-current supply. The issue of a new edition of their Peebles motor converter list by Bruce Peebles & Co. recalls the above-mentioned controversy, and it also gives striking evidence of the utility of these machines and the variety of uses to which they have been put.

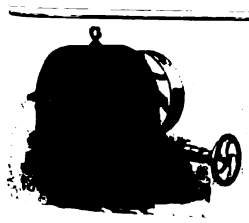


General View of Two-bearing Peebles Motor Converter.

We may recall the most notable features of the motor converter as a matter of interest. In the first place it dispenses with transformers, the line voltage being brought directly into the alternating-current side of the unit. This naturally reduces the size of the sub-station for machines of this class. It also simplifies the switchgear and practically solves the problem of the skilled attendant. In the construction of the machine only two bearings are required for units of comparatively large output, and it is only in the large capacity machines that three bearings are introduced. A further interesting feature of the machine is that all rotating parts are operated at low voltage. In principle the unit comprises an ordinary induction motor and a rotary converter mechanically coupled on the same shaft; the rotor winding and the armature winding of the induction motor and rotary respectively are connected in parallel. The number of poles of the alternating-current machine is such that the frequency of the currents introduced in the armature winding is the same as the frequency of the rotor currents. These two windings can be connected together when the E.M.F.s are equal and in phase, and after this has been done the speed remains constant, and the two machines connected in tandem function as a single synchronous machine. Half the electrical energy supplied to the induction motor is converted into mechanical energy, transmitted by the shaft to the direct-current portion of the converter; the other half of the energy is transferred to the rotor winding and thence to the converter armature. The converter runs at a speed equal to half the primary frequency, so that it can be made of smaller proportions than the ordinary direct-current generator for the same output and frequency.

The machines are built up in sizes suitable for the supply of traction loads, in which case they are arranged to compound automatically from 500 volts at no-load to 550 volts at full-load. They are capable of withstanding 100 per cent. overload without sparking, and are free from liability to reversal of polarity either when starting up or when "shorts" come on the line. The lighting motor converters are made shunt or compound wound according to requirements, and the standard shunt machine will operate on a 5 per cent. voltage drop from no-load to full-load with practically unity power factor. Special motor converters are also made for both traction and lighting and for operation from direct-current circuits for the supply of alternating-current energy at high voltage.

In the publication to which we have referred a comparison is given between the motor converter, the rotary converter and the motor generator, which places the advantages of the first named well to the front. We give an illustration of a standard two-bearing type converter above. Interested engineers should apply for pamphlet No. 20B to the offices of the company, East Pilton Works, Edinburgh.



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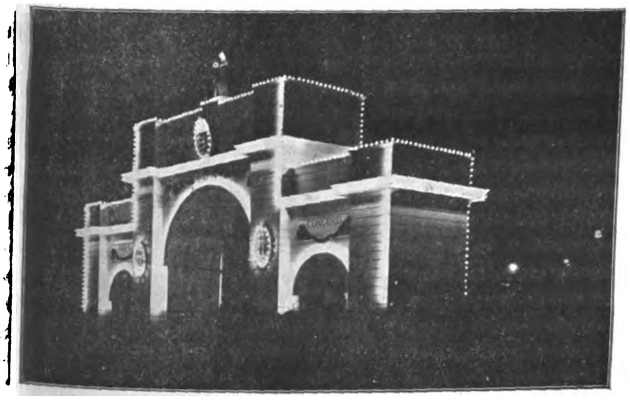
ILLUMINATION EFFECTS.

Carbon filament lamps will no doubt be almost generally used during the forthcoming Coronation celebrations, because the temporary nature of the various installations will prohibit the higher priced metal lamps being widely adopted. Siemens Bros.' Dynamo Works inform us that they are now holding large stocks of carbon lamps which can be supplied immediately at remarkably low prices, which will, however, only



Arch Illuminated with Siemens Carbon Lamps.

hold good until the present stocks are exhausted. Orders will be executed in strict rotation, and it would be advisable to send orders or reserve sufficient quantities immediately. These lamps have been in great demand for illumination work, and we illustrate here some night effects which were obtained during the Royal visit to South Africa on the occasion of the opening of the Imperial Parliament there. The many thousands of lamps employed in these decorations were supplied by the Siemens South African branch, and, as will be seen, highly satisfactory results were obtained. Similar lamps will be used in the various schemes which the firm are catering for, and the actual fixing and erecting work will be placed in the hands of competent electrical contractors. Copies of the company's Coronation devices and accessories' list will be sent on request to any who are interested in illumination schemes.

SIEMENS ENAMELLED WIRES.

The enamelled wire is the result of considerable manufacturing experience, and Siemens Bros. & Co. are now publishing particulars of this class of conductor. The enamel is hard, flexible, watertight and capable of withstanding high temperatures for short periods without injury. It is practically non-inflammable and capable of resisting the action of most of the re-agents met with in general practice. Its dielectric strength is high, and it can be made to withstand high electrical pressures if required. We understand that there is no electrolytic action under the most unfavourable conditions. The applications of enamelled wires are, of course, wide and varied. In the saving of space alone they have an advantage over silk or cotton-covered wires for the purposes for which these are now adopted ; further, they are suitable for many purposes where such wires cannot be employed at all. They are specially recommended

EXCELLO
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for bobbins of electric bells, telephones, measuring instruments, indicators and annunciators; also for induction coils, arc-lamp coils, resistance and choking coils, small transformers, &c. Siemens Bros. & Co. will forward a copy of supplement No. 1 to their catalogue No. 532, which contains prices of these enamelled wires from No. 22 to No. 40 S.W.G.

ELECTRIC COOKING AT GRIMSBY.

The advantages of electric cooking are best demonstrated in the summer months when gas is at a premium and coal fires are anathema. Mr. W. A. Vignoles, electrical engineer at Grimsby, is keenly alive to the possibilities of increased business from this direction. He has been holding an exhibition at which the merits of electric cooking with an E.O.A. Eclipse oven were successfully demonstrated by Miss G. A. Paget. Lectures were given in connection with the demonstrations. We understand that upwards of 1,000 persons attended during the course of the week. Great interest was taken in the show, and a few orders were booked, in addition to a large number of inquiries being received. Suitable literature was distributed to each visitor, and among the pamphlets was a most convincing testimonial from a Grimsby lady resident, who is the proud hostess of an electric household. During a period of 10 weeks the cost worked out at 3s. 4d. a week for cooking and heating; this includes the preparation of three meals daily, and the heating of all water required. The demonstration was arranged in co-operation with the Electric & Ordnance Accessories Co., whose Eclipse apparatus was used throughout. We described this apparatus in our issue of December 2, 1910. We extend our congratulations to Mr. Vignoles on his enterprise.

WESTINGHOUSE TURBINE PLANTS.

It is a regular practice in the industry for electrical manufacturers to sub-contract to engine and turbine builders or vice versa, when the equipment of generating plants, &c., is under consideration. The British Westinghouse Co. now intimate that they are in a position to supply the complete generating plant from "stop valve to switchboard," so to speak, and that such plant, in the shape of steam turbines, turbo-generators, turbo-blowers, turbo-pumps, condensers, &c., is made complete in their large works, Trafford Park, Manchester. They point out that there are certain advantages to be derived from the placing of the whole of a contract with a single firm. The responsibility is undivided, the question of delivery is less troublesome to deal with, the plant is the product of a single organisation having but one "body to be kicked, &c.," and grievances or complaints are confined to the smallest possible area. It is urged that these are sufficiently good reasons for the placing of business with the firm in question. In so far as power installations are concerned, the arrangement should work to the mutual advantage of the parties concerned because guarantees of coal and steam consumption can be undertaken with a greater degree of certainty than is probably possible where plant is sub-contracted for.

H. WEIDMANN,
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Manufacturers of—
CONDUITS, CABLES, ACCESSORIES, FITTINGS, MOTORS, ELECTRIC HEATING AND COOKING MATERIAL, &c.

Printed and Published by GEORGE TUCKER, at the Editorial, Printing and Publishing Offices, 1, 2 and 3, SALISBURY COURT, FLEET STREET, in the City of LONDON, FRIDAY, MAY 19, 1911.

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THE ELECTRICIAN COMMERCIAL AND INDUSTRIAL SUPPLEMENT.

C. & I. Supplement No. 86.] MAY 26, 1911. [Gratis to Subscribers.

MANCHESTER COLLIERY AND MINING EXHIBITION.

CONCLUDING NOTICE.

We understand that this exhibition, which closes to-morrow, May 27th, has been a distinct success from the commercial point of view. After all, an exhibition of this kind does not provide any particular attractions for the general public. The fact that the annual convention of the National Association of Colliery Managers coincided with the opening of the exhibition ensured the attendance of large numbers of interested engineers and gave an excellent opportunity to the exhibitors of bringing their products to the notice of interested prospective buyers.

One of the most prominent exhibits was that of Tilghman's Patent Sandblast Co., who exhibited a two-crank air compressor of the vertical high-speed two-stage type. This has a capacity of 400 cubic ft. of free air per minute delivery against a pressure of 100 lb. per sq. in. This is fitted with a patent automatic multiple plate system of valves, and forced lubrication is supplied to all bearings and slides. The compressor was shown in operation direct connected to a 75 B.H.P. Lancashire Dynamo motor, connection being made through a flexible coupling. The iron door of the crank chamber was replaced by one of plate glass, and through this the cranks could be seen at work and the splash system of lubrication for the big ends. The compressor is fitted with an automatic unloader on the air inlet, and this is operated by air pressure in the receiver. All dust in the air is extracted by an improved air washer before it enters the compressor cylinders. Running silently with its motor this compressor constituted one of the most attractive items in the exhibition.

The Lea Recorder Co. made a good show of their well-known V-notch recorders for the measurement of the flow of water and also of certain acids. The exhibit comprised one Lea patent self-contained recorder with 5 in. chart, flow chamber and notch tank, also one self-contained set with 6 in. recorder V notch having a capacity of 50,000 lb. of water per hour. This was shown in operation measuring steam consumption. The most recent pattern of combined indicating, recording and counting instrument was also exhibited in operation. This apparatus demonstrates the method employed for measuring water when the instrument is placed at a distance from the notch tank. The Lea Recorder Co. have also developed a midget portable testing apparatus which is suitable for dealing with small flows. This formed one of the attractions of the exhibit. The stand was completed by a number of photographs depicting actual installations of the Lea recorder in central electricity stations and power plants in practically all parts of the world. The mining engineer is perhaps not yet educated up to the importance of measuring his steam consumption, principally because coal is cheap at the pit bank, at the same time the modern turbo-electric installation, in which the power plant is concentrated rather than scattered, has impressed upon the colliery engineer the absolute necessity for the running of the plant upon highly economical lines. With the Lea apparatus it is possible to do this with the minimum of outlay and also with practically no skilled attention. This latter item is of considerable importance, because, as a rule, the number of skilled engineers in a colliery is small.

Messrs. Matthews & Yates, who are well known as ventilating engineers, had an impressive exhibit with their "Cyclone" blowers and exhausters, designed specially for colliery ventilation, induced draught for boilers, and all kinds of difficult ventilation problems. These fans were shown in operation, both direct connected and belt driven from electric motors. The Cyclone refuse and dust-collecting and separating

Westwood Hall, Leek, Staffordshire. Illuminated throughout by OSRAM Lamps. Contractors, Messrs. Blackburn, Starling & Co., Ltd., Hanley, Staffs.

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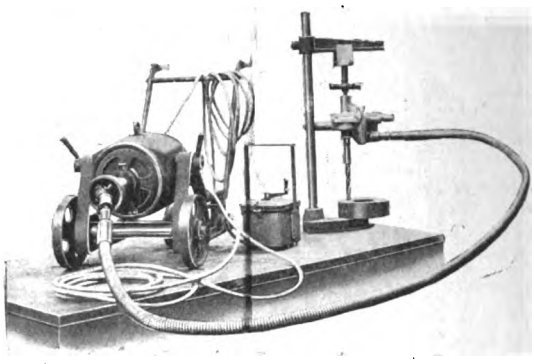
plant for the collection of coal-dust from screens and tipplers, also from wood-working mills and carpenters' shops, was among the features of the exhibit. In addition, a show was made of Cyclone autogenous welding and cutting plant for the welding and cutting of all kinds of metals from thin sheets to pieces 6 in. or 8 in. thick.

An exhibit which is not without interest is that of the Power Gas Corpn., Stockton-on-Tees. This company owns the patents and manufactures Mond producer gas plants from 100 to 30,000 H.P. and Mond gas plants with ammonia recovery, also producer gas plants from 10 H.P. upwards for every class of fuel. The exhibit comprised a large Mond gas and sulphate of ammonia recovery plant, and also a large number of photographs of gas plants actually installed. While it will be difficult to prophesy that power supply to collieries will in future be given from large plants operated by gas engines, it is at the same time of interest to note that engineers are working persistently at the problem of the supply of cheap gas for the operation of large engines, and the work of the Power Gas Corpn. in this respect is worthy of note.

PORTABLE ELECTRIC DRILLS.

The average modern workshop is now fitted with electric power circuits and in addition to the operation of the main shaft and the principal tools by electric motors there is generally a demand, particularly in engineering workshops, for portable tools. We illustrate a modern pattern of Witton-Kramer drilling outfit with trunnion type motor. This can be supplied for use on direct-current and alternating-current circuits, and holes from ½ in. to 1½ in. can be drilled with the various sizes of outfits. The equipment includes motor mounted on trunnion trolley, flexible length of armoured conductor and modern pattern of flexible shaft with steel wire core. The trolley head has a gear reduction of 1 in 4, and is fitted with a suitable clutch. The outfit is light and portable and can be used for drilling holes in practically any required position. A new list (K 20), issued by the Witton-Kramer



WITTON-KRAMER PORTABLE DRILL OUTFIT.

Electric Tool & Hoist Co., Witton, Birmingham, contains full details of these machines, together with a variety of other portable tools, such as polishers, blowers, boiler cleaning outfits, &c.

SILVERTOWN GALVANIC BATTERIES.

A very complete list of Leclanché and other batteries is being sent out by the India Rubber Co., Silvertown. Practically every known type of primary battery is listed and priced. We illustrate a set of Silvertown Leclanché firing batteries of 10 cells, complete in polished teak case. The cells are of the

SILVERTOWN LECLANCHÉ CELLS IN CASE.

six-block agglomerate type made up in a wood case. This construction is lighter and more portable than a stoneware cell. The top is sealed in so that there is no loss of liquid either through evaporation or spilling. We understand that these cells are largely employed by the Government for torpedo firing and also for mining blasting operations. A line of Silvertown-Leclanché medical batteries is listed, and these are supplied in sets of 20 to 60 cells. Considerable space is devoted to the Silvertown Bleecklove primary battery, which has an E.M.F. of 2·7 volts and which we described some time ago when it was first brought out.

OSRAM-LAMPS

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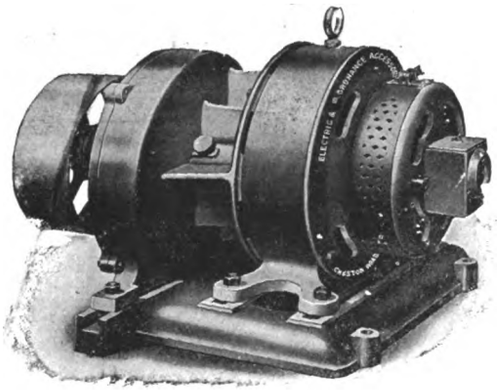

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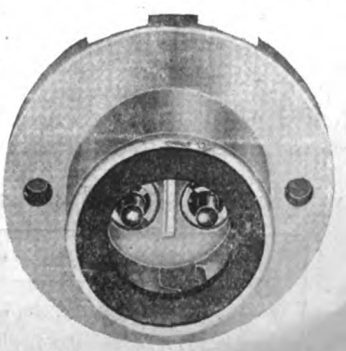
B.T.H. CORONATION DEVICES.

We have received particulars of a wide range of Coronation devices which the British Thomson-Houston Co. are offering for the forthcoming celebrations. The list describes complete emblematic devices with the portrait of the King or monograms of the King and Queen, crowns, scrip and block letters, illumination strip, multi-coloured lanterns, festoon strip, &c. B.T.H. carbon lamps and "Mazda" metal lamps are also included in the list. The latter are for 25 volts and have a 6-watt consumption. They are intended for use on alternating current circuits where transformers are employed for reducing the service voltage. We illustrate one of the emblematic devices herewith. In conjunction with the Coronation list a full list of the surplus stock of carbon lamps is offered at prices ranging from 2s. to 18s. per dozen. Contractors should make earliest application for this list, as doubtless there will be a big demand for lamps of this class.

B.T.H. Emblematic Coronation Design.

AN ALL-CHINA SIGN HOLDER.

The Benjamin Electric, Limited, have introduced a new design of lamp-holder, illustrated herewith, which possesses sundry novel features. This holder is useful for outlining borders and sign-letters, and is adapted for mounting on the back of the sign with the barrel projecting through the wood surface. This brings the lamp close to the surface to be illuminated, giving a better lighting effect. The holder is weatherproof, there being an original method of preventing moisture entering the lamp-holder after the lamp has been inserted. The connecting-up is quite simple as the terminal screws lie in the grooves at the back of the base. The holder is recommended



View of China Holder.

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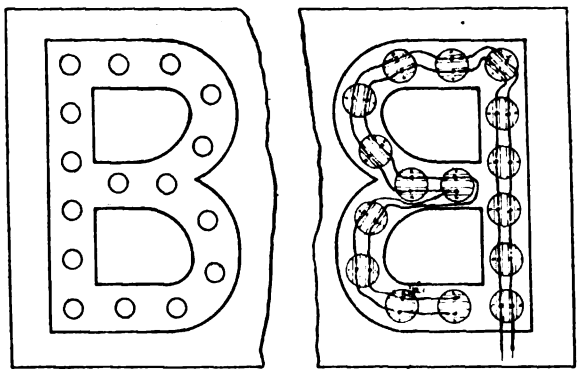
STERLING TELEPHONES
The Sterling Telephone & Electric Co., Ltd., 200, Upper Thames Street, London, E.C. Works: Dagenham, Essex.

for permanent work as well as temporary installations such as for the Coronation. It is an improvement on the ordinary



BENJAMIN CHINA HOLDERS MADE UP FOR OUTLINING LETTERS.

brass batten holders which are not weatherproof and also deteriorate rapidly when exposed to the elements.

REMARKABLE RUBBER BALLS.

One of the most interesting exhibits which will be seen at the International Rubber and Allied Trades Exhibition at the Royal Agricultural Hall in June and July comes from Brazil. It consists of 500 balls of rubber, which will be piled up in a pyramid occupying a space of about 29 ft. 2 in. by 21 ft., and will reach approximately a height of 20 ft. The average weight of each of these balls is 56 lb., and at 6s. per lb. would work out at £16. 16s. per ball, and the whole would cost £8,400. In addition, Brazil will show a ball of rubber weighing about a ton. This will be cut open at the beginning of the Exhibition, and prizes will be given to those who estimate the correct weight at the conclusion of the Exhibition. This is the largest ball of rubber that has ever been seen in this country.

PUBLICITY COMMITTEE PAMPHLETS.

A fresh set of circulars has been issued by the Electric Supply Publicity Committee and covers literature for distribution to both consumers and non-consumers. One of the most interesting of the pamphlets is one entitled "Electricity in the Nursery." The main intent of this is for non-consumers, urging primarily the adoption of electric light. The nursery is, of course, merely taken as a typical instance as illustrating the great convenience of electric light. The circular also deals with various other electrical apparatus which should prove useful in the nursery.

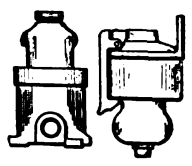
The issue includes a feature which will appeal to every undertaking, and this is a booklet on electrical apparatus which has been prepared with a view to familiarising existing consumers with the various types which can be used on the supply mains. It is also useful for distribution to non-consumers. The apparatus dealt with in the present booklet includes fans, grillers, kettles, irons, vacuum cleaners, &c. This particular booklet can be enclosed with the ordinary correspondence, receipts, &c.

The following circulars are also included in the issue:— An illustrated circular for non-consumers addressed to housewives, urging the value of electric light for lessening the work in the home. Two cards, with illustrated designs on one side, advertising respectively power and lighting, the other sides being left blank for use as postcards, or for giving particulars of rates, &c. Two cards, advertising electric light, in the form of reply postcards, suitable for being enclosed with other circulars. A card advertising electric lamps and urging that the best lamps should be adopted, suitable for use of undertakings who give advice, &c., on lamps. Illustrated circular to property owners, builders, landlords, &c., pointing out that houses should be wired prior to tenancy, on the grounds that the letting and selling is easier and also that there is a save in re-decoration. Circular on the safety of electric light, giving important testimony on the part of insurance companies. Power leaflets addressed severally to engineers, bakers, printers; also dealing with electro-plating works and saw mills. These leaflets have been carefully compiled and will be of use for sending out to the various trades or for following up inquiries, as each trade has been dealt with from its own particular point of view.

PUBLIC TIME SERVICE.

A public clock was set going at the Marble Arch on the 23rd inst. and was presented to the Borough of St. Marylebone by Mrs. Mocatta, of Great Cumberland Place. It consists of two large dials facing East and West, fixed upon an arc-lamp standard in Oxford-street, opposite the end of Park-lane. The dials are operated by an electrical time transmitter contained in a cast-iron pillar on the refuge. The instrument receives an electrical impulse every hour from Greenwich Observatory and transforms it into the half-minute impulses necessary to propel the hands of any number of clock faces. It does this quite automatically, so the clock never requires to be wound up. Though clock faces have as yet only been fixed to one arc-lamp standard there is no reason why a pair should not be mounted on every other lamp post down the street as the controlling mechanism will operate any number and the dials themselves are quite simple, the only works they contain being one wheel and an electromagnet. The work has been carried out by the Synchronome Company on the system invented by Mr. Hope-Jones, who has been advocating municipal time service for many years. He looks upon this as an important step in the right direction and an object-lesson to other boroughs, both metropolitan and provincial.

REYROLLE WALL PLUGS
For Portable Machines, Lights, &c.
Pamphlets 114, 122, 88 and 45 give all particulars
WORKS—
HEBBURN-ON-TYNE, ENGLAND



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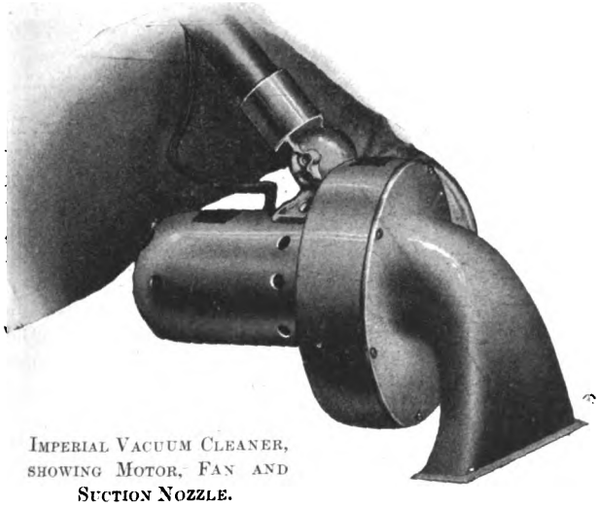
THE IMPERIAL SUCTION CLEANER.

We have been given an opportunity of inspecting a new type of suction cleaner which is intended specially for domestic service. It is of what we may call the electric broom type, in that the motor, suction fan and nozzle are made up as a complete unit and attached to a long handle which is used to pass the nozzle over the floor surface to be cleaned. It will be seen from the illustration that the motor is in a horizontal position and that the fan is directly attached to it. It is stated that the speed of the motor and fan is 10,000 revs. per min. Fan and motor are enclosed in an aluminium casing, which is splayed out directly below the fan to form the suction nozzle. The placing of the fan in a horizontal plane ensures a direct suction at the nozzle itself. The delivery nozzle also forms part of the



IMPERIAL VACUUM CLEANER, SHOWING MOTOR, FAN AND SUCTION NOZZLE.

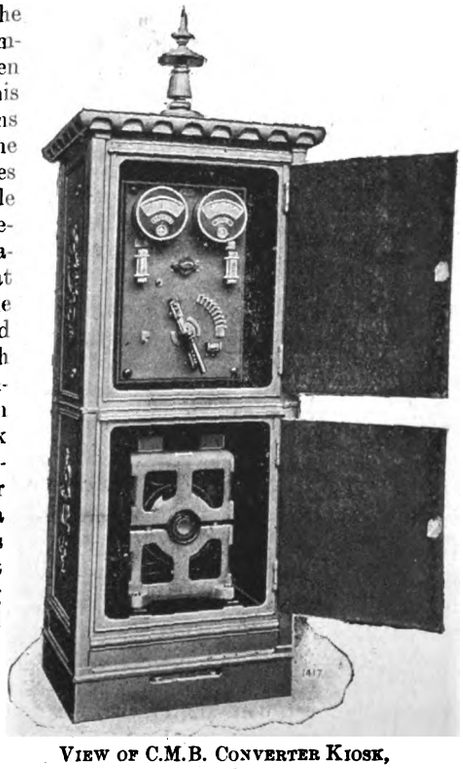
aluminium casing and to this outlet the dust collecting bag is attached. The bag hangs immediately below the operating handle, where it is quite out of the way. By the use of a horizontal motor it is also possible to run the cleaner underneath beds and furniture without damaging the motor or the casing.

The Imperial suction cleaner can be used for curtains and other furniture by the attachment of a flexible hose and suitable nozzles to the intake on the fan casing. The suction at the end of the nozzle is almost as powerful as that obtained without it. The various attachments for use with the flexible hose will allow of the cleaning of walls, cornices, skirtings, radiators, book cases, &c. The cleaner can be fitted with wheels if required, and we understand that it has been in successful operation in bioscope theatres, where there is naturally a large amount of dust to be cleared away each day. In this case the flexible hose is employed not only for cleaning the chairs, but also for the ornamental plaster with which these places of amusement are generally embellished. The cleaner has also been tested on carriage cushions, and found to extract dust even though the surface is very irregular.

THE C.M.B. BALANCER KIOSK.

When Messrs. Crompton introduced the C.M.B. converter some two years ago we published a detailed description of the principle and construction of the machine. As we remarked in a recent issue, we had an opportunity of looking through the machine shop at the Arc Works, Chelmsford, and noticed a large number of these machines in process of manufacture. This may be taken as indicative of the continued demand for this interesting type of machine.

A new edition of the C.M.B. converter pamphlet has just been issued, and while this describes the functions and applications of the converter it also includes an interesting example of its utility as a three-wire balancer. The machine is so compact that it can be placed inside a cast-iron pillar and installed, together with the necessary switchgear, at ground level on a direct-current network The adjoining illustration depicts the balancer and its gear inside a cast-iron kiosk. In this form it can be placed at the far end of a long feeder, and be entrusted with the balancing of the network in some small outlying district. The kiosk need not be erected on the side walk of a main road, it can be placed in any out-of-the-way street at a point most convenient for the balancing up of the system. The cost of sub-station buildings is saved, together with that of extensive switchgear and connections.



VIEW OF C.M.B. CONVERTER KIOSK, SHOWN OPEN.

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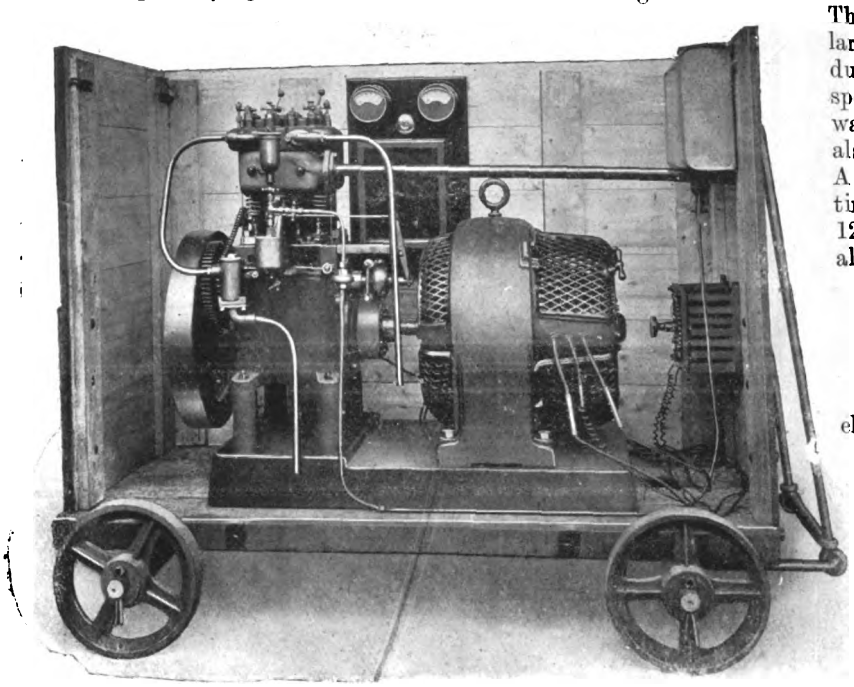
"KELVIN" LIGHTING SETS.

The number of small isolated electric lighting and power sets is being constantly added to, a fact which indicates that there is business in these tiny units if contractors will only go after it. The latest arrival is the "Kelvin," which, as its name implies, hails from Glasgow. Details of this petrol-paraffin unit have just been sent to us by Messrs. Fyfe, Wilson & Co., Bath-street, Glasgow. We illustrate a portable outfit of 3 kw. capacity, mounted on a substantial and wheeled truck for transport purposes. The engine is a two-cylinder machine, 3½ in. by 4¾ in., and is fitted with l.t. magneto throttle



KELVIN PORTABLE LIGHTING SET.

governor, vaporiser, water-circulating pump, &c. The galvanised fuel tank holds fuel and oil for a 12-hour continuous run. The sets are listed in sizes to supply from 50 to 300 lights. By fitting ball bearings to the engine the overall length has been considerably reduced. In the 16 kw. size a four-cylinder engine is employed and this is provided with a safety starting device. Interested contractors and shippers should apply for the catalogue describing these plants in full.

HAIR DRYERS.

By a combination of an enclosed electric fan and resistance element it is possible to make up an effective form of dryer which can be used principally for drying the hair and also as a hot and cold air douche. A device of this pattern is being put on the market by the Electrical Co., and is supplied for direct-current and alternating-current circuits of any lighting voltage. The fan is completely enclosed and the air is taken in through a number of holes at the side of the casing and discharged through a nozzle which is surrounded by a wire resistance which is heated by the passage of the current passing through the fan. A pleasing effect is produced by the application of the warm air to the bare skin. The air blast is sufficiently strong to carry away moisture rapidly from the hair or from other surfaces which require drying. The apparatus is moderate in price and the Electrical Co. will be pleased to furnish full details.

VULCANISED FIBRE.

Our readers will be interested to note that Messrs. Mosses & Mitchell have again enlarged their turning and cutting shops in order to cope with the increased demand for their products. This extension of the works has proceeded side by side with a large increase in the number of the staff. The principal products of the company are vulcanised fibre and electric specialities, these being supplied as sheets, tubes, rods, washers, rings, cones, &c. Gear and spur wheels in fibre can also be supplied, also brake shoes, bushes, switch bases, &c. A speciality is also made of condenser ferrules and insulating saddles and staples. The works of the company are at 122-124, Golden lane, London, E.C., and we understand that all interested enquiries will receive prompt attention.

"ECLIPSE" ELECTRIC COOKING.

In our last issue we commented upon the demonstration of electric cooking apparatus made by the Grimsby Corporation. We understand that this demonstration was mainly due to the enterprise and co-operation of the Electric & Ordnance Accessories Co. This company is carrying out a publicity scheme which includes, in addition to the distribution of a quantity of literature on the subject of "Eclipse" cookers, also a number of demonstrations in important centres of the actual apparatus. This cannot fail to impress upon the people, and particularly those who are already electricity consumers, the advantages and general importance of electric cooking. The summer months are eminently

"ECLIPSE" COOKER AT GRIMSBY.

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Western-Electric TELEPHONES.
WORKS: NORTH WOOLWICH
Telephones: Gerrard 5349. Central 2389. East 1400.

suitable for demonstrations of this character, and it is to be hoped that the enterprise of the manufacturers will meet with the success which it deserves.

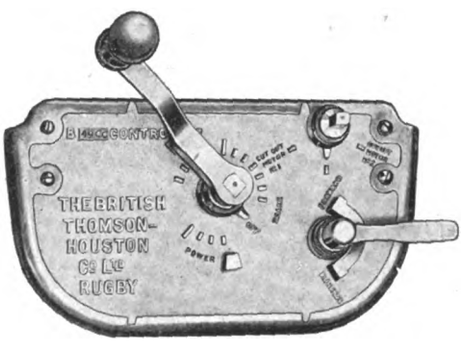
We give an illustration of the "Eclipse" oven as shown and demonstrated during the Grimsby Exhibition.

A NEW TRAMWAY CONTROLLER.

Tramcar controllers of the braking type now in general use are arranged so that if the car is running forwards, on moving the handle to the brake notches currents are generated in the motors producing a retarding torque, the direction of these currents being such as to strengthen the magnetism of the fields. If the car is running backwards and the controller handle is moved to the brake notches the currents generated in the motors will demagnetise the fields, so that no braking effect is produced.

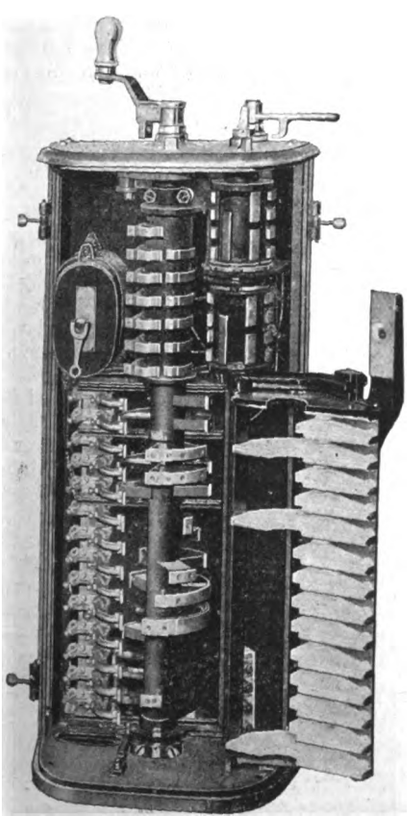
To obtain a braking action when the car is running backwards, the British Thomson-Houston Co. have designed and manufactured controllers in which, when the controller handle is moved to the "off" position, connections are made which cause one or more of the motors to act as generators, producing a braking effect. These connections give no braking action during forward running if the handle is in the "off" position. A preferable arrangement is one in which the motion of the control handle, which produces braking for forward running, will also produce braking for backward running. The B 49 B.T.H. controller shown in the illustration will give this result. The reverse switch handle may be in either the forward or reverse position, when, by moving the main control handle to the braking notches, a rheostatic braking effect will be obtained for either forward or backward motion in the car.

This controller is suitable for use with two 40 H.P. 500 to 600-volt series motors, and has four series, four parallel, and seven brake-controlling points.

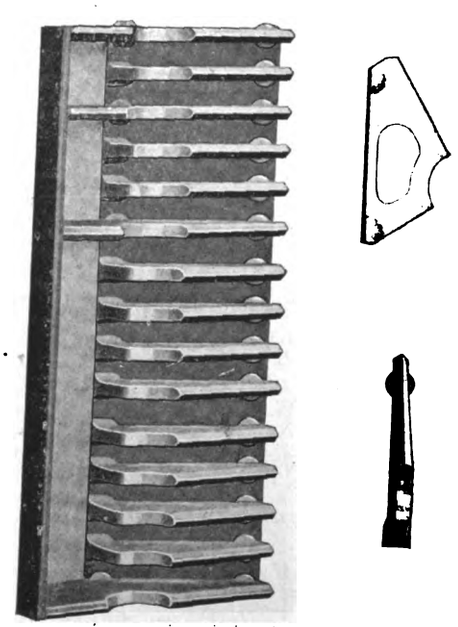


CAP PLATE OF NEW CONTROLLER.

Another important feature of the B 49 Controller is a mechanism for cutting out a defective motor without removing the cover of the controller. To cut out a motor it is only necessary to remove the reverse switch handle from its spindle and apply it to the cut-out spindle which projects through the cap plate, shown in the illustration, near the back edge. This cut-out spindle has three running positions, a central position for which both motors are in circuit, and a position on each side to cut out either motor. An interlocking device prevents the reverse switch being moved unless the cut-out switch



GENERAL VIEW OF NEW B.T.H. TRAMCAR CONTROLLER (OPEN).



ARC DEFLECTOR OF NEW CONTROLLER.

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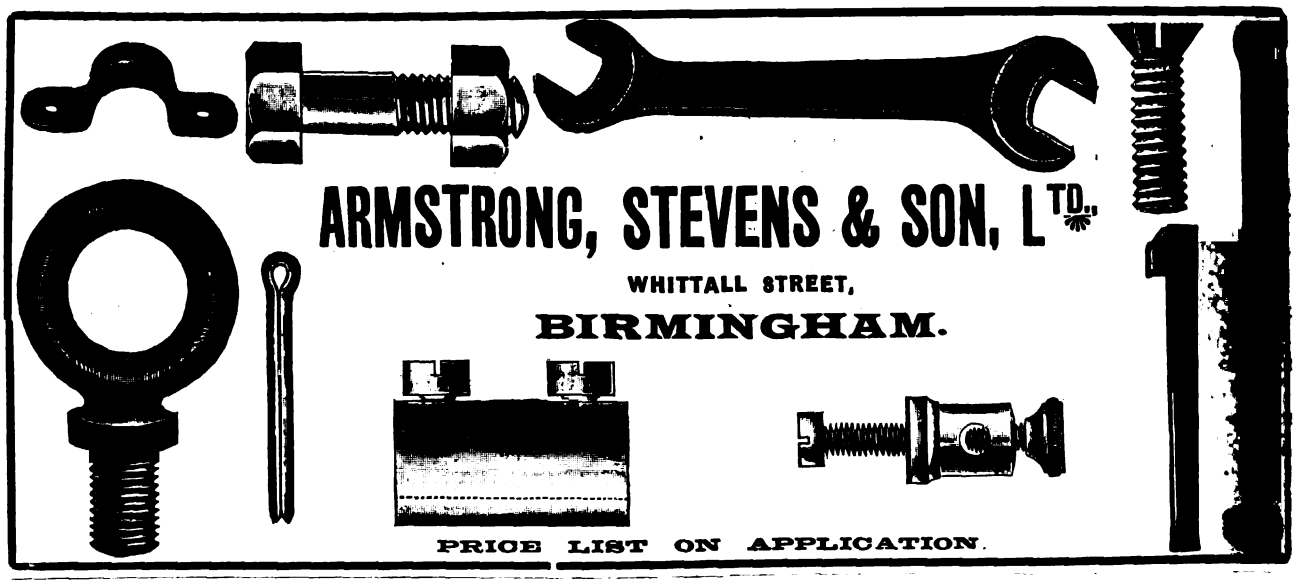

spindle is in one of its three running positions. The usual interlocking mechanism is provided to prevent the reverse switch being moved unless the main drum is in the "off" position.

The arc deflector of the controller consists of fire-proof barriers of strong mechanical construction, the large deflector plates being supported at both ends, and the small plates moulded with large bosses for the fixing screws, thus providing rigid fixing for the plates.

A powerful magnetic blow-out is provided for all fingers of the main cylinder on which arcing takes place, and an insulating trough surrounds the back half of the main cylinder protecting the frame from the influence of the arc or live parts. The trough is divided into sections by barriers; these, with the arc deflector which covers the front half of the main cylinder, form separate chambers for enclosing the various sections of the cylinder which may be at different potentials.

The brake cylinder is mounted on the main cylinder spindle in accordance with standard B.T.H. practice, this preventing any possibility of change in the relative positions of brake cylinder and handle which may occur, due to wear on the gears or cams when the brake cylinder is mounted on a separate spindle.

Ample space for the incoming cables is provided, and the arrangement of the various parts enables the wiring to be easily and quickly effected.

ELECTRIC CHARGING MACHINES.

We learn that Messrs. Babcock & Wilcox, Ltd., now include among their manufactures steel works cranes and charging machinery, and have just received an order for a slab-handling and charging machine, of 5-ton capacity, from James Dunlop & Co., Calderbank Steel Works, Scotland. The machine is electrically driven in all its motions and is designed, with several important improvements, to secure rapid handling of the slabs. It is expected that this machine will increase the output of the rolling mills and reduce the present labour costs at Calderbank.

NEW TRADE LITERATURE.

During the past week we have received a big budget of literature from various electrical manufacturers. We refer more fully to a number of special pieces of apparatus which figure in these lists in the pages of the "Supplement" this week.

FREEZOR FANS.—Section E of the General Electric Co.'s main catalogue describes and prices Freezor electric fans. The first item that meets the eye in the list is a table of reduced prices for the coming season. The list itself is replete with information on the subject of Freezor fans of every type. A noticeable improvement this year is the introduction of "airo blade." In this three narrow blades are placed one behind the other in the same plane on the fan motor-shaft. The blades are of the two-way type, and it is stated that for the same energy consumption 30 to 40 per cent. more air is moved. The pitch of the blade is determined by the speed of the motor, and in making inquiries for this type of fan the speed should be specified. The company is prepared to quote for the fitting of these blades to existing fans.

WATER LEVEL APPARATUS.—Siemens Bros. & Co. send us a copy of catalogue No. 533, in which their water-level transmitters and indicators are fully described. Various applications of this interesting and useful device are given, together with a number of illustrations.

WITTON SWITCHBOARDS.—Section X of the G.E.C. catalogue is devoted to descriptions, diagrams, illustrations and prices of Witton switchboards. Considerable care has been exercised in the preparation of this list, and the diagrams are noteworthy for their clearness and the interesting problems with which they deal. In addition to complete switchboards there is a useful list of accessories in the shape of switch material for building up various classes of gear.

WESTINGHOUSE FANS.—A pamphlet is being issued by the British Westinghouse Co. in the shape of supply list No. 140.2. In this the company's "Ariel" fans for desk, bracket, ceiling and cabin use are described and priced in detail. This list will be ready in a fortnight.

KINEMATOGRAPH RESISTANCES.—The M. & C. Mfg. Co., Conduit place, Paddington, London, W., have issued a useful list dealing with their regulating and plain resistances. These are built up in sizes varying from 5 to 100 amperes capacity, and are specially recommended for use in regulating arc lamps for kinematograph lanterns. The resistances are of the coiled wire type, and are arranged on suitable insulators fixed in metal frames.

FOSTER TRANSFORMERS.—A leaflet from the Foster Engineering Co. illustrates a 35 kw. and a 50 kw. Foster transformer. The company state that they make a special feature of large transformers for step-up or down single or polyphase, stationary or portable service.

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THE ELECTRICIAN COMMERCIAL AND INDUSTRIAL SUPPLEMENT.

C. & I. Supplement No. 87.] JUNE 2, 1911. [Gratis to Subscribers.

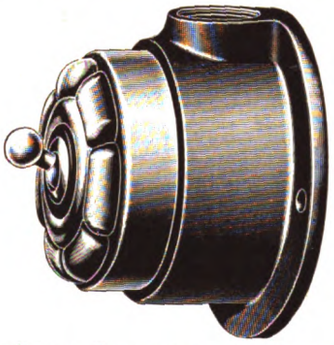
"SUN" SCREWED TUBE SYSTEM.

The many installations which have been carried out on the "Kalkos" system of wiring will have familiarised electrical contractors with the general merits of this method. When "Kalkos" was first brought out some four years ago the boxes for switches, ceiling roses, junctions, &c., were of brass, and the tubes were sweated into them. The type of box employed possessed a number of novel features, amongst which the adjustment ring was the most striking. With this fitment it is possible to utilise the same box for surface or flush wiring simply by the alteration of the position of the adjustment ring. To all intents and purposes this ring forms a false bottom to the box, on which the porcelain of the ceiling rose or switch is made to rest.

The general scheme of the "Kalkos" box has now been worked into the "Sun" screwed system of wiring. The boxes are of iron, and can be supplied with back entry or with side entries from one to four in number. The illustration shows a one-way "Kalkos" iron box into which a surface switch has been fitted. This view will serve to show the general arrangement of the other patterns of boxes. The lid of the box is another adjustable feature, and it can be supplied in two depths for surface or flush wiring.

By the use of the "Kalkos" switch (which we described in a recent issue) in these boxes a water and air-tight switch box is obtainable. When the switch is placed in position on the adjustment ring and held securely by the cover, the switch dolly is automatically earthed. This affords complete immunity from shock, because it is impossible for the dolly to become charged while the system is efficiently earthed. This automatic earthing is of great advantage, because no special connections have to be made, the act of screwing up the cover making the only contact necessary.

Similarly, with the "Kalkos" three-pin plug, which has been introduced to comply with the regulations which require the earthing of portable lamp-holders. The earth terminal in the plug socket is connected to a brass tongue, which projects below the porcelain base of the socket, and makes a rubbing contact with the adjustment ring in the box. This plug can be used on three-wire systems in which the barrel is employed as the neutral conductor. In this case the third pin can be used to carry current, and the pressure between it and the others will, of course, be half that between the two live conductors. There are numerous other interesting features of the "Kalkos" screwed tube system, but we would recommend our readers to apply to the Sun Electrical Co. for catalogue No. 201, section C, for more detailed information.



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PORTHOLE FANS

FOR

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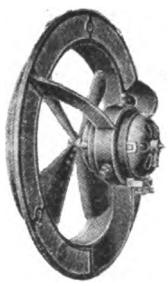

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IMPERIAL SUCTION CLEANERS.

We omitted to mention in our description of the Imperial suction cleaner last week that the small motors employed in connection with these cleaners are suitable for direct-current and alternating-current circuits, the latter of any frequency. The motors are wound for 100 volts. A lamp resistance is inserted on 200-volt circuits. We understand that the recent tests in a West of England city were direct-current supply at two voltages and alternating-current supply at two voltages and two periodicities. The motor of the cleaner was switched from one circuit to the other and operated with every satisfaction. This is somewhat of a critical test, but it should materially assist station men and electrical contractors in pushing this useful device. The motor is, of course, of the commutator pattern, and runs at the extremely high speed of 10,000 revs. per min.

ELECTRIC THEATRES.

We are constantly being reminded of the popularity of the electric theatre. Not only are these places of amusement to be found in practically every town, but there are out-of-the-way places almost without number in which they have been erected. This fact is no doubt indicative of the profit-bearing nature of this class of investment. But it is interesting to note how the electrical engineer has been able to contribute to the economical operation of the illuminating side of these places of amusement. The British Westinghouse Co. has prepared a brochure entitled "The Cinematograph Theatre," which sums up the situation on the opening page. Shakespeare's Iago remark "Put money in thy purse" is inscribed on the title page, with a sub-note to the effect that "this booklet tells you how." The booklet explains how the main source of electricity can be made to operate a motor-generator which will supply a bioscope lantern at a low voltage and thereby save the wasteful expenditure of many kilowatt-hours in resistances. These motor-generators are made up for alternating-current or direct-current supply, and they are worked out on highly efficient lines, also they run at a high speed and occupy a minimum of space.

Certain figures are given which explain the economy of the motor-generator. A 100-volt circuit must be reduced to 60 volts for the bioscope arc. That is 40 volts, with a current of, say, 60 amperes must be absorbed in the resistance, representing about 2½ units an hour. With energy at 2d. this is about 5d. an hour loss. Where the price is higher the loss is proportionately greater. In the case of a 200-volt supply the situation can only be summed up as it is in the booklet "dead loss," or in round figures 1s. 8d. per hour. If these losses are spread out for an extended period, on a rough calculation a sum of upwards of £200 will be expended in heating resistances. If these figures do not compel the bioscope manager to adopt the motor-generator it is difficult to understand what will. The brochure proceeds to describe the Westinghouse bioscope standard equipments, together with the necessary switchgear. Stand-by plant, in the shape of emergency resistances which can be switched on in case of the failure of the motor-generator, is also referred to.

Where a public supply of energy is not available the management must have recourse to either gas or petrol-driven dynamos, and in the booklet a brief description and illustrations of these units are given. Views are also shown of a number of cinematograph theatres in which Westinghouse equipment has been installed. Interested electrical engineers and contractors should apply for Special Publication No. 7,974/1. We understand a copy of this will be forwarded.

"ONEWATTS" AND AUTO-TRANSFORMERS.

A range of 55-watt "Onewatt" drawn tungsten lamps for high and low voltage circuits will soon be on the market. These lamps are of the same quality as the other sizes of "Onewatts," which are specially suitable for street lighting on account of the robust nature of the filament. They may be used for either alternating or direct-current circuits. They are being supplied in the same size bulbs as tantalums of the corresponding voltage and candle power. The price for 100 to 130 volt lamps in pear-shaped bulbs is 2s. 9d. each, and for 200 to 250 volt lamps 3s. 9d. each; round bulbs 3d. extra. The discounts and selling conditions are identical with those in force.

The new "Onewatts" can be supplied with either B.C. or Edison screw caps at the same price. We understand that Messrs. Siemens Bros. Dynamo Works have large stocks on hand, and orders can be promptly attended to. Lists dealing with these lamps will shortly be issued.

We have also to acknowledge from the same source receipt of a pamphlet dealing with auto-transformers for tantalum, "Onewatt" and other metal lamps. These are offered in sizes from 125 to 8,000 watts, and also a line of balancing, double-wound and bell transformers.

TURBO-BLOWER TEST.

At the invitation of the British Westinghouse Company a large number of managers of iron and steel works and others interested paid a visit to Trafford Park on Monday and Tuesday, May 29th and 30th, to inspect the test of a mixed pressure turbo-blower for operating in connection with blast furnaces. The blower has a capacity of 25 c.f. of free air per minute against 8 lb. to 10 lb. pressure. Considerable interest was shown by the visitors in the test, and every facility for inspection was afforded by the Company, the visitors being accompanied by several Westinghouse engineers.

OSRAM-LAMPS

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CENTRIFUGAL FANS

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The fan runner is so shaped that it gives more air per revolution, and hence can be run at a lower speed than any other like fan on the market.

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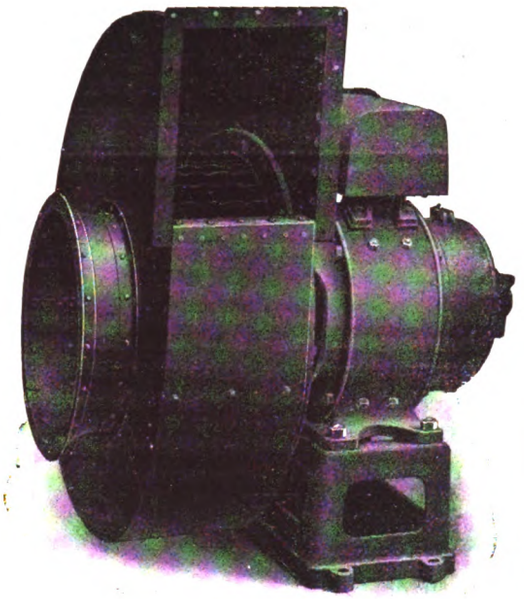

The Electric & Ordnance Accessories Co., Ltd.,
(Proprietors: VICKERS LIMITED.)
Aston, Birmingham.

SIEMENS CORONATION ILLUMINATIONS.

When the general catalogue of illumination material was issued by Siemens Bros. Dynamo Works we gave details of the designs and devices which had been prepared for the Coronation. We understand that a large number of buildings have been fitted up with Siemens material, prominent among them being that of Messrs. Woolland Bros., Knightsbridge. On this building there is a splendid array of illumination devices in wood and cut crystal glass, together with coloured transparencies of the King and Queen, and a number of shields, emblems, flags and wreaths. The drapery is also tastefully arranged, and the Bro-ite strip and floral festoons are employed with beautiful effects. The adjoining illustration gives a fairly good idea of the scheme, though, of course, it should be seen illuminated in order that all its pretty colour effects may be appreciated. Each carbon filament lamp as fixed in its Bro-ite strip holder is surrounded by a rosette which gives each individual lamp when illuminated the appearance of a flower. This effect is lost in the detail of the picture, but we reproduce in the top left-hand corner a large scale view of the lampholder.

Among other installations carried out by Messrs. Siemens we may mention Messrs. Mann, Crossman & Paulin, all the City offices of the Royal Mail Steam Packet Co., the Commonwealth of Australia, the "Statist," three branches of Williams, Deacons Bank, Cox's Bank, Gramophone (Ltd.), Brown, Shipley & Co., Shoreditch Town Hall, &c.

The installation work has been sublet to electrical contractors and much the same class of material as at Messrs. Woolland's has been used.

SIEMENS CORONATION ILLUMINATION DEVICES AT WOOLLAND BROS., KNIGHTSBRIDGE, LONDON.

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CHEAP STEAM PLANT.

We are reminded of the economies which are possible with the highly superheated form of combined steam plant known as the locomobile, by a new catalogue just issued by Messrs. R. Wolf. This illustrates and describes the latest types of Wolf locomobiles, which we understand are made in various types and sizes up to 800 H.P. With these machines the makers guarantee a coal consumption from 1·2 lb. per brake-horse-power-hour and a steam consumption of 9·7 lb. per brake-horse-power-hour. The company inform us that they have just shipped for Rio de Janeiro two 650 B.H.P. locomobiles. These plants will be installed in the emergency station at Nichteroy. The plant is of particular interest in that the engines are direct connected to the alternators which they drive. These machines are of the British Thomson-Houston make, and each has a capacity of 400 kw.

IFS AND QUERIES.

Will the Electro-Harmonic Society change its name for the 1911-12 season ?

Will the Publicity Committee survive the stress of the Olympia Electrical Exhibition ?

We have standard varnish, standard oil, engineering standards and standard bread, why not a standard metal lamp ?

Why are our gas contemporaries lacking in humour ? Can it be because they must now work at high pressure in order to make a living ?

Mr. Pain, the pyrotechnist, recommends gas as a Coronation illuminant because of its flickering proclivities. Has Mr. Pain forgotten that "all that flickers is not gold" ?

Will the automatic telephone be fitted with a tablet for the writing down of expletives ?

H. WEIDMANN,
RAPPERSWIL, SWITZERLAND,
FOR
Presspahn and Insulating Material.
(See larger Advt. last week.)

EXCELLO
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TWO YEARS' WARRANTY

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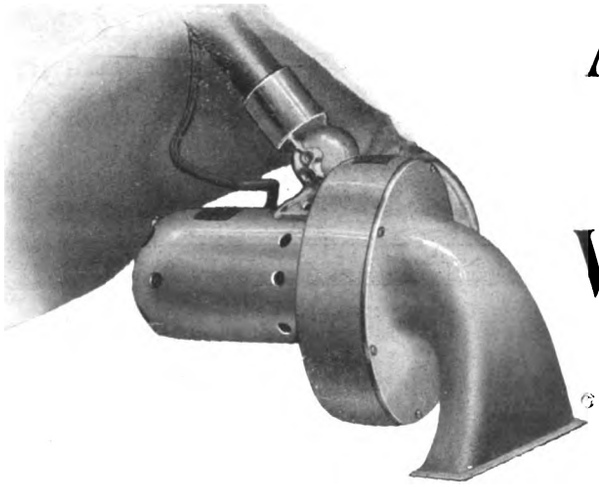

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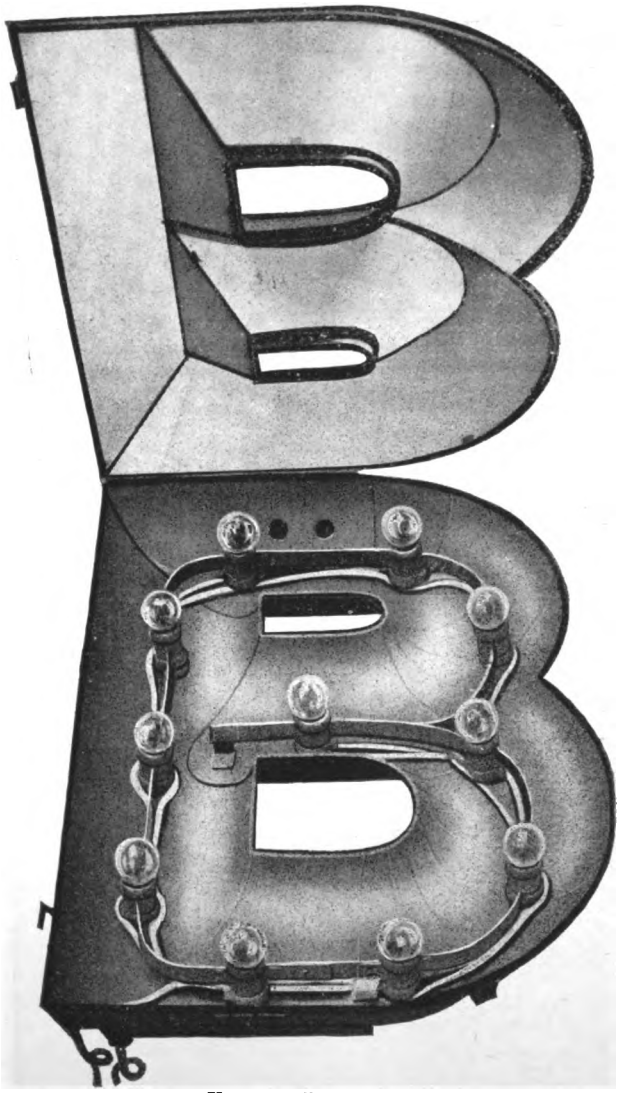
STERLING TELEPHONES
The Sterling Telephone & Electric Co., Ltd., 200, Upper Thames Street, London, E.C. Works: Dagenham, Essex.

NEW DAY AND NIGHT SIGN LETTER.

We have received advance particulars of a new pattern of illuminated letter which can be made up into signs and figures for display advertising, &c. It is known as the "Diamond" letter, and it will be seen from the illustrations accompanying this article that by reason of the shape adopted the letter is clearly visible from all angles. This has a particular advantage, as it admits of the sign being placed directly on the wall surface, where it can be securely fixed and presents a minimum of wind resistance. The letters are made up on an outer casing of enamelled metal, with front panels of opal glass. These panels are hinged, and can be opened to give access to the lamps inside, and also to admit of the cleaning of the glass. The lamp-holders themselves can be mounted in a substantial manner in the interior of the letter, and there is the further advantage of their being under cover and thoroughly protected from the elements.

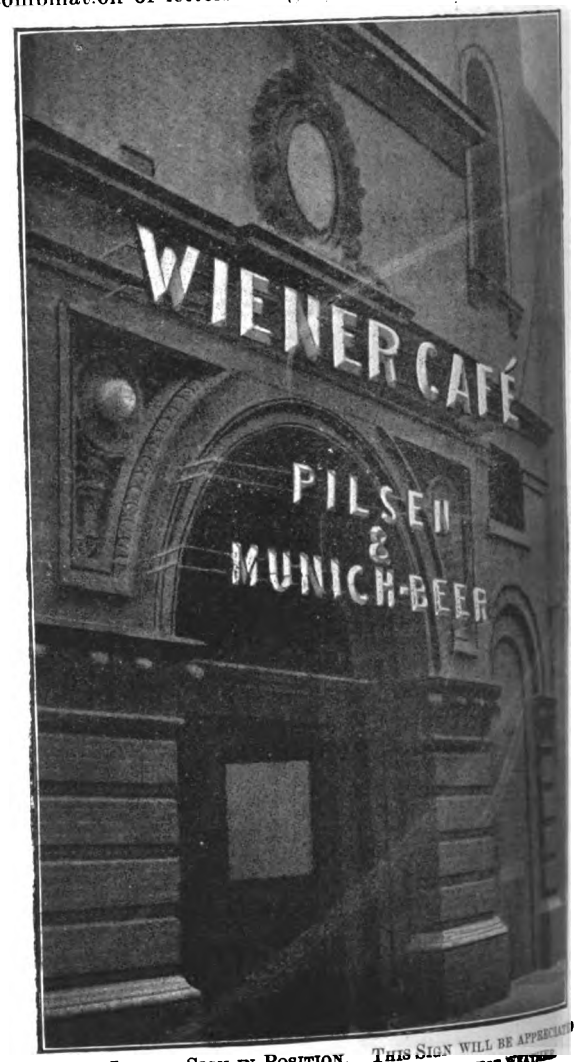


General View of Diamond Letter.—Open.

In a pamphlet just issued describing and pricing this interesting letter it is stated that, compared with wooden letters, the illumination can be carried out with one-half the candle-power. This is due to the design of the back of the letter affording an ample and efficient reflecting surface. The light from the lamps is also utilised to the fullest extent for the illumination of the letter, and none is wasted on the surrounding walls. The all-metal construction also reduces the chances of leakage, as there is practically nothing to absorb moisture.

The interior of the opal face of the letter, and in fact the exterior also, can be easily cleaned with a damp cloth. Any combination of letters or figures can be made up. Coloured lamps may be introduced and various effects obtained by the use of a suitable switch.

The wiring is arranged for 14-volt metal or carbon lamps and these are connected up in series parallel. The lamps in the letters are in parallel and the letters themselves are placed in series. The "Diamond" letter is made up in sizes varying from 12 in. to 48 in. high, and full particulars will be supplied by the makers, Messrs. Hill & Harrington, Great Portland street, London, W.



Diamond Letter Sign in Position. This Sign will be appreciated by our readers during the present spell of hot weather.

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Telephone : 6323 HOLBORN.
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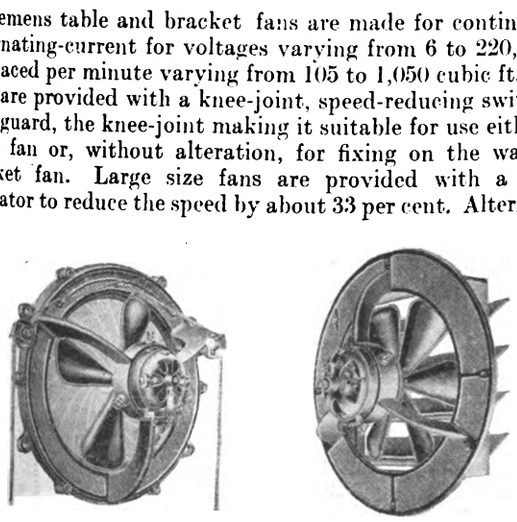
SIEMENS FANS.

Siemens table and bracket fans are made for continuous or ternating-current for voltages varying from 6 to 220, the air isplaced per minute varying from 105 to 1,050 cubic ft. These ns are provided with a knee-joint, speed-reducing switch and ire guard, the knee-joint making it suitable for use either as a ble fan or, without alteration, for fixing on the wall as a racket fan. Large size fans are provided with a special gulator to reduce the speed by about 33 per cent. Alternating-



Siemens Porthole Fans.

rent fans are provided with induction motors which run ntly, and, having neither commutator, slip-rings nor shes, can be left running for considerable periods without endance. Fans for installing in damp situations are pro-ed with special insulation.

A line of standard porthole fans is also made by Siemens os. Dynamo Works, and types of these are illustrated here-h. They are supplied for alternating-current and direct-rent motors and both horizontal and vertical positions. damp situations and acid-laden atmospheres a centrifugal e of fan is recommended, as in this case the moving air does not make contact with the motor. Fans and motors for every class of ventilation can be supplied, and full details will be forwarded on request.

METAL TUBOLITES.

The system of lighting introduced some years ago by the Linolite Co. has made considerable headway since its inception, and particularly so since the company introduced the metal filament into the system. 25-volt Tubolite lamps have been on the market for nearly three years, but we understand that the company now has a stock of 100 to 125 volt lamps, and that they are prepared to make immediate delivery. The candle-power of these lamps is 12, and the efficiency is stated to be 1·5 watts per candle. There is no difference in the price per foot of the complete fitting over that which obtained with the low-voltage lamps, so that there will be no complication in the matter of prices. A descriptive booklet has been issued by the company, and this gives full particulars of the Tubolite lamps and their fittings. In this we note that the Civil Service Supply Association has installed some 200 25-volt metal Tubolites, which have been running since December, 1908. Boots Cash Chemists are also large users of the same pattern of lamp.

DUST EXTRACTOR FOR COAL MINES.

A demonstration of a new apparatus for extracting dust from coal mines was given recently by Mavor & Coulson, Glasgow. The plant has been designed in view of the fact that recent experiments have proved that explosions in collieries are not gas explosions, but are propagated through the mine by coal dust. The dust extractor consists of a combination of pressure air jets directed upon the surfaces to be cleaned

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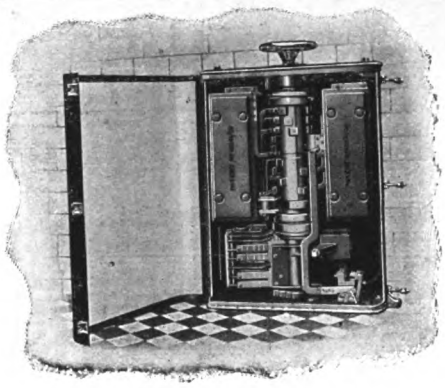
REYROLLE



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in order to raise the dust from them and the simultaneous withdrawal of the dusty air by suction. The apparatus is operated either by an electric motor or by compressed air where that source of power supply is used. Its main parts are a bell-shaped mouthpiece, close to which is a nozzle carrying a jet of pressure air, a means of obtaining the jet of air for disturbing the dust, a means of obtaining suction for with drawing the dust, and a filter for retaining it and allowing the air to escape. The apparatus may be adapted for searching deep crevices and for removing dust from above and around timbers, The plant will shortly be sent to a colliery in South Wales.

THE "ELECTRIC ARC."

Now that the days of electric propulsion for ships has arrived we shall no longer refer to a vessel as s.s. "Polly Ann," or whatever its particular name may be; it will have to be e.s. "Polly Ann," although this will not sound anything like so euphonius. In our special issue, "Marine Electrical Practice," published last year, we included an article on the alternating-current system of ship propulsion invented by Messrs. Mavor & Coulson. We have now received from this firm a brochure describing the equipment of a 50 ft. vessel with this system of propulsion. She has been built by McLaren Bros., Dumbarton, and is certified for the carrying of 50 passengers.

OSRAMS AT TORQUAY.

When the electricity works were opened by the Corporation of Torquay nealy 13 years ago the lighting of the Torbay-road and the High-street from Torre station to the harbour was entrusted to open-type Crompton arc lamps. These were supplied in series for three Ferranti rectifiers,and until just recently have been running continuously since they were started. The illumination was probably one of the best examples in street lighting by open-type arcs which could have been met with in this country, and no doubt the clearness of the atmosphere and the position of the lamps, particularly along the sea front, round Torbay, had a good deal to do with the result.

After so many years of yeoman service these arc lamps have had to give way to the high candle-power metal lamp. We give an illustration of a portion of the street lighting in the neighbourhood of the inner harbour, showing the 1,000 c.p.

STREET LIGHTING AT TORQUAY WITH 1,000 C.P. OSRAM LAMPS.

Osram lamps now in use. By the installation of these lamps the rectifier plant—which is now, of course, obsolete—has come out of service. The labour item for attending to these machines and also that formerly necessary for the trimming of the arc lamps, has also been saved. Mr. Salt, the borough electrical engineer, is, we understand, particularly pleased with the economies which this alteration has effected, and the Town Council is also very satisfied with the lighting of the streets.

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THE ELECTRICIAN COMMERCIAL AND INDUSTRIAL SUPPLEMENT.

C. & I. Supplement No. 88.] JUNE 9, 1911. [Gratis to Subscribers.

GLASS GLOBES FOR STRIP LIGHTING.

In Coronation illumination material such as continuous lengths of lighting strip the effect of the small lamps can be considerably enhanced by the use of glass globes. The Sun Electrical Co. are offering these glass globes to clip over their "Suncolite" lamps or any other form of lighting strip. The globe is held in position by small clips as shown in the illustration. They are supplied in two sizes 4½ in. and 6½ in. diameter,

GLASS GLOBE FOR SUNCOLITE AND OTHER STRIP ILLUMINATING MATERIAL.

and are stocked in five colours—red, white, blue, green and amber. The globe is easily fixed, and from samples shown to us in the Sun Electrical Co.'s show-room the improvement in the lighting effect is very marked. The globes look very well at intervals of about 3 ft. to 6 ft. with the smaller lamps in between. Contractors and central station engineers should make early application for these globes before the stock is exhausted.

ICE MAKING.

A cool subject for the sultry weather! Central station service should benefit in these sweltering days, for although people do not want light or heat they are crying out for fans and ice. The electric fan is sufficiently well known now to be demanded by a gasping public when the temperature gets into the "eighties," and contractors and the trade generally are able to cope with the demand.

An entirely different class of service is that given to the electric ice-making plant. This kind of load is not cultivated "on this side" like it is in the States, where a flourishing business in small ice-making outfits is done. These are usually just big enough to be driven by a small motor, and the additional load is welcome enough to the central station. We believe that many of the smaller electricity plants in America are able to fill in the valleys of the summer load by giving a supply to ice-making plants. As a rule the load is a 24-hour one during the season, because the heat is maintained and so also is the demand of the public for ice.

Here in this country there are ice and cold storage plants which do a great business all the year round. The foods imported to our great shipping commercial centres need preservation, and only a low temperature will assure this. These storages generate their own energy and compete in some measure with the smaller plants which hotels, restaurants, &c., might otherwise instal. There is, however, a ripe field for central station service if the publicity men will chase round and garner the harvest. This must be particularly the case in types of small towns which are remote from an ice supply, and where very large quantities of ice are not really required. Perhaps those station men who supply cold storage and small ice-making plants can give us some information on this subject.

Railway Lighting.

Victoria Station. London (Underground Rly.)

ILLUMINATED BY

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LAMPS.

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WATER-LEVEL INDICATORS.

In a recent issue we remarked upon the publication of a new list by Siemens Bros. & Co. in which their water-level indicating

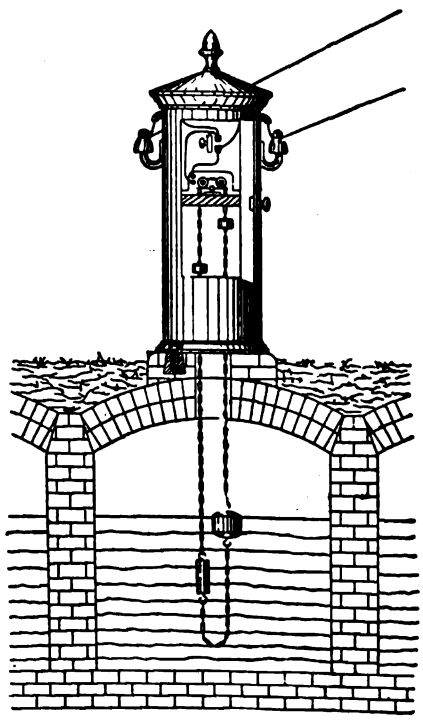

FIG. 1.—WATER-LEVEL TRANSMITTING PILLAR FOR USE OVER UNDERGROUND RESERVOIRS, ETC.

appliances were described in detail. We are now able to illustrate patterns of this apparatus. For purposes of water-level indication a transmitter, indicator and battery are necessary. The transmitter, which is always in a damp situation, is provided with a watertight case, which adequately protects the contacts from the effects of oxidation. Fig. 1 shows a pattern of transmitter which is enclosed in an iron pillar box and is suitable for mounting over an underground reservoir. The transmitting wires are arranged on insulators on the top of the pillar, and a lightning arrester is also fitted. In Fig. 2 is shown a level indicator with recorder which is intended for a terminal station. The apparatus is contained in a polished walnut case, which also is fitted with train with large dial, plate lightning arrester for two lines, bell-recording device and drum. This apparatus is supplied for levels of 10 ft. and 20 ft., and the clockwork can be wound for one or seven days according to the size used. For an intermediate station the apparatus is slightly modified.

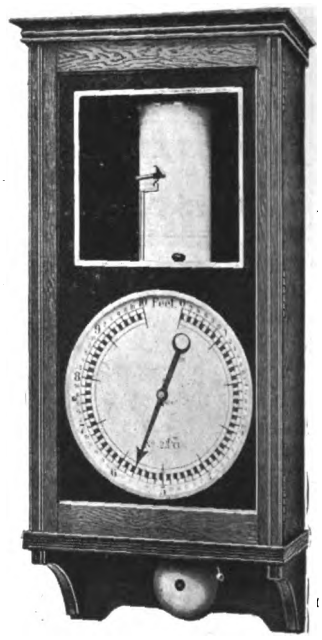

FIG. 2.—WATER-LEVEL INDICATING AND RECORDING INSTRUMENT.

In the catalogue to which we have referred above a line of bell switches with auto-replacement is described. These can be employed on waterworks where the minimum or maximum water level of the reservoir is maintained over a long period. In such cases it is inconvenient if the corresponding bell signal is continued over the whole of this time. The switches in question permit of the disconnecting of the bell by sharply depressing a button. In the same list a series of portable telephones with buzzer call, &c., is described.

FAN PUBLICITY.

"Phew! Ain't it 'ot, Bill? What?" This has been the cry of the last few days, and there should have been a boom in electric fans in consequence. The Electric Supply Publicity Committee in their new publicity issue are giving a special fillip to electric ventilating and cooling.

In the fan poster the breezy and exhilarating effects of an electric fan are depicted. An old sea captain of jovial aspect is caught in the full blast of an electric fan at top speed, and, to judge by his countenance, he thinks it only a trifle second best to a "sou' wester." To follow up this there is a 6 pp. folding booklet, illustrating fans for various uses, and with an illustra-

OSRAM·LAMPS

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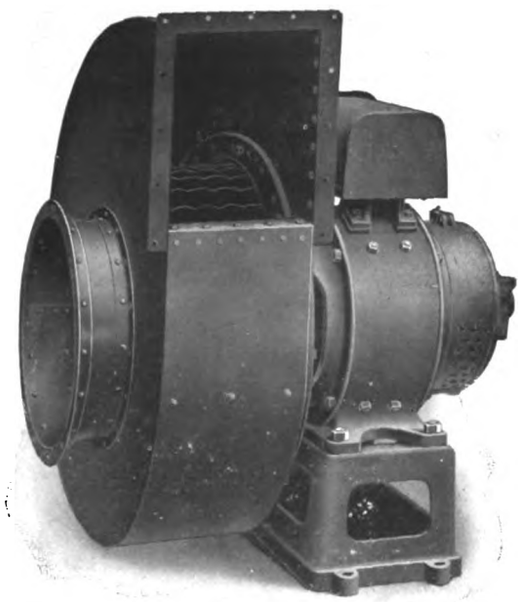

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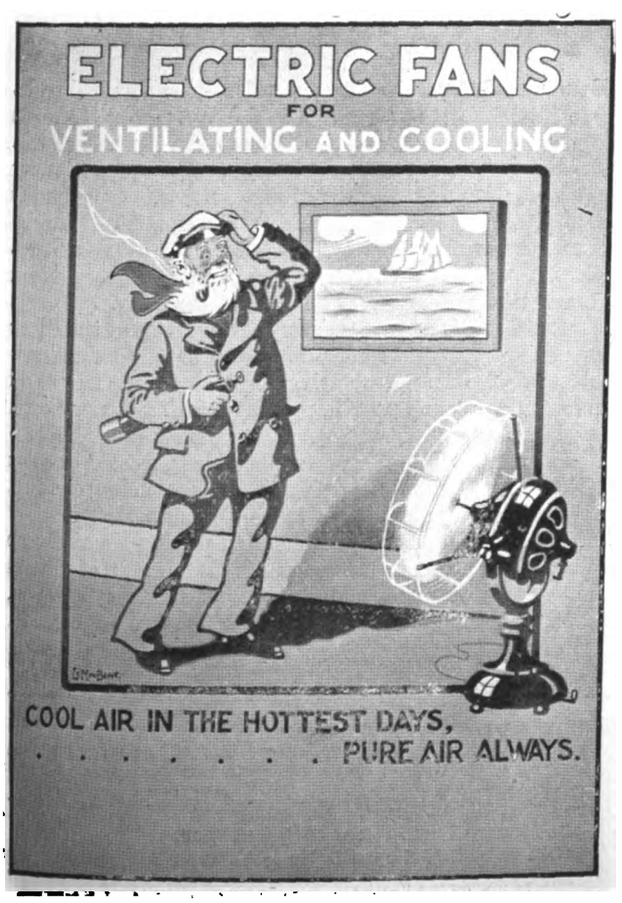

ELECTRICITY SUPPLY FAN POSTER.

tion on the cover which should commend these fans to all homes where comfort is a consideration. This booklet is suitable for sending out with the June quarter's accounts or with the receipts. There is also an adhesive label included which is a miniature of the poster, and which may be useful for attaching to correspondence.

The issue also includes an ironing folder, which is adjusted to go in the ordinary correspondence envelope, and should be useful for pushing this important side of electricity supply.

The Committee have also done a little catering for the trade in the way of a circular on electric signs. The circular should appeal particularly to shopkeepers, and the arguments are driven home with a number of illustrations.

MARELLI OSCILLATING FANS.

Electrical contractors and central station engineers will be interested in a new leaflet, L.B. 11/16 of their 1911 season fans, which Ercole Marelli & Co. are putting on the market this season. The fan is of the oscillating type, and can be supplied for alternating-current and direct-current circuits. This fan is of the convertible type—that is, it can be used as a desk or bracket fan. Interested readers should make application to the offices of the company, 26, Garlick-hill, London, E.C.

REYROLLE WALL PLUGS

For Portable Machines, Lights, &c.

Pamphlets 114, 122, 88 and 45 give all particulars

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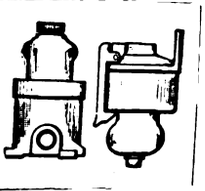

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THE DIAMOND SIGN.

Messrs. Hill & Harrington, whose diamond sign we described in last week's issue, write us to the effect that while they are the patentees and owners of the Diamond letter, those shown in the illustration of Wiener Café were supplied by them through S. J. Smith & Co., 46A, Holborn-viaduct, London, E.C.

WESTINGHOUSE TURBO BLOWER.

We stated in error in last week's issue that the turbo-blower which a number of colliery engineers inspected recently at the Westinghouse Works had "a capacity of 25 c.f." This should, of course, have read 25,000 cubic ft.

BRIMSDOWN OUTING.

Over 500 "Brimsdownites" and their friends saw things in a better light last Saturday at Hastings, the occasion being that of the third annual outing. The large party left Brimsdown in a special train at a very early hour, and Hastings was reached at about 8:30. The heat of the sun was tempered during the morning by a sea fog, but the afternoon was superbly fine. Luncheon was served in the Royal Concert Hall, and it was a particularly gay company that sat down to a most enjoyable repast. Mr. E. Scharrer, the genial general manager of the Imperial Lamp Works, was in the chair, and on rising was accorded a great reception, an incident which abundantly testified to his popularity. His health was proposed in pleasing terms by Mr. Haynes, of the Nottingham office, who dealt particularly on Mr. Scharrer's activities at the works, and also upon his kindly treatment of those employed there. After lunch the party broke up, and generally amused themselves in the neighbourhood, there being no set programme for the afternoon. The officials and their friends much enjoyed a char-a-banc ride to Battle Abbey, and returned in time to join the special back to town. The outing was voted a huge success. The company also included Mr. J. J. Chiswell (the sales manager), and Mr. M. Brinckmann. The latter carried through the whole of the arrangements, and was the recipient of a special vote of thanks for his efforts. But for the fact that the outing clashed with the Whitsun Holiday, there would have been 600 present, this number being employed at the works.

IFS AND QUERIES.

If the N.T.C. is not transferred to the G.P.O. at the year end, will the P.M.G. be present at the next Annual Dinner?

Will the Inst.E.E. arrange its summer meeting before or after the I.M.E.A. next year?

Will Mr. Hope Jones fit his clocks to all the Coronation Arches?

What has become of the sea serpent in the daily press these hot days? Perhaps it is another victim of "the fusing of electric wires"?

NEW TRADE LITERATURE.

ELECTRIC BELLS AND TELEPHONES.—The new bell and telephone list of Falk, Stadelmann & Co. is a publication of over 100 pages and contains a vast amount of information on electric bells, pushes, indicators, bell pulls, wires and staples, wiring accessories, wet and dry batteries, switches, telephone instruments of all kinds, portable electric lamps, &c. We do not remember having seen so comprehensive a catalogue dealing with this subject. We should recommend every electrical contractor to make early application for a copy.

SERIES STRIPLITE.—The Lamp Department of the Electrical Co. is offering series striplite for coronation illuminations at a special price of 1s. per point, which includes the lamp. Striplite is made up with porcelain holders 5 in. apart supported by flexible metal bands and complete with 2 c.p. 14-volt pear-shaped lamps which can be supplied clear, frosted or coloured.

GRAPHITIC CARBONS.—Geipel & Co. are sending out two lists dealing with their Graphitic carbon brushes for dynamos and motors, and also a list describing and pricing Henrion carbons. This last-mentioned list contains a number of interesting photographs of various kinds of arcs, flame type, open, enclosed, searchlight and welding, which are of considerable interest.

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THE "LIGHTNING" GRILLER.

An interesting addition to the ranks of electric cooking and heating appliances has recently been made in the shape of the "Lightning" griller. This has been designed for pressures up

FIG. 1.—ELECTRIC GRILL.

to 250 volts, and is being introduced by Siemens Bros. Dynamo Works. In the adjoining illustrations Fig. 1 shows the electric heater, which is a detachable unit, and is made up of copper or aluminium with hard wood carrying handle. The grid and cooking dish and tray shown in Figs. 2 and 3 are for use in conjunction with the heater. When the food is to be cooked it is placed on the grid, which in turn is placed over the cooking dish

FIG. 2.—GRILL PLATE.

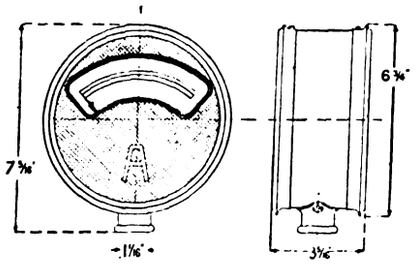
or tray. The heater is then placed on top and the heat is directly applied to the meat on the grill. Cooking commences as soon as the heater is turned on. We understand that two pieces of toast can be made in five minutes with an energy consumption of $\frac{1}{30}$th unit, or 1 lb. of sausages will be fully cooked in the space of 15 minutes, $\frac{1}{10}$th unit being required to furnish the

FIG. 3.—COOKING DISH AND TRAY.

requisite heat. We are informed that the grill is quite simple in operation, and that it can be cleaned thoroughly after use with a minimum of trouble. Full details are contained in a price list just issued.

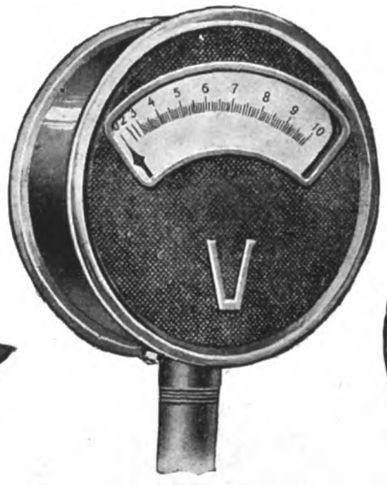
"ADNIL" INSTRUMENTS.

Particulars have been issued by the Adnil Electric Co. of a line of electrical instruments which they have put on the market. These instruments are made for alternating-current and direct-current circuits, and are of the electro-magnetic type. The makers state that the effects of wave form and frequency in the alternating-current instruments are comparatively



GENERAL DIMENSIONS OF AMMETER.

slight, also temperature errors are practically negligible. The energy consumption of the instrument has also been reduced to a minimum. The oscillations of the needle are damped by an air dash pot, and all moving parts are enclosed in dustproof cases. At the same time the coils themselves are well ventilated. The moving spindle is mounted in jewelled bearings at



FRONT CONNECTION VOLTMETER.

OPEN SCALE AMMETER.

both ends. The standard finish of these instruments is black enamelled case with polished nickel front rim. The instruments, types of which are illustrated herewith, are intended mainly for switchboard use, and can be supplied both as regards

SIMPLEX CONDUITS Ld.,
Garrison Lane, BIRMINGHAM.
Manufacturers of—
CONDUITS, CABLES, ACCESSORIES, FITTINGS, MOTORS, ELECTRIC HEATING AND COOKING MATERIAL, &c.

EXCELLO
FLAME ARC WITH UNIQUE
TWO YEARS' WARRANTY

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STERLING TELEPHONES
The Sterling Telephone & Electric Co., Ltd., 200, Upper Thames Street, London, E.C. Works: Dagenham, Essex.

ammeters and voltmeters with front and back connections. List AE. 58, just issued, gives full details of these instruments. They can be divided into two main types, model BN, with 6 in. dial, and model K, with 4 in. dial. In the model BN type instruments are made as voltmeters for pressures up to 750 volts, and as ammeters for currents up to 800 amperes, without transformers. The makers state that voltage and current transformers are only required for instruments above these pressures and capacities. It will be seen from the illustrations that the scale readings are open and distinctive, though these can be made suitable for any special requirements.

B.T.H. ELECTRIC KETTLE.

Particulars have reached us of a new pattern electric kettle which is being introduced by the British Thomson-Houston Co. The feature of this kettle is the heating element. This is made up of calorite wire wound on a mica former, which is then enclosed between two cast-iron plates and insulated from them by mica discs. This should make a particularly useful element, as calorite has a melting temperature of 2,800°F. This means that the heating element is thermally indestructible under service conditions. Of course, if the kettle is left on circuit dry, the bottom would be badly burned, but the element itself would not be destroyed. The element can be removed and readily replaced by the user if it is desired to connect the kettle to a circuit of different voltage.

The body of the kettle is of solid copper, highly polished and finished. The interior is tinned to prevent corrosion, and the normal capacity is two pints; at the same time $2\frac{3}{4}$ pints of water can be got into the kettle. The rating is 500 watts, and the kettle will boil two measured pints of water at 60°F. in $17\frac{1}{2}$ minutes. The kettle is listed at 20s., and is offered in four sizes, giving voltages from 95 to 250. Price list No. 298 gives full particulars and also details of the accessories and separate parts of the kettle.

MORE SIEMENS CORONATION INSTALLATIONS.

We are informed by Messrs. Siemens Bros. Dynamo Works that, in addition to the contracts for complete Coronation schemes to which we referred in our last issue, they have secured a further batch of orders. As in the previous cases, the work will be sublet to electrical contractors. The customers include the Commerical Union Assurance Co. for their City and Pall Mall offices, Kensington Town Hall, Kensington Library, North Kensington Branch Library, Kensington Baths, and Messrs. Carreras (Ltd.), Arcadia Works, City-road.

HENLEY'S FLEXIBLES.

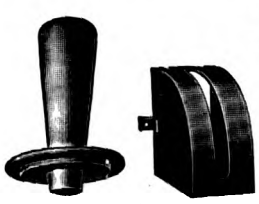
A particularly attractive catalogue is being issued by Messrs. W. T. Henley's Telegraph Works. The list is noteworthy from the manner in which the cover has been arranged and the matter itself displayed. We understand that this is the first time the Company has issued a separate list dealing with their flexibles, the data and prices for this particular product having previously been embodied in their V.I.R. cable list. There can be no doubt that this separate publication will be much more convenient and will be generally appreciated. We understand that several classes of flexibles have been added to the new list, and amongst these we may specially mention what are known as Home Office flexibles, which are braided with specially hard cord which affords as effective a protection as metallic covering; at the same time it obviates the necessity for earthing the protective covering.

A "LOW FREQUENCY" ARC LAMP.

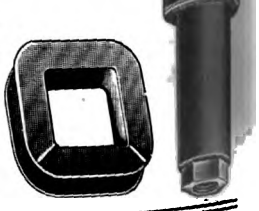
Consumers on low periodicity (anything below 40 periods) alternating-current circuits will be interested in a new form of arc lamp which possesses advantages over the ordinary enclosed arc lamp actuated by a coil. The construction is of the simplest, and little trouble is experienced in making adjustments, and hence unskilled labour can be employed for cleaning and trimming. The regulation is based on an improved form of the thermo-expansion principle—a strip of special alloy being used to operate the essential working parts. Increased reliability is secured by the absence of a dash pot. A high power factor is also maintained in the circuit because the lamp has practically no self-induction. This is most important when a large number of lamps are employed, because the P.F. may be appreciably decreased owing to the presence of coils and relatively large masses of iron.

On 200-440 volts it is recommended that the lamps be run in series-parallel with a transformer. This not only makes for steadiness and reliability, but each lamp is independent, and can be switched on and off regardless of any other lamp connected to the same transformer. This method, too, renders a substitutional resistance and auto cut-out unnecessary when a number of lamps are run on a high-voltage circuit. The lamp is made by the Foster Engineering Co., Wimbledon.

H. WEIDMANN, RAPPERSWIL, SWITZERLAND.
Manufacturer of PRESSPAHN AND INSULATING MATERIAL.



PRESSPAHN in sheet, rolls and tapes. Presspahn tubes and stampings.
CORNITE, high tension Material. Handles for Switchgear and Heating Apparatus. Controller Insulation. Moulded parts of all kinds.
ASBESTOS CEMENT in Plates, Arc Shields for Controllers, &c.
AMIANITE, Vulcanised Asbestos. Coil Frames. Spools for Dynamos, Motors and Transformers. Boxes, &c. Insulating Blocks, Tubes, Plates.



Insulators for Electric Furnaces, Tramways, &c.
Insulating Pearls, MICA and Substitutes. Transformer Spools.
Japanese Paper in Rolls and Tapes. Oil Varnished Linen, Silk and Paper, &c.

Printed and Published by GEORGE TUCKER, at the Editorial, Printing and Publishing Offices, 1, 2 and 3, SALISBURY COURT, FLEET STREET, in the City of LONDON, FRIDAY, JUNE 9, 1911.

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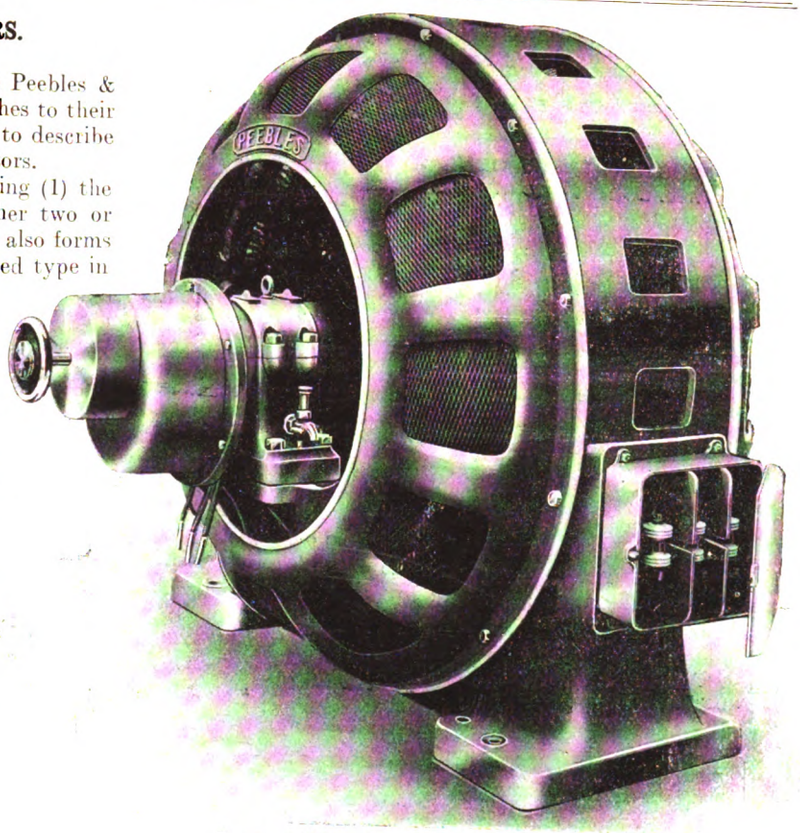
THE ELECTRICIAN COMMERCIAL AND INDUSTRIAL SUPPLEMENT.

. & I. Supplement No. 89.] JUNE 16, 1911. [Gratis to Subscribers.

PEEBLES A.C. LARGE TYPE MOTORS.

The dynamo electric products of Messrs. Bruce Peebles &). are well known, and considerable interest attaches to their test catalogue, which has been prepared in order to describe e Peebles large size alternating-current motors. The catalogue is divided into two parts, describing (1) the dplate type motors, in which the bearings, either two or ree in number, are mounted on a bedplate, which also forms base for the motor body, and (2) the self-contained type in hich the bearings form part of the motor case. e illustrate one of these latter machines, and it ll be noticed that a particularly compact type of nstruction is obtained in this pattern. The otor has been designed to meet the require-nts of industrial service, where the space al-ted to the power agent is, more often than not, ited. The motor has been designed for the ving of fans, pumps and other types of industrial chinery. The general electrical features are ilar to the firm's standard machine, the dis-tive difference being in the arrangement of the rings and the slip-ring gear. The bearings are he pedestal type and are carried on suitable sup-ts cast as part of the end hoods. This arrange-nt places the bearings well within the limits of body of the machine. It also admits of the rings being fixed in a convenient and accessible tion. The machine illustrated is of 150 B.H.P. was designed for operation on a 3,000-volt uit.



PEEBLES 3,000 V. 150 H.P. SLIP RING MOTOR.

TITTENSOR CHASE, STAFFS.
Illuminated throughout by OSRAM Lamps.
Contractors, Messrs. Blackburn, Starling & Co., Ltd., Hanley, Staffs.

Country House Lighting

BY

OSRAM

LAMPS.

The General Electric Co., Ltd., Head Office: 67, QUEEN VICTORIA ST., LONDON, E.C.

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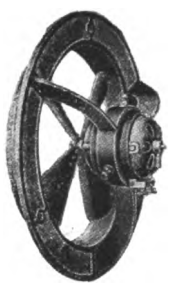
SIEMENS

PORTHOLE FANS

FOR

CONTINUOUS AND ALTERNATING CURRENT.



Standard Porthole Fan.

Write to our Supplies Dept. for Prices and Particulars.

SIEMENS BROTHERS DYNAMO WORKS LIMITED.

HEAD OFFICE: CAXTON HOUSE, WESTMINSTER, S.W.

Telephone: GERRARD 960. Telegrams: "SIEMBRALOS, LONDON."

Supplies Dept.: 39, UPPER THAMES STREET, E.C.

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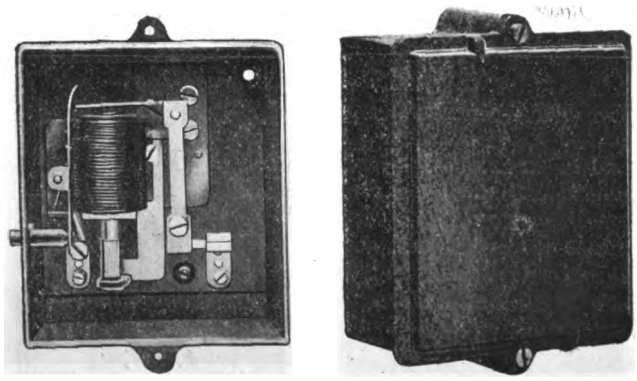
ADNIL LIMIT SWITCHES.

In certain classes of consumers' installations a meter cannot profitably be installed, and a fixed charge for a certain number of lamps is made. In order to prevent the consumer exceeding the agreed number of lights some current-limiting device is used. Its functions should be to first warn the consumer of the excess and then to interrupt the supply altogether if no reduction in the load is made. We illustrate an interesting current-limit switch with which the Adnil Electric Co. has made



THE ADNIL SWITCH WITHOUT AND WITH COVER.

considerable headway. It is constructed for alternating-current and direct-current circuits, has a current range of from 0·2 to 6 amperes. It is a simple series solenoid device and previous to the opening of the circuit it "flickers" the lights, thus giving visual warning of its likely operation. It is enclosed in a cast-iron case which may be sealed by the supply authority after the switch has been adjusted for the desired current. The switch is made single pole only.

These switches should enable supply stations to make profitable fixed contract rates with small consumers for a few metal lamps. For consumers installing, or requiring to burn, at one time, only a few lamps, the running cost to the station is small. The lamps may be burned one hour or 3 to 6 hours per day or more, because the rates fixed for each consumer per lamp per annum will cover the fixed standing charges and the profit for the supply authority.

There are considerable advantages with this system. The consumer knows how much he has to pay per annum, and the supply station also knows how much it is to receive. The costs of account checking and meter reading are therefore avoided.

The general failure of supply stations to obtain small consumers in competition with gas and other forms of lighting is largely due to the fact that the small consumer has a persistent idea that electric lighting is too expensive for him. With this system he will be found willing to pay a fixed sum per annum for all the electricity he uses.

Where a supply is given for heating and cooking, power &c., on the ordinary system it is merely necessary to have a lighting and power circuit with a limit switch on each. One of the chief applications of these switches, however, is for lighting circuits. The Adnil limit switch corresponds, in great measure, to a slot meter in its working. The cost of the switches is only about 9s. each net for the small sizes up to 3 amperes in cast-iron cases. The most useful size is probably that for adjustment of 0·2 to 1 ampere limit. This would provide for a maximum 3 to 14, 16 c.p. metal lamps installed on a 220-volt circuit and all alight at one time, and be suitable for, say, the installation of one-and-half times to twice that number of lamps by the consumer.

This cost of 9s. per switch is only about one-third to one-sixth the cost of a meter for similar requirements. The system of charging by contract rates with limit switches is especially applicable to cottage and artisan dwellings and is well worth the consideration of central-station engineers seeking to extend their supply in these directions.

The fixing of the contract rates depends of course on the capital and standing charges and running costs of the respective supply station and the kind of lamps used, and is a matter for the decision of the station engineer. We understand that sample switches will be supplied to order.

A further application of Adnil limit switches is in connection with the well-known Therol system of electric water heating by contract. When the current is switched off the heater or to the lights, &c., it is necessary for the supply station to know that a certain current limit or wattage will not be exceeded by the consumer. For such installations meters would, of course, be considered little else than a superfluous expense both to the supply station and to the consumer.

THE C.W. TESTING SET.

A new instrument is being put on the market by Messrs. Elliott Bros. under the above title. These testing sets are of the dynamometer pattern, and, with the addition of transformers, are suitable for use on alternating current, or with shunts they can be used on both alternating and direct-current circuits. They are made in several distinct combinations. The construction of these instruments is such as to make them practically independent of the wave form and periodicity of the circuit on which they are used, as well as being free from errors due to temperature variations. They are spring-controlled, with balanced movements and dead-beat action, as

OSRAM-LAMPS

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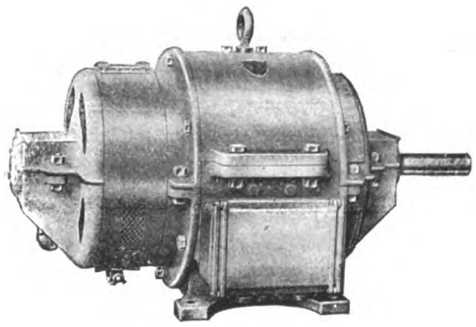
VICKERS MOTORS.



ALL SIZES UP TO 50 H.P.

Liberally rated, they can be subjected to severe intermittent overloads without trouble.

For certain conditions of service, interpoles are fitted, thus ensuring freedom from sparking under overload or frequent reversal.

Commutator of ample depth for years of wear.

Current carrying parts are of sufficient section to avoid overheating.

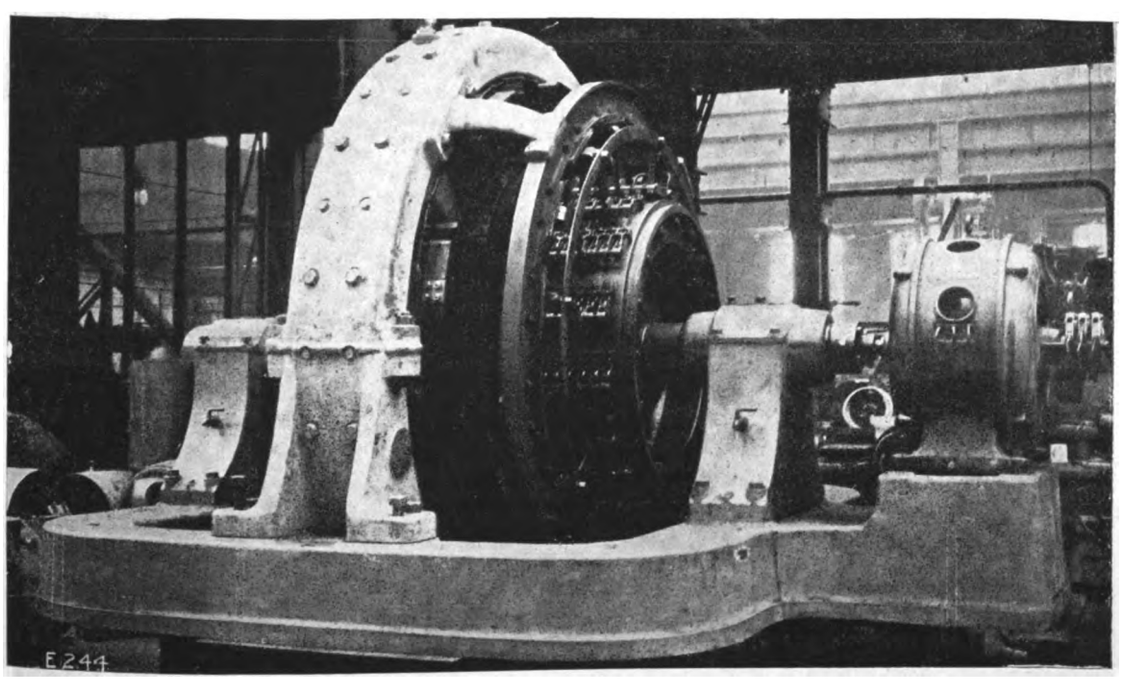
ALL PARTS TO GAUGE.

The Electric & Ordnance Accessories Co., Ltd.,

Proprietors: VICKERS LIMITED.

LONDON—Electric Motors and Export Business: Vickers House, Broadway, Westminster, S.W. (C. S. Thomson.)
MANCHESTER—196, Deansgate.
GLASGOW—J. & A. ANDERSON, 231, St. Vincent Street.
NEWCASTLE-ON-TYNE—J. MORLEY, Consett Chambers.
NOTTINGHAM—F. S. MANSFIELD, 197, Station Road, Beeston, Notts.
NEWPORT (Mon.)—C. R. HOUGH, 7, Summerhill Avenue.
YORKSHIRE—F. MACCALLUM, Austhorpe Road, Crossgates, Leeds.
IRELAND—The Hurst Electric Manufacturing Co., Clokey's Buildings, King Street, Belfast.

VICKERS' 500 kw. ROTARY CONVERTER



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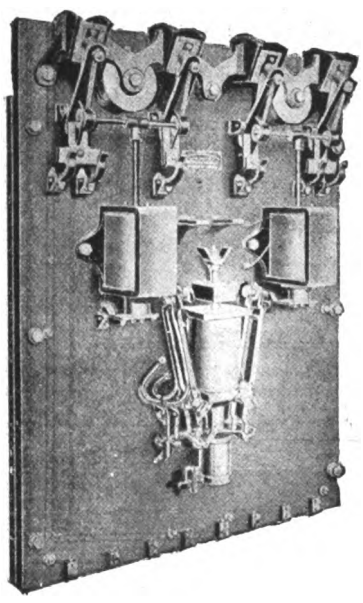
PATENT
D.C. LIFT CONTROLLERS,
Car Switch and Push Button Types.
Strongly constructed in every detail, and, having NO SLIDING CONTACTS, these Controllers are most reliable in service.

We are Specialists in Lift Controllers, both D.C. and A.C., and in Automatic Starters and Accessories for the automatic control of Pumps, Hydraulic, Accumulators, Air Compressors, Machine Tools, Capstans, etc.



All "EMPIRE" apparatus is BRITISH MADE from FIRST to LAST.
Write for Catalogue E.

ELECTRIC CONTROL, LTD.
177, REID STREET
BRIDGETON, GLASGOW.
Telegrams—"CONTROL, GLASGOW."
Telephone—2847 BRIDGETON.

all the parts are carefully selected and, where necessary, aged to secure permanency of calibration. An automatic clamping device is fitted to protect the instrument in transit, and, in common with all instruments of Elliott manufacture, a zero device is fitted to enable the pointer to be accurately adjusted to zero without breaking the seals.

The makers recommend this type of test set where instruments of maximum precision are required. Full details and prices in section G, list 11.

"ONEWATTS" AT MARGATE.

The contract for the supply of Tantalum and "Onewatt" Lamps, together with special fittings for the Fort Pavilion, Margate, has been placed with Siemens Bros. Dynamo Works. This pavilion is a magnificent new concert hall, and the fittings have been specially designed in order to obtain an artistic illuminating effect. In the centre of the main hall there will be four cut crystal glass electroliers, each having 6 in. to 9 in. projecting arms, with 10 c.p. to 30 c.p. lamps in each. There are also four similar cut crystal glass electroliers in which 8 c.p. to 50 c.p. Tantalum lamps are installed. Under the balconies there will be 14 holophane bowl fittings, each having three projecting arms; in the central bowl a 200 c.p. "Onewatt" lamp will be installed, and 50 c.p. Tantalum lamps in the holophane reflectors on each of the projecting arms.

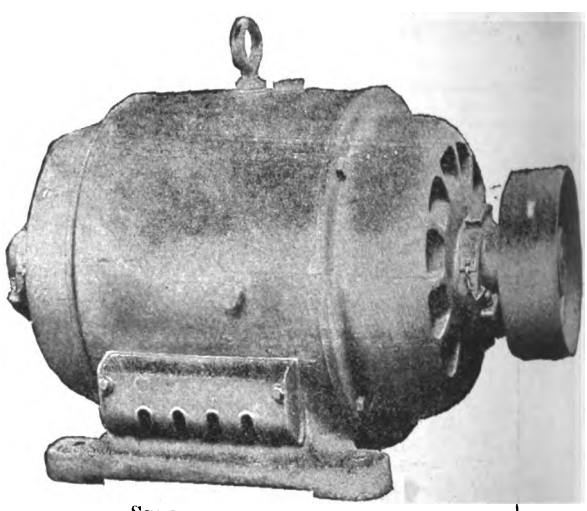
Under and over the gallery there will also be four holophane bowl fittings similar to the above but without projecting arms, and 200 c.p. "Onewatt" lamps will be installed. On the stage ceiling there will be 10 holophane bowl fittings suitable for taking 1 c.p. to 200 c.p. "Onewatt" lamps, and it is expected that an effective illumination will be obtained by these means.

Holophane fittings are also being supplied for the colonnade and entrance halls. Ornamental brackets with best quality etched shades will be used for the front of the gallery. In the outside entrance hall, torch fittings and flambeaux will be used, whilst for subways and outside steps cast-iron water-tight fittings will be used. For external lighting there will also be 40 cast-iron standards, approximately 8 ft. high, suitable for taking 100 c.p. "Onewatt" lamps. In addition to this, the footlights will be 30 ft. long, being constructed with short iron reflectors, enamelled white inside and black outside. There will also be a quantity of holophane shades and accessories for use in pendants, &c.

The value of the fittings will be £400, and, as mentioned in last week's issue, the total cost, including contracting, will be £729. 15s. The contracting work is placed in the hands of Kingston & Co., Northdown-road, Margate, and when completed this should be one of the most up-to-date installations in the country.

ELECTRICAL CO.'S D.C. MOTORS AND DYNAMOS.

The general merits of the direct-current machines made by the Electrical Co. are set out in a well-prepared price list. The size and style of this will commend itself to contractors and electric-power engineers. The machines listed range in output from the smallest ¼ H.P. to 100 H.P. They are grouped in three different types; N.E.G. up to 2 H.P.; E.G. from 1 H.P. to 6 H.P. and H.N. up to 100 H.P. Standard machines only are described, and to facilitate delivery certain sizes are printed in heavy type, these being available for delivery at a moment's notice. A wide speed range is allowed for on the machines when used as motors. This amounts to 25 per cent. on ordinary motors and considerably more to inter-pole machines.



SEMI-ENCLOSED TYPE MOTOR OR DYNAMO.

As is usual with these motors, either the open, semi-enclosed or enclosed types can be supplied. The design of the machine allows for complete protection of the commutator and brush gear while leaving these readily accessible. As a semi-enclosed machine the motor is fitted with louvred shutters which fit over the end openings on each side of the machine.

The range of motors and dynamos described is entirely new and, we understand, in no way a modification of the older patterns. By the use of the inter-pole fan cooling and simple brush gear the motors will stand up to 100 per cent. overload without sparking. In an efficiency curve (shown in the list) of a 14 H.P. 220 volt 1,100 revs. per min. motor an efficiency of

SIMPLEX CONDUITS LD.,
Garrison Lane, BIRMINGHAM.
Manufacturers of—
CONDUITS, CABLES, ACCESSORIES, FITTINGS, MOTORS, ELECTRIC HEATING AND COOKING MATERIAL, &c.

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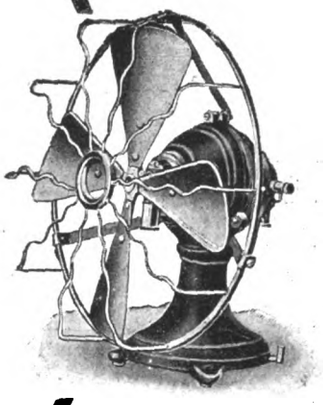
SUN FANS

Of sound design and finish—yet noiseless.

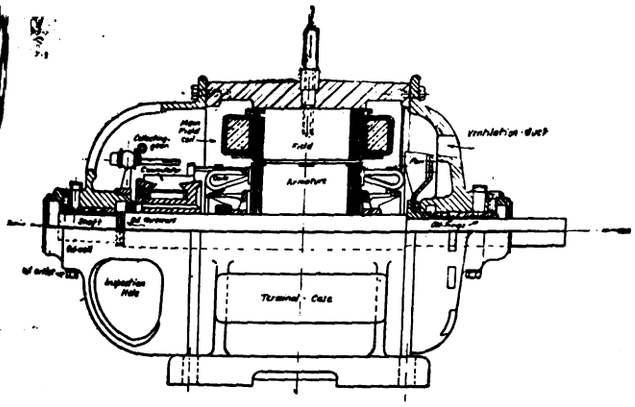
Every Sun Fan combines these features, and is listed at a price which will satisfy you. A new list is in the press; make sure you get a copy. ¶ Pamphlet No. 215, just issued, gives particulars of some exceptionally cheap lines, which are being cleared to make room for new stock.



THE SUN ELECTRICAL CO., LTD.,
118-120, Charing Cross Road,
LONDON, W.C.

SUN FANS

85 per cent. is maintained between ½ load and 50 per cent. overload. At quarter load it is well over 75 per cent. As far as temperature rise is concerned, we understand that the requirements of the Engineering Standards Committee are complied with and that exact figures will be supplied in answer to specific enquiries.



Section Hn Machine.

In addition to the direct-current motors and dynamos referred to above there is a line of motor generators and converters listed and suitable motor starters and shunt resistances for these machines. The list is further commendable for the useful tables which it contains and also for the general instructions regarding running and maintenance.

EXCELLO
FLAME ARC WITH UNIQUE TWO YEARS' WARRANTY

IFS AND QUERIES.

Why is there so little gas illumination in the City of London ? (and elsewhere for that matter). Will our gas contemporaries deign to enlighten us on this point ?

If the figures of the cost of lighting up all the gas illuminations throughout the country could only be published. (The Bank of England cost £20 a time to light up when illuminated by gas !)

Why do not all the metal lamp makers have their annual works outings on the same day at the same seaside place ?

Would it not promote a friendly feeling among the employees and enable the " chiefs " to meet on common ground ?

Will the President and Council of the E.C.A. be invited to the I.M.E.A. Convention—just for a " blow " by the sea ?

What has become of the Kniltic air pump ?

If the use of gas as an illuminant were made a criminal act. (We repeat this in order that it shall catch the eye of some young M.P. who is anxious to champion a new cause in the House ; also it amuses one of our gas contemporaries).

THE DEMAND FOR STRIP LIGHTING.

The doubts expressed earlier in the year that there would be much demand for Coronation material have not been justified by events. In London, which is of course the centre of the celebrations, there has been a rush unprecedented at the last moment for every kind of electrical device, and the trade houses and contractors are evidently up to their eyes in work. It would be interesting to know how many scores of miles of " strip " lighting have been made and erected. There must have been a great run on twin conductor cable to meet the call for this class of illumination material. Small lampholders too will have been frantically made and assembled for the purpose. If any of the makers of this class of material have figures of their output since the beginning of the year we should be glad to publish them if they will furnish them.

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STERLING TELEPHONES
The Sterling Telephone & Electric Co., Ltd., 200, Upper Thames Street, London, E.C. Works: Dagenham, Essex.

THE BOSTON ELECTRIC SHOW, 1912.

The superintendent of advertising of the Electric Show which is to be held in Boston from Sept. 28 to Oct. 26, 1912, has favoured us with a prospectus of this interesting exhibition. The letter accompanying the prospectus contains a paragraph which we think is well worth reproducing. It reads: "Our Boston Show will be many times larger than any electric show that has ever been held. We are proud of the start, we are tickled at our progress and we glory in the anticipation of the finish." Here is a pattern for show organisers in this country to follow. It is difficult to beat the average American for enthusiasm, and although "we say it as shouldn't," as Mrs. Brown says, we rather think that what we Britishers lack in initial enthusiasm we make up for in subsequent enterprise. Quite aside from this, however, we find on turning to the prospectus that the Mechanics Building (Boston, Mass.), comprising 100,000 sq. ft. of exhibition floor space and accommodation for 100,000 visitors, is at the disposal of the show organisers, at the back of whom are the Edison Electric Illuminating Co. This company is one of the most powerful in the States and operates electricity supply plant in 38 cities and towns. The Mechanics Building, according to the plans accompanying the prospectus, comprises three spacious floors, the whole of which will be devoted to the exhibitors at the show. On the plan there is a boiler and dynamo room, and from this it would appear that the building is lighted from an isolated plant, hardly the sort of thing that one would expect with the Edison Co., who are no doubt the local electricity authority, giving a supply. Among the items in the prospectus is one which strikes us as rather singular. This reads as follows:—"Ordinary carbon and metalised filament lamps in the usual sizes will be furnished free to exhibitors, and the management will also be prepared to sell Mazda lamps in all sizes at a fair price." Surely this is unduly penalising the metal lamp? This remark is, however, quite by the way.

The management is straining every effort to make the exhibition a popular one, and, from what we can gather, special facilities will be arranged for English exhibitors to make a display of their products. We understand that the Edison Illuminating Co. of Boston "has no intention of making a profit on the show either for itself or for any individual or group of individuals, but is undertaking work to promote the electrical industry and to familiarise the public with the possibilities and economy of electric service."

We would commend to the notice of the organisers of this exhibition our own small show (by comparison) which opens at Olympia on Sept. 23. While we do not suggest that we can in any way offer them points, at the same time we ourselves should be happy to welcome them at our own stand (No. 180) and to give them facilities for making a thorough inspection of the exhibits. It may be interesting for them to know that we hold an electrical exhibition in this country once every six years, and we especially pride ourselves on the display which we shall make at the forthcoming show.

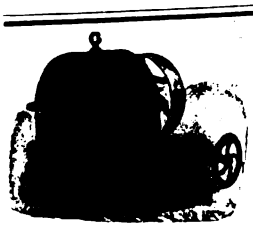
THE OLYMPIA POSTER.

The managers of the Olympia Electrical Exhibition are making headway with the publicity work in connection with this exhibition. We understand that the bulk of the space, both in the main hall and galleries, has been let up and that

Reduced Illustration of Olympia Poster.

the show will be representative of every branch of the electrical business. Judging by a preliminary list of exhibitors which has been sent to us there should be a predominant popular note about the exhibition. This is something which we have looked for, and it is to be hoped that the response from present

PROMETHEUS
ELECTRIC HEATING & COOKING.
London Showrooms:
9, NEWMAN ST., OXFORD ST., W.
THE BRITISH PROMETHEUS CO., LTD.,
SALOP ST. WORKS, BIRMINGHAM.



PELTON WHEELS for Hydro-Electric Plants.
Patent Hydraulic Speed Governors.
I specialise in these, and my prices will be found lower than those of any other first-class manufacturer. I have supplied English and Colonial Governments, my tenders being accepted in open competition.
PERCY PITMAN, 3, Willcott Road, Acton, LONDON, W.

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SPECIFY AND USE

FERRY RESISTANCE WIRE.

No Temperature Coefficient. Wire will not Rust or Perish.
Contains no Iron.
The only Material of its kind Manufactured in England.
Used largely and Specified by the Admiralty.
Used also by the Italian and Japanese Admiralties.

Write for List giving Electrical Particulars of Ten Grades of Wire.

WIRE. STRIP. SHEET. BARE. COVERED.

Makers :
HENRY WIGGIN & CO., Ltd.,
GEORGE STREET, BIRMINGHAM.
Telephone : 6400 CENTRAL. Telegrams : "WIGGIN BIRMINGHAM."

Agent : LIONEL ROBINSON,
3, Staple Inn, London, W.C.
Telephone : 6323 HOLBORN.
Telegrams : "FERRYDOM, LONDON."

and prospective users of electricity will more than exceed expectations.

We reproduce on a small scale the poster which is to be used to advertise the exhibition in all parts of the country. It is sufficiently striking to attract attention and it has the further merit of being extremely simple in design. We have not yet seen the colour scheme adopted for the poster, but doubtless this will be such as to give the exhibition the utmost possible prominence. In these days of poster advertising it is extremely difficult to hit upon some novel colour arrangement which will appear sufficiently distinctive amongst the mass of advertising matter which is usually displayed on the hoardings.

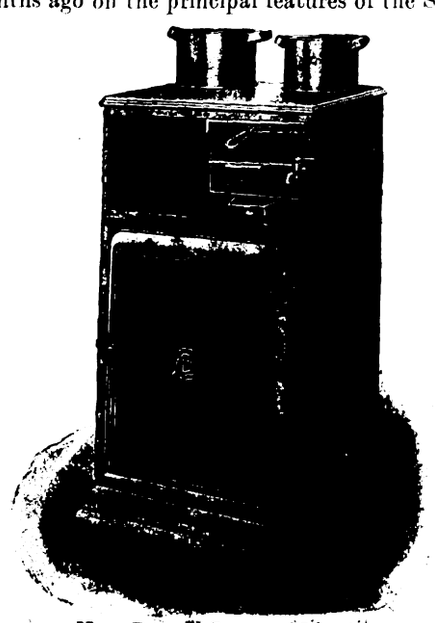
SIEMENS CORONATION ARRANGEMENTS.

Messrs. Siemens Bros. Dynamo Works inform us that they have made special arrangements to hold their offices and stores at Tyssen Street, Dalston, open during Thursday and Friday, 22nd and 23rd inst., from 9:30 a.m. until the official time of extinction of Coronation illuminations—12:30 a.m.—and are holding stocks of lamps and accessories used in connection with Coronation illuminations. Messrs. Siemens have laid themselves out to give contractors every attention either before the Coronation or on the two days and nights mentioned, and hold themselves ready as far as possible to deliver goods or render assistance, if necessary, in answer to telegraphic or telephonic requests. We may remind our readers that they can get into touch with these facilities by telephone or telegraph; telephone numbers Central 8387, 8388, 8,389; Dalston 2440 (three lines), telegraphic address "Siemodyn" London.

A section of the Dalston staff will be in attendance at 39, Upper Thames-street (telephone No. 8,270 London-wall, six lines), and, in addition, a staff of engineers will make periodical visits over the illuminations for which Messrs. Siemens are responsible. It is hoped that these arrangements will be of material assistance to contractors and others interested in Coronation work.

SIMPLEX OVENS.

We commented in our special heating and cooking issue some months ago on the principal features of the Simplex electric oven. We have now received further [illegible] oven and give an illustration of the



New Design Simplex Oven.

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FERRANTI
LIMITED.

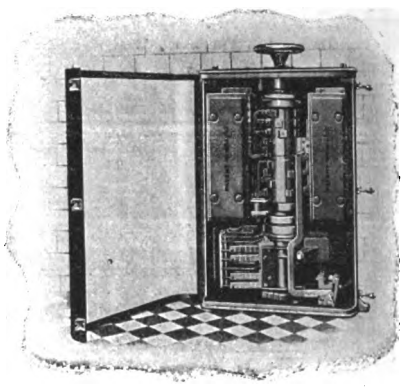
IRONCLAD
OIL OR AIR BREAK
SWITCHES.

Substantial, Reliable, Efficient.

WRITE FOR LISTS.

HOLLINWOOD, LANCS.,
78, KING STREET, MANCHESTER.

REYROLLE



DRUM-TYPE
MOTOR STARTERS
With Patent "Current-Growing" Resistances.

Combine Overload, No Volt and Push Button Releases.
One handle only to operate.

— Send for Pamphlet 33. —

WORKS: HEBBURN-ON-TYNE, ENGLAND.

intended to be as complete as the requirements of a large kitchen. In addition to the oven proper there are two boilers of one and ¾ gallons capacity respectively, a grill and a boiling ring. The oven is provided with switches for three heats and the energy consumption for these is 2,400, 1,500 and 900 watts. The grill requires 1,000 watts, the gallon boiler 1,000, and 200 watts, the ¾-gallon boiler, 750 and 150 watts and the boiling ring, 750 watts. The total capacity is therefore 6kw. The oven is supplied in two sizes, one for 10 to 12 persons and the other for six persons. Simplex conduits (Ltd.) also supply a combined cooker and grill which is made up of sheet metal with cast-iron top plate. On the right of this is arranged a grill and on the left is a ¾-gallon water boiler. This is a medium-priced cooker which should meet the requirements of a small household or flat. The grill is loaded for 1,000 watts and the boiler 750 watts, with a minimum rating of 150 watts. These cookers are worthy of the attention of electrical contractors and station men.

THE LAMPLIGHTER.

Time was when the lamplighter was looked upon in the same way as the Waverley pen—"a boon and blessing to men." Robert Louis Stevenson thus speaks of him :—

"God bless him, indeed! For the term of his twilight diligence is near at hand; and for not much longer shall we watch him speeding up the street and, at measured intervals, knocking another luminous hole in the dusk. The Greeks would have made a noble myth of such an one: how he distributed starlight, and, as soon as the need was over, recollected it; and the little bull's eye, which was his instrument, and held enough fire to kindle a whole parish, would have been fitly commemorated in the legend. Now, like all heroic tasks, his labours draw towards apotheosis and the light of victory himself shall disappear. For another advance has been effected; our tame stars are in future to come out, not one by one, but all in a body and at once. A sedate electrician somewhere in a back office touches a spring—and behold! from one end to another of the city, from east to west, there is light! *Fiat Lux* says the sedate electrician. What a spectacle, on some clear, dark nightfall, when in a moment, in the twinkling of an eye, the design of the monstrous city flashes into vision—a glittering hieroglyph many square miles in extent and where to borrow and debase an image, all the evening street lamps burst together into song! Such is the spectacle of the future. Star-rise by electricity, the most romantic flight of civilisation.

We commend this to the further consideration of our contemporaries, for we cannot think that they are unfamiliar with the original essay from which it is taken. Also, we think that the publicity managers of metal lamp firms would find texts for a good series of advertisements in the essay in question.

H. WEIDMANN,
RAPPERSWIL, SWITZERLAND,
FOR
Presspahn and Insulating Material.
(See larger Advt. last week.)

SUN WIRES AND CABLES.

A new catalogue is available at the offices of the Sun Electric Co. which deals with the wires and cables supplied by this firm. Cables of 600 megohm and 2,500 megohm grade are listed with the usual kinds of rubber insulation and braid or lead as a protective covering. Flexible wires for ordinary and special purposes are also priced in the list. A fly-leaf is attached to the catalogue giving prices and particulars of the Kalkos insulating boxes; we described these in a recent issue.

Printed and Published by GEORGE TUCKER, at the Editorial, Printing and Publishing Offices, 1, 2 and 3, SALISBURY COURT, FLEET STREET, in the City of LONDON, FRIDAY, JUNE 16, 1911.

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THE ELECTRICIAN COMMERCIAL AND INDUSTRIAL SUPPLEMENT.

C. & I. Supplement No. 90.] JUNE 23, 1911. [Gratis to Subscribers.

CORONATION ILLUMINATIONS AT BRIGHTON.

In another part of this issue we publish articles describing the principal electrical features of the Brighton Corporation electricity supply. We have been furnished with particulars of a few of the principal items of the special illuminations which have been erected for the Coronation, and which will remain in position for about a month after the celebrations. Members attending the I.M.E.A. Convention will have an excellent opportunity of seeing the many artistic effects produced. The sea front will be the centre of attraction, and will probably look at its best from the extreme ends of the two piers. The entire length of the front will be illuminated with festoons of lamps, and the total distance from the eastern boundary at Black Rock to the western boundary at Hove, a matter of 3½ miles, has been treated in this manner.

The Aquarium, which occupies a central position on the front, has been outlined with electric lamps, and the terraces surrounding it have also a number of illuminated festoons. From the Aquarium itself to Grand Junction-road opposite, festoons of lights will be carried across the thoroughfare, and these will be continued along the Esplanade, crossing and re-crossing one another.

The enclosures in the Steyne, which is a pretty garden at a central point near the Aquarium, are also to be outlined with lamps. The dolphins and the three basins, together with the fountain at the top, will be lighted with fairy lamps, of which something like 500 have been used. For the promenade concerts, which are a feature of the Brighton season, the pavilion lawns are usually illuminated, and the regular scheme is to be specially elaborated by electrical designs placed at the north and south gates. On the eastern side there will be two huge letters, G and M, with a central star, each 6 ft. high and each carrying 100 electric lamps.

The electricity department have erected some 10 miles of special wiring and fixed over 10,000 lamps.

On the town hall there will be exhibited a large illuminated transparency 12 ft. by 8 ft., showing pictures of the King and Queen and the borough arms. These devices weigh nearly ½ ton, and have been carried out in cloisonné and make a particularly brilliant effect.

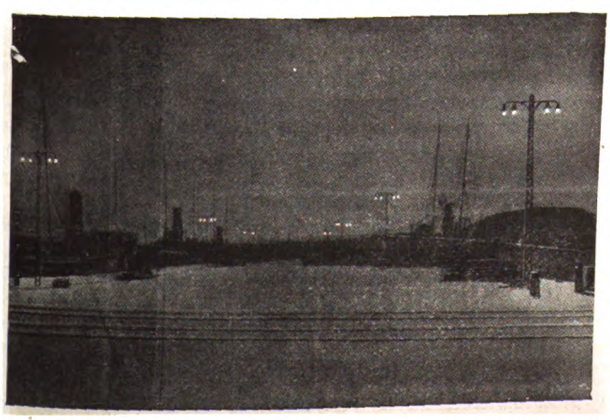
Volk's electric railway are arranging to illuminate all their cars, and each of the stations will be picked out with electric lamps. The effect of the lighted cars passing from point to point should be very pretty.

The Corporation has decided to bring out one or two electrically illuminated tram cars. A most elaborate scheme of lighting can be worked out on one of these vehicles, and doubtless the tramways department will have acquitted itself well in this respect.

All the principal hotels, business premises and banks have been outlined with electric lamps, and the most brilliant displays will be seen at the *Imperial*, the *Old Ship* and the *Queen's*. At the latter hotel, the King as Admiral of the fleet and the Queen in court dress have been reproduced in cloisonné designs, which are life size. The details of the uniform and orders of the King and the colours in the Queen's dress have been faithfully reproduced.

The electricity department has laid itself out specially to advise shopkeepers on electrical illumination schemes, and a special rate of 1d. per unit was fixed for all illuminations.

The programme of the I.M.E.A. Convention announces that



DOCK LIGHTING

BY

OSRAM

LAMPS.

The General Electric Co., Ltd., Head Office: 67, Queen Victoria St., London, E.C.

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SIEMENS

THE "DOMESTIC"

MOTOR EQUIPMENT

FOR

SEWING MACHINES.

Address enquiries to Supplies Department.

SIEMENS BROTHERS DYNAMO WORKS LIMITED.
HEAD OFFICE: CAXTON HOUSE, WESTMINSTER, S.W.
Telephone: GERRARD 860. Telegrams: "SIEMBRALOS, LONDON."
Supplies Dept.: 39, UPPER THAMES STREET, E.C.
Telephone: LONDON WALL 8270. Telegrams: "SIEMOTOR, LONDON."
BRANCHES:

BIRMINGHAM	GLASGOW	SHEFFIELD	CALCUTTA	SINGAPORE	SYDNEY
BRISTOL	MANCHESTER	JOHANNESBURG	BOMBAY	PENANG	MELBOURNE
CARDIFF	NEWCASTLE	CAPE TOWN	MADRAS	RANGOON	TORONTO

the meetings will be held in the Pavilion, and that the venue of the annual dinner will be the Dome. Both these buildings are of more than ordinary interest, and from an electrical point of view will be found to contain a number of exceptionally fine lighting effects. In the Dome these are obtained with an enormous electrolier, in which there are some hundreds of electric lamps. This has been suspended from the centre of the Dome and surrounded by a number of smaller fittings which harmonise with it. The Pavilion, which was at one time a Royal palace, has a number of beautiful decorations, and the original candle fittings have been adapted for electric lighting. These should be closely examined by illuminating engineers, who occasionally have an opportunity of working fittings of this character into some of their schemes. Some of the modern productions of electrical fittings makers compare rather unfavourably with these designs.

BUSH ROLLER CHAINS.

Messrs. Hans Renold, the chain experts of Manchester, and who are looked upon as chain makers par excellence, has just issued for the trade catalogue 3/35. This describes a new pattern of power chain which has recently been introduced by this enterprising firm. It is known as the bush roller chain, and is distinctive from the silent chain, which has been so largely used for mechanical work of every class. The new bush roller chain is of interest to electrical power engineers because it can be used for medium speeds on power drives where a positive form of transmission is required. The chain is offered in a number of standard sizes, which are divided into four classes—short, medium and long pitch, and extra strong. The short pitch chains are 1·25 in. and the long pitch 2·5 in. The extra strong is 1 in. The short pitch chains are suitable for normal power transmissions and for wheels having from 9 to 100 teeth. The breaking strengths vary from 1,850 lb. to 86,000 lb.

The silent chain has been designed for speeds up to 1,300 ft. per minute, and the new bush roller chain is intended for speeds from 400 ft. to 900 ft. per minute. For slow drives the block chain is employed, so that it will be seen that the new bush roller chain forms a useful intermediate type between the block and silent chains. The chain speed will naturally depend on the size of the chain and the number of teeth on the small sprocket. ½ in. pitch roller chain can be run up to a speed of 1,200 ft. per minute, and even as high as 2,000 ft. per minute under conditions where the service is intermittent and the life of the chain unimportant. The 3 in. pitch chain would not be run continuously at speeds above 400 ft. per minute. These speeds apply where the chains are used with wheels having 16 or more teeth. If smaller wheels are used the speed must be reduced. For example, with a 9-tooth wheel a 3 in. pitch chain should not be run above 200 ft. per minute, and a ½ in. pitch chain on the same wheel should not be run above 750 ft. per minute. The makers recommend that sprocket wheels should not have less than 9 teeth and not more than 70. An ordinary gear ratio is 4 or 5 to one, in which a minimum of 11 or 12 teeth will be used on the small sprocket. Where impulsive loads are driven by the chain a spring wheel is recommended to introduce a certain amount of slip. The booklet to which we refer contains a quantity of useful matter on the care of chains, and amongst these are instructions for taking out and putting in links. Engineers who are interested in the chain drive should take an early opportunity of applying for a copy of the above-mentioned booklet.

GLOVER'S 1911/1912.

Once again Glover's hardy annual in the shape of their tear-off calendar has put in an appearance. The calendar dates from July 1st, in accordance with the arrangement adopted last year for the first time. The daily slips are punched for attachment to a pair of substantial hooks which project from the front of the calendar card. Each slip is devoted to some matter of interest to cable engineers, and we must compliment the firm on the reproduction of the photographic illustrations. These have been submitted to a degree of touching up which brings out the details remarkably clearly, but at the same time the effect is not overdone. Practically every class of cable laying is represented, and many interesting pictures are reproduced. The editors must have a difficult task in selecting pictures which have not been previously published. The text matter of the calendar is mainly reproduced from the electrical journals and the Papers of the various engineering societies. There is a humorous vein running throughout the text, and this has been supplied by the band of humourists who, judging by their initials, get their living in their spare time in the electrical industry. The sketches are, if anything, above the standard of previous years, and we shall take an opportunity of reproducing one or two of these from time to time. The quotations from THE ELECTRICIAN are as numerous as ever. The item for Christmas Day is of interest. It is a sketch by Mr. H. W. Hartnell representing a jointer's tent set up next to a pole transmission line, away out on the moors. The country is covered with snow, and the jointer is endeavouring to smoke a Christmas pipe in front of a bucket fire.

We ventured a suggestion to the editors last year that the support for the calendar should be provided with a pocket into which the best of the daily slips could be dropped and kept for reference. At one time a separate pair of hooks was provided for this purpose, but this was not satisfactory. We still

OSRAM·LAMPS

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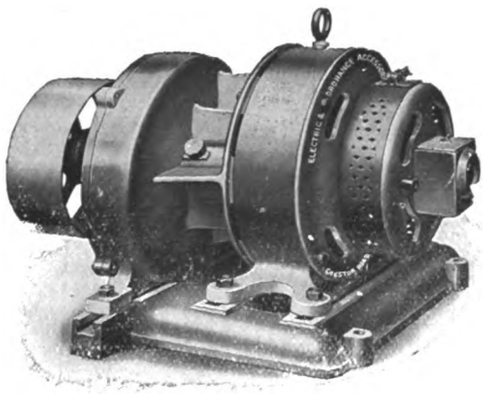


VICKERS Motors

in all sizes up to 50 H.P., with back gear enclosed as illustrated, or of the usual open type.

"They give satisfactory service under all working conditions, as their great feature is Reliability.

Quick Delivery. *Competitive Prices.*

The Electric & Ordnance Accessories Co., Ltd.,
Proprietors: VICKERS LIMITED.
Aston, Birmingham.

think that a pocket somewhere on the calendar would hold the superlatively excellent slips. We understand that the calendar will be sent to interested engineers on receipt of business card.

EXCELLOS FOR DECK LIGHTING.

In our record of electrical practice on shipboard in the special Marine Issue which we published last year we could not instance a single case of the lighting of a ship's deck by arc lamps. The

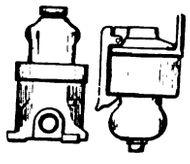
Excello Lamp Lighting Steerage Deck of "Olympic."

Union Electric Co. has kindly furnished us with an illustration which shows an Excello lamp as used on board the new White Star liner "Olympic." We understand that this photograph was taken during the trials of the liner, and that it shows an Excello lamp as used for the general illumination of the steerage deck. It is an extremely interesting example of electric lighting, and we hope that it will establish a precedent which will be regularly followed in the future. There should not be the least difficulty in an illumination problem of this kind.

CROMPTON SPORTS.

The 22nd annual sports of the Arc Works, Chelmsford, were held on Saturday last in perfect June weather. The meeting has been marked by indifferent climatic conditions on many occasions, so that the ideal summer aspect on Saturday was greatly appreciated by competitors and visitors alike. The gathering was marked by a number of "unique" incidents quite apart from that of the weather: The Arc Works Band made its first public appearance, and under the conductorship of Mr. W. Hall (who has trained the men in the short period of six months) acquitted itself most creditably in a varied musical programme. Then for the first time an "overseas cup" was offered to the best all-round man at the sports by the staffs of the foreign department and colonial branches. The moving spirit in the presentation to the club of this handsome trophy was, we understand, Mr. Erskine, of the Australian branch, that gentleman being now in this country on a business tour. There was a record entry for the events, and the attendance of spectators was well above the average. Among the items of interest were a number of championships in the shape of silver cups which become the absolute property of holders after three

REYROLLE WALL PLUGS
For Portable Machines, Lights, &c.
Pamphlets 114, 122, 88 and 45 give all particulars
WORKS—
HEBBURN-ON-TYNE, ENGLAND



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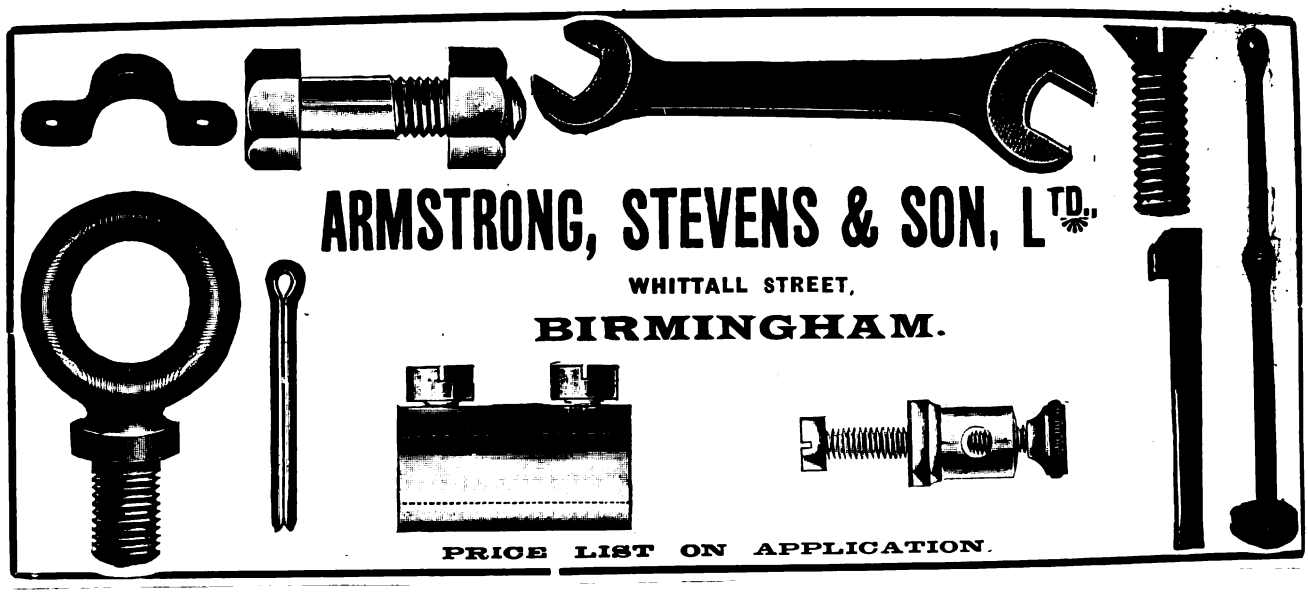


ARMSTRONG, STEVENS & SON, LTD.,

WHITTALL STREET,

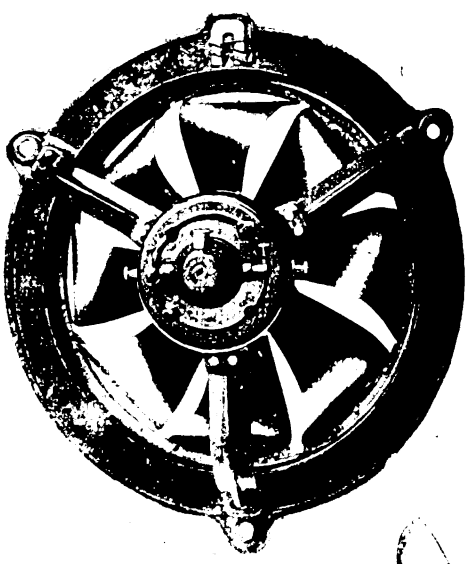
BIRMINGHAM.

PRICE LIST ON APPLICATION.

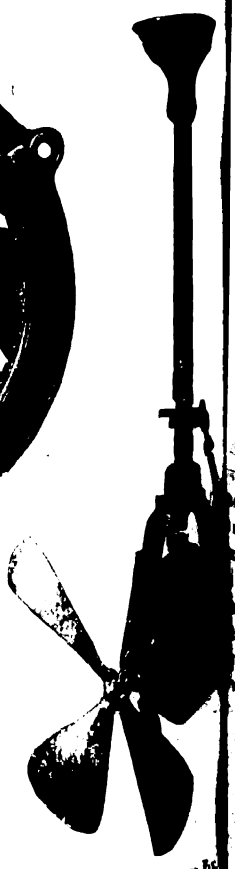
successive years, or four years in all. These championships were for the 100 yds. flat, the one mile flat, the two mile bicycle and the quarter mile flat; these events were won respectively by D. C. B. Copeland and A. G. Wells (dead heat), E. H. Barnes, A. F. Bearsby and E. H. Barnes. The last-named was also awarded the "overseas cup" referred to above, as the winner of the greatest number of events. When it is considered that Mr. Barnes figured in six important events he well deserved this trophy. At the conclusion of the sports the prizes were presented by Mrs. Clibborn, the wife of Lieut.-Col. J. Clibborn. Music, dancing and fireworks were the order of the evening. The company included Lieut.-Col. Crompton, C.B., Mr. Claud Crompton, Mr. Hew Stevenson, Mr. E. Reeves, Mr. Bernard Gibson, Mr. C. Peel and a large number of visitors from London.

1911 FREEZOR FANS.

The new list of the General Electric Co., describing their current season's fans, contains a number of interesting new types brought out in response to a considerable demand. In the aeroblade type the propeller consists of three narrow blades placed one behind the other in the same plane. The makers claim that with this blade 30 to 40 per cent. more air can be moved with the same expenditure of energy. This type of fan should be inspected. We illustrate the Freezor oscillating pattern fan, which is intended for suspension from ceilings. In this type the motor shaft is brought out from the opposite end of the fan blades, and is provided with a worm shell, which gears up to a flexible shaft at the end of which is a pinion arranged to rotate around a fixed toothed wheel. When the motor is running it is slowly made to revolve round the central support by the action of the small external shaft. The effect of this is to distribute the air evenly in the room below. We also illustrate a new pattern of box-blade fan, which has been introduced this year. This has been designed for the ventilation of large rooms, kitchens, smoking rooms, restaurants, steamships, and in fact in any position where a considerable amount of air is required to be moved. The motors are of the Witton semi-enclosed type, fitted with self-aligning and self-oiling bearings. The fan blades blow the air away from the motor, so that the latter is always on the intake side of the fan. The fan is made in sizes varying from 12 in. to 42 in. The first-mentioned will approximately move 1,000 cubic ft. of air per minute with an expenditure of 60 watts, and the latter 14,000 cubit ft. per minute with 550 watts. These fans can be supplied with the motors in a vertical position, which slightly increases the cost. They can be furnished for alternating-current or direct-current circuits.



G.E.C. Box-Blade Fan.



Freezor Oscillating Fan.

H. WEIDMANN, RAPPERSWIL, SWITZERLAND.

Manufacturer of PRESSPAHN AND INSULATING MATERIAL.

PRESSPAHN—Pressboard.

BEST QUALITY. PROVED BY REPEATED TESTS.

Sheets in thickness from 0·1 upwards. Endless Rolls and Strips from 0·1 to 1 mm. thickness.

BLACK PRESSPAHN IF SPECIALLY ORDERED.

Presspahn Coils and Tubes for Transformers, Armatures, Discs and Shaped Articles.

Varnished Presspahn. Mica-Covered Presspahn, &c.

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HAWTHORN BRAND.

FOR FINE ELECTRICAL JOINTING

Western-Electric

RESIN CORE SOLDER

IS INDISPENSABLE.

POINTS: The Seamless Tube prevents spilling of the Resin.
It may be kinked or crushed with impunity.
Solder and Flux are always in correct proportion.
Solderer will not waste pieces of Solder because there is no Flux in part of the tube. Pure white Resin Flux, non-corrosive.

Write for Sample to Ref. H. WESTERN ELECTRIC COMPANY, LTD.,

NORFOLK HOUSE, VICTORIA EMBANKMENT, W.C. WORKS: NORTH WOOLWICH, LONDON, E.

BIRMINGHAM: 115, Culmore Row.
CARDIFF: 2, Bank Buildings, St. Mary Street.
LEEDS: Standard Buildings, City Square.
And at Sydney and Johannesburg.

MINE SIGNALLING.

At a recent meeting of the Manchester Geological and Mining Society, when the president, Mr. A. J. Tonge was in the chair, an interesting Paper on "Luminous Electric Mine Shaft Signalling," was read by Mr. J. C. Eadie. In bringing the new system of mine signalling to the notice of the audience, Mr. Eadie made use of a model apparatus. The object of the system is to lessen the responsibility of the engine man in the winding operations by the provision of a double check of both luminous and bell signals. By the use of the apparatus Mr. Eadie explained that a system was provided by which the bell signals were confirmed by visual signals, and the apparatus complied fully with the Home Office regulations. It had been in use for over two years in a Durham colliery and had been found to give complete satisfaction. The system was designed to afford a safe and rapid means of communication of orders from the different levels of the mines to the engine room. The system could be employed in conjunction with any existing bell system; it practically eliminated the risk of mistakes on the part of the engine men in receipt of instructions from the men in the mine. The entire process of winding men and coal from the bottom of the shaft is one which requires the utmost care, and by the use of a variety of safety devices to prevent overwinding, &c., it was possible to protect the lives of the men. By the further installation of a system of luminous shaft signals the dangers which always attach to the introduction of the human element were reduced to the lowest possible minimum. Mr. Eadie, who is on the staff of Siemens Bros. Dynamo Works at Manchester, was accorded a vote of thanks for his interesting Paper.

I.M.E.A. IFS AND QUERIES.

If the Convention at Brighton lasted a month, would the "stalwarts" stick it out?

Will the Mayor speak of electricity as being in its infancy when he welcomes the members?

Will the gas illuminations survive on a certain hotel?

If the spirits of Brighton give out, will it be permissible to swear a big M.D.?

Will Mr. Christie instal Diesels as a stand-by at North-road?

Who will miss the last train from Portsmouth?

What will the men do on Tuesday and Thursday afternoons, seeing that the ladies are so well looked after?

Who will go to Boulogne for the week-end?

Will there be a crocodile at the Aquarium?

Will B–rm–ngham or H–rr–g–t– be the meeting place of the Convention next year?

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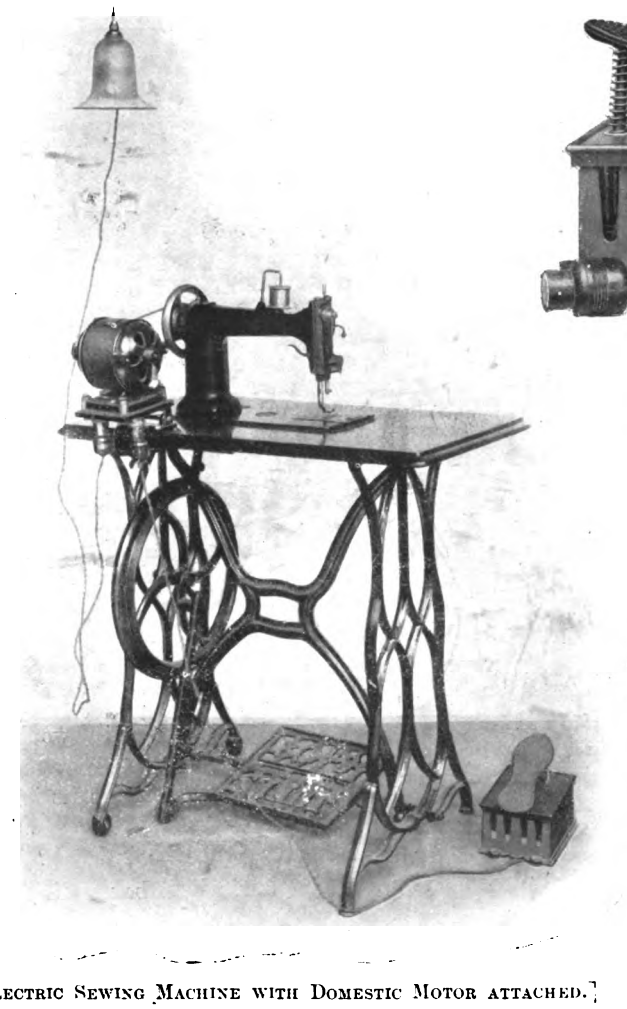
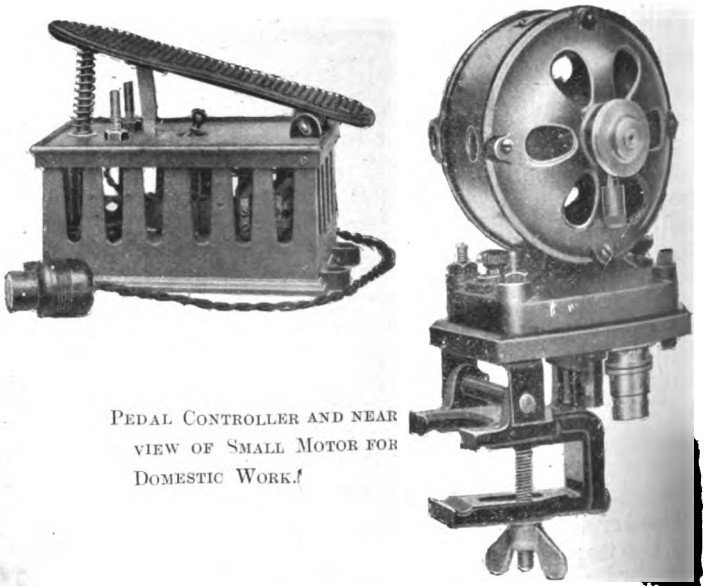
THE "DOMESTIC" MOTOR EQUIPMENT.

The use of electric power for driving sewing machines has hitherto been restricted, owing to the want of an equipment which would be suitable for any type of treadle sewing machine without modification. It has been previously necessary to employ a skilled mechanic to make an ordinary treadle sewing machine suitable for electric drive, and structural alterations have been necessary which have made it difficult to use the treadle drive when again required. Siemens Bros. Dynamo Works are now placing on the market the "Domestic" Motor Equipment, which has been designed to do away with these objections, and has the following special advantages: A lady can fix it and take it off in a few minutes. It fits all kinds of treadle machines without alteration, and the machine can be converted again to treadle drive in a few seconds.

The speed of the machine can be varied at will by means of the special foot-control switch, leaving the operator's hands free for the work. The motor is of $\frac{1}{16}$ H.P. output, and is mounted on a special table clamp, which is swivelled so that the weight of the motor automatically keeps the correct tension on the belt. The equipment includes motor, foot-control switch, two lengths of flexible cord with plug adaptors for connecting to electrical supply and switch, also special table clamp and two metal rails for fixing same to table, and the whole arrangement, as can be seen in the illustrations, is very neat and compact.



ELECTRIC SEWING MACHINE WITH DOMESTIC MOTOR ATTACHED.



PEDAL CONTROLLER AND NEAR VIEW OF SMALL MOTOR FOR DOMESTIC WORK.

REASON'S AND THE I.M.E.A.

The visit of the I.M.E.A. to Brighton will give its members a splendid opportunity to visit the works of the Reason Mfg. Co., Lewes-road, where so many specialities used in connection with central stations and electrical supply are made. The management are making arrangements to give engineers who favour them with a visit every facility for inspecting both the processes of manufacture and the finished article. A great variety of street lighting fittings will be on view, besides electrolytic meters, fuse boxes, demand indicators, time switches, &c.

LEWIS'S TO LIBRARIANS AND GENERAL READERS. The Quarterly List of Additions is sent post free regularly to any address. It is a Classified and Annotated Guide to the Scientific Publications of the previous three months. CIRCULATING
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THE ELECTRICIAN COMMERCIAL AND INDUSTRIAL SUPPLEMENT.

& I. Supplement No. 91.] JUNE 30, 1911. [Gratis to Subscribers.

C. & P. SILENT AUTO-TRANSFORMERS.

Station engineers and contractors will be interested in these nsformers, because the makers claim that special attention s been paid to the combination of very small iron losses h high full load efficiency; this ensures low voltage drop on secondary circuit between full load and no load. Great e has been exercised in manufacture, and the coils, during ding, are thoroughly impregnated with a waterproofing and ulating compound. The transformers, though ventilated, in so far as the case is concerned, can be used with satisfaction in damp situations. A feature of the terminals is the use of mica and metal in the insulation and the cable holes are bushed with porcelain to prevent abrasion of the insulation.

C. & P. AUTO-TRANSFORMER.

A 12 months' guarantee is given with C. & P. transformers, which covers the usual defects orkmanship or material, excluding, of course, bad ling, misuse, &c.

arefully prepared list (No. 102), just issued, will enable ayer to select the required type of transformer for his se. A convenient formula is included in the list whereby ansformer, the nearest to the unlisted ratios, can be selected the standard stock.

temperature rise with these transformers is low, the regulation is close and the device operates without noise. The overload capacity is 25 per cent. for two hours, a particularly generous rating. An illustration of the transformer is given herewith, and full details can be obtained from Messrs. Carney & Pearn, Nutsford Vale Works, Manchester, S.E.

THE HOADLEY CURRENT LIMITER.

This instrument consists of a laminated electromagnet, one limb of which is pivotted and, by means of a screw adjustment fitted to the end, can be moved round the pivot. The energising coil for this magnet is in series with the consumer's lamps and the magnetic circuit is completed by means of a Z-shaped armature carrying a pair of contacts dipping into two mercury cups.

On the current through the coil exceeding a predetermined limit the Z-shaped armature tends to revolve on its pivot, and in doing so lifts the contacts out of the mercury cups. The circuit is thus broken and the magnet de-energised. The contacts then fall back into the mercury cups and the cycle is repeated, producing a very decided flicker on the lights until the amount of current is reduced to such an extent that the armature is no longer attracted. The flicker may be stopped in another way, by turning the milled knob at the top of the instrument clockwise. The pivotted limb of the magnet is raised, and the air gap in the magnetic circuit increased, thus the amount of current which is necessary to create a field strong enough to attract the armature is increased, and consequently the number of lights which can be lit without causing a flicker is also increased.

This alteration can be effected by the consumer without in

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"SMOOTHWELL"

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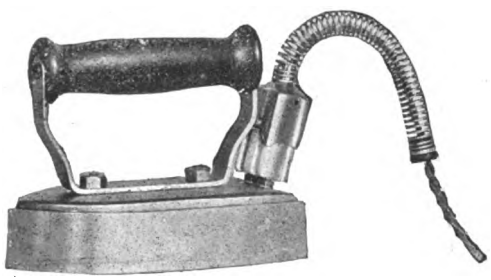

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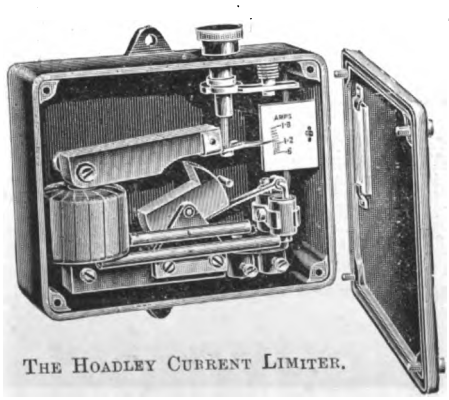
any way having to send to the supply authority. Once, however, the number of lamps or amount of current required has been raised by means of the milled knob, this cannot be again decreased until the instrument has been re-set by the supply authority.

These limiters may be used with great advantage either under a system of charging where the price per lamp is inclusive or they may be used as demand indicators where the charges are based on the "telephone system," such charges consisting of a comparatively large fixed charge and a small price per unit. These fixed charges are arrived at in several ways, either at a percentage of the ratable value of the property or on a definitive proportion of the lamps installed or in some other way; but for installations using current for lighting purposes only, by far and away the best arrangement is a current limiter, provided it possesses the advantages enumerated above, first and above all else that it can be regulated by the consumer himself. By this method not only are all the advantages of the maximum demand system of charging retained, while its disadvantages (which in England have practically killed the demand indicator system of charging) are eliminated, but additional advantages possessed by the demand indicator are to be had. Full details can be obtained from the General Electric Co., who are putting this interesting device on the market. It is made in sizes ranging from 0·3 to 1·5 amperes capacity and any voltage.



THE HOADLEY CURRENT LIMITER.

TABLES OF ELECTRIC POWER SUPPLY.

Our quarterly tables of electric power supply will be found in the centre portion of the Supplement this week. Most of the returns have been kindly brought up to date by the engineers, and our thanks are due to them for the interest which they take in this matter.

From a detailed examination of the tables we find that steady progress is being made in the connection of motors to the supply mains. At Bradford the total number of motors connected to the general supply network is 1,705, representing an aggregate of 7,463 H.P. In this district a bulk supply is also given, and to this system 220 motors are connected having a total horse-power of 2,806. At East Ham there are now 15[illegible] motors on circuit, as compared with 136 three months ago, and at Bolton an additional 27 motors have been added during the past quarter. At Salford the total brake-horse-power connected to date is 12,152, this being spread over a total of 1,0[illegible] motors. In a comparatively small town like Lincoln good progress has been made and the largest size of motor on circuit is now 100 H.P., as against 70 H.P. three months ago; the total brake-horse-power connected is now 1,785. Belfast records an exceptional rate of progress. The total number of motors has been increased from 714 to 904 and the aggregate brake-horse-power is now 6,860 as against 5,875. At Blackburn some 49 motors have been added, the total now being 7[illegible] machines on circuit. Luton has been busy with its power supply and has increased the total number of motors from 330 to 411. These aggregate 2,457 H.P. as against 2,086 H.P. Brist[illegible] also has a good return to make. There has been an increase in the number of motors of 96, and the increase in the brake-horse-power connected of 519. The Barnsley return is [illegible] made out to the 31st March of this year and the total brake-horse-power has been increased from 1,698 to 2,908.

As far as the total number of motors are concerned Liverpool has a splendid record to make, there being nearly 3,000 motors on circuit. The actual figures are 2,981, these representing a total brake-horse-power of 12,335. Birmingham runs the figures very close with a total of 2,941 motors connected, while the total brake-horse-power is more than doubled, the figure being 26,114. An interesting item in this return is one of five 720 H.P. high-tension motors; the return also shows that the approximate horse-power of other power displaced by electric motors is 15,700. This is an example which other large municipalities might do well to follow. Leeds can now boast a total of 2,482 motors connected, representing an aggregate of 14,964 H.P. Since the last return made by the Newcastle and District Electric Lighting Co., 600 H.P. of motors has been added. At Partick considerable progress has been made. The total number of motors is 315 as against 295, and the total brake-horse-power of these machines is now 3,347. The Clyde Valley Electric Power Co. show an increase of 2,200 H.P. during the past 6 months.

At Brighton, which is very much in the municipal eye at the moment, the total number of motors connected is now 5[illegible] these have an aggregate horse-power of 2,815. Sheffield has added 72 motors since last December, and these have a total brake-horse-power of 17,086. The Metropolitan Electric Supply Co., of London, now returns 1,246 motors connected, having a total brake-horse-power of 5,446. Mr. S. J. Wa[illegible] at Bury, has been making good progress. The largest [illegible] on circuit is now 100 H.P. as against 80 H.P. in the last [illegible] and 333 motors are on circuit with a total horse-power of [illegible] From Greenock we get an exceptionally good record of pro[illegible] during the past six months, the total number of motors [illegible] increased from 472 to 670.

OSRAM-LAMPS

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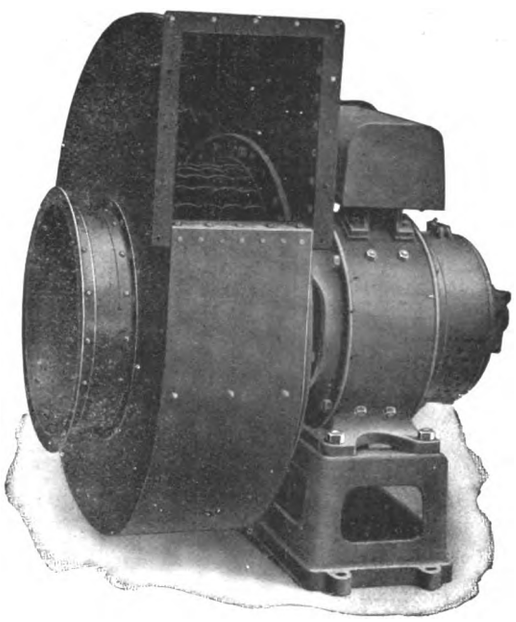

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"THE ELECTRICIAN" TABLES OF

No.	Supply Authority.	Engineer and Manager.	Principal Local Trades.	Power Voltages. A.C.	Power Voltages. D.C.	Total B.H.P connected at date indicated below.	Total number of Motors connected.	Largest Motor on Circuit. H.P.	Max. demand Kw
1	**Aberdeen Corporation**	J. Alex. Bell	Granite quarries, eng. works, shipyards, ice factories, fish-curing and preserving wks., paper wks., woollen and jute wks.	400	220, 440 three-wire 230 2-wire	4,820 31/5/11	857	104	
2	**Acton Council**	J. Martin Blair	Laundries, motor works, dyeing and cleaning, printing	...	230, 460 three-wire	705¾ 23/5/11	83	170	
3	**Aston Manor Corporation**	R. Foster	General	400 3-phse. 50 ∼	460 three-wire	5,120 31/7/10	280	500	2,3
4	**Ayr Burgh Council**	Roland Marshall	Principally residental, building trades, laundries, small eng.-works, shipyard, carpet works, boot factory	100, 200 Single phase	250 500	533 23/5/11	139	30	
5	**Barnes Urban District Council**	C. S. Davidson	Gas mantle works, sawmills, brewery, golf-club making, laundries, printers	..	210, 420 three-wire	458 31/3/11	55	20	
6	**Barnsley Corporation**	E. A. Barker	Foundries, laundries, builders and joiners, linen manufacturers, paper mill, glass bottle makers, &c.	...	230 460	2,908 31/3/11	123	30	
7	**Barrow-in-Furness Corporation**	H. R. Burnett	Shipbuilding, iron, steel and engineering works	...	220, 440	840 30/6/10	172	25	
8	**Bath Corporation**	Francis Teague	Engineering, cabinet-making, clothing and corset factories	110 single-phase	220, 440 three-wire	788½ 23/5/11	203	72	
9	**Battersea Borough Council**	F. A. Bond	Soap and candle works, engineering works millers, railway goods yards, stone yards	...	230*, 460†	2,756 16/5/11	..	75	
10	**Belfast Corporation**	T. W. Bloxam	Shipbuilding, spinning and weaving, ropeworks, handkerchief making.	...	220, 440 three wire	6,860 31/3/11	904	70	
11	**Birkenhead Corporation**	W. Wyld	Shipbuilding and ship repairs, laundries, leather works and foundry	...	230, 460 three-wire	981¼ 30/5/11	172	120	
12	**Birmingham Corporation**	R. A. Chattock	Metal, cycle and jewellery trades	5,000	220, 440 three-wire	25,114 30/4/11	2,941	350	
13	**Blackburn Corporation**	P. P. Wheelwright M.I.E.E.	Cotton manufacture and general industries	220	220 440	3,155 25/3/11	74	120	
14	**Blackpool Corporation**	C. Furness	Joinery works, bakeries, bottling stores, laundries, cinematogrphs & entertainmts	200	500	1,349 27/2/11	198	80	
15	**Bolton Corporation**	Arthur A. Day	Cotton spinning and engineering works	100, 200* 400†	230, 460	10,645½ 30/4/11	1,041	150	
16	**Bootle Corporation**	T. Dawson Clothier	Timber, engineering, dyeing, pumping, tinsmelting & general	...	220, 440 three-wire	2,533 31/3/11	...	60	
17	**Bournemouth & Poole Electricity Supply Co., Ltd.**	E. Ll. Ingram* W. D. Brightman†	Boarding-houses and hotels	100,200,400 three-wire	250, 500 three wire	624 1/6/11	227	25	
18	**Bradford Corporation**	Thomas Roles	Textile works, dye works, mechanical and electrical engineering, miscellaneous.	230, 400 50∼	230 460	General *7,163 Bulk Supply *2,806 10/5/11	Supply *1,705 Supply *722	110	
19	**Brighton Corporation**	J. Christie	Engineering works, breweries, sawmills, laundries, foundry, &c.	...	230, 460	2,815 23/5/11	528	100	
20	**Bristol Corporation**	H. Faraday Proctor	Tobacco, cocoa, printing, leather, confectionery, cloth and brewing	105 & 210 93∼ S.P.; & 365 50∼ 3-phase	250 500	11,777 25/3/11	1,346	120	
21	**Burnley Corporation**	Jas. E. Starkie	Cotton weaving, foundries, &c.	...	220, 440	841¾ 31/3/11	285	30	
22	**Burslem** (County Borough of Stoke-on-Trent).	C. H. Yeaman	Potteries, engineering works	None	220, 440	1,130 28/2/11	189	135	
23	**Burton-on-Trent Corporation**	T. Hall	Breweries, timber mills, engineering works	200, 100, 400	500 (tramways only)	1119·47 20/5/11	177	66	
24	**Bury Corporation**	S. J. Watson	Textile, engineering, paper, &c.	400	220, 440	2,880 7/6/11	333	100	
25	**Carn Brea, R.S.O. (Urban Electric Supply Co.)**	L. A. Hards	Mining and foundries	10,000, 440	240, 480 three-wire	2,671 25/5/11	175	50	
26	**Canterbury Corporation**	C. A. Blascheck	Brewing, engineering works, foundry, printing	...	220, 440	504 30/5/11	109	50	
27	**Cardiff Corporation**	Arthur Ellis	Ship-repairing yards, engineering works, foundries, laundries, printers, brewers, millers, cold storage, &c.	200 400	200, 400 three-wire	3,628 31/1/11	538	110	
28	**Carlisle U.D.C.**	S. T. Allen	Cotton factories, tinplate printers, engineering works and railway shops (companies)	...	L. & P. 230 400, 3 wire, traction 500	1,075 31/4/11	269	57	
29	**Charing Cross, West End & City Electricity Co.**	H. W. Kingston J. M. Gatti (*Mn. D.*)	Printing	10,000	100, 200, 400, 1,000	Ex. bulk sup. 16,263, 30/4/11	...	250	
30	**Chester Corporation**	S. E. Britton	Engineering, flour mills and printing	...	210, 420 three-wire	887 25/3/11	179	30	
31	**Chesterfield Corporation**	R. L. Acland	Printing, brewery, furniture-making, foundries	...	240, 480 three-wire	716 31/12 08	150	30	
32	**Clyde Valley Electrical Power Co.**	D. A. Starr	Steel works, rolling mills, collieries, paper mills, brickworks, foundries, shipyards, &c.	11,000 trans. to 400 for power	...	38,200 30/4/11	...	500	
33	**Colne Corporation**	A. G. Cooper	Weaving, spinning, loom making, foundries, fell-mongering and electric crane making	...	240, 480 three-wire	417 31/8/10	188	20	
34	**Cork Electric Tramways & Lighting Co.**	H. H. Nalder	Breweries, butter factories, laundries, bacon curing, feather purifiers, printing, tanneries, milling, refrigerating, &c.	...	460	2,592 1/6/11	377	40	
35	**Coventry Corporation**	George Tough	Cycle and motor cars, toolmaking, weaving, watchmaking	200 two-phase	...	6,772 26/4/11	691	100	
36	**Darlington Corporation**	J. R. P. Lunn	Engineering, yarn spinning and school furniture	...	230, 460	2,190 24/5/11	234	125	
37	**Derby Corporation**	T. P. Wilmshurst	General engineering, foundries, motor cars, silk mills	200	460, 230 three-wire	3,500	436	230	
38	**Derbyshire & Nottinghamshire Electric Power Co.**	A. E. Loos	Iron works, collieries, lace and hosiery works, engineering works, brickworks, &c.	440	500 550	2,920 6/3/11	...	300	
39	**Dewsbury Corporation**	R. H. Campion	Woollen manufacturers, rag grinding, printing, laundries, clothing manufacturers, wool shaking, iron cutting	...	220 440	820 30/5/11	161	30	
40	**Dublin Corporation**	M. Ruddle	Saw mills, factories, elevators in stores, lifts, bakeries, captans, etc.	200 S.P. 3-phse. 346	...	3,253¾ 1/3/11	582	35	

‡This figure arrived at by taking the general supply load at 11 a.m. on fine days and deducting 10 per cent., this being estimated as the lighting

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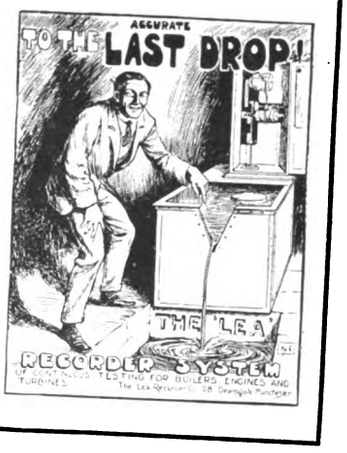
ELECTRIC POWER SUPPLY.

o.	Method of Driving: Group. H.P.	Method of Driving: Indiv. H.P.	Rates: Per unit.	Rates: Bulk supply.	Approx. H.P. of other power displaced by electric motors.	Isolated Plants at present Operating. g=Gas. sg=Suction Gas. s=Steam.	Remarks. (Note.—Inst. E.E. Wiring Rules for Motors generally apply in all districts.)
	...	...	2½d. to ⅞d. accord. to cons.	...	...	H.P. ...	.....
	...	...	1¾d. flat 2½d.&1d.M.D.	On application	...	150*g*, 220*sg*, 200*s*	Includes three electric pumps at Council's sewage works, auto. plant.
	...	...	1½d. to 6d. sliding scale	On application	...	...	* All purposes except traction.
	200	100	2d. to 1½d. Load factor basis	...	400	150*g*, 50*sg*, 200*s*	.....
	48	410	1½d.with dis. to 33⅓ p.c.	On application	*	55*g*, 500*s*†	* Consumers mostly new to district. †Incl. sewage works plant. Council installing a 600kw. steam dynamo with boilers and accessories.
	...	...	1½d.-1d. motors, 3½d.flat, lighting 7d & 1½d. D.I.*	...	...	...	* Discount 5 per cent. off lighting accounts
	...	...	3d. and 1d. M.D. 2d.—1½d. F.R.	...	...	...	Sliding scale for motors. [only.
	...	...	1d. day rate 1⅜d. to 1d.	...	...	*	.....
	...	...	Flat rate1d.‡	Terms by arrangem't	...	...	* Isolated plants using gas, suction gas and steam are in operation, of which there are no particulars.
	...	...	2½ to 1½d. & 1d. M.D., accord. to cons.	On application	1,300	...	* Under 3 H.P. † 3 H.P. and above. ‡ Or £4 per kw. per annum and ½d. per unit.
	...	...	1½d. for first 1,500 units†	...	...	...	* Lighting and power 4,214, traction 3,465.
	...	...	1·35d. to 1·10d.	1d. to 0·575d.	15,700	...	* Motor load only. † Exceeding 1,500 units per quarter at 1d.
	...	...	...	F'm 1½d. to0·45d.*	...	...	.....
	...	...	3d. and 1d. M.D.	...	...	...	Total B.H.P. does not include traction. * Sliding scale according to amount taken.
	...	...	2d. 1st 1,000, 1d after less 10°/₀‡	...	...	...	.....
	...	...	2d. to 500 per qtr., 1d. after	...	1,000	1,500*g*, 80*sg*, 4,510*s*	* Single-phase. † Three-phase. ‡ Extra discounts to large consumers.
	...	...	2½d. flat.	On application	...	...	.....
	...	...	2d. to 1d. 2d. to ¾d.	£3 per kw.†	...	...	* Chief Engineer. † Local Secretary.
	...	...	1d. restricted hours, 1½d. unrestricted	...	...	...	*These figures include the following motors owned by a consumer taking a supply of current from 3 500 kw. motor-gens. used for converting our supply current at 6,600 volts, 3-phase, 50 periods, to d. cur. at 230 and 460 volts. †Plus ½d. per unit, less discount. Special terms to large users.
	...	...	1½d. & dis., 1½d. and ¾d. *M.D. with discount	On application	...	800*sg*	*To avoid as far as possible the use of max. demand indicators a flat rate is usually agreed upon.
	680	..	Lighting3½d.flat Pwr. 1½d. 1st 39 hrs.per ½.1d. aftr	None	...	...	Special agreements based on a fixed charge of £7 3s. per annum per kw. plus ·2d. per unit. .....
	...	...	3d., 1d., ⅝d. and ½d.	On application	...	...	.....
	777·0	842·47	3d. & 1d. M.D also 2d.&1½d. 1d.-¾d†	...	362	75*sg*	80 % of total power is on restricted hour system. 80 % of total power units sold on restricted hour system. 1 2,000 synchronous motor. *Includes lighting. †Restricted hour.
	,476	404	...	...	770	40,300	.....
	...	126	4d.& 1d. M.D. or 2½d. flat	On application	...	50*g*, 10*sg*	Power supply includes driving stamps, pumps and other mining machinery.
	...	504	1½d. flat 5 p.c. dis. cash 28 days	...	...	...	Maximum demand to date (Saturday, Aug. 6, 1910) = 414 kw. on feeders, includes light and power.
	...	...	1½d. flat, 4d. & 1d. M.D.	Spl. rates to large consumers	...	...	Most of the engineering works on private property, from which Corporation are at present debarred from entry.
	315	760	2d. flat. 1d. and 3½d. two-rate. Also Maximum Demand.	Special terms	416	...	Power supplied to tramway company, also to Council for sewage pumping.
	...	...	3d. to ¾d.	On application	...	...	.....
	485	402	1½d. 1st 200 units per qtr., 1d. after	Above 25,000 p.a. 1d.flat rate	...	...	.....
	...	...	1½d.—1d.	...	...	...	.....
	...	...	On application	On application	...	...	.....
	62	96	2½d. flat, 3d. and 1d. M.D.	On application	212	...	Several of ½ H.P. and less not included in return. Motors let out on hire.
	795	800	2d,1½d.,1½d., 1d. sliding scale	None	500 steam 450 gas	500*g*, 200*sg*, 2,000*s*	Competing gas 2s. 8d. per 1,000 c.f. with 25% disc. when annual bill exceeds £50.
	969 out	322 about	1½d. 2,500 units per quarter and 1d. after*	...	4,200	...	* Over 50,000 units per quarter flat rate of 1d.
	..	...	1½d.to¾d.: £4 kw M.D. and ½d.unit	...	...	...	.....
	..	...	1d. for all day use	...	800	...	.....
	..	...	1⅜d. to 0·4d.	...	...	...	.....
	Both		*	Two Tramway Companies.	...	...	Maximum demand system or 1d. restricted hour. *2½d. 1 hr. per day, ½d. after. M.D.S.
	Both		1¼d	...	2,200	...	Demand steadily increasing.



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FOR PROTECTION FROM ACID FUMES.

Sole Makers—

GRIFFITHS BROS. & CO.

MACKS ROAD, BERMONDSEY, LONDON, S.E.

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"THE ELECTRICIAN" TABLES OF

No.	Supply Authority.	Engineer and Manager.	Principal Local Trades.	Power Voltages. A.C.	Power Voltages. D.C.	Total B.H.P. connected at date indicated below.	Total number of Motors connected.	Largest Motor on Circuit. H.P.	Max. demand Kw.
41	**Dundee Town Council**	H. Richardson ...	Jute mills, shipbuilding, foundry	...	400	1,950	404	65	...
42	**East Ham Corporation**	W. C. Ullmann ...	Printers and wood yard for motors, otherwise district is purely residential.	...	240, 480	Pte.485, Stn. 43½ May21,'11	Prvte., 152 Station, 5	40	...
43	**Edinburgh Corporation**	F. A. Newington.	Printing, joiners, masons, engineers, brewers	...	230, 460	11,440 31/5/11	2,601	50	...
44	**Fulham Borough Council**	Arthur J. Fuller	Engineering works, woodworking machinery, laundries, paper mill	200 two-phase above 5 H.P.	...	1,555 2/2/11	188	80	540
45	**Frome U.D. Council**	F. H. Merritt.....	Cloth, silk and india-rubber mills, iron foundries, engineering and motor works, breweries, mill furnishing, dairies, bacon curing, printing, furniture & cabinet mkg.	...	240, 480 three-wire	920 30/4/11	213	35	240 approx
46	**Glasgow Corporation**	W. W. Lackie.....	Engineering, clothing, printers, butchers and bakers	6,500	250/500 three-wire	36,466 31/1/11	5,305	250	...
47	**Govan Council**	T. C. Parsons ...	Shipbuilding and engineering ...	...	500, 250	6,627 15/5/11	...	165	2,12
48	**Grantham Urban Electric Supply Co.**	J. E. Edmundson	Brickwork, foundries, timber merchants, engineering works, glue works, malting	...	240, 480 three-wire	376 30/4/11	111	17½	...
49	**Greenock Corporation**	J. A. Robertson...	Shipbuilding, engineering, sugar refining	380	500	8,791 31/5/11	670	545	...
50	**Grimsby Corporation**	W. A. Vignoles ...	Docks, timber yards, foundries and engineering works	...	230, 460 three-wire	1,297 27/4/11	204	90	1,56
51	**Guernsey Electric Light Power Co.**	A. N. Rye	Stoneworks and quarries, fruit growing	...	210, 420	2,200 31/8/10	215	80	85
52	**Hammersmith Borough Council**	G. G. Bell	Engineering works, electric lamp works, small laundries, &c.	110, 220, 440 2,300 H.T.	...	4,772 16/8/10	402	500	...
53	**Hanley** (County Borough of Stoke-on-Trent).	C. H. Yeaman ...	Brickworks, potteries, iron works, collieries, earthenware and china manufactories	Single-phase 100 ~, 100-200, 400	50*	1,251 28/2/11	163	60	1,25
54	**Heckmondwike Council**	G. H. Carter	Woollen manufacturers, rag grinders, foundry, boot and shoe, factory, coachbuilders, &c.	...	230, 460 three-wire	1,423 30/4/11	158	150	...
55	**Hereford Corporation**	W. T. Kerr.....	Cider making, breweries, mills (flour), farm work, joinery, refrigerating	...	220, 440	559 31/8/10	117	50	41
56	**High Wycombe Electric Light & Power Co.**	W. E. Brandreth	Chair and cabinet making, paper mills, engineering	...	420	663	156	30	...
57	**Hove Electric Lighting Co.**	C. B. Smith.....	Purely a residential district excepting shops	...	210 220	1/5/11 490 31/5/11	162	12	...
58	**Huddersfield**	A. B. Mountain ...	Cloth manufacturers	Three-phase One-phase	... ...	*3,484 *1,777	182 501	150 35	1,13 1,4
59	**Hull Corporation Electricity Department**	H. Bell	Oil mills, cement manufactories, shipbuilding, engineering and docks	440 & 220 for large supplies	220, 440 three-wire	8,138 28/2/11	650 Consumers	100	4,22
60	**Ilford Urban District Council** ...	A. H. Shaw	Photographic apparatus, chemical works, paper mills	...	230, 460 three-wire	704 19/5/11	133	60	...
61	**Islington Borough Council**	Albert Gay	Bakers, brewers, builders, clothiers, coach and van builders, engineering works, confectioners, printers	Single-phase 50 ~ 100 200 and 400	...	3,134 30/4/11	598	105	...
62	**Kettering Council**	W. A. Walker.....	Boot and shoe and clothing factories	...	230, 460 three-wire	886½ 30/4/11	183	30	35
63	**Kidderminster & District Electric Lighting & Traction Co.**	A. Charlton.....	Carpet manufacture.....	...	460	1,074	...	26	no
64	**Kirkcaldy Corporation**	O. F. Francis	Linoleum, engineering, furniture, malting works, linen, &c.	...	230 460	978 31/12/10	...	130	80
65	**Lancaster Corporation**	Geo. C. Milnes ...	Timber yards, builders' yards, foundry, linoleum works	...	230, 460	551 24/5/11	134	50	20
66	**Leeds City Council**	H. Dickinson	Numerous	200 400	...	14,964 30/4/11	2,482	100	7,5
67	**Leith Council**	A. Peden Rutherford, M.I.E.E.	Engineering and general.....	...	230, 460	3,579·54 30/4/11	472	100	1,5
68	**Liverpool**	Alfred Clough ...	.....	...	230, 460	12,335 31/3/11	2,981	80	...
69	**Lincoln Corporation**	Stanley Clegg ...	Engineering works	...	230, 460 and 500	1,784½ 25/5/11	224	100	45
70	**Longton** (County Borough of Stoke-on-Trent).	C. H. Yeaman....	Earthenware manufactories, brickworks, potteries, collieries.	None	230, 460	250¾	82	60	22
71	**Loughborough Corporation**	W. H. Allen	Hosiery and engineering	...	220, 440 three-wire	562 31/5/11	111	45	1,5
72	**Luton Corporation**	W. H. Cooke.....	Straw hat making, motor cars and lorries, hydraulic and general engineers, foundries, printing works	...	500	2,457 4/5/11	411	160	1,1
73	**Maidstone Corporation**	E. E. Hoadley ...	Building, brewing, paper making	...	230, 460	1,7c0 23/5/11	223	60	...
74	**Mansfield Corporation**	E. Holcombe Hewlett	Boots, hosiery, cotton doubling, foundry, tin box, motor bodies, sand and stone quarries, coal mining	...	240, 480 500-600	326 26,5,11	103	12	4
75	**Metropolitan Electric Supply Co.**	J. S. Highfield.....	Ordinary shops	200	200	5,446 23/5/11	1,246	60	...
76	**Middlesbrough Corporation**	H. M. Taylor.....	Iron and steel works, shipyards, joiners shop	...	220, 440 three-wire	1,786 About	303	50	2
77	**Motherwell**	James A. Wishart (Interim)	Engineering and steelworks	...	230, 460	3,500 15/5/11	100	3 of 12 1 of 30	1
78	**Newcastle and District Electric Lighting Co.**	W. D. Hunter ...	Engineering and shipbuilding, steel and lead works, &c.	100	240, 480 three-wire	10,600 23/5/11	...	150	2
79	**Nelson Corporation**	D. Helme.....	Cotton manufacturing	...	230, 460 three-wire	320 27/2/11	72	40	...
80	**Newport Corporation**	H. Collings Bishop	Coal, iron, clothing, nails, brickworks, millers, ship repairs, &c.	200 A few permitted	230, 460 three-wire	2,434 15/5/11	On hire 303	100	1

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ELECTRIC POWER SUPPLY.—*Continued.*

No.	Method of Driving. Group H.P.	Method of Driving. Indiv. H.P.	Rates. Per unit.	Rates. Bulk supply.	Approx. H.P. of other power displaced by electric motors.	Isolated Plants at present Operating. g=Gas, sg=Suction Gas, s=Steam.	Remarks. (Note.—Inst. E.E. Wiring Rules for Motors generally apply in all districts.)
						H.P.	
1	500 approx.	1,450 approx.	2½d. downwards	On application	...	...	.....
	...	...	2d., 1½d. & 1d.	...	...	...	*Motors used in gen. stn. for cooling towers, artesian well, driving machinery, &c.
	...	...	1½d. flat, ¾d. Stch. R., 1d. 5hr. M.D.	...	...	...	... .
	...	...	1d. flat	...	...	...	Power and lighting on same mains, 540 kw. day-load motors only.
	160 approx.	740 approx.	2½d. flat; 4d. and 1d. M.D.	On application	200, also 365 private electric plant	50g, 20sg, 850s, 10 water (approx.)	.....
	...	...	1½d. & ¾d. M.D. 1d. flat rate for restricted hours	¾d. & ½d. M.D.	...	...	.....
	...	...	Sliding scale 2d.—¾d.	...	...	290s, 200s, 4,000s	.....
	...	...	4d. and 1d. M.D.I. 2½d. flat.	Special rates	...	No record.	.....
	...	...	2½d. to 1d.	1d. to 8d.	...	...	.....
	..	...	2½d. to 1d. with dis., 1d. T.S.	...	...	...	Number and horse-power of motors does not include the docks or Admiralty supply.
	...	...	2d. flat, special for large consumers	To sub-stations	1,000	..	.....
	...	...	1½d. with dis. to a max. of 33⅓ p.c.	...	...	...	.....
	...	...	3d., 1d., ⅝d. and ½d.	On application	...	...	Power load rapidly growing and especially favoured with the many small and diverse trades subsidiary to staple industries of district. *Local for magnetting
	...	...	2d. to 1d. Sliding scale	Special terms	...	...	.....
	100	285½	*3d. to 1d.	...	...	20g, 160g, 300s	* With discount on hours of running.
	...	...	4d.—1d. M.D. system, 2½d. flat rate or on 2 rate meter	...	...	16g, 200sg	All motors are hired out by this company, and are maintained and inspected.
	...	...	3d. one hr., 1d. after	...	...	...	Radiators are at power rates but are not included in this return.
	...	...	2d. and 1d. less discount	...	...	...	* April 30, 1911.
	...	...	2d.—1d. per sliding scale*	On application	...	..	Hired motor system in operation. About 600 H.P. connected
	...	..	2d. & 1d. M.D.	...	..	...	*Subject to 2½ per cent. dis., for payment within 14 days.
			2d. to 1d. sliding scale				1d. power rate for large consumers.
	...	...	1d. flat	Nil	1,540	678g, sg, 660s, o	.....
	801	85½	2d. to 1d.	On application	618	...	... .
	...	...	1½d.	...	...	No information available	*This is a combined figure for lighting and power.
	...	...	2½d. to ¾d. sliding scale	...	...	...	1 large engineering w'ks, 1 large malting w'ks received entire power supply from Corp.
	184	367	2½d. sliding scale to ½d.	By contract	440	200g 500s	.....
	...	...	0·8d. to 1·75d. less 5 per cent.	...	...	...	.....
	...	...	1·125d. to ·844d.	...	...	...	*For industrial purposes only.
	...	...	*2d., 1½d., 1d.	...	...	...	* 2d. up to 3,000 per qr., 1½d. from 3,000 to 10,000 per qr. 1d. all units in excess of 10,000 per qr.
	...	...	2½d., 2d. & 2d. & 1d. M.D	On application	...	...	.....
	Both		2½d. and 1d.	On application	...	...	.....
	389	173	1d. flat, ¾d. for night shifts.	...	...	49g, 25sg, 386s	Two private plants, total 1,200 kw., running. About 180 B.H.P. in four different firms' factories all under consideration for change over during next year.
	About 2,031	About 426	*2d., 1½d., 1d. & ¾d.	...	About 400	About 200g 100sg, 250s	*2d. first 500 per qr., 1½d. next 1,500 per qr., 1d. next 3,000 per qr., ¾d. remainder.
	Both		Various.....	...	650	15sg	.....
	...	...	4d. & 1d. M.D.	...	214	450s*	Town gas sold at 1/6 1,000 for power. Tramway supply 1,200 H.P. not included.
			1d. daylight				* Not including collieries.
	...	...	3d. and ¾d. M.D.*	On application	...	...	* £4 per kw., plus 1d. per unit, subject to rebate under certain conditions.
	...	...	2d. & ½d. M.D.	...	1,500	...	Largest installation, shipyard, max. demand 400 kw.
	...	...	Sp. on app'n. 1d. and ¾d.	...	...	...	.....
	...	...	Max. 1½d.	According to load factor, &c	...	...	Largest consumer, Sir W. G. Armstrong Whitworth & Co., Ltd, Elswick Works.
	Both		*	...	...	...	* Motive power—2½d. for 1st hour per day, 1⅛d. every subsequent hour, less 5%.
	About 899	1,838	3d. and 1d. acc. to quan.	On application	...	...	... .

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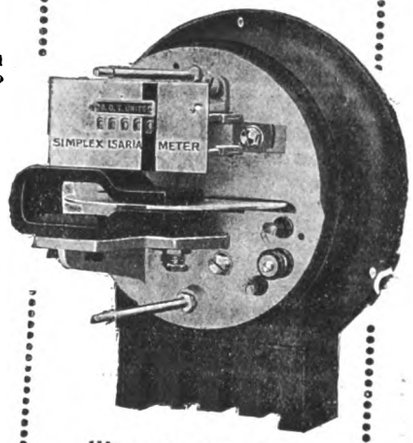

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No.	Supply Authority	Engineer and Manager.	Principal Local Trades.	Power Voltages. A.C.	Power Voltages. D.C.	Total B.H.P. connected at date indicated below.	Total number of Motors connected.	Largest Motor on Circuit.	Max. Demand Kw.
81	**Northampton Electric Light & Power Co.**	G. H. Jackson ...	Boot and shoe factories, engineering works, printers, motor car works and tanneries	...	210, 420 three-wire	1,943 30/4/11	...	40	...
82	**North Wales Power and Traction Co.**	G. K. Paton (Chief Elec. Eng.)	Slate quarries	500 3-phase	...	3,050 31/8/10	60	200	1,000
83	**Norwich Corporation**	F. M. Long	Boot and shoe, mustard, printing, breweries	...	220, 440	3,208 31/3/11	558	150	800 B.H.P. station.
84	**Nottingham Corporation**	H. Talbot	Lace, hosiery, tobacco, engineering, leather	...	200, 400 three-wire	4,682 16/5/11	1,198	60	...
85	**Nuneaton Corporation**	S. C. Gibson	Hat making, hosiery, wool, cotton, elastic web, foundry, quarries and collieries, boot and shoe factories.	...	220, 440 three-wire	426¼ 23/5/11	97	60	250
86	**Partick Council**	W. Sillery	Shipbuilding and engineering works	...	240, 480 three-wire	3,346¼ 15/5/11	315	80	2,143
87	**Peterborough Corporation**	J. C. Gill.....	Engineering, brickworks, railway	...	200, 400	319 30/4/11	89	20	522
88	**Reading Electric Supply Co**.....	E. Rowley Hill ...	Printers, engineers and iron founders, saw-mills	200	200, 400	1,961 31/12/10	288	65	1,365
89	**Redditch Urban District Council**	Wm. J. Ferguson	Needle trade, fishing tackle, cycle factories	200	...	1,350 31/7/08	137	40	...
90	**Rochdale Corporation**	C. C. Atchison ...	Textile and engineering.....	3,000 220	220, 440, 500	1,834 31/5/11	295	50	...
91	**Rotherham Council**.....	E. Cross	Iron, steel and brass works	...	230, 460 three-wire	1,229 1/12/10	132	106	455
92	**Salford Corporation**	H. J. Hawkins ...	Textile and engineering	200	220, 440 three-wire	12,152 30/4/11	1,096	300	...
93	**Sheffield Corporation**	S. E. Fedden	Steel and iron works, cutlery works, foundries, general engineering works	6,600 2,000 400, 200	...	17,086 25/3/11	1,680	350 H.P.	8,450
94	**Shoreditch Borough Council**.....	C. N. Russell	Printing, shoemaking, cabinet and furniture manufacture	...	240, 480 three-wire	5,041 30/11/10	1,000	...	3,815
95	**Shrewsbury Corporation**	C. M. Johnston ...		...	210 420	202 31/3/11	85	20	370
96	**Smithfield Markets Electric Supply Co**	Edgar Dowling ... (*Chief Engineer*)	Cold storage, wholesale meat, poultry, &c.	...	100 200	510 30/11/10	40	130	498
97	**South Shields Corporation**	J. H. Cawthra ...	Shipyards, docks and marine engineering works	110, 220	550	3,000 23/5/11	...	160	...
98	**Stalybridge, Hyde, Mossley and Dunkinfield Electricity Board**	Robert Blackmore	Textile, paper mill boiler works, bleach works engineering works, iron works	400 230	460 230	8,000	325	375	5,100
99	**Stamford (Urban Electric Supply Co.)**	J. E. Edmundson	Brickworks, laundry, foundry, engineering works, flour mills, printing works, timber yard	..	240, 480 three-wire	425 30/4/11	95	35	...
100	**St. Helens Corporation**	E. M. Hollingsworth	Chemical, glass and bottle works, steelworks, collieries, copper works	230, 400 3-phase	230, 460 three-wire	2,500 31/3/11	319	300	750
101	**St. Marylebone Borough Council**	A. Hugh Seabrook	Printing, building, small workshops (various trades)	None	240 480	3,254 31/3/11	870	110	...
102	**Stockton-on-Tees Council**	J. J. Smith.....	Shipbuilding, engineering and ironworks	...	230, 460 three-wire	1,200 31/10/10	135	120	...
103	**Stoke-upon-Trent** (County Borough of Stoke-on-Trent).	C. H. Yeaman.....	Potteries, engineering works.....	None	240, 480 three-wire	1,155½ 28/2/11	...	80	540
104	**Sunderland Corporation**	A. S. Blackman...	Shipbuilding, marine engine and boiler makers, coal mining, flour mills	5,000 220	220	11,618	832	280	4,425
105	**Swansea Corporation**.....	C. A. L. Prusmann M.I.E.E., A.M.I.M.E.	Metallurgical, coal exporting tinplate manufacture, &c.	220, 440 three-wire	220, 440 three-wire	2,430 1/5/11	...	60	1,275
106	**Uxbridge and District Electric Supply Co.**	A. Randall Bell...	Flour mills, printing, engineering, brickmaking	200, 400	...	959 1/6/11	97	60	717
107	**Wakefield Corporation**	H. A. Nevill	Engineering, woollens, coal, printing, laundries, wire mills	200	...	1,378 31/8/10	183	110	1,305
108	**Walsall Corporation**	A. S. Barnard ...	Saddlery, harness, leather, clothing, iron founding, tubes, brushes and rolling mills	(See Remarks)	105 210	1,105 26/5/11	222	35	...
109	**Warrington Corporation**	F. V. L. Mathias..	Wire mills, printers, saw mills, tanneries, engineers, corn mills, gas stove manufacturers, builders, min. water mfctrs, &c.	*	†	5,662 27/2/11	...	215	...
110	**Wellingborough Electric Supply Co.**	W. J. S. Jones ...	Boot factories, engineering works and joineries	...	230, 460 three-wire	340	31	20	135
111	**West Bromwich Corporation** ...	W. A. Jackson ...	Spring works, steel rolls, hollow ware foundries, edge tools, tubes, school furniture, corn mills, wire nails	...	230, 460 500	... 30/4/11	187	125	1,000
112	**West Ham**	H. H. Couzens ...	Chemical, engineering, flour mills, ink mills	100, 200, 400	500	8,524 kw. 28/2/11	1,109	115	...
113	**West Hartlepool County Boro'..**	H. F. Friederichs	Blast furnaces, steel wks., ship yds., engine wks., paper mill, saw-mills and joinery wks	...	230, 460 three-wire	2,057 30/4/11	240	120	550
14	**Whitby (Yorks) District Council**	L. H. King	Fishing	...	460	458	59	40	300
115	**Whitehaven Corporation**	B. Sankey	Tannery, flour mill, printing and machinery works, &c.	...	420, 210 three-wire	206¼ 1/6/11	40	90	550
116	**Wigan Corporation**	Jas. Slevin	Coal mining, cotton mills, engineering works	...	230, 460 three-wire	1,723 1/3/11	258	50	550
117	**Windsor Electrical Installation Co.**	A. E. Farrow, A.M.I.E.E.	Brewing	220	220	222	82	10	75
118	**Wolverhampton Corporation** ...	C. E. C. Shawfield	Ironworks, edge tool works, corn mills, paint works, cycle and motor works, saw-mills, lock works, &c.	6,000, 400	440, 220 three-wire	5,948 31/9/10	463	100	4,000
119	**Worcester Corporation**.....	C. M. Shaw	Porcelain, glove, leather, flour, engineering, various, buttons, confectionery, printing, horse-hair cloth, &c., works	100, 200	230, 460 500	980 31/8/10	178	2 40's	2,250
120	**York Corporation**	J. W. Hame	Confectionery, printing, railway works, flour mills, brickworks	...	230, 460 three-wire	1,541½ 31/3/11	290	50	1,200 1,875

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ELECTRIC POWER SUPPLY.—*Continued.*

No.	Method of Driving. Group. H.P.	Method of Driving. Indiv. H.P.	Rates. Per unit.	Rates. Bulk supply.	Approx. H.P. of other power displaced by electric motors	Isolated Plants at present Operating. g=Gas. sg=Suction Gas s=Steam.	Remarks. (NOTE.—Inst. E.E. Wiring Rules for Motors generally apply in all districts.)
						H.P.	
31	About 1,630	About 313	2d. to 1d. sliding scale*	On application	About 1,400	...	* Large consumers 1d.
32	575	2,475	1½d.—¾d. and under sliding scale	...	3,050	...	Slate quarry load mostly winding, pumping, air compressor and mills. Transmission at 10,000 volts three-phase, all overhead, bare wire and 20,000 volt.
33	...	...	1½d. to ¾d.	...	...	...	.....
	...	...	1¼d.	...	...	...	.....
	...	220	2½d to ¾d. on sliding scale	On application	500	50*sg*, 100*s*, 20 *oil*	.....
	...	...	1d. flat rate	...	...	...	.....
	...	...	1½d. flat.	...	...	...	.....
	About 1,400	300	£4. and 3 d. or ½ d. per unit according to demand	...	400	50*g*, 125*sg*	.....
	...	...	2d. to 1d. sliding scale.	...	...	350*sg*	.....
	Practically all group driven.	...	2d. to ·6d. sliding scale*	On application	Steam 849 Gas 227	206*g*, 120*sg*, 867½*s*	Isolated plants on present route of mains (approximate only). *Special terms for special conditions.
	Both		1½d. and 1d.*	On application	About 1,000	...	Several large firms about to adopt electric drive. *Sliding scale down to 0·6d. for large users.
	...	...	*	...	...	...	* Flat rate.—1½d. first 1,000 units per qr. 1d. all in excess. Fixed charge system £1 per qr. per E.H P. demanded and ½d. per unit consumed
	...	..	Lht 4d., Heat 1d., Power 2d. to ½d.	...	7,000	...	Great expansion of use of power supply in rolling mills and cutlery works.
	...	...	½d. up to 75,000 p.a., ¼d. after*	...	...	..	* Plus £3 per E.H P. demanded.
	...	...	*3d., 2d. and 1½d.	...	...	...	*Discounts: 5 per cent. over 600 units, 10 per cent. over 1,000 units.
	...	...	1½d. and 1d.	...	...	...	.....
	Both		1½d. 1st 5,000 per qr. 1d. after. less discount 2½%	...	...	...	Also traction supply.
	...	..	2½d.—·35d.	On application	2,000	300*g*, 1,700*s*.	... .
	...	...	2½d. flat, 4d. and 1d. M.D.	On application	..	...	.. ..
	...	...	2d. and 1d. with disc'nts	...	1,500	100*sg*	.....
	...	...	2d. & 1d. M.D.*	...	220 since Aug., 1905	703*g*, 10*sg*, 1,109*s* 160 *oil*	* Restricted hour and telephone system.
	...	...	Sliding scale 2d. down to 1¼d.	On application	...	...	One works take about 250,000 units per annum, and the total amount sold per annum for power purposes amounted to 421,692 units.
	Both		1½d. to 0·8d.	On application	...	...	The potteries all require steam for heating, and this is generally the drawback to electric driving.
	..	...	2½d. (dis. to ¾d.)	On application	...	...	.. ..
	...	...	2d. (1st hr.) & 1½d. M.D.*	...	...	...	Motor hiring scheme in operation.
	...	...	2½ to 1½ flat*	...	...	50*g*, 1,200*sg*, 500*s*	* 200,000 per annum and over special rates.
	...	...	2d. to 1d.	On application	746½	...	Large power users by contract at prices based on load factor. * £4 per H.P. demanded per an. and ¾d. per unit.
	...	...	(*See* remarks)	On application	...	...	.....
	...	...	0·6d. to 2d. according to conditions	...	4,500	...	(1) Any convenient pressure for large supplies in bulk transforming from 3,000 volts (3 phase 50 ∿). (2) For distributing purposes, power 365, parts of area only.
	...	...	1½d. flat and spl.agreem'ts	...	120	...	*Under 1 H.P. 220 single phase, 1 H P. and above 330 3-ph. 50 periods. †Under 3 H.P 230, 3 H.P. and upwards 460.
About 1,103	About 801		1½d. to ¾d.	...	About 750	...	.....
Partly	both		Less ¾ % dis. 1d. max.	On application	5,241 kw.	...	72 motors on hire = 487 H P. * Motors only.
120	1,893		2d.—1½d. flat with disc.	1d.—¾d.	1,650	510*g*, 230*sg*, 5,369*s*	.....
...	...		£5 per kw. per an. at 1d. unit	...	...	...	Flat rate for less than 50,000 per annum, 2d.-1½d.; over 50,000, under 500,000, 1½d.-1d.; from 500,000 to 600,000 and over, 1d.-¾d.
...	...		1½d and 1¼d. or 2 rate, 2d. for small motors	...	77	45*g*, 20*sg*, 12*s*	.....
About 900	823		Up to 1 000 units per annum 2d., over 1,000 1d.	...	300	...	.....
...	...		£3 per H.P. installed per ann. and 1d. per unit	None	108	15*g*, 90*sg*, 40*s*	.....
...	...		1d. to ½d.	Various	...	...	.....
714	266		2½d. & 1d. M.D. ¾d. sewerage P. 1d. & 1½d. restricted hour 1¼ downwards	...	Over 1,000	200*g*, 300*sg* 2,060*s*	350 H.P. awaiting connection. Will displace steam.
...	...			On application	...	..	Two large pumps for dealing with surface water.

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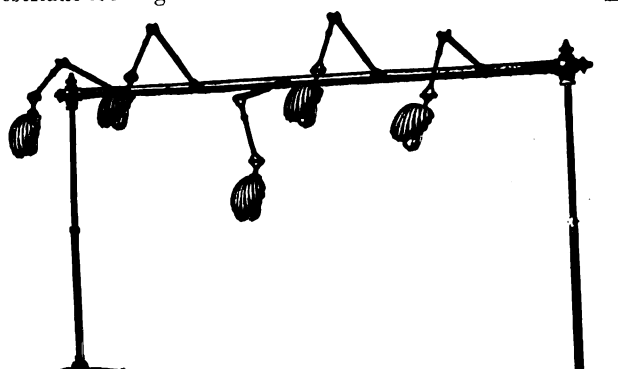
STERLING TELEPHONES
The Sterling Telephone & Electric Co., Ltd., 200, Upper Thames Street, London, E.C. Works: Dagenham, Essex.

A NEW WINDOW FITTING.

Electrical contractors will be interested in a new pattern of fitting which is being introduced for the better illumination of shop windows. Its trade name is the "Constellum," and it is shown in the accompanying illustration, which practically explains the principle adopted in the fitting. The arrangement is intended to provide an undoubted want for a conveniently adjustable fitting which can be a fixture or readily portable in shop window lighting. The movable brackets are noteworthy for the knuckle joints employed. These give a wide range of movement of the bracket without the use of loose "flex" at the same time the wire inside the bracket tube is not submitted to abrasion no matter how roughly the fitting is moved or to what extent. By the use of shell reflectors the direct rays from the lamps in the brackets are shielded from the eyes of pedestrians looking into the window.



THE "CONSTELLUM" WINDOW FITTING.

The Constellum is supplied as a four-light fitting, either in enamelled steel, polished brass, bronzed brass and oxidised copper. The pillars supporting the rail to which the lamp brackets are attached are 30 in. high in the standard size of Constellum. Further details can be obtained from J. Dugdill & Co., Failsworth, who are the patentees and makers.

ALUMINIUM IN THE CHEMICAL FACTORY.

The application of aluminium to chemical work may be readily adduced from its more salient properties. The most striking physical attribute of aluminium is its lightness. Wherever large pieces of plant have to be erected or carried in difficult situations, the fact that aluminium weighs a third of iron and copper, and almost a fifth of lead, is of paramount importance. Still more important is this factor where there is question of transporting materials. The saving in weight of the containers often allows of heavier effective loads being carried; above all, where manual labour cannot be dispensed with, and where the carrying capacity of the operatives, especially of women, is limited. The high conductivity of aluminium causes it to be selected in preference to earthenware, wood, lead, tin, or iron, wherever rapid heat transference is an essential. Mechanically, aluminium is well suited to the design of chemical plant. Its great malleability allows of its being hammered into the shape of pans, drawn into the form of tubes, and rolled into sheets; whilst its tenacity is such that pressure vessels and vacuum pans can readily be made in aluminium. Though not quite as stiff as copper, aluminium is far stronger than either lead or tin.

Of the chemical properties of aluminium, the most important to the chemical engineer is the fact that aluminium salts are absolutely *non toxic*. For this reason, if for no other, it is pre-eminently the material to be used wherever possible for the manufacture, storage, and distribution of all materials destined for human consumption, such as sugar, jams, preserves, edible oils, meat extracts, milk, &c. Even in those cases where some solution of the apparatus cannot be avoided, the manufacturer may be assured that by using aluminium he is free from all danger of poison in his products. The salts of aluminium are, without exception, colourless—a factor of the utmost importance where a colourless product is required.

Aluminium shows remarkable indifference towards many organic materials, which enables it to be used very effectively for such different materials as ether and formaldehyde, citric acid, glycerine, &c. Of the common metals, aluminium is the only one which successfully resists the attack of nitric acid. As a consequence, it finds application in the nitric acid and explosives industries for such purpose as the piping of nitric and mixed acids, in the construction of acid gutters, nitrating vessels, the cages of centrifugals, &c.—*From a pamphlet of the British Aluminium Co.*

LANCING WORKSHOPS OF THE L.B. & S.C.R.

The new railway carriage works which the London, Brighton and South Coast Railway has been building at Lancing are electrically operated throughout with energy supplied from a Diesel driven power house. Two units are being installed, one of 350 kw. and the other of 250 kw., both operating at 200 revs. per min., and furnishing energy at 230 volts. The motor equipment includes one 50 H.P., one 30 H.P., 10 15 H.P., four 10 H.P. and two 5 H.P. machines. These are arranged for the group driving of modern woodworking machines. The electrical portion of the installation has been manufactured and supplied by Messrs. J. P. Hall & Co., Ltd., Blackrinding Iron Works, Oldham. The plant complies with the standard productions of this firm, and is modern in every respect. The Diesel engines are by Mirrlees Bickerton & Day and consist of one of 500 H.P. and one of 375 H.P., both of the 8-cylinder type. These engines are now undergoing test and will shortly be delivered.

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ILLUMINATED CARS AT BRADFORD.

As we pointed out in our last issue, the electric tramcar is a vehicle which is conveniently adaptable to the formation of any suitable design which can be illuminated for display at night time. The Bradford Corporation set an admirable example in the recent Coronation festivities. One of their standard cars was decked out to represent a crown on a pedestal. This occupied the whole of the top deck of the car, and was elaborately treated in gold bronze, suitably lined. The band was perforated and small coloured celluloid windows were let in. When these were lighted up with lamps from behind the representation of jewels was very real.

On the lower part of the car was a red ribbon on a ground-work of royal blue, with the words "Long Live the King, 1911," in bright gold. These letters were picked out with gold coloured lamps, and a shield in gold bearing the monogram "G.R.I." in white, red, and blue lamps. On the opposite side of the car the same scheme was employed with the letters "God Save the Queen." From the ground level to the top of the Maltese Cross surmounting the car the distance was 16 ft. An elaborate scheme of illumination was adopted for the car and upwards of 1,050 lamps were introduced. The adjoining illustration shows the car in the day time. We understand that the entire scheme was designed and executed by the Bradford Corporation Tramways Department. We think it is to be congratulated on the result.

CORONATION CAR DESIGNED AND BUILT UP BY BRADFORD CORPORATION TRAMWAYS.

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THE ELECTRICIAN COMMERCIAL AND INDUSTRIAL SUPPLEMENT.

C. & I. Supplement No. 92.] JULY 7, 1911. [Gratis to Subscribers.

THE WORKS AND PRODUCTS OF ENGINEERING INSTRUMENTS (LTD.)

The manufacture of switchgear and motor control apparatus has gradually evolved from the chaotic period in which each maker designed and built practically every class of switching apparatus according to the requirements of the particular case in view, to the stage in which each manufacturer is practically a specialist in a particular class of control apparatus. Throughout the electrical industry at the present time there are many manufacturers of switchgear, but each one has some speciality which he has made peculiarly his own and for which he has acquired a reputation. This may be said of Engineering Instruments (Ltd.), whose factory at Skerne Works, Darlington we were recently given an opportunity of inspecting. The principal products of this company comprise motor starters, controllers and regulators, metallic and liquid resistances, oil switches for both high and low voltages, and complete switch panels of both ironclad and cubicle type for central station or industrial power service.

In our walk through the shops at Skerne Works we were particularly struck with the methods which have been adopted for the standardising of each particular type of apparatus or gear. This is a desirable feature in switchgear production, because it makes for interchangeability of parts, and is an encouragement to the customer to come again. At the same time, it is an important factor in the reduction of works costs and in the cutting down to the irreducible minimum of the types of gear

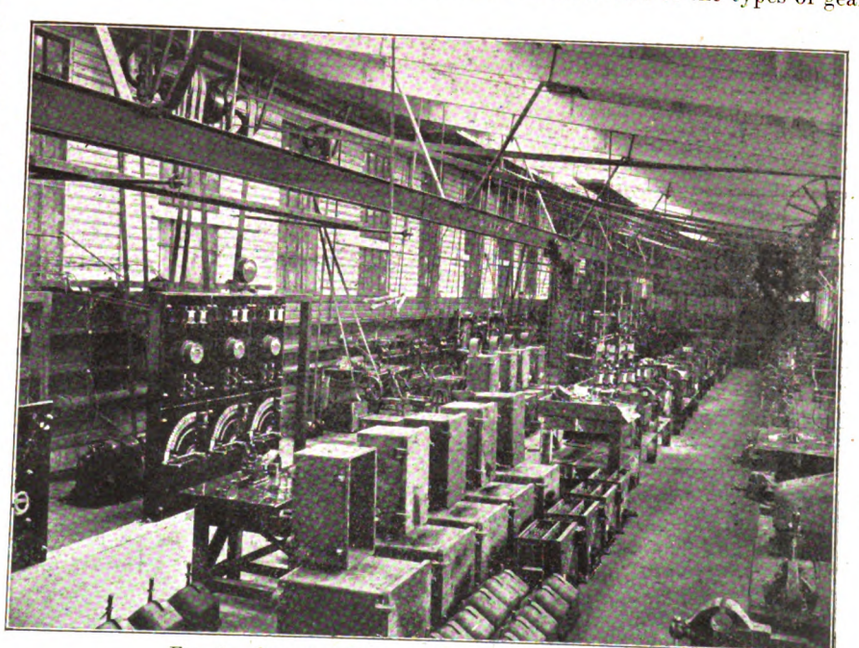

FIG. 1.—GENERAL VIEW IN SWITCH ASSEMBLY SHOP.

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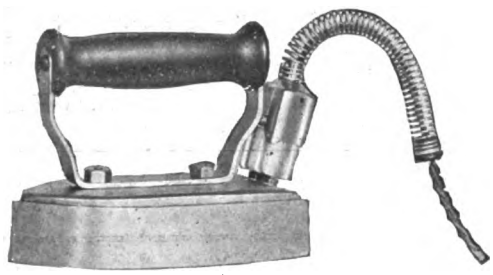

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manufactured. If the average consulting engineer appreciated more the importance of encouraging standardisation in switchgear manufacture he would be less exacting in his requirements of switchmakers, and would assist in the placing on the market, at reasonable rates, of reliable and satisfactory apparatus. In many cases the cost of the control gear in a motor installation is a serious item, and it may be run up to a tremendous extent if what we may call "gadgety" fitments are insisted upon.

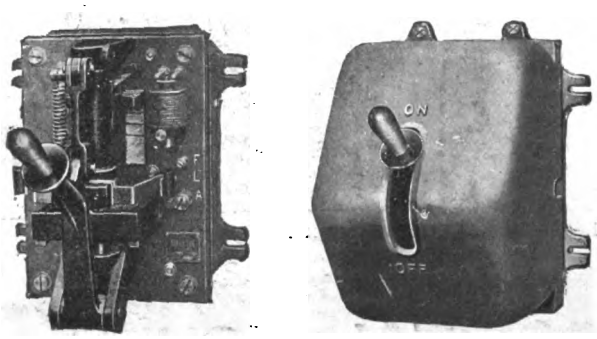

FIG. 2.—DIREKTON MOTOR STARTER, OPEN AND ENCLOSED TYPES.

The Works.—Skerne Works, Darlington, cover an area of several acres, and are devoted to the production of switchgear and stamped metal articles. The switch works comprise a roomy stores, a spacious machine fitting and assembly shop and a testing department (Fig. 1). In conjunction with these shops is a paint and enamel shop, in which certain portions of the metal supporting work are painted and stove enamelled. The equipment of machine tools includes a number of lathes, drilling, slotting, shaping and boring machines in addition to numerous metal saws. These do not call for any special comment, except that they are of modern design and are a practical assurance of accurate workmanship.

In the winding department are wound coils for the overload and no-voltage releases of the various types of circuit-breakers. The assembly benches are equipped on modern lines, and include a variety of jigs, which are used for the fitting-up of switchgear to standard centres, &c. A portion of the metal stamping works is at the disposal of the switch factory, and keeps it supplied with copper and steel stampings for contacts, springs, resistance grids, &c. The shops are light and airy, and the workmen have every convenience and comfort at all

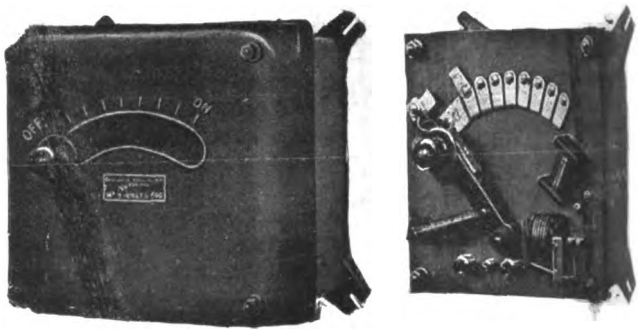

FIG. 3.—STANDARD PATTERN MOTOR STARTER.

seasons of the year. At the time of our visit we noticed a quantity of switchgear going through, particularly a number of 500-volt three-phase oil circuit-breaker control panels for colliery service. We understand that a large business in this class of apparatus is done by the firm. We also noticed a high-tension switchgear for the control of a number of generators and feeders for a textile mill installation; similarly, an iron

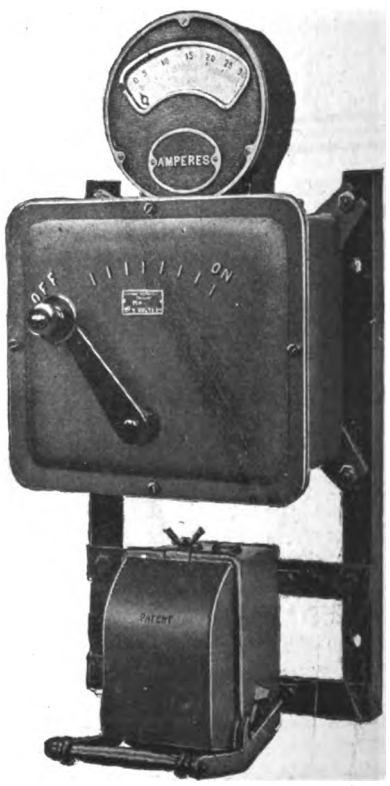

FIG. 4.—WATERTIGHT MOTOR STARTER PANEL.

enclosed high-tension cubicle type switching panel for the control of a high-voltage colliery pump. Upwards of 160 men are employed in the works.

Principal Products.—We may now turn to a few of the standard types of switching apparatus made by Engineering

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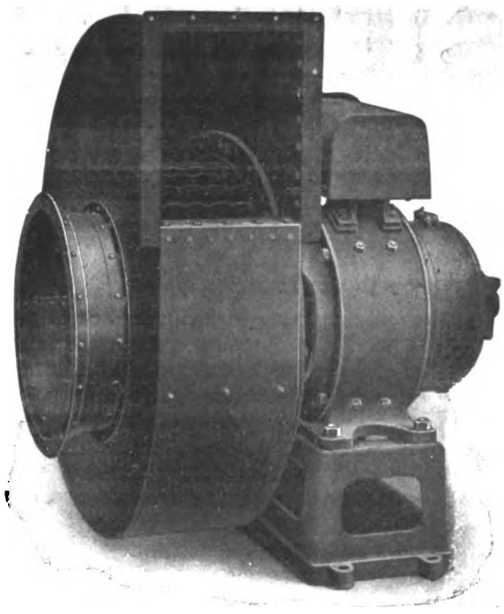

The Electric & Ordnance Accessories Co., Ltd.,
(Proprietors: VICKERS LIMITED.)
Aston, Birmingham.

Instruments, Ltd. Before doing so we may in justice to the company state that they are among the few remaining firms who carried through a considerable amount of pioneer work on switches and switchgear, and who have furthermore witnessed the complete vindication of the principles put forward and their successful application in practice.

Direkton Motor Starters.—These motor starters have now been on the market for some considerable time, and are well known. Their great advantage is that the starting of the motor is entirely independent of the operator, and they can, therefore, be used by unskilled persons. The principle of operation is that of a spring acting against an oil-filled dashpot, the moving portion of the mechanism carrying heavy carbon brushes, which pass over the contacts and cut out resistance at a predetermined speed. Copper brushes are provided to short-circuit the carbon brushes when all the resistance is cut out. No current is, therefore, being actually carried by the carbon brushes continuously.

The starting and stopping of the motor is accomplished by pushing the handle "direct on" or pulling off. The motor starters are fitted with no-volt and overload releases, both being in operation while the motor is actually starting, giving a circuit-breaker effect, and thus entirely protecting the motor. The starters are made in the open, semi- and totally-enclosed type. Fig. 2 showing the starter in the open and semi-enclosed type respectively.

Standard Motor Starters.—The standard motor starter which has recently been introduced by the firm has several novel features, and we were particularly struck with the patent renewable contacts employed. These contacts are more readily replaceable than any which have yet come under our notice, and although held by one screw only, there is no fear of their working loose or moving in any way. Fig. 3 shows one of these starters.

All sizes of these starters are fitted with renewable contacts; complete panels are also made up consisting of standard motor

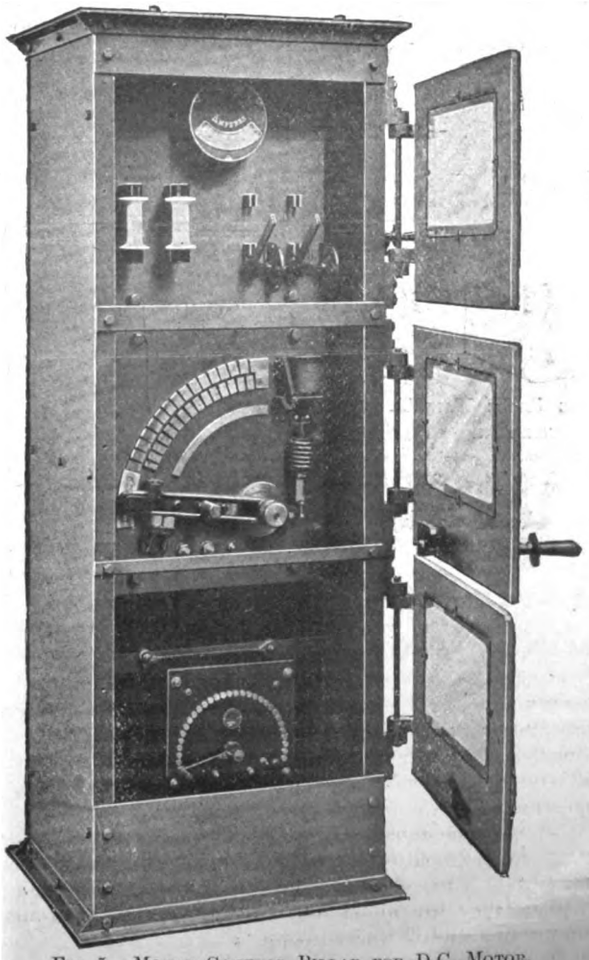

FIG. 5.—MOTOR CONTROL PILLAR FOR D.C. MOTOR.

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STERLING TELEPHONES
The Sterling Telephone & Electric Co., Ltd., 200, Upper Thames Street, London, E.C. Works: Dagenham, Essex.

starters and combined watertight switch fuses, a complete panel being shown in Fig. 4.

Motor-control Pillars.—Fig. 5 illustrates a sheet steel motor-control pillar, the particular pillar illustrated being designed for controlling a 50 H.P. 500-volt continuous-current motor.

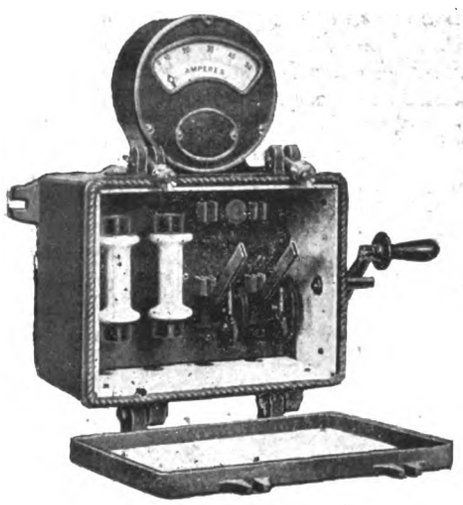

FIG. 6.—IRONCLAD SWITCH AND FUSE BOX WITH INSTRUMENT.

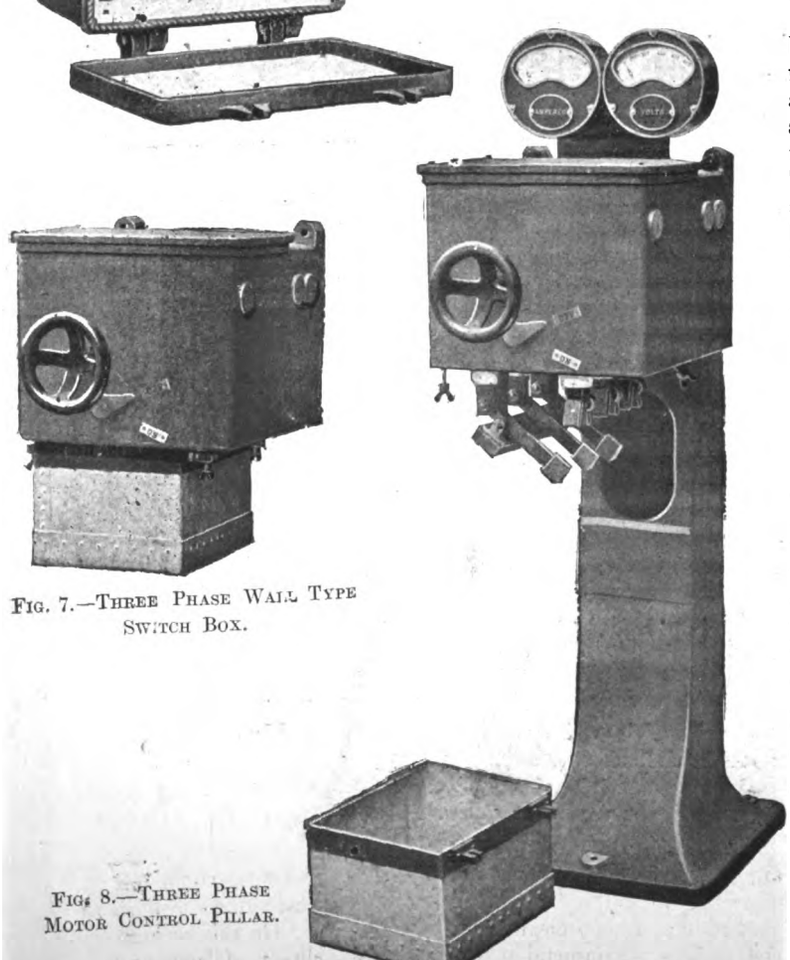

FIG. 7.—THREE PHASE WALL TYPE SWITCH BOX.

FIG. 8.—THREE PHASE MOTOR CONTROL PILLAR.

These panels are of the totally-enclosed dust-proof type, the whole design being of a substantial construction. A neat switchbox, illustrated in Fig. 6, is also one of the manufactures of the firm, these switchboxes being suitable for a current up to a maximum of 50 amperes. The boxes are fitted with double or triple-pole switches and fuses, the switches being of the quick-break knife type with operating handle outside, and the fuses of the porcelain handle tubular type.

Ammeters are also supplied with the switchboxes if required, these ammeters being bolted to the top of the switchbox, and connected between one switch and fuse internally.

Figs. 7 and 8 illustrate totally enclosed three-phase oil circuit-breakers of the wall or pillar type respectively. These circuit-breakers, which have been designed to meet the special rules for the use of electricity in mines, are of the totally-enclosed oil-immersed pattern. The oil tanks are readily removable without interfering with the gear in any way.

The circuit-breakers can be made up in the loose or fixed handle type, and fitted with overload trip coils in all three phases and no-volt release if required. The trip coils are enclosed in the top of the switch casing, covers being provided for adjusting and inspection. With this arrangement the trip coils cannot be tampered with as the covers protecting them can be sealed. Ammeters can be supplied with these circuit-breakers, and are bolted to the top of the switch casing.

The apparatus above illustrated and briefly described has been subjected to severe tests in practice and proved its general reliability in every way. Switchgear for the control of circuits and motors of every class has been installed in collieries, mines, steel works, textile mills, docks, on shipboard, &c., and under the most severe conditions met with in industrial power work. These installations are to be found in all parts of this country and the colonies, and they are a striking testimony to the excellence of the design and quality of the workmanship embodied in the apparatus.

In conclusion, we must express our thanks to Mr. E. Garside, the managing director of the works, for the facilities given us in preparing this article, and for his courtesy in showing us over the works.

HENLEY'S PAPER-INSULATED HOUSE WIRES.

In view of the discussion at the I.M.E.A. meeting at Brighton on the subject of "Modern Wiring Practice" considerable interest attaches to Henley's latest list, No. 64, which deals with paper-insulated house wires. The makers are offering two classes of this form of conductor, class YT, plain lead-covered, with twin conductors, each of high conductivity copper, insulated with paper thoroughly impregnated with a special insulating compound, the two cores being twisted together (each a different colour) and covered with a further layer of impregnated paper and sheathed with a solid drawn tube of pure lead. In the 7/20 and large sizes there are wormings between the conductors. The class YTW is the same as the above except that sizes 7/20 and smaller are served with two coats of stout compound tape, and the larger sizes are served with tarred jute yarn, and armoured with a layer of galvanised steel wires, which are left bright. The makers recommend this conductor for pressures up to 250 volts and they offer it in sizes from No. 20 to 7/16 twin conductor.

SIMPLEX CONDUITS LD.,
Garrison Lane, BIRMINGHAM.
Manufacturers of—
CONDUITS, CABLES, ACCESSORIES, FITTINGS, MOTORS, ELECTRIC HEATING AND COOKING MATERIAL, &c.

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THE WEEK'S TRADE LITERATURE.

THE USCO AIR HEATER.—We commented in a previous issue on the advantages of the air heater for promoting the combustion of fuel. A new pamphlet issued by the Underfeed Stoker Co. emphasises these advantages and gives technical and engineering details of the heater and its application to boilers of every class.

AUTOMATIC FRICTION CLUTCHES.—An interesting pamphlet dealing with a new pattern of centrifugal friction clutch has been issued by Messrs. Thos. Broadbent & Sons, Huddersfield. This clutch is specially recommended by the makers for use with alternating-current motors where the starting torque is low and where it is necessary that the load shall be applied gradually to the motor. The makers give particulars of a number of applications of these clutches in the driving of hydro-extractors and textile machinery of various kinds.

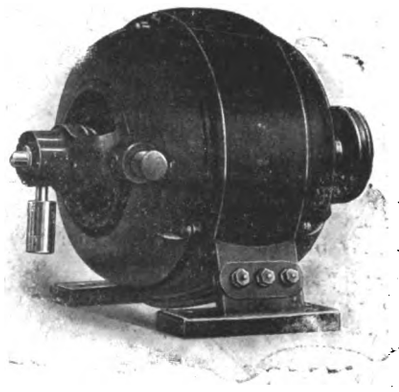
THE COMPLETE SILVERTOWN PRICE LISTS.—The Indiarubber, Gutta Percha & Telegraph Works Co. (Ltd.), has issued a substantial file in which the whole of their electrical price lists is bound up. These deal with gutta-percha insulated wires and cables and jointing materials, electric bells and pushes, Silvertown instruments, standard mica tin foil condenser, telegraph and telephone line materials, dynamos and motors, and electric light cables and wires. We have had occasion to deal with these lists separately at various times in our columns, so that the general details of them will be known to our readers. We are asked by the company to state that the complete file will be forwarded to all bona-fide inquirers.

OSRAM LAMPS BY AEROPLANE.

Members of the I.M.E.A. in Brighton last week were notified of an attempt which would be made, under favourable weather conditions, to carry a consignment of Osram lamps from Worthing to Brighton by aeroplane. This novel method of transport would have been a fitting culmination to the kite advertising which the General Electric Co. carried out from the West Pier and Beach at Brighton during the Convention. But the clerk of the weather was not kindly disposed towards the passage of Osram lamps over the "filmy ocean of air," and municipal engineers and their friends had to depart disappointed.

The arrangements with the airman, Mr. H. Barber, held good, however, for some days, and on Monday last it was thought that the weather was suitable for the attempt. Some 5,000 people gathered outside Hove Marine Park, where the descent with the lamps was to be made, but they were disappointed, as Mr. Barber was for some reason delayed until it was too dark to make the attempt. On Tuesday evening there was much the same crowd, and under ideal weather conditions Mr. Barber piloted the all-British Valkyrie monoplane over from Shoreham and made a fine descent in the Marine Park. The case of Osram lamps was securely tied under the airman's seat, and was safely delivered to Messrs. Page and Miles, electrical contractors, Brighton, who had arranged to take over the consignment at the end of its novel journey. Mr. Barber then returned to Shoreham amid the enthusiastic cheers of the crowd. The idea of delivering the lamps by aeroplane originated with Mr. H. Clifford Palmer, publication manager of the General Electric Co., and we must congratulate him on the result after so many disappointments. We were present at the descent of the aeroplane, and can testify to the safe delivery of the lamps. We have since heard that not one of the large number carried was broken. The facilities for the arrival of the airman were afforded by the Hove Corporation, who kindly policed the ground, and also placed it at Mr. Palmer's disposal. The flight was made at a late hour, and several photos were taken, and we shall reproduce from these in our next issue. We may mention that Mr. Barber follows aviation in a private capacity, and the proceeds of flights of this character are devoted by him to a prize fund for the encouragement of the sport. He recently presented four Valkyrie monoplanes to the Government.

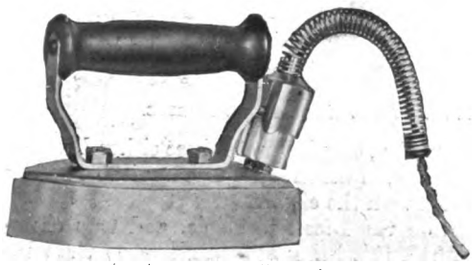
E.M.I. FANS
and
Small Motors
A.C. & D.C.
All Sizes.
All Voltages.



HOGAN & WARDROP,
2, GRESHAM BUILDINGS,
BASINGHALL STREET,
LONDON, E.C.
Telephone - - - 723 LONDON WALL.

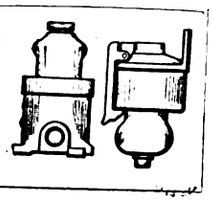
THE SMOOTHWELL ELECTRIC IRON.

A new pattern of electric iron which has been given the above trade name has been put on the market by Messrs. Siemens Brothers Dynamo Works. We understand that it is well made and inexpensive, and at the same time is a reliable article. It is well finished in nickel plate, including the face of the iron, so that it should keep clean and free from rust. On this account the makers recommend it for the most delicate of laces and light garments such as are dear to the female heart. The iron is neat in appearance, as the adjoining illustration shows, and the flexible cord has been protected by a special wire guard. The weight of this iron is 6 lb. and the energy consumption is stated to be 400 watts. Where the supply of energy is given at a penny a unit this makes the use of the iron very inexpensive.



THE SMOOTHWELL IRON.

REYROLLE WALL PLUGS
For Portable Machines, Lights, &c.
Pamphlets 114, 122, 88 and 45 give all particulars
WORKS—
HEBBURN-ON-TYNE, ENGLAND



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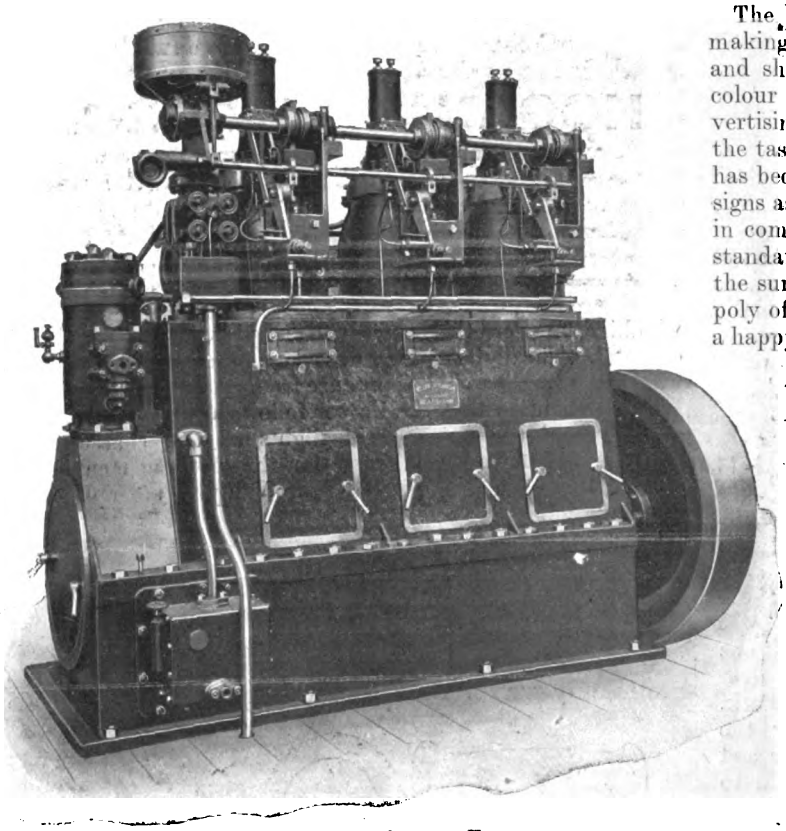
SUBSCRIPTION, Town or Country, from ONE GUINEA. READING ROOM open Daily to SUBSCRIBERS.
136, GOWER St., & 24, Gower Place, LONDON, W.C.

THE WILLANS TWO-STROKE DIESEL ENGINE.

In order to meet the demand for an internal combustion engine which embodies the advantages of the Diesel principle as well as those of high speed, Willans & Robinson (Ltd.) have utilised their extensive experience in the manufacture of the Willans-Diesel slow-speed oil engine and the Willans high-speed steam engine to design and produce a type of engine on quite new lines. The engine illustrated herewith has three cranks, and will develop 75 B.H.P. when running at its normal speed of 450 revs. per min. This size of engine is also built with two or four cranks, the powers being 50 or 100 B.H.P. respectively. It may be used for driving all classes of machinery, for it is equally well suited for driving electric generators, a line of shafting, agricultural machinery, centrifugal pumps, fans,



WILLANS-DIESEL TWO-STROKE ENGINE.

compressors or blowers, &c., coupled up to these either direct or by means of belts or ropes, in which latter case a suitable belt or rope pulley is provided with the engine.

The engine works on the Diesel principle, and uses cheap crude petroleum as fuel, this being ignited solely by the temperature of the air compressed in the main cylinder, where it burns slowly, power thus being imparted to the piston without any explosion, or the use of any ignition apparatus. No vaporiser is required, and the engine may be started up without any preliminary heating. It differs, however, from the ordinary type of Diesel engine, insamuch that in every four strokes which each piston makes two of these are power strokes, whereas in the ordinary type only one of the four is a power stroke. As a consequence of this, and the high speed at which the engine may be run, it is small in size, compact in form and all its parts are light. The cost of a complete installation is thus reduced to a minimum, not only as regards the engine itself and the generator or machinery it may have to drive, but also as regards the foundations, buildings and accessories; whilst at the same time the well-recognised advantages of the Diesel system are retained. These latter advantages are set out in Willans & Robinson's pamphlet dealing with their ordinary type of Willans-Diesel engine, a copy of which will be sent to those interested in the use of internal combustion engines for any purpose. The above engine was on view at the Royal Agricultural Show, Norwich, where it was running as part of Willans & Robinson's exhibit.

NOVEL SHOWCARD COMPETITION.

The appeal which the metal lamp manufacturers are now making to the public necessitates the distribution of posters and showcards which will be both distinctive in design and colour and attractive and pleasing to the public. Modern advertising has been brought to such a degree of efficiency that the task of publicity managers in the selection of good matter has become increasingly difficult. As far as we know such designs as are accepted are submitted by the regular trade artists in competition with one another. This factor ensures a high standard of excellence, because competition usually results in the survival of the fittest. Even trade artists have no monopoly of ideas. Sometimes the lay man will suddenly hit upon a happy idea which, if worked up by a professional man, will give the advertising manager exactly what he requires. This peculiarity of the public to provide spontaneously what the professional man cannot evolve by hours of thought and labour has been proved over and over again. It was particularly evident when the "Evening News" asked the public for its ideas as to a suitable poster for the London Underground Railways Co. The design selected was not only novel but it proved that the author was an artist of no mean ability.

With these preliminary remarks we will turn to the Tantalum showcard competition which Messrs. Siemens Brothers Dynamo Works (Ltd.) have just arranged. The main idea in view is to give everyone, but we may say more particularly present and prospective consumers of electricity, an opportunity of submitting to the company what they think to be a suitable showcard for the advertising of its products. The Tantalum lamp public advertising and postering has always been consistently good. The company were pioneers in this direction and their "Satisfied Consumer" poster has found its way into every corner of the world. We have from time to time reproduced illustrations of this poster in almost every language.

The general conditions of the competition are set out in an advertisement which will be found on another page of this issue, but briefly we may say that the company offer prizes of £75 and £25 for the best and second best design for a showcard to advertise to the public the merits of their Tantalum lamps. It is stated that preference will be given to designs which embody the chief features of the "Satisfied Consumer" poster, though the inclusion of this is not absolutely essential. The design must be submitted in colours on stiff card 24 in. high by 18 in. wide. One condition must be strictly observed, and that is that the designs submitted must have no political reference. The com-

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NORFOLK HOUSE, VICTORIA EMBANKMENT, LONDON, W.C.

Western-Electric TELEPHONES.

WORKS: NORTH WOOLWICH

Telephones: Gerrard 5349. Central 2389. East 1400.

pany reserve to themselves the right to accept the prize designs, the payment for which will be the prizes themselves, and further to accept and use any other submitted design on the payment of £5 per design. The designs will, of course, become the property of the company and may be copyrighted by them. Original designs will be returned, though the company will not be held responsible for loss or damage.

This novel competition is now open and the last day for receiving designs is Monday, July 31. They may be sent to Messrs. Siemens Brothers Dynamo Works (Ltd.), Tyssen-street, Dalston, London, N.E.

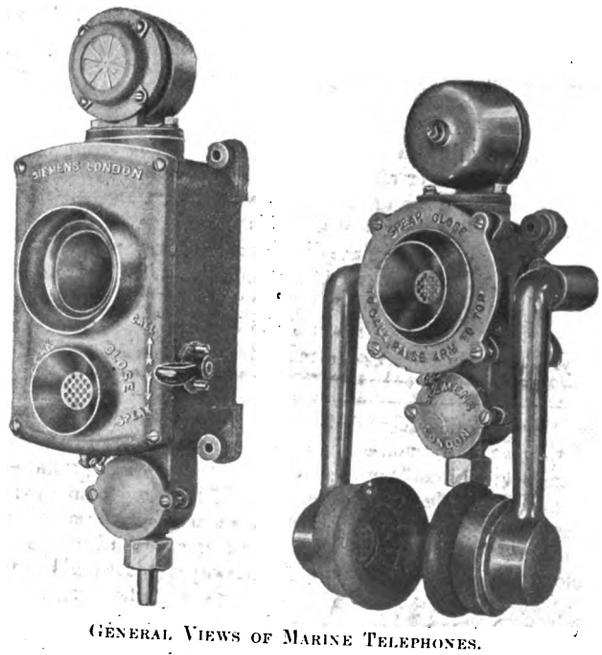
We hope that our readers, both professional and trade, will take an interest in this competition, because they must have a considerable fund of ideas upon which to draw for a competition of this nature. We shall be pleased to publish the names of the successful prize winners as soon as these are announced, and we understand that the company is advertising the scheme in the daily papers.

GLOVER'S ANTICIPATIONS.

Reproduced by permission from W. T. Glover & Co.'s 1911-12 *Almanac.*

MARINE LOUD-SPEAKING 'PHONES.

The importance of telephonic communication on shipboard has long been recognised and electrical practice in the marine world have produced the loud-speaking telephone which is now a standard attachment of all modern vessels. The chief feature of the Siemens loud-speaking telephone system is that the loud tone is not obtained by the usual method of allowing large currents to pass through the microphone; this is usually a source of trouble, as it causes the carbon granules to agglomerate and thereby to reduce the volume of sound—but by the special construction of the microphone and the method of connections. The current passing through each microphone is only about 0·07 amperes. In addition, with the system of connection used, the speaking current does not pass through the source of supply as is usually the case. The passage of the speaking current through the source of supply greatly impairs the articulation. Another important point in these instruments is that the microphone and telephone are constructed in a removable capsule form, and are perfectly watertight. This is important in the case of the microphone, as the presence of moisture on the carbon granules prevents clear and loud speaking. In addition to the capsules, the cases of the instruments are also made watertight. The instruments are manufactured



General Views of Marine Telephones.

in two types, the ordinary type with fixed trumpet, and the engine room type with movable ear trumpets for particularly noisy situations. The ordinary type is also supplied mounted in a hood supported on a column for deck use, such as for docking purposes. Both types are so arranged that, without any alteration, a bell or indicator, or both, can be added. In addition, they can be connected directly in pairs, or grouped on switches or connected to an exchange board.

The instruments are arranged for working on 15-volt circuits, which can be provided either from the ship lighting mains by means of a potentiometer resistance, or by batteries. Complete installations are undertaken and all accessories, including instruments, cable, line coils, switches, exchange boards, batteries, motor-generator or resistances, to form installations of any number of instruments or any desired system of connections, can be supplied. Siemens Bros. & Co. will furnish additional particulars.

EXCELLO

FLAME ARC WITH UNIQUE TWO YEARS' WARRANTY

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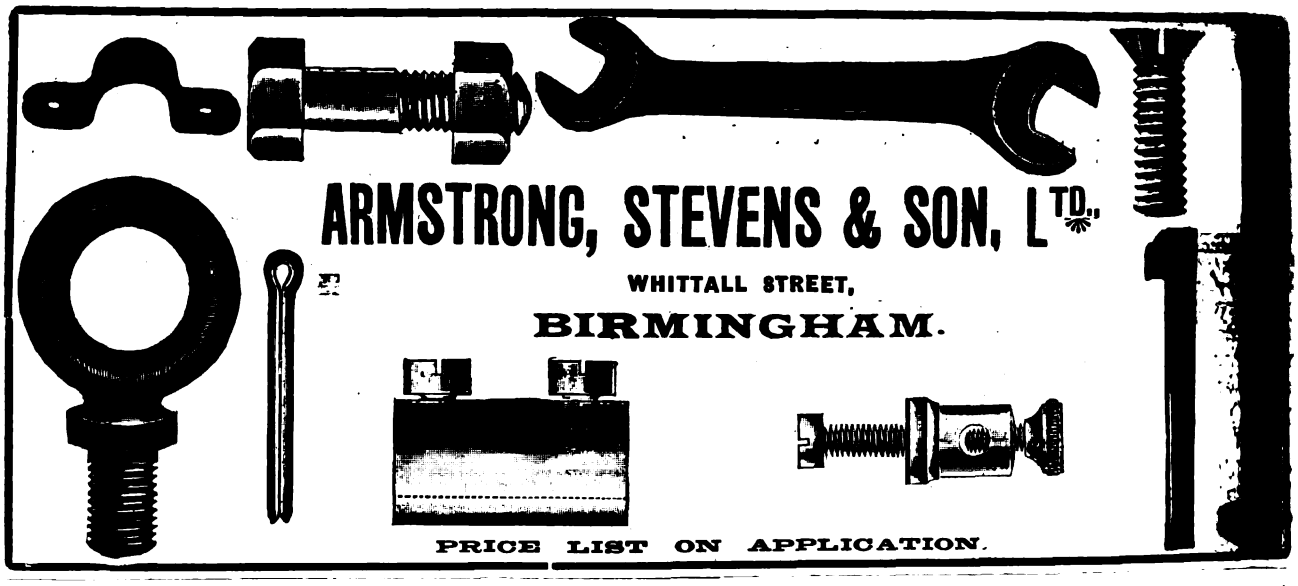


PROVINCIAL ILLUMINATIONS.

The provincial electricity supply authorities were exceptionally busy during the Coronation and seem to have lost no opportunity in getting a good advertisement for electric lighting in general and for decorative illumination in particular. Mr. W. Bache, chief engineer at Cheltenham, sends us an illustration, shown in Fig. 1, of the Manchester-street showrooms specially decorated for the celebrations. This showroom is in a building which has a reputation in the district for extreme ugliness. We believe it is locally known as "the prison." With its festoons of electric lamps it has, however, been transformed into something of a fairy palace, that is if the illustration is anything to go by. The scheme has been tastefully carried out having

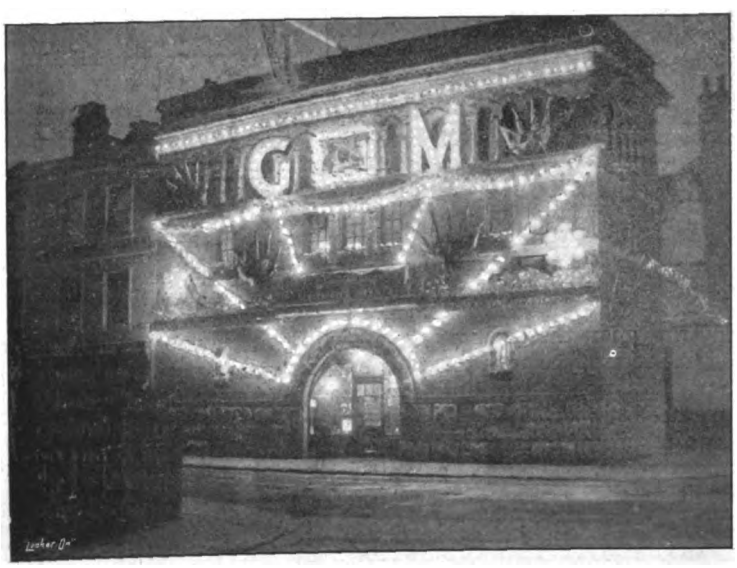


FIG. 1.—THE CHELTENHAM SHOWROOM.

regard to the configuration of the building itself, and we must compliment Mr. Bache and his assistants upon the result.

Mr. R. W. Phillips, the engineer of the Bedford Borough electricity works, has also been good enough to send us particulars of the illuminations carried out in his district. These seem to have been upon the most elaborate scale on the river. The Weir bridge was fitted up with a large illuminated sign "GEORGE, 1911, MARY," surmounted by a large crown.

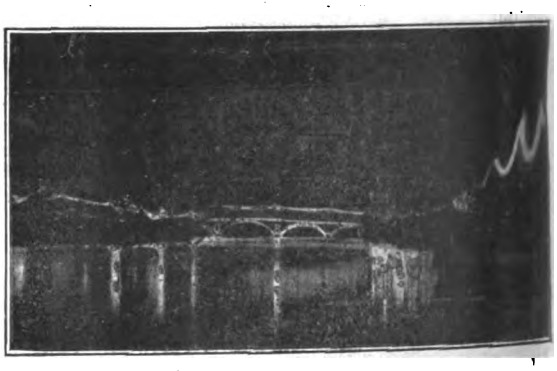
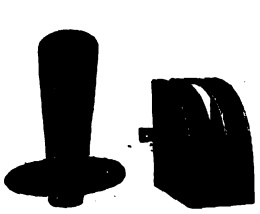


FIG. 2.—THE RIVER OUSE AT BEDFORD.

This could be seen from a good distance down the river. We illustrate in Fig. 2 the general effect on the river at night. Mr. Phillips informs us that the installation will remain up during the summer and be repeated on such gala nights as the Regatta on July 27. A special transformer is put up for the reduction of the supply pressure of 2,000 to 210 volts and 2½ c.p. lamps were used. The entire scheme of illumination on the river formed part of an elaborate river fête in which a procession of illuminated boats was a prominent feature. The illustration shows the passage of a number of these boats up and down the river. Practically every building on the banks seems to have been outlined with electric lamps, and we are afraid that our picture does but poor justice to the details of the lighting of these buildings. Appropriate colour effects were introduced into the scheme so that the public found nothing lacking in the way of variety. The townspeople appear to have entered enthusiastically into the scheme, and there can be no doubt that the electric service will reap great benefit from the display. It was particularly noticeable that throughout the illuminations gas cut a very sorry figure.

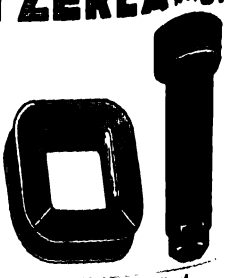
H. WEIDMANN, RAPPERSWIL, SWITZERLAND.

Manufacturer of PRESSPAHN AND INSULATING MATERIAL.



PRESSPAHN in sheet, rolls and tapes. Presspahn tubes and stampings.
CORNITE, high tension Material. Handles for Switchgear and Heating Apparatus. Controller Insulation. Moulded parts of all kinds.

ASBESTOS CEMENT in Plates, Arc Shields for Controllers, &c
AMIANITE, Vulcanised Asbestos. Coil Frames. Spools for Dynamos, Motors and Transformers. Boxes, &c. Insulating Blocks, Tubes, Plates.



Insulators for Electric Furnaces, Tramways, &c.
Insulating Pearls. MICA and Substitutes. Transformer Spools.
Japanese Paper in Rolls and Tapes. Oil Varnished Linen, Silk and Paper, &c.

Printed and Published by GEORGE TUCKER, at the Editorial, Printing and Publishing Offices, 1, 2 and 3, SALISBURY COURT, FLEET STREET, in the City of LONDON, FRIDAY, JULY 7, 1911.

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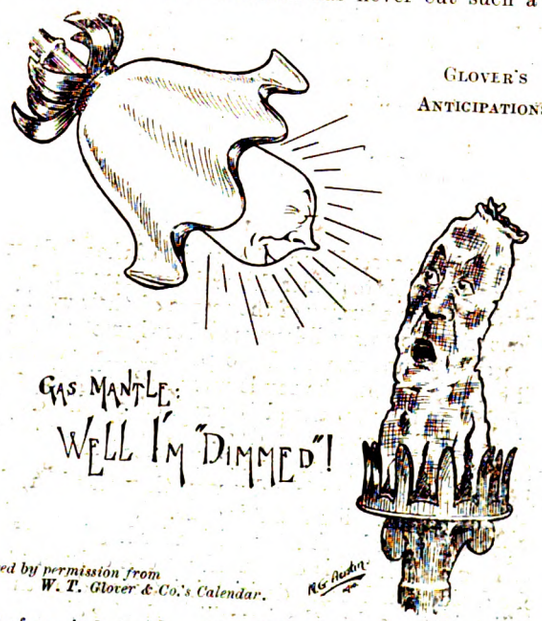
THE ELECTRICIAN COMMERCIAL AND INDUSTRIAL SUPPLEMENT.

C. & I. Supplement No. 93.] JULY 14, 1911. [Gratis to Subscribers.

THE FLICKERING OF GAS ILLUMINATIONS.

Now that the Coronation is over we have an opportunity of reviewing dispassionately the displays made by the three illuminants which figured most prominently in the celebrations—(1) electricity, (2) gas, (3) candles. As far as electricity is concerned, there can be no denying that the displays made in London and the provinces were upon a scale of magnitude and magnificence not previously attempted. As far as we can judge by the reports sent in to us there were practically no cases of fire due to electrical causes as the result of bad workmanship or the action of bad weather upon the illumination material. In fact, the electrical industry can pride itself upon having secured a huge success for electric lighting and also upon giving to the celebrations an after-dark display which would not have been possible with any other illuminant.

The advocates of gas must in great measure lay the blame upon the clerk of the weather for the sorry figure cut by their carefully-planned devices and schemes. In London the principal evenings of the celebrations were marked by windy and wet weather, and these two components of the elements were responsible for the painfully complete failure of the gas display. Where open piping with punched holes was used, either for outlining a building or for lettering or some heraldic device, the effect of the wind was to either blow out the whole of the jets or to cause various sections of these to light up at spasmodic intervals, the sections themselves being badly "out of phase." For instance, in Piccadilly "God Save our King and Queen" was a huge gas device surmounting one of the buildings overlooking the Green Park, and the combinations of letters which the wind permitted the gas to display were always amusing but never dignified. In the provinces much the same thing happened. In Brighton one of the large hotels attempted to display Britannia and the Lion and Unicorn in gas jets. A local correspondent informs us that Britannia has never cut such a sorry figure before, it being possible for her to show on occasions only one or two prongs of her trident. The lion and the unicorn remained practically invisible beasts except for a stray whisker,



GLOVER'S ANTICIPATIONS.

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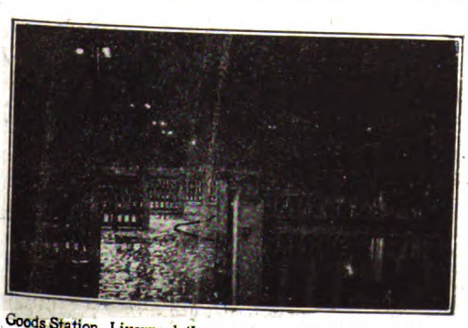

Goods Station, Liverpool (Lancashire and Yorkshire Railway) illuminated by H.C.P. OSRAMS.

RAILWAY LIGHTING BY OSRAM LAMPS.

The General Electric Co., Ltd., Head Office: 67, Queen Victoria St., London, E.C.

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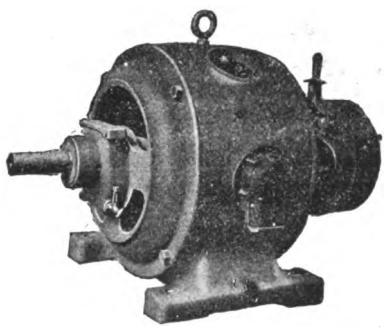
SIEMENS

THREE-PHASE
INDUCTION MOTORS



Protected type with slip-ring rotor, short circuiting and brush-lifting device.

All speeds, frequencies, voltages and outputs.

SIEMENS BROTHERS DYNAMO WORKS LIMITED.
HEAD OFFICE: CAXTON HOUSE, WESTMINSTER, S.W.
Telephone: GERRARD 860. Telegrams: "SIEMBRALOS, LONDON."
Supplies Dept.: 30, UPPER THAMES STREET, E.C.
Telephone: LONDON WALL 8270. Telegrams: "SIEMOTOR, LONDON."
BRANCHES:

BIRMINGHAM	GLASGOW	SHEFFIELD	CALCUTTA	SINGAPORE	SYDNEY
BRISTOL	MANCHESTER	JOHANNESBURG	BOMBAY	PENANG	MELBOURNE
CARDIFF	NEWCASTLE	CAPE TOWN	MADRAS	RANGOON	TORONTO

a hoof or a horn, according as the caprice of the wind permitted. As far as we are able to gather the gas interests were able to create a record in the perfuming of the scenes of their would-be celebrations with the now well-known and easily recognisable odour. Where an attempt was made to protect the gas flame with small coloured globes the result was practically the same, the rain quickly filling up the globes and effectually dousing the gas jet. Surely our gas friends should see in these signs and portents "the writing on the wall." If the elements are arranged against them in this unfriendly way they should realise that the day of gas as an illuminant is gone. We are quite prepared to give them their legitimate position for heating and cooking, but so far as lighting is concerned we can only say "Let the public decide," and if this decision is influenced by the Coronation illuminations then the day will not be far distant when the users of gas as an illuminant will be legally proceeded against. As far as candles are concerned their chief merit lay in the fact that they came to the rescue of the gas people in the predicaments above referred to.

C.T.S. HOUSE WIRES.

We are all familiar with C.I.V., B.D.V., I.D.B., E.M.I., J.C.P. and other magic initials, which we have come to associate with either persons, deeds or things. The latest arrival is "C.T.S." which the St. Helens Cable & Rubber Co. would like every electrical contractor and station engineer to impress deeply upon his mind. The magic initials stand for Cab Tyre Sheathing, and they refer to a new class of insulation which is being put forward for the protection of exposed cable. The material was successfully experimented with for trailing cables for mines and dock cranes, and steps are now being taken to introduce this class of insulation for house wiring. The insulation is extremely flexible, and the branch wiring conductors recommended are a pair of 22/36 s insulated with pure and vulcanised rubber and enclosed in a cab tyre material tube $\frac{1}{16}$ in. thick at the thinnest places, and having an overall diameter of $\frac{5}{16}$ in. In appearance the flexible resembles compo gas piping, but it has a leaden colour. The makers claim that the material is both cable and conduit combined, that it can be run in any position, being simply cleated or stapled up, that it is quite flexible, that it cannot possibly be kinked even deliberately, that it is water and shock proof, that it occupies a minimum of space, and that it is impossible to injure it without cutting tools. If the sheathing is cut and the cord violently twisted and bent, the cut does not tend to spread. After a lighted match has been applied to the material it burns quietly, the flame travelling slowly along. The actual sheathing is not relied upon in any way as a conductor. It simply forms a flexible mechanical protection. In the use of the material for house wiring there is an enormous saving in the cost of labour. Under the score of durability, the makers have submitted the material to the action of ozone for long periods without any destructive effects. We understand that Messrs. Callenders and Messrs. Siemens Bros. & Co. are manufacturing this class of conductor under licence from the St. Helens Cable & Rubber Co.

BUSH ROLLER CHAINS.

We are now able to give illustrations of the new pattern of power chain which Messrs. Hans Renold are putting on the market and which we briefly described in a recent issue. Fig. 1 shows the spring clip joint which was introduced primarily for motor-cycle work, where the clearance between the bolt head and the nut was small. It comprises a side plate and two studs which are grooved round the ends where they project through the detachable sideplate. The plate is secured by a clip sprung into place in the stud grooves. Fig. 2 is a section through the bowl and brush and roller chain and is intended to compare these two types. The hatched portions in the sections illustrate the relative bearing surface of the two chains. In the bowl type of chain the plates were threaded on the rivets and spaced apart by bowls or rollers, the plates and rollers bearing directly on the rivets, there being only the

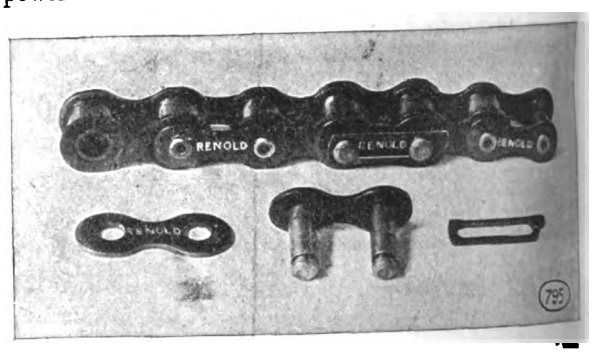


FIG. 1.—BUSH ROLLER CHAIN, SHOWING LINKS.

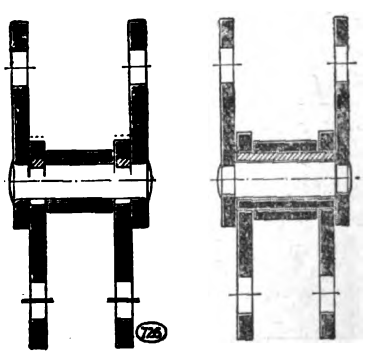


FIG. 2.—DETAIL OF BUSH ROLLER CHAIN.

OSRAM-LAMPS

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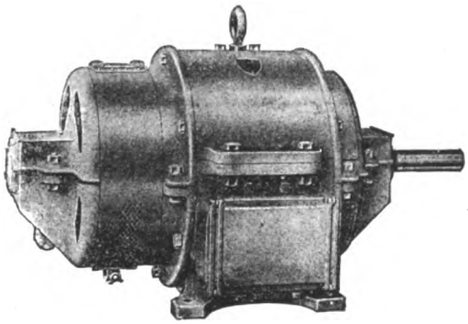
VICKERS MOTORS



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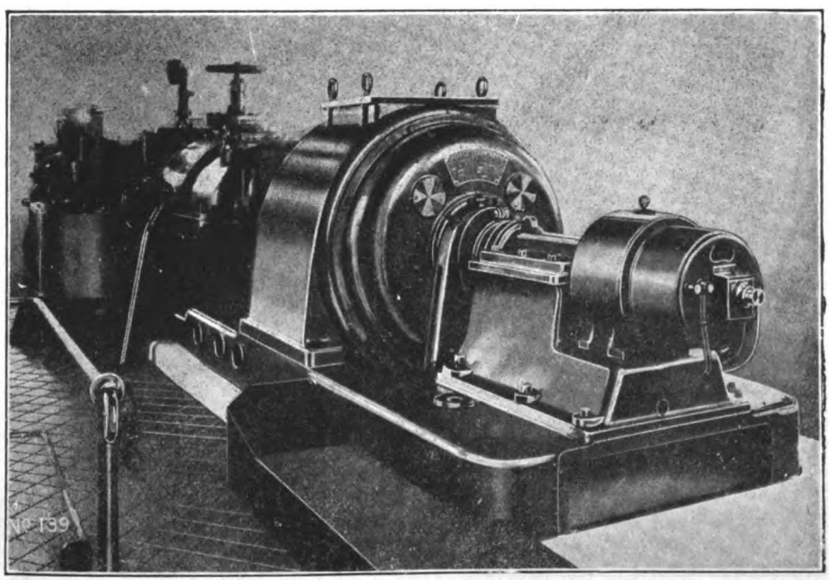

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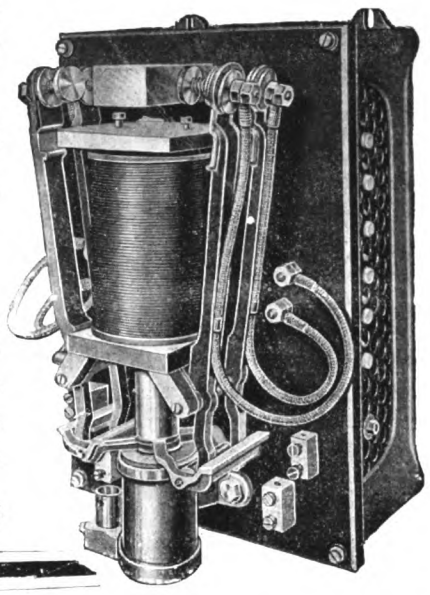

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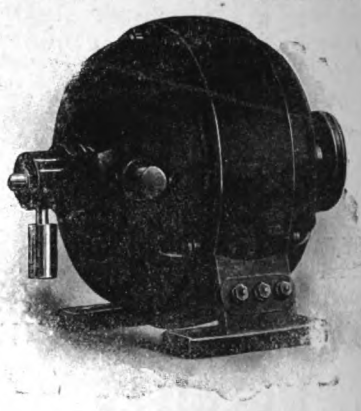

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thickness of the two inner plates as a bearing surface. A chain of this type will lose its pitch very rapidly. In the bush pattern it will be seen that the improvement consists in placing the inner plates on the bushes in such a way that these turn on the rivets fixed to the outer plates. The full length of the bush is therefore used as a bearing surface and the life of the chain is increased by at least several 100 per cent. The wearing surfaces are also case-hardened in the bush roller, but this is not possible in the bowl pattern of chain.

THE PRICE OF METAL LAMPS.

We have asked repeatedly in our Queries column if there is to be a reduction in the price of metal lamps this season. So far the lamp makers have vouchsafed no reply. They evidently prefer to leave the matter in the hands of electrical contractors, judging by the adjoining photograph which has been sent to us by an enterprising contractor in Brighton. The sandwich men shown in the picture have been parading the late scene of the I.M.E.A. Convention with announcements to the effect that reliable metal lamps can be purchased 230 volts at 2s. 6d. and 115 volts at 2s. This is a reduction with a vengeance. It is a pity that the coup was not arranged to startle the engineers who visited Brighton for the convention proceedings, but perhaps the contractor was anxious that they should all reach their respective homes in safety. From enquiries which we have made we gather that the lamps in question are supplied by the Gabriel Lamp Co., who inform us that as a result of their improved methods of manufacture they can offer a lamp which will show them a reasonable margin of profit at the prices mentioned, and at the same time maintain the standard of efficiency and life which we have learned to expect from the more high-priced and better known lamps. We also gather that exhaustive tests of these lamps have been made by the Corporation Electricity Department which have been in every way satisfactory, and they have not hesitated to recommend them to their consumers. This certainly lets a little side-light into that part of Mr. Christie's Presidential Address to the I.M.E.A. with reference to selling powers, &c. So long as there are contractors prepared to assist the supply undertaking by popularising electricity and attacking the gas interests, they may expect, and no doubt will obtain, every consideration from the engineers, and Brighton is to be congratulated on having taken the initiative in this matter.

STREET ADVERTISING OF METAL LAMP REDUCTIONS IN BRIGHTON.

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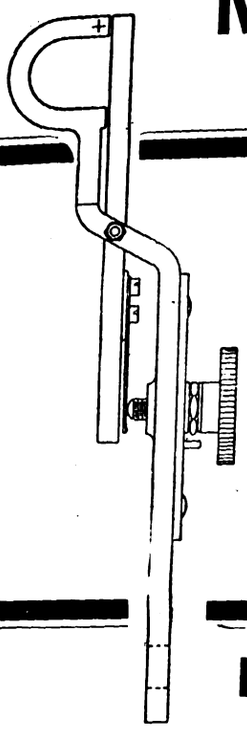
MECHANICAL ELECTRIC CURRENT GAUGE.



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The fight with gas has been borne in mind in the lettering on the sandwich boards, the passer-by being admonished upon its use and warned not to poison himself by allowing it in the house as an illuminant. As far as we ourselves are concerned, we have no opinion to express. The engineers at the Convention were of opinion that the serious effect of the metal lamp upon the load factor of the station has now been counteracted by the ever-increasing power load. If this is the case then the more metal lamps which the station man is able to connect the better, particularly if the question of the cost of a new service does not enter into the question. In the early days of the metal lamp the cry was the more lamps per existing consumer the merrier. The problem for the station men, however, has been the small 5-light consumer who wants a service and who has been, and no doubt still is, a thorn in the side of the undertaking. Setting these things upon one side, however, and looking at the question purely from the point of view of supply and demand, the case for a reduction in the price of metal lamps can be made a strong one. The matter seems, however, to be left to the larger metal lamp manufacturers, and they will doubtless decide, probably at the time of the Olympia Exhibition, what policy they will adopt. In the meantime it will be interesting to follow the results of the price-cutting campaign at Brighton.

NEW CATALOGUE.

Light Accessories.—Section L of Messrs. D. H. Bonnella's catalogue has just been issued. This deals with light accessories. The apparatus described comprise switches, wall sockets and pushes for flush and surface work. A feature is made of flush switch fronts, both of the plain and ornamental type. These designs are worth the careful study of electrical contractors, particularly those who have the opportunity of doing work in good residential districts or country houses. They can be made to harmonise with surrounding decorations.

IFS AND QUERIES.

Will the new C.T.S. flexible be mistaken for the garden hose during the summer months?

If the Contractors and Supply Station men would only settle their differences and get to serious business.

Cannot the General Electric Co. arrange for each of the competitors in the London-Brighton walk (July 29) to carry an Osram lamp, the Osram Cup which is being presented by Mr. H. Hirst to go to the man arriving first with his lamp intact? (No swopping of lamps en route.)

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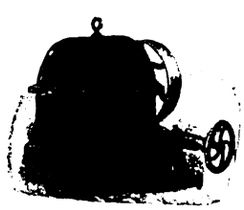

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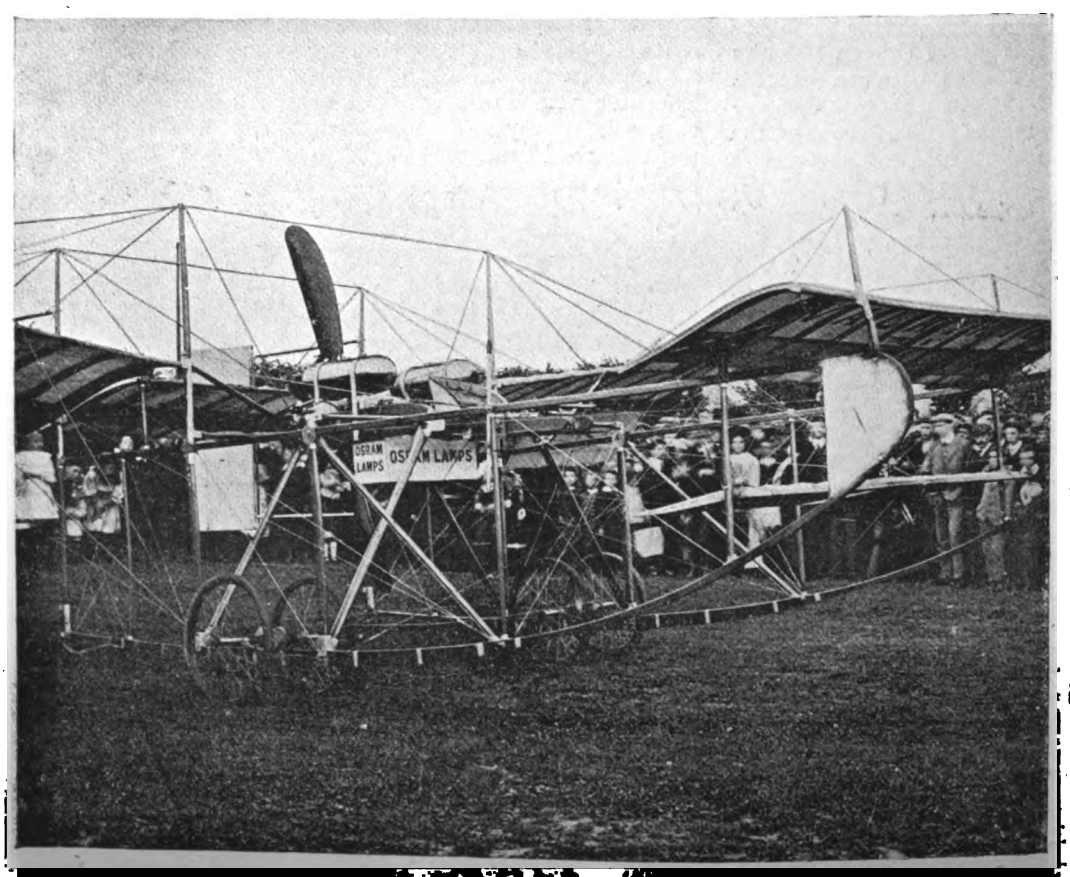
AERIAL DELIVERY OF OSRAMS.

For I dipt into the future
Far as human eye could see;
Saw the vision of the world
And all the wonder that should be.

Saw the heavens fill with commerce,
Argosies of magic sails,
Pilots of the purple twilight,
Dropping down with costly bales.

"*Alf.*'

And Tennyson was not far wrong, though he could not be expected to foretell that the first of the costly bales to be delivered by air would be a parcel of Osram lamps, although it is extraordinary that his prophecy should come strictly true both in this respect and in regard to the purple twilight. When Mr. Barber made his flight from Shoreham to Hove last week he landed just as the sun was setting. His box of Osram lamps may justly be here looked upon in the light of costly bales. The above remarks are supplementary to those which we made last week upon this epoch-making event, and we are now further able to illustrate the incident after the successful landing of the aeroplane. The illustration shows the box of Osram lamps securely tied under the aviator's seat and the dense crowd gathered around the machine. It is particularly gratifying to note that the machine is an all-British one, and, furthermore, that the lamps delivered were manufactured at Hammersmith.



THE "OSRAMPLANE" IMMEDIATELY AFTER LANDING AT HOVE WITH ITS LOAD OF OSRAM LAMPS.

ELECTRICAL IRONWORK.

The extent to which cast-iron is used by the average station engineer in connection with his service boxes and street lighting is shown in a marked degree by the new list which W. Lucy & Co. (Ltd.), Eagle Iron Works, Oxford, have just issued. This list is entitled "Electrical Ironwork," and contains a description of the principal products of the company. It is divided into sections which are devoted to street lighting, fuse boxes, joint and service boxes, disconnecting boxes, feeder pillars, time switches, speed and frequency indicators, and steel storage shelving. In the street lighting section will be found a number of interesting illustrations of lamps and lanterns suitable for side street lighting with metal lamps. The variety is so great that it is impossible to select any one type as being particularly distinctive. After all, the design of the street lamp-post should be made to harmonise with the architectural features of the district, and we think that engineers who make a selection on this basis will be able to choose something from Messrs. Lucy's new list to meet their requirements. In particular they will be interested in a high candle-power street lighting lantern which will accommodate four 100 c.p. or three 200 c.p. lamps. It is fitted with a shaped enamelled reflector which has been designed to give efficient light distribution. The lantern is also properly ventilated and ample vibration supports are provided for the lamp holders. Engineers will also be interested in an automatic controlling gear for street lighting which we illustrate in Fig. 1. This has been designed for attachment to the top of the ordinary side street standard. It comprises a compact and serviceable arrangement of a time switch and an ordinary switching fuse. These accessories are enclosed in an iron case which is fitted with a spring door and rendered water-tight by compressing a rubber casket between the lid and the box. Either damper fuses or Zed fuses can be used. The ordinary switches and fuses are intended for use in areas which are liable to dense fogs, and they enable the street lighting authority to turn on a number of lamps at irregular intervals which the time switch does not usually provide for. The hand operated tumbler switch is in parallel with the time switch.

In the service box section engineers will find a great variety of boxes for practically every type of cable now in use. The triple-concentric box is of particular interest. Arrangements are made in many of the boxes for taking out two services, the

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Telephone: 6323 HOLBORN.
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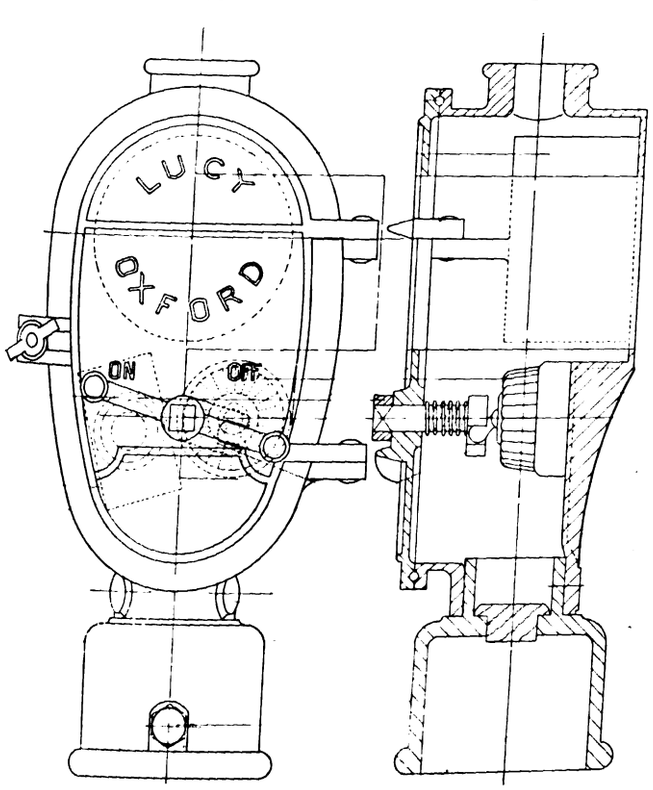
fittings for the second service being available when it is required to make an additional connection. A line of lead service boxes is also offered and practically any shape of this pattern of box can be supplied to order. The feeder pillar section should also be turned to with interest by supply station engineers. High-tension feeder pillars are dealt with as well as the more ordinary low-tension type. In the time switch section there is described the Arbiter type time switch, which comprises an oil switch with plug contacts and magnetic blow-out, the switch being operated by handwheel and clockwork mechanism. The switch can be turned on by the movement of the handwheel to the right and it is opened by giving a slight pull on the handwheel. When the clockwork is running over the restricted hour section the switch cannot be closed. The switch is made in two models, one for capacity of 50 amperes at 500 volts and the other for 25 amperes at the same pressure. The clock will go for 35 days in the large type and 16 days in the small one.



TIME AND AUXILIARY SWITCH FOR LAMP POST.

POLYPHASE INDUCTION MOTORS.

The vogue of the polyphase motor is constantly spreading and the utility of this useful power agent in industrial service has been considerably enhanced by the excellent work put into the machines by modern makers. The polyphase motor of to-day is essentially built for hard wear, and the makers as a rule spare no pains to design the machines upon rugged lines. Messrs. Siemens Bros. Dynamo Works have paid special attention to this class of machines and they offer them in sizes from the smallest to the largest and for any voltage or frequency. The usual scheme of classifying the motors into protected, ven-

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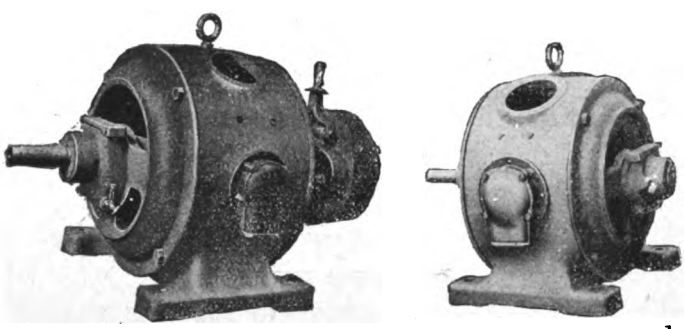
tilated and open types has been adopted, and the temperature limits specified by the Engineering Standards Committee are complied with in the design. A generous overload rating is



also allowed for, this varying from 25 to 100 per cent., according to the type of machine. The power factors for which the machines are listed are for rated full load or any of the frequencies specified. The current consumption of the machines is given by the formula

$$C = \frac{746 \times \text{B.H.P.}}{1{\cdot}732 \times \text{voltage} \times \text{power factor} \times \text{efficiency}}.$$

For two-phase motors the formula is

$$C = \frac{746 \times \text{B.H.P.}}{2 \times \text{voltage} \times \text{power factor} \times \text{efficiency}}.$$

We illustrate the squirrel-cage and slip-ring type motors here-with. Where machines have to run in damp places, such as breweries and mines, or in humid climates, the insulation is treated with damp-proof compound at a small extra charge. The machines can be supplied with overhung pulley or outdoor bearing as required.

THE WEEK'S TRADE LITERATURE.

HENLEY'S RUBBER CABLES.—A handsome price list has been prepared by W. T. Henley's Telegraph Works dealing with all classes of their rubber cables. Special attention is directed to a high-tension and extra high-tension cable section in which cables for from 2,000 to 11,000 volts are dealt with. Special sections are also devoted to aerial cables, flexible dynamo and motor connections, motor car flexibles, flexible trailing cables for portable machinery, especially in mines, ozone and fireproof cables, cables for chemical works, high temperatures and tropical climates. The makers also call attention to the new type of protection in the Home Office flexible section, this comprising a hard cord braiding, which is exceedingly durable covering, and obviates the necessity for metal armour, with its earthing complications. We may remind our readers that Henley's are backed by 58 years' experience in the manufacture of cables and that their clients have the advantage of such experience.

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Manufacturers of—
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THE ELECTRICIAN COMMERCIAL AND INDUSTRIAL SUPPLEMENT.

C. & I. Supplement No. 94.] JULY 21, 1911. [Gratis to Subscribers.

C.T.S. HOUSE WIRES.

A CORRECTION.

The St. Helens Cable & Rubber Co. (Ltd.) have pointed out to us a serious mistake in the notice of their new cab-tyre sheathed cables and wires which appeared in our last issue. The C.T.S. covering was spoken of as an insulator, whereas it is intended to act as a protection for the insulated conductors. We also referred to the material as being shock-proof, whereas the makers claim that it decreases the risk from shock. The chief error to which we would direct attention is, however, the sentence in which we stated that the actual sheathing was not relied upon as a *conductor*. This is, of course, an obvious mistake for *insulator*, and we much regret that it should have crept into the notice. We feel sure that our readers will have detected the mistake, but we take the first opportunity we have had of correcting it.

NEW TRADE LITERATURE.

The Globe Standard Flame Arc.—Particulars are being sent out by the Globe Electric Co. of the Globe standard flame arc lamp for direct-current and alternating-current circuits. The details of this lamp have been published in our columns on a previous occasion. We would recommend interested contractors and engineers to apply for pamphlet S. 50 which will give them these details and prices.

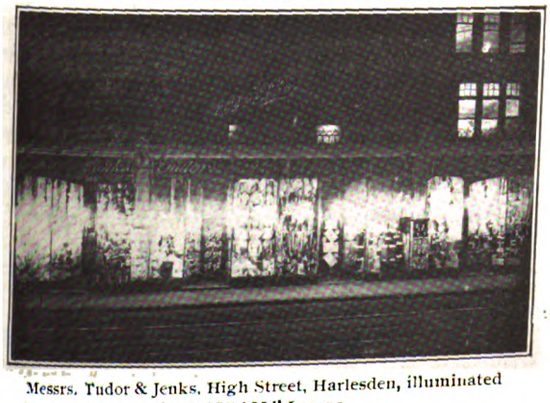
New "Onewatts."—A 300 c.p. "onewatt" lamp in spherical bulb is now on the market, and Siemens Bros. Dynamo Works have ready a list which gives particulars and prices. This new pattern of lamp is 12 in. long and 8 in. diameter and is supplied only with "Goliath" Edison Screw Cap. Particulars are also given of holders for these lamps. The lamp filaments are drawn tungsten and are supported on tantalum hooks.

Spookie Shades.—The popularity of "spooks" and spookie shades is being well maintained (or at any rate the latter are deservedly popular) and Simplex Conduits Ltd. are issuing a new list concerning them. The styles include patterns which are now household words, particularly the "old Nuremberg" lanterns, and a new series of spookie screens for candle and bracket lamps is offered. These must be seen to be appreciated.

Loom Motors.—A line of small polyphase motors for the direct driving of looms is being put on the market by the Union Electric Co. These motors are high-efficiency machines and should make headway in textile districts.

MACHINE TOOL MAKERS' ASSOCIATION.

Particulars have reached us of a new Machine Tool and Engineering Association which has just been formed, more or less as the outcome of a meeting of machine tool makers at Olympia, 1910. The association has been registered as a limited company, and its object is to exercise some control over the organisation and frequency of exhibitions. It is felt that the latter are being overdone, and already it has been decided to hold one exhibition in 1912 instead of two, one in that year and another in 1913. The offices of the new association are at 104, High Holborn, London, W.C., and the secretary is Mr. H. G. Williams, who is backed by a strong committee composed of the principal tool makers.



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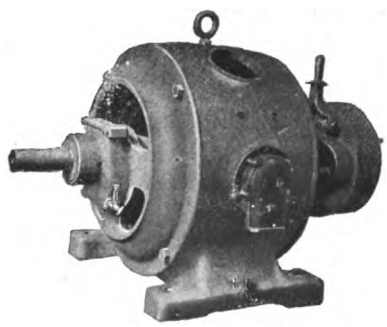

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WATERTIGHT WALL PLUGS.

The Home Office Regulations have had a considerable influence upon manufacturers in the production of satisfactory wall plugs and sockets for use in damp situations. Messrs. A. Reyrolle & Co. send us particulars of a new pattern of wall plug and socket which complies with the Home Office Regulations, and it is stated by the makers to be suitable for all

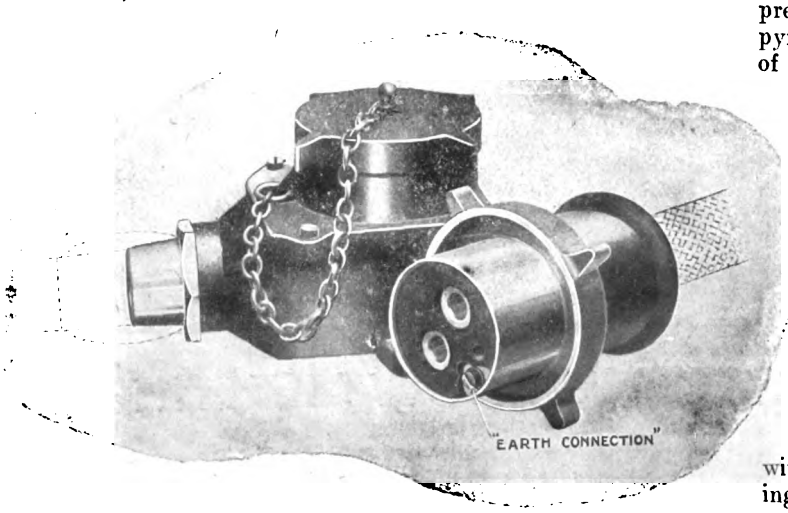

FIG. 1.—50 AMP. REYROLLE WALL PLUG.

damp positions. Fig. 1 illustrates a pattern suitable for a 50-ampere circuit, and it will be noticed that the design is on substantial lines, and the makers guarantee the plug to be strong and serviceable in use. It is recommended for cranes and heavy portable tools on dock sides, shipyards, engineering works, &c. It will be seen that an extra pin is provided for the earth connection, and this makes contact before the current carrying pins, and also breaks contact after them. The contact

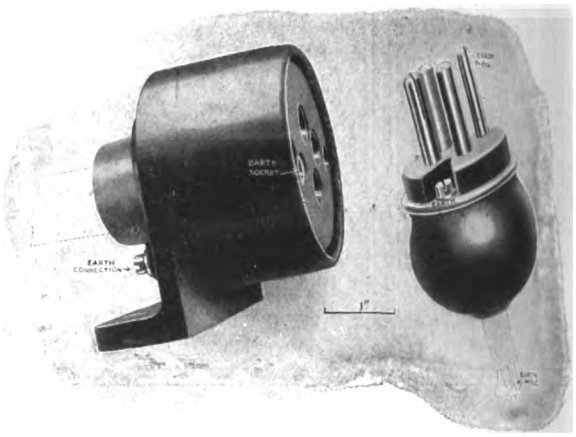

FIG. 2.—DUST PROOF WALL PLUG.

surfaces are of ample proportions. Fig. 2 illustrates a 10/20-ampere dustproof type which will be found useful in dry situations.

THE RUBBER EXHIBITION.

Three years have elapsed since an exhibition devoted exclusively to rubber growing and rubber products was held in London. The exhibition was held this year at the Agricultural Hall, and was even more interesting and representative than its predecessor. The electrical engineer is specially interested in rubber production, and although he relies to a considerable extent upon substitutes for the insulation of cables and other pieces of electrical apparatus, at the same time he must still depend to an enormous extent on this natural product. We gather from the prospectus of the exhibition that the Governments of rubber producing countries have accorded their support to the exhibition, and have spent considerable sums in order that the cultivation and preparation of the rubber product as carried out in their particular districts may be accurately presented to the public. The exhibits of Brazil and British Malaya, of Ceylon and India and the Dutch Colonies were of particular interest. As we remarked in a previous issue the Brazilian Government exhibited an immense pyramid of rubber comprising 500 56-lb. balls, the total value of this being estimated at £8,400. According to a report made up to June 30, 1911, 21,680 tons of Brazilian rubber have been delivered into Manaos, this including the deliveries from Peru, Bolivia and Venezuela. It is stated that upwards of 50 millions are invested at the present time in the rubber industry in the Malay Peninsula, and that there are 400,000 acres of Para rubber under cultivation. Last year the export of rubber from this district was 6,500 tons, and in the first four months of this year was nearly 3,000 tons. Southern India, British Guiana, British East Africa, the Gold Coast and Queensland, also the British West Indies, contributed special exhibits. Germany and her colonies were also represented, the rubber industry dating back to the year 1829. Not only was the rubber product dealt with in the exhibits, but there was a fine display of rubber working machinery. In this section British engineering firms were

OSRAM-LAMPS

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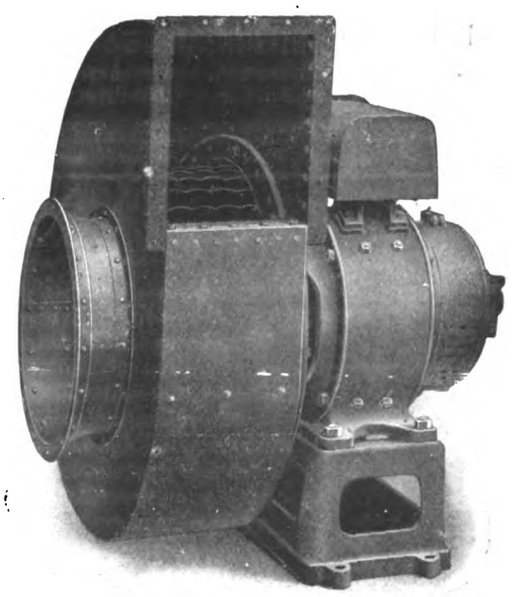
VICKERS
CENTRIFUGAL FANS

FOR VENTILATION, AND FOR MECHANICAL DRAUGHT FOR BOILERS.

The fan runner is so shaped that it gives more air per revolution, and hence can be run at a lower speed than any other like fan on the market.

Economy. Efficiency.



The Electric & Ordnance Accessories Co., Ltd.,
Proprietors: VICKERS LIMITED.
Aston, Birmingham.

shown to the best possible advantage. They appear to have achieved immense success in the development of this class of plant, and their exhibit was a predominating feature of the engineering section. Germany and France also made exhibits.

Our readers who are interested in this question from a financial point of view could not do better than turn to "The Times Finance, Commerce and Shipping Supplement" of the 7th inst. This deals with the subject in an exhaustive manner, and at the same time interspersses among the financial items a number of interesting articles dealing with the uses and importance of rubber.

AUTOMATIC FRICTION CLUTCHES.

We referred last week to the publication by Messrs. Thomas Broadbent & Sons, Huddersfield, of a new pamphlet on their automatic centrifugal friction clutches. We are now able to give some additional particulars of this interesting device. Fig. 1 is a section through this clutch and shows the spring controlled shoes for regulating the speeds at which the driving commences. It will be seen from this that the clutch comprises a central boss keyed to the motor shaft and carrying friction shoes or slippers in suitable slides. Under the action of centrifugal force these shoes move outwards as the speed of the motor increases, and they gradually engage with the internal rim of the clutch pulley, by which the power is transmitted to whatever machinery is being driven. The acceleration of the outer portion of the clutch is quite gradual and when driving at full speed there is no slip. The clutch can, however, be designed to slip under overload, and in this capacity checks undue strain upon the motor and shafting. The clutch acts as a flexible coupling, in that it prevents shocks or load variations from being transmitted to the motor. The renewable portions of the clutch are comparatively inexpensive and can

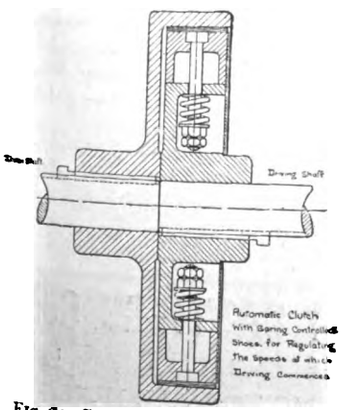


FIG. 1.—SECTION THROUGH CLUTCH.

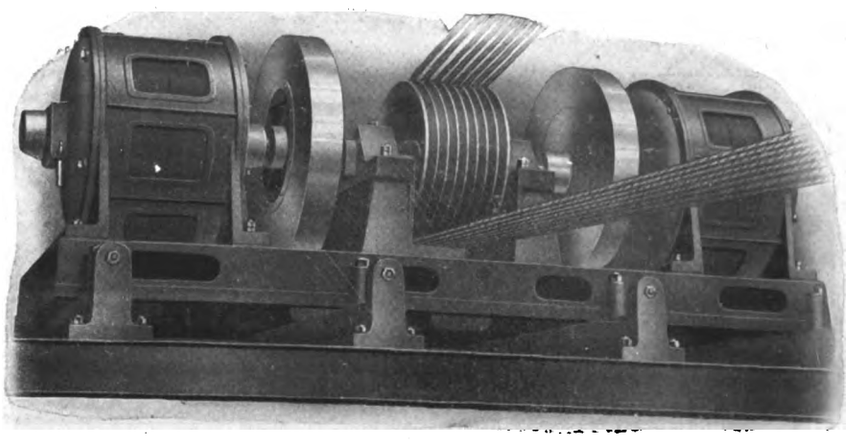


FIG. 2.—TWO 50 H.P. ONE-PHASE MOTORS DRIVING ROPE PULLEY THROUGH FRICTION CLUTCHES.

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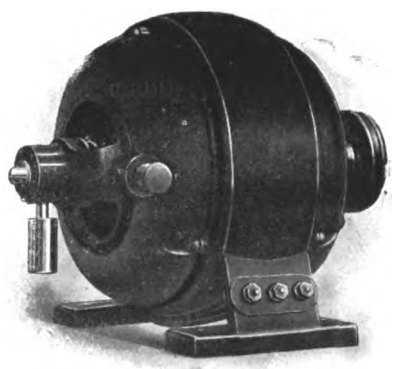
E.M.I. FANS
and
Small Motors
A.C. & D C. All Sizes. All Voltages.



HOGAN & WARDROP,
2, GRESHAM BUILDINGS,
BASINGHALL STREET,
LONDON, E.C.
Telephone - - - 723 LONDON WALL.

be replaced in a few moments. They have a long life under the most severe working conditions. The form of clutch illustrated in Fig. 1, in which springs are used, is made so that the engagement of the motor with the outer portion of the clutch takes place only at a certain predetermined speed. This form

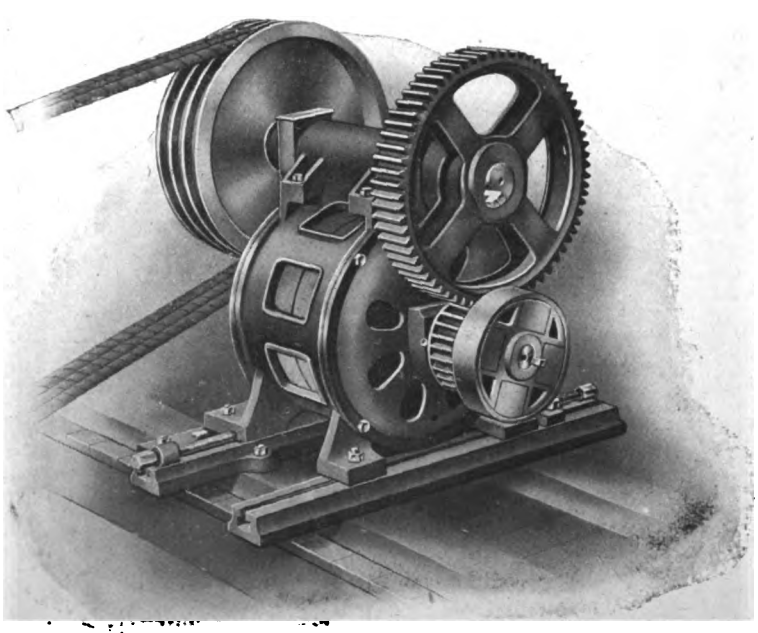
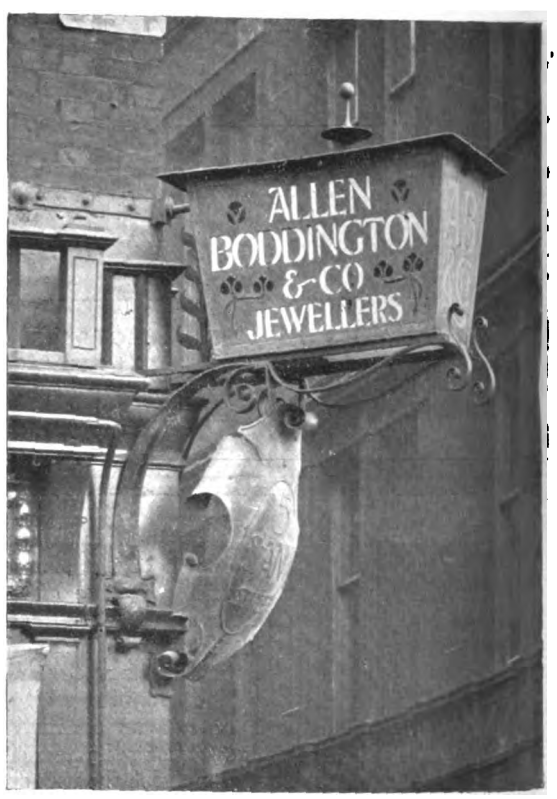


FIG. 3.—25 H.P. BACK-GEARED MOTOR DRIVING THROUGH FRICTION CLUTCH.

is recommended for one-phase motors. Fig. 2 illustrates a pair of 50 H.P. squirrel-cage induction motors arranged to drive line shafting by ropes. Fig. 3 is an illustration of a 25 H.P. squirrel-cage motor back-geared to a rope pulley for driving shafting. A star delta starting switch is employed and the clutch is designed to slip at about 75 per cent. overload. We understand that Messrs. Broadbent have fitted a number of clutches to capstans, and that they make a practice of supplying them with their alternating-current hydro-extractor motors. The clutches are made in sizes from ½ to 1,500 H.P., and Messrs. Broadbent will be glad to furnish additional data to interested inquirers.

SIMPLEX WINDOW SIGNS.

The production of the artistic and at the same time useful advertising sign for tradesmen has engaged the attention of electrical manufacturers for some time past. Messrs. Simplex Conduits have recently evolved a pattern of sign which should find considerable favour among shopkeepers. It can be supplied in the hanging or bracket forms and may be either of the



SIMPLEX ARTISTIC BRACKET SIGN.

open or closed-back type. The illuminating units may also be fitted with holophane reflectors if required. The lettering of the sign is in artistic open-work of the metal face and is backed by opal glass behind which is the lamp itself. This glass serves as a reflector to light up the goods in the shop window. A new list (S.1) has just been published by the company and in this are reproduced many artistic designs of shop signs. We are sure that this will attract the attention of all up-to-date tradesmen, or of that class of shopkeeper who is engaged in the modernising of his establishment. The present-day trading concern must be fitted up to attract the public eye and the main streets of our great cities testify to the care and thought which are expended on the design of shop windows, facias and fronts. In schemes of this character the Simplex sign should find a prominent place.

The ALUMINIUM CASTINGS Co., Ltd.
GREENOCK.
ALUMINIUM CASTINGS OF ALL KINDS
MACHINE MOULDED. FINE FINISH.

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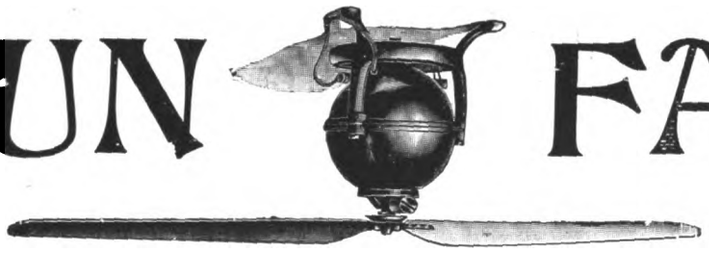
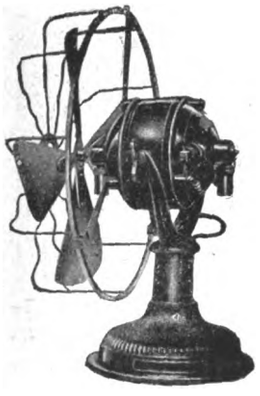
SUN FANS.



A NOTE ON FAN EFFICIENCY.

Low consumption of current in a fan does not necessarily mean high efficiency—the actual work done, *i.e.*, delivery of air has also to be considered.
Every Sun Fan is designed to give the maximum efficiency possible for the current consumed.



New List now ready—write now for copy.

The **Sun** ELECTRICAL COMPANY LTD.
118-120 Charing Cross Road, London, W.C.

A NEW OIL ENGINE.

The interest taken in the Papers on the internal combustion engine read at the I.M.E.A. will be sustained by the introduction of new patterns of oil engines at this time. We mentioned the 2-cycle Willans-Diesel engine, and are now able to give particulars of a 2-cycle semi-Diesel engine which Petters Limited have put on the market. This differs from the ordinary Diesel in that the high compressions which are utilised in that engine are not made use of in this particular engine, the compression only reaching a maximum of 160 lbs. pressure. Advantage is, however, taken of this particularly high pressure in combination with a self-heating and vaporising device to simplify the explosion of the mixture, and at the same time to make it possible to employ crude oil or petroleum residue. The engine is of the high-speed type and may be direct-coupled to a dynamo. The smallest engine at present made is 10 H.P., and the largest shown in a recent list is 50 H.P. Before starting the engine the vaporiser is heated by a small lamp, and after the engine has been running a few minutes this is extinguished. As we have already said the engine is of the 2-cycle pattern, and at the end of the firing stroke when the exhaust ports are opened the burned gases are expelled through the ports by the inrush of air which is compressed in the crank chamber. This satisfactorily clears out the compression space. At the end of the compression stroke the fuel oil is pumped into the vaporiser under pressure and being mixed with the compressed air satisfactory combustion is obtained, and the makers claim that there is no deposit or residue after the explosion. The oil consumption is stated to be ½ pint per brake-horse-power per hour. Taking the price of crude petroleum at 50s. per ton, although it may be obtained cheaper at seaports, the cost of running for fuel alone would be in the neighbourhood of ⅛d. per brake-horse-power hour.

An inertia pattern governor is fitted which operates on the fuel pump, and the makers claim that the engine runs sufficiently smoothly to be direct coupled to dynamos for electric lighting. Water-cooling is arranged for, and a rotary pump driven from the crank shaft circulates the water through the cylinder jacket. The main bearings are ring oiled, and the piston and cylinder, also the big end of the connecting rod, are supplied with forced lubrication from a positive feed pump. Provision is made for self-starting the engine from a compressed air "bottle," which is kept charged up to a certain pressure, shown on a gauge, by a portion of the air which is compressed in the cylinder itself. When the desired pressure is reached in the bottle it can be cut off from the cylinder by the closing of a small valve.

IFS AND QUERIES.

What's in the air? (Osram lamps, someone from Brighton will reply.)

Will the new current gauge of Drake & Gorham be in demand in Piccadilly Circus?

Has the Welsbach mantle fallen on the Welsbach metal lamp?

There are twenty million electric light points in the U.K. How many have metal lamps?

Will the mills in Manchester and Salford be closed down during the Smoke Abatement Exhibition?

SIMPLEX CONDUITS LD.,
Garrison Lane, BIRMINGHAM.
Manufacturers of—
CONDUITS, CABLES, ACCESSORIES, FITTINGS, MOTORS, ELECTRIC HEATING AND COOKING MATERIAL, &c.

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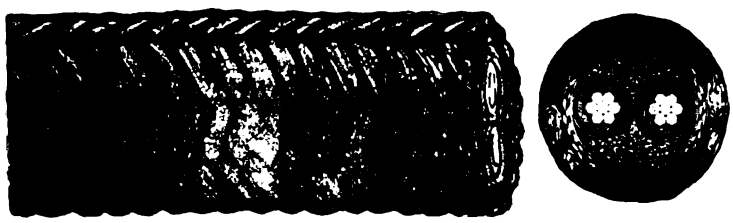
CORD BRAIDED FLEXIBLES.

The use of portable electrical apparatus, particularly in mines and industrial establishments, has extended so rapidly that the cable makers have had some difficulty in keeping pace with suitable "flexibles" for the supply of energy to the apparatus. W. T. Henley's Telegraph Works have followed closely developments in this direction and have produced a class of cord-braided flexibles which they have found to answer admirably for hard industrial service. By dispensing with the metallic covering to the flexible the need for elaborate earthing fittings is obviated. Where the regulations stipulate that the case or carcase of the apparatus shall be earthed, then an earthing wire can be carried through the flexible. This particularly



ELEVATION AND SECTION OF CORD BRAIDED FLEXIBLE.

applies to hand lamps where the metal guard and fitting must be earthed. The standard specification for vulcanised flexible is as follows:—"Conductors composed of h.c. plain copper wires 0·006 in. diameter, lapped with cotton insulated with two layers of V.I.R. and vulcanised together. Earthing conductor composed of h.c. plain copper wires 0·006 in. diameter braided with cotton and compounded. Three cores (two insulated and one earthing core) laid up circular with jute wormings strongly braided and served overall with preservative compound. Insulation resistance 300 megohms per mile after a minute's electrification." These flexibles are offered in sizes from 22/38's to 114/38's. Electric power engineers and contractors should apply to Henleys for samples.

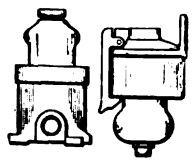
OSRAMS AT A CREMATION.

We are now so accustomed to the Osram lamp as a part of our vital essence that we may express no surprise to find it being used to illuminate a funeral ceremony. We do not yet conduct illuminated funerals in these civilised climes, but the fashion set at the cremation of King Chulalonkorn may perhaps be followed in this country at no distant date. We are informed by the General Electric Co. that the funeral rites for the late King were conducted in the light of Osram Lamps, and that upwards of 100,000 c.p. of illumination was displayed. The Eastern agents of the G.E.C. state that the Siamese papers referred to the brightness of the scene as indescribable. This we can readily understand if so large an amount of light was available. The illustration below will give some idea of the imposing nature of the ceremony, but of course it can only do

100,000 C.P. OF OSRAMS AT A KING'S FUNERAL.

scant justice to the actual brilliance of the scene. The Osram lamp appears to be maintaining its reputation for records in the novelty of its uses.

REYROLLE WALL PLUGS
For Portable Machines, Lights, &c.
Pamphlets 114, 122, 88 and 45 give all particulars
WORKS—
HEBBURN-ON-TYNE, ENGLAND



WESTINGHOUSE CONTRACTS.

We are informed by the British Westinghouse Company that amongst recent important orders received by them the following will be found of interest: Newcastle Electric Supply Co. (for Bradbury, Williams & Co.), three 175 kw. rotary converters, transformers and switchgear; Tyneside Electric Developments Co. (Horden & Shotton Colliery), three 400 k.v.a. rotary converter set; John Summers & Co., one 500 kw. rotary converter and switchgear; Greenock Corporation, two 450 kw. rotary converter sets, direct-current switchgear, &c.; Admiralty (Devonport), 14 440-volt direct-current motors, aggregating 267½ H.P., control gear and spares; Sir William Arrol & Co. (for Admiralty, Portsmouth), eight 440-volt motors, aggregating 230 H.P., control gear and spares; Cowans, Sheldon & Co. (for Imperial Japanese Navy), four 220-volt 500 revs. per min. motors, aggregating 205 H.P., control gear and spares; R. H. Barker & Co., seven 440-volt two-phase alternating-current motors, aggregating 313 H.P., and control gear; Holders Brewery (Ltd.), 12 440-volt three-phase squirrel-case motors, aggregating 141½ H.P., and starters, and one M.G. set 440-volt alternating current to give 9 amperes at 110 volts direct current, and one 160 k.v.a., one 25 k.v.a. three-phase 25-period transformers and switchgears; Wellman, Seaver & Head, 11 440-volt motors, aggregating 355 H.P.; Ransomes & Rapier (for Admiralty, Devonport), eight 440-volt direct-current motors, aggregating 89 H.P., control gear and spares; B.A.G.S. Railway, four 20 H.P. 440-volt 1,440/1,500 revs. per min. three-phase motors and starters, eight 550-volt 930 revs. per min. motors, aggregating 105 H.P. and starters; Cjers, Mills & Co., one Westinghouse Rateau blower, to deliver 25,000 cubic ft. free air per minute against terminal pressure of 6½ lb. to 8 lb. per square inch direct driven by 900 H.P. 3,000 revs. per

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NORFOLK HOUSE, VICTORIA EMBANKMENT LONDON, W.C.
Western-Electric TELEPHONES.
WORKS: NORTH WOOLWICH
Telephones: Gerrard 5349. Central 2389. East 1400.

min. single velocity wheel turbine; Manchester Corporation, 50 magnetic brakes; Blackburn Corporation, one 2,000 kw. 3,000 revs. per min. alternating-current turbo-generator set; County Borough of Blackburn, one 800 kw. rotary; South Shields Corporation, one 1,500 kw. high-pressure turbine (impulse type), coupled to one 1,000 kw. direct-current generator and one 1,100 alternating-current generator in tandem with surface-condensing plant, Lea recorder and Brown-Boveri regulator; East Indian Railways Co., two 400 kw. direct-current turbo-generators and spares; Strain & Robertson (for Alienza Co., Oficinia), one M.G. set, consisting of one 30 H.P. and one 20 kw. 2,215-1G, and thirteen 200-volt three-phase 50 per. motors, aggregating 217½ H.P., main switchgear control gear and spares; J. Howden & Co., one 1,000 kw. turbo-alternator; Randfontein Mines, one 265 and one 40 B.H.P. alternating-current motors; La Plata Trams, ten 200 tramway controller equipments.

ALUMINIUM FOR TRACTION SERVICE.

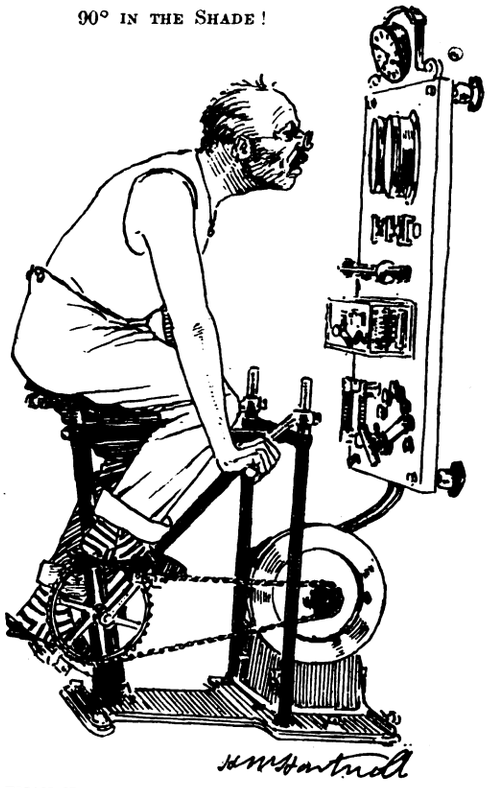
The importance of aluminium as a conductor for more specific purposes than transmission line work is being emphasised more and more every day. The British Aluminium Co. are constantly issuing literature pointing out the merits of aluminium for 'bus bars and special conductors in power houses, such as feeder and battery connections. They have recently sent us a reprint of an interesting paper by M. Mariage, of the General Omnibus Co. of Paris, in which data is given of the use of aluminium coils in place of copper coils in traction motors. The weight varies from 50 to 55 per cent. of copper. In the cost of manufacture there is also a considerable saving, it being shown that a copper coil weighing 68·2 lb. costs 89s. 2d. and an aluminium coil weighing 33 lb., 33s. 4d. In the renewal of the coil there was a saving in favour of aluminium of 15s. There does not appear to be any difficulty in the application of aluminium to this class of service, and doubtless an extension in this interesting direction may be looked for in the near future. The pamphlet in question is interesting to tramway engineers, and those who have not secured a copy should take an early opportunity of doing so.

SUN FANS.

The continuance of the tropical weather has brought the fan-makers out into the open. They have been chary of really coming out from their shells during previous years, because a cold snap has driven them in directly they have poked their heads out only a little way. The Sun Electrical Co., however, makes a full display with a wide range of fans extending from the smallest lamp-holder pattern to large ventilating types. The usual desk and bracket fans are listed, and there is practically no departure from previous types. Of some interest is that known as the revolving or oscillating fan, which is made for alternating-current circuits only. This has three distinct features. It is arranged so that it will oscillate within any given arc of the circle, the sweep of the fan being adjustable by reversing stops. By the removal of these stops the fan will completely revolve, presumably without tying the supply flexible into knots, and it can also be made to give a current of air in one given direction by placing the deflecting vane in a dead central position. This is a type of fan for which there should be a good demand. It is finished in black enamel with gold lines, with polished brass blades and guard and three-speed regulator. The company also list an oscillating fan base upon which an ordinary fan can be placed, and can thus be converted into an oscillating type. Among the novelties in the list we notice a reading lamp and a fan combined. In this case the motor is contained in the base of the lamp, and an extension shaft is carried vertically through the stem to the fan blades which are fixed outside the reflecting shade at the top. The fan consequently revolves in a horizontal plane and the air is deflected at any desired angle, distributing the cooling breezes without draught. Another novelty is a combined table fan and fruit dish. The fruit dish is a cut-glass bowl and is placed immediately above the fan blades on suitable supports. This can be supplied for alternating-current and direct-current circuits, either 100-110 or 200-230 volts. A copy of this fan list may be obtained from the Sun Company on application.

GLOVER'S ANTICIPATIONS.

90° IN THE SHADE!



THIS GENTLEMAN IS CONVERTING HIS ADIPOSE TISSUE INTO ELECTRICAL ENERGY, WHICH HE IS "STORING" IN HIS MOTOR CAR IGNITION CELLS.

EXCELLO
FLAME ARC WITH UNIQUE TWO YEARS' WARRANTY

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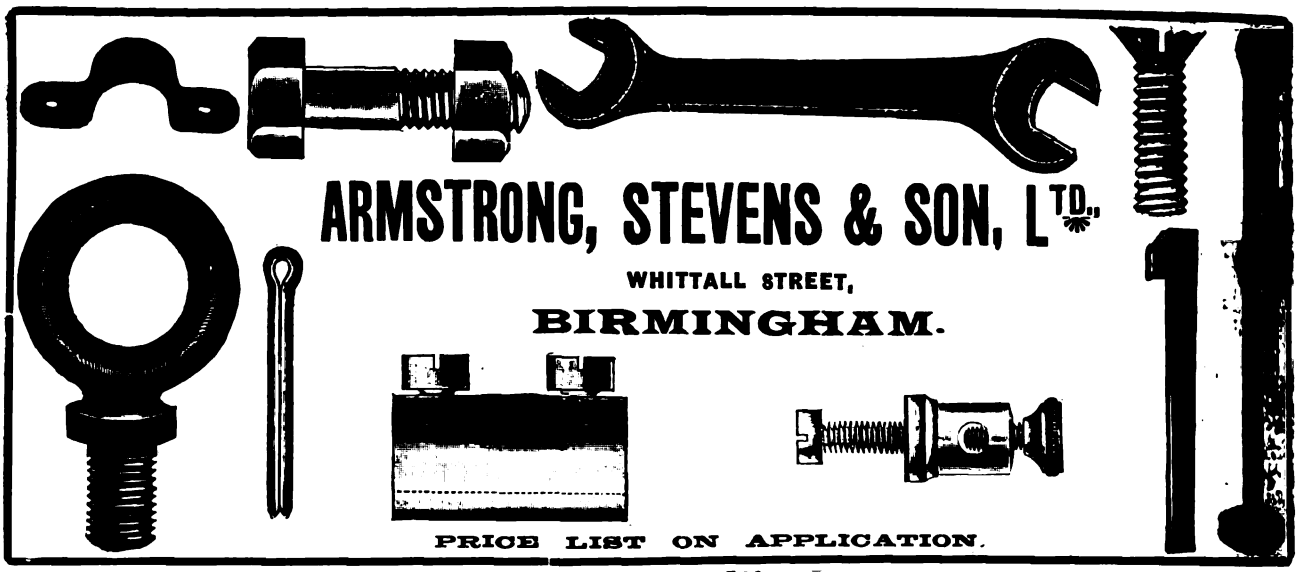
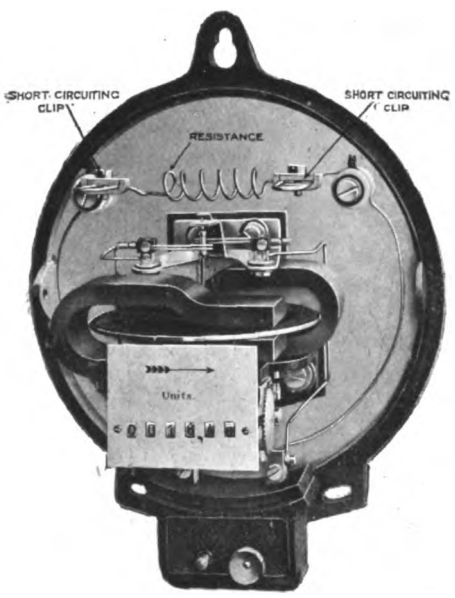


"FORTITER" METERS.

So high a reputation for excellence of workmanship has been achieved by the makers of the "Excello" arc lamp that they have turned their attention to the production of a direct-current ampere-hour meter. This is being put on the market by the Union Electric Co., who have given it the trade name of the "Fortiter" meter. The above illustrations show the chief features of the meter, these being the extreme lightness of the moving element (40 grammes is its weight), the absence of a locking device for transport purposes and the provision of a renewable hardened steel pivot at the lower or footstep bearing end of the spindle. The brake disc is of aluminium with turned up edge and the commutator is of silver, in accordance with standard practice, to ensure good contact. The footstep bearing is jewelled with a selected sapphire which is mounted in an oil-retaining brass cell arranged to slide into the bearing collar. The cell is supported by a retaining spring which can be swung round to allow the cell to be withdrawn, without altering the adjustment of the meter.

The brushes employed are of phosphor bronze faced at the free ends with gold wire, which is of course non-oxidising. With the silver commutator already referred to almost perfect contact between the fixed and moving connections is obtained. Light brush pressure only is needed, consequently the friction load on the meter is small. An integrating registering mechanism is fitted and this is operated from the armature shaft by worm and spur gearing. It is stated that the power required to move all the figure drums at once is only 1 per cent. of the load; this load is, however, seldom imposed.



"Fortiter" Meter with Case Removed.

Terminal Block of "Fortiter" Meter.

Back View of Dial Mechanism.

The permanent magnets which are essential to a meter of this type are of large sectional area, and are made of thoroughly "aged" steel. The armature will, it is stated, start at 1 per cent. of full load, and the watt loss is small, the series resistance having a drop of 1 to 1·2 volts at full load. The meter is designed for closest accuracy at about one-tenth of full load. The meter insulation is mica and the terminals are carried in a fire-proof insulating block. A sheet metal dust-tight case encloses the meter and terminals.

H. WEIDMANN, RAPPERSWIL, SWITZERLAND.

Manufacturer of PRESSPAHN AND INSULATING MATERIAL.

PRESSPAHN—Pressboard.

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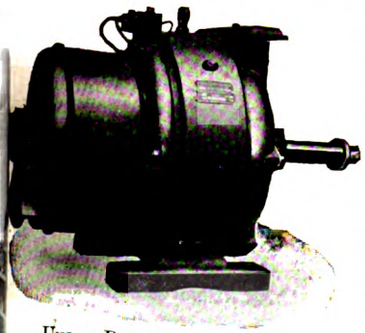
THE ELECTRICIAN COMMERCIAL AND INDUSTRIAL SUPPLEMENT.

C. & I. Supplement No. 95.] JULY 28, 1911. [Gratis to Subscribers.

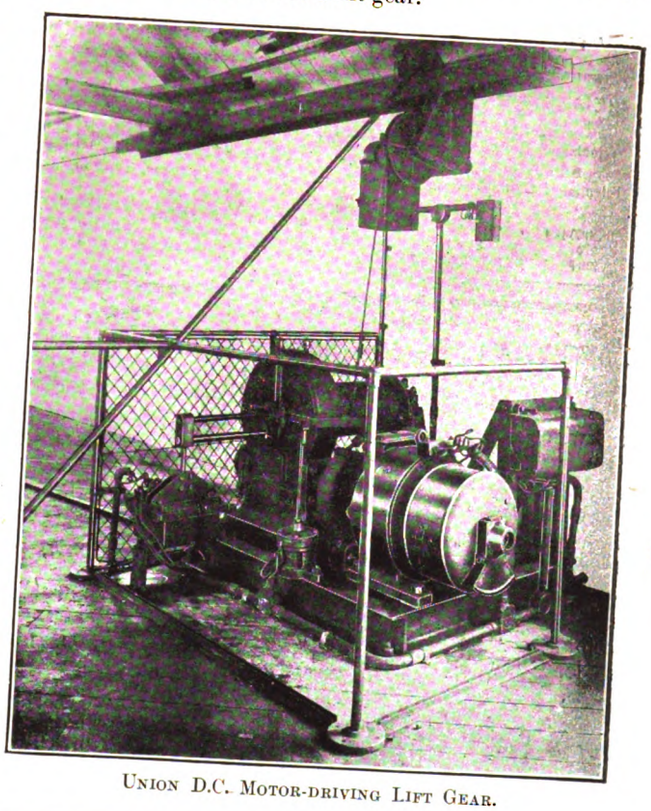
CRANE MOTORS.

The Union Electric Co. is offering an entirely new line of motors specially rated for crane service. The motors are made for direct-current and alternating-current circuits, and are rated on the one-hour, half-hour and intermittent basis. Direct-current motors are either shunt or series wound. The former are recommended for single-motor cranes and passenger and goods lifts. The latter are used for traversing and swinging cranes, or traversing and rotating conveyors. For special service, compound wound motors with suitable controllers are recommended. The motors are constructed for the purpose of overcoming static friction. The momentary starting torque is equal to three times the normal running torque. Standard motors are made for 110, 220, 440 and 500 volts. The motors can be supplied in the open, enclosed ventilated, and totally enclosed types.



UNION D.C. CRANE MOTOR.

In the alternating-current machines the one-hour rating has been adopted. The momentary starting torque is equal to 2½ times the running torque, and under these conditions the current at starting is from 3 to 3½ times that taken at full load. For intermittent service these motors are supplied with wound rotors and slip rings. Standard machines are made for 50-cycle circuits, and the maximum voltage is 500. We illustrate herewith one of the direct-current motors, and a similar machine attached to a lift gear.



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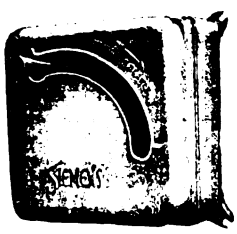
SIEMENS

CONTINUOUS-CURRENT STARTERS.



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LARGE AND SMALL CAPACITY TIME SWITCHES.

The station engineer has already proved the utility of the time-switch for street lighting, and he has succeeded in applying it to trade consumers, particularly shopkeepers who employ this class of device for switching out lights which have been burning after business hours. The idea of utilising a switch of this class for the control of motor circuits during restricted hours has often occurred to English engineers, but we are not sure that any attempt has been made to put it into practice. On the Continent and in America there is a certain class of power consumer who keeps clear of the mains during peak load times. Whether he does this by time-switch or by

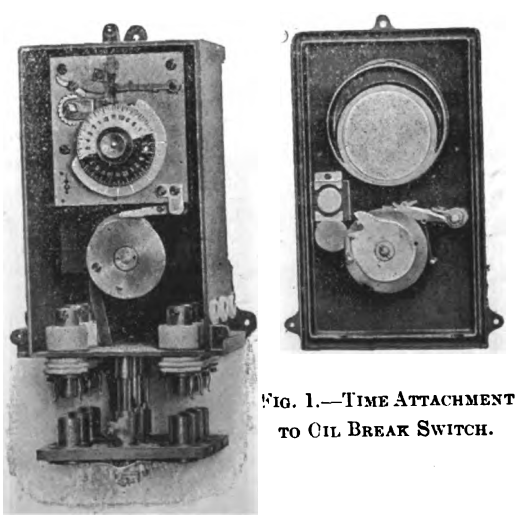

FIG. 1.—TIME ATTACHMENT TO OIL BREAK SWITCH.

arrangement we are not sure, but in any event there is probably a meter which changes over the rate of reading during restricted hours so that units consumed at that particular time are charged up at abnormal rates. We have received particulars of a pattern of high duty time-switch which is recommended for the control of motor and large capacity circuits somewhat upon these lines. Fig. 1 illustrates a switch of this class with the actual circuit-breaking device in an oil bath, the entire apparatus being enclosed in a cast-iron case. The switch proper is fitted with an accessory clock which will run for 35 days, this clock operating a dial which makes one revolution every 24 hours. Attached to this dial are curved discs which can be adjusted to lock the switch at predetermined times. A roller lever attachment rests on the periphery of the dial, and as

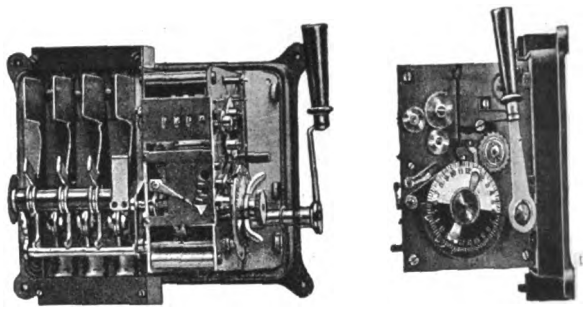

FIG. 2.—AIR BREAK PATTERN SWITCH WITH TIME ATTACHMENT.

long as this is maintained the switch can be opened or closed. When the limit period is reached the curved disc moves underneath the roller and raises it so that the switch itself is opened automatically and cannot be again closed. A large hand-wheel, which is not shown in the illustration, is used for the hand opening and closing of the switch. A counting mechanism can be fitted by which the number of hours during which the switch is closed can be registered. Similarly it is possible to fit an alarm bell which will ring some moments before the switch is timed to open automatically. A switch of the class illustrated is designed for a maximum capacity of 250 amperes. For a smaller pattern of motor an apparatus similar to that

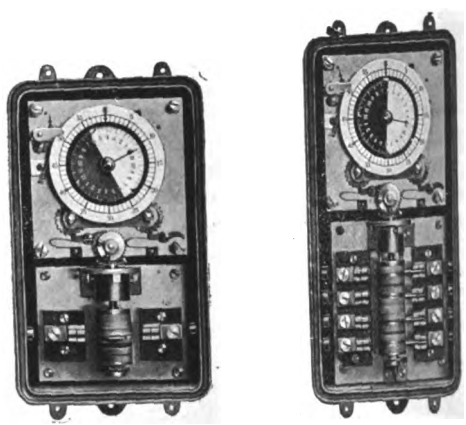

FIG. 3.—DRUM TYPE SWITCH WITH TIME ATTACHMENT.

shown in Fig. 2 is employed, the operation in this case being upon much the same lines, although the device is naturally smaller. In this instance the clock is arranged with the run of 16 days, and the consumer can wind up the clock himself, there being a device fitted by which warning is given to the running down of the clock. Should the clock be allowed to run right down the switch is automatically opened and cannot be closed again until the supply authorities are called in. Fig. 3 shows a smaller pattern of time switch which is recom-

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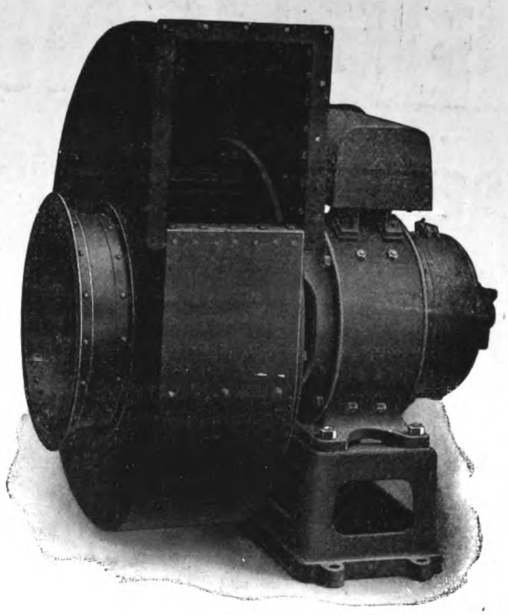


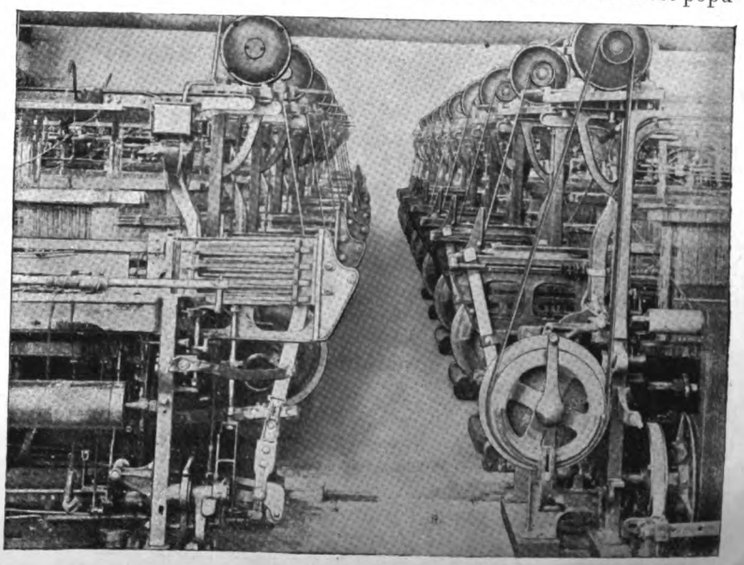
The Electric & Ordnance Accessories Co., Ltd.,
Proprietors: VICKERS LIMITED.
Aston, Birmingham.

mended for the control of street lights or all-night circuits in asylums, warehouses, jewellers shops, &c. This is designed for the maximum current of 30 amperes, and the clock is arranged for 14 to 16 days. There are adjustment pieces whereby the exact time of opening the switch can be predetermined. It is also possible to use switches of this class for change over from one set of circuits such as arc lamps to another, say incandescent lamps, and finally to extinguish the latter. These switches are being manufactured by Messrs. Novitas, Ltd., Zurich.

UNION LOOM MOTORS.

Developments in the textile industry are gradually bringing the small owner a firmer belief in the efficiency and reliability in the individual motor drive for looms and certain other special textile machinery. At one time the controversy raged around the great question of the collective efficiency of a large number of small motors as compared with the general efficiency of the scheme of modern rope drive. Slowly but surely the small motor has been gaining ground. In America, on the Continent, in India and in Japan electrical men have been installing small alternating-current motors for the individual driving of textile machinery. This experience has been brought to the notice of the Lancashire and Yorkshire Mill engineers and we understand that a combined movement is on foot for the more general introduction of motors of this class. In view of this fact interest attaches to a new list which the Union Electric Company are putting forward in which they describe their pattern "T" three-phase loom motors having an output of $\frac{1}{3}$ to $1\frac{1}{2}$ B.H.P. The pamphlet particularises upon the advantages to be gained by individual drive, and it then proceeds to refer in detail to the Union loom motor. Efficiency curves are published which go to show that as high as 87·7 efficiency can be obtained through a special motor of this class as compared with 76 per cent. with a motor which has not been specially designed. A number of interesting figures are given. A $\frac{3}{4}$ H.P. motor is assumed to be running 10 hours per day. If energy is supplied at 2d. a unit the cost for 300 days for a 76 per cent. efficiency motor will be £15, 9s.; with a Union 87·7 per cent. motor this cost will be reduced to £13. 9s., or a saving of £2 for every motor installed.

The loom motor can be arranged to drive by (1) direct spur gear; (2) friction coupling; (3) worm gear; (4) chain gearing; and (5) belt driving. Of these means the belt is the most popu-



GROUP OF LOOMS EACH DRIVEN BY A UNION POLYPHASE MOTOR.

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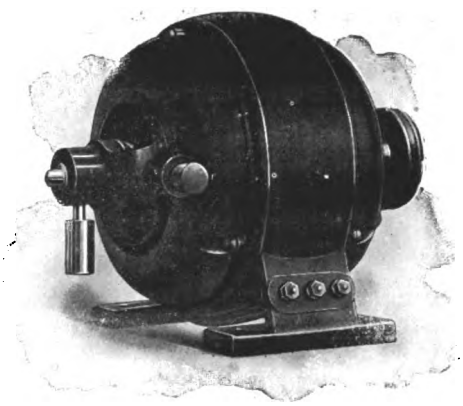

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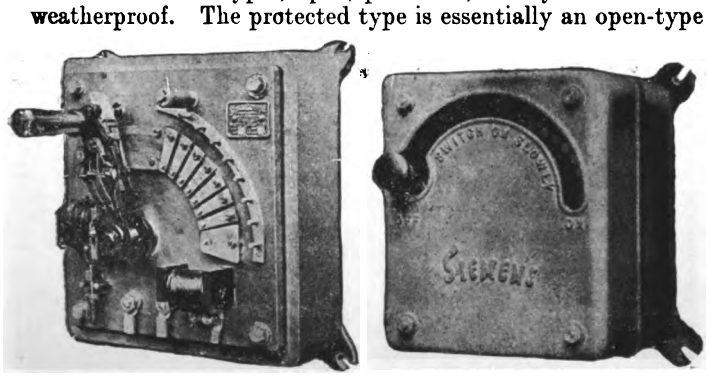
lar. The general construction of the Union motor follows the lines usually adopted with squirrel-cage alternating-current machines. The motors are standardised for 50 periods and run at a uniform speed of 1,000 revs. per min. Standard voltages are 110, 220, and the machines can be supplied with cradle suspension, and automatic spring controlled belt tightener. We illustrate a weaving shed in which a number of these motors have been installed for the individual drive of looms.

CONTINUOUS-CURRENT MOTOR STARTERS.

The continuous-current motor starters illustrated herewith are made in four types, open, protected, totally-enclosed and weatherproof. The protected type is essentially an open-type



C.C. Motor Starters.

starter with an iron cover having a slot through which the handle of the starting lever projects. The totally-enclosed type has a cast-iron cover provided with a glass window for inspection of the contacts, and handle outside the cover. The weatherproof type has a cast-iron cover with rubber packing and is provided with glands for cables.

All sizes have copper contacts easily renewable from the front, except in the case of the smallest sizes, where button contacts are used. Renewable rectangular contacts can be fitted at a slight charge. On all sizes, except the smallest, the overload release is designed to prevent further motion of the switch arm if the release operates during starting; this prevents the motor from being started up against an excessive overload.

The overload release can be set to act at various overloads. A hand trip is provided in all sizes except the smallest. All sizes from 6 B.H.P. can be fitted with a patent step-by-step slow motion gear. This ensures the motor being switched on slowly, so that the current at starting is kept within safe limits and the risk of overload on the motor during starting is reduced. The movement of the switch arm can only take place step-by-step, thus preventing sparking at the contacts and prolonging their life. Starters for outputs of 60 to 100 H.P. are fitted with carbon rollers, which protect the contacts against sparking.

The resistances are designed for starting a motor on full load once every 30 minutes, with a time of starting not less than 15 seconds for motors up to 25 B.H.P. and not less than 30 seconds for motors above 25 B.H.P. and up to 50 B.H.P. From 50 B.H.P. the starting time should be not less than about 45 seconds and for motors between 100 and 200 B.H.P. it should not be less than one minute. Full details can be obtained from Siemens Bros. Dynamo Works.

THE BOSTON ELECTRIC SHOW.

In our issue of June 16th we gave some particulars of the important electric exposition known as the "1912 Boston Electric Show" which is to be held during the fall of next year. We commented upon the various sections of the building in which the exhibition is to be held and referred to the boiler and dynamo room. We have since received a communication from the show authorities in which they say that this will shortly be shown as a motor generator room. The Edison service, as is practically common throughout the city of Boston, will be taken into the building, and it is stated that the electricity supply will only be available from this service. We also remarked upon the policy of the exhibition authorities in supplying carbon lamps free and making a charge for Mazda lamps. We looked upon this plan as placing an embargo on the metal lamp, but the exhibition authorities do not agree with us on this point. They write to say that the Boston Edison Company "were the first in the United States to forcibly and effectively permit the use of tungsten or Mazda lamps on lamps. We had 10,000 25-watt tungsten or Mazda lamps on our system when the largest number put out by any other company was less than 200. We have steadily sold Mazda lamps at the lowest prices and have been the first on every occasion to establish the new low level." The officials of the company have extended a hearty invitation to us to visit the exhibition and they also look for a good response from British manufacturing firms in the matter of actual exhibits. We hope that some of the originators of the exhibition will take an opportunity to visit Olympia, because we believe they will gain a considerable amount of useful information from a tour of the show.

A NOVEL CATALOGUE FILE.

Manufacturers are now accustomed to send out catalogue sections which deal with specific branches of their business. We receive these from time to time and they are usually

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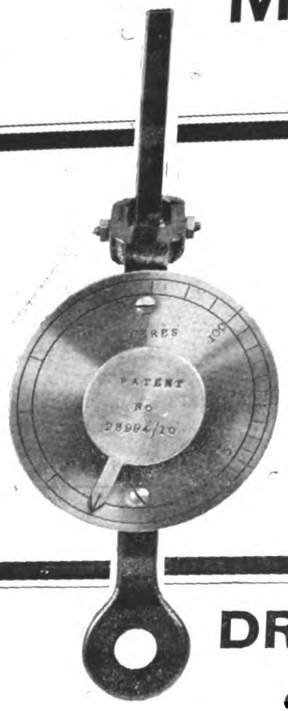

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accompanied by some form of filing device which is arranged to take a full series of lists, perhaps a dozen or more in number. These filing arrangements vary in form and utility, but as a rule err on the side of undue complication. A simple form of file has just been sent to us which seems to solve the knotty problem completely. It is a box with flap lid and fall down right-hand side. The hinge for the lid is placed about an inch from the extreme left-hand edge of the box, and this portion forms a recess into which the small sectioned lists are dropped. There is no holing or clasping or any mechanism to operate. The flap lid is closed up by a spring button and the contents of the box are practically dust-tight. A list can be removed or replaced in a second. This neat device hails from Messrs. James Keith, Blackman & Co., 27, Farringdon-avenue, London, E.C., and enclosed in it are lists on the Keith fan, mechanical draught, belt-driven volume fans, electric volume fans, forges and forge blowing, high-pressure air blowers, the open Keith fan, electric table fans, all of which will be of interest to electrical engineers and contractors. Copies will be forwarded on request.

THE WEEK'S TRADE LITERATURE.

Dry Battery Ignition.—The merits of the dry cell for motor-cycle service are emphasized by a leaflet just published by Messrs. Siemens Bros. & Co., which gives particulars of a number of trials of motor cycles in which the Siemens-Obach dry battery was used. One of these runs may be cited—that from London to Exeter and back—a distance of 322 miles. One of the competitors who gained a gold medal used one of these dry cells measuring 4 by 4½ by 6½ in. He negotiated all the hills without failure or misfires, and no reserve battery was carried. The same battery was used for some months after this trial in a petrol consumption trial of the North-West London Motor Cycling Club, and it carried the winning competitor through successfully. The record of another battery measuring 4½ by 2-$\frac{9}{16}$ by 6½ in. is 764 miles of competition journeys, and we understand that this cell is still far from exhausted.

Governors and Governor Gear.—A pamphlet has been issued by Messrs. Wilson Hartnell & Co., Volt Works, Leeds, in which the Hartnell automatic expansion governor regulator is fully described. We understand that these engine accessories will be on view at the Olympia Exhibition Stand No. 255.

Motor Starters.—Messrs. A. Reyrolle & Co. have ready a pamphlet (No. 19) in which their lever type motor starters are priced and described. A feature of the starter is a patent resistance in which there are no wires to fuse or break. This particular resistance prevents sparking of the studs, and allows of the motor starting on all loads on the first stud. Slow motion gear is not necessary, and we understand that the starters will stand up to heavy service.

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IFS AND QUERIES.

What will be the trade name of the Dick-Kerr metal lamp?

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If electric pools did not contain so many eddies.

Will the E.C.A. and I.M.E.A. be booth neighbours at Olympia?

After the Edinburgh Tramway Conference, will Mr. G. H. J. Hooghwinkel wear his tie in a bow?

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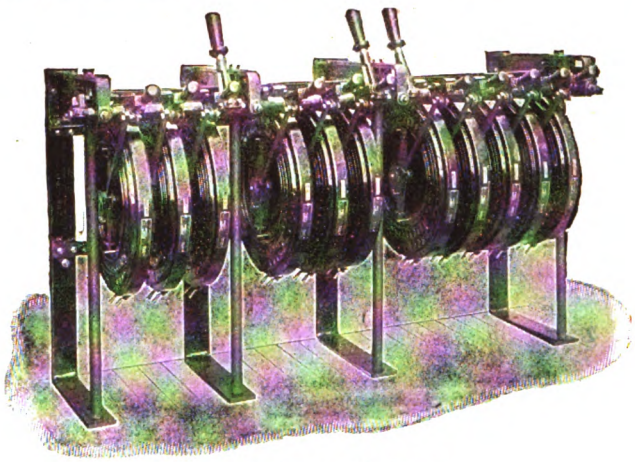
STERLING TELEPHONES
The Sterling Telephone & Electric Co., Ltd., 200, Upper Thames Street, London, E.C. Works: Dagenham, Essex.

STAGE LIGHTING.

We have had occasion from time to time to comment upon the developments in the construction of electrical apparatus for the general control of theatre lighting. In this sphere of illumination the "dimmer" now occupies a position of considerable prominence, and its relation to the lighting equipment of a theatre is an extremely important one. For many years the liquid dimmer was installed, and there can be no doubt

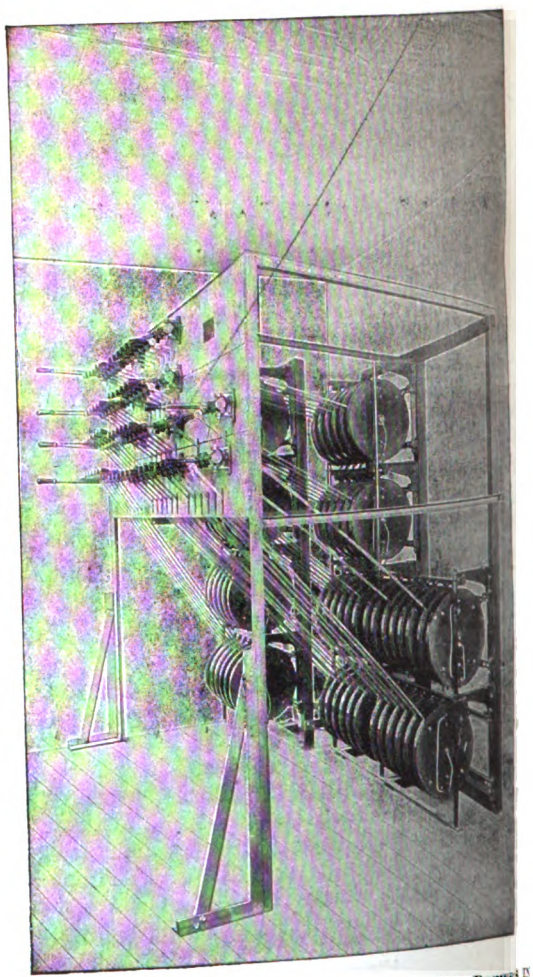


GROUP OF IGRANIC DIMMERS.

that it presented a fairly satisfactory solution of the problem. Long experience, however, has brought out its principal defects and emphasised the necessity for improvement. Judging by the literature issued by the Adams Mfg. Co. on this subject in general and the design in construction of the Igranic metallic dimmer in particular sufficient progress has been made to justify the close attention of theatre managers to this type of resistance. The Igranic metallic dimmer is of the radial-contact type with the resistances embedded in fireproof cement in recesses in a circular iron frame. The resistances occupy a position concentric with the radial contacts. It is

LEVER BY WHICH SINGLE DIMMER IS COUPLED TO A GROUP FOR FULL STAGE EFFECTS.

only necessary to attach a lever to the moving contact arm and to place this lever in the most suitable position for operating in order to provide a complete self-contained dimmer. A number of the resistances can be grouped together, and it is possible to so arrange the operating levers that they can be moved individually or collectively in any desired number of groups. The resistances may be placed in any desired position with respect to the operating levers, the connection between the lever and the moving switch being then a purely mechanical one. In the old pattern of multi-contact switch the switch being placed on a switchboard and connected by cables to resistance frames placed high on the wall there was considerable risk of fire or of troubles with the connections. With the Igranic dimmer this risk appears to be entirely removed, because the connections between the radial contacts and the



VIEW SHOWING METHOD OF OPERATING A NUMBER OF DIMMERS IN A METAL SUPPORTING FRAME.

various points of the embedded resistances form part and parcel of the dimmer unit. It is only necessary to bring two leads of the circuit upon which the dimming is to be done. The illustrations accompanying this short notice will explain

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Pamphlet 93 gives full particulars.
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how this useful and compact dimmer can be made up to suit the requirements of various locations.

Dimmers are supplied for two or three wire circuit 110 or 120 volts. They are standardised for a maximum current of 100 amperes on the first step and 25 amperes on the last step, this being the largest size made for 110-volt circuits. For 220 volts the current is halved. The pamphlet which we have already mentioned has been prepared with a view to giving a volume of information on the use of these dimmers. We would recommend interested electrical contractors and consulting engineers to obtain a copy, and we understand that this will be forwarded on request.

We are informed by the Adams Mfg. Co., who are the makers of this interesting device, that it has been fitted to the Little Theatre, Adelphi, London, W.C.

"ONEWATT" LANTERNS.

The improved type of high efficiency drawn tungsten lamps which have been on the market for some time under the trade name of "Onewatt" are, we understand, making considerable progress. Messrs. Siemens Bros. Dynamo Works appreciate the importance of the use of these lamps in properly designed lanterns. They have therefore brought out a type of fitting, which will be known as the "Bradford" lantern, and this is being made in various sizes. We give an illustration of one of these herewith. The smallest size is suitable for 50 or 100-watt bell-shaped or spherical lamps. The lantern will also accommodate 200-watt lamps, and the largest size will take lamps of from 300 to 1,000 watts. The lantern body is of zinc with a large dished white enamelled reflector. Clamped under this

THE "BRADFORD" LANTERN.

is a fluted air globe. The lantern should be in demand amongst tradesmen for outside shop lighting, and also amongst central station engineers for street lighting. The overall dimensions of the size illustrated are 15 in. by 15 in. Shopkeepers should especially welcome a fitting of this kind because it replaces the small arc lamp, gives no trouble, does not need trimming and will give more light without risk than a "gas arc."

H. WEIDMANN,
RAPPERSWIL, SWITZERLAND,
FOR
Presspahn and Insulating Material.
(See larger Advt. last week.)

Printed and Published by GEORGE TUCKER, at the Editorial, Printing and Publishing Offices, 1, 2 and 3, SALISBURY COURT, FLEET STREET, in the City of LONDON. FRIDAY, JULY 28, 1911.

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SUPPLEMENT to "The Electrician," August 4, 1911.

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THE ELECTRICIAN COMMERCIAL AND INDUSTRIAL SUPPLEMENT.

C. & I. Supplement No. 96.] AUGUST 4, 1911. [Gratis to Subscribers.

A MOTOR-OPERATED BALING PRESS.

Electricity is now being adapted for working baling presses. Hitherto hydraulics have practically held the field against all comers as the source of power for such presses. In places where the water pressure cannot be obtained from a central source, the use of hydraulic pressure carries with it the necessity of installing pumps or accumulators with their attendant heavy foundations and excavations. Now electricity is being introduced for this class of apparatus and a new type of baling press operated by an electric motor has been designed and constructed. In the electric press, according to the "Electrical Review and Western Electrician," the moving table is swung from the press head by means of steel-wire ropes, which are arranged in sets of four, two at each end of the table, which is equivalent to lifting at the four corners. The end of each rope is secured to the press head and passes round a number of sheaves, whereby a purchase is obtained; the free ends of the four ropes being wound simultaneously on to drums, which are directly driven from a reversible motor, through suitable reducing gear. In the hydraulic system the press head is attached to the cylinder by corner tie rods of the requisite combined sectional area to withstand the full pressure exerted by the ram. In the electric press no such stresses are involved on the corner pillars, which merely support the press head and the machinery contained thereon; consequently they only act as guides for the moving table on which the bale, or the material to be compressed is placed. This table is forcibly pulled up by means of the steel ropes, which divide the load equally. Both this table and the press head are therefore of similar design and are simply beams or girders supported at the ends and loaded in some symmetrical manner, distributed about the centre line.

A series-wound motor is used in which the ratio of speed from no load to full load is at least three to one; this ratio can if necessary be made greater by employing a diverter resistance in parallel with the fields, or by using a double commutator motor with a series-parallel control. The motor is run in one direction to lift and in the reverse direction to lower the table, an important feature of the new electric press being that the sheaves should be limited to such a number that the efficiency of the wire-rope blocks may be more than 50 per cent. when lifting the empty table, under which circumstances the table will run down by its own weight when the motor is reversed and the ropes are paid off the drums.

As the material or bale is compressed the motor current gradually increases to a maximum corresponding to the total pressure required. Duplicate circuit-breakers operate to open the circuit at the point of maximum load, and an automatic brake on the armature spindle sustains the table without further expenditure of electrical energy.

The size of the motor is determined by the maximum specified pressure and the final speed of the table at that point; thus in a 100-ton press having a final speed of 3 in. per minute, the work performed would be at the rate of 50,000 ft. pounds per minute, or say 1·5 H.P.; the brake-horse-power of the motor being about 50 per cent. greater than this figure to allow for losses due to friction, as is usual in the design of electric cranes. The motor may, however, be more highly rated than for steady load, for not only does it run for a very short period, but the average of the load-curve is only 25 per cent. of its maximum. Very little resistance is offered during the greater portion of the compression, which simply means expelling air from the folds of the material to be compressed.

Victoria Station, Manchester (Lancashire and Yorkshire Railway), illuminated by H.C.P. OSRAMS.

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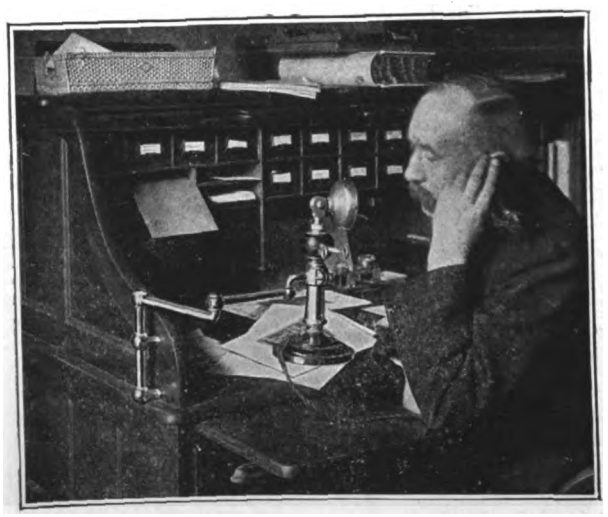
THE HELPTOPHONE.

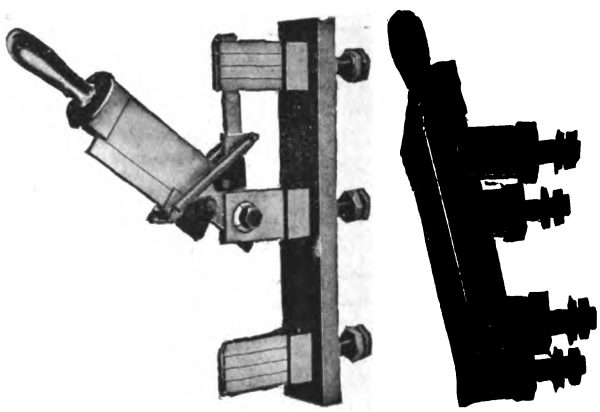
The busy commercial man expends a considerable amount of energy daily in lifting down his telephone receiver and holding the transmitter with its heavy base up to his mouth. Since the Post Office abandoned the hand combination instrument for the desk type with separate receiver and transmitter the commercial telephone has become a much more cumbersome instrument to use. A man who handles upwards of 100 calls during the day should take advantage of the neat device shown in the accompanying illustration. It depicts the Simplex "Helptophone," and it will be noticed that it consists of a simple bracket with three hinged extension arms to the outermost of which the telephone transmitter and its base are clamped. A handy device of this kind will save a lot of time and labour and keep the busy man's telephone at his elbow and in such a position as to be clear of the papers on his desk. The instrument is made in a variety of sizes having different lengths of extension. It is extremely moderate in price. The smallest instrument extends to 18 in. and the largest to 23 in. We understand that it can be supplied for use with inter-communication instruments as well as for those of the N.T.C. Simplex Conduits will supply full particulars and prices.



THE HELPTOPHONE IN USE.

G.E.C. KNIFE SWITCHES.

The knife switch is a comparatively common piece of electrical apparatus, and on this account the details of its design and construction are apt to be overlooked. The feeling is probably that when a knife switch is required any cheap and nasty type can be made use of. This is, of course, a big mistake, because the knife switch, particularly one of the heavy current pattern, has as important a function in the circuit as a more expensive piece of apparatus. The General Electric Co. have sent us particulars of a standard line of their knife switches, all of which we understand are manufactured at their Witton works. The switches have been generously designed and are of ample dimensions. A low current density has been worked to. The makers state that at no part of the switch does it exceed 1,000 amperes per square inch for high conductivity copper and 60 amperes per square inch in the contact clips. On the score of surface density the switches appear to have a large margin to spare. In fact, the makers are so confident upon this score that they claim that the switches can be overloaded as much as 50 per cent. without dangerous heating, and much higher for short periods such as emergency overloads. The usual type of flipper blades are fitted to give the requisite quick break. In the fitting of these blades to the contact blade a steel stamping is employed and the main blade is bushed with a steel bush for the hinge pin. At the handle end the main blades are fitted with solid steel blocks upon which the handle is screwed. In switches of the change-over type shaped steel springs are provided, which are fixed to the side of the hinge contact and act on the rounded end of the flipper blade pivot pin. The switches are stocked single, double and triple pole and can be supplied for front or back connection. The above illustrations explain the general details.



S.P. CHANGE-OVER SWITCH. D.P. SWITCH.

AN ELECTRIC CYCLE.

We receive, repeatedly, inquiries from all parts of the world for the latest electric cycle, the request usually being for one fitted with "Edison's battery." We gather from our American contemporary the "Electrical World" that a satisfactory

OSRAM-LAMPS

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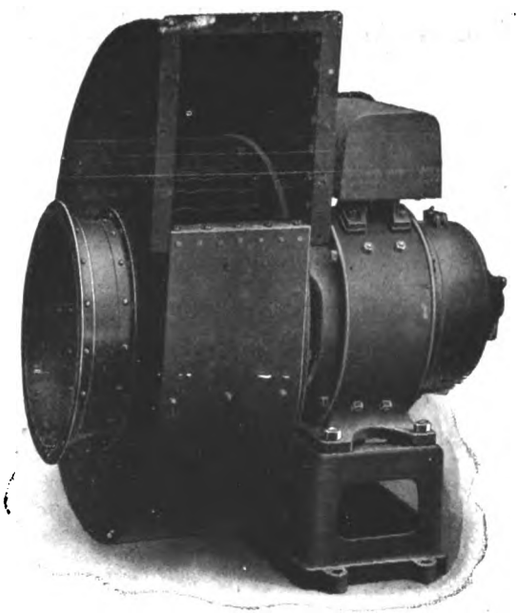


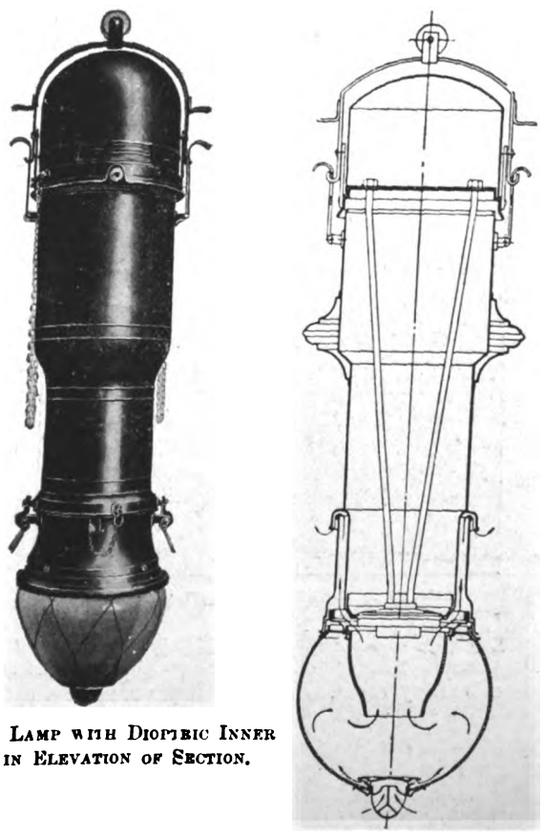
The Electric & Ordnance Accessories Co., Ltd.,
Proprietors: VICKERS LIMITED.
Aston, Birmingham.

electric vehicle has been invented by a Mr. F. E. Hatch, 85, Horton-avenue, Detroit, Mich. (We print the address in full for the benefit of likely correspondents). An illustration of the machine is given in the journal mentioned and it shows a large battery underhung in the frame between the two wheels and motor immediately below the saddle with chain drive to the back wheel. The battery is of six cells and the motor operates at 12 volts giving speeds of 4, 15 and 35 miles per hour. The battery is said to have a radius of 100 miles on asphalt or tarred roads in town areas and 75 miles over country "give and take" roads. The vehicle weighs 200 lb. An Edison Exide or any standard battery can be used. The machine has a 51 in. wheel base, and the motor is fitted with ball bearings.

A standard British Triumph 3½ H.P. motor cycle weighs about 150 lb. and has a range of 120 miles with one filling of petrol, also a maximum speed of about 45 to 50 miles per hour. If fitted with magneto ignition it will start up at any time, so that the advantage of the electric vehicle is practically nil in comparison.

THE NEW EXCELLO LIST.

The flame arc lamp movement in its early stages probably received its chief impetus from the Excello lamp, and there are many important installations of this lamp in all parts of the world. In spite of its popularity the makers are constantly improving the lamp in detail, and we gather from the latest list that the 1911-2 Excello has points of interest and novelty to distinguish it from its predecessors, while all its specially unique features are retained. The list to which we refer (7,023) is just issued, and our readers who are in need of information regarding the latest Excello should obtain a copy. The deposit-free cover of course still figures prominently in the list and also the storm-proof ash tray. It should be noted that the old pattern lamps can be converted to deposit-free at a comparatively small cost, considering the advantages in light efficiency obtained.



EXCELLO LAMP WITH DIOPTRIC INNER GLOBE, IN ELEVATION OF SECTION.

For the illumination of large areas, streets, wharves, dock-sides, public squares, &c., the flame arc lamp is not so suitable

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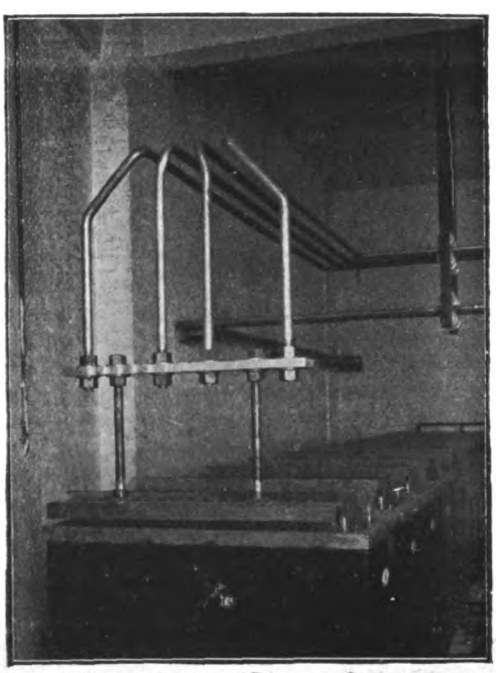
as the open arc, because the downward illumination of the latter is too intense. By the use of a dioptric inner globe the rays of light from the arc can be bent in a more horizontal direction and the distribution of light over a wider area can be effected by this simple means. The angle at which the maximum of light is obtained by the use of the dioptric globe is 20 to 30 degrees below the horizontal. The globe itself is made up of a number of prism rings of different angles, and by reason of its position inside the outer globe it remains free from the deposits of the arc. In a general scheme of exterior illumination it means that by the use of the dioptric inner globe a smaller number of lamps is needed than would be the case if the globe was not introduced. The Excello arc lamp is, of course, suitable for a.c. and d.c. circuits and can be burned single or in series according to circumstances. Another feature of the list is a dimension sheet of the different kinds of globes used with Excello lamps.

ALUMINIUM BATTERY CONNECTIONS.

The value of aluminium conductors has been demonstrated recently, principally in connection with low-tension heavy-current networks, &c. In the battery room this class of conductor has been proved to be exceptionally useful by reason

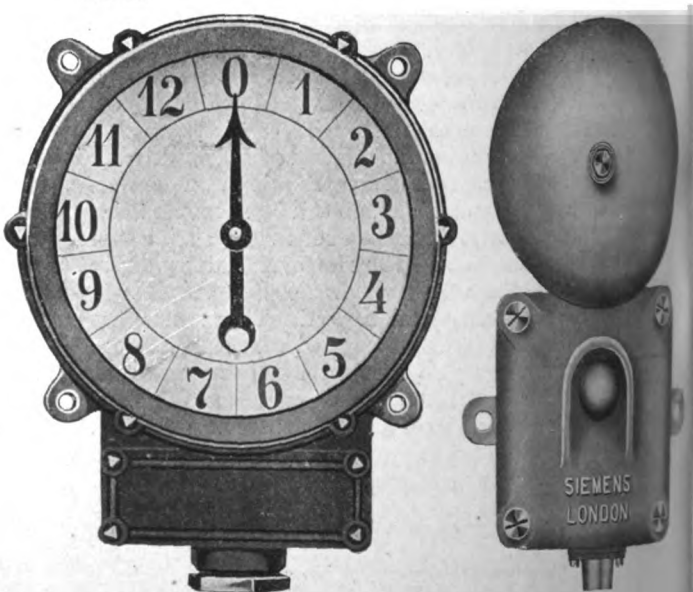


VIEW OF ALUMINIUM BATTERY CONNECTIONS.

of its light weight and acid resisting properties. It is a difficult and expensive matter to carry heavy copper rods and bars about a battery room, but aluminium presents a convenient solution of the problem. The British Aluminium Co. has recently installed a quantity of 1¼ in. diameter aluminium round rod in the battery room of the Westminster Electric Supply Co.'s new station, Horseferry-road, Westminster. In the adjoining illustration we show how easily the rod can be bent to suit the angles of the battery room and the position of the terminals. The particular battery on which these aluminium conductors were used is of the standard type, with sweating sockets for solid copper rods. It was not thought advisable to alter this connection, so the copper rods were cut off at a convenient height above the end cell and joined to an aluminium bridge piece. Into this bridge piece the connecting aluminium rods have been bolted. The rods themselves are supported by reel insulators placed in hangers suspended from the roof. The rods are taken the full length of the building to the switchboard. All the joints were made by butt welding, so that no solder or foreign metal was introduced.

BELL SIGNAL INDICATORS.

Where electric bells are employed to give important signals it is advisable and often necessary to have some visual indication of the signals given. Siemens bell indicator consists of a dial instrument which indicates the number of bell strokes given, and is particularly applicable for shaft winding or haulage in mines. It comprises an electromagnet which operates an armature, actuating a pointer through one section of the dial for each ring of the bell, so that the number of rings received is recorded by the pointer. It is provided with a releasing mechanism to set the pointer back to zero. This can be done either by hand at the instrument by means of a lever provided, or electrically by a press button switch in the engine room. This switch may also be so arranged that it is automatically operated by the engine. The indicator can be applied to any existing bell signalling apparatus without any alteration to the latter.



BELL INDICATOR AND BELL WITH PUSH KEY.

Two bells with a dial indicator are provided in the engine room, the latter indicating the number of strokes on the bells, thus forming a visual indication of the order received. A bell and two

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press switches are also provided at the pit bank, and a bell and press switch at the pit level, which enable the usual order of bell signals to be used.

The following description of working the signals is only taken as an example to illustrate how the apparatus may be used. The procedure may be varied to suit the requirements in each particular case. For instance, if men are to descend the shaft, the banksman gives three rings on his own bell and that at the pit level by pressing one of the switches at the pit bank. To this signal the onsetter at the level replies, before men enter the cage, by giving the bell at the pit bank three rings; at the same time one of the bells in the engine room will ring three times, and the indicator moves forward one step for each ring and will stand at 3. When the onsetter's cage is ready to ascend he signals the banksman and engine man one, the pointer on the indicator moving forward to 4. To start the descending cage the banksman now signals to the engine man by pressing the second switch and ringing the second bell in the engine room once. The indicator pointer moving to the engine man knows that the cage is ready to descend and proceeds accordingly, at the same time putting the pointer back to zero by means of the press switch. This last operation can also be effected by a release switch actuated by the engine, so that it is impossible for the engine to be moved and the old order to remain on the dial. The divisions on the dial allow various extra orders to be used up to 12 bell strokes. Whenever a signal is sent from the level or pit bank, the bell at either of these places rings, thus confirming that the signal has been received correctly. The bell signal system with indicator can also be adapted for mines having two or more levels.

EXCELLO

FLAME ARC WITH UNIQUE TWO YEARS' WARRANTY

A NEW E.C.C. MOTOR.

The Electric Construction Co. have just introduced a new direct-current motor, which is designed to meet the demand for a cheap yet thoroughly reliable low-power machine. Its construction embodies various new features—notably a radial commutator—which reduces manufacturing costs, and at the same time sacrifices nothing to efficiency, mechanical strength or general reliability. The temperature rise of the "S V P" motor does not exceed 70°F., after six hours' run at full load, and it has an overload capacity of 25 per cent. for two hours and 50 per cent. momentarily. The face of the commutator is in the vertical plane. Each of the two brushes is held against the commutator by a small spiral spring, adjustable for pressure by means of a milled-head vulcanite screw. Some of the advantages derived from the adoption of the vertical commutator may be stated briefly. (1) Cost of production is reduced. (2) The brushes are accessible from the outside of the frame. Adjustment or replacement of the brushes is much easier than in an ordinary open machine, although the "S V P" motor is of the protected type. (3) Smooth running is assured, and the danger of high bars or of the commutator getting out of truth is remote. (4) As the commutator surface is flat, practically no bedding of the brushes is required. (5) The overall length of the motor is reduced. The "S V P" motor is at present offered for the following outputs: ¾ B.H.P. at 1,000 revs. per min., 1 B.H.P. at 1,400 revs. per min., 1½ B.H.P. at 2,000 revs. per min. Interested readers should apply for fuller particulars and prices either to the head offices of the company at Dashwood House, London, E.C., or the works, Wolverhampton.

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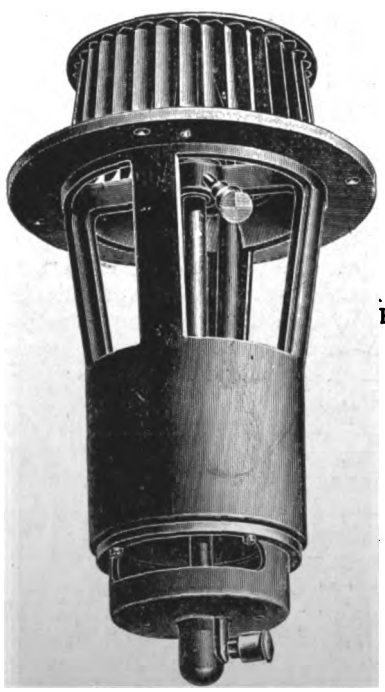
STERLING TELEPHONES
The Sterling Telephone & Electric Co., Ltd., 200, Upper Thames Street, London, E.C. Works: Dagenham, Essex.

MINING TELEPHONES.

Electric bells have been installed for many years in mines and collieries, and gradually the telephone has been brought into play and is replacing or supplementing in many districts the original bell system. Messrs. Haslam & Schontheil of Cardiff are issuing particulars of a line of telephone instruments which are quite suitable for use in mines. The novelty of the instrument consists in the use of hearing and speaking flexible tubes which are brought out from the case of the instrument by a special elbow. At the extremity of these tubes and inside the cast-iron case are the transmitter and receiver proper. This is an arrangement which dispenses with outside flexible cords and confines the whole of the electrical connections to the fixed case in which they are permanently enclosed. Aluminium mouth-and-ear pieces are attached to the "hand-com" fitting at the outer end of the flexible tubes. A magneto call bell is placed in a separate compartment at the bottom of the case. The instrument is strongly recommended for coal mines, steel works and engine rooms, or in fact any position where risk in handling is likely to be met with and where it is essential to use a water, dust and gas-tight enclosing case.

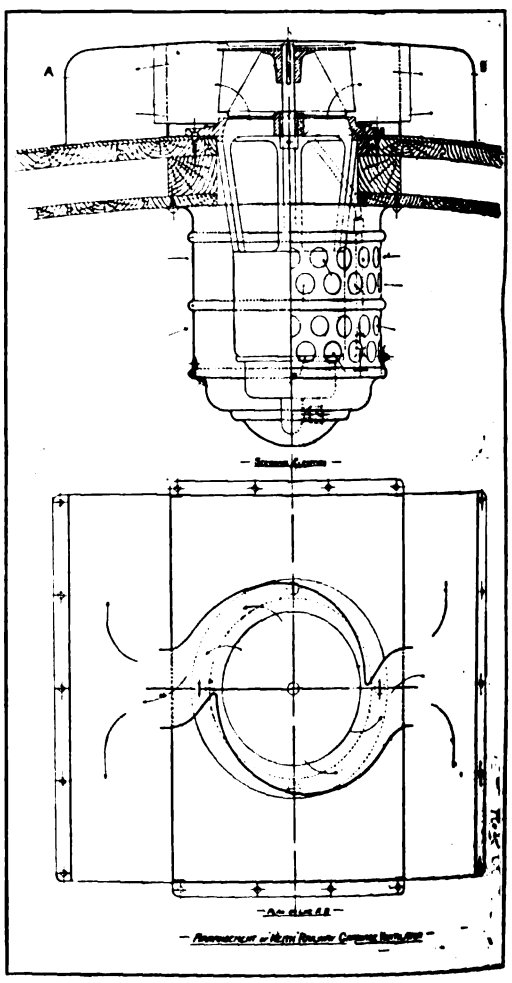
RAILWAY SALOON VENTILATION.

The supply of fresh air to the average dining saloon on railway trains is not altogether an easy problem. The use of bracket fans at each end of the saloon is certainly no solution of the problem, because the fans simply blow the vitiated air backwards and forwards, and as a rule there is some "crusty"



KEITH RAILWAY SALOON FAN.

passenger who objects to the breeze because it is a "draught." In both summer and winter the air in these saloons is generally at too high a temperature, and this fact is simply attributable to faulty ventilation. Messrs. James Keith & Blackman have developed a form of carriage ventilator which certainly tackles the problem on a more reasonable basis. A small Keith fan of the centrifugal type and 5 in. diameter is directly connected to a vertical spindle electric motor. The motor is placed inside the roof of the saloon and drives the fan wheel, which is outside, through an extension of the motor shafting. The wheel runs in a specially designed cowl and discharges into two channels which are constructed so that there is no back draught,



SECTION AND PLAN OF KEITH RAILWAY FAN.

and it is impossible for flying cinders from the engine to enter the wheel casing when the fan is out of use. Both fan and wheel are self-contained, and can be dropped through a port-hole in the roof, a flange under the fan wheel taking the weight and only needing fixing by a few screws. The motor itself is covered by an ornamental ventilated casing, which is supported inside the ceiling of the saloon. The illustrations herewith will explain the design of the ventilator.

The ALUMINIUM CASTINGS Co, Ltd.
GREENOCK.
ALUMINIUM CASTINGS OF ALL KINDS
MACHINE MOULDED. FINE FINISH.

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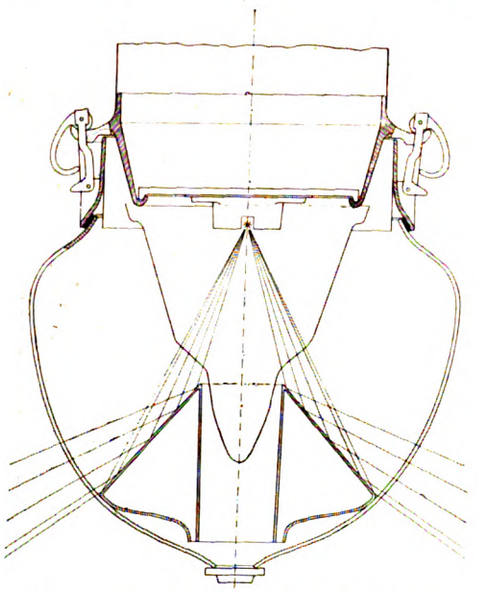
MULTAX ARC LAMPS.

The makers of this lamp, the Globe Electric Company, have just issued a brochure describing the latest pattern in which the burning hours have been increased 150 per cent. without adding to the length of the lamp. Our readers will doubtless remember that patent bridge-core carbons are used in conjunction with a special method of enclosure of the arc. The latter comprises a replaceable fire-resisting inner globe which is fitted to the lamp in such a way that the fumes from the carbons are carried away at the top of the globe case and do not enter the mechanism of the lamp. The sectional illustration herewith will explain this arrangement. It also shows the patent light distributor which bends the light rays considerably towards the horizontal. The deflector is described in the list as a hollow glass ring of triangular section, the inside surface of the hypotenuse being silvered. It is placed in the bottom of the globe and its slope is so proportioned that the rays from the arc fall on it at the proper angle required to bend them in a horizontal direction. The fact that the silvering is done on the inside of the glass ensures a constant brilliance for the reflecting surface quite irrespective of the cleaning of the globe.



View of Multax Distributing Reflector.

The Multax lamp is offered in two patterns, one for 20 to 25 and the other for 26 to 40 burning hours. The first-mentioned lamp is only 33 in. in overall length and is recommended by the makers for shops and public buildings. The lamp is made for direct-current and alternating-current circuits and the Globe Electric Co., Farringdon-avenue, London, E.C., will be glad to send fuller particulars on request.

A NOVEL COVER.

In this country we are not privileged to utilise the front covers of our technical periodicals for other than advertising matter. The "Canadian Electrical News" established a useful precedent in one of its recent issues by reproducing on the front cover a highly original design by an equally original artist. We reproduce the design on a small scale herewith. It is self-explanatory and will bear examination in detail. We commend it specially to the notice of students of wireless telegraphy, as possibly they may evolve some new application of etheric wave systems from it.

REYROLLE WALL PLUGS

For Portable Machines, Lights, &c.

Pamphlets 114, 122, 88 and 45 give all particulars.

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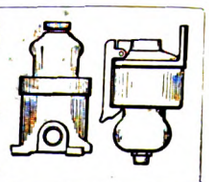

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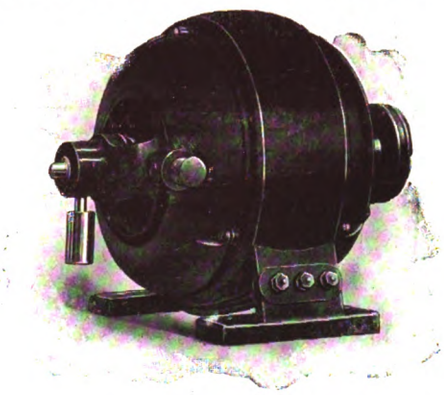

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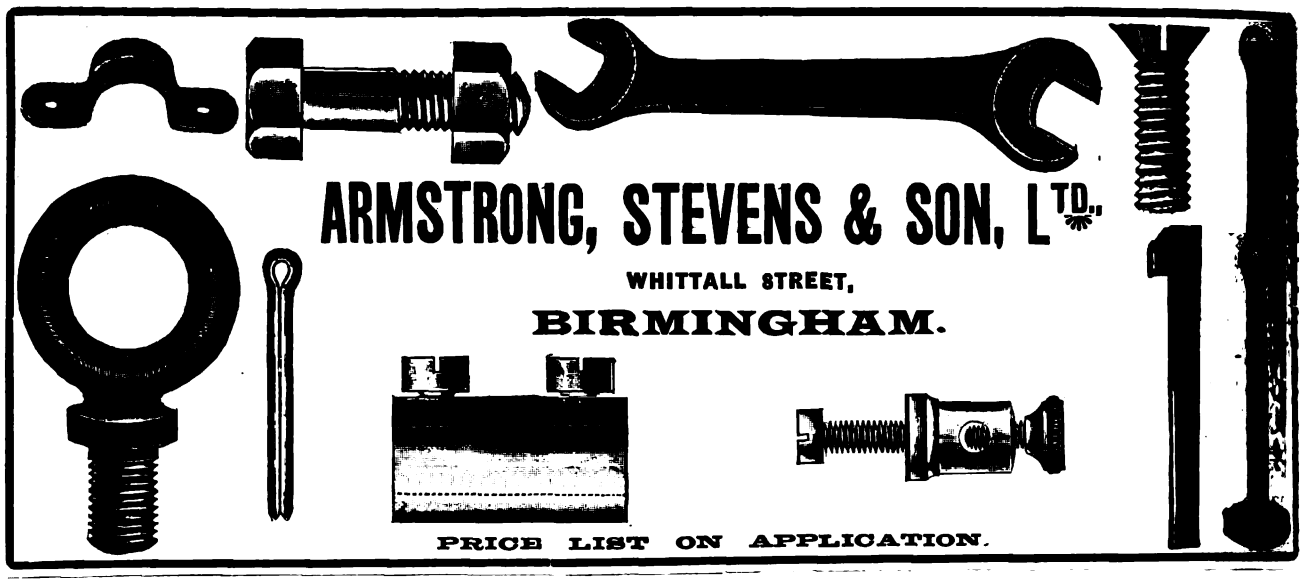
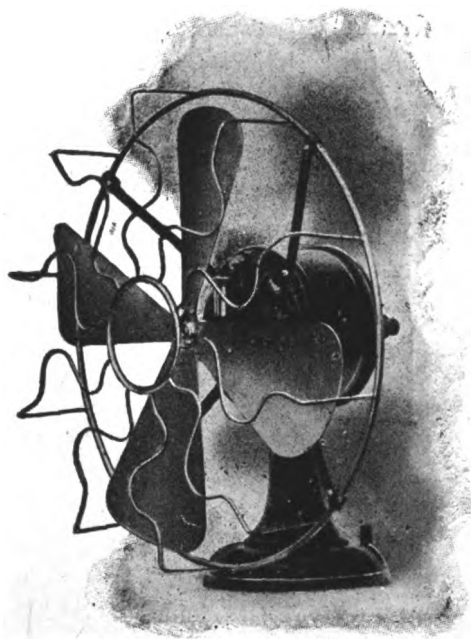


SIMPLEX FANS AND SMALL MOTORS.

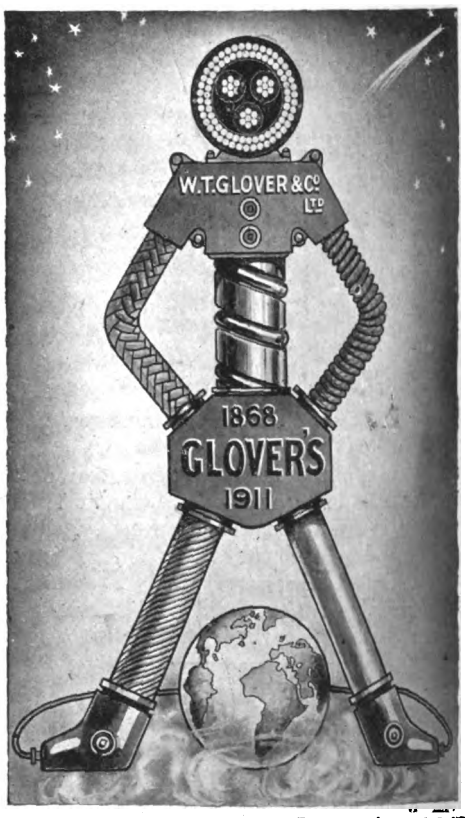
In the new Simplex fan list will be found a range of electric cooling devices to suit all tastes and requirements. The now familiar types of fan—desk, bracket, ceiling and porthole—are well represented. Swivelling bases for fans are also a feature of the list. These have come to the front of recent years and are deservedly popular. It is possible by their use to use



Simplex Desk Fan.

a fan and distribute the breeze about a room or office, the result being somewhat of an economy in fans, because one man in a large office who may be the head of a department can arrange matters that the breeze from his single fan can be shared by the other members of the staff. In the Simplex fan list is also a full account of the Simplex small motors. Among these we notice a polyphase motor, the driving of looms and the other small power machines in textile factories. This motor is fitted with the balance cradle suspension and balanced spring tension adjustment for tightening the belt automatically.

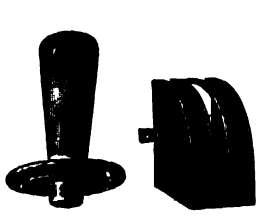
FROM GLOVER'S 1911-12 CALENDAR.



Not to be confused with the first British Airman landing at Manchester in the "Daily Mail" Air Race.

H. WEIDMANN, RAPPERSWIL, SWITZERLAND.

Manufacturer of PRESSPAHN AND INSULATING MATERIAL.



PRESSPAHN in sheet, rolls and tapes. Presspahn tubes and stampings.

CORNITE, high tension Material. Handles for Switchgear and Heating Apparatus. Controller Insulation. Moulded parts of all kinds.

ASBESTOS CEMENT in Plates, Arc Shields for Controllers, &c.

AMIANITE, Vulcanised Asbestos. Coil Frames. Spools for Dynamos, Motors and Transformers. Boxes, &c. Insulating Blocks, Tubes, Plates.

Insulators for Electric Furnaces, Tramways, &c.

Insulating Pearls. MICA and Substitutes. Transformer Spools.

Japanese Paper in Rolls and Tapes. Oil Varnished Linen, Silk and Paper, &c.

Printed and Published by GEORGE TUCKER, at the Editorial, Printing and Publishing Offices, 1, 2 and 3, Salisbury Court, Fleet Street, in the City of London Friday, August 4, 1911.

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THE ELECTRICIAN COMMERCIAL AND INDUSTRIAL SUPPLEMENT.

C. & I. Supplement No. 97.] AUGUST 11, 1911. [Gratis to Subscribers.

CAN IT BE POSSIBLE?

In their competition with electric light the advocates of gas have put up some remarkable performances. The records of the controversy show the display of a greater amount of zeal on the part of the champions of gas as compared with those of electricity. In the case of gas the realisation of the knowledge of the ultimate result of the struggle must be somewhat fateful like the classic sword of Damocles over the heads of the contestants. The time appointed for the falling of that sword is not a matter for discussion at the moment. The development of the struggle between the two illuminants, particularly in the past 12 months, has witnessed a consistent advance of electricity side by side with the adoption of tactics by the gas adherents which can only be attributed to the promptings of despair.

In the present year of grace electricity has taken advantage of the great opportunity presented by the Coronation. In spite of all the shufflings of the gas partisans, they have emerged from the competition in the decorative illuminations as the laughing-stock of the entire country. Our rivals are unfortunately unable to profit by this rebuff—they have simply to take it lying down.

Not content with administering a decided setback to gas at the Coronation, the electrical industry is having the audacity to hold an Electrical Exhibition at Olympia in the autumn of this year. This exhibition will centre public interest in electricity and will undoubtedly give a great impetus to the wider utilisation of electrical energy for lighting, heating and power. Of these three we confidently anticipate that lighting and the sale of metal lamps will receive an extraordinary fillip. We have ventured on previous occasions to suggest the possibility of a reduction in the price of metal lamps for this exhibition. While we look forward to it with confidence the gas interests cannot but regard it with the utmost dread. We appear to hold several trump cards in the game we are playing. Not only have we a considerable amount in hand in regard to the price of electrical energy for lighting purposes (indeed there are some engineers of large stations who hope that the lighting load will be something of a by-product), but also we have the tremendous advantage of being able to bring down, with their increased use, the cost of all electricity-consuming devices, be they lamps, motors, heaters, &c. With gas, on the other hand, there appears to be only one weapon left, that is, the price of the commodity, for it is difficult to conceive that the cost of gas-consuming devices can be reduced very much lower than it is at present.

Reduced to this extremity the gas industry is occupying itself in the attempt to discover some means of stemming the tide in favour of electricity. We hear rumours that efforts are being made to revive the gas-driven dynamo for electric-light consumers, and particularly the large consumer, who is a profitable adjunct to the electric light mains. We understand that a scheme is on foot in one of the large provincial towns to put in gas plant and supply cheap gas at a rate which will make the cost of the electricity generated 1d. per unit. The consumer is to be relieved of all capital charges and the maintenance of the plant. A nominal charge per horse-power per annum only will be made, and while the gas suppliers will make what profit they can out of the transaction the electricity consumer, who will then become their customer, will still retain the advantages which originally influenced him in adopting electric lighting. This is a crafty manœuvre and does not deserve to succeed. There are even suggestions that the town supply can be used as a standby. If this is proposed, the station engineer has the obvious rejoinder to fixing the maximum charge under the Act for this class of service. Faced with the possibility of paying

The West End Picture Theatre, Sauchiehall Street, Glasgow, illuminated by High C.P. OSRAMS.

PICTURE THEATRE LIGHTING BY OSRAM LAMPS.

The General Electric Co., Ltd., Head Office: 67, Queen Victoria St., London, E.C.

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TABLE AND BRACKET

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ALTERNATING CURRENT

ALL VOLTAGES

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Telephone: LONDON WALL 8270. Telegrams: "SIEMOTOR, LONDON."
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CARDIFF	NEWCASTLE	CAPE TOWN	MADRAS	RANGOON	TORONTO

for energy at the rate of £8 per kilowatt per annum, and with a shaky gas engine in the cellar, the electricity consumer would doubtless feel that he had dropped the bone in grasping for the shadow. We invite our readers to co-operate in the supply of particulars from their districts as to what is being done both by the gas engine makers and gas suppliers towards the placing of a scheme of this kind on its legs. For the moment we are content to repeat the question, Can it be possible?

EFFICIENT GRINDING.

Engineers have made use of grindstones ever since the cradle days of the industry, but the most sanguine of the pioneers of grinding machinery would not have prophesied the evolution of present methods from so simple a beginning. Modern abrasives are sufficiently hard to apply to the hardest metals and innumerable commercial processes are given a remarkably high degree of accuracy simply on account of the grinding methods introduced. Some idea of the diversity of these methods can be gathered from a list just published by B. R. Rowland & Co., of Reddish, who have made a study of abrasives and their practical applications for over a quarter of a century. They offer a number of different kinds of abrasives for different purposes. These include corundum which is the hardest substance known to science, excepting the diamond, crystal Canadian corundum, which is a cutting material, and does not rub, burn, or glaze; it is recommended for steel tools because it will not draw the temper. This last-named abrasive owes its special properties to the absence of chemically combined water and lime and to its crystallisation. Then there is carbo-corundum which is produced by an electrochemical process; this is infusible at the highest temperatures and is insoluble in all liquids. It is more brittle than crystal corundum and is recommended for certain special purposes.

Messrs. Rowland & Co., in addition to making abrasives, are also manufacturers of grinding machines. They have a special method of mounting for grinding wheels, the feature of which is the fitting of one plate over the boss of the other and the recessing of all bolt heads. The inner faces of the plates are dovetailed and fit the wheels in such a manner that wholly eliminate the risk of bursting. Of the grinding machines we can say that they are offered in many types and sizes. A special pattern is one for twist drill grinding. This will take drills up to 2½ in. diameter and is fitted with belt-driven centrifugal water pumps and a smaller wheel for thinning off the drill points. All patterns of grinders can be arranged for belt or motor drive. A large fully illustrated catalogue has been prepared of all the machines made by this company and a copy will be forwarded to interested inquirers.

SIMPLEX NEW FITTINGS.

A supplementary fittings list has just been issued by Simplex Conduits, and it will be found to contain a great variety of new designs. The pages of the list are devoted, in pairs, to the different styles or periods which the fittings represent. The Adam, Georgian, Dutch and modern are represented, the concluding pair of pages dealing with holophane fittings. The designs shown are tasteful and artistic. On the score of price practically every pocket is catered for. The holophane fittings especially are very reasonable but at the same time are well selected and admirably suitable for flats and small households. A novelty among the holophanes is a dining-room pendant, hung from an ornamental ceiling fitting by three chains, there being a reflector bowl at the lower end surrounded by a large silk shade. The holophane table standards are also very pretty.

NEW HOLOPHANE PENDANT FITTINGS (SIMPLEX).

OSRAM LAMPS

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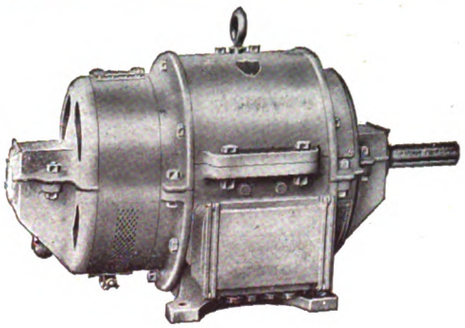
VICKERS MOTORS



FOR ALL PURPOSES.

Their rigid and substantial construction enables them to withstand the most severe usage and give a continuous and uninterrupted service without help from the repair shop or any undue heating.

Send for Lists.

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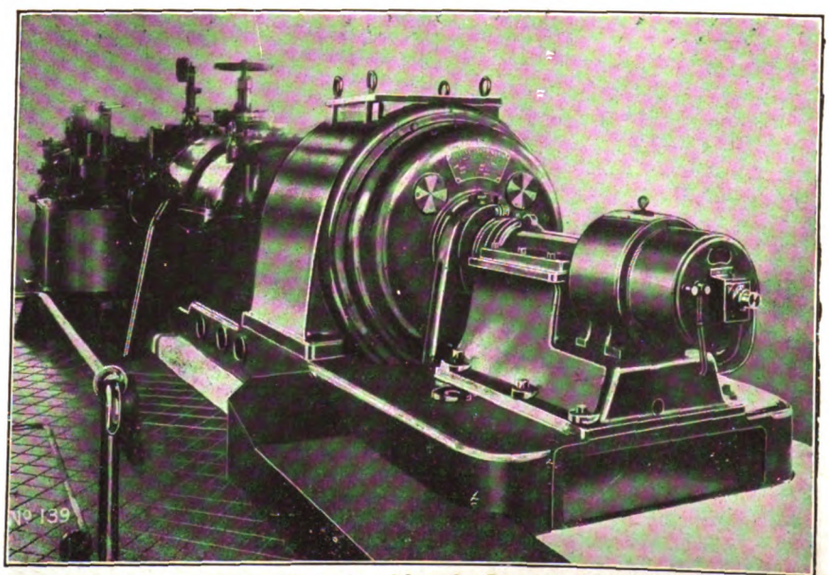
Proprietors : Vickers Limited.
ASTON, BIRMINGHAM.

VICKERS ALTERNATORS



VICKERS' 500 kw. 3-phase Alternator driven by Parsons Exhaust Steam Turbine.

VICKERS LIMITED

River Don Works,
SHEFFIELD.

ON ADMIRALTY LIST. ON WAR OFFICE LIST.

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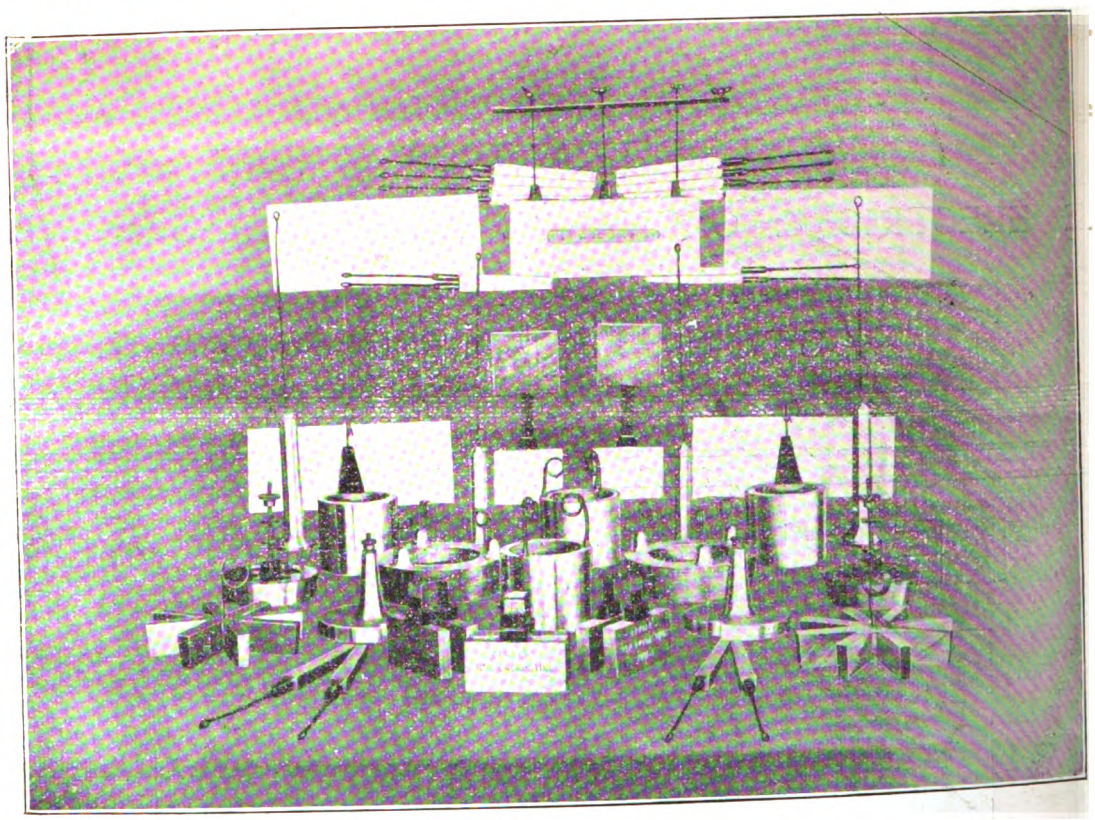
STERLING TELEPHONES
The Sterling Telephone & Electric Co., Ltd., 200, Upper Thames Street, London, E.C. Works: Dagenham, Essex.

BAMBER NON-ENCRUSTING ZINCS.

Most of the commercial primary batteries in use to-day are fitted with zinc as one of the elements. This metal is gradually eaten away as the battery is used and must be replaced at intervals which vary with the amount of work done by the battery. Primary batteries are employed largely on railways for telegraph and track circuits. It is of the utmost importance that the zincs used in these batteries do not become encrusted as the zinc is eaten away. If this takes place there is a considerable reduction in the life of the battery due to local action; the efficiency of the battery is also impaired. For many years past the Eyre Smelting Co. have produced, by a special process, a form of non-encrusting zinc for all classes of primary batteries. These are known as Bamber zincs, and it is claimed for them that they are free from encrustation and local action, they ensure a full and constant supply of current, that they have more than double the life of ordinary zinc, and that they require practically no attention. These claims are certainly not exaggerated, because they are amply confirmed by the reports of actual users of batteries fitted with these special zincs. These reports emanate from railway companies both at home and abroad, electric clock companies and consulting engineers. Tests conducted by the National Physical Laboratory also are conclusive in support of the claims of the makers. One of the latter tests is worth quoting in detail.

"Two simple voltaic cells, with copper plates, and with zinc rods (in one cell a 'Bamber' zinc and in the other an ordinary amalgamated zinc), the sulphuric acid having a specific gravity of 1·074, were connected across a constant resistance of 1 ohm. The discharge was continued for 49 hours, at the end of which time the ordinary zinc rod was gassing violently.



Group of Bamber Non-encrusting Zincs.

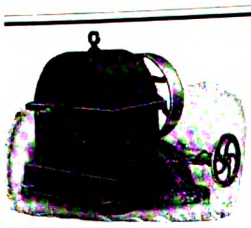
"The following figures show at a glance the result of the above test:—

"'Bamber' zinc: 11·7 grammes zinc consumption.
0·6 gramme loss due to local action.

"Ordinary zinc: 26·5 grammes zinc consumption.
10·1 grammes loss due to local action.

"The loss due to local action in the case of the ordinary zinc rod was, therefore, very nearly 17 times that of the 'Bamber' zinc; further, it will be seen that the zinc consumption in this 'Bamber' zinc very closely approximated to the theoretical consumption figure.

PROMETHEUS
ELECTRIC HEATING & COOKING.
London Showrooms:
9, NEWMAN ST., OXFORD ST., W.
THE BRITISH PROMETHEUS CO., LTD.,
SALOP ST. WORKS, BIRMINGHAM.



PELTON WHEELS for Hydro-Electric Plants.
Patent Hydraulic Speed Governors.
I specialise in these, and my prices will be found lower than those of any other first-class manufacturer. I have supplied English and Colonial Governments, my tenders being accepted in open competition
PERCY PITMAN, 3, Willcott Road, Acton, LONDON, W.

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MECHANICAL ELECTRIC CURRENT GAUGE.

This novel invention enables one to determine with sufficient accuracy the amount of current passing in Cables (whether insulated or otherwise).

Vertical or horizontal conductors can be measured with equal ease.

Nett Price - - £1 18 0

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66, Victoria Street, Westminster, S.W.
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Telegrams: "ACCUMULATOR," LONDON, MANCHESTER, or GLASGOW.

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"It should be borne in mind that, whilst at the end of this test the ordinary zinc is described as 'gassing violently' and, it is further stated, that the 'protective surface was apparently disintegrated,' no gassing is mentioned for the 'Bamber' zinc, which is described as being 'pitted somewhat irregularly.' It is stated that the main action on the 'Bamber' zinc had apparently taken place at the corners and at the top level of the acid. This latter emphasises the importance of having the largest section at the top of the zinc. In view of this and that the loss of zinc on the 'Bamber' zinc up to the end of the test was only about 13 per cent. by weight, we may claim that the useful life of the 'Bamber' was no means at an end."

We take the foregoing illustration from a list just issued by the makers and sent to us by their sole London agents, Alan S. King & Co., 28, Victoria-street, Westminster, S.W.

IFS AND QUERIES.

Has the Chairman of the N.E.M.A. melted himself out of the snowdrift yet ?

If there were a society for the protection of electrical salesmen.

Has Mr. Durtnall arranged to take his summer holidays on board "The Electric Arc" ?

If only the "glad eye" came within the range of practical photometry.

Will Lord Haldane restrain the publication of THE ELECTRICIAN Tables of Electricity Undertakings on the ground of their dealing with prohibited places ?

Has the Electrical Contractors' Association arranged to visit the Turin Exhibition while the Electrical Show at Olympia is in progress ?

Will Mr. Mordey do a *pas seul* at the Café Chantant at Olympia ?

Will there be any findings of the new Joint Committee of the Textile Institute and the Institution of Electrical Engineers ?

GLOVER'S ANTICIPATIONS.

GLOVER'S IDEA OF A JOINTER'S CHRISTMAS.
(Worth studying this hot weather !)

EXCELLO

FLAME ARC WITH UNIQUE TWO YEARS' WARRANTY

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CONTROLLERS.

RELIABLE.
SILENT.

We specialise in Lift Controllers, Automatic Starters for the Control of Pumps, Hydraulic Accumulators, Air Compressors, Machine Tools, Capstans, etc.

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Write for Catalogue E.

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177, REID STREET,
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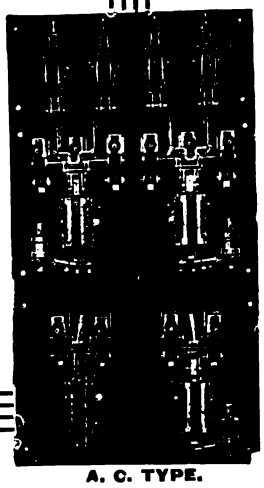
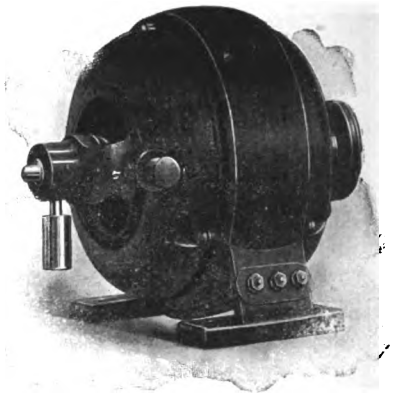
Telephone: 2847, Bridgeton.
Telegrams: "Control, Glasgow."



A. C. TYPE.

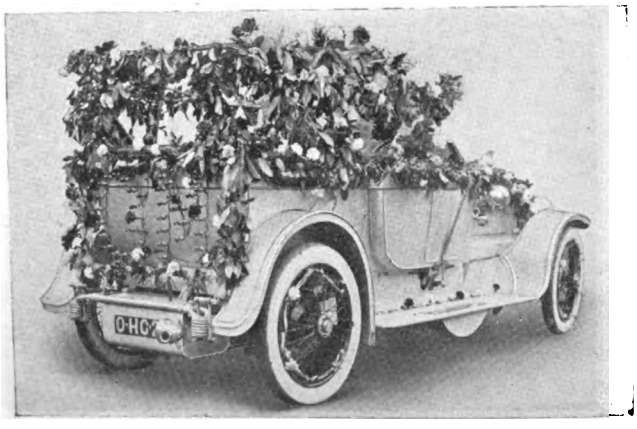
E.M.I. FANS
and
Small Motors
A.C. & D.C.
All Sizes.
All Voltages.



HOGAN & WARDROP,
2, GRESHAM BUILDINGS,
BASINGHALL STREET,
LONDON, E.C.
Telephone - - - 723 LONDON WALL.

ANOTHER USE FOR OSRAMS.

One of the interesting instances of electrical illumination on the occasion of the recent Coronation Festivities was that of a 23 H.P. six-cylinder "Daimler" Car, belonging to Mr. G. F. Heath, of Birmingham. For some days during the period in question this car, which is known locally as "Silvery Silence," attracted considerable attention in the Midlands on account of



MOTOR CAR ILLUMINATED WITH OSRAM LAMPS.

its elaborate scheme of decorative illumination, the entire effect being produced by means of 400 Osram lamps. Osrams were also fixed to the wheels of the car and revolving with them greatly added to the artistic effect. Such a test speaks well for the strength of the Osram filament, and if they will stand the "jolts" and "jars" of rough roads (to which the wheels of any car must be subjected) they are more than especially suitable for the wear and tear of ordinary everyday use.

ELECTRIC POWER IN QUARRYING.

There is a field of industry in this country in which, as far as we are able to gather, electric power has made but little headway. This is in the quarrying business, and the lack of users of electrical energy in this particular province is probably due to the distance of quarries from sources of supply. With large concerns, however, there should be sufficient justification for the installation of a central plant from which energy can be transmitted and distributed to the various motors. An interesting instance of electric driving on these lines is afforded by the equipment of the Dolese & Shepard Co.'s quarry which is located on the drainage canal of the sanitary district, Chicago. The site of the quarry is within touch of the power supply mains of the Economy Light & Power Co., of Joliet, and a demand of 1,200 kw. is made regularly on this concern. The use of electrical energy was hastened considerably by the fact that a fire destroyed a portion of the works, and in the rebuilding operations it was decided to use electric power. Motors are employed for drilling, loading cars, and conveying, shovelling and crushing. The electric drills in use replaced a number of compressed air drills and they are operated at half the previous cost with an increase of 25 per cent. in the output. The loading cars are supplied with energy from a third rail, and a batch of 25 cars daily handles 6,000 to 8,000 tons of stone, and only two men are required to run the cars as against a large number needed for the original seven steam locomotives. Each car holds 20 tons and runs up a 6 per cent. gradient to a height of 70 ft.

SIMPLEX CONDUITS Ld.,
Garrison Lane, BIRMINGHAM.
Manufacturers of—
CONDUITS, CABLES, ACCESSORIES, FITTINGS, MOTORS, ELECTRIC HEATING AND COOKING MATERIAL, &c.

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FERRY RESISTANCE WIRE.

No Temperature Coefficient. Wire will not Rust or Perish.
Contains no Iron.
The only Material of its kind Manufactured in England.
Used largely and Specified by the Admiralty.
Used also by the Italian and Japanese Admiralties.

Write for List giving Electrical Particulars of Ten Grades of Wire.

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Agent: LIONEL ROBINSON,
3, Staple Inn, London, W.C.
Telephone: 6323 HOLBORN.
Telegrams: "FERRYDOM, LONDON."

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LIMITED.

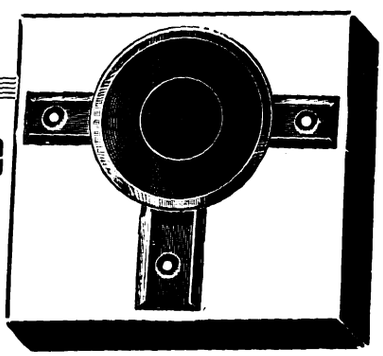
IRONCLAD
OIL OR AIR BREAK
SWITCHES.

Simple. Efficient. Reliable.

WRITE FOR LISTS.

HOLLINWOOD, LANCS.,
78, KING STREET, MANCHESTER.

Woodhouse
STEEL
CASING



has all the advantages of wood and tube systems, but it is far less trouble to erect, and is much neater in appearance. With the Woodhouse system THERE ARE NO FIRE RISKS and the wires at any part are easily inspected.

BENDING TOOLS ARE DISPENSED WITH
NO THREADING OR DRAWING-IN OF WIRES
NO MITREING OR FITTING
NO SCREWING OR NAILING OF COVERS

WRITE FOR FULL PARTICULARS TO-DAY.
THE WOODHOUSE STEEL CASING CO., LTD.,
172, CRAVEN HOUSE,
KINGSWAY, LONDON, W.C.
TELEPHONE: 2236 CITY.
J.C.P.

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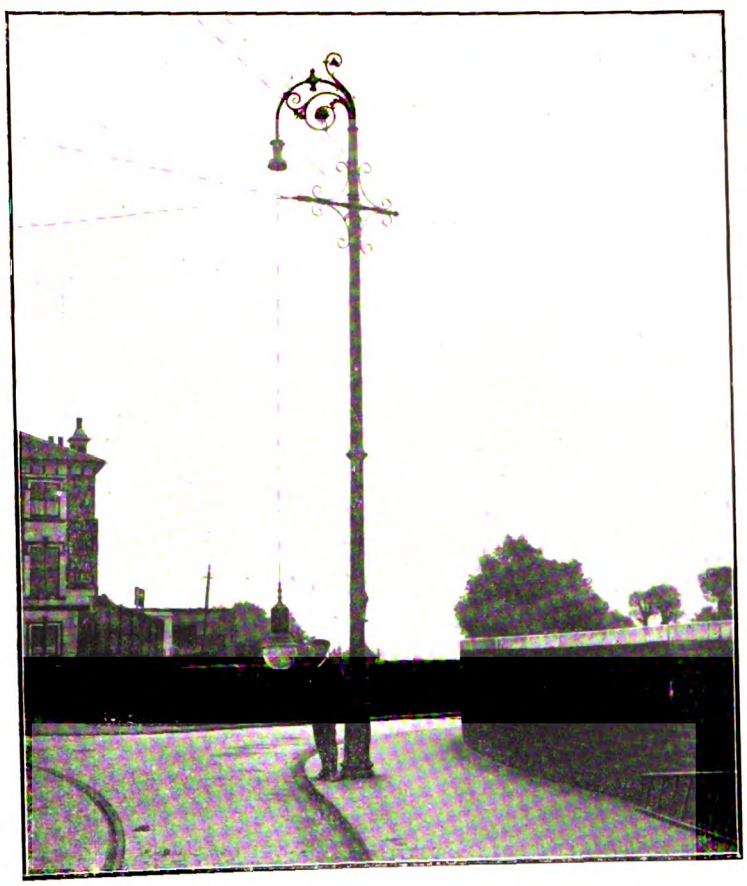
the crusher. The cars are electrically braked on the descent, and the motors are connected to a dead resistance formed of No. 6 Climax wire. The crushers handle 50 tons an hour and rolls are used for reducing below 6 in. in size. In the sub-station are motor generators for conversion of the transmitted energy to direct current, and also transformers for lowering the alternating-current supply to 440 volts.

TANTALUM SHOW CARD COMPETITION.

We are asked by Siemens Bros. Dynamo Works to announce that the number of designs submitted for their show card competition is far in excess of their wildest anticipations. The work of the many competitors is however being gone over as quickly as possible and the selection of the best designs will be announced shortly.

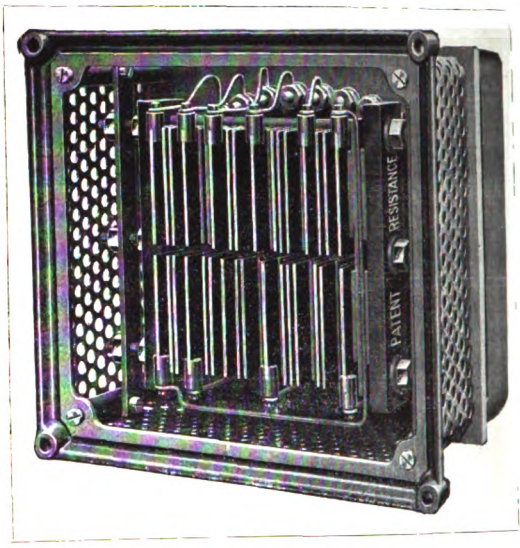
METAL LAMPS AND LOWERING GEARS.

During the past 12 months the metal lamp has made extraordinary progress in street lighting. We have had occasion to record the displacement of arc lamps of the open type either by



METAL LAMP LANTERN AND LOWERING GEAR AT CROYDON. (London Electric Firm).

metal lamp clusters or high candle-power lamps. The development of the metal lamp for street lighting has up till now been principally in the direction of side streets, but since the domain of the arc lamp has been invaded the metal lamp has figured prominently in large thoroughfares, and probably the principal item of interest is the use of lowering gear for the metal lamp lantern which has taken the place of the arc lamp on the same post. Messrs. The London Electric Firm, of Croydon, who are specialists in a patent form of lowering gear having only one part, have introduced these devices for metal lamps in a large number of districts. We illustrate one of the lamp-posts at Croydon fitted with this gear and with the lamp lowered for cleaning and general inspection. The makers claim that the use of this gear for metal lamps is justified because their particular device is extremely simple and inexpensive to instal. It dispenses with the time and labour required for the power waggon which is apt to be dangerous and also impede traffic. It may be remarked that the contact suspension device is of the positive acting weight relieving type, and combined with it is a self-contained winch which is without rachets, pawls, springs or triggers.



BACK VIEW OF A

REYROLLE

LEVER-TYPE MOTOR STARTER.

Fitted with Patent "Current-Growing" Resistance.

Pamphlet No. 19 (which gives full particulars), has just been revised, and in many cases prices have been reduced.

SEND FOR A COPY.

A. REYROLLE & CO., Ltd.,

HEBBURN-ON-TYNE, ENGLAND.

ELECTRIC SIGNS FOR CHURCHES.

An American contemporary in discussing the merits and development of the electric sign remarks upon the possibility of its use for churches. Although no instances are quoted it is stated that the electric sign is being used by churches, and is considered in good taste. Now in this country if any such movement were set afoot it would be foredoomed to failure because our national ideas are diametrically opposed to those in vogue "across the stream." We ourselves can see no reason why an electric sign should not be used to direct the stranger from a main to a bye thoroughfare in which a place of worship is situated. The actual fixing to the walls of the church or chapel of an electric sign would we imagine rouse a storm of indignation among the congregations over here. Still there are enterprising ministers of the younger schools of British denominations who would erect a "talking sign" on or near the sacred edifice in which they exercised their pastorate. To put up a sign within the precincts of any sacred building would be rightly looked upon as sacrilege. The school and assembly rooms and church hall may appropriately be used to cry out their presence by means of electric signs.

H. WEIDMANN,

RAPPERSWIL, SWITZERLAND,

FOR

Presspahn and Insulating Material.

(See larger Advt. last week.)

Printed and Published by GEORGE TUCKER, at the Editorial, Printing and Publishing Offices, 1, 2 and 3, SALISBURY COURT, FLEET STREET, in the City of LONDON FRIDAY, AUGUST 11, 1911.

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THE ELECTRICIAN COMMERCIAL AND INDUSTRIAL SUPPLEMENT.

C. & I. Supplement No. 98.] AUGUST 18, 1911. [Gratis to Subscribers.

CAN IT BE POSSIBLE?

A COMMENT FROM THE PROVINCES.

We have received a communication from one of our readers dealing with the subject discussed under the above heading in our last issue. He writes as follows :—

The article under the above heading in the current issue of THE ELECTRICIAN, although somewhat belated, is the most refreshing draught the present writer has had during this season of wasp-stings and empty bottles. The invitation to your readers to co-operate with you in comparing notes as to their experiences in the field of competition should be productive of much good and useful information.

In the opening paragraph, owing to the hot weather or a side-slip of the typewriter, a wrong impression is caused by the following statement: "The *records* of the controversy show the display of a greater amount of zeal on the part of the champions of gas as compared with those of electricity." This is true only so far as the records go, as, owing to the lethargy of the electrical press, much goes unrecorded that would be most useful to those in the field. Whilst, on the other hand, our friends the enemy go to the other extreme, and record more than actually happens, as instanced in a certain gas journal a couple of weeks ago when they adduced certain *scientific* proofs from an unknown source to show that a tantalum lamp created more carbon dioxide than a gas burner in the same room under similar conditions.

With regard to their many desperate attempts to find fresh outlets for gas, the vendors of this superfluity are finding that their opportunities are becoming fewer daily, and it only requires a combined forward move on the part of all concerned in the electrical industry to co-operate as you suggest and keep in close touch through the medium of the technical press. The necessity for this vigilance is shown by the latest move on the part of the gas undertakings. Even in the past their tactics have often times been more vindictive than competitive, their real aim, wasp like, being to damage their opponent at the cost of greater damage to themselves. When their new scheme, financed by the funds being raised on the basis of 2s. 6d. per million cubic feet is launched, we must be prepared to compel them to spend it for the public good.

An allusion is also made in THE ELECTRICIAN article to the forthcoming Olympia Exhibition, and a hope is expressed that one of the outcomes of it will be a reduction in the price of metal filament lamps. This is an absolute necessity, as it must be obvious to all concerned that the inflated prices of these lamps has placed a strong weapon into the hands of our rivals, and caused the greatest set-back to many electrical undertakings which has been felt much more than gas or any other competition. The losses due to their reduced consumption have not been made up, in many cases, by additional lamps, owing to their prohibitive prices. Unfortunately, there is a difference of opinion on this question in our own camp, as recently a contemporary connected with the electrical industries, commenting on the fact that one firm of lamp manufacturers are supplying a high-voltage lamp at 2s. 6d., concludes by asking the following question: "Is the game of cutting prices worth the candle?" This lamp at the price quoted yields a clear 30 per cent. profit, without any risks whatever, and if the man behind the counter is not content with this, the only remedy is to effect a more efficient means of distribution, and the sooner the better.

This question cannot be viewed or discussed along parallel lines, as they never meet, but rather as an equilateral triangle, the base of which is the supply undertaking, the other sides being represented by the consumers and the manufacturers respectively. All other interested parties are merely adjuncts, or in some cases hangers-on. The sooner that this is realised it will be better for all concerned, and once we get our own house in order, we may hope for satisfactory results all along the line. The tail has wagged the dog too long. Much more might be added, but for various reasons must be deferred for the present, as the writer is by no means a prime mover, but a mere

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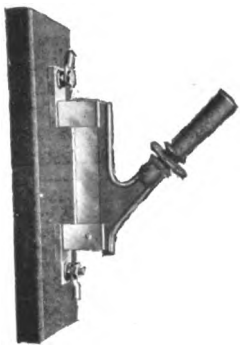

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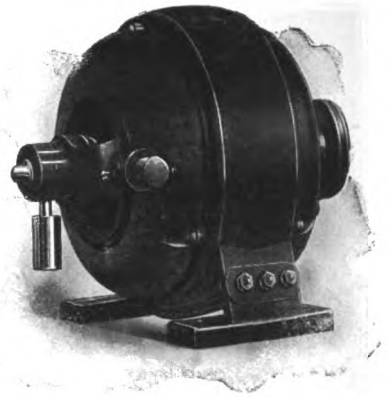

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LEWIS'S LIBRARY.

Messrs. H. K. Lewis have sent us a copy of their quarterly list of new books and additions to their medical and scientific library. In the scientific section we notice that the already fairly representative collection of books has been brought up to date by editions in aeronautics, civil engineering, electrical and general engineering, mechanics, mining, metallurgy and technology. In the electrical section we notice particularly the addition of the revised edition of Von Schon's "Hydro-Electric Practice," a voluminous work dealing with the practical use of water power for electrical transmission purposes. Dr. Fleming's "Lectures on the Propagation of Currents in Telephone and Telegraph Conductors" is also included and should be useful to telegraph and telephone engineers who are anxious to keep abreast of the times. Our readers should make application for particulars of the library, and also of these recent additions, to Messrs. H. K. Lewis, 136, Gower-street, London, W.C.

THE BENJAMIN FRICTION-DRIVE SCREWDRIVER.

There are innumerable instances in which it is convenient to turn a screw driver without removing the business end from the slot in the screw. The rachet screw driver is well known, but it has certain limitations and is apt to be expensive. With the Benjamin friction-drive driver there are frictional surfaces between the cap and the handle, and these engage when the ordinary natural working pressure is applied to the end of the handle. There is a spring which separates the surfaces as soon as the pressure is relieved, and the loose free end of the handle can be turned back without removing the screw. This spring maintains a slight constant pressure on the screw, holding it firmly in the slot. There is a free swivel connection between the cap and the handle by which it is possible to turn very rapidly free-running metal screws simply by the operation of the fingers and thumb. The driver can be used by either hand, and is therefore suitable for dealing with difficult places where constant lifting of the blade from the screw slot not only wastes time but is apt to be annoying. The driver is suitable for turning right or left hand screws without any adjustment. The price is extremely moderate, and two types are offered, one with diameter blade and the other with a diameter. The blade is of high-grade crucible steel carefully forged, tempered and polished, and the handle is of black insulating material moulded round the blade. The Benjamin Electric (Ltd.), 117, Victoria-street, London, S.W., will supply particulars.

BENJAMIN SCREWDRIVER.

TIME SWITCHES.

In our issue of July 28th we described a pattern of time switch which is manufactured by Messrs. Novitas (Ltd.), Zurich. We have since received a pamphlet from Messrs. Wm. Geipel & Co., St. Thomas-street, London, S.E., in which the same pattern of switch is described and priced. We are asked

OSRAM-LAMPS

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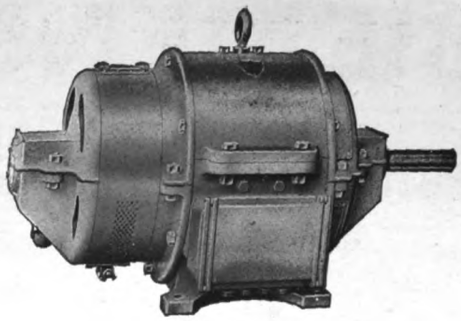
VICKERS MOTORS



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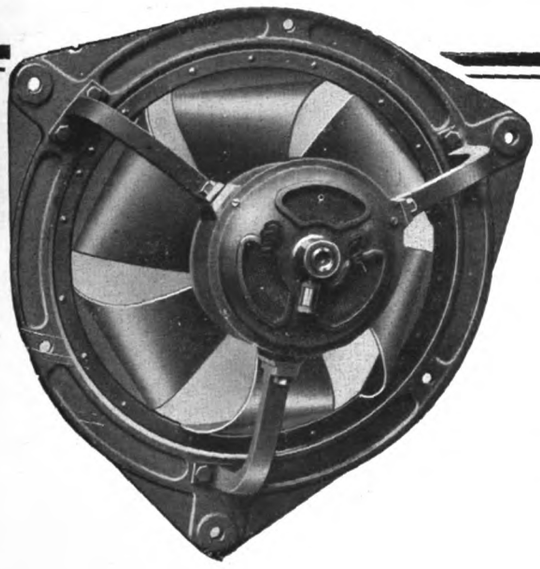

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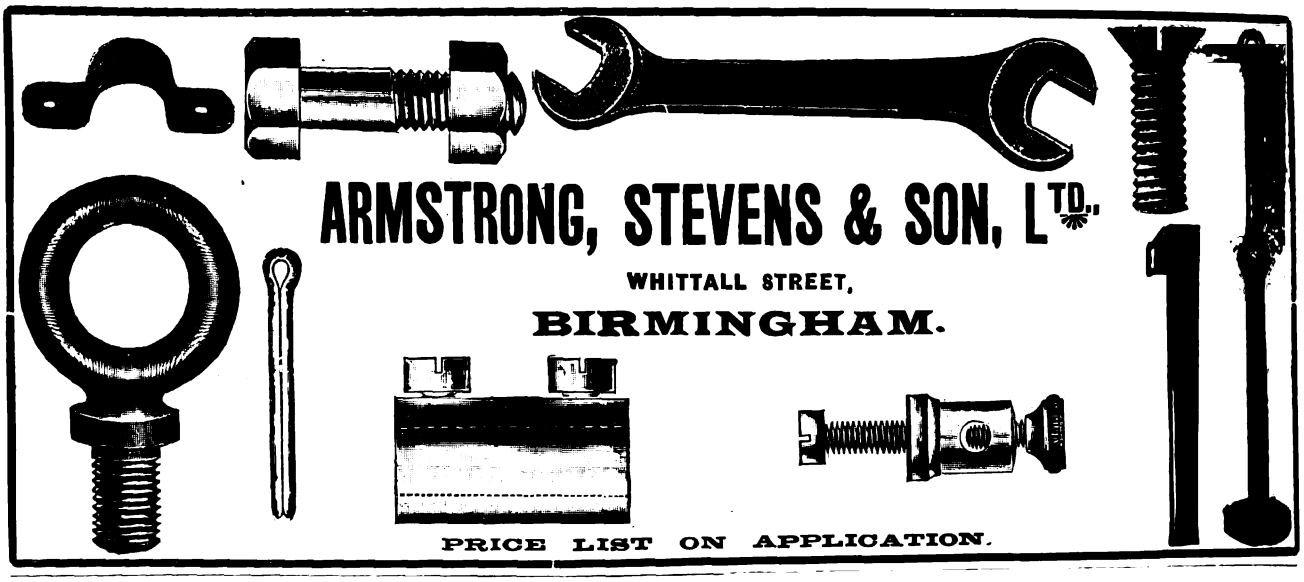
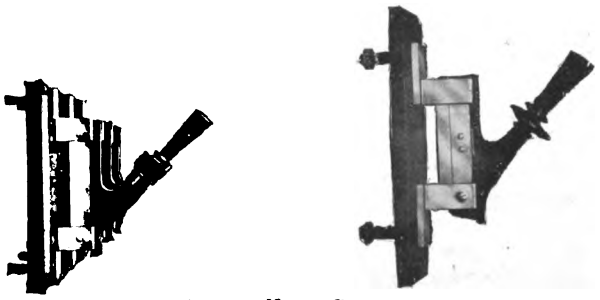


to state that this firm are placing these time switches on the market as agents for the United Kingdom and colonies. They also inform us that the switches are being used by a number of Corporations in this country, particularly by the Manchester Corporation. The switch has been marketed under the trade name of the "Arbiter."

QUICK-BREAK KNIFE SWITCHES.

The single-pole and triple-pole quick-break knife switches illustrated herewith have all current-carrying parts of hard-drawn copper. The handle is well insulated, and the risk of shock when operating is reduced to a minimum. Single-throw switches are supplied with knee-type handles only, while double-throw switches are made with straight handles only. The contacts are made in the double "U" form, and act as a guide for the blade when closing the switch. They are strengthened by mild steel stirrups which assist in maintaining pressure between the contact surfaces. The blades are made in the "U" form, and are hinged to cast-iron blade carriers. In the case of

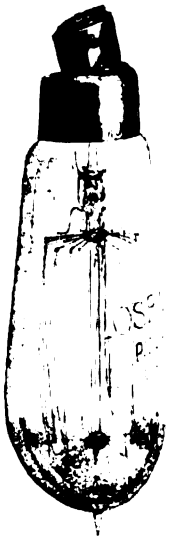


Siemens Knife Switches.

switches for currents up to 200 amperes, the whole of the blade has a quick-break action, but in larger sizes a follower blade is provided. For currents above 700 amperes, two or more blades in parallel are provided, according to the capacity. Both blades and contacts are easily renewable. In the case of double or triple-pole switches, the blades are mechanically connected by an insulating bar to which the handle is fixed. Switches can be supplied mounted or unmounted for either front or back connection. When ordering unmounted switches, the thickness of panel should be stated. The switches are made by Messrs. Siemens Bros. Dynamo Works.

WHAT ABOUT THE BULB?

The adjoining illustration has been reproduced from an untouched photograph taken of a lamp sent to the G.E.C. by Rawlings & Co., of High-street, Lee, Kent. This lamp has recently undergone and withstood a test such as does not fall to the lot of many. For some time past it has been burning in a private garage in Kent, and on Thursday the 10th it was struck by the rear part of a car backing into the garage. It is of interest to record that the only damage done to the lamp was the indentation of the cap shown in the above picture, the filament after the collision being found *absolutely intact*.



A Sturdy Osram.

THE VIBRAGRAPH.

An extremely ingenious instrument, and one which should have a wide field of application, is that known as the Vibragraph, which Messrs. Siemens Bros. & Co. are putting on the market. This instrument has been designed to give accurate records of every kind of vibration. In a pamphlet published by the makers an interesting description is given of the instrument and also several photographic records, which are termed vibragrams, of various objects, such as a house with no traffic passing and with a tramcar passing, a turbo-generator, a two-crank engine, a four-cylinder motor-car engine, &c. The instrument is of simple construction and is compact and light, therefore easily portable. In principle a small mirror is floated on mercury, a beam of light from a tiny electric lamp is thrown on to the mirror and reflected on to either a ground-glass screen or a photographic plate. In order to measure the vibrations within a wide scale three differently adjusted mercury cups are provided with each instrument. We understand that the

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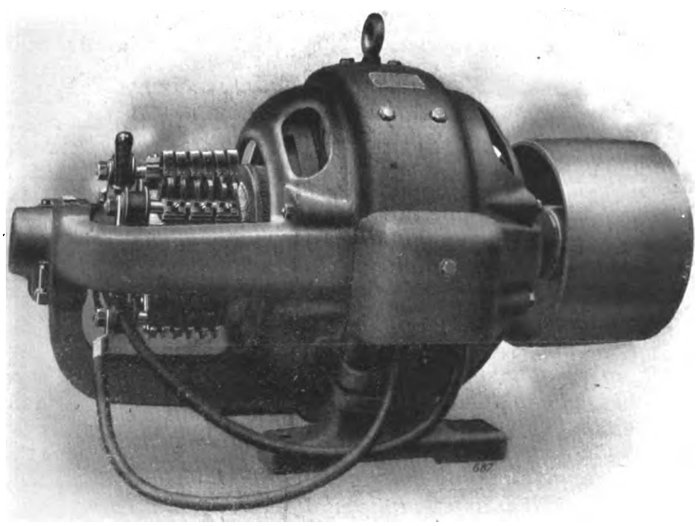
apparatus has been on test for over 18 months, and has proved highly satisfactory. It has also been used in vibration litigation cases in which municipal supply undertakings were involved.

INTERPOLE DYNAMOS AND MOTORS.

The introduction of the auxiliary pole for dynamo-electric machines at the time of the last electrical exhibition at Olympia was a matter of considerable importance to the development of industrial electric power applications. In the meantime,



UNION INTERPOLE DYNAMO.

manufacturers have carefully introduced this important adjunct into their designs, and the net results have been a cheapening in the cost of production, increase in the capacity of the machine and a reduction in its overall dimensions. Practically all dynamo and motor makers at the present time have a special line of interpole machines for direct-current working. The Union Electric Co. has just published a special list dealing with their machines of this class, and it will be found of interest to electrical contractors and industrial power engineers. We understand that in the electrical and mechanical design and construction of these machines the requirements of the British Engineering Standards Committee are complied with. The principal features of the machine are the fixed brush position for all variations of load, the fitting of a special terminal box at the side of the magnet frame, and the general provision of an extremely compact and neat machine. The machines are designed for a 25 per cent. overload for half an hour and 40 per cent. for three minutes. It is stated that the ratings are upon conservative lines, and that under continuous running conditions the temperature is always within safe limits. The machines can be supplied open, semi-enclosed and enclosed.

NEW "ARMORDUCT" CATALOGUE.

An interesting general catalogue of electricity supplies and wiring accessories is being sent out by the Armorduct Mfg. Co. The majority of the specialities of this firm have been before the industry for some years and are consequently well known. The list is the complete catalogue of the company's products and covers practically every item required by the wiring contractor. The company's conduit system and accessories is fully described in the list, and a considerable number of pages are devoted to these details. Incidentally, we may remark that the company has an extensive works at Witton, Birmingham, where all its conduit material is produced, and we give an illustration showing one of the departments of these works. We notice in the conduit section details of an interesting type of adjustable wall box which should prove very useful in difficult situations. It is not always possible to plumb up a box with the face of the wall. When the surface from which the switch knobs are to project is not in a vertical plane it is necessary to adjust the position of the bottom of the box until it becomes parallel with the flush surface. The adjoining sectional illustrations show how the Armorduct adjustable fittings box overcomes this difficulty. The switches are mounted on a back plate which is arranged with an adjusting screw in such a way that the top or bottom of the plate can be set at at any desired angle to

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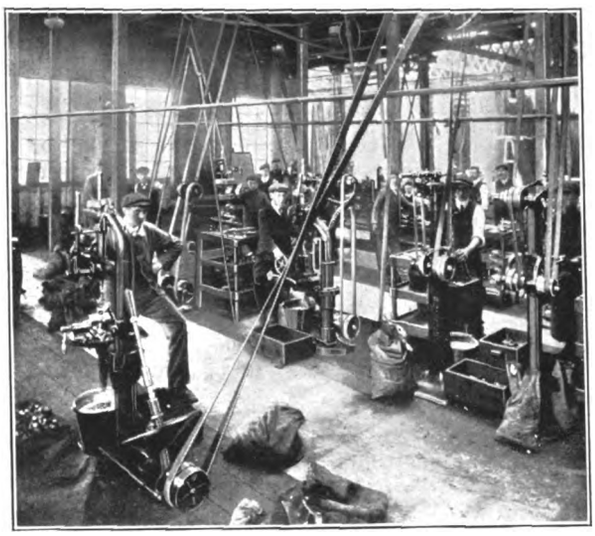
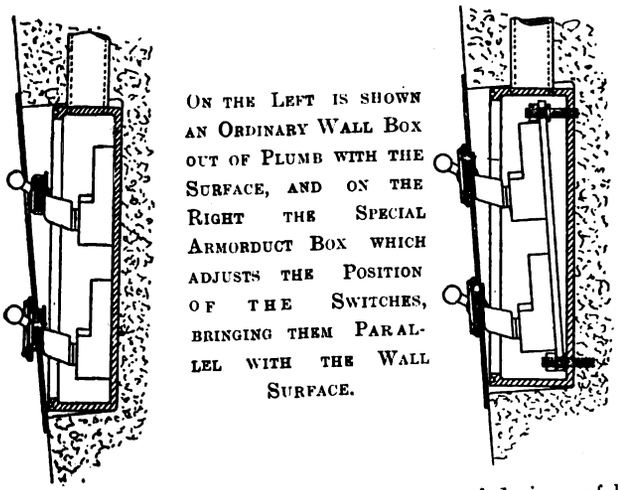


CONDUIT DEPARTMENT, WITTON WORKS OF ARMORDUCT CO.

the bottom of the box. This movement enables the switch knobs to be brought into line with the flush plate covering the box on the surface of the wall.

A large amount of space in the list is also given up to water-tight fittings both for single metal lamps and for clusters.



ON THE LEFT IS SHOWN AN ORDINARY WALL BOX OUT OF PLUMB WITH THE SURFACE, AND ON THE RIGHT THE SPECIAL ARMORDUCT BOX WHICH ADJUSTS THE POSITION OF THE SWITCHES, BRINGING THEM PARALLEL WITH THE WALL SURFACE.

Details are also provided of a large variety of designs of lanterns for outside lighting. We are sure that the list will be appreciated by the trade, and would recommend interested readers to make early application for a copy.

MOTOR DRIVEN FIRE SYSTEM.

An interesting account of an up-to-date equipment for providing protection from fire is given in a recent issue of the "Electrical World." It is in use at Boyne City, Mich., which is a town of 2,000 population near the northern end of the lower peninsula of the State. The water supply of this town is derived from a well, whence it is pumped by means of an air lift, delivering into a low-level receiving basin. High-duty pumps next force the water to the reservoir on a hilltop 250 ft. above the town. The main supply to the town is through a 12 in. pipe in which, at the city limits, is inserted an electrically controlled gate, by-passed by a pressure-reducing valve. Normally the gate valve is closed, passing the town water supply through the reducing valve, and so lowering its pressure from 115 lb. to 40 lb. per square inch for domestic use. In case of fire in the town the electrically operated gate valve can be opened from the fire department office, at once impressing the entire 115 lb. pressure of the reservoir on the town mains. With this pressure no fire engine is needed to throw a good stream over any house in Boyne City.

The main lift pump is of the triplex-plunger type, and is driven by a slip-ring induction motor. The pump delivers directly into the 12 in. main pipe between the gate valve and the reservoir. When in operation this pump supplies a greater volume of water than the town demands at any time, so that the pump is continually making delivery to the reservoir. When the level of the reservoir has risen to a pre-determined height the pump is automatically shut off, being again started when the reservoir falls a given amount.

This automatic control of the pump motor is effected by a float at the upper reservoir controlling the circuits of the automatic starting panel in the pump house half way down the hill. On account of the exposed position of the float and the severe climate to which it is exposed a pilot pipe filled with oil has been provided in which the float moves. This pipe is tapped from the lowest level of the reservoir, so as to be unaffected by ice on the surface. The oil line is also so arranged that in case the reservoir is drained the oil will not be spilled. Normally this float contact controls the pilot circuit of a full automatic self-starting panel for the pump motor, but if desired the float control can be cut out by opening a double-pole switch, leaving the motor to be started from the panel by hand. The latter feature makes it possible to keep the motor off the line during hours of heavy load on the generating station. The motor driving the high-duty pump is protected by an oil switch, which also serves as a circuit-breaker. The air compressor used for blowing the well is driven by a squirrel-cage motor. The attendant in charge of the station visits it during a short time each day to inspect the operation of the equipment.

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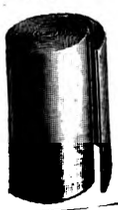

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THE ELECTRICIAN COMMERCIAL AND INDUSTRIAL SUPPLEMENT.

C. & I. Supplement No. 99.] AUGUST 25, 1911. [Gratis to Subscribers.

GAS AND ELECTRICAL HEAT.

We have trodden on so many of the pet corns of the "Journal of Gas Lighting" lately that it has devoted quite a considerable amount of its valuable space to the application of salve to the bruised spots. Our remarks under the head of "Can it be possible"? have caused it an immense amount of merriment, so it tells us, and it has, no doubt, got rid of much perspiration (condensed gas, if it prefers the name) in shaking its sides with laughter. We are delighted; indeed, we had grossly underestimated our esteemed contemporary's sense of humour. Maybe we doubted its existence altogether. But to return to one of the corns. We are now invited to take up the cudgels on behalf of the Berry Construction Co., about whose "Tricity" cookers, at Preston, we ventured (withou tasking the permission of the "Journal of Gas Lighting") to give a few figures. Now figures to our esteemed contemporary are like the winds about the vitals of a gas mantle, they bring on violent tremblings. Meat shrinkage in gas cookers is the cause of the trouble of the figures. The full blown wholesome appearance of a "Tricity" cooked joint is something which the gas people are incapable of understanding. They have not seen it, won't trouble to see it (why should they!), and because it does not appear "scientifically" correct, they say it is impossible and silly. Not content with a wild prancing around the hot plate of discussion, our contemporary endeavours to escape the grilling figures by abusing the author of a testimonial to the "Tricity" cooker. The insinuations are that the testimonial was influenced by the Berry Construction Co., and that Mr. Haynes, the householder in question, was not satisfied with cooking the meat but "cooked" the figures as well. Vulgar personalities were also indulged in at the expense of Mr. Haynes. These tactics are unworthy of our pugilistic contemporary, whom we have never until now had to accuse of hitting below the belt. It must not wonder that the Berry Construction Co. and Mr. Haynes maintain a dignified silence as the best "response" to such attacks. Mr. Berry is by no means "Coy." We advise the "Journal of Gas Lighting" to cultivate its old sporting style and get in, if it can, a few heavy body blows on the "Tricity" cooking proposition. It will not then be necessary for it to turn from the Berry Construction Co. to us for an explanation of the difference between gas and electrical heat.

IFS AND QUERIES.

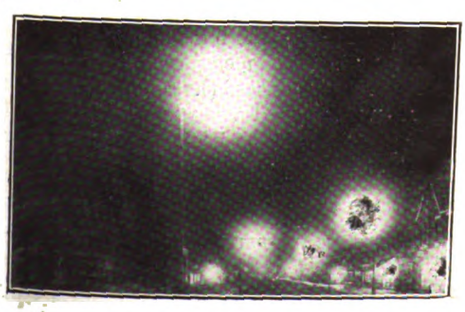
Will the other lamp makers now bring out drawn tungsten wire lamps?

Mr. Steinmetz asks a question:—What is permanent in the permanent magnet, the magnetic flux, or the magneto-motive force, or the flux density, or flux distribution, or the magnetic energy? The answers of disappointed competitors in Siemens' Tantalum poster competition will receive every consideration.

Will the Lea Recorder Co. fit their instruments to each of the bars at Olympia?

Is there any reason to suppose that, if any other lamps but Brimsdown had been used at the Carlton Hotel, the falling of debris in the recent fire would have failed to break them?

Will there be a strike of electrical contractors, and, if so, will the Electrical Engineers' Corps be quartered on their premises to maintain order and keep up the price of metal lamps?



Street illumination at Hanwell by High C.P. "OSRAMS." The lamps are fitted in "Highfield" Patent Fittings and erected on Tramway Poles.

STREET LIGHTING

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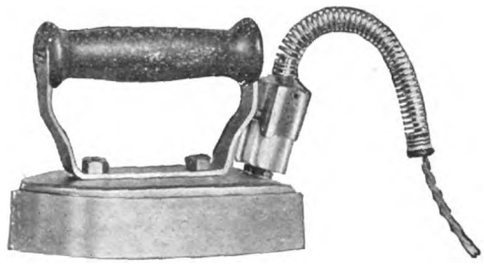
SIEMENS

THE

"SMOOTHWELL"

ELECTRIC IRON



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THE ELECTRICAL CONTRACTOR IN AMERICA.

The relations between the electrical contractor and the central station engineer in this country has been discussed in the technical Press *ad nauseam*. The position of affairs as between the parties has undergone no change despite the amount of ink and paper which has been used with that object in view. If a poll were taken of the electrical contractors in the country, probably half of them would express the utmost indifference as to what the central station engineer did or did not do. The other half would be probably divided into those whose relations with the central station engineer were of the best possible description and those whose were not. The National Electrical Contractors' Association has recently held its annual meeting at Niagara Falls, and it is interesting to turn to views expressed by one of the staff of the New York Edison Co. on the subject of the contractor and the central station. We have often said that the conditions under which a supply of electrical energy is given in the United States differ vastly from those which obtain in this country. There are practically no legal restrictions of any kind, and there appears to be a delightful flexibility about the fixing of rates for various classes of consumer. Probably this is only equalled by the methods which we understand are in vogue among electrical power in bulk supply companies in this country and those municipalities who are sufficiently large to offer inducements to the power consumer. "The Electrical Review and Western Electrician," commenting upon Mr. Williams' Paper, to which we have referred, throws some interesting sidelights on the position of affairs "on the other side." It says: "Very often it is necessary in the carrying out of a campaign, looking to the introduction of current-consuming devices as a necessary adjunct to building up the central station load, that the company must strike a bargain with the customer and prospective consumer." This indicates that the consumer is offered special inducements in the matter of price, to come on the mains. Probably he has a private plant, and only a specially low rate will tempt him to scrap this and depend upon the public service. Over here we have very few opportunities of striking bargains of this kind. Then again our contemporary says: "Where a campaign having for its purpose the introduction of heating devices, electric fans, portable lighting outfits, domestic appliances such as washers or vacuum cleaners, is projected, the contractor stands no chance whatever in the matter of meeting the central station company's price for the apparatus. However, there should be no animus upon the part of the contractor in an incident such as this. While it may deprive him of a small profit which he might make as a merchant, so long as the central station company is not entrusted with the wiring of the premises or the installation of the apparatus, every device that is sold improves the business of the electrical contractor."

This matter of the price of the central station for electrical apparatus being below that of the contractor is one which we have had little occasion to deal with on this side. We understand there have been complaints against some show-rooms in London and the provinces for offering apparatus at list price. Where the station man has been inclined to embark upon a price-cutting campaign the contractor has been able to check him. But the real point of our contemporaries' remark in this connection is that relating to the wiring of the premises and the installation of the apparatus. It seems as if here the American contractor has been able to take a firm stand, and obtained a recognition of his real position in the contracting business. While we do not say that the station man should be able to sell apparatus, at the same time it would be something of a solution of the difficulty between the two parties if the contractor were satisfied to carry out the wiring of the premises and the installation of apparatus, leaving the central station authority to run its own showroom and bring the merits of electricity consuming devices particularly to the notice of the public.

Mr. Williams lays some emphasis upon the position of the big contractor in the United States and the power which he possesses in persuading the user of private plant to abandon this installation and take a supply from the mains. Evidently this class of contractor has firmly established himself in such a position that he can make an important deal on behalf of his client in the matter of obtaining exceptionally low rates for the public service. Another significant remark of Mr. Williams is that, first and foremost, the contractor is entitled to a square deal. He says: "For business reasons, as well as for absolute justice, fair and generous treatment should be accorded. If this is done, in 99 cases out of 100 the contractor will pass on to his customers the impression that they, too, may expect a square deal from the station and the proper adjustment of whatever differences may arise between the company who sends the bills and the consumer who pays them." Here again we get a further interesting sidelight on American practice. Evidently the average consumer is enticed on to the mains by a system of bargaining, and if the contractor gets a square deal from the station he persuades the consumer that he also is likely to get the same. We have advanced a stage beyond this point in the relations between our central stations and their consumers, and we think the cases are few and far between where the station engineer has to cavil with the consumer over the bill. We can imagine the feelings of British central station engineers if we suggested that it would be necessary to placate the contractor and fix up with him what the Americans call a square deal before he (the central station engineer) could be certain of working upon amicable lines with the consumer.

OSRAM-LAMPS

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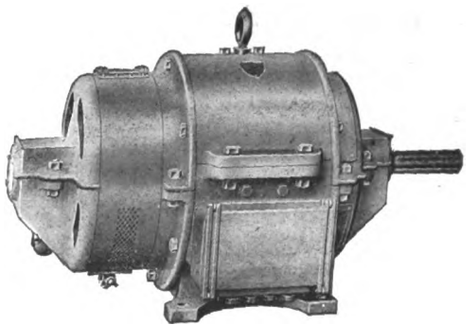
VICKERS MOTORS



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THE ELECTRIC & ORDNANCE ACCESSORIES CO., Ltd.,
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A.E.G. PROGRESS.

We have received copies of the July and August A.E.G. "Journal," and must compliment the company upon the excellent arrangement and high quality of the matter therein. In the July issue there is an interesting article on the new steam turbine shops at Berlin, the lay-out of which is strictly in accordance with modern practice. On the cover of the issue is an illustration of a 12,000 kw. turbo-alternator, which is shown on the test plate at the works, side by side with a turbine-driven boiler feed pump for the same set. It is stated that the new shops are specially suited for the construction of large capacity turbines up to 20,000 kw. units. Interesting details are also given of turbine-driven centrifugal pumps. We may particularly mention one vertical pattern, in which the turbine is direct connected to an air pump and water-extracting pump, the design being specially for marine purposes. Two interesting railway systems are described in the issue, that at Bitterfeld, which is a 10,000-volt one-phase trolley line, and that at Hamburg, which is a direct-current operated elevated line. Of interest to manufacturers, particularly at the approach of the Olympia Exhibition, is the description of the A.E.G. exhibit at Munich, where a special electrical exhibition for domestic appliances and small industries and agriculture was opened under the auspices of the Elektrotechnische Verein.

In the August number the steam turbine article is continued, and an interesting comparison is made between the reciprocating pumps at the Hamburg waterworks and turbo-driven pumps. It is shown that three of the former, of 300 H.P. capacity each, occupy a greater amount of space than two of the latter, one of 900 H.P. and the other of 300 H.P. Views are also shown of the turbo-compressor shop, this being a comparatively new application for steam turbines. The description of the Bitterfeld line is continued, with an account of the locomotives used for the haulage of the passenger trains on this line. Each locomotive is fitted with a 1,000 H.P. alternating-current commutator motor, which is coupled to the two driving axles by a connecting rod at each side of the locomotive. These connecting rods are placed in a vertical plane. The maximum speed of the driving wheels is 400 revs. per min. This type of locomotive has been in use on regular passenger service since the beginning of the year. The August edition is concluded with an interesting account of the A.E.G. plant at the Cedegolo station of the Adamello 72,000-volt power transmission scheme. The equipment includes five 5,000 H.P. Pelton water wheels direct connected to A.E.G. generators, which generate three-phase 42-cycle energy at 9,000 to 12,000 volts. This voltage was decided upon to enable the plant to run in parallel with that at Isola, which is part of the same power scheme, but is some 4 miles distant. The switchgear is also A.E.G. design, and considerable ingenuity has been shown in the lay-out of the 72,000-volt equipment.

TRANSPORTING TRANSFORMERS.

The growth of hydro-electric plants on the Continent and America has given rise to the necessity for transporting completely assembled transformers by rail. Most of these pieces of apparatus reach up to a considerable height, and as they must be shipped in a vertical position it is necessary to place them on some special form of car which will admit of the transformer being kept in an upright position, and also of its passing successfully through tunnels and under bridges. A special type of car has recently been constructed for the American Westinghouse Co., which has a capacity of 75 tons in the well of the car. The type of car adopted is one with bogies at each end and a dropped centre forming a well in which the transformer is placed. The car frame is of heavy steel girder construction, and the bogies are fitted with 36 in. wheels of rolled steel. The total capacity of the car for a weight distributed evenly is

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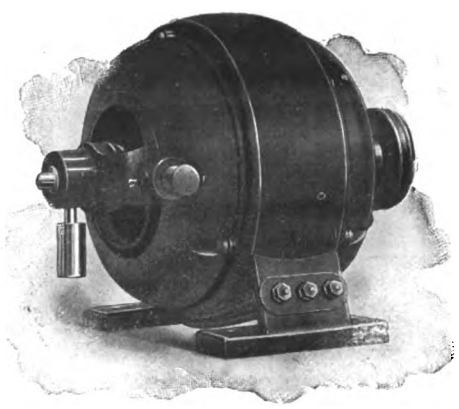

HOGAN & WARDROP,
2, GRESHAM BUILDINGS,
BASINGHALL STREET,
LONDON, E.C.
Telephone - - - 723 LONDON WALL.

205,000 lb. The car is fitted with Westinghouse brakes and Westinghouse friction draught gear. A description of the car published in our American contemporaries includes an illustration of a 2,000 kw. 60-cycle 101,200 volts transformer of the oil insulated tubular self-cooling type, built by the Westinghouse Co. for the Southern Power Co. The top of the transformer when in position on the car was 16 ft. above the level of the rails, the surface of the floor of the well about 2 ft. 2 in. above the tops of the rails.

This is an interesting development and serves to show the extent of the business done in America in hydro-electric plant and apparatus. The particular type of car solves the problem of railway transport, but it would be interesting to know how so large a piece of apparatus is conveyed up country to the actual site of the station. Very often only mule tracks are available, and it is sometimes necessary to lower plant and machinery several hundred feet down the face of a cliff.

TEN YEARS OF THE "JANUS" INTERCOMMUNICATION TELEPHONE.

The "Janus" system of intercommunication telephone for large private offices was invented some 10 years ago by Messrs. Mix & Genest, of Berlin. It differs somewhat from the ordinary intercommunication system, in that in one office instrument may be combined connections both to the other offices in the same building and to the city and trunk systems. Further, a special arrangement enables one person who is speaking to another on the city system to discontinue his conversation for a minute or so without being cut off, and meanwhile to make inquiries from another office in the same building. That is to say, should a client ask for certain information which the person rang up is not able to give, the latter could get into communication with another man in the same office and carry on a perfectly private conversation on his instrument without the outside connection being severed.

The "Janus" telephone is made in the two ordinary types, namely, the wall and table instruments. A number of switches are provided in accordance with the number of instruments on the circuit, and besides there is a black knob which, when pressed, enables the instrument to be directly connected with the central exchange. When this is done a signal in the instrument indicates whether the wire to the exchange is free or not. In the same way, by pressing either of the white knobs a connection can be made to any of the offices in the same building. If one of these white knobs is pressed while a conversation is going on with a subscriber on the main exchange the black knob springs automatically back to its off position, thus cutting the instrument off the subscriber and ensuring privacy of conversation.

In celebration of the successful working of this system of instrument over 10 years, Messrs. Mix & Genest have issued a pamphlet, a copy of which has been sent us. After describing the essential points of the instruments and illustrating the various types made by them, a series of interesting photographs are to be found showing examples of large offices, Government buildings, mines, foundries, swimming baths and other similar places where this system of intercommunication is used. These buildings include the Ministry of Trade and Industry at Berlin, the Palace of Justice in the same city, the Rheinish-Westphalia Bank at Dusseldorf, the new swimming baths at Breslau, and several mines in the coal district. In many of these large offices, of course, a sub-exchange is used. In this case the operation of the system is exactly the same, except that when the black knob is pressed communication is made to the sub-exchange instead of direct to the main exchange. The number is then asked for in the usual way. This does not interfere with the direct intercommunication system between the various rooms in the same office described above.

Messrs. Mix & Genest have also arranged a control set, which can, if necessary, be installed in the manager's office. This instrument consists of the ordinary hand combination mounted on a small desk. On this desk is mounted an ordinary telephone glow lamp and a special control switch. Directly a call to the main exchange occurs the glow lamp lights up. The chief, by pressing the control knob, can then listen in and find out whether the conversation is being conducted for purely business purposes or not.

THE MERITS OF CO-OPERATION.

Among the various electrical interests in this country there is probably the minimum amount of co-operation. By this we mean the desire to meet and discuss questions which affect the industry as a whole. We have the Institution and various Associations, each of which has been formed with the idea of obtaining the advantages which only concerted effort can procure in any business. Up to the present the history of these combinations does not furnish enough evidence to show that their existence is altogether justified. Co-operation would, of course, be particularly welcome among the manufacturers. This section of the industry may be regarded as the basis from which all else springs, and it should present a degree of solidity to act as a firm foundation for the rest of the structure. We are apt to compare the position of the electrical industry in this country with that which obtains on the Continent and in America. The comparison is in no way just or reasonable. Our geographical position and configuration and our markets and conditions of labour necessitate that our case should be considered entirely on its own merits.

We cannot look to the Institution of Electrical Engineers for measures which will place the manufacturing element upon an organised footing. We do not refer to the individual management of the various manufacturing concerns. That is a matter which must always remain independent of outside influences.

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PREPARE FOR THE APPROACHING LIGHTING SEASON by ordering a supply of "POPE" METAL LAMPS NOW.

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J.C.P.

There is enough evidence to show that all the recognised manufacturing firms in this country conduct their establishments upon modern lines; in fact, this must be so, otherwise they would not be in the position in which they are to-day.

Turning to the various associations which have been formed to concentrate attention upon the requirements of individuals or firms there is a lack of cohesion and an absence of directive effort which can only strike the observer as remarkable. Valuable years have been allowed to elapse, and the associations have done little more than pull themselves together as such. There have been no attempts at co-operation between the parties, because the objects of the respective associations have been considered to be in every way divergent. This is all the more deplorable because if we have anything to learn from Continental and American experience it is in the direction of concentrated effort on the part of manufacture and the interests, industrial, commercial and domestic, which spring from it. Concentration has built up the United States and Germany.

While we keep in mind, as we have already said, the peculiarity of the conditions which govern industry in this country, we feel that the actual example of concentration and concerted effort should be followed in our own case. There are innumerable ways in which concerted action of the electrical manufacturers in this country should result in expansion of every branch of the industry. The railways are not yet electrified, and will continue under steam conditions until a sufficient weight of evidence, which can only come by co-operation, has been brought to bear upon the railway companies. The suburban traffic problems of most of our large cities can be solved by electric traction, and here again the disjointed efforts of a few manufacturers are inadequate to bear down the prejudice which it is necessary to remove before definite steps can be taken. There is the gigantic gas industry in the country which needs to be vigorously fought for some years until it has been forced to take up its legitimate position as a supplier of gas for heating purposes. There are vast fields of industry in which electric power is as yet unknown. There are openings for uses of electrical energy in agriculture. Most of these matters require action on the part of a representative body which can assist toward the desired end by legislation and by the publication of literature which will further the efforts of manufacturers themselves.

It seems extraordinary in an industry in which the concentration of power plant is advocated and practiced, that there should be so little concentration and effort among the interests which go to make up this industry. A score of years ago a dozen manufacturers built a dozen different small dynamos. To-day the dozen dynamos are rolled into one, but the number of manufacturers has not decreased. Surely the coming generation of electrical engineers will see to it that there is some change made in this state of affairs. Mr. Ferranti has pointed the way. Is it not time that we set out on the road?

A BUYER'S CATECHISM.

Some months ago we published a salesman's creed, and we have now been supplied with a copy of a buyer's catechism. This is being issued by the Silent Electric Clock Co., who are anxious to catechise would-be purchasers on the lines of the publication referred to. Each of the questions is answered in the printed catechism, and we understand that if our readers would care to ply the company with further questions they will receive satisfactory answers through the post. The catechism is a novel form of advertisement, and a copy will be forwarded on request. The company's address is 192, Goswell-road, London, E.C.

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(See larger Advt. last week.)

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The "UNITYPE" INDICATOR

NEW, PRACTICAL, INEXPENSIVE.

Each movement a complete unit. Contained in black metal case. Can be mounted in any number of designs.

Price 1/6 each.

THE STERLING TELEPHONE AND ELECTRIC CO., LTD., 200, UPPER THAMES STREET, LONDON, E.C.

Write for New List No. . . 177.

THE RUPING PROCESS OF CREOSOTING.

The creosoting of telegraph and electric light and power transmission poles has been practised with fair success for a considerable number of years. It has been found, however, that the weakest point in any creosoted pole is that immediately above the ground level. It is at this point that the moisture, air and warmth which are necessary to the formation of fungus are to be found. The result is that after a certain period the pole shows signs of eating away. Hitherto it has been impossible to prevent this attack upon the pole at this weakest point, as the ordinary process of creosoting does not afford immunity from trouble. We are informed by Messrs. Richard Wade, Sons & Co., Ltd., Hull, that the greater part of the troubles with poles is due to the above-mentioned cause and that they have taken steps to introduce into their business the Ruping process of creosoting by which the actual walls of the cells which go to make up the timber are saturated with the preserving fluid. The aim of the inventors of this system has been to protect the substance of the timber without wasting the preservative. In the ordinary red fir-tree, which is mostly used in this country for poles, there is about 40 per cent. of what is known as heart wood, which cannot be impregnated to any appreciable extent because the cells become closed. The balance of the tree is made up of sap wood, which is open cellular tissue. This is comprised of the substance or fibre of the tree and a number of open spaces, in the proportions of about half each. It is the fibrous portion of this part of the tree that is specially treated by the Ruping process, which at the same time leaves no preservative in the interior of the cells. We understand that a considerable amount of research work has been carried on in connection with this process, and these investigations have shown the fallacy of supposing the decay of the wood has been caused by something in the tree itself. The wood is actually attacked from the outside, and not from the inside. We understand that in the Ruping process no new substances such as antiseptics or germicides are introduced. It really constitutes a new method of introducing ordinary creosote into the wood. It was at one time supposed that the creosoting of timber by the ordinary method prevented the absorption of moisture by the wood, and that for this reason it was impossible for decay to take place. Messrs. Wade point out that a number of tests were made a few years ago by certain English railway companies which satisfactorily disposed of this fallacy. A number of telegraph poles were weighed wet out of water and again when dry, and a third time after creosoting. Subsequently they were weighed at intervals, and it was found that the creosote did not prevent the entrance of moisture. There is also a tendency for the creosote to drain out of the poles when they are placed in a vertical position. Experiments have been made which show that the loss of creosote will amount to from 7¼ to 9½ lb per cubic foot over comparatively short periods. The Ruping process has been introduced to prevent this. It is claimed for it that there is a thorough saturation of all parts of the timber which can be saturated by the preservative, that there is an absorption of only so much liquid as is necessary to accomplish this, that oozing and sweating of the wood is completely prevented, the timber being dry and clean, and that there is a great saving in cost without reducing the life of the timber. The process has been extensively employed on the Continent and in America, where upwards of the equivalent of 38,900,000 sleepers 9 ft. by 10 in. by 5 in. have been put down. Messrs. Wade have taken up the process on behalf of Great Britain and the English speaking Colonies, and we understand that they will be shortly making a demonstration at their works of the process. The company is to be complimented upon its enterprise in taking up this process, because it will enable it to get rid of one of the most serious troubles with telegraph, telephone, and transmission line poles.

General View in Richard Wade, Sons & Co.'s Pole Yard at Hull.

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Contains no Iron.
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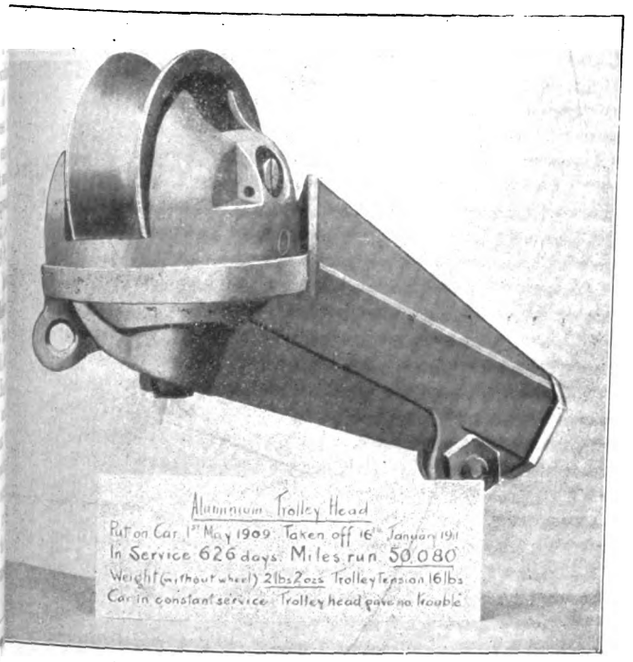
ALUMINIUM TROLLEY HEADS.

The use of aluminium on the Continent for bow collectors on tramways is now quite general. The trolley wheel is the exception rather than the rule. The durability of aluminium has been practically demonstrated on the modern bow collector, and the satisfactory results obtained point to the special utility of this material for this purpose. In this country we have pinned our faith to the trolley wheel, and although the bow collector would be very much quieter there seems to be no possibility of changing over to it. Aluminium may, however, be used in the trolley head. It has been found exceptionally valuable as a support for the trolley wheel at the business end of the trolley pole. It is extremely light and at the same time is sufficiently tough to stand up to the hard wear which is imposed upon a fitment of this character. We illustrate a pattern of trolley head made by the British Aluminium Co. and supplied to a large number of tramways. This particular pattern has been in service over a period of nearly two years, and during this time had run 50,080 miles. The car was actually in service 626 days. The weight of this particular pattern of trolley head without the wheel is 2 lb. 2 oz. The trolley tension is 16 lb. We understand that this trolley head gave no trouble at any time. The use of a lighter metal for trolley-heads together with a lower spring pressure will naturally have a beneficial effect upon the overhead work. The metal used is one of the standard light alloys of the British Aluminium Co., having a specific gravity of only 3·10. There is thus a saving of about 60 per cent. on the weight of gunmetal or phosphor-bronze. When the hammer-like action of the trolley on the wire is considered, together with the accompanying heavy maintenance expenses, a reduction of from 3 lb. to 4 lb. in the weight of the trolley-head will appear as a potent advantage. The low-tension on the trolley boom may be relaxed in proportion, whilst maintaining good contact between the trolley wheel and the wire. The trolley head illustrated was made by Messrs. Brecknell, Munro & Rogers.



VIEW OF ALUMINIUM TROLLEY HEAD.

EXCELLO
FLAME ARC WITH UNIQUE
TWO YEARS' WARRANTY

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LIBERAL DESIGN.

TOTALLY ENCLOSED.

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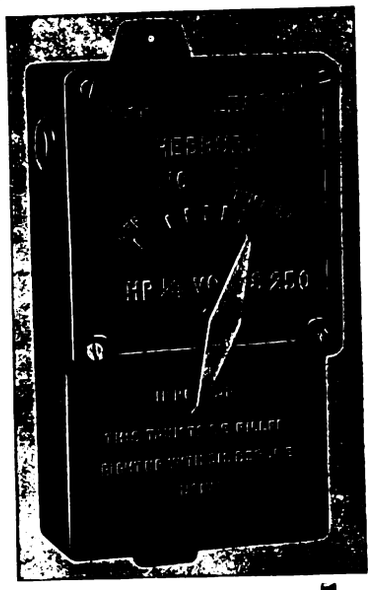
MAGNETIC BLOWOUT ON ALL STEPS.

LOW PRICES.

Sizes up to 2 H.P.



These Starters have been designed to meet the demand for cheap but well-made apparatus for use in connection with small motors.

Pamphlet No. 93 gives full particulars.

A. REYROLLE & Co., Ltd.,

HEBBURN-ON-TYNE, ENGLAND.

TRADE MARK

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PERMANENT MAGNETS.

W. F. DENNIS & Co.,

49, QUEEN VICTORIA STREET,

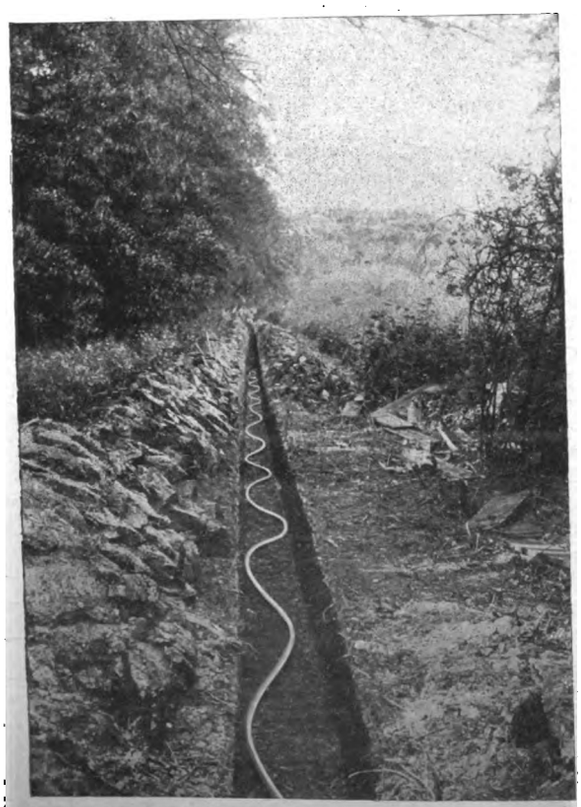
LONDON, E.C.

TELEPHONE-BANK 343.

TELEGRAMS-FREDENNIS, LONDON.

FROM GLOVER'S CALENDAR.

CABLE LAYING IN TREACHEROUS GROUND.



IF ONLY ALL ELECTRIC LIGHT AND POWER CABLES COULD BE LAID LIKE THIS WHAT DIVIDENDS THE C.M.A. MEMBERS WOULD PAY?

MERCURY VAPOUR LAMPS.

The lighting season is upon us and the lamp makers are getting busy with their trade literature. The Westinghouse Cooper-Hewitt Co. is issuing a number of lists which describe the Westinghouse silica lamp for d.c. and a.c. circuits and illustrate a number of interesting installations which have been carried out. The mercury vapour lamps for a.c. circuits are arranged to burn in series in circuit with a mercury vapour converter. This is a simple piece of apparatus and requires no attention. It is self-contained with the switchgear for the turning on and off of the lamps. The lamps are supplied for one-phase circuits 40 to 60 periods. The voltage on the d.c. side is 35. The converter is included in the price of the lamp. The energy consumption is stated to be 0·33 watts per candle, or a total consumption, including that of the converter, of 175 watts per lamp. These figures show a greater economy than arc lamps or metal lamp clusters. A fitting known as the Saturn type is also described in which there is a large central globe containing the lamp, and metal lamps which are hung at equal distant points round the equator. These lamps supply the necessary red rays which are, of course, eliminated from the light of the silica lamp. These lamps light up as soon as the switch is turned on, and the silica lamp is tilted by hand for lighting purposes. We published a description of this silica lamp in our issue for September 23, 1910.

The company are also offering what they term a light transforming reflector for use with their lamps. The principle of this is based on the phenomenon of fluorescence, a portion of the primary illumination being actually transformed and the reflector acting as an auxiliary luminous source. We understand there is no appreciable loss in luminous intensity. It is stated that with this reflector an agreeable white light is produced, having a slight rosy tint.

Printed and Published by GEORGE TUCKER, at the Editorial, Printing and Publishing Offices, 1, 2 and 3, SALISBURY COURT, FLEET STREET, in the City of LONDON FRIDAY, August 25, 1911.

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THE ELECTRICIAN COMMERCIAL AND INDUSTRIAL SUPPLEMENT.

C. & I. Supplement No. 100.] SEPTEMBER 1, 1911. [Gratis to Subscribers.

AMERICAN ADVERTISING METHODS.

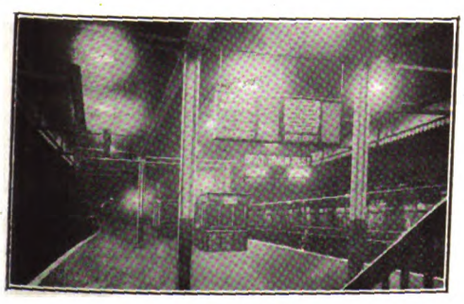
"Two hundred and fifty thousand bulletins in six days, siree! That's what I call publicity, and, geewhizz, arn't we just busy in our department!" And with all our persuasive eloquence we could not convince our "hot air" Yankee that it's none of it any good for the British market. There must have been tens of thousands of pounds spent in this country on attempts to sell every conceivable kind of article by American advertising. It's a pity that those who have wrecked their own publicity ship on this attractive but rocky coast have done nothing to erect a lighthouse, warning others of the danger. But if a firm has quietly lowered 50 or 60 "thou" over the side it does not want to sing about it. The "other" man may do the same for all it cares; he's a rival and his money "don't count."

In the electrical industry up till quite recently most of the money allocated to advertising has been devoted to technical and trade papers. There has not been any need to appeal directly to the public through posters and the lay newspapers. The "popular electricity" idea, however, is changing the policy of many electrical supply houses who have planned or are already planning campaigns for circularising and newspaper advertising for such things as metal lamps, vacuum cleaners, electric irons, kettles, &c. These electricity consuming devices are deserving of attention at the hands of the public, and are likely to interest them in a mild kind of way, at any rate at present. A note of warning may, therefore, we think be sounded at this juncture to those manufacturers who have a leaning towards American advertising methods.

In the first place it must be remembered that the householder and tradesman are already pestered with literature which is delivered either through the post or by hand. They are used to it, and recognise it as soon as they see it. "Another of those confounded ——— lamp things. Oh, give it to Willie to play with." Even this treatment may be regarded as exceptional, the more usual fate for the appealing document being the W.P.B., unopened. So far as we can see there is no need for the electrical manufacturer to ply the consumer direct in this way with arguments in favour of his line. If he persists in adopting this policy he is overlooking those more efficient distributing agencies—the Publicity Committee, the electrical contractor, the ironmonger and the central station engineer. They will handle his stuff more readily, too, provided that the style of the literature is not of the American "tub-thumping" order.

We are not inveighing against circulars, bulletins, leaflets, &c., as such. They are most useful reminders when sent with accounts or wrapped in parcels or handed out at Exhibitions. But they are unwelcome to the average Britisher when shot at him from the short range of his breakfast table. The electrical supply house must have this in mind unless it is anxious to throw its good money after bad.

Much the same may be said of electrical poster advertising and display announcements. That strong sense of exaggeration which is so dear to the American heart must be rigorously excluded from the policy of the publicity manager who is voicing an appeal for electrical goods. Let it be remembered that we Britishers have made our advertising what it is—dignified, artistic, attractive. That is the verdict of globe trotters who have had opportunities of comparison. There may be a little to learn from American advertising, but we think it requires the most careful application to electrical publicity. Home methods are best.



Mansion House Station (Underground Rly.) London illuminated by "OSRAM" Lamps.

RAILWAY LIGHTING

BY

OSRAM

LAMPS.

The General Electric Co., Ltd., Head Office: 67, Queen Victoria St., London, E.C.

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SIEMENS

TABLE AND BRACKET

FANS

CONTINUOUS AND

ALTERNATING CURRENT

ALL VOLTAGES

For particulars, write to our Supplies Dept.

SIEMENS BROTHERS DYNAMO WORKS LIMITED.
HEAD OFFICE: CAXTON HOUSE, WESTMINSTER, S.W.
Telephone: GERRARD 960. Telegrams: "SIEMBRALOS, LONDON."
Supplies Dept.: 39, UPPER THAMES STREET, E.C.
Telephone: LONDON WALL 8270. Telegrams: "SIEMOTOR, LONDON."
BRANCHES:

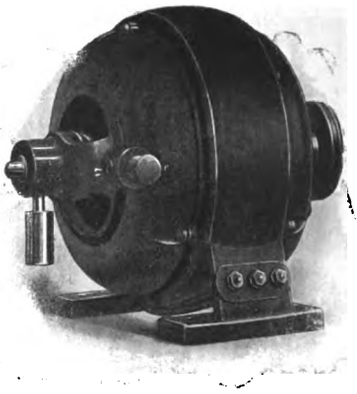
BIRMINGHAM	GLASGOW	SHEFFIELD	CALCUTTA	SINGAPORE	SYDNEY
BRISTOL	MANCHESTER	JOHANNESBURG	BOMBAY	PENANG	MELBOURNE
CARDIFF	NEWCASTLE	CAPE TOWN	MADRAS	RANGOON	TORONTO

E.M.I. FANS

and

Small Motors

A.C. & D.C. All Sizes. All Voltages.



HOGAN & WARDROP,
2, GRESHAM BUILDINGS,
BASINGHALL STREET,
LONDON, E.C.
Telephone - - - 723 LONDON WALL.

CONNOLLY'S ENAMEL INSULATION.

For many years attempts were made to coat a bare wire with a thin covering of enamel which would have a high insulation resistance, be capable of resisting chemical action and mechanical damage, and show no signs of deterioration under the action of moisture. Some years ago Messrs. Connolly Bros. introduced an enamelled wire which they offered to the electrical trade for bell wire circuits, for winding solenoids for instruments, circuit breakers, small field coils, &c. The company has obtained an exceptional degree of success with this insulation, and they have now issued an interesting booklet which is one of the best publications on the subject of enamelled wire that we have yet seen. The entire situation from the initial experiments to the present position of the development of the material is reviewed in detail. We would strongly recommend electrical contractors and electrical manufacturers to make a study of this interesting publication.

On the ground of chemical tests the enamel-coated wire has been tested with a number of solvents without showing any signs of their influence. Among these solvents we may mention a 4 per cent. caustic soda solution in which the wire was boiled for several hours, a 10 hours' immersion in a 10 per cent. ammonia solution, 2 hours' boiling in a saturated salt solution, an hour's immersion in equal parts of alcohol and acetone, a 20 hours' immersion in a warm saturated solution of bisulphate of soda, and 5 hours' cold immersed in a solution made up of equal parts of absolute alcohol and 30 per cent. solution of caustic potash. These are some of the most interesting tests described in the booklet. The insulation resistance of the material has been severely tried from time to time. A single layer of No. 20 wire was wound on an iron spindle 1½ in. diameter and 1½ in. long, and test pressures were applied varying from 150 volts to 2,000 volts alternating current on the three grades of insulation manufactured.

Numerous tests were also made to ascertain the flexibility of the enamel. The enamel-covered wires are quite suitable for winding coils of the smallest diameter without fear of removing or cracking the enamel. It has been found that the enamel breaks with great reluctance and not in the way that a brittle or metal substance breaks. It is recommended that the enamelled wire should not be bent round a cylinder less than four times its own diameter. Amongst the uses to which the makers recommend that the wires should be put we may mention arc lamp coils, electric bell indicators, telephone receivers, induction coils, solenoid switches, air-cooled transformer windings, dynamo and motor field coils, armature coils, telephone central station connections, electric bell and telephone line wires. With the experience gained since the introduction of the wire the manufacturers state that they now have no hesitation in recommending their class C type of enamel insulation for electric light circuits up to 220 volts. This is an interesting development and one which central station engineers and contractors should take special note of. We understand that the Bradford Corporation has approved of the use of this class of wire for drawing into conduits. Messrs. Connolly Bros. inform us that they will be pleased to forward copies of this interesting list, together with samples of enamelled wire, to interested inquirers.

G.C. RAILWAY ELECTRIC SIGN.

With its customary enterprise in giving publicity to its service the Great Central Railway have just erected an electric sign of rather novel construction and design. It runs the

OSRAM-LAMPS

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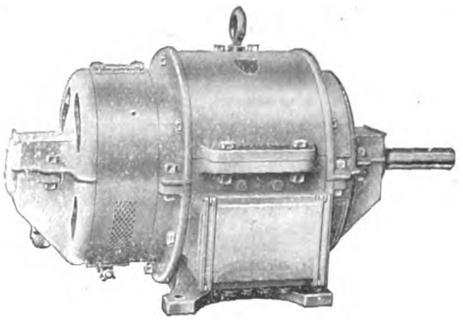
VICKERS MOTORS



FOR ALL PURPOSES.

Their rigid and substantial construction enables them to withstand the most severe usage and give a continuous and uninterrupted service without help from the repair shop or any undue heating.

Send for Lists.

THE ELECTRIC & ORDNANCE ACCESSORIES CO., Ltd.,
Proprietors : Vickers Limited.
ASTON, BIRMINGHAM.

entire length of a 50 ft. wall, directing the traffic coming both ways along the Marylebone-road down to the Great Central station. The wall has been built up to suit the sign. The sign itself is of the standard construction which Messrs. O. C. Hawkes have adopted in all their railway work. It is built up of massive channel iron frames with T-iron divisions and sheet-steel sides. The main features of the sign are the colouring and its size; we believe it to be the longest sign of its kind in this kingdom.

THE G.C.R. SIGN BY NIGHT AND DAY.

In the design and manufacture of this class of glass faced sign it is a difficult thing to achieve novelty. In this case the size of the sign has rendered it possible for the manufacturers to create a novel effect by mounting each letter alternately on a different ground colour. We do not know whether the prevailing aim for Coronation effects has had any influence in the matter, but the letters are white, while the groundwork is alternately red and blue. The letter is of ornate design, being lined with gold and shaded black, which gives a distinctive appearance to the sign by day as well as by night.

In construction the heavy angle-iron frames, dovetailed and brazed at the corners, and the T and channel-iron divisions and bracing pieces are made in such a fashion that, given proper painting at due intervals, the sign is practically everlasting. The glass work is also limited to natural colours, and the work on them is permanently engraved, so, beyond the accident of breakage, they cannot be injured in any way. The internal wiring, as in all Hawkes standard signs, is done with 2,300-megohm Association cable, and porcelain non-corrodible holders are used, features which should reduce the maintenance charges to a minimum.

The Great Central Railway in their adoption of alternate colouring of the letters of their signs have in view what we think should be the aim of every sign buyer—a distinctive appearance for the sign—an appearance which immediately suggests to the observer the Great Central Railway before the wording is actually read.

We are indebted to the Publicity Department of the Great Central Railway Co. for photographs of the sign, and to Messrs. O. C. Hawkes for general details of its construction.

The ALUMINIUM CASTINGS Co., Ltd.,
GREENOCK.
ALUMINIUM CASTINGS OF ALL KINDS
MACHINE MOULDED. FINE FINISH.

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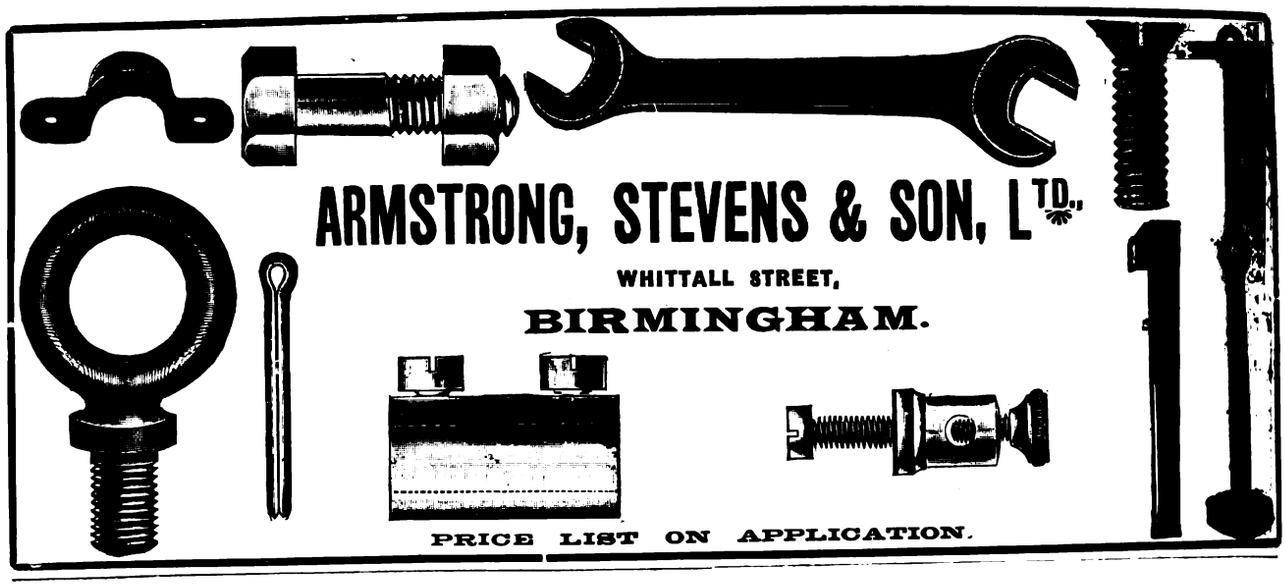


"GRAPHIC" INSTRUMENTS.

Confusion often arises between a "watt hour meter" and a "recording wattmeter" (owing to the latter expression being loosely applied to both instruments). Everett, Edgcumbe & Co. have accordingly decided as far as possible to abandon the term "recording," and to speak of a "graphic" ammeter, wattmeter, &c. By this means it is felt that all possible confusion will be obviated, and it is hoped that this example will be followed by those responsible for the drafting of specifications and the placing of orders.

The new instruments which this firm are making include voltmeters and ammeters for continuous and alternating currents, wattmeters for continuous single-phase and polyphase circuits whether balanced or unbalanced, speed and frequency indicators, pyrometers, pressure and vacuum gauges, and, in fact, for any and every purpose for which a graphic record may be required.

Fig. 1 shows the general appearance of a graphic voltmeter. The exceptionally large glass window will be noticed through which a long length of record can be clearly seen, and also the special spring fastening which affords a dust-tight joint and yet can be opened with one hand. A padlock, or seal, can be employed, if thought desirable. Fig. 2 shows the internal appearance of a moving coil graphic ammeter. Covering the permanent magnet, and shielding it from stray magnetic fields, is a detachable hood, which is seen as a shadow in the figure. A roll of chart is inserted between spring centres above the clock and passes down under two springs and a toothed guide wheel in the centre. Under this latter lies the driving wheel of the clock mechanism. The arrangement is such that the

Fig. 1.—Outside View of Graphic Voltmeter.

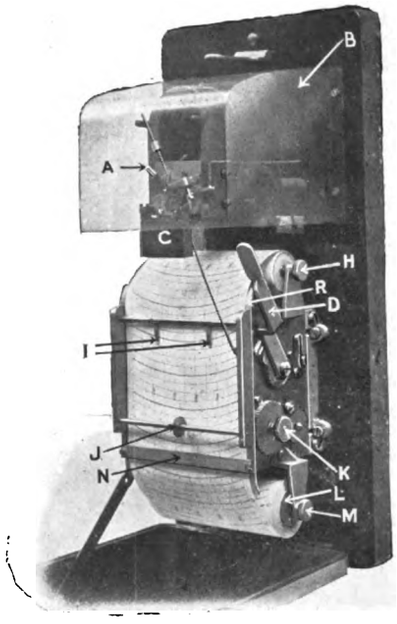


Fig. 2.—Interior View of Graphic Ammeter.

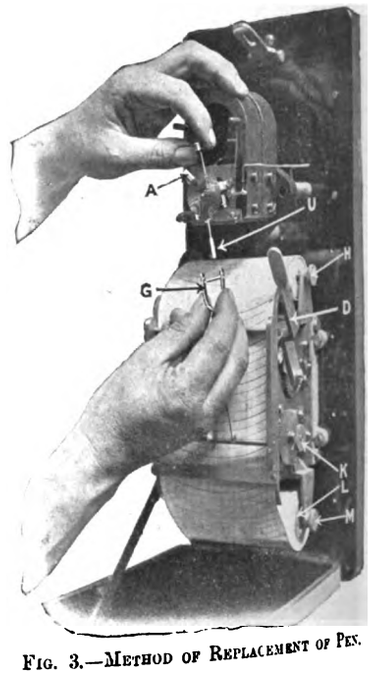
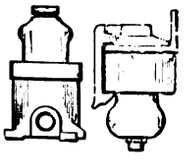


Fig. 3.—Method of Replacement of Pen.

REYROLLE WALL PLUGS
For Portable Machines, Lights, &c.
Pamphlets 114, 122, 88 and 45 give all particulars
WORKS—
HEBBURN-ON-TYNE, ENGLAND.



SIMPLEX CONDUITS LD.,
Garrison Lane, BIRMINGHAM.
Manufacturers of—
CONDUITS, CABLES, ACCESSORIES, FITTINGS, MOTORS, ELECTRIC HEATING AND COOKING MATERIAL, &c.

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Western-Electric TELEPHONES.

WORKS: NORTH WOOLWICH

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ELECTRICAL, MECHANICAL & GENERAL ENGINEERING TEXT BOOKS & TECHNICAL WORKS.

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SUBSCRIPTION, Town or Country, from ONE GUINEA. READING ROOM open Daily to SUBSCRIBERS.

136, GOWER St., & 24, Gower Place, LONDON, W.C.

chart cannot possibly slip, and the guiding is so accurate that all tendency to creep to one side or the other is avoided.

Below the clock is a roller on which the chart can be made to wind itself up, if required. On the right hand side is the winding lever which, owing to the construction of the case, is quite accessible. Below this lever are the change wheels whereby any desired paper speed can be provided. Any subsequent change in the chart speed can be carried out in a few moments, and without returning the recorder to the factory. Further, by means of a simple gear-changing device, two or more speeds can be provided on a single instrument, so that the same recorder can be used for widely different purposes. For example, a speed of 1 inch per hour can be provided for ordinary work, and this can instantly be altered to, say, 1 inch per minute for use in connection with machine tool driving.

A special feature is made of a hinged pen arm which can be at once removed for cleaning or replacement. The simplicity of the operation is well shown in Fig. 3, which indicates the method of removing it by merely pressing together the two arms of the spring fork between the finger and thumb. Amongst the advantages claimed for this construction of pen are, besides ease of removal, a constant and readily adjustable pressure on the paper, and the maintenance of a high insulation resistance between the current-carrying parts and the pen, which last is a most important point, particularly in connection with traction and other earthed systems. The chart over which the pen moves is perfectly flat. The pen itself takes different forms according to the purpose for which it is to be used—that is, according to whether the paper speed is high or low and the load a steady or variable one, and so forth. Again, the damping, which is provided by means of an oil bath, is adjustable so that any required degree of dead-beatness can be obtained. Special care has been devoted to the construction of the clock, so as to provide ample driving forces and to enable it to withstand the rough treatment so often meted out to a "graphic" instrument.

RIVAL LAMP MAKERS AT CRICKET.

We understand that for the third year in succession the Tantalum Cricket Club has met the eleven of the Imperial Lamp Works, and has come off with a third signal victory. The "Brimsdownites" batted first and knocked up 30 runs. This effort was responded to by 128 scored by the "Tantalites," who even then had five wickets in hand. It is pleasant to record these friendly rivalries between concerns which meet in the sterner fields of commerce. The secretaries of both clubs wish us to specially note that the meeting of the rivals is intended to be in no way a test of the merits of their respective works products. Doubtless the "Tantalites" wore the "Satisfied Consumer" expression during the match, and the "Brimsdownites" were given an opportunity of "Seeing things in a better light."

AN INDUCTION MOTOR CONTROLLER.

The type of reversing controller for induction motors mostly used in colliery and similar work is that in which a revolving contact drum is employed. A new type of contactor controller has been designed to obviate contacts rubbing on a slowly moving drum for the make and break, and in order to ensure that the maintenance shall be extremely low under all conditions of service. The maintenance cost of the drum controller has been found to be considerable. Small replacements, however trivial in cost, always cause inconvenience and expense. A controller which will avoid any excessive wear on contacts and give a positive action should appeal to power users. The contactor system, which gives quick break and make and maintains the surfaces smooth and clean with a minimum of surface wear, has been adopted in the new controller to which we are about to refer.

The method of making contact will be seen from the diagram, which shows that there is a fixed frame on which is carried the spindles A1, which extend almost the entire height of the controller. Pivoted on each of these spindles are movable arms, A2, to which are fixed contacts, A3, each spindle carrying the number of arms with contacts corresponding with the steps of the rotor resistance, of which there are usually nine, with one-step full resistance. These arms, A2, have a rotating movement on the spindle and also a small lateral movement, the combination of these movements ensuring that the contact pieces shall approach one another (when making circuit) at such an angle as to ensure a good wiping contact. Corresponding with and registering horizontally to these contacts, A3, are the same number of fixed contact pieces, B1, mounted on vertical standards, B, but insulated therefrom by mica. Each of the movable contact pieces A3 is held extended to the left by means of a spring, the spring movement being limited by blocks, A5. This addition ensures that in each case when contact is made between the two contact pieces A3 and B1, any wear or unevenness of alignment will not cause sparking as in the closed position, and perfect contact is made against the full compression of this spring. A main operating pillar, C, is actuated by the controller handle and carries a number of cams, each cam engaging with one of the movable cradles A4, on which are pivoted the movable contact arms A2.

The first operation of the handle moves a cam which closes the stator circuits. At this point the motor is connected

EXCELLO
FLAME ARC WITH UNIQUE
TWO YEARS' WARRANTY

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The "UNITYPE" INDICATOR

NEW, PRACTICAL, INEXPENSIVE.

Each movement a complete unit. Contained in black metal case. Can be mounted in any number of designs.

Price 1/6 each.

THE STERLING TELEPHONE AND ELECTRIC CO., LTD., 200, UPPER THAMES STREET, LONDON, E.C.

Write for New List No. . . 177.

to the line and with all resistance in. The next and following notches actuate the movable contacts in turn, moving them forward through the necessary path to make contact with the fixed contact pieces. An automatic device is fitted to the handle which prevents the operator from moving forward more than one notch at a time. The time allowed between the notches permits the motor to accelerate the requisite amount before it is possible to pass to the next notch. To stop the motor the controller handle can be brought rapidly to the "off" position, the whole of the speeding-up action being reversed, and the stator connection broken last.

For starting up the motor in the opposite direction a handle is brought into operation, the movement of which raises or lowers the reversing drum so that the stator connections are reversed. The reversing handle is locked in position by the first movement of the controller handle. Also the controller handle is locked by the reversing handle in any intermediate position of the latter. Most users of controllers for large induction motors have found that the removal of the contact drum for examination has been exceedingly troublesome. The contacts usually have to be lifted for examination by means of a derrick or other means, and when so raised are at a very inconvenient height for effecting repairs. In this new type of controller the casing of the controller moves vertically up and down in guides, giving complete access to the contacts.

The weight of this casing, including the oil, is taken by a counterweight. All current-carrying parts are immersed in oil, and the lowering of the controller case which contains the oil leaves all the contacts exposed and at a convenient height for inspection or repair. These controllers are usually supplied with 10 positions in either direction, and although this number is rather less than is usually considered necessary in a drum type of controller, a much smoother acceleration is obtained than is possible with the older type.

These controllers can be supplied in two forms, A and B, respectively, for three and two-phase wound rotors. Both can be used for either balanced or unbalanced regulation.

The controller is small compared with the older forms in use. It is of the vertical type and the average dimensions are 5 ft. high by 2 ft. 7 in. wide. The operating handle is at the top as in the tramway type of controller, and the reversing handle is on the right-hand side.

All current-carrying parts are mounted in the tank and are oil immersed. All insulation is mica, no other composite substances or wood being used. In addition, all similar parts of the controller are interchangeable. These controllers are said to be easier to operate than the ordinary drum type. It often happens that the operator is signalled to stop instantly, and then—the next moment—he has to reverse and re-start. This may occur several times at short intervals, as in the case of a derailment at some joint in a haulage-way. Ease of operation as well as a definite indication of the direction of travel are, under such circumstances, very important features. The controller has a wide number of applications for industrial power purposes, and its introduction should be followed closely by electric power engineers and contractors.

This interesting controller is made by Messrs. Dick, Kerr & Co. of Preston and London, and they will be pleased to forward additional particulars on request.

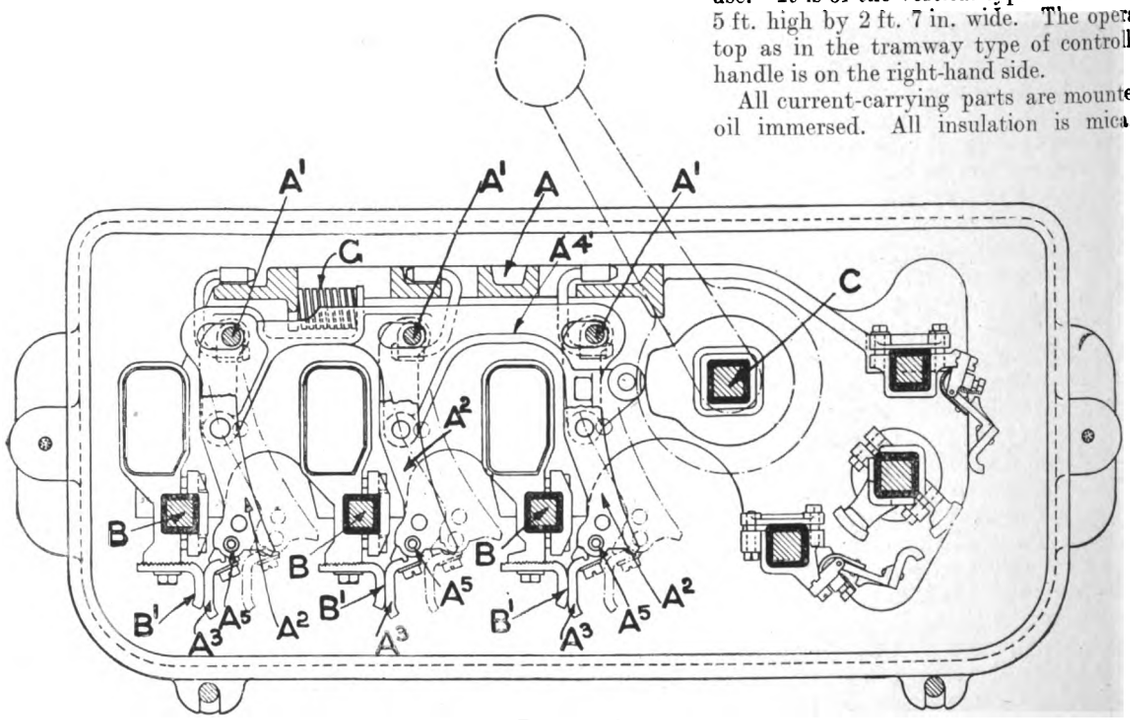

Diagram Plan of Controller.

H. WEIDMANN, RAPPERSWIL, SWITZERLAND.

Maker of PRESSPAHN AND INSULATING MATERIAL.

Specialist in the Manufacture of

PRESSPAHN—Pressboard.

BEST QUALITY. PROVED BY REPEATED TESTS.

Sheets in thickness from 0·1 upwards. Endless Rolls and Strips from 0·1 to 1 mm. thickness.

BLACK PRESSPAHN IF SPECIALLY ORDERED.

Presspahn Coils and Tubes for Transformers, Armatures, Discs and Shaped Articles.

Varnished Presspahn. Mica-Covered Presspahn, &c.

Printed and Published by GEORGE TUCKER, at the Editorial, Printing and Publishing Offices, 1, 2 and 3, SALISBURY COURT, FLEET STREET, in the City of LONDON, FRIDAY, SEPTEMBER 1, 1911.

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THE ELECTRICIAN COMMERCIAL AND INDUSTRIAL SUPPLEMENT.

C. & I. Supplement No. 101.] SEPTEMBER 8, 1911. [Gratis to Subscribers.

ELECTRICAL PUBLICITY AND THE ARTIST.

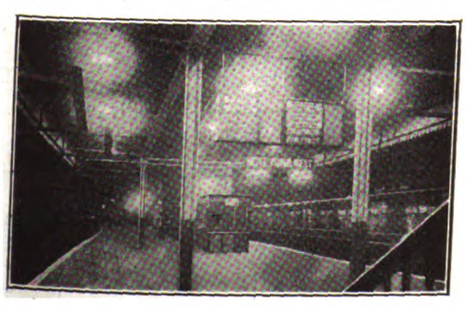
Ever since Messrs. Pears succeeded in obtaining an advertisement picture from one of the world's greatest painters, the manufacturer who has any public appeal to make has endeavoured to go one better than "Bubbles." From this celebrated beginning—and an effort which has never been surpassed—there arose the idea of commissions to well-known artists to execute designs which should voice the manufacturers' appeal to the public in the most attractive and least offensive form. The "Bubbles" stage in the progress of the artist into advertising was passed through some years ago and the "funny" or "Hassal" stage entered upon. Hassal, who is a sufficiently eminent artist to make a name outside advertising, ushered in the idea of the humorous poster and for some years contributed quite the best of the displays made on the public hoardings. The net result of these two developments in advertising has been the creation of a fashion or craze among manufacturers and publicity men for some *chef d'œuvre* of a well-known brushman for use as a piece of advertising matter. This craze has found its way into the electrical world, and we are bound to say with but indifferent results.

The failure of the famous artist to make good in electrical advertising may be attributed to two causes. Probably the first is the difficulty of obtaining an enormous fee for a really good piece of work, and the second may be the failure of the artist to produce a satisfactory result owing to the essential peculiarities of electrical devices and their presentation to the public in the right way.

All things considered, the experience of the electrical industry with the "famous artist" has not been a happy one. Publicity men have paid good sums for submitted designs and pictures, but almost without exception these have not been suitable for public distribution.

This disappointing result suggests the conclusion that there is no field in electrical advertising for the work of the good painter whose name has been made outside the realm of publicity work. It is wrong to suppose that because a design bears the signature of a well-known artist, the manufacturer or publicity organisation will secure any greater prominence for the line they may be pushing in the sketch. It is the *tout ensemble* of the picture which must first impress the public, not the peculiarly fashioned signature or initials of the artist in the corner.

Furthermore, the electrical manufacturer in seeking the services of the outside artist to do his work is overlooking the many good men who have built up businesses within the confines of the industry. These men are quite capable of doing all the work that the electrical manufacturer needs in his publicity campaign. Moreover, his results as an investment will show a more valuable return than those obtained for the exorbitant fee of the "famous" artist. In all advertising artistry imitation is rampant. The great business of advertising would not continue if it were otherwise. The electrical manufacturer who is only now on the verge of public advertising has the advantage as a late comer of observing the mistakes which his predecessors have made. In particular let him take warning and not spend money on the "great artist." We do not wish to disparage the efforts of the latter to please his client. We know from what has already been done that the results have been failures and there is little reason to suppose that in the future they will be otherwise.



Mansion House Station (Underground Rly.) London illuminated by "OSRAM" Lamps.

RAILWAY LIGHTING

BY

OSRAM

LAMPS.

The General Electric Co., Ltd., Head Office: 67, Queen Victoria St., London, E.C.

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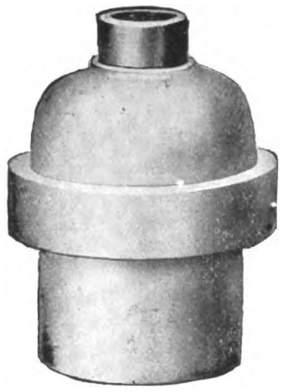
SIEMENS

"GOLIATH" LAMPHOLDERS

(Edison Screw)



ALL PORCELAIN.

For Particulars and Prices, apply to our Supplies Dept.

SIEMENS BROTHERS DYNAMO WORKS LIMITED.

HEAD OFFICE: CAXTON HOUSE, WESTMINSTER, S.W.

Telephone: GERRARD 960. Telegrams: "SIEMBRALOS, LONDON."

Supplies Dept.: 39, UPPER THAMES STREET, E.C.

Telephone: LONDON WALL 8270. Telegrams: "SIEMOTOR, LONDON."

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BRISTOL	MANCHESTER	JOHANNESBURG	BOMBAY	PENANG	MELBOURNE
CARDIFF	NEWCASTLE	CAPE TOWN	MADRAS	RANGOON	TORONTO

REFLECTOR SIGNS.

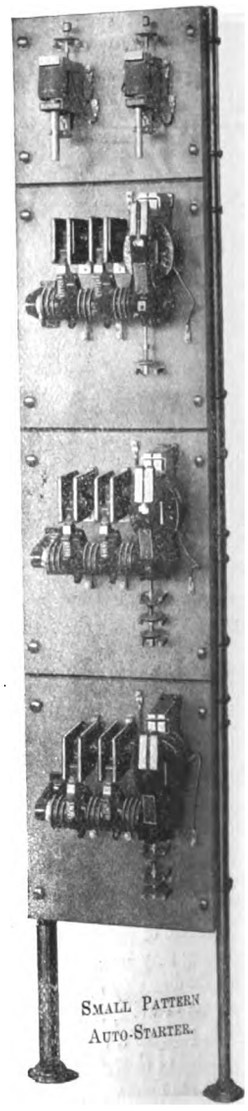
The art of applying modern illuminants to shop window dressing has been given a utilitarian phase by the introduction of advertising signs. These are constructed to serve the double purpose of throwing light upon the goods displayed in the window and illuminating the stencilled lettering at the front of the reflecting surface. Messrs. W. Leonard & Co., Oxford-street, London, W., send us some interesting particulars of their new electric reflecting signs, which include specialities for shop window service. The sign constitutes a simple right angle with a row of lamps suspended in a vertical plane and an opal reflector fronted by a stencilled metal guard, which is also placed vertically in front of the row of lamps. The suspension of the sign is by chain, and we understand that not only is the illuminating effect all that can be desired, but that the tradesman obtains the maximum value from the light by using it to advertise his wares. The sign is very moderate in price and we understand that it is being largely taken up by tradesmen.

A NEW HYDRAULIC GOVERNOR.

We are informed by Mr. Percy Pitman, hydraulic engineer, that his patent governor has been entirely remodelled and fitted with a number of improvements. Among these we may mention a compensating device which prevents over-governing and ensures close speed regulation, and a sensitive spring pendulum which is adjustable for speed and sensitiveness, the parts working on knife edges and the weights enclosed in polished steel casing. There is also a balanced distributing valve having an adjustable sleeve to alter the travel of the servo-motor piston and an automatic self-clearing fitter. The governor is suitable for any type of water wheel on the market. Mr. Pitman will supply fuller details on application.

A.C. AUTO-STARTERS.

The contactor type of motor starter for induction motors is only of recent development, the radial or drum type having previously been used. The advantages of the independent contactor pattern will be apparent from a glance at the accompanying illustration, which depicts a new pattern of automatic starter, manufactured by the British Thomson-Houston Co. The capacities of these starters range from 1 to 300 H.P. and they are suitable for circuits having voltages from 110 to 550. We understand from a recently issued list (No. 302) that this type of starter has been designed for motor-driven pumps, air compressors, &c., which are required to be started and stopped automatically in accordance with the variation of air pressure or water level, as the case may be.



SMALL PATTERN AUTO-STARTER.

The equipment is made up of two-current limit relays, a double-pole main line contactor and a number of double-pole contactors for notching out the rotor resistance. The number of the latter will depend upon the size of the motor and the percentage of full load torque required at starting. The current relays are electrically interlocked with the contactors in such a way that they control the rate of acceleration without the use of dashpots. It is impossible for the motor to be switched in circuit without all resistance being inserted. We understand that the contactors themselves have been specially designed with a view to eliminating noise. Not infrequently switches of this class are apt to be very clattery and may constitute a nuisance.

In the operation of the controller a small switch is utilised for energising the coil of the opening and closing switch. If this small switch has been put in the automatic features of the controller come into operation. This small master switch can also be opened and closed by tappets which will be moved by a tank float or by the up and down motion of a hydraulic accumulator. In the case of vacuum or compressed air systems the switch is dispensed with and the opening and closing of the contactor switch is put in and out of circuit by the contacts of a pressure or vacuum governor.

The controller is offered in a variety of sizes, and we would refer interested readers to the British Thomson-Houston Co. for these particulars.

From the same source we have received lists No. 300 and 301 which respectively deal with B.T.H. alternating-current high torque house pattern watt-hour meters and B29 controllers.

OSRAM-LAMPS

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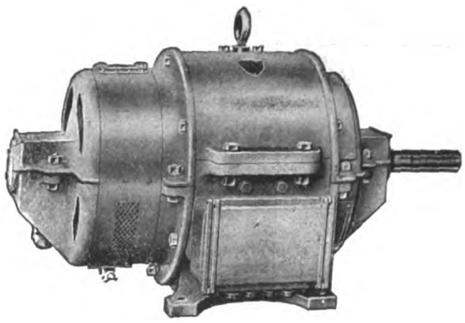
VICKERS
MOTORS

FOR ALL PURPOSES.



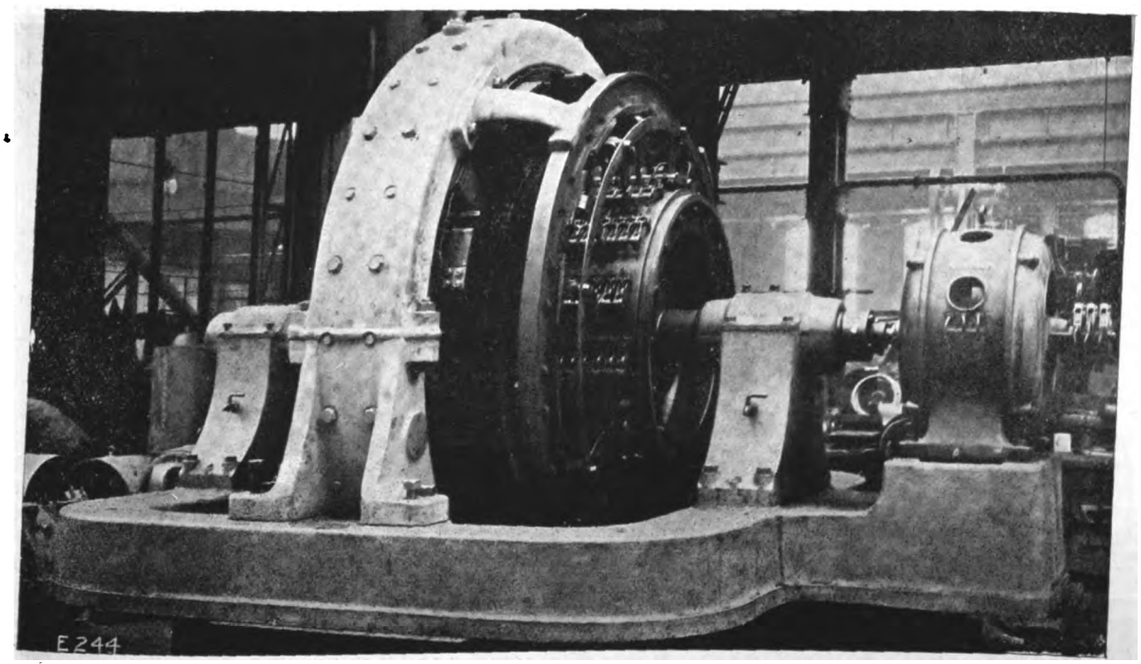
IN ALL SIZES UP TO 50 H.P.

Their rigid and substantial construction enables them to withstand the most severe usage and give a continuous and uninterrupted service without help from the repair shop or any undue heating.

Send for Lists.

THE ELECTRIC & ORDNANCE ACCESSORIES CO., Ltd.,
Proprietors : Vickers Limited.
ASTON, BIRMINGHAM.

VICKERS' 500 kw. ROTARY CONVERTER



VICKERS LIMITED

TELEGRAMS: VICKERS SHEFFIELD.
TELEPHONE: No. 3200 SHEFFIELD.

SHEFFIELD.

ON ADMIRALTY LIST.
ON WAR OFFICE LISTS.

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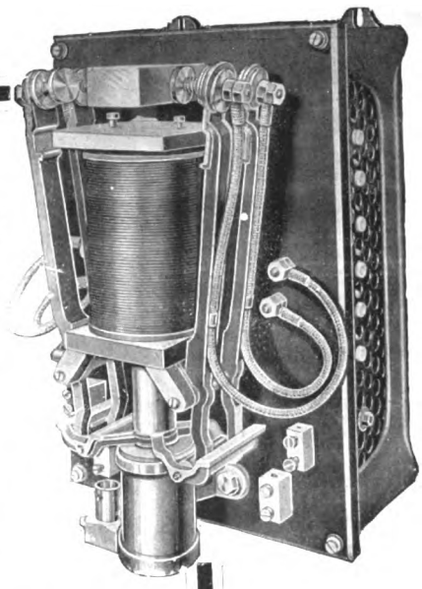
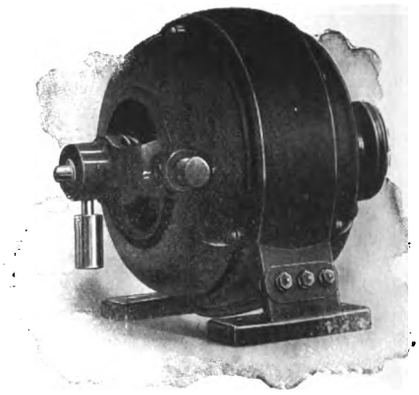
"EMPIRE"
PATENT
AUTOMATIC STARTERS
For Direct or Alternating Current.
The design embodies all the most up-to-date principles.
ONLY ONE SOLENOID.
NO SLIDING CONTACTS.
BRITISH MADE
from first to last.
Write for Catalogue E.
ELECTRIC CONTROL, LTD.,
177, REID STREET,
BRIDGETON,
GLASGOW.
Telephone: 2847 BRIDGETON. Telegrams: "CONTROL, GLASGOW."



E.M.I. FANS
and
Small Motors
A.C. & D.C.
All Sizes.
All Voltages.



HOGAN & WARDROP,
2, GRESHAM BUILDINGS,
BASINGHALL STREET,
LONDON, E.C.
Telephone - - - 723 LONDON WALL

TIMBER PRESERVING.

A successful demonstration of the Rüping process of timber preservation was made at Richd. Wade, Sons & Co.'s works on Tuesday last. Various kinds and shapes of timber were selected for the experiment—redwood, poles, timbers, sleepers, fencing and paving blocks, and whitewood battens and boards. These were all weighed and measured, and then sealed up in the cylinder, where they were subjected to an air pressure of 50 lb. per sq. in. The cylinder was then filled with creosote, whilst the air pressure was maintained. Then a pressure of 80 lb. per sq. in. was put on, after which the pressure was released and the cylinder opened, when the timber was taken out and re-weighed, showing the amount of oil remaining in it. Various pieces of the wood were cross-cut and showed a remarkable penetration of the oil, nearly to the centre; which we are told is impossible in the old method, except at a great cost. The same applied to the whitewood, into which we believe it used to be considered impossible to inject the oil. The extreme cleanliness of the wood was very noticeable, it being quite dry and clean to handle and not dirty and clogged with oil such as one usually associates with creosoted wood. This should render it very valuable where its dirtiness from the old method had precluded its use.

There was a very representative gathering at the demonstration, and the guests were afterwards entertained to lunch in the works. There are at present plants in the world, either specially erected for, or altered to suit the Rüping process, capable of doing over 38,000,000 sleepers, 9 ft. 10 by 5, by this process. The Santa Fé Railway Co., in America, are one of the largest users, and they say the sleepers creosoted by this process have given every satisfaction. The German Government has also adopted the process for all the German railways and telegraphs; also Italy. Messrs. Wade have also plant for Burnettising timber by the well-known process invented by Sir Wm. Burnett which the English Post Office have used for many years, and is eminently suitable for indoor use, also in ships, &c.

SIMPLEX CONDUITS Ld.,
Garrison Lane, BIRMINGHAM.
Manufacturers of—
CONDUITS, CABLES, ACCESSORIES, FITTINGS, MOTORS, ELECTRIC HEATING AND COOKING MATERIAL, &c.

THE NEW BRIMSDOWN LIST.

The trade has been so repeatedly requested by the makers of Brimsdown lamps to "see things in a better light" that they will be prepared, with the issue of the Brimsdown list, to impress this necessity upon their customers. The Brimsdown slogan, like the Brimsdown lamp, may be said to have caught on if the new catalogue is anything to go by. The copy before us shows it to be the product of considerable thought and care with one eye on effect and the other on utility. We must compliment the company on the cover. It conveys an abundance of information at a glance. The composite pictures of the Brimsdown works on the second page are clear and convincing. There can be no mistaking the fact that lamps are in process of manufacture. The lamps listed, priced and illustrated cover the complete range from the smallest train-lighting lamp to those of 1,000 c.p., through the usual gamut of voltages and candle-powers. The tables of prices contain useful columns which British and Hefner candle-power are compared side by side. The efficiency of the Brimsdown lamp is 1·12 watts per British and 1 watt per Hefner candle-power. Copies of the list will be forwarded on application to the sales department, Brimsdown Lamp Works, Kingsway House, London, W.C.

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SPECIFY AND USE

FERRY RESISTANCE WIRE.

No Temperature Coefficient. Wire will not Rust or Perish.

Contains no Iron.

The only Material of its kind Manufactured in England.

Used largely and Specified by the Admiralty.

Used also by the Italian and Japanese Admiralties.

Write for List giving Electrical Particulars of Ten Grades of Wire.

WIRE. STRIP. SHEET. BARE. COVERED.

Makers :
HENRY WIGGIN & CO., Ltd.,
GEORGE STREET, BIRMINGHAM.
Telephone : 6400 CENTRAL. *Telegrams : "WIGGIN BIRMINGHAM."*

Agent : LIONEL ROBINSON,
3, Staple Inn, London, W.C.
Telephone : 6323 HOLBORN.
Telegrams : "FERRYDOM, LONDON."

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The "UNITYPE" INDICATOR

NEW, PRACTICAL, INEXPENSIVE.

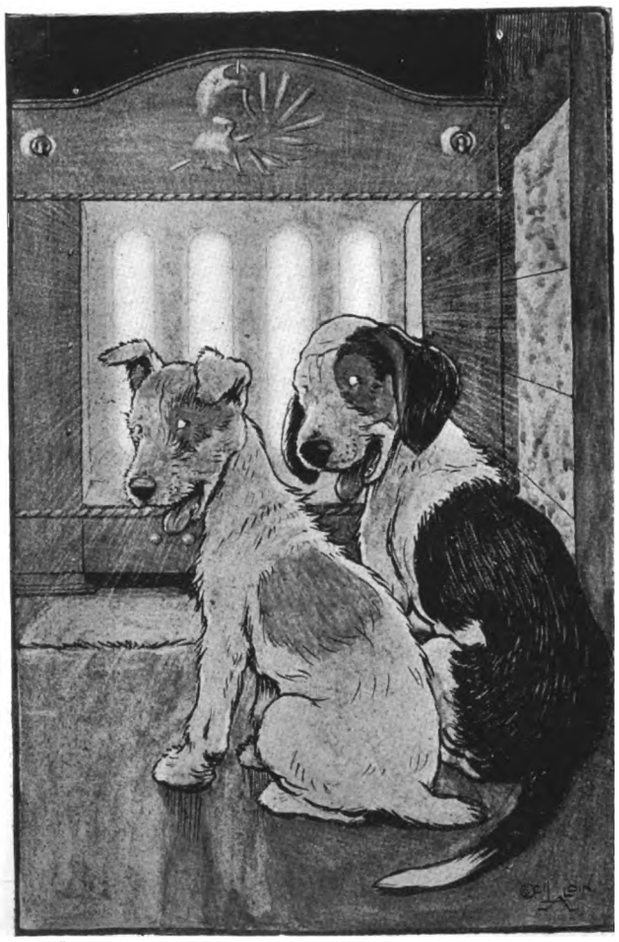
Each movement a complete unit. Contained in black metal case. Can be mounted in any number of designs. Price 1/6 each.

THE STERLING TELEPHONE AND ELECTRIC CO., LTD., 200, UPPER THAMES STREET, LONDON, E.C.

Write for New List No. . . 177.

"LOVE ME, LOVE MY DOG."

The Electricity Supply Publicity Committee has got Mr. Cecil Aldin to design them a cover for their new heating and



"SMILE, PUPPY, SMILE!"

radiator literature. Mr. Renwick has kindly favoured us with an illustration of Mr. Aldin's effort, and this we reproduce herewith. As our readers are doubtless aware, Mr. Cecil Aldin has made a name for himself as an artist of hunting scenes and dogs, consequently he is able to make the puppies in the picture turn for a moment from the charms of the electric radiator to smile their canine contentment. Doubtless, as a result of the distribution of this little picture, there will be a big demand for electric radiators among ladies who lavish money on pe animals of all kinds.

AMERICAN ADVERTISING METHODS.

We have received the following letter on the above subject and publish it as a matter of interest :—

A perusal of the article "American Advertising Methods" in your last issue produced a feeling that a damper had been thrown over the enterprise of British advertisers, whose increasing interest in advertising during the past few years has resulted in so marked an improvement. I am not an American, neither have I been to America. But, seeing it is the most progressive country in the matter of advertising, I admire it for that. Had this distinction belonged to any other country my esteem would have been none the less. If any country, by specialised study, gained more enlightenment on a certain subject, and found its application to business highly successful, surely we should not refuse to consider whether these improved methods, either in part or whole, could be applied to our advancement just because they happened to originate in Germany, France or America. I agree that much good money has found its way into the accommodating pockets of the daily newspaper proprietor without producing that which it was intended to produce. But instead of attributing this to American advertising, let us put it down to a misconceived and ultra-aggressive policy.

That circulars, leaflets and other business literature sent through the post are unwelcome to the average Britisher is largely due to their often uninteresting get-up and cheap appearance. Instead of exciting interest they irritate. To be in any way successful, advertising matter of this nature should embody an original idea that will at once attract the attention and excite the curiosity of the recipient. His first impression must be one of inquisitive interest, or, preferably, admiration at its cleverness. Either will invariably lead to a careful perusal, if the story is crisp and well told. I would say—rather than warn the English manufacturer against American advertising methods—suggest that he makes a careful study of them. If, after careful study, any of these so-called American methods seem worthy, let prompt adoption add yet another tribute to his remarkable judgment.

Yours faithfully,
MARCUS HEBER SMITH.
Pp. A. J. GREENLY.

"TANTASHADES."

The metal lamp is responsible for a new design of lamp shade. The old carbon lamp did not lend itself to the pear-drop type of shade, being too short in the neck and too round in the neck. The metal lamp is built on more graceful lines and the shade which clothes its brilliance with a greater beauty must be shaped in keeping with it. Siemens Bros. Dynamo Works have kept the necessity well to the fore and their latest list provides a selection in glassware which would be difficult to beat. The shapes are as varied as the pebbles on the beach. In particular the bead shades should attract attention. They are offered in many different shades, colours and designs. A bead shade might almost be described as "a thing of beauty and a joy for ever."

BEAD AND ETCHED "TANTASHADES."

PELTON WHEELS & WATER TURBINES
IMPROVED DESIGN. HIGH EFFICIENCY.
PITMAN'S PATENT SPEED GOVERNOR, combining Sensitive Spring Pendulum, Servo Motor, Compensating Device, Automatic Filter and Hand Regulator. Close Speed Regulation. High-class Workmanship.
Proposed Water Power schemes surveyed and reported on at moderate fees.
PEROY PITMAN, *Pelton Wheel and Turbine Manufacturer,*
3, Wilcott Road, Acton, London W., England.

EXCELLO
FLAME ARC WITH UNIQUE TWO YEARS' WARRANTY

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"The Shades of Night were falling fast."

Then
there's nothing
quite like

AEGMAS

with
Holophane
Shades.

The ELECTRICAL Co., Ltd.,
Aegma Lamp Dept.,
122/4, CHARING CROSS ROAD,
LONDON, W.C.

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FERRANTI
LIMITED.

OLYMPIA ELECTRICAL EXHIBITION

WE ARE EXHIBITING
AT STANDS Nos. 102 & 113

A NEW COMPRESSION TYPE
MOTOR STARTER

HOLLINWOOD, LANCS.,
78, KING STREET, MANCHESTER.

LIBERAL DESIGN.

TOTALLY ENCLOSED.

FITTED WITH NO-VOLT RELEASE.

MAGNETIC BLOWOUT ON ALL STEPS.

LOW PRICES.

Sizes up to 2 H.P.

These Starters have been designed to meet the demand for cheap but well-made apparatus for use in connection with small motors.

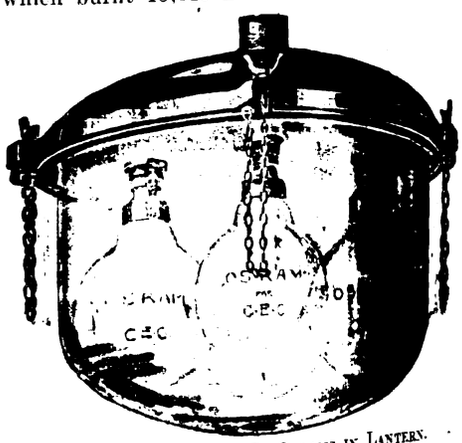
Pamphlet No. 93 gives full particulars.

A. REYROLLE & Co., Ltd.,
HEBBURN-ON-TYNE, ENGLAND.

HIGH-CANDLE OSRAMS.

The latest list from the General Electric Co. is devoted to arguments and practical examples of the high candle power Osram lamp. The cover of the booklet is attractive to the eye and in keeping with the contents of the publication. The opening page is occupied by a cartoon from our contemporary the "Electrical Times," which represents the flame arc lamp turning away from the remains of a contest with the incandescent gas mantle to view the challenge of the high candle power Osram lamp, which is represented as a diminutive David throwing down the gage to a giant flame lamp. This cartoon is significant of the future. It will give pause to many a tradesman and contractor who is considering the use of the arc lamp and comparing its value as an illuminant with the high candle power metal lamp. The publication to which we refer and of which an advance copy is before us is mainly devoted to a comparison of the high candle power Osram lamp with the arc lamp and it gives in addition a considerable number of representative installations of Osram lamps for the illumination of every conceivable kind of public place—railway stations, main and side streets, circuses, cinematograph theatres, skating rinks, bowling greens, shops, warehouses, factories, &c. The arguments in favour of the high candle power metal lamp are practically irrefutable, and we anticipate that they will appeal to both the contractor and the light user alike. While it would be incorrect to state that the arc lamp is doomed, it is becoming more and more apparent that the choice of light units for open spaces in the immediate future will rest upon either the flame arc or high candle power metal lamps.

The sizes of the high candle power Osram lamp go up from 100 to 1,000 c.p. units and they are suitable for voltages from 100 to 260. The energy consumption is in the neighbourhood of 1·2 watts per British candle, and this should be sufficiently good to satisfy the requirements of any user. The life of the lamp is also on the high side, though of course the lowest lamp which burnt 15,643 hours at the Stafford Corporation



GROUP OF HIGH C.P. OSRAMS IN LANTERN.

Electricity Works is, fortunately for the lamp makers, the exception rather than the rule.

In the application of these high candle power lamps for practical purposes special lanterns are offered by the General Electrical Co. which will contain one or a group of lamps. The circumstances will of course govern the number of lamps employed. For shop window lighting the grouping of the high candle power lamps appears to be favoured, whereas for open spaces and streets the higher candle power units are employed singly.

H. WEIDMANN,
RAPPERSWIL, SWITZERLAND,
FOR
Presspahn and Insulating Material.
(See larger Advt. last week.)

Printed and Published by GEORGE TUCKER, at the Editorial, Printing and Publishing Offices, 1, 2 and 3, SALISBURY COURT, FLEET STREET, in the City of LONDON, FRIDAY, SEPTEMBER 8, 1911.

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THE ELECTRICIAN COMMERCIAL AND INDUSTRIAL SUPPLEMENT.

C. & I. Supplement No. 102.] SEPTEMBER 15, 1911. [Gratis to Subscribers.

Olympia Report.

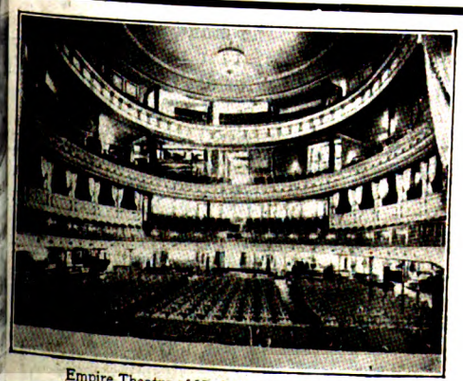
During the Electrical Exhibition we shall enlarge the pages of the Commercial and Industrial Supplement in order adequately to describe the Exhibits. We have already addressed letters to manufacturers asking for details of the specialities they are showing. Will those Exhibitors who have not replied kindly send *Matter and Blocks* in to us at once.

We are at Stand 180.

GAS AT OLYMPIA.

We extend a cordial invitation to all users and advocates of gas to the Electrical Exhibition at Olympia next week. In particular do we hope that the editor of the "Journal of Gas Lighting" and the writer of the Electricity Supply Memoranda in that garrulous publication will honour the exhibition with their presence. Our own stand number is 180, and if our contemporary will be good enough to make a note of this and look in on us either before or after a round of the exhibits we will gladly administer to his bodily comforts. Would that we might assist him in the preparation of his copy! We know that every effort will be made to bring gas consumers to the exhibition. Manufacturers, contractors and electricity supply authorities will, we are sure, have taken steps to make the exhibition known among this class of prospective consumer. Of course, there are great numbers of gas users who will come both out of curiosity and the natural desire to find something better than they already have. Even our friends of the "Journal of Gas Lighting" would not wish these seekers after light to be debarred from attending at Olympia.

The contemporary referred to above has recently been worried about certain facts regarding the Tricity cooker, and instead of applying direct to the makers of this effective and efficient device asked an explanation of us. We now beg leave to ask our contemporary why it does not organise a gas exhibition at Olympia. In the stuffy sanctity of its own office it can inveigh against electric lighting, heating and power with an amount of energy which might be better displayed in other directions. With a show at Olympia, where there would be plenty of space to fill with burnt gas fumes, the public would have the deciding voice in those matters upon which our contemporary feels itself able to speak with such authority.



Empire Theatre of Varieties, London, showing illumination by "OSRAM" Lamps.

THEATRE LIGHTING

BY

All Voltages 2 to 260.

All Candle-Powers 1 to 1,000.

OSRAM

LAMPS.

The General Electric Co., Ltd., Head Office: 67, Queen Victoria St., London, E.C.

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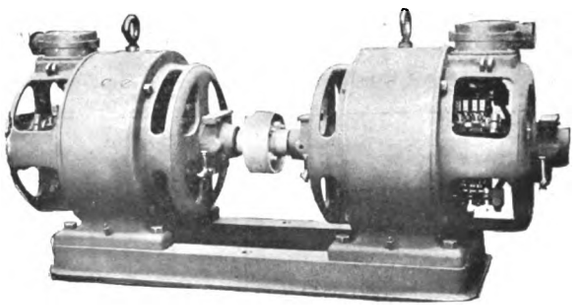
SIEMENS

MOTOR-GENERATORS
FOR
CINEMATOGRAPH WORK.



SIEMENS BROTHERS DYNAMO WORKS LIMITED.
HEAD OFFICE: CAXTON HOUSE, WESTMINSTER, S.W.
Telephone: GERRARD 960. Telegrams: "SIEMBRALOS, LONDON."
Supplies Dept.: 39, UPPER THAMES STREET, E.C.
Telephone: LONDON WALL 8270. Telegrams: "SIEMOTOR, LONDON."
BRANCHES:

BIRMINGHAM	GLASGOW	SHEFFIELD	CALCUTTA	SINGAPORE	SYDNEY
BRISTOL	MANCHESTER	JOHANNESBURG	BOMBAY	PENANG	MELBOURNE
CARDIFF	NEWCASTLE	CAPE TOWN	MADRAS	RANGOON	TORONTO

ELECTRIC WATER HEATERS.

We have been supplied with particulars of an interesting type of electric water heater which is intended for use in the household. It is of the geyser type in that the water is delivered hot as soon as it is turned on. The heater is a porcelain tube which is packed for the greater part of its length with carbon granules. The two ends are stopped by a special perforated carbon disc, which will allow passage of water but keeps the granules in position. Arrangements are made for passing a current through the granules so that they offer a high resistance and quickly attain a high temperature, which is, however, immediately conveyed to the water which is kept constantly passing through. It is claimed that any desired temperature can be obtained from the cold-water supply in 5 seconds. There is no radiation loss. The water is heated only as used. Consequently, electrical energy is economised. Hot and cold water can be obtained from the same tap. The device can be fitted to any cold-water supply in a few moments. It is also stated that the water is sterilised in passing through the heater. The makers of the device are Messrs. Electric Water Heaters (Ltd.), Gordon-street, Glasgow. It is intended to introduce the device for general purposes, and we understand that it is likely to be fitted to liners or large ships in which there is a supply of electricity available. The energy consumption is either 3 or 6 units for 25 or 50 gallons per hour.

"R.R." CARBONS.

A great variety of carbons for electrical purposes is made by Messrs. Rylander & Rudolphs, Henriksdal, Sweden. We understand that this firm has been established nearly 30 years. Their agents over here are Messrs. James McMillan & Co., Surrey-street, Strand, London, W.C., and they have sent us a very complete catalogue of "R.R" carbons. The list also contains particulars of "R.R." wet batteries and dry cells. The wet batteries are offered in a considerable variety of sizes and shapes and are intended for special use on different kinds of circuits. The dry cells are also made in a large number of different sizes. There is a section in the catalogue devoted to carbon brushes, and here again the products of the company are shown to cover a wide range of shapes and styles. There are some useful notes on the treatment of dynamo brushes at the end of this section. Details are also given of carbon packing rings for steam turbines, these being offered in different radii. One of the most striking portions of the list is that devoted to carbons for telegraphs and telephones. It is almost bewildering to look through the pages in which the different shapes of microphone carbons are illustrated. The list concludes with particulars of carbon shot and granules and special carbons for lightning arresters.

FRANCO SIGNS.

The Electrical Exhibition will be a striking example of what can be done with electric lamps and electric lighting in connection with signs. Practically every stand of any importance will be surmounted by some illuminated electrical device. There are, of course, many admirable examples of electric signs to be met with in the streets of London and also in the provinces. In London especially we notice a form of sign of which a typical example is illustrated herewith. It is made up of a combination of seasoned hard wood into which a number of

FRANCO CHANGING SIGN IN LONDON.

small watertight porcelain holders are fitted. These holders carry miniature lamps of 1 to 2 c.p. equally spaced in the centre of either the letter or the particular design which is to be illuminated. The lamps are wired in series parallel groups and can be connected to any of the standard circuits. We understand that seven 12 in. letters require only ½ unit an hour. The lamps are quite suitable for use in connection with ordinary flashers or time switches. Letters varying in size from 6 in. to 18 in. in height are provided with a single row of lamps, from 19 in. to 36 in. a double row of lamps is employed. Readers who are interested in a sign of this kind for use at Olympia should apply to the Franco-British Electrical Co., Oxford-street, London, W., for further details.

OSRAM-LAMPS

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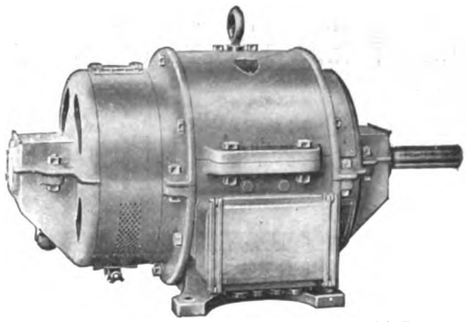
VICKERS
MOTORS

FOR ALL PURPOSES.



IN ALL SIZES UP TO 50 H.P.

Their rigid and substantial construction enables them to withstand the most severe usage and give a continuous and uninterrupted service without help from the repair shop or any undue heating.

Send for Lists.

THE ELECTRIC & ORDNANCE ACCESSORIES CO., Ltd.,
Proprietors : Vickers Limited.
ASTON, BIRMINGHAM.

The **Sun** ELECTRICAL COMPANY LTD.
118-120 Charing Cross Road, London, W.C.

ELECTRICAL EXHIBITION OLYMPIA.

Do not fail to visit us at Stand 104/111. We are showing the Latest Improvements in Modern Electric Installation practice and the only conduit system which is entirely free from condensation troubles :—The KALKOS SYSTEM.

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regularly to any address. It is a Classified and Annotated Guide to the Scientific Publications of the previous three months.
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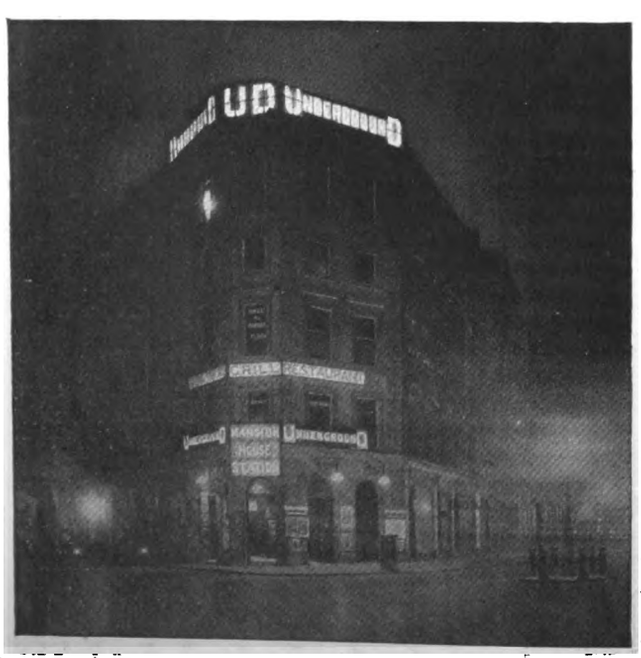
"TILLING-STEVENS" PETROL-ELECTRIC OMNIBUSES.

As a result of the successful running of the new "Tilling-Stevens" petrol-electric omnibuses in London service, Messrs. Tilling have decided to adopt that type for all their future omnibuses and are constructing a fleet to replace their present horse-drawn vehicles. Messrs. Tilling have designed the chassis and body, which are being built at their works at Peckham, but the electrical transmission is supplied by Messrs. W. A. Stevens, of Maidstone. An agreement has been entered into between the two companies in which Messrs. Tilling have secured the sole rights of use and sale of the "Stevens" patent electrical transmission for use in omnibuses and mail vans in the Metropolitan police area, Messrs. Stevens to have the sole rights of manufacture and sale of the complete "Tilling-Stevens" petrol-electric chassis outside the Metropolitan area, and also inside the area for vehicles other than omnibuses or mail vans. The same construction will be adopted in the chassis for use either inside or outside London. The "Tilling-Stevens" petrol-electric vehicles are the result of exhaustive experiments carried over a period of four years under public service conditions in London. The first vehicle, which is still in service in excellent condition, has run over 120,000 miles. As the new vehicle has been designed by the oldest established motor omnibus company in London to meet the latest requirements of the Metropolitan Police, it possesses all the essential qualifications for success, and its extreme silence, smooth running, flexibility and ease of control, together with low cost of upkeep due to the substitution of a flexible electrical transmission for the gear box, should appeal to the travelling public as well as to the operating engineer.

OSRAM LIGHTING IN LONDON.



ONE OF THE FINEST EXAMPLES OF SIGN LIGHTING WITH METAL LAMPS TO BE SEEN IN LONDON.

TWO-POINT LIGHT CONTROL.

What can be more exasperating than to find in a bedroom that control of the light is obtainable at the door only, this necessitating getting into bed in the dark, and having to get out of bed before light can be obtained again. It is not an uncommon occurrence to find houses where the only switch control of the hall and staircase light is provided at the front door, the lack of control from the upper floor necessitating the use of the time-honoured candle to go upstairs to bed by or when descending again during the night. These are but two cases, and many others might be cited. Had greater conveniences been provided the "unsatisfied consumer" would have been a satisfied one and his installation would prove a good advertisement for electric lighting.

When noticing these weak points in his installation he interviews a contractor to have an improvement made, but is usually informed that the alteration will mean pulling the walls about and upsetting the decorations, &c. Consequently the desired addition is seldom effected or else postponed for attention when the next decoration upheaval takes place, he, mean-

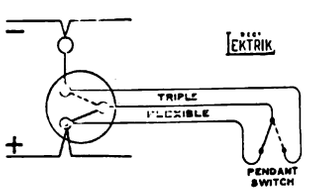


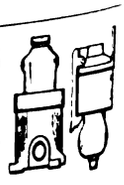
DIAGRAM OF CONNECTIONS.

while, having to make shift with the installation as it stands. It is a simple matter, so Messrs. A. P. Lundberg inform us, to convert the present single-way switch control to that giving control from two points, without any disturbance of the wiring. The conversion simply involves the substitution of a two-way surface switch for the single-way one.

A hole is bored in the wood block and a triple flexible led off from the switch on porcelain buttons, or through insulated screw eyes, to the desired extension point, consisting of a two-way pear switch for bedroom use or one of surface pattern for ordinary use. The simplicity of the adaptation is clearly shown in the above diagram, where it will be noticed that the leads are not interfered with in any way when making the change, and that, contrary to usual custom, the "common" terminals of the two two-way switches are interconnected.

To leave the switch point as it was originally is a simple matter, the two-way switch being made to act as a single-way one by short-circuiting two of the terminals, the flexible and extension switch being disconnected. This provides for the case of the obstinate landlord who requires the installation left as it was found. This simple method, if commonly known, would assist in providing the contractor with some genuine friends amongst his clients, whose recommendations would extend business in the neighbourhood.

REYROLLE WALL PLUGS
For Portable Machines, Lights, &c.
Pamphlets 114, 122, 88 and 45 give all particulars.
WORKS—
HEBBURN-ON-TYNE, ENGLAND.



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TELEPHONES & CABLES
The Premier Telephone Exhibit.

Stands
Electrical Exhibition
Sep. 23 to

51 & 72
Olympia, London.
Oct. 21, 1911.

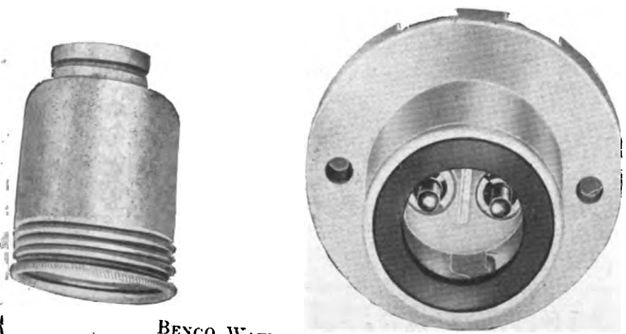
Western-Electric COMPANY, Ltd.,
Norfolk House, Victoria Embankment, LONDON, W.C.
Works: NORTH WOOLWICH, E.
BIRMINGHAM, CARDIFF, LEEDS, SYDNEY and JOHANNESBURG.

LARGE PRESSURE FILTER ORDER.

The Sheffield Corporation Waterworks Department have just placed a contract for 32 patent mechanical pressure filters and auxiliary plant, capable of dealing with a flow of 6,000,000 gallons per day, with the well-known firm of Mather & Platt (Ltd.), of Manchester. This firm are to be again congratulated upon securing this order, which follows so closely upon the large order they were recently successful in securing from the Ashton, Stalybridge and Dukinfield District Water Board.

BENJAMIN SPECIALITIES.

The Benjamin Electric (Ltd.) has issued several new lists which contain particulars of some of their recent specialities. List No. 42 is devoted to special lampholders, which are in-



Benco Watertight Holder.

nded for use in connection with shop window illumination. everal of these holders are weather-proof, and we illustrate a attern which is all china and which is suitable for mounting strips, borders, ceiling blocks or casings. Moisture is prented from entering the holder by a specially fixed rubber ring, which makes an effective joint with the lamp cap. In list No. 41 particular emphasis is laid upon the company's specialities in reflectors for shop-window and show-case lighting. Some of these reflectors are supplied without lamps, others are fitted with the Benco patent lampholder, which secures the lamp in a horizontal position within the trough of the reflector. The shop-case reflectors are suitable for standing lightly on the glass-work at the top of the case and throwing the accentuated rays of the lamp on to the goods in the case below. The Benjamin Electric, at 117, Victoria-street, London, S.W., are willing to advise intending users of electric light as to the best method of utilising their special reflector.

OLYMPICS.

Will Mr. Hirst buy the Crystal Palace and present it to the N.E.M.A. for a permanent electrical exhibition?

Why cannot the editor of the "Journal of Gas Lighting" be compelled to open the exhibition?

Will there be a strike among the bar attendants?

Will non-exhibiting canvassers be frog-marched out of the exhibition?

Can the Executive prevent the manufacture of ozone while the band is playing?

Will Sir Wm. Preece be allowed to mention T—— R—— at the inaugural banquet?

Will the new N.E.M.A. secretary give a dinner to the disappointed applicants for the post?

EXCELLO
FLAME ARC WITH UNIQUE
TWO YEARS' WARRANTY

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"AFTER SUNDOWN, BRIMSDOWN."

A good slogan will ofttimes bring business in making a commodity known to the public in a happy kind of way. The above is the latest addition to the list of electrical slogans. It is both apt and easy and rolls readily off the tongue. We find it embodied in a pithy little folder which the Brimsdown Lamp Works are now sending out with this season's literature. It tells of the sizes of Brimsdown lamps and their prices and candle-power, British and Hefner. Actually it is something of a pocket edition of the larger Brimsdown list which we reviewed last week. Incidentally, we may say, that in that list particulars are given of the numbers of the holophane shades which may be used with Brimsdown lamps of various sizes.

SMALL SIZE REPRODUCTION OF BRIMSDOWN CIRCULAR.

E.P.S. MINER'S LAMPS.

There have always been difficulties in the way of the introduction of electric battery lamps for mines and collieries. We have been over a large colliery in the North of England in which all the batteries are made at the pit bank, in fact, everything is manufactured *in situ* except the lamps. Singularly enough, in this instance the management have been unable to get a satisfactory metal lamp which would stand up to the rough handling to which all miner's lamps are subjected. The E.P.S. Co. have sent us particulars of their miner's lamps, which are made in a number of patterns of different capacities. It is claimed for these lamps that they have a high efficiency and a powerful working light can be obtained. Three patterns of lamps are fitted in enamelled metal outer cases. The burning hours range from 15 to 30 hours. It is stated that no cleaning or trimming is needed. In a pattern known as the "up and down" lamp, the light is thrown on the ground and on the roof.

The ALUMINIUM CASTINGS Co., Ltd.,
GREENOCK.
ALUMINIUM CASTINGS OF ALL KINDS
MACHINE MOULDED. FINE FINISH.

GLOVER'S ANTICIPATIONS.

With the approach of the Olympia Exhibition there are possibilities of something fantastic in the way of stands. We do not think, however, that the artist on Glover's Almanac will be able to find in actuality the scene which he depicts herewith.

NOT TO BE SEEN AT OLYMPIA.

The lady customer is not at all particular wh... motor of indifferent efficiency as long as the ... machine she has matches that of the machi... purchase. Exhibitors may, however, take ... violet voltmeters and apricot ammeters to ... at Olympia. We are indebted to W. T. G... mission to reproduce the sketch.

SIMPLEX COND...
Garrison Lane, BIR...
Manufacturers of—
CONDUITS, CABLES,
TINGS, MOTORS, ... &c.
AND COOKING ...

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POPE

AT OLYMPIA

you will find the

LIGHT WAY to a LIGHT HOUSE.

Our stand—like the houses of all users of "Pope" Metal Lamps—is a **LIGHT HOUSE.**

Make a note of the numbers:

STANDS No. 207-208.

We shall be pleased to see you. Let us show you several of our very latest types—ask to see the

STANDARD "POPE" METAL LAMPS for High and Low Voltages,

NEW TYPE OF TUBULAR LAMP FOR WINDOW LIGHTING,

SPECIAL RADIATOR LAMP,

PLAIN, FANCY AND TWISTED FLAME LAMPS

—in fact, Lamps of all types for all purposes.

Pope's Electric Lamp Co., Ltd.,

HYTHE ROAD, WILLESDEN, LONDON, N.W.

Telephone: OLYMPIA ONE.

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The "UNITYPE" INDICATOR

NEW, PRACTICAL, INEXPENSIVE.

Each movement a complete unit. Contained in black metal case. Can be mounted in any number of designs. Price 1/6 each.

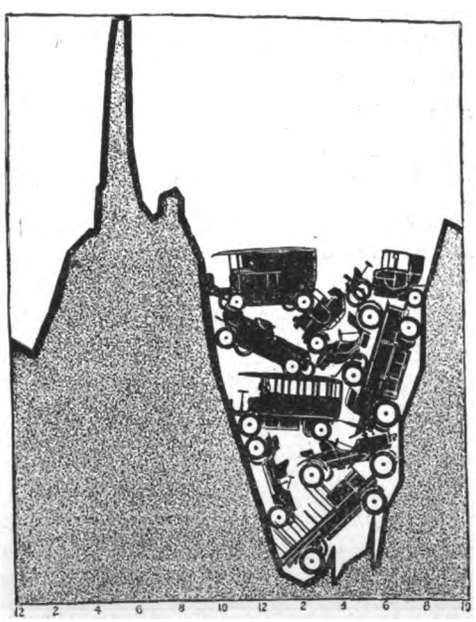
THE STERLING TELEPHONE AND ELECTRIC CO., LTD., 200, UPPER THAMES STREET, LONDON, E.C.

Write for New List No. . . 177.

ENAMELLED COPPER WIRE.

A special sheet (No. 34A) is being issued by W. F. Dennis & Co., 49, Queen Victoria-street, London, E.C., giving prices and particulars of F. & G. black enamelled H.C. copper wire. This is offered in sizes ranging from 14 to 42 S.W.G., and can be supplied on reels which vary in weight according to the size of the wire from ½ lb. to 28 lb. per reel. The wire is delivered in lots of 2 cwt. and over. We understand that the enamel has a high insulation resistance, and that it has considerable heat and moisture-resisting properties. Instrument makers and switchgear manufacturers, also arc lamp makers, will doubtless be interested in this new leaflet.

FILLING IN THE VALLEYS BETWEEN THE PEAKS.



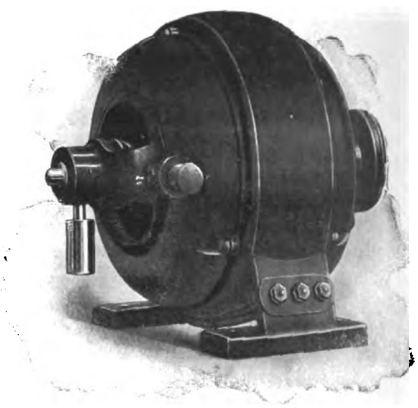
We take the above from an American contemporary. It should be a lesson to station engineers who are considering the question of the electromobile.

E.M.I. FANS

and

Small Motors

A.C. & D.C. All Sizes. All Voltages.



HOGAN & WARDROP,
2, GRESHAM BUILDINGS,
BASINGHALL STREET,
LONDON, E.C.

Telephone . . . 723 LONDON WALL.

J. & P. SWITCHGEAR.

A comprehensive switch and instrument list has been prepared by Messrs. Johnson & Phillips, and it appears to us to be one of the most complete publications of its kind that has been sent out in recent manufacturing literature. It comprises 72 pages, which are replete with information on the subject of switches of all patterns and switchgear accessories. The line of oil switches listed is very complete and covers types suitable for pressures from 600 to 30,000 volts. There is a standard line of these switches made for the control of three-phase circuits. In the H.T. switchgear section there are details given of current and potential transformers, isolating switches, choking coils, lightning arresters and limiting resistances. These have all been carefully standardised, and we understand can be delivered at short notice. The list also gives details of motor starters for A.C. slip-ring motors and these starters can be supplied with automatic overload and no-load features. In the same section star-mesh starters are described and priced. Interesting details are included of A.C. liquid motor-starters. There is a considerable portion of the catalogue devoted to D.C. motor-starters. The list is concluded with illustrations of typical assembled switchboards. One of these was designed for controlling a large pumping plant.

H. WEIDMANN, RAPPERSWIL, SWITZERLAND.

Manufacturer of PRESSPAHN AND INSULATING MATERIAL.

PRESSPAHN—Pressboard.

BEST QUALITY. PROVED BY REPEATED TESTS.

Sheets in thickness from 0·1 upwards. Endless Rolls and Strips from 0·1 to 1 mm. thickness.

BLACK PRESSPAHN IF SPECIALLY ORDERED.

Presspahn Coils and Tubes for Transformers, Armatures, Discs and Shaped Articles.

Varnished Presspahn. Mica-Covered Presspahn, &c.

Printed and Published by GEORGE TUCKER, at the Editorial, Printing and Publishing Offices, 1, 2 and 3, SALISBURY COURT, FLEET STREET, in the City of LONDON, FRIDAY, SEPTEMBER 15, 1911.

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OLYMPIA ISSUE.

THE ELECTRICIAN COMMERCIAL AND INDUSTRIAL SUPPLEMENT.

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C. & I. Supplement No. 103.] SEPTEMBER 22, 1911. [Gratis to Subscribers.

NEW THINGS YOU MUST SEE AT OLYMPIA.

Our readers who are interested in the novelties at the Exhibition, and by these we mean things which will "first see the light" of Olympia, should make notes of the following items:—

New Osram Lamp 200 v. 16 c.p. General Electric Co. Stands 103-112.

Henley's New Wiring System. Stand Nos. 178, 185.

Barbour's 50 kw. Homopolar Generator. Stand Nos. 27, 34.

B. T.-H. Mazda Wire Lamp. Stand Nos. 124, 135, 297.

Buller's 100,000-volt Disc Insulators. Stand Nos. 118, 141.

W. F. Dennis' New Twin Lead-covered Wire. Stand No. 293, Gallery.

New Compression Motor Starter and Electric Cooking Apparatus. Ferranti Limited. Stand Nos. 102, 113.

Dugdill's "Constellum" Adjustable Fitting. Stand No. 238.

Quick Break Two-way Thermo-Blink Sign Flasher. Sun Electrical Co. Stand Nos. 104, 111.

Hope's "Bimetal" Fuse Wire, stands 90 per cent. fusing current before blowing. Parmiter, Hope & Sugden (Stand Nos. 81, 91) and Simplex Conduits (Stand Nos. 148, 163).

"The Ducter." Evershed & Vignoles. Stand No. 168.

C.T.S. (Cab-tyre Sheathing) Conductors of St. Helen's Cable & Rubber Co. Stand Nos. 196, 219. Callenders.

Gray's Electric Oven. Bertram Thomas. Stand Nos. 22, 39.

The Cross Engine. Westinghouse Brake Co. Stand No. 6.

Bruston Automatic Electric Light Plant. R. A. Lister. Stand Nos. 11, 12.

20,000-volt Ironclad Switch Panel. A. Reyrolle & Co. Stand No. 147.

Preliminary Description of Exhibits, p. 177.

Map Plan of Olympia and Classified List of Exhibits and Stand Nos. on pp. 178, 179.

A HOMOPOLAR GENERATOR.

On Stands 27-34 Messrs. Homopolar Machines are showing a 50 kw. 100-volt direct-current turbo-generator on the homopolar principle (Fig. 1). In this the armature flux never changes sign, so that there is no core loss. Fig. 2 shows a section (not to scale) through the machine on the centre line. The magnetic circuit is double, *a a* and *b b* being the two portions, each of which forms one end pole. Each pole extends

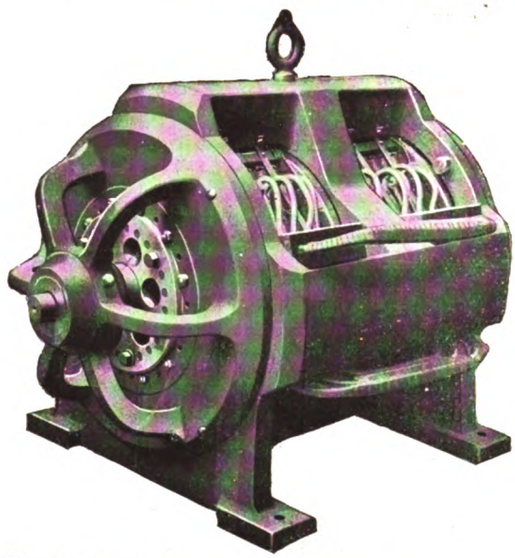

FIG. 1.—GENERAL VIEW OF HOMOPOLAR GENERATOR.

The "Southern Belle" Express, London and Brighton, illuminated by "OSRAM" Lamps.

TRAIN LIGHTING BY OSRAM LAMPS.

All Voltages 2 to 260.

All Candle-Powers 1 to 1,000.

The General Electric Co., Ltd., Head Office: 67, Queen Victoria St., London, E.C.

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SIEMENS

"ZED" FUSES

COME AND SEE THEM
AT OUR STANDS AT

OLYMPIA

SEPT. 23RD. TO OCT. 21ST.

SIEMENS BROTHERS DYNAMO WORKS LIMITED.
HEAD OFFICE: CAXTON HOUSE, WESTMINSTER, S.W.
Telephone: GERRARD 960. Telegrams: "SIEMBRALOS, LONDON."
Supplies Dept.: 39, UPPER THAMES STREET, E.C.
Telephone: LONDON WALL 8270. Telegrams: "SIEMOTOR, LONDON."
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BIRMINGHAM GLASGOW SHEFFIELD CALCUTTA SINGAPORE SYDNEY
BRISTOL MANCHESTER JOHANNESBURG BOMBAY PENANG MELBOURNE
CARDIFF NEWCASTLE CAPE TOWN MADRAS RANGOON TORONTO

completely round the armature with no change of sign. There is thus no iron loss. R is the rotating part, or armature. M is the fixed part, or frame. E E′ are the exciting coils, which are placed directly round each air-gap, so that leakage is reduced to a negligible figure. The smallness of the gap is limited only by mechanical considerations, consequently the field copper loss is small. The conductors C in which the volts are generated lie in micanite tubes in tunnels in the armature, under the central pole, and are connected at each end to slip rings D from which the current is collected.

The rotor has a strong steel shaft S, and a high permeability steel core P. On this are mounted the slip rings D, and also the rings GG forming the end poles. In the diagram the centre pole of the rotor is shown solid with the core, and the end poles are solid rings. While this is not necessary electrically it is sometimes convenient mechanically to build these up of laminations. Bolts B pass from one end of the rotor to the other and are insultated by mica tubes like the armature conductors, and hold the slip rings and pole rings solidily in position. There are mica washers between the rings; thus mica is the only insulating material used in the rotor. The rotor has a periphery of great strength, and it is claimed that the construction adopted renders the machine mechanically sound. The frame M of the machine consists of three castings, a large one comprising the central pole and the yokes, and two smaller ones forming the end poles and carrying the bearing brackets. The frame carries stationary conductors, which connect the armature conductors in series.

The slip rings are grooved, and in the grooves lie the brushes AA (Fig. 3), which consist of a flexible copper core wound with an armouring. The latter, though slightly diminishing the flexibility, both protects the core from wear and is found by experience to make better contact with the slip ring than any other form of brush. The brush is held in place round the ring by springs BB, the tension of which is regulated by the screw and nut K, while the current is led away by the flexible leads L to the stationary conductors. Appended are the leading dimensions and particulars of the machine, from which it will be seen that it is of extremely compact dimensions. The shortness of the distance between bearings is especially remarkable, and should lead to freedom from vibration troubles.

DATA OF THE MACHINE EXHIBITED AT OLYMPIA.
50 *kw.*, 100 *volts*, 500 *amperes*, 3,500 *revs. per. min.*

Total length between bearings	29½ in.
Height of frame	28½ in.
Width of frame	28 in.
Diameter of rotor	14½ in.
Peripheral velocity	12,800 ft. per min.
Field amperes	5
Number of conductors	12
Width of each slip ring	½ in.
Length axially of centre pole	6 in.
Length of each end pole	3½ in.

The generator is belt-driven by an induction motor, the speed of which can be regulated by a patent regulator lent by the Electrical Apparatus Co., Ltd. This regulator gives infinitely gradual control of the speed, but has no water resistance and no contacts, the operation being entirely electromagnetic.

Messrs. Homopolar Machines also show an interesting model on the Homopolar principle in which all the iron of the ma-

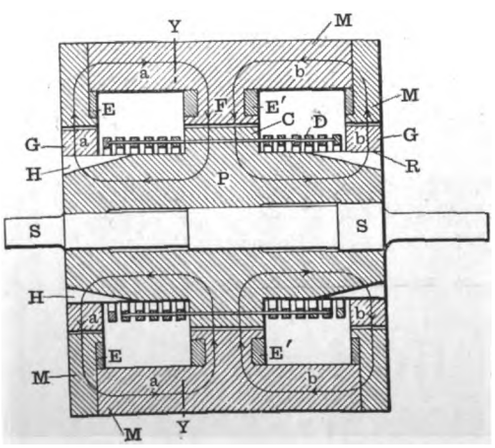
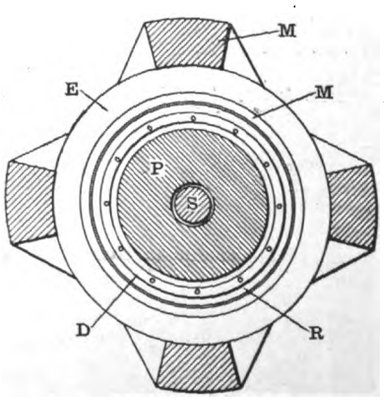


FIG. 2.—SECTION THROUGH HOMOPOLAR GENERATOR.



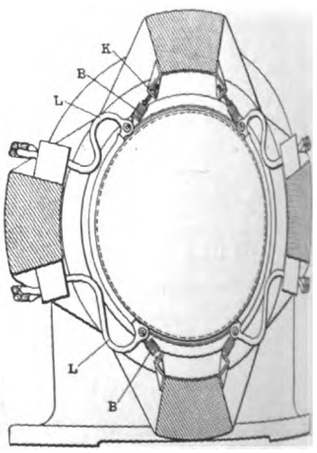


FIG. 3.—VIEW OF BRUSHES.

netic circuit and the field coil revolve, as well as the armature, the brushes only being stationary. This was invented by Mr. R. H. Barbour, managing director of Messrs. Homopolar Machines, as a self-driving flywheel for a gyroscope, where the weight of the stationary portions of the machines must be reduced to a minimum. This machine is described in detail in the columns of THE ELECTRICIAN this week.

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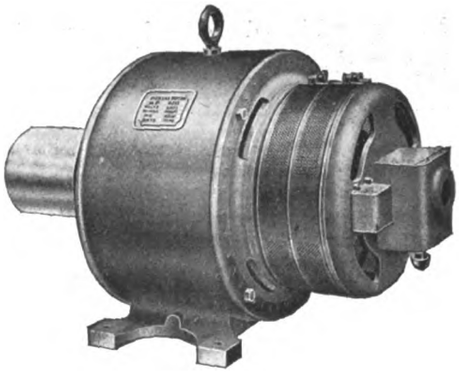
VICKERS
MOTORS
FOR ALL PURPOSES.



IN ALL SIZES UP TO 50 H.P.

Their rigid and substantial construction enables them to withstand the most severe usage and give a continuous and uninterrupted service without help from the repair shop or any undue heating.

Stand Nos. 80 and 92 Olympia Electrical Exhibition.

THE ELECTRIC & ORDNANCE ACCESSORIES CO., Ltd.,
Proprietors : Vickers Limited.
ASTON, BIRMINGHAM.

Visit the UNION Stand

at the Electrical Exhibition. It isn't a "pretty" stand—but it's an engineering job. We shall be showing a full range of our specialties (Dynamos, Motors, Arc Lamps, Switchgear and Meters) and our engineers will be delighted to explain the salient points of these.

OUR STAND IS No. 101–114.

Our Stand Telephone number is Olympia 46. Ring us up and make an appointment.

BRANCHES IN ALL THE PRINCIPAL BRITISH CITIES.

Union Electric Co. Ltd.
PARK ST., SOUTHWARK, LONDON, S.E.

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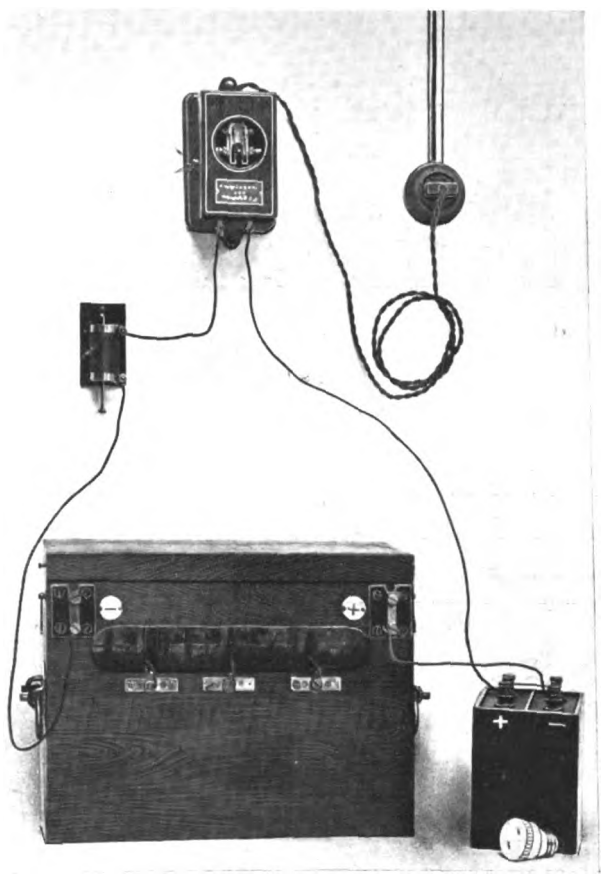
A VIBRATORY RECTIFIER.

When Mr. Ferranti introduced his famous rotating rectifier for the supply of an interrupted but uni-directional current for arc lighting, hopes were entertained by some engineers of replacing the rotating mechanism by some vibratory form of apparatus. Of recent years the problem has again been tackled, and mainly with the idea of producing a device for the charging of accumulators from A.C. circuits. The Adnil Electric Co. is issuing a pamphlet describing a vibratory rectifier which has been developed and successfully applied for the last-mentioned purpose. The rectifier is, of course, simplicity itself. It comprises a transformer in which the stray field is utilised to actuate an armature which moves the contact system provided for breaking the circuit at the zero point on the



Adnil Rectifier Charging Accumulators.

A.C. curve. By this means a rectified current is produced. We understand that perfectly synchronous working of the contacts is assured. It is also stated that the efficiency on load and open circuit is practically that of a transformer of similar output. Adjusting screws are provided by which the vibrating contacts can be altered for various frequencies. It will be noted from the illustration that the rectifier is complete in itself and has no auxiliary apparatus. For accumulator charging the device is extremely economical. With energy at 3½d. per unit a 6-volt 25 ampere-hour capacity battery will cost 2s. to charge when using resistances. With a rectifier the cost would only be 1½d. The rectifier is offered in four sizes for voltages between 100 and 250 and capacities from 1·2 to 2·2 amperes charging current. If a condenser is used small motors and alarms, &c., can be put in circuit with the rectifier.

OSRAM·LAMPS

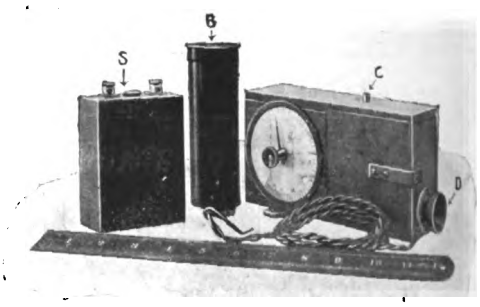
THE LUXOMETER.

The widespread interest now being taken in the measurement of illumination, both interior and exterior, has led to a demand for an inexpensive instrument, which, while not claiming to be a standard in the same respects as the Trotter portable photometer could yet be relied upon to give results of ample accuracy for all purposes, and which was, at the same time, not only light and thoroughly portable, but above all easy to use.

In the past, portable photometers have been looked upon somewhat as luxuries, to be possessed only by the larger undertakings, and it is with the object of dispelling this erroneous idea that the Luxometer has been placed on the market. For the comparison of the candle-powers of various forms of lamp, or for the measurement of the illumination of any surface, or that of a room in which it is desired to improve the lighting, as well as for the determination of the efficiency of daylight illumination, and, in fact, for general use by electrical or gas engineers, officers of health, architects, &c., the Luxometer is particularly suitable. Apart from its low cost, the instrument embodies the following features:—Extreme compactness. This is strikingly shown in Fig. 1 which shows the complete outfit, including the Luxometer (C), Battery (S), and Daylight attachment (B). It may be added that the weight is only 11 lb.

Long open scale. The scale is about 6 in. long and in standard instruments is graduated up to 10 or 20 foot candles, as preferred, with two ranges. It is specially opened out for the lower part so that great accuracy is possible even when measuring feeble illuminations. The scale is direct reading.

When in use the instrument is held in the hand, no stand or other support being required. For transport, both the photo-



General View of Luxometer.

meter and the battery can be carried in the pocket, or they can be supplied fitted in a small leather case with shoulder strap if preferred. Illumination measurements can be made at any angle, irrespective of the colour of the light.

Candle-power measurements can be readily made (also irrespective of the colour of the light).

The surface brightness or intrinsic brilliancy of any surface can be instantly measured by viewing it through the instrument.

The principle upon which this photometer is based is a modification of the well-known Trotter method in which the illumination derived from an electric lamp, contained in the case, is adjusted until it is equal to that to be measured. A pointer moving over a direct reading scale indicates this illumination without any calculation whatever. Of all the standard lamps which have been tried with portable photometers the electric lamp has proved itself to be by far the most satisfactory, and some recent investigations by Mr. A. P. Trotter show conclusively that such a lamp worked off a portable accumulator more than fulfils all requirements.

The cell supplied with the Luxometer is of a special "non-spillable" type contained in a celluloid or ebonite case so that it can be used in any position or carried in the pocket without fear of spilling. It only requires charging at rare intervals, and this can be done at any motor garage.

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ELECTROMOTORS LTD

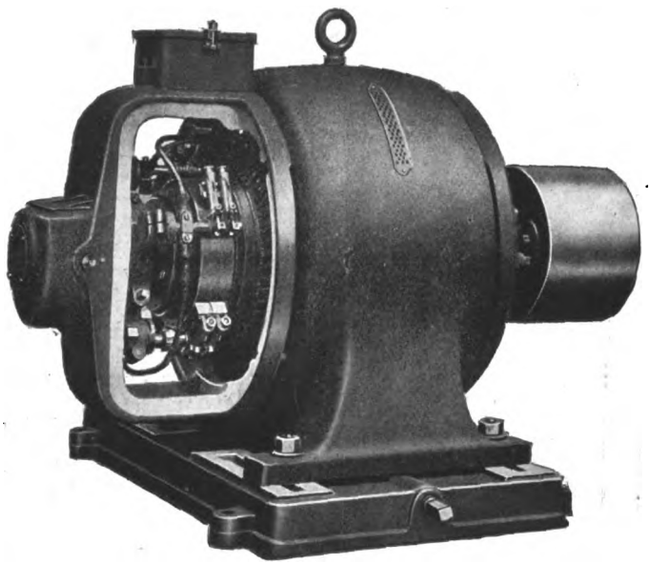
OPENSHAW, MANCHESTER.

SPECIALISTS IN

THE COMPLETE ELECTRIFICATION

OF

WORKS & FACTORIES.



SEE OUR

STAND NOS. 126/133

ELECTRICAL EXHIBITION OLYMPIA,

and ask for Booklet of Typical Drives.

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LIVERPOOL	121, High Street, Wavertree.
LEEDS	Ashfield, Myddelton, Ilkley.
GLASGOW	68, Gordon Street.
BELFAST	38, Chichester Street.
HOLLAND	G. W. E. Gibson, 55, Stadhoudersplein, The Hague.
NEW ZEALAND	Jas. J. Niven & Co., Napier, and Branches.
AUSTRALIA	T. K. Steanes, Pitt Street, Sydney.
TRANSVAAL	Reath & Co., Howard Buildings, Johannesburg.
NATAL	A. B. Jones, Ltd., Durban.
ARGENTINE	Angel Muzzio é Hijos, Rosario.

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"Pope"

Notes for Olympia.

1. Stop at the LIGHTHOUSE STAND.
2. Examine our Exhibit.
3. Ask us questions — find out the advantages of "POPE" Metal Lamps.
4. Get a batch of our smart, forceful advertising literature and novelties.
5. See our special Radiator Lamp.
6. — and the New Type "POPE" Metal Filament Tubular Lamp for Effective Shop Window Lighting.
7. Note the large variety of plain, Twisted and Fancy Flame Lamps.
8. DO NOT FORGET THESE NOTES — jot them down *NOW* — and remember the Stand Numbers—207—208. *THE DISTINCTIVE LIGHTHOUSE STAND.*

Brilliant.

British Made Entirely.

Reliable.

Pope's Electric Lamp Co., Ld

HYTHE ROAD, WILLESDEN,

LONDON, N.W.

OUR EXHIBITION TELEPHONE NO. IS "OLYMPIA ON

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THE OLYMPIA ELECTRICAL EXHIBITION.

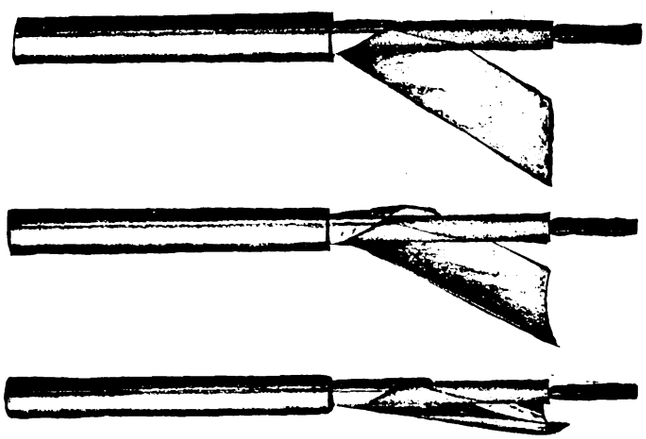
A List of the New Things at Olympia is given on the first page.

The usual complaint about Exhibitions is that they are never ready on the opening day. This indictment cannot be levelled against the Electrical Exhibition which will be opened at Olympia to-morrow. The exhibitors were admitted to the building on Monday week last, the 11th inst., and in the space of a fortnight, which, though it seems long, is in reality all too short, they have done little less than wonders. Several of the stands are fitted out on exceptionally elaborate lines, and will be immediately distinguishable among the many in the body of the hall. With few exceptions the stands are being brilliantly illuminated. Every conceivable kind of lamp and sign has been pressed into service, and the public will be almost dazzled by the persistent abundance of the illumination. We hope they will profit by observing that with such a superfluity of light there is neither smell nor heat. Their imagination may be permitted full play in an attempt to conceive what Olympia would be like under similar conditions with gas!

There are conspicuously few open stands in the Exhibition. By this we mean displays in which there is no attempt to enclose the main portion of the stand with box-like structures which completely obscure the general view of the exhibit. The most noticeable of the open stands is that of Ferranti, Ltd., which has been prepared on quite unusual lines. There is an elaborate woodwork "surround," arranged at a convenient angle, upon which the various smaller products of the company are displayed. Within the space enclosed by this novel border there is room for the display of photographs of many of the company's important installations. The centrepiece of the exhibit is a three-panel extra-high-tension ironclad switchgear and three-phase extra-high-tension solenoid operated switch. Even these have been sunk down below the level of the floor so that they admit of a clear view over the stand. Another open stand is that of the Union Electric Co., which immediately adjoins that of Messrs. Ferranti, and ironclad switchgear is made the centrepiece of this exhibit, the gear being surmounted by arc lamps and a searchlight. Most of the heavy exhibits machinery such as the Brush Electrical Engineering Co., Bruce Peebles, Electromotors, Ltd., Sunderland Forge & Engineering Co., have also stands of the open pattern. The Berry Construction Co. have also an open stand. The majority of the other stands are closed in, mainly on account of the fact that exhibitors require to display fittings, lamps, shades and reflectors which can only be attached to vertical supports or suspended from something in the nature of a roof. The utmost advantage has been taken of this form of stand by most of the exhibitors to render it as artistic and ornate as possible. Here we may specially mention the exhibits of the General Electric Co., the British Thomson-Houston Co., the Siemens pagodas, Henleys, Simplex, the Jandus Arc Lamp and Electric Co., Drake & Gorham, St. James and Allied London Companies and Municipalities, the Sunbeam Lamp Co., and Messrs. Edison & Swan. At the present juncture we cannot enter into full details of the exhibits, because at the time of writing most of the stands are in an incomplete condition. We have, however, been able to gather from a preliminary round of the show what the finished appearance of the stands will be like. We give below a few details of the principal exhibits and particularly of those in which novelties are displayed.

Henley's. (Nos. 178, 185.)

An exceptionally fine and comprehensive display of their products is being made by W. T. Henley's Telegraph Works Co. The stand is one of the largest in the exhibition and is near the centre of the hall on the right-hand side. In particular our readers will be attracted to this stand by a new wiring system which the company is bringing to the notice of the trade for the first time. The essentials of the system are its low first cost, and its economy and adaptability in erection. The system has been introduced with a view to meeting the undoubted demand for an efficient and inexpensive method of wiring domestic premises of moderate rental. From an initial inspection of the system there should be every possibility of the manufacturers' hopes being realised. A single V.I.R. insulated conductor is used and over the insulation is laid a thin spiral of copper tape, finally there is a lead covering over all. This constitutes the conductor. The fitting utilised for ceiling roses, switches, &c., is extremely simple and allows for the ready connection of the outer copper tape and the bringing of the insulated conductor through the wooden block. The conductor is suitable for concentric wiring, and on alternating-current systems there should be a big demand for it



Conductors for Henley's New Wiring System.

The lead covering renders the conductor infinitely flexible and it can be fitted up with ordinary cleats and saddles. We shall fully describe the system in our next issue.

Siemens. (Nos. 179, 184, 206, 209.)

The exhibit of the Siemens Companies (Siemens Bros. & Co. and Siemens Bros. Dynamo Works) is housed in two stands which are attractively built up as Japanese pagodas. The design and arrangement of the stands is such that visitors will have no difficulty in recognising them on sight. The display of apparatus comprises a show of cables and accessories, the well-known O.S. Wiring System and a variety of instruments. An interesting show is being made of electric heating, cooking and power devices. Amongst the latter may be mentioned a 5 H.P. vacuum cleaner with direct-current motor, and also, touching the heavier side, a desk type mining pillar of the draw-out pattern, suitable for voltages up to 3,300. Batteries and testing units are well to the front, and in the region of lighting the famous Tantalum and Onewatt lamps are prominently exhibited, both individually and in conjunction with an elaborate collection of fittings.

Continued on page 180.)

EXCELLO
FLAME ARC WITH UNIQUE TWO YEARS' WARRANTY

SIMPLEX CONDUITS Ld.,
Garrison Lane, BIRMINGHAM.
Manufacturers of—
CONDUITS, CABLES, ACCESSORIES, FITTINGS, MOTORS, ELECTRIC HEATING AND COOKING MATERIAL, &c.

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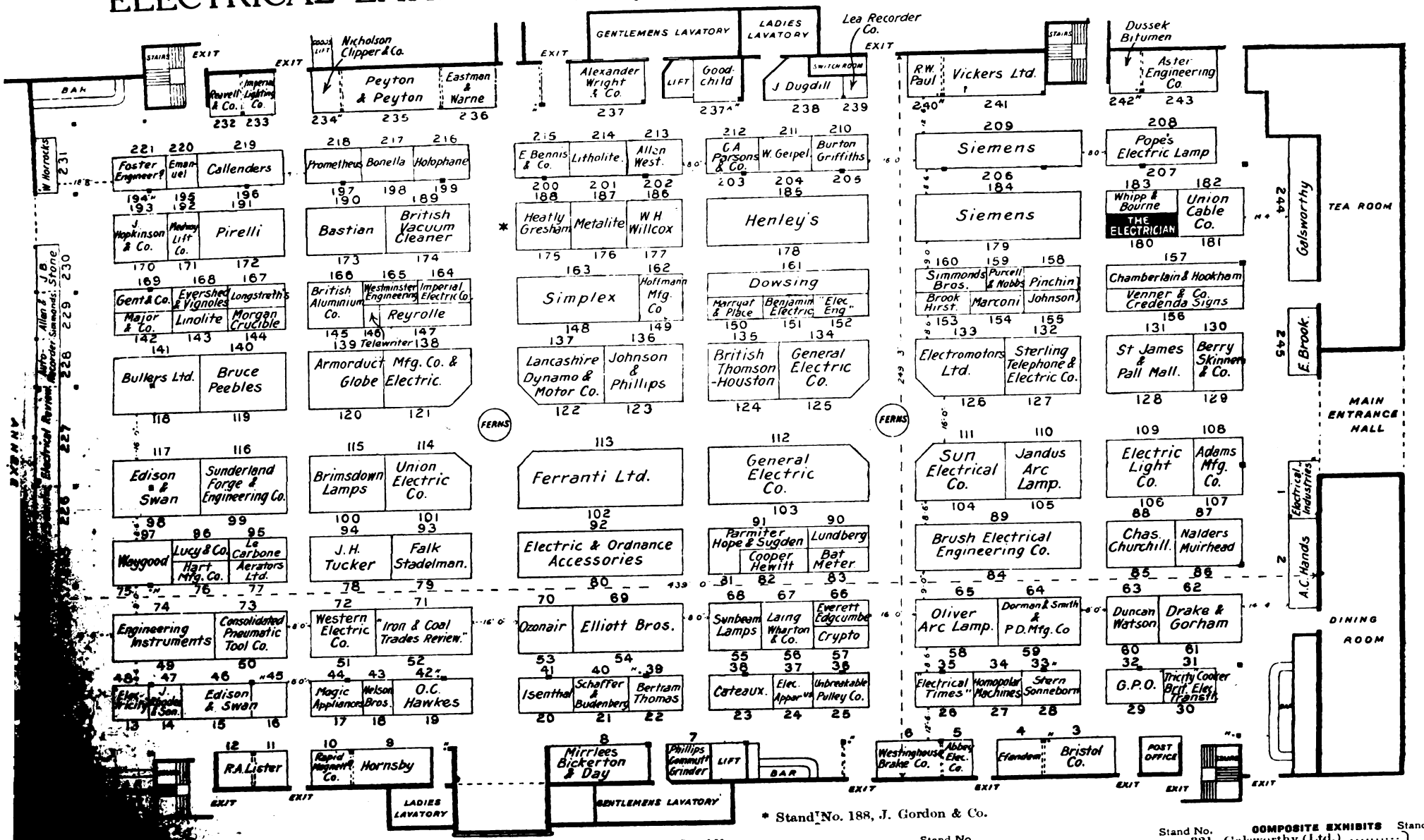
ELECTRICAL EXHIBITION, Olympia, London, September 23 to October 21, 1911.



* Stand No. 188, J. Gordon & Co.

	Stand No.
Eddy (G. M.) & Co.	297
Louis Co.	282
Electric Co.	272
Wire Co.	270
Felt & Tarrant Mfg. Co.	299
Gambrell Bros.	290
Haydn T. Harrison	309
"Hardware Trade Journal"	274
Lea Recorder Co.	289
London Decorative Metal Wks	291
Marconi's Wireless Tel. Co.	246
(also	154)
Sessions & Sons	321
Silver Replating Powder Co.	287
Slingsby, H. C.	279
Sparkes & Co.	285
Skefko Ball Bearing Co.	257
Tackley (W. C.) & Co.	286
Tella Camera Co.	268
Wannbacher, T. & E.	308
Wiggin (H.) & Co.	247
Wigmore (C.) & Co.	264

COMPOSITE EXHIBITS	Stand No.
Galsworthy (Ltd.)	244
Corona Lamp Wks. Co.	
Wandsworth Mfg. Co.	
Dorman & Smith	59-64
P.D.M. Co.	
Muirhead & Co.	86-87
Nalder Bros. & Thompson	
Nalder Bros.	
Mawdsley's	49-74
Buckley & Austin	

SUPPLEMENT to "The Electrician," September 22, 1911.

NOTES OVER LEAF

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Accessories, Switches. Lampholders, &c. Stand No.
Armorduct Mfg. Co. 120, 121, 138, 139
Benjamin Electric 151
Bonnella (D. H.) & Son 198, 217
Derman & Smith 59, 64
Drake & Gorham 61, 62
Edison & Swan U.E. Light Co. 15, 16, 45, 46, 98, 117
Efandem Co. 4
Emanuel (A.) & Sons 195, 220
Falk, Stadelmann & Co. 79, 93
Galsworthy (Ltd.) 244
General Electric Co. 103, 112, 125, 134
Hart Mfg. Co. 76
Lundberg (A. P.) & Sons 90
Siemens Bros. Dynamo Works 179, 184, 206, 209
Simmonds Bros. 160
Simplex Conduits (Ltd.) 148, 163
Sun Electrical Co. 104, 111
Tucker (J. H.) & Co. 78, 94
Wandsworth Electrical Mfg. Co. 244

Arc Lamps (including Mercury Vapour Lamps).
Abbey Electric Co. 5
British Thomson-Houston Co. 124, 135
Brush Electrical Eng. Co. 84, 89
Drake & Gorham 61, 62
Electric & Ordnance 60, 92
Engineering & Arc Lamps 327
General Electric Co. 103, 112 125, 134
Globe Electric Co. 120, 121, 138, 139
Jandus Arc Lamp & Electric Co. 105, 113
Johnson & Phillips 123, 136
Oliver Arc Lamp (Ltd.) 58, 65
Siemens Bros. Dynamo Works 179, 184, 206, 209
Union Electric Co. 101, 114
Westminster Engineering Co. 165
Westinghouse Cooper-Hewitt Co. 82

Ball Bearings.
Goodchild (G. W.) & Partner 237A
Hoffmann Mfg. Co. 149, 162
Skefko Ball Bearing Co. 257

Battery Zincs.
Eyre Smelting Co. (Bamber's Non-Encrusting) 263
Siemens Bros. & Co. 179, 184, 206, 209

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Armorduct Mfg. Co. 120, 121, 138, 139
British Aluminium Co. 266
Callender's Cable & Construction Co. 196, 219
Concordia Electric Wire Co. 270
Dennis (W. F.) & Co. 293
Dussek Bitumen Co. 244
General Electric Co. 103, 112, 125, 134
Henley's (W. T.) Telegraph Works Co 178, 185
Johnson & Phillips 123, 136
Pirelli (Ltd.) 172, 191
Siemens Bros. & Co. 179, 184, 206, 209
Simplex Conduits 148, 163
Sun Electrical Co. 104, 111
Union Cable Co. 181, 182
Western Electric Co. 51, 72

Cooking Apparatus (Irons, Kettles, Hot-plates, Ovens, Utensils, &c.)
Bastian Electric Heating Synd. 173, 190
Berry Construction Co. 30, 31, 312
British Prometheus Co. 197, 218
British Thomson-Houston Co 124, 135
Dowsing Radiant Heat Co. 161
Eastman & Warne 236
Edison & Swan Co. 15, 16, 45, 46, 98, 117
Electric & Ordnance Accessories Co. 80, 92
Ferranti Limited 102, 113
General Electric Co. 103, 112, 125, 134
Hawkes (O. C.) (Ltd.) 19, 42
Holmquist Electric Co. (Hat Pad) 225
Isenthal & Co. 20, 41
Premier Electric Heaters 244
Purcell & Nobbs 159
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Spagnoletti (Ltd.) 49, 74
St. James' & Pall Mall Electric Light Co 106, 109, 128, 131
Sun Electrical Co. 104, 111
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Driving Chains. Stand No.
Coventry Chain Co. 251
Hans Renold (Ltd.) 250

Dynamos, Motors, Generators, &c. (Large and Small).
British Thomson-Houston Co. 124, 134
Brook (E.) (Ltd.) 245
Bruce, Peebles & Co. 119, 140
Brush Electrical Eng. Co. 84, 89
Consolidated Pneumatic Tool Co. 50, 73
Crypto Electrical Co. 57
Electric & Ordnance Accessories Co. 80, 92
Electromotors (Ltd.) 123, 133
General Electric Co. 103, 112, 125, 134
Homopolar Machines 27, 34
Johnson & Phillips 123, 136
Lancashire Dynamo & Motor Co. 122, 137
Mawdsley's Ltd. 49, 74
Parsons (C. A.) & Co. 203, 212
Phœnix Dynamo Mfg. Co. 59, 64
Siemens Bros. Dynamo Works 179, 184, 206, 209
Simplex Conduits 148, 163
Sunderland Forge & Eng. Co. 99, 116
Sun Electrical Co. 104, 111
Union Electric Co. 101, 114
Vickers (Ltd.) 241
Western Electric Co. 51, 72
Wright & Wood 129, 130

Engineers' Stores.
Stern, Sonneborn Oil Co. 28, 33
Willcox (W. H.) & Co. 177, 186

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Ferry Resistance Wire and Material.
Wiggin (H.) & Co. 247

Fittings (Reflectors, Shades, Globes, &c.)
Armorduct Mfg. Co. 120, 121, 138, 139
Benjamin Electric (Ltd.) 151
British Metal Engraving Co. 261
B. T.-H. Co. 124, 135
Drake & Gorham 61, 62
Durdill (J.) & Co. 238
Edison & Swan Co. 15, 16, 45, 46, 98, 117
Electric & Ordnance Accessories Co. 80, 92
Emanuel (A.) & Sons 195, 220
Escare & Denelle 145, 166
Falk, Stadelmann & Co. 79, 93
Galsworthy (Ltd.) 244
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London Decorative Metal Works 291
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Sun Electrical Co. 104, 111

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Auto Recorder Co. (CO_2) 228
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Union Electric Co. 101, 114
Venner & Co. 156, 157
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Major & Co. 142
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British Thomson-Houston Co. 124, 135
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Corona Lamp Works Co. 244
Drake & Gorham 61, 62
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Falk, Stadelmann & Co. 79, 93
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Crypto Electrical Co. 57
Drake & Gorham 61, 62
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Siemens Bros. Dynamo Works 179, 184, 206, 209
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Sun Electrical Co. 104, 111
Sunbeam Lamp Co. 55, 68
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Switchgear, Ironclad Switches (H.T. and L.T.), Controlers, Motor Starters, &c. Stand No.
(*See also* Accessories, &c.)
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British Thomson-Houston Co. 124, 135
Brook, Hirst & Co. 153
Brush Electrical Eng. Co. 84, 89
Dorman & Smith 59, 64
Electric & Ordnance Accessories Co. 80, 92
Electrical Apparatus Co. 24, 37
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Johnson & Phillips 123, 136
Parmiter, Hope & Sugden 81, 91
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Union Electric Co. 101, 114
West (Allen) & Co. 202, 213
Whipp & Bourne 183

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Electric & Ordnance Accessories Co. 80, 92
General Electric Co. 103, 112, 125, 134
Gent & Co. 169
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Muirhead & Co. (Wireless) 86, 87
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Siemens Bros. & Co. 179, 184, 206, 209
Sterling Telephone & Electric Co. 127, 132
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Westinghouse Brake Co. 6

Transformers (H.T., L.T. and Auto.).
Armorduct Mfg. Co. 120, 121, 138, 139
British Electric Transformer Co. 30, 31
British Thomson-Houston Co. 124, 135
Brush Electrical Eng. Co. 84, 89
Edison & Swan Co. 98, 117
Electric & Ordnance Accessories Co. 80, 92
Elliott Bros. 54, 69
Ferranti Limited 102, 113
Foster Eng. Co. 194, 221
General Electric Co. 103, 112, 125, 134
Isenthal & Co. 20, 41
Johnson & Phillips 123, 136
Nalder Bros. & Thompson 86, 87
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Sunbeam Lamp Co. 55, 68
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Union Electric Co. 101, 114
Vickers (Ltd.) 241
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Turbines, Turbo-Generators, Turbo-Alternators, &c.
British Thomson-Houston Co. 124, 135
Bruce, Peebles & Co. 119, 140
Brush Electrical Eng. Co. 84, 99
General Electric Co. 103, 112, 125, 134
Lancashire Dynamo & Motor Co. 122, 137
Parsons (C. A.) & Co. 203, 212
Phœnix Dynamo Mfg. Co. 59, 64
Siemens Bros. Dynamo Works 179, 184, 206, 209
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Imperial Electric Co. 164
Magic Electric Appliances 17, 44

Voltmeters. (*See* Instruments, &c.)

Wires and Wiring. (*See* Cables & Wires, &c.)

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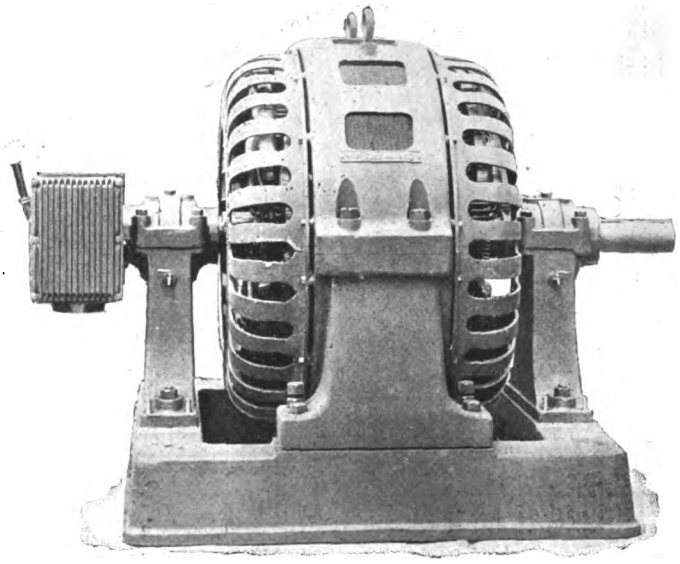
Simplex. (Nos. 148, 163.)

The exhibit of Simplex Conduits, Ltd., should attract attention on account of the neat little interior showroom for fittings which has been erected on the stand. This has been arranged to show fittings to visitors under the only possible conditions and to the best advantage, namely, with the lamps lighted in them. This display will be very largely one demonstrating the advantages of holophane reflectors. The outside of this novel showroom is made use of to display the Simplex conduit system for electric light and power wiring. The collection of signs which have been designed for use in shop windows combining the functions of advertising and illumination, should be specially examined. We may also remind our readers that Simplex Conduits are showing their latest designs in cooking apparatus, also small motors and meters.

Phœnix Dynamo Mfg. Co. and Dorman & Smith. (Nos. 59, 64.)

These companies share a stand not far from the main entrance, on the lefthand side. The first mentioned has a 300 B.H.P. 3,000-volt slip-ring type induction motor operating at 3,000 volts 485 revs. per min. This is suitable for underground haulages, and slip rings are enclosed in flameproof boxes. The Phœnix patent mining



P.D.M. 300 H.P. A.C. MOTOR.

motor, exhibited in the 35 B.H.P. 500-volt pattern, is also a prominent feature on the stand. It is claimed that there is total immunity from fire risk by the use of this motor in mines.

The Dorman & Smith section of the exhibit comprises practically all the switchgear products for which this well-known firm has made itself famous.

Ferranti, Ltd. (Nos. 102, 113.)

As we have already intimated above, the display made by Ferranti, Ltd. is of an exceptionally striking character. The company is making show of a full range of its manufactures. They wish to direct attention to a new direct-current motor starter which has no face plate and only two contacts are utilised in its construction, these being those of the circuit breaker. We understand that there are no metal resistances nor asbestos, only mica being employed, the principal elements of the starter being iron, steel, carbon and mica. There are new designs in time switches and cooking apparatus of all descriptions. The company also make an interesting announcement in regard to their cooking and heating exhibit. This comprises a tin oven mounted on a hotplate, large and small radiators and toaster, single and double heat hotplates and 4 lb. and 6 lb. flat irons. Messrs. Ferranti also have a switchboard in service in the substation supplying energy to the Exhibition, and this doubtless will be inspected with interest.

Johnson & Phillips. (Nos. 123, 136.)

A comprehensive exhibit is being made by this firm and our readers will be specially interested in the magazine "Metroflam" arc lamp. This has been developed from the designs of Mr. J. Brookie and it embodies many interesting features which can be examined in detail at the stand. This lamp burns for 80 hours at each trim and there is no dark interval during the change of the carbons. The lamp enjoys a considerable vogue and is being taken up largely by light users of all descriptions. There is a prominent searchlight display on the stand and in the switchgear section will be found a remote control board, a 3,000-volt board and a quantity of low-tension gear. In the substation which supplies energy to the Exhibition there are also two boards which control the 2,000-volt two-phase supply and the three-phase low-tension supply. The high-tension board is inside the sub-station.

Pope Lamps. (Nos. 207, 208.)

A decidedly novel exhibit is that arranged by Messrs. Pope's Electric Lamp Co. It takes the shape of a lighthouse, which is placed in the centre of the stand and from the upper window there are radiated in four directions particularly solid beams of light, bearing the letters "Pope Lamps" picked out in metal lamps. This is an effective exhibit and will doubtless prove one of the most popular of the attractions. The company manufactures practically every standard type of metal lamp and has arranged to give facilities for the inspection of these to visitors to the stand.

Electromotors, Ltd. (Nos. 126, 133.)

This company is making a comprehensive exhibit of its products on an attractive stand near the centre of the hall. They specially direct attention to the fact that they are makers of dynamo and motors and specialists in the complete electrification of works and factories. The exhibit will be representative of all the company's products in this particular. We may mention specially a 4 kw. 550 revs. per min. steam dynamo for ship lighting, a 20 H.P. 850 revs. per min. type ventilated motor with weather-proof cowl, a 5 cwt. friction hoist and a 30 in. slow-speed propeller fan capable of dealing with 6,900 cubic ft. of air per minute at 450 revs. per min.

"Tricity" Cooker. (Nos. 30, 31, 312.)

The much talked of "Tricity" cooker is being shown on this stand by the Berry Construction Co., and is to be seen in practically all its forms. In conjunction with it are ovens, coffee and water urns, grills, flat irons, saucepans and steamers. We would also call attention to the special chinaware utensils which have been introduced in connection with these cookers. The company has laid itself out to give an adequate demonstration of what can be done with electric cooking, and its efforts in this direction should be appreciated.

Nalder Bros. & Thompson. (Nos. 86, 87.)

Our readers will be able to inspect the display of "N.C.S." instruments, such as voltmeters and ammeters, of both the recording and indicating type, the Ohmer and the "N.C.S." thermal limiter. The latter is a comparatively recent instrument, and is intended for use in the circuits of consumers who pay for energy at so much per lamp per annum.

Westinghouse Cooper-Hewitt Co. (No. 82.)

On this stand will be shown the Westinghouse silica lamps, "the flame arc without carbons." Of interest will be the lamps arranged for alternating-current circuits in conjunction with a special mercury vapour rectifier. This lamp has been found more efficient than the direct-current pattern. The Westinghouse water sterilisers and a large number of special fittings for use with Cooper-Hewitt lamps complete the exhibit.

B.T.-H. Co. (Nos. 124, 135.)

The display made by the B.T.-H. Co. is principally attractive on account of the Mazda drawn-wire lamp. This is the first occasion upon which the lamp has been publicly exhibited, and it should be inspected with considerable interest on that account. The stand has been arranged on extremely novel lines, and is surmounted by a mechanical representation of the company's well-known poster which represents the earth, the sun and the Mazda lamp in juxtaposition, the latter being represented as rivalled by the sun. The company's many other products, such as arc lamps, particularly the Magnetite, calorite irons, Mazdaliers, are effectively grouped on the stand. Photographic illustrations are shown of the company's manufactures in the way of switchgear, turbo-generators, motors, &c.

C. A. Parsons & Co. (Nos. 203, 212.)

The exhibit of this well-known Newcastle firm has been confined to models and photographs of their famous turbo-generators. These are admirable examples of the model maker's art, and clearly serve to depict the excellence of the design of these machines.

Brimsdown Lamps. (Nos. 100, 115.)

The growing popularity of the Brimsdown lamp should secure for it many visitors to the Exhibition. The company's stand has been arranged for the effective display of the Brimsdown (colloid-tungsten) metal lamps which our readers are aware are made for all voltages and candle-powers. We understand that a complete range of illuminating specialities, particularly in the way of shades and reflectors, will be made. The facia of the stand has been outlined with a new pattern of reflector illuminating strip. With these and numerous other attractions the Brimsdown Lamp Works should be able to make its visitors "see things in a better light."

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BAMBER'S

NON-ENCRUSTING ZINCS

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AND

"EYRE" ANTI-FRICTION METALS

FOR ALL CLASSES OF BEARINGS

GALLERY 263.

Do not fail to visit our Stand and obtain full particulars of above.

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200, UPPER THAMES STREET, LONDON, E.C.

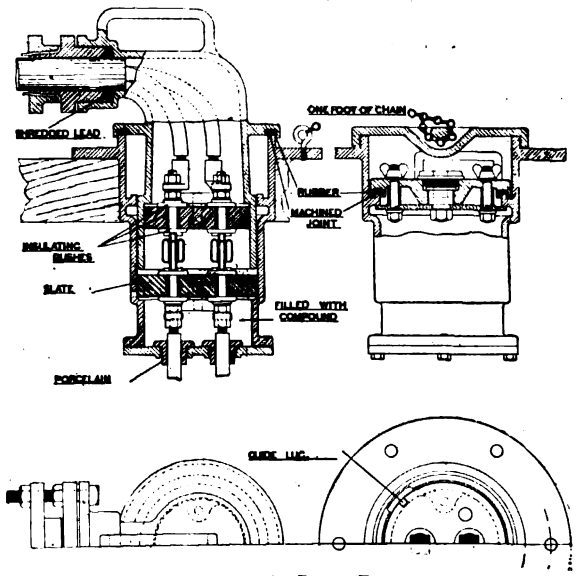
Write for New List No. . . 177.

Sun Electrical Co. (Nos. 104, 111.)

This company's stand is near the centre of the hall and will be found principally attractive on account of its varied display of electrical signs. The company has specialised in these for many years past, and have we understand built up a big business in connection with them. Fittings and accessories of all kinds will also be shown, and electrical contractors, consulting engineers and architects should make a point of inspecting the Kalkos wiring system to which considerable prominence is being given.

Callender's. (Nos. 196, 219.)

Boxes.—The exhibit of Messrs. Callender's Cable & Construction Co., Ltd., consists principally of a collection of various types of electrical and underground junction boxes. The exhibit contains examples of feeder pillars, both lighting and traction, underground network boxes, mining boxes, as well as ordinary service and house-fuse boxes. The combined high and low tension pillar should be noted; when used in conjunction with underground transformer tank, it forms a small transforming station. This should be of great interest to engineers in charge of an extensive district in which alternating-current is supplied. A special colliery iron winding drum is shown of a small size, but these drums are made of full size for high or low tension sinking cable, and for sinkings to 900 ft. in depth



CALLENDER'S PLUG BOX.

Alloys.—The alloys section of this exhibit will also be of interest to engineers. Callender's have already established a considerable reputation for the quality and reliability of these materials. As they are large users of the metals from which their alloys are manufactured, they are in a position to offer alloys of all qualities at low prices. The exhibit consists principally of bronzes and anti-friction white metals.

Kalbitum Paint.—As there is always a demand for a preservative paint for use with ironwork for preventing rust and corrosion, Callender's take the opportunity of this exhibition to bring to the notice of the public their now well-known Kalbitum paint. Free samples of this paint will be sent on application.

Kalanite.—This material is well known to the electrical trade as an insulator of high quality which can be supplied at a low price, and inquiries will be welcomed. It can be moulded or turned, and made up into any shape; it can also be supplied in sheet or rod form.

Electric Batteries.—Callender's also manufacture the "Fors" accumulator for Richard Pape, Ltd., and a further section of the stand is given up to these well-known accumulators. In this description it is not possible to give all the special features of this battery, but it is sufficient to say that its weight and size in proportion to its output is less than any other accumulator on the market, while owing to its design, short-circuiting and the buckling of the plates are absolutely impossible.

Brush. (Nos. 84, 89.)

The exhibit of the Brush Electrical Engineering Co. ranks in the class of "heavy" manufacturers. It comprises a Brush-Parsons combined action and re-action mixed pressure turbine operating at 2,500 revs. per min.; the machine has an output of 400 kw. with high-pressure steam or mixed high and low pressure, and of 300 kw. with low-pressure steam (about 16 lb. per sq. in.), the vacuum being 28 in. A direct-current generator is direct connected to the turbine, and has commutating poles, slotted drum armature, special ventilated commutator and sliding box pattern brush-holders. Adjoining the turbine is a 22·5 kw. steam dynamo designed to run at 650 revs. per min. under 200 lb. pressure. The dynamo is filled with special ball bearings, direct-current and alternating-current motors, travelling pulley blocks, and Gese pulley block and the Marshall hoist, a portable grinder and the collector gear for the Bremen trackless trolley system complete the exhibit.

Western Electric Co. (Nos. 51 and 72).

This exhibit is mainly comprised of telephones and switchboards for large exchanges for operation on both the central battery and magneto systems. The company has done a great deal of work in this direction, and the illustrations of large exchanges equipped with Western electric apparatus should be examined with interest. From the more public point of view, the telephone exchanges for use in hotels, municipal buildings, asylums, hospitals, factories, clubs and commercial houses are of considerable importance, and the examples exhibited are, we understand, up to date in every respect. The largest telephone exhibited is a central battery multiple switchboard with lamp signalling, as installed at the G.P.O. It comprises three two-panel sections with two operators, and immediately adjacent are the main distributing frames, combined meter and relay rack, power board and battery of 11 storage cells. A large hotel switchboard suitable for installations of not more than 240 lines is shown.

WESTERN ELECTRIC INTERCOMMUNICATION TELEPHONE.

This is fitted with eyeball signals. The cordless table switchboards made by the company are also exhibited. These are extremely convenient, and, owing to their simplicity and low maintenance, have been found of immense value in the Colonies and foreign countries. The company's "Westophones" and interphones are also to be inspected. There is an electrical supplies section, in which metal lamps, "Amazon" insulating tape, fibre conduit, line material, fuses, &c., are prominently displayed.

H. WEIDMANN,
RAPPERSWIL, SWITZERLAND.
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Presspahn and Insulating Material.
(See larger Advt. last week.)

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The efficiency is proved—there is none actually higher.

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YOU
AT
LUNDBERGS'
STAND No 90
OLYMPIA
ELECTRICAL
EXHIBITION.

General Electric Co. (Nos. 103, 112, 125, 134.)

A wide and comprehensive exhibit, representative of most of the company's manufactures, is being made near the centre of the hall. The exhibit is divided into two stands, one on each side of the central gangway. A considerable portion of it is devoted to Osram lamps and fittings, and a fine display is being made. There is also a good show of the company's heavier products in the way of switchgear, motors, telephone apparatus, tools, &c.

Jandus Arc Lamp & Electric Co. (Nos. 105, 110.)

The attention paid by this company to the regenerative arc lamp, of which they make a speciality, is exemplified in the excellent arrangement of their exhibit. The lamps will be shown burning in special compartments fitted with blue glass fronts, through which the behaviour of the arc can be comfortably examined. The company direct attention to their small consumption lamp, which takes only 250 watts, including line resistance, and gives a candle-power of 1,800 to 2,000 at an angle of about 15 per cent. below the horizontal. The lamp burns 100 hours, and, compared with a 200 c.p. metal lamp, consumes the same energy but emits approximately 10 times the candle-power.

Lancashire Dynamo & Motor Co. (Nos. 122, 137.)

The exhibit of this firm is combined with that of Messrs. Joshua Buckton & Co., and is principally noticeable for the display of a large planer, in which the table is operated by variable-speed direct-current motor, which is arranged by special control gear to speed up the table of the planer on the idle stroke. A representative exhibit of the company's products in direct-current and alternating-current motors is also made.

Sunbeam Lamp Co. (Nos. 55, 68.)

An attractive exhibit has been got together by the Sunbeam Lamp Co. comprising a full range of their electrical fittings and accessories. In particular they wish to call attention to their metal lamps which are made in sizes from the smallest battery lamp to those of 1,000 c.p. The carbon lamp is, of course, not dead yet, though we anticipate at the next Electrical Exhibition it will be displayed rather as a relic than an exhibit. We may, however, remind our readers that the Sunbeam raidator lamp which is used by the Dowsing Radiant Heat Co. is one of the best upon the market.

Bruce Peebles. (Nos. 119, 140.)

There are comparatively few heavy-plant manufacturers in the Exhibition, and prominent among them may be mentioned Messrs. Bruce Peebles. The *piece de resistance* of their exhibit is their now famous motor converter. We have described this so many times in our pages that we do not need to give further details. We would, however, remind our readers that the opportunity of actually inspecting one of these interesting machines should be taken the fullest advantage of. The other features of the exhibit are mainly centred in types of alternating-current and direct-current motors made by Bruce Peebles at their Edinburgh works. There is a machine fitted with an automatic centrifugal starter which comes into action as a short-circuiting device when the motor has attained full speed. The contacts of the device are of ample surface ensuring good connection. The motor has a starting torque 70 per cent. of full load torque with full load current. A standard Peebles slip ring motor with removable cover for the slip rings is also shown. A feature of this machine, as also the one mentioned above, is the provision of adjustment screws in the end plates carrying the bearings. These screws are finely threaded and admit of the adjustment of the air gap for wear in the bearings. Peebles crane capstan mining and traction motors are also on view.

Sub-station Plant. Vickers, Ltd. (Nos. 80, 92.)

At one side of the Exhibition is the substation in which the Hammersmith supply is transformed and converted for use on the various stands. Berry and Westinghouse transformers are installed and Johnson & Phillips and Ferranti switchgear. The rotary plant is of interest and comprises a Vickers 300-kw. 50-cycle 6-phase rotary converter, direct-current voltage 220, alternating-current voltage 160, speed 750 revs. per min. It is of the Vickers standard type, fitted with interpoles to enable the machine to withstand heavy overloads. It is provided with a standard three-phase induction motor, direct-coupled for starting up the set on the alternating-current side. The rotary is provided with six slip-rings through which the six-phase current enters the armature. The rings are so constructed that by removing the bolts any ring can be replaced without dismantling the whole gear. The bearings are of the swivel type, the bush being of cast-iron lined with white metal. Lubrication is supplied by means of rings running in an oil bath.

Electric & Ordnance Accessories Co. (Nos. 80, 92.)

The display of E.A.O. specialities made by this company is one of the most striking in the centre of the hall. This exhibit is bridged by a large sign which effectively displays the name of the company and its principal products. Our readers are mainly familiar with these. We may mention in particular the wide range of Vickers' alternating-current and direct-current motors, centrifugal fans, propeller fans, ironclad switchgear and motor starters. The Vickers' controllers and lock-on and off switches should be inspected, and station engineers and contractors are specially directed to the "Eclipse" electric cooking and heating apparatus. The company's experience in this direction extends now over a period of years and as a result they have been able to develop a highly satisfactory and efficient apparatus. This portion of the exhibit will be in the hands of a lady demonstrator, who, as a qualified cook, will be able to bring out the advantages of the apparatus to the utmost. Vickers' arc lamps and metal lamps will be on view, also porcelain insulators, and Fireite, the latter being a new heat-resisting insulator. Timkin adjustable roller bearings and Vickers' Duralumin complete the exhibit.

OLYMPICS.

Was the King asked to open the Exhibition?

Will there be any wrecks at the foot of the Pope Lighthouse?

Why has Edison been put in the Gallery? He usually plays to it.

Is it true that there is a plot on foot to present Sir Joseph Lyons with a "Tricity" Cooker?

Where are the battery makers?

How many "new" metal lamps will the Exhibition give birth to?

Why Pintsch Aur lamp?

Under its reorganised scheme what firms will constitute the "allied" section in the new Manufacturers' Association?

B.E.A.M. (British Electrical Allied Manufacturers' Association Incorporated) May we hope that the scriptural significance of the "beam," and the "mote" will not be lost on the members of the reorganised Association?

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THE ELECTRICIAN COMMERCIAL AND INDUSTRIAL SUPPLEMENT.

C. & I. Supplement No. 104.] SEPTEMBER 29, 1911. [Gratis to Subscribers.

OLYMPIA ELECTRICAL EXHIBITION.—II.

MORE NEW THINGS AT OLYMPIA.

Hope's Honeycomb Fuse. (Stand 81–91.)
Abbey Enclosed Flame Arc. (Stand 5.)
Brimsdown Reflecting Strip. (Stand 100–115.)
Westminster Enclosed Flame Arc. (Stand 165.)
Tantalum Prize Show Cards. (Stand 179–184.)
Credenda Picture Signs. (Stand 156–157.)
Broughton's Book, "Electric Cranes and Hoists." (Stand 180.)

OLYMPICS.

Are we downhearted? Chorus of Exhibitors: NO!!!

When is a quid a pro quo?
Why did not the Executive advertise the Exhibition in the agony columns of the daily Press?
Are the non-exhibitors now wishing they had?
Why did the Mazda-lier at the Venerable Bede?
Will the Lord Mayor really come to the Show?
Who said we should not have a band?
Have you been under the Bridge of Sighs in the Italian Garden?

THE NEW OSRAM LAMP.

The General Electric Co. seems to be able to startle the industry at times when it is least prepared for it. We have hardly recovered from the shock of the introduction of a 50-watt drawn wire tungsten lamp when we are asked to inspect a 20-watt 200-volt lamp with a jointless filament. As we announced exclusively in our columns last week, there is an Osram lamp of this size on view at the stand of the General Electric Co. By this it must not be implied that only one of these lamps is being shown, wrapped in cotton wool and placed in a glass case. On the contrary, they are there apparently in their hundreds, and visitors can take and handle them as they please. To give the fullest assurance that the filaments will stand vibration *when cold* as well as hot, two model tramcars have been fitted up and arranged to run down inclines towards each other and bumping against buffers in the centre. While these shocks are administered the lamps are switched on and off. The illustration on page 202 is a full-size view of the lamp, and its remarkably short bulb will be noticeable. Standard shades and reflectors, which are now largely used with carbon lamps, will, therefore, be available for use with the new 200-volt Osram. The station engineer may look askance at the new lamp, but he need not fear that it will do him any harm. It will encourage the smaller consumer to come on the mains, and extend the supply by that means, and it will encourage the uses of electricity for other purposes besides lighting, in any case.

S.S. "MANTUA" of the P. & O. Line.
Illuminated by "OSRAM" Lamps.

SHIP LIGHTING
BY
All Voltages 2 to 260.
All Candle-Powers 1 to 1,000.
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WE ARE EXHIBITING
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Sole Agents for
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THE INAUGURAL BANQUET.

On the evening preceding the opening of the Exhibition, Sir Wm. Preece, K.C.B., presided over an interesting gathering of Pressmen and members of the B.E.A.M.A. (incorporated). The proceedings were unduly prolonged by the large number of toasts and the absence of brevity on the part of one or two of the speakers. Sir Albert Rollitt proposed the toast of the evening, that of "The Electrical Exhibition," and was in rare good humorous form. He delighted the audience with, as Sir William himself acknowledged, "the best collection of stories he had heard for many a long day." Apart from his lighter passages, Sir Albert was rich in reminiscences of the early days of the electrical industry, and particularly of his association with Sir Wm. Preece, to whom he paid many tributes. In his reply, Sir William Preece reminded those present of his 60 years' work in the field of electricity, 30 years in connection with private enterprises and 30 years with the Post Office. At the beginning of next year Sir William said that he would celebrate his diamond jubilee as a civil engineer. He made the interesting statement that in the year 1834, when he was born, Elkington took out his first patent for the electro deposition of silver. He totally disagreed with the pessimists of the time, who believed in every country but their own. He had recently been to South Africa for his health, and was much impressed by the vigour and enterprise of the Britishers out there, in spite of the many Germans and Americans who were active competitors. He thought that the old country was well ahead in matters electrical and scientific. He announced, in speaking of the late Lord Kelvin, that Lady Kelvin would, at the next session of the Institution of Electrical Engineers, present that body with a bust of the great scientist. On that occasion and on the eve of a great popular Electrical Exhibition he should like to adapt certain lines from Shakespeare.

The note of the evening was, however, struck by Mr. H. Hirst in proposing "The Electric Supply Authorities." From the manufacturers' point of view, he put his finger on the pulse of the situation. He at first mildly chided the Exhibition authorities on their failure to make Olympia a blaze of light. If the matter had been apprehended in the right spirit the value of the Exhibition as a popular advertisement would have been enormously enhanced. He deplored the fact that the manufacturers had lacked necessary cohesion to provide this aggregation of illumination which would have made Olympia a centre of attraction over all London.

He also voiced the opinion that the Exhibition in great measure failed of its object because the various interests represented were scattered in all parts of the Exhibition. He hoped that when the next Exhibition was held, it might be in only a few years' time, they would see to it that the various sections of the industry were represented in a composite sense. He hoped to see the motor manufacturer, the lamp manufacturer, the arc lamp makers, the fitting designers and producers all assembled at their respective corners of the Exhibition. Then, from the public point of view, there would be no confusion in an inspection of the Exhibition. Each thing would be in its right place, and irrespective of the individual merits of the particular product, the public would be impressed with the advantages which they would derive by the uses of electricity for the particular purpose in view.

We discussed this matter after the dinner in an informal way and many people expressed the hope that something would be done with the suggestion at a future exhibition. But things don't hold well enough together to try it just yet!

OSRAM LAMPS

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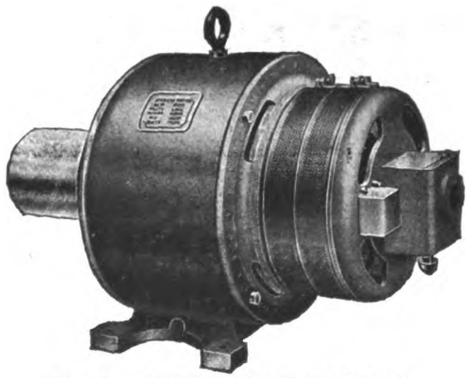
VICKERS
MOTORS
FOR ALL PURPOSES.



IN ALL SIZES UP TO 50 H.P.

Their rigid and substantial construction enables them to withstand the most severe usage and give a continuous and uninterrupted service without help from the repair shop or any undue heating.

Stand Nos. 80 and 92 Olympia Electrical Exhibition.

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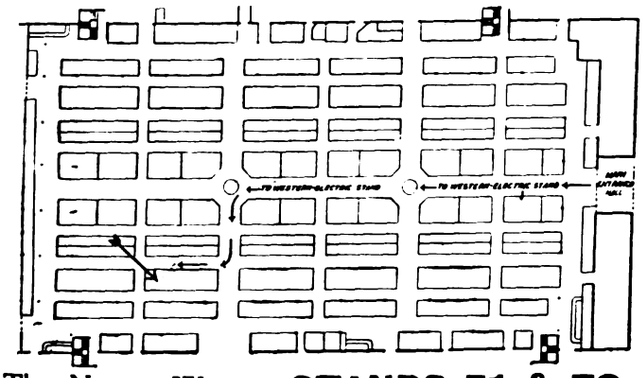
Proprietors : Vickers Limited.
ASTON, BIRMINGHAM.



The Nearest Way to **STANDS 51 & 72.**

Olympia.

All Contractors should make a point of visiting our Exhibit.

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ELECTRICAL SUPPLIES.
Telephones and Switchboards in Operation.

Western Electric Co., Ltd.,

Norfolk House, Victoria Embankment, LONDON, W.C.
Works : NORTH WOOLWICH, E.

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QUALITY
UNEQUALLED,
ALL
LATEST
INGENUITIES
TEMPT
YOU
AT
LUNDBERGS'
STAND No 90
OLYMPIA
ELECTRICAL
EXHIBITION.

HENLEY'S NEW WIRING SYSTEM.

Undoubtedly the chief attraction to electrical contractors and wiremen at the Exhibition is the new Henley Wiring System. We have already explained briefly the elements of this ingenious adaptation of metal sheathed insulated conductors to the requirements of inexpensive wiring. We were slightly in error in stating last week that the outer covering of the wire is lead. It is actually a special lead alloy which possesses, we understand, certain advantages over the pure metal. To turn now to the details of the system. The conductor is of copper, V.I.R. insulated, laid over with a thin copper tape, and finally covered with the lead alloy already referred to. The copper tape is utilised as the return conductor when the system is run concentric: where double wiring is needed the outer is just earthed suitably. A metallic continuity of tape is maintained throughout the running of the wiring, and this is accomplished by the use of an extremely simple fitting, if it can really be given this title. Fig. 1 will explain how the wiring is dealt with at either switch or ceiling points. An ordinary wood screw, which is turned home into a wood plug in the wall, is tapped to receive a long stud screwed through out its length. This stud provides a terminal for the copper tape on the special conductor, and also serves as support by which the wood block is firmly held in place. The illustration shows how the copper tape is clamped under a knob provided for the purpose. Now a piece of bare wire is taken from this to form one terminal (the earthed one) and how the insulated conductor is also passed through a hole in the block, for connection to the particular accessory that may be attached to it. This arrangement holds good for the concentric or earthed return application of the system. The twin conductors used are shown in Fig. 2, and Fig. 3 illustrates the special clamp and bonding device for use with these conductors.

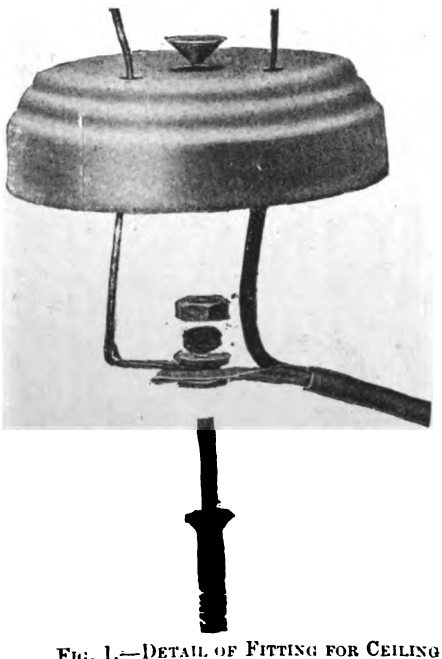

Fig. 1.—Detail of Fitting for Ceiling and Switch Points.

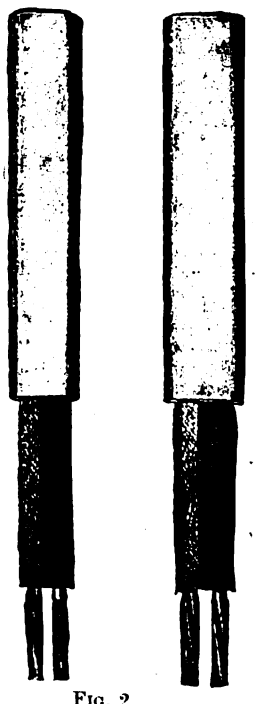

Fig. 2. Twin Conductors.

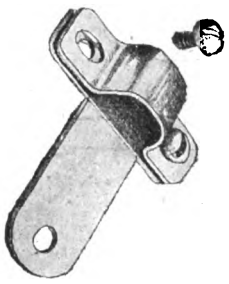

Fig. 3.—Bonding Clamp for Twin Wires.

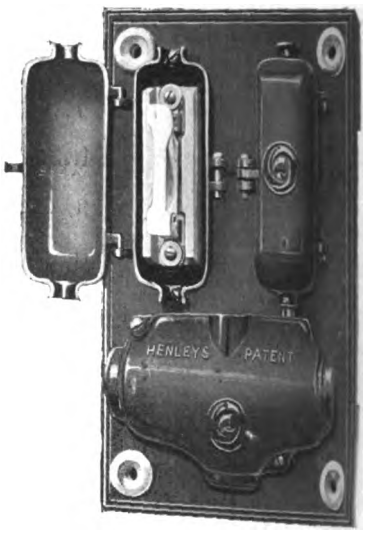

Fig. 4.—House Fuse Board.

The conductor is commendable because it is very flexible, can be run round bends and corners by mere bending with the fingers. Some difficulty is often experienced with these new wires in the matter of the bending. With Henley's new system this embargo is likely to be removed, because it is put on the market without a "bending tool," and this may be taken as a recommendation for easy working of the system. The copper tape after being turned back is doubled on itself for a space of about ½ in. to ¾ in., and a hole is punched through the two thicknesses of tape, and it is this which serves to hold the tape in position on the stud which acts as the earthing and bonding terminal. A special punch is provided for the making of this hole. The conductor is secured to the wall by brass saddles having one or two nails. The stand at the Exhibition is fitted out with specimen installations of the system, both double conductor and concentric. The work is neatness in the extreme, and the wiring is quite unobtrusive. There are samples of the conductor, which is made single and strand, on view, and visitors can see for themselves how the conductors can be worked. Messrs. Henley's have introduced this interesting system to provide the industry with an inexpensive method of surface wiring, particularly for houses of moderate rental. They claim it to be a complete solution of the cheap wiring ploblem. The system is, of course, completed by a suitable distribution box having S.P. fuses, and a common terminal bar to receive the ends of the copper tape. We understand that the company has laid down a quantity of special plant for the making of the new conductor, and that a large number of orders have been received for it. Fig. 4 shows the house fuse board and dividing box which Henley's recommend for use with the above system.

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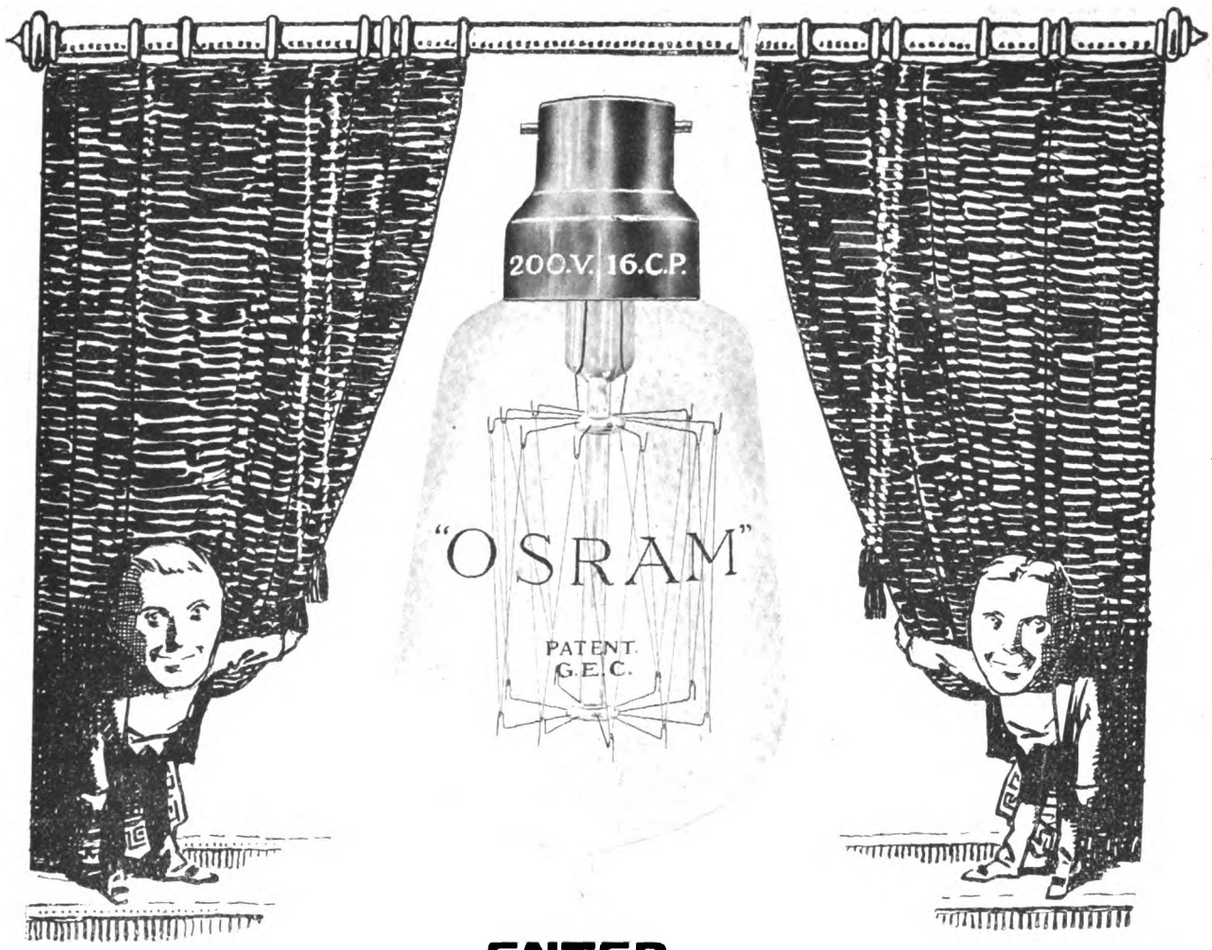

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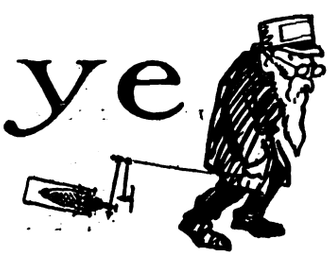

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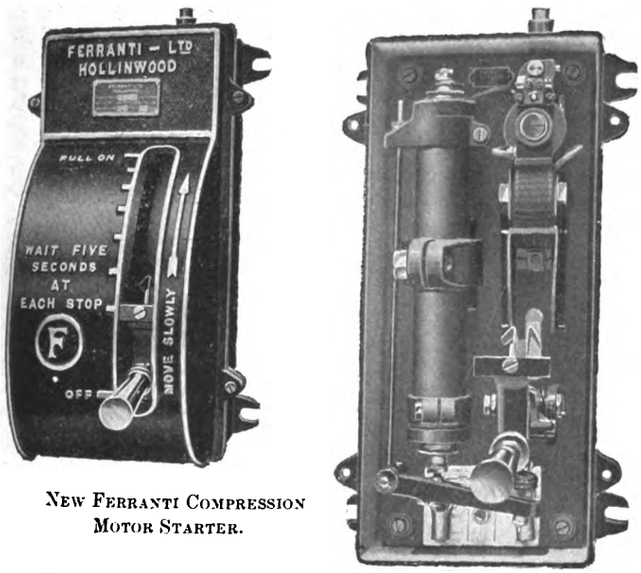
OLYMPIA EXHIBITION.—*Continued.*

Ferranti, Limited. (Nos. 102, 113.)

We have already complimented Messrs. Ferranti, Limited, upon the design and arrangement of their stand. Now that the exhibition is open it appears in bold relief in the body of the hall among the neighbouring exhibits. It is a model of how electrical control gear and apparatus should be displayed in an exhibition of this character. We have found that our good opinion has been generally endorsed since the opening of the show, and the officials of the company will, we are sure, feel particularly proud of the distinctive nature of their exhibit.

To central station engineers and electrical contractors the chief object of interest on the Ferranti exhibit is the new compression motor starter. As we stated in our last issue, this is an entirely new application of the carbon rheostat to the function of motor starting. In fact, the starter is a combination of a compression rheostat with a circuit breaker. The successful development of the design has hung



New Ferranti Compression Motor Starter.

upon the provision of an insulating lining to a steel tube which would be fireproof and have the same coefficient of expansion as the steel. We understand that this desirable result has been obtained, and the company is now in a position to supply a form of starter in which contacts, connections, studs, plates, wires, grids and woven resistances have absolutely no place. We illustrate the simplest form of starter in which the resistance element is contained within a single steel tube lined with the insulating material to which we have referred. Within the tube is a great number of extremely thin carbon discs. These discs form a column in the tube, with a fixed terminal at one end and a movable one at the other. This movable terminal is so arranged that by the movement of the circuit-breaker handle the lever comes into operation, actuates the movable terminal and exerts pressure on the column of discs. This pressure is, however, not applied until the shunt circuit of the motor has been closed by the first movement of the circuit-breaker handle. Further movement of the handle brings about the pressure on the column of discs, the resistance in the motor circuit is gradually reduced, and by the time that it is entirely cut out the circuit-breaker is closed. The handle of the breaker is passed through a slot in the iron cover which completely encloses the apparatus. The edge of this slot is marked with instructions that the handle be held for 5 seconds at each of the lines on the slot. This ensures even starting. There is a no-volt and overload release to the breaker, so that the motor is absolutely protected. A mechanical trip to the breaker latch is provided for the opening of the switch and the shutting down of the motor. The starter occupies a minimum of space, and can be placed complete on a wall surface or fastened directly to the motor carcase. The starter is at present manufactured in sizes up to 30 H.P., and it can be combined with shunt regulator and separate circuit-breaker in a complete motor control ironclad panel. By the increase in the number of rheostat tubes the larger sizes of motors can be controlled. The same principle is introduced into the Ferranti regulators which are offered in various sizes for controlling the speed of small motors. In this class of apparatus carbon washers resting on quartz tubes are made use of, and pressure is brought to bear upon them by a common face-plate, which is acted upon by a central hand-wheel. We would strongly recommend to engineers who are interested in the control of motor circuits to take an opportunity of inspecting this interesting portion of the exhibit.

Mirrlees, Bickerton & Day. (No. 8.)

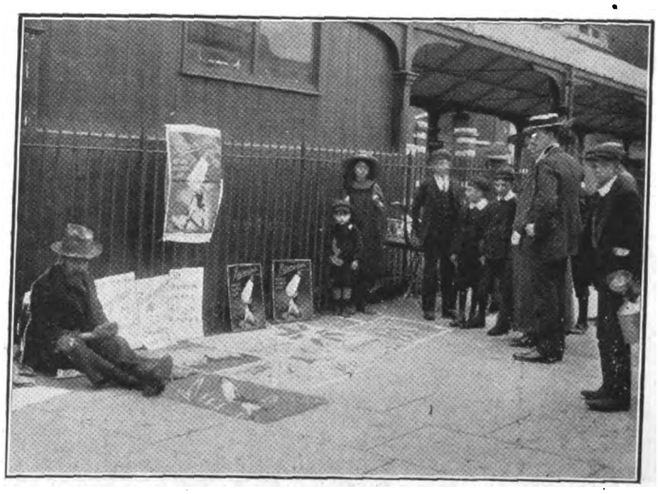
This exhibit includes a "Mirrlees-Diesel" oil engine of the four-cylinder type, 160 B.H.P. and is a duplicate of a considerable number of engines the company have made for driving dynamos on board warships, most of the recent British battleships and first-class cruisers being fitted with these engines. The engine is of the completely enclosed type, with forced lubrication to all bearings, and is direct connected to a dynamo, built by the Lancash,re Dynamo & Motor Co. Four separate oil supply tanks containing different grades of oil are connected with the engine in such a manner that the engine can be switched over from one grade of oil to another whilst running, the object being to demonstrate that no alterations are necessary to enable the engine to work with widely varying qualities of oil. The dynamo is connected with a water resistance, and suitable switches are provided so that full-load or partial loads can be switched on and off as desired. Visitors will have an opportunity of noting the behaviour of the engine on widely varying loads. The engine is exceedingly compact, and occupies little space and forms a most interesting exhibit.

Pooley & Austin. (Nos. 49, 74.)

The exhibit of this company is comprised of the manufactures of three of the firms for which it holds sole agencies. These are Messrs. Mawdsleys (Ltd.), Spagnoletti (Ltd.) and Engineering Instruments (Ltd.). The Mawdsley display is confined to direct-current dynamos and motors ranging in size to 300 H.P. A Mawdsley 50 kw. dynamo is also shown direct-coupled to a four-cylinder vertical oil engine. The products of Messrs. Engineering Instruments and Spagnoletti are in the nature of switchgear and switching apparatus, and representative types of these have been selected and displayed.

An Advertising Tramp.

A touch of humour was given to the opening of the Electrical Exhibition at Olympia on Saturday last by a unique advertising scheme of the Brimsdown Lamp Works. A well known Fleet-street artist, dressed for the part in a scraggy sandy beard, tow wig, battered hat, battered coat and vest and cast-off "bobby's" trousers, alighted from a taxi in a quiet side street near Addison-road. Adopting the footsore walk of the type he represented he crawled along to the main entrance of Olympia, passing on the way several acquaintances. Assuming a "husky beery" voice he asked permission of a six-foot-six commissionaire to make sketches near the gateway. Permission having been graciously granted to the "old bird," he commenced to clear the paving stones, but did not disclose his advertising scheme until six sketches were completed. Then placing two showcards and a large poster in the background, he wrote advertising phrases on each sketch, much to the amusement of the onlookers. The tramp artist had the unique experience of having coppers flung to him in



The Brimsdown Pavement Artist at Olympia.

charity by electrical men whom he knows intimately in his business capacity of advertising specialist. During the occupation of the pitch, from 3:30 to 5:30, the "takings" amounted to 7s. 7d.—85 pennies, and a sixpence given by a charitable elderly lady on her way to Addison-road Station. Mr. J. Conway Price, the "gentleman" in question, pays a glowing tribute to the kindness and sympathy he received from the policeman and commissionaire at Olympia, who frequently gave him a few words of encouragement. In return for the coppers he received Mr. Price handed out "Brimsdown" Turkish or Virginian cigarettes.

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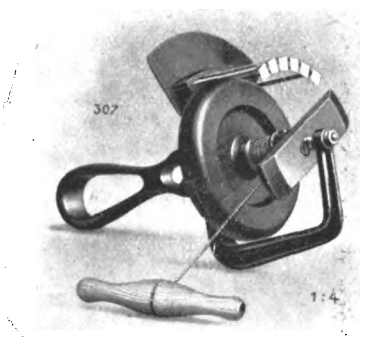
Union Electric Co. (Nos. 101, 114.)

The exhibit of the Union Electric Co. is noticeable from practically all parts of the exhibition. It is one of the most striking of the "open" stands in the show. The centre of the exhibit is occupied by what appears to be an ironclad switch pillar of large dimensions. As a matter of fact, it is the office of the exhibit lined up with the sheet metal work used by the company in many of their h.t. switchgear designs.

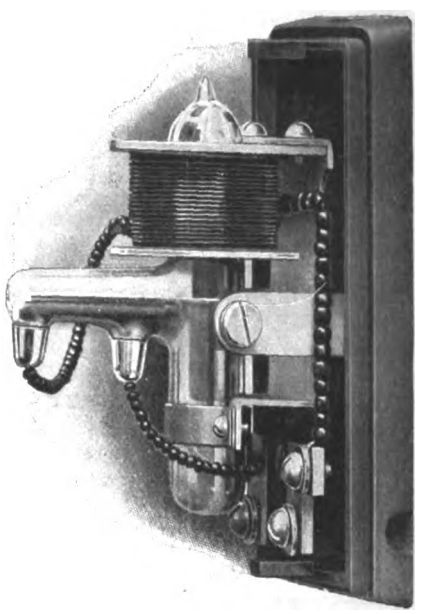
The products of the Union Company are so varied that it is difficult to single out for special notice any one of them. The requirements of many branches of the electrical industry are met by the company's manufactures, and we may specially itemise arc lamps and accessories, including the famous "Excello," "U.E.C." motors and dynamos in all types and sizes, Hartmann & Braun instruments and ironclad switchgear and motor starters. Turning to the last mentioned first, we may specially comment upon the "Fortiter" automatic field regulator. This is one of the simplest of the solenoid type of regulator, which has come under our notice. The solenoid is provided with a movable core to which is attached a trough of insulating material filled with mercury, and the ends of the resistances are fixed above this trough in the form of a comb having teeth of gradually decreasing length. It is obvious that by moving the comb vertically a greater or smaller number of the resistance coils



PORTABLE LABORATORY FREQUENCY INDICATOR.

are put in and out of circuit. This apparatus should be inspected, as it is shown in operation. The switchgear section of the exhibit is arranged, as we have already intimated, on somewhat striking lines. Included in it are two oil-break switches designed for pressures as high as 20,000 volts. There are also two switches shown for 10,000-volt circuits, and these can be arranged for lever or solenoid operation. An interesting feature of these switches is a special hollow insulator, in which the copper conductor passes through a non-hygroscopic insulating tube to the cast-iron flanges at each end of the insulator, and is surrouned by a fluted hollow porcelain insulator, which tapers in both directions from the centre. We are informed that this special pattern of insulator normally rated for 10,000 volts will stand a breakdown pressure as high as 47,000 volts. The Union switchgear is well known in this country, and has been installed in most of the great centres of industry, where a power supply either for public or private sources is available. Another feature of the h.t. exhibit is a form of water resistance for use with lightning arresters of a.c. circuits. We may also mention an inductionless resistance in which a special material known as "Ohmit" is introduced.

Instruments.—In the instruments shown, in addition to the usual patterns of ammeters and voltmeters, there is an interesting selection of frequency meters of the vibrating reed type. These are made on the Union Hartmann-Kempf system. A synchroscope of the vibrating reed pattern is included in this series. The hot-wire instruments are of interest, because of the use of a special platino-iridium alloy which makes the instruments independent of the temperature of the surrounding air. In this same series is a new line of ammeters for use in wireless telegraph installations, which are made to carry currents up to 100 ammeters. The instruments are of the straight-through type—that is, they have no external shunts—the platinum-iridium strips carrying the current being arranged symmetrically in cylindrical form. We understand that a wattmeter of



UNION CURRENT LIMIT SWITCH.

the same pattern is also shown for wireless telegraphy. The instrument section is so full of items of interest that it would take almost the whole of our exhibition space to describe the instruments in detail. We may, however, enumerate some of the other patterns shown. There is a line of electro-dynamometric wattmeters of the moving-coil type, a range of moving-coil instruments, a power-factor indicator of the differential moving-coil pattern for one and polyphase circuits, portable ammeters and wattmeters for incandescent lamp testing, small precision instruments, a new form of current limiter and an earth indicator.

Dynamos and Motors.—One of the most interesting of the types of motors shown is a three-phase loom motor having a cradle suspension. This is made in sizes from ½ to 1½ H.P., and is said to have high efficiency, a high power factor and a large starting torque. The new "U.E.C." motors and dynamos exhibited are of either the open or enclosed patterns, and there is being shown a totally enclosed 6 H.P. machine having a special cooling arrangement, whereby the air is constantly circulated through the motor, and is passed through a cooling grid. In this same section is exhibited a petrol-electric set for country house lighting or cinematograph work.

Arc Lamps.—The arc-lamp exhibit is one which will doubtless attract a considerable amount of attention. It includes the "Union" searchlight projector, which surmounts the pedestal in the centre of the stand, and a variety of enclosed and "Excello" lamps which are appropriately grouped on the stand. Bioscope photographic arc lamps and inverted arc lamps are also displayed.

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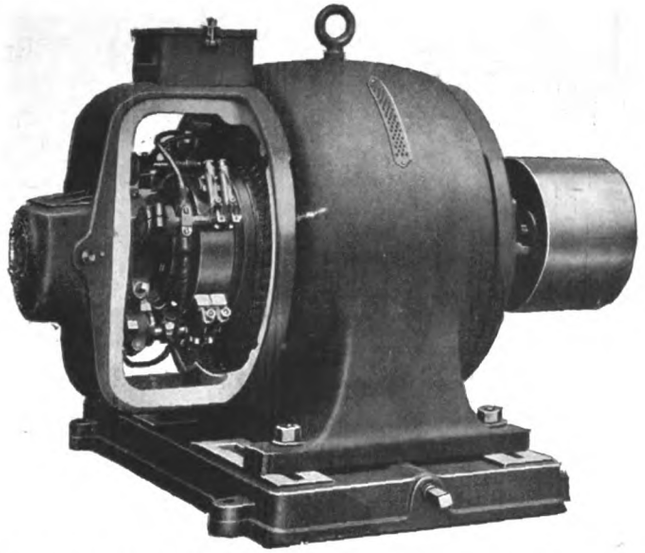

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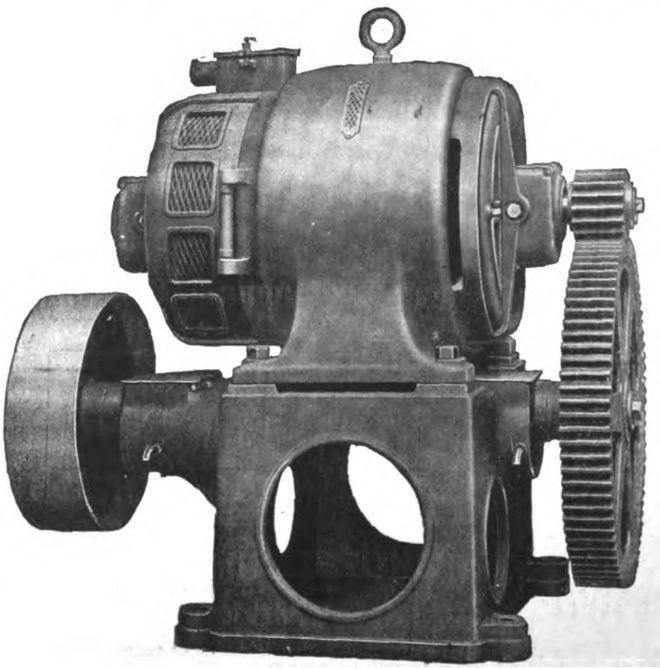

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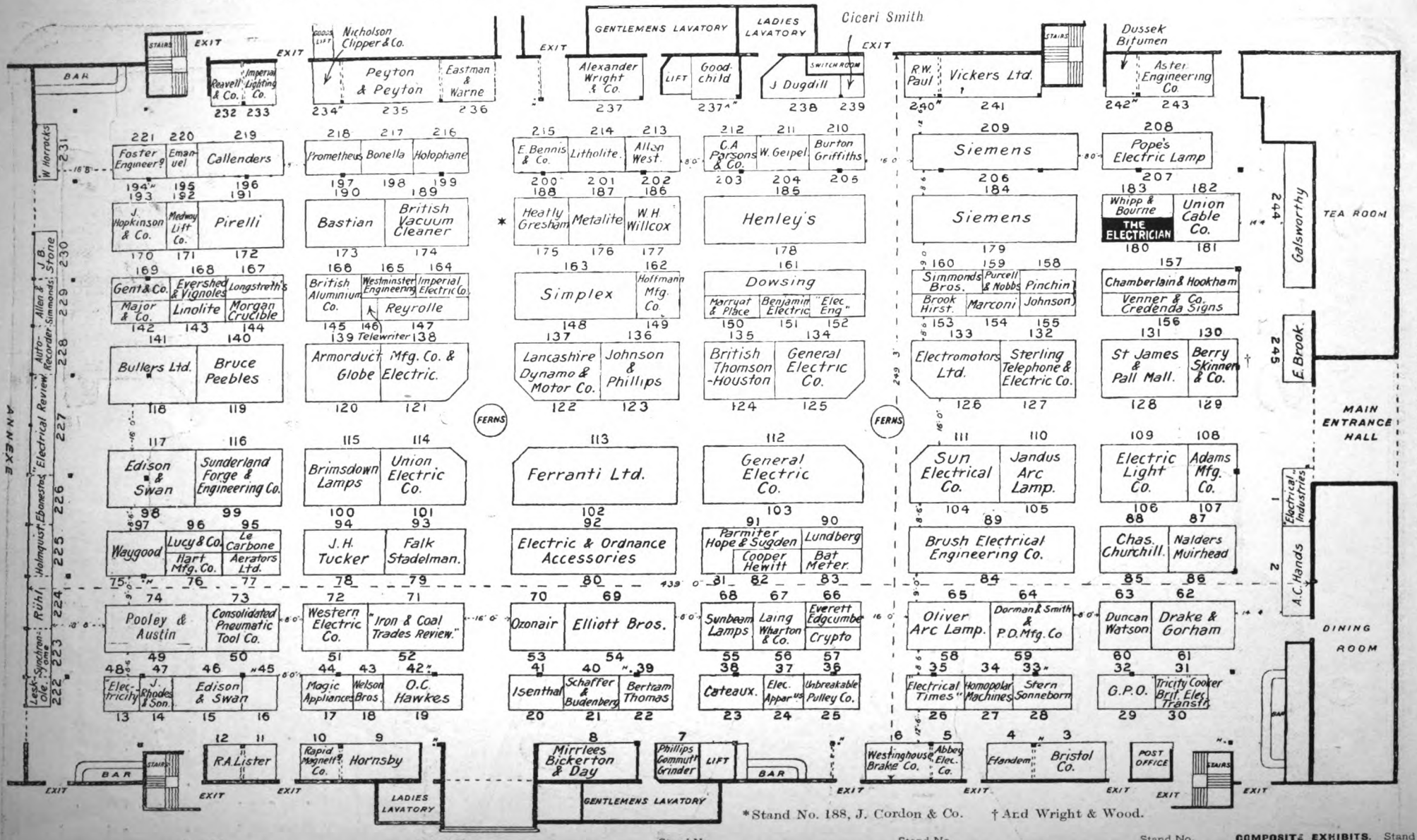

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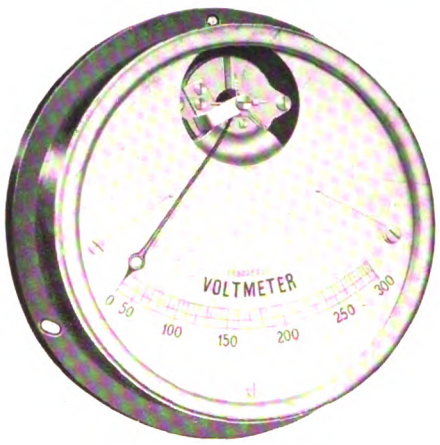

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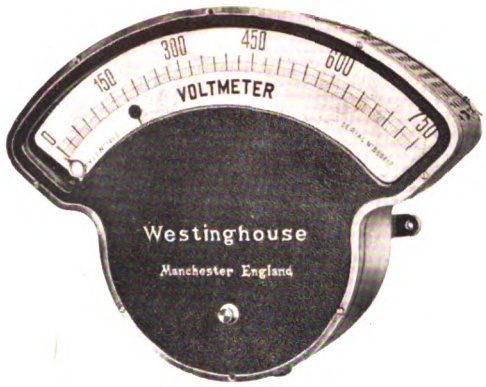

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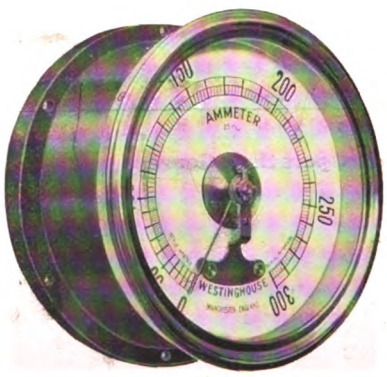

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SUPPLEMENT to "The Electrician," September 29, 1911.

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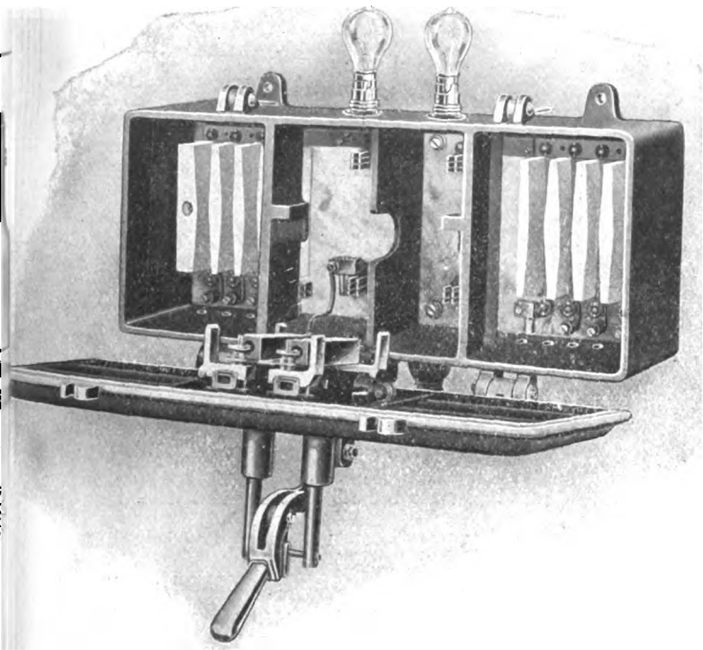
OLYMPIA EXHIBITION.—*Continued.*

Electric & Ordnance Accessories Co. (Nos. 80, 92.)

This exhibit is among the few in the exhibition which are completely open from all sides. The stand is a large one near the centre of the hall, and is surmounted by the bridge sign which bears the name of the company and its principal manufactures. Of particular interest is the complete range of Vickers direct-current motors, which are shown in sizes from 18 H.P. to 50 H.P. These machines have stood the test of hard service in all parts of the country and Colonies, and they certainly have a most businesslike appearance. The yoke and poles are of cast steel, the poles being fitted with laminated tips. The armature coils are former wound dropped into open slots, which are closed by specially treated wooden wedges. There is a generous provision made for cooling the field and armature coils. Where motors are required to be reversed or are subject to severe overloads, they are fitted with interpoles. Our readers should take special note of the brush-holders and terminals of these motors. The brushes are of the box type, and can be adjusted by the simple movement of a milled disc. The terminals are conveniently placed on the motor shell for wiring purposes. The Vickers alternating-current motors exhibited also display numerous points of interest. Electric power contractors and industrial power engineers will find the display of motors, starters, ironclad switchgear and controllers one of the most comprehensive in the exhibition. The Electric & Ordnance Accessories Co. have specialised for some years past in controllers of all kinds, and they are able to offer a variety of designs for almost every purpose. Vickers controllers are made for cranes, machine tools, lifts, hoists, printing presses and similar classes of power service. We understand that the company is prepared to supply controllers for any standard or special apparatus. Metal and mica construction is a feature of the apparatus, and the spark guards are fitted with the company's new insulating material known as "Fireite." Efficient magnetic blowouts are included in this important equipment. A switch recently patented by the E.O.A. is that known as the lock-on and off switch. In this a quick break and make is obtained and the blade is locked both in the on and off positions by means of steel balls.



E.O.A. Crane Switch and Panel.

The insulating material to which we have just referred is a special heat-resisting substance which the company is manufacturing at Hanley. It is recommended for carbon guides, arc lamp caps, burner nozzles and, in fact, anything which is brought into direct contact with a flame. It has considerable strength, possesses a good even surface and is, we understand, cheaper than any other similar material at present on the market. It is possible to supply it in almost any shade required. Vickers Duralumin, which is a substance to which we have previously referred, is also on view on the stand, and is shown in a variety of specimens. It is unaffected by mercury, is non-magnetic, will not oxidise, and will withstand the action of sea or fresh water. It will take a polish equal to nickel plating. It has a tensile strength of 40 tons per square inch, with very little elongation, of 28 to 30 tons per square inch with 18 per cent. elongation in 2 in., or 25 tons per square inch with about 20 per cent. elongation in 2 in. It can be supplied in 15 different grades and qualities, and in the shape of plates, sheets, screws, rivets, bars, wire, forgings, stampings, angles, tees, tubes and rolled or extruded sections. The material is not suitable for castings. The Timken roller bearing is a friction-defying device which is capable of taking loads from 270 lb. to 1,935 lb. It is of paper construction, and so arranged that end thrust can be supported as well as ordinary radial load. This arrangement also admits of the adjustment of the bearing to compensate for wear.

In every way the company must be complimented upon the manner in which its exhibit has been displayed.

The Lancashire Dynamo & Motor Co. (Nos. 122, 137.)

As explained in our last issue, a most important exhibit on this stand is a 4 ft. by 4 ft. by 10 ft. Buckton planer fitted with the "Lancashire" patent reversing motor drive. This drive has been so successful that upwards of 150 equipments have been supplied during the last 18 months. The planer will take two $\frac{5}{16}$ in. by $\frac{1}{16}$ in. cuts in mild steel at 75 ft. per minute. The cutting speed may be set at will to any speed between 25 ft. per minute and 75 ft. per minute by turning one handle, and in a similar manner the return speed may be varied between 120 ft. per minute and 220 ft. per minute.

Special attention is called to the accelerating device, which is in the form of a small switch worked by adjustable stops on the planer table. It performs two functions: (1) Speeding up between cuts when two or more surfaces some distance apart are being planed. (2) Speeding up when the tool has entered the work, so that higher cutting speeds can be used without extra wear on the cutting edge of the tool. If necessary the table can be retarded before the tool leaves the work, so that the end of the work is not broken. This has never before been done by any system of planer driving.

The switchgear used is simply that for an ordinary variable-speed motor, and is made in ordinary starting-panel form. The only switch moving at each reversal of the planer is the reversing switch, which only deals with the field current of the generator, this being equivalent to the current required by a few lamps.

The "Lancashire" system of driving a planer or other tool by a reversing motor is as follows: A motor-generator is mounted on the upright or in any convenient position, and the motor is connected to the power curcuit. Either alternating or direct current may be used, and if no current is available the generator may be driven from a line shaft.

The generator is connected electrically to the planer motor which is direct coupled or geared to the planer driving shaft. This generator and motor are direct-current machines, and may be wound for any convenient voltage. A reversing switch is actuated by one light tappet rod from the reversing gear of the planer. When this is thrown over it reverses the direction of the current in the field winding of the generator, thus reversing the direction of rotation of the planer motor. At the same time it so regulates the voltage of the generator as to cause the planer motor to run at the speed required according to whether it is on the cutting or return stroke.

The tappet rod mentioned above is the only mechanical connection between the switchgear and the planer. The cutting speed may be varied by hand to suit the work being done by means of a regulating resistance in the generator field. This gives a constant return speed, but if desired the return speed can be varied also.

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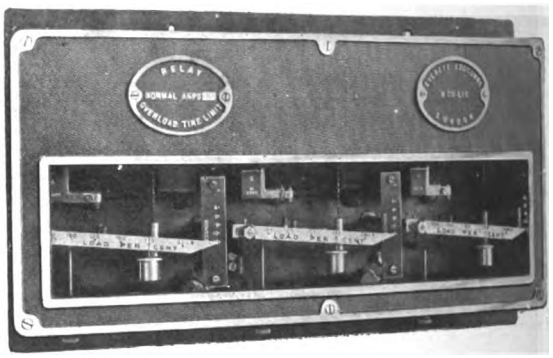
The planer table is driven by a machine cut spiral pinion-gearing into a machine-cut rack on the underside of the table. On the outer end of this spiral pinion shaft is a spur-wheel driven by a similar steel spiral pinion coupled up to the shaft of the reversing motor of the Lancashire Dynamo Co.'s "Lancashire" drive. With this spiral gear there are always a number of teeth, usually not less than four, in mesh simultaneously with the rack, and the motion of the table is effected noiselessly with extreme smoothness and without any jar or chatter, while the frictional resistance is reduced to a minimum. A distinguishing feature, and one which tends to greatly increase the output of the machine is the patent power feed and traverse motion. By means of this the feed of any tool box in any of its automatic motions can be varied over the whole range from a fine feed to a broad finishing cut with suitable intermediate rates.

The feed on all the motions can be stopped, reversed or varied instantly without stopping the machine. The cross slide can be rapidly traversed up and down by power, and all or any of the tool boxes can be rapidly traversed by power in any of their automatic motions. All these various motions are actuated by the patent power drive, and all the regulating handles are conveniently arranged to be operated from one side of the machine, and from approximately one position.

Everett, Edgcumbe. (No. 66,)

(*The Luxometer.*—In our last issue we gave a short description of this interesting instrument, but inadvertently omitted to mention that it was manufactured by Messrs. Everett, Edgcumbe. We take this opportunity of correcting this omission.)

This well-known instrument firm has an effective display of the large variety of instruments which it has been regularly manufacturing for many years past. We think that central-station engineers will be particularly interested in the alternating-current relays on view. We illustrate one of the induction overload pattern with inverse time element, a feature of which is that both the current and time settings are adjustable over a wide range. Further, the time limits can be relied upon to keep their proportional settings at all overloads, however heavy, consequently accurate discrimination is obtained. We also show a pattern of reverse relay, in which although a pressure winding is provided, it simply determines the direction of the flow of the current and not the magnitude of the overload required to trip the breaker which it controls. The makers contend, and apparently with reason, that a reverse power relay is not what is required and that a reverse relay should act or not according to the magnitude of the current flowing. Owing to the fact that on the occurrence of a bad short the pressure may fall very seriously, it is essential with a reverse power relay to make it extremely sensitive, and set it excessively fine. For example, if such a relay is required to trip at full-load current when the pressure falls to 10 per cent. of its normal value (a by no means unlikely occurrence) it must be set to trip with less than 10 per cent. of the full-load current at normal current. As a result, such a relay will almost certainly come out unexpectedly and when least wanted. With Messrs. Everett, Edgcumbe & Co.'s reverse relays, on the other hand, such an instrument can be set for 50 per cent. of the full load current and satisfactory working will be ensured owing to its independence of the pressure.



EVERETT EDGCUMBE THREE-PHASE INDUCTION RELAY.

Amongst the interesting exhibits we may mention the company's Graphic instruments, which are made for all circuits and voltages, their rotary synchronisers, an electrically-operated engine-room telegraph and a variety of tachometers and tachographs. The leakage indicators shown should also attract attention, particularly as they have been in use for some years, and the makers can vouch for their reliability. There is a line of water-tight instruments shown, which should be seen by electric power contractors who require to instal this pattern of instrument in damp and difficult situations in factories and workshops. The photometer equipments displayed by Everett, Edgcumbe are of the utmost interest, and our readers will find the attendants at the stand willing to supply any information and also to demonstrate the operation of the instruments. The importance of good illumination at the present time is being constantly emphasised, and on this account the attention paid by this firm to reliable instruments for its measurement should not go unrecognised.

Johnson & Phillips. (Nos. 123, 136.)

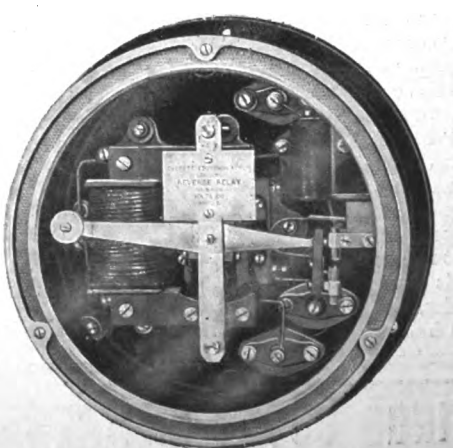
Arc Lamps.—A prominent feature of this exhibit is the "Metroflam" flame arc lamp. This is a magazine lamp, in which a number of carbons are employed, but in spite of this fact the change from one pair to the other is accomplished without any interruption of the light or objectionable flickering. We shall return to this interesting lamp in another issue, and at the moment may refer to the display of the company's other products.

Cables.—A particularly fine show is being made of v.i.r. and paper-insulated cables. Samples of these have been carefully grouped in show cases, and by an inspection of the cross-sections of the cables it is possible to observe the efficient manner in which the insulation and other protective coverings are applied. The cable manufactures are supplemented by examples of "J. & P." service and straight through boxes. The latter has been designed for colliery use, and admits of the connections being made without the use of solder. Mica and porcelain are the only insulating materials introduced.

Machinery.—A 10 kw. motor-generator designed to operate at 1,000 revs. per min. is exhibited. The output of the generator is 100 amperes at 100 volts. Ball-bearings have been introduced into this machine, and we understand that these bearings are so designed that they will not require attention for 12 months. The system of lubrication employed also guards against leakage.

Switchgear.—The switchgear portion of the exhibit occupies the

EVERETT EDGCUMBE SYNCHRONISER.



EVERETT EDGCUMBE REVERSE RELAY.

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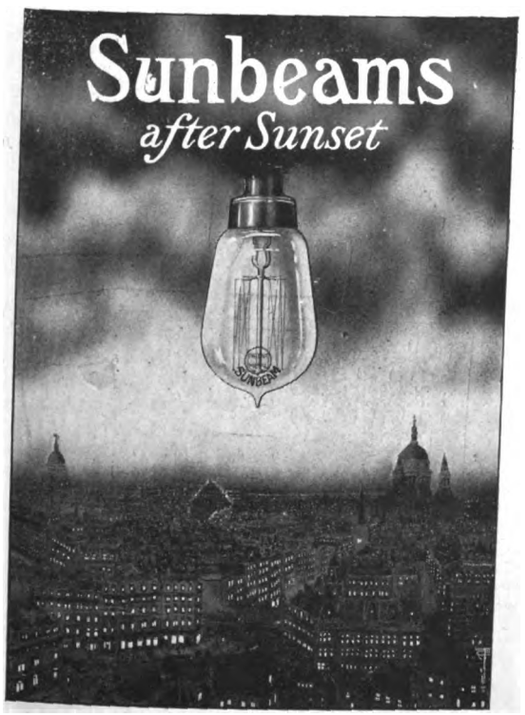

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AND
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AT
OLYMPIA
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AT

STAND NOS. 55 AND 68

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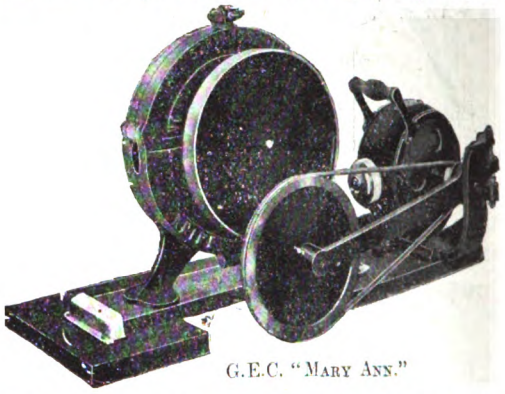
bulk of the floor space available. There is a remote control 10,000-volt three-phase panel built up in a glazed brick cubicle. The cells are arranged to separately accommodate the 'bus bars isolating switches, current and potential transformers and oil-break switches. The operating front is of marble, and contains the necessary instruments and gear. The oil switch is lever operated, and is provided with a strip coil and free-handled attachment, three single-phase relays come into operation on overload and also reverse, and bring the strip coil into circuit for the operation of the switch. The instruments on the board are of the Johnson & Phillips well-known hot-wire type. An interesting lamp-indicating device is fitted in connection with the oil switches to show whether the switch is in the on or off position. In another part of the switch exhibit will be noticed a 3,000-volt board designed to comply with the latest Home Office regualtions. A complete enclosure is made round all the live parts by means of extensions in every direction with the minimum of trouble. There is also a low-tension board on which one of the panels is fitted for the control of a standard tramway feeder of 600-amperes capacity. The other panel is connected in circuit with the apparatus on the stand-by way of the motor-generator already mentioned. The panel controls two separate circuits of 220 volts, one single-phase alternating-current and the other direct-current, and a further circuit of 80-volts direct current. The sub-station at the right-hand side of the Exhibition near stand 241 is also equipped with a "J. & P." 2,000-volt two-phase board, being part of the supply from the Hammersmith Borough Council. This board is fitted with two-phase oil switches with overload direct operating drop coils. There is also in the sub-station a "J & P." low-tension board. Tramway and power transmission engineers will be interested in the "J. & P." limiting resistances, which provide protection from the effects of lightning where horn arresters are used. The resistances comprise three earthenware troughs filled with graphite powder, having a known ohmic resistance, and these are coupled in series with the horn arresters, so that in the event of the latter arcing over only a certain amount of current can flow to earth. The powder is of such a consistency that it returns to its original condition after the passage of a severe current, so that it automatically sets itself in readiness for the next discharge.

General Electric Co. (Nos. 103, 112, 125, 134.)

This exhibit is practically in the centre of the hall, and is divided into two parts, one at stands 103 and 112, on the left-hand side of the

200 v., 16 c.p., Osram Lamp.

main hall, and the other at stands 125 and 134 on the right-hand side. The first mentioned is the larger of the two, and is devoted to the illumination products and fittings of the company. It includes a prominent display of Osram lamps, and particularly the new 200-volt 16 c.p. 20-watt size, to which we refer elsewhere. The stand is surmounted by a large sign, which is a bas-relief reproduction of the company's new poster, representing as it does a pair of hands holding up an Osram lamp. In this particular case the lamp is lighted, and produces a very fine effect. The display of lanterns and fittings is brilliant in the extreme. The company appears to have spared no effort to show how its designs can meet the requirements of electrical illumination at the present time. The display ranges from the most

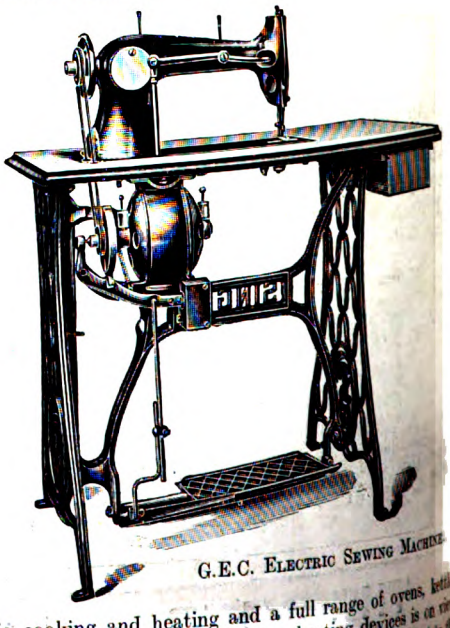


G.E.C. "Mary Ann."

elaborate and expensive chased fittings to the neat and artistic pendant which the moderate man will install in his house or flat. The range of shop-lighting fittings is such as would delight the eye of the proprietor of the largest emporium or the smallest tradesman. The display of the Butt magazine flame lamp and a variety of other arc lamps and accessories has been prominently and tastefully grouped.

G.E.C. Convertible Set.

Stands 125 and 134 contain the heavier portion of the company's products, such as "Salford" ironclad switchgear, "Witton" motor starters and motors, country-house lighting plants, "Witton-Kramer" drilling machines, &c. A portion of the same stand is set apart for an interesting display of certain processes in the manufacture of the Robertson lamp. The exhibit includes the Archer system



G.E.C. Electric Sewing Machine.

of electric cooking and heating and a full range of ovens, kettles, irons, radiators and a number of other heating devices is on view. In fact, the company's exhibit contains so much of interest to the

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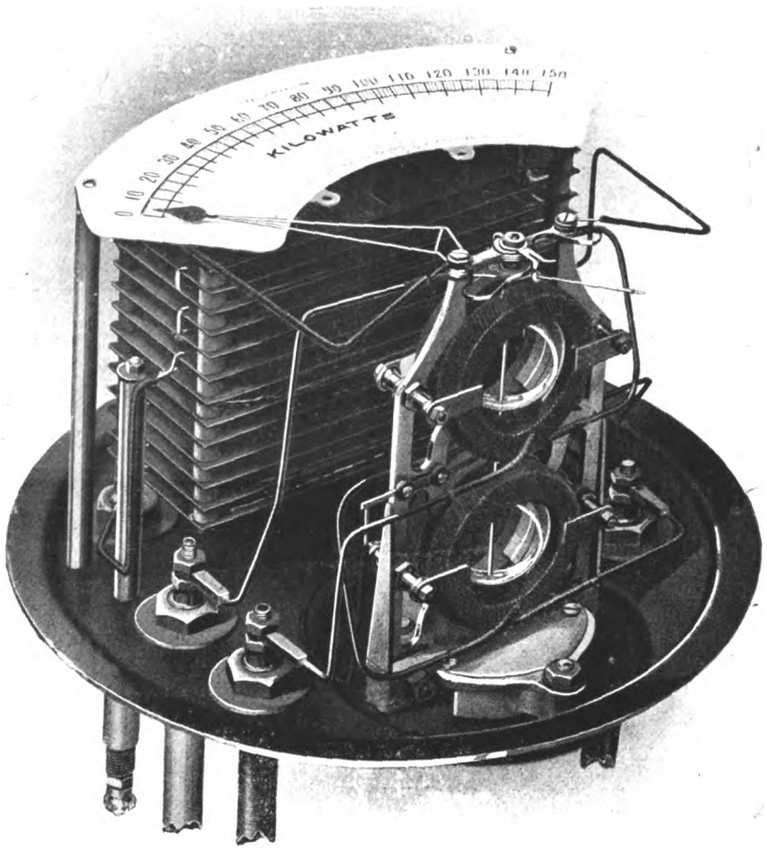

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All these New Instruments as well as our A.C. Switchboard Voltmeters and Ammeters, Models 151 and 156, are fully illustrated and described in our New Catalogue 16. This whole group of Instruments embodies the results of several years exhaustive study and scientific investigation of all the complex electrical and mechanical problems involved in the development of durable, reliable, sensitive and accurate instruments for use on A.C. circuits. These Instruments are far superior to any that have ever been produced for A.C. Switchboard service, and the above illustration will indicate the exceptional character of the interior work.

By means of this new group of Instruments an A.C. plant may be more efficiently controlled than has hitherto been possible, thereby producing greater economy in operation and maintenance.

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For Catalogue 16, write to—

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public that a full inspection of everything that it has to show would practically cover all the branches of electrical manufacture at the present time.

The Siemens "Tantalum" Showcard Competition. (Nos. 179, 184.)

We are informed that approximately 2,000 designs were submitted for this competition, and that each has had careful consideration by the staff responsible for the selection of the winning designs. A first prize of £75 was offered, with a second prize of £25, together with a prize of £5 for any designs of more than average merit which the firm decided to adopt and reproduce. The task proved somewhat difficult, and eventually it was decided that the two best designs should be bracketed as of equal merit, and the £100 prize divided between the two successful competitors. Therefore a prize of £50 goes to Mr. L. Sutton Wood, 3, Featherstone Buildings, Holborn, W.C., and a similar prize of £50 to Mr. Frank M. Barton, 2, Montague-road, West Ealing, W. We shall reproduce a black-and-white drawing of Mr. Barton's design, which will be attractively printed in several colours, and we illustrate Mr. L. Sutton Wood's design in this issue. Further accepted designs were submitted by Mr. R. F. Higgins, 8, Grenville-place, Maida Vale, W., and Mr. F. Insall, Waterlane, Brislington, Bristol, who are recipients of prizes of £5. The designs of non-successful competitors will be returned in due course, and it is hoped that they will arrive in good condition.

ONE OF THE "TANTALUM" PRIZE SHOWCARDS.

A Remarkable Fuse Wire.

At the stands of Parmiter, Hope & Sugden and Simplex Conduits (Ltd.) demonstrations are being given of the latest in fuse wire and fuses. Mr. Vernon Hope, who is well-known as a maker of switchgear, has been experimenting for the past three years with fuses, and as a result of his labours has been able to present the industry with a satisfactory solution of the problem of the fuse. We understand that in this undertaking he has received material assistance from Simplex Conduits (Ltd.), who have one of the few fuse wire making plants installed at their Birmingham works. Hope's "Bi-metal" fuse wire is remarkable in that it actually possesses a definite time element, a function it was at one time thought impossible to obtain with a fuse wire. The wire, as its name implies, is made up of two metals—copper, in the shape of wire and placed as a central core, and a special low-melting alloy which concentrically surrounds the copper wire. The wire will carry 90 per cent. of its fusing current without heating, and may be touched by the fingers when within 10 per cent. of its blowing current. It will carry five times its fusing current for short periods, and is not liable to oxidation. The advantages of this material will be at once obvious. A porcelain fuse handle or cartridge fuse will not get hot when working up to the limits of its capacity, as is always the case with copper or lead-tin fuses. The fuse does not splutter on blowing, and the low-melting metal is not volatilised except on dead short circuits. On the stands of the exhibitors above mentioned special boards have been erected to allow of demonstrations of the bi-metal fuse wire to be made and comparative tests with other makes of wire carried out.

We were present at some tests and were struck with the low watts loss. On a 70-ampere copper fuse the loss was 45 watts and on bi-metal only 7 watts. A 20-ampere fuse was also shown to be able to carry 80 amperes for a few seconds without blowing. The 12-ampere arc lamps on the stand are run on a 15-ampere bi-metal fuse.

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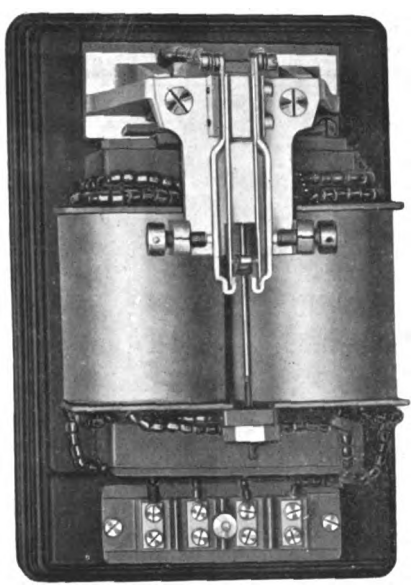

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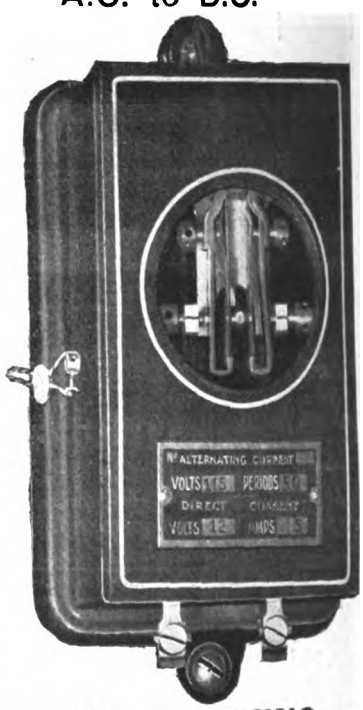

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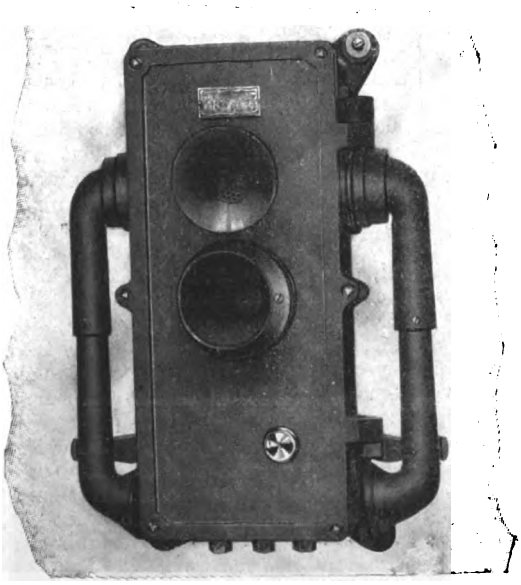

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Printed and Published by GEORGE TUCKER, at the Editorial, Printing and Publishing Offices, 1, 2 and 3, SALISBURY COURT, FLEET STREET, in the City of LONDON, FRIDAY, SEPTEMBER 29, 1911.

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LAMPS OLYMPIA LIGHTING

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THE ELECTRICIAN COMMERCIAL AND INDUSTRIAL SUPPLEMENT.

C. & I. Supplement No. 105.]

OCTOBER 6, 1911.

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DON'T MISS THESE AT OLYMPIA.

Purcell & Nobb's "Electroyl" New Oven and Steamer. (Stand 159.)

"Submersible" Motors in the Gallery.

W. Horrock's Automatic Petrol-Electric Plant. (Stand 231.)

W. F. Dennis' Automatic Telephone System. (Stand 293, Gallery.)

Vanalium, New Aluminium Alloy. (Stand 58-65.)

Beacon New Arc Lamp Mechanism. (Stand 327, Gallery.)

At Siemens' stands, New Railway Signal, actuated by dry battery; New Electric House Pump, New Vortex Vacuum Cleaner. (Nos. 179-184, 206-209.)

Cooper-Hewitt Rectifier for Bioscope Lamps. (Stand 82.)

Mazdalux Reflectors, B.T.-H. (Stands 124-135.)

Pirelli 70,000-volt Cable. (Stands 172-191.)

Benjamin Screwdriver. (Stand 151.)

"Attractor" Signs. (Stand 327, Gallery.)

METAL LAMP SLOGANS.

Most of the metal lamp manufacturers have adopted some phrase which has been brought out prominently in all their literature and their posters. For the guidance of visitors we give below a list of the slogans of the principal lamps exhibited.

AEGMA (Electrical Co.). Lights the World.

AURIGA (British Westinghouse Co.). Cheaper than Gas

BRIMSDOWN (Brimsdown Lamp Works, Stand 100-115.). See Things in a Better Light.

EFESCA (Falk, Stadelmann & Co., Stand 79-93.) Double the Light—Half the Cost.

MAZDA (B.T.-H. Co., Stand 124-135.). Electric Light for Everybody.

METALLUM (Brush Elec. Eng. Co., Stand 84-89.). Turn Night into Day.

OSRAM (General Electric Co., Stand 103-112.). Last Longest—Beat Gas.

COMING HOME FROM OLYMPIA: THE EFFECTS OF A ROUND OF THE EXHIBITS.

POPE (Pope's Electric Lamp Co., Stand 207-208.). Light Way to a Light House.

ROYAL EDISWAN (Edison & Swan U.E. Light Co., Stand 98-117). Best and Cheapest in the End.

SUNBEAM (Sunbeam Lamp Co., Stand 55-68.) Sunbeams after Sunset.

TANTALUM (Siemens Bros. Dynamo Works, Stand 206-209.). Lighter than Ever.

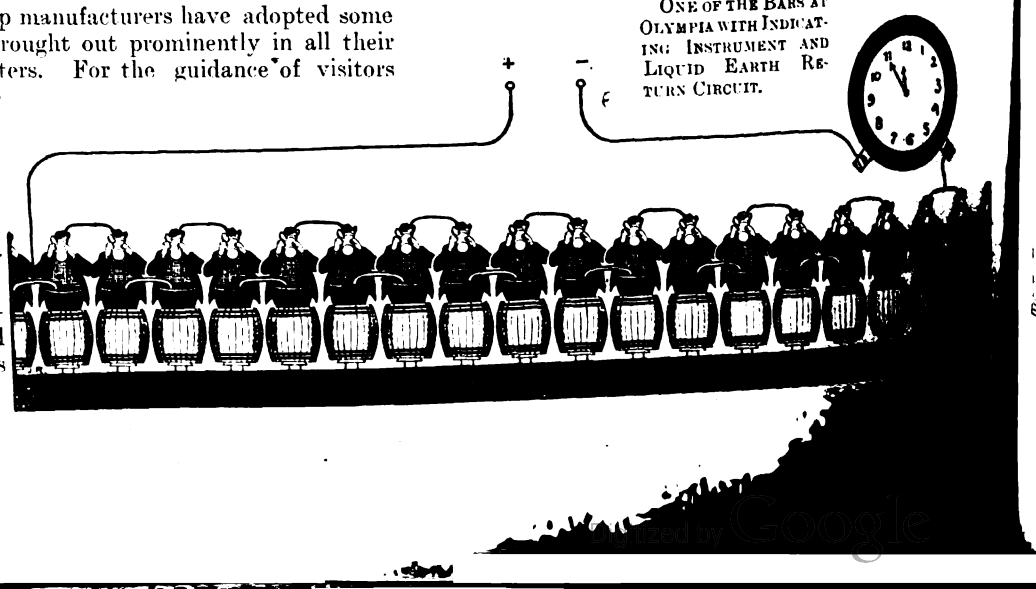
OLYMPICS.

Will anyone confirm the report that Tricity Grogan has joined the staff of the "Journal of Gas Lighting"?

Is *crême de menthe* the correct drink at the Westinghouse Cooper-Hewitt stand?

Our Venner-able Bede joke was spoiled last week by the insistence on the part of one of our proof readers in removing the necessary *n*. We have given him a letter of introduction to the gentleman in question.

Will Mr. Marryat shortly visit the United States to inspect electric printing press control systems?



ONE OF THE BARS AT OLYMPIA WITH INDICATING INSTRUMENT AND LIQUID EARTH RETURN CIRCUIT.

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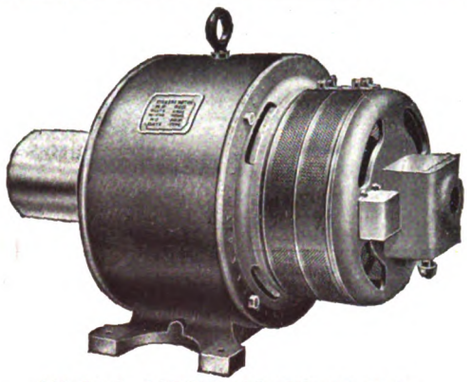

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Their rigid and substantial construction enables them to withstand the most severe usage and give a continuous and uninterrupted service without help from the repair shop or any undue heating.

Stand Nos. 80 and 92 Olympia Electrical Exhibition.

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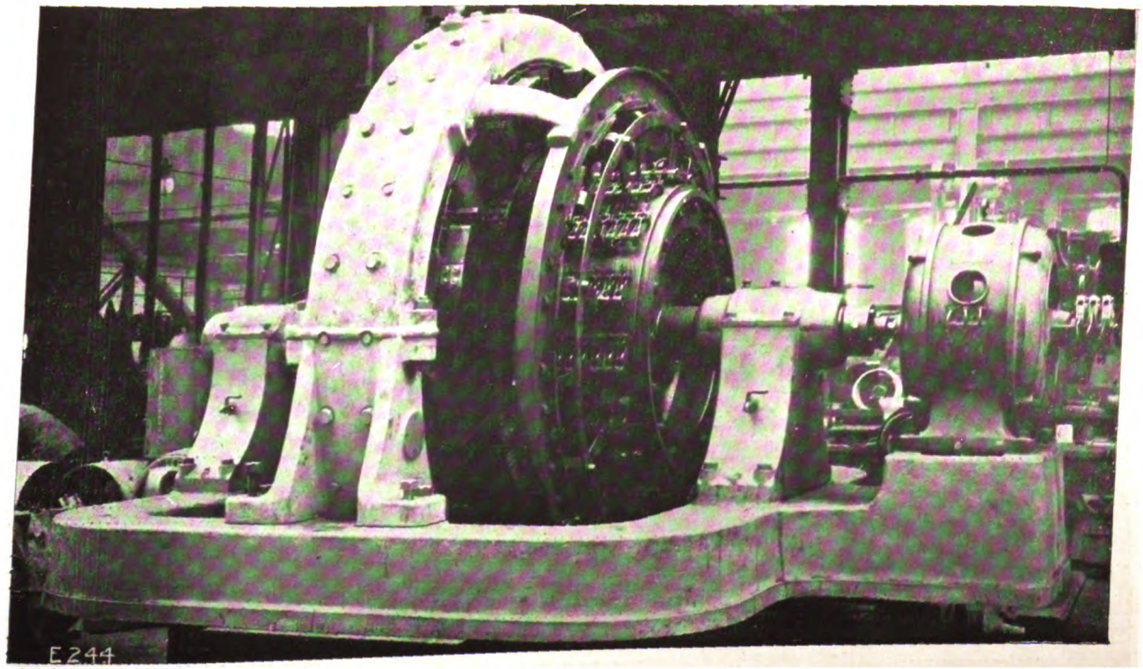

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ON ADMIRALTY LIST
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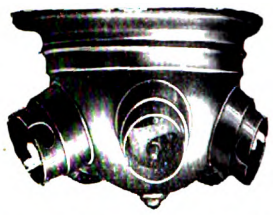
Pope's Electric Lamp Co.

It was a decidedly novel idea which this company decided upon for its stand at Olympia. The central feature of the exhibit is a tall lighthouse, the lantern of which reaches up to the gallery roof. The interior of the lantern is illuminated with a number of Pope lamps, and radiating to the four corners of the stand from the lantern are four signs made up to represent beams of light from the lighthouse. These signs bear in letters of light the name "Pope Lamps." The adjoining illustration gives a good idea of the effective manner in which this has been carried out. The exhibit is a centre of attraction, and reflects great credit upon the company. It is difficult to display a commodity of this character in the most effective manner, but the company has undoubtedly succeeded on the present occasion. The surrounding parts of the stand are devoted to individual exhibits of the different classes of lamps made at the company's works at Willesden, London. The metal lamps have a high efficiency, and are made up of squirted filaments. A demonstration of the durabiliy of the filament is in constant process of showing, there being a motor-operated mechanism which raises each of four lamps in turn to a certain height, and then allows the lamp to drop with a jerk to the full length of a flexible cord. This administers a sharp shock, which is a severe test of the strength of the filament.

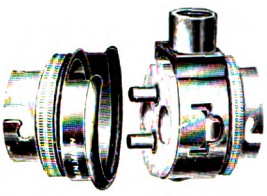
Pope Lighthouse at Olympia.

Benjamin Electric (Ltd.).

The development of the metal lamp cluster has necessitated the introduction of special fittings which can be used for the convenient spacing of the holders for combinations of metal lamps. The wireless clusters exhibited by the Benjamin Electric (Ltd.) are typical of the neat designs which are possible in this direction. It was at one time an extremely difficult matter to wire up a cluster fitting, because the space at disposal is so small. With the Benjamin wireless cluster this difficulty is obviated. The lamp-holders are mechanically connected to the bodies, and no wiring of any kind is necessary, except that of coupling each cluster to its circuit. Electrical contractors should make a special point of visiting this stand (151) and inspecting these interesting cluster bodies. A feature is also being made in the exhibit of watertight holders and combination holders for use with special reflector fittings. These are most useful for shop window lighting, where it is necessary to make up the holder as part and parcel of the shop fittings. We illustrate typical examples of these fittings. The Benjamin patent friction drive screwdriver should also be examined, as the makers claim that it is superior to the ratchet screwdriver. It can be inspected at the exhibit and tried on screws of various sizes.



Types of Benjamin Wireless Cluster Bodies.



Twin Lamp Holder for Shop Fittings.

DIRECTORY OF LAMP AND LIGHTING EXHIBITS AT OLYMPIA.

Arc Lamps (including Mercury Vapour Lamps).

	Stand.
Abbey Electric Co.	5
British Thomson-Houston Co.	124, 135
Brush Electrical Eng. Co.	84, 89
Drake & Gorham	61, 62
Electric & Ordnance	80, 92
Engineering & Arc Lamps	327
General Electric Co.	103, 112, 125, 134
Globe Electric Co.	120, 121, 138, 139
Jandus Arc Lamp & Electric Co.	105, 110
Johnson & Phillips	123, 136
Oliver Arc Lamp (Ltd.)	58, 65
Siemens Bros. Dynamo Works	179, 184, 206, 209
Union Electric Co.	101, 114
Westminster Engineering Co.	165
Westinghouse Cooper-Hewitt Co.	82

Metal Lamps, Metal Lamp Clusters, &c.

(*See also* Arc Lamps.)

Armorduct Mfg. Co.	120, 121, 138, 139
Brimsdown Lamp Works	100, 115
British Thomson-Houston Co.	124,135
Brush Electrical Eng. Co.	84, 89
Corona Lamp Works Co.	244
Drake & Gorham	61, 62
Edison & Swan Co.	15, 16, 44, 46, 98, 117
Electric & Ordnance Accessories Co.	80, 92
Falk, Stadelmann & Co.	79, 93
Foster Eng. Co.	194, 221
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General Electric Co.	103, 112, 125, 134
London & Rugby Eng. Co.	23, 38
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Pope's Electric Lamp Co.	207, 208
Siemens Bros. Dynamo Works	178, 184, 206, 209
Simplex Conduits	148, 163
Sun Electrical Co.	104, 111
Sunbeam Lamp Co.	55, 68

Fittings (Reflectors, Shades, Globes, &c.)

Armorduct Mfg. Co.	120, 121, 138, 139
Benjamin Electric (Ltd.)	151
British Metal Engraving Co.	261
B. T.-H. Co.	124, 135
Drake & Gorham	61, 62
Dugdill (J.) & Co.	238
Edison & Swan Co.	15, 16, 45, 46, 98, 117
Electric & Ordnance Accessories Co.	80, 92
Emanuel (A.) & Sons	195, 220
Escare & Denelle	145, 166
Falk, Stadelmann & Co.	79, 93
Galsworthy (Ltd.)	244
General Electric Co.	103, 112, 125, 134

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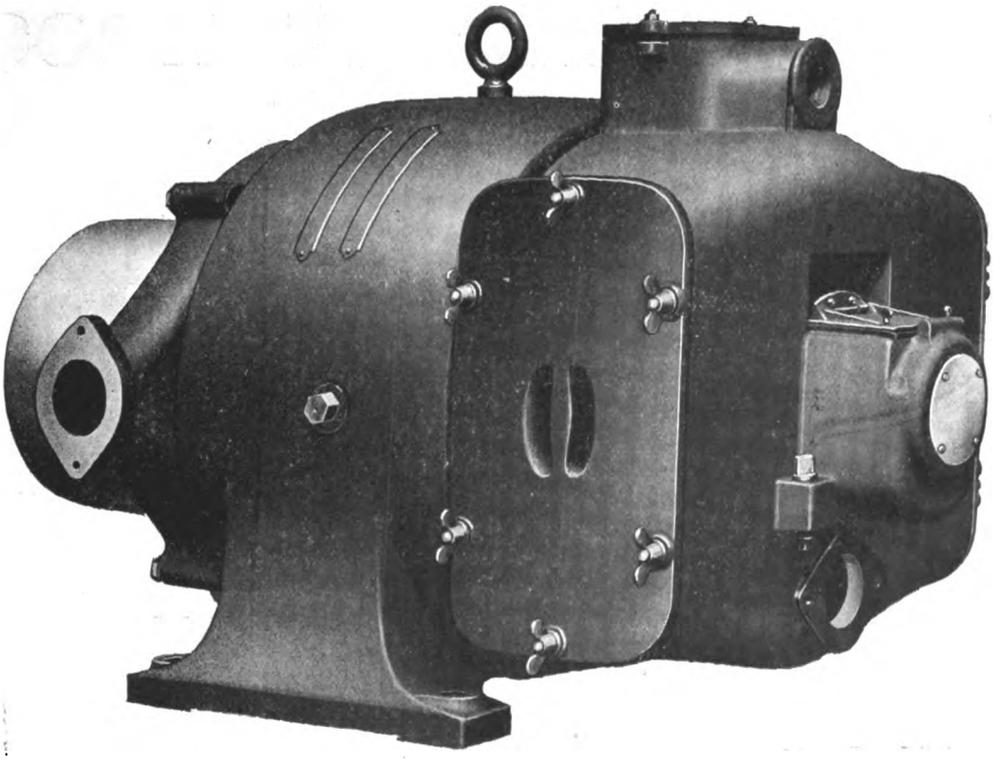

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DEVELOPMENTS IN LAMPS AND ILLUMINATION.

The Olympia Electrical Exhibition is in every sense of the term a striking example of what can be done with modern electrical illuminating units. In the present issue we have attempted to concentrate attention on the most recent improvements in arc and metal lamps and their application to most purposes of illumination.

Since we published our last special Flame Arc Lamp Issue a great deal has been done in the development of new patterns and in the persistent application of existing types to the requirements of all classes of light users. It is pleasing to be able to record distinct progress in all branches of electrical illumination and those of our readers who are able to take advantage of the Olympia Exhibition will confirm the opinion that every effort has been made to place electrical illumination on a thoroughly practical and commercial basis.

There can be no doubt that the authorities of the Exhibition have lost a great opportunity in regard to the lighting of the exterior of Olympia. The signs erected on the front of the building are not quite suitable to convey to the public at a distance that an important show of the latest electric-lighting appliances is being made. Mr. Hirst, at the inaugural banquet, expressed the opinion that Olympia should have been "a sea of light." With so many manufacturers of lamps taking an interest in the Exhibition it should have been a simple matter to get together a co-operative scheme for the external illumination of Olympia. On the score of cost we feel that the project could have been carried through with a minimum of expense. The illumination material employed in London at the Coronation for the outlining of buildings might have been purchased after the festivities and applied to the outlining of Olympia with light for the opening of the Exhibition. There is no record of this huge building having ever been illuminated in this way. This fact alone would have drawn thousands to the Exhibition and would, we are sure, have been the wonder of London. Still, the opportunity is one which will present itself again and no doubt it will be put to its fullest use. We cannot, of course, look for a Coronation coincident with the next Electrical Exhibition, but Mr. Hirst's suggestion will, without doubt, materialise.

One of the most striking advances in the field of illumination is the growth of the movement characterised as illuminating engineering. Since the last Electrical Exhibition this movement has been born and has increased in vigour until at the present time it has become a power in the industry, but particularly so in the United States. The extraordinary zeal with which our American cousins take up any new thing is exemplified in the present position of illuminating engineering on the other side of the water. A considerable literature on the subject has sprung up and there are periodicals devoted solely to the advancement of improved methods of applying light units to practical purposes. We, on this side, have given a certain measure of support to a monthly publication, the "Illuminating Engineer" and this, as the organ of the Illuminating Engineering Society, is doing exceptionally useful work. The matter is one which is also engaging the attention of architects, and since the sympathies of this important profession have been enlisted the correct use of light in public buildings, private houses, picture galleries is more generally being insisted upon.

The improvements in the metal lamp have given a most extraordinary impetus to illuminating engineering. Some years ago when holophane reflectors were introduced they did not meet with the reception which they deserved because the carbon lamp did not give the ideal combination of light unit and shade. The metal lamp has changed all this and the Olympia Exhibition is a striking example of the progress made in holophane illumination. This may also be said of other forms of reflectors which have been introduced in order to obtain indirect lighting effects with a minimum of glare and a maximum of light distribution.

We hope that the efforts of the salesmen on the stands of the firms who have made a display with holophane lighting, particularly to visitors who are purely light users and are unconnected with the electrical industry, will bear good fruit in the immediate future. Educational work of this character is bound to produce good results. It should give the electricity consumer a better idea of what he can do with his light and it should assist him in his dealings with the electrical contractor who at the present time rather endeavours to force more light upon the consumer than he actually requires. These demonstrations should also be attended by electrical contractors who have a most important function to fulfil in that they act as intermediaries between light makers and light users. At the present time they have not sufficiently realised their responsibilities or opportunities in this connection. As we have just stated, their main object has been to get a consumer to put in as many lights as possible quite irrespective of their disposition, the effect they will have upon his eyes or, what is even more important, the influence they will exercise on his energy consumption. We think that it cannot be too strongly impressed upon the electrical contractor that the Electrical Exhibition at Olympia is a Mecca to which he should immediately and frequently resort. He will not have an opportunity for many years to come of studying at close quarters an aggregation of light units of all classes and their application to the requirements of light users. It seems a pity that the Illuminating Engineering Society did not seize the opportunity to arrange for one or two lectures by, say, Mr. Gaster or Mr. Francis Willcox to drive home the real lesson to the electrical contractor of the lighting developments of the Exhibition.

An Example of Office Lighting with Mazda Lamps.

It is quite impossible for us in the space at our disposal to give a full description of the good work which makers of arc lamps and metal lamps, fittings, signs and lighting accessories, are doing at Olympia. We reproduce a number of pages which are purely illustrative and which are intended to typify the latest advances in illuminating engineering. If these are studied in conjunction with the brief notes which we introduce of the actual displays of the exhibitors concerned we feel sure that some good will result.

SIMPLEX CONDUITS Ld.,
Garrison Lane, BIRMINGHAM.
Manufacturers of—
CONDUITS, CABLES, ACCESSORIES, FITTINGS, MOTORS, ELECTRIC HEATING AND COOKING MATERIAL, &c.

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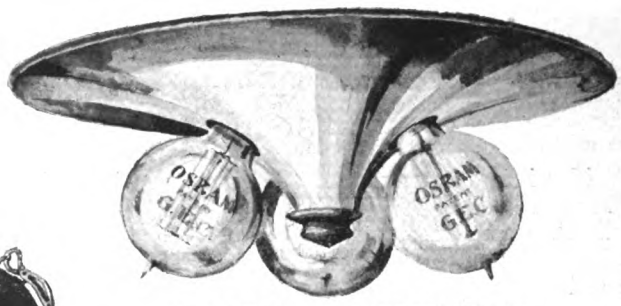
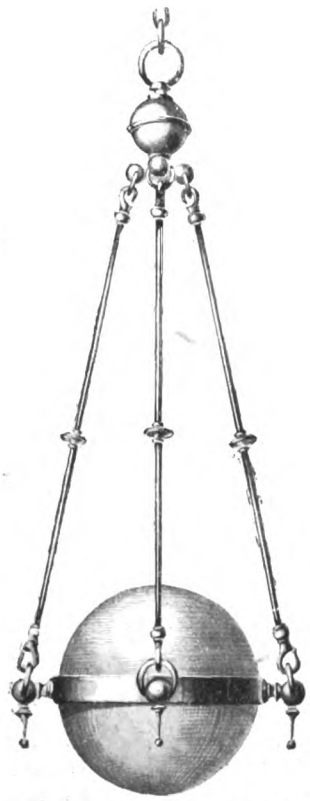
AN OSRAM 1,000 C.P. LANTERN.
(G.E.C.)



OSRAM THREE-LAMP CLUSTER FITTING.
(G.E.C.)

CEILING BOWL FITTING.
(DRAKE & GORHAM.)

SHOP LANTERN AND REFLECTOR FOR HIGH C.P. OSRAM.
(G.E.C.)



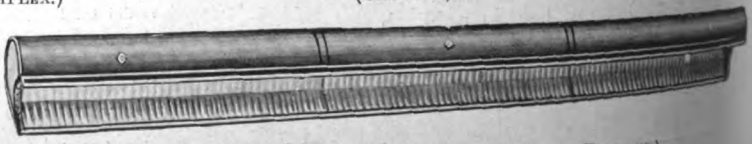
HOLOPHANE PENDANT-SPHERE.
(SIMPLEX.)

DESK OR TABLE LAMP.
(SIMPLEX.)

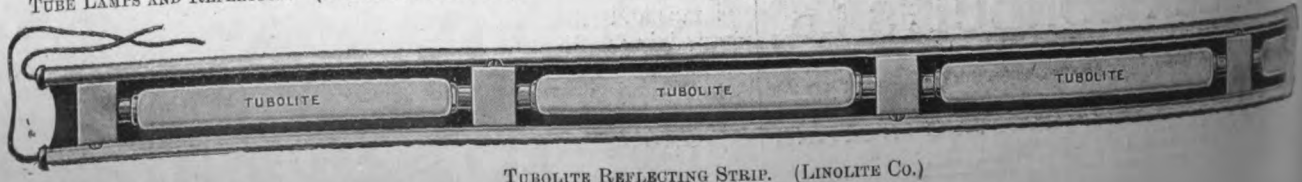
STILETTO HOLOPHANE FITTING.
(SIMPLEX.)

HOLOPHANE PENDANT BOWL.
(SIMPLEX.)

TUBE LAMPS AND REFLECTOR. (BENJAMIN ELECTRIC.)



SILVERED TROUGH REFLECTOR. (BENJAMIN ELECTRIC.)



TUBOLITE REFLECTING STRIP. (LINOLITE CO.)

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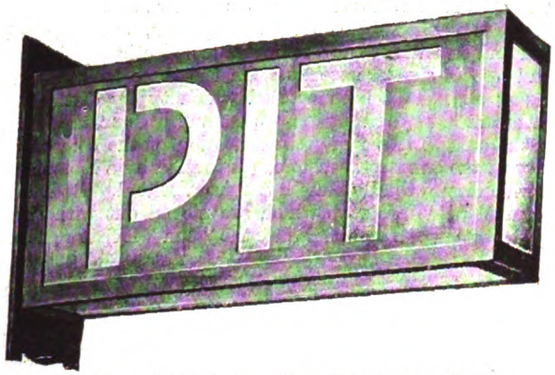
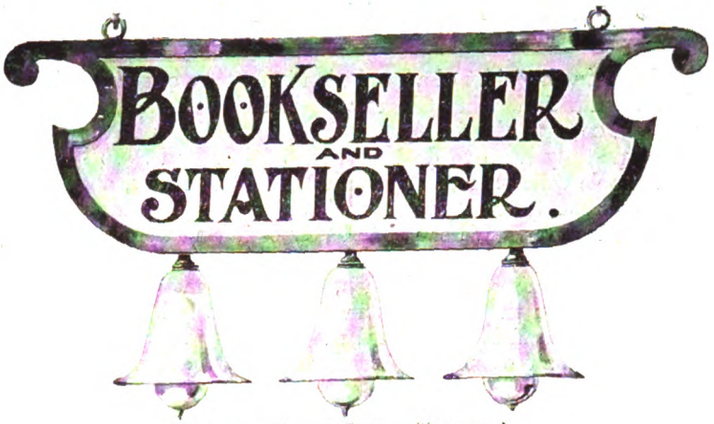


THEATRE BOX SIGN. (SUN ELECTRICAL CO.)



ARTISTIC TRADE SIGN. (SIMPLEX.)

ART METAL WORK SIGN. (O. C. HAWKES.)

WINDOW SIGN FOR SHOPS. (SUN ELECTRICAL CO.)

BRACKET SIGN FOR THEATRES, PICTURE PALACES, ETC. (SUN ELECTRICAL CO.)

THE VERTICAL SIGN ON O. C. HAWKES' EXHIBIT.

HANGING LETTER BEAD SIGN. (FRANCO BRITISH ELECTRICAL CO.)

STENCILLED WINDOW SIGN WITH HOLOPHANE REFLECTOR. (SIMPLEX.)

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SIGNS AND SIGN LIGHTING.

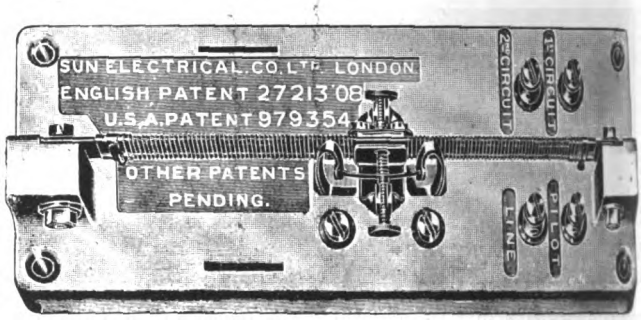
We are in the midst of a revolution in matters of signs and sign illumination. The Olympia Electrical Exhibition contains more novelties in signs and sign accessories than we could possibly hope to deal with in a full volume. It is a remarkable collection of the products of sign makers, and is also a striking testimony to the zeal and enterprise of this class of manufacturer. We can confidently commend the signs at Olympia to the notice of electrical contractors, central station engineers, architects, tradesmen, &c. The metal lamp is responsible for these changes in electric signs. Its brilliant light and high efficiency have raised the sign to such a level that it becomes an economic necessity for the tradesman, the restaurant and hotel proprietor, railway companies, theatres and cinematograph shows, and, in fact, for anyone who has to appeal to the public on the pavement.

A particularly noticeable item about the signs at Olympia is their artistic arrangement. There is a certain class of tradesman who does nothing except in a perfectly dignified manner. This type of customer is admirably catered for by the sign makers at Olympia. He is offered art metal signs which he hangs inside or outside his windows, and which, while he makes known to the passing public his products by means of the stencilled lettering of the face of the sign, he also uses the same lamps which illuminate this lettering to light the goods in his windows. This is a notable achievement, and is quite the latest thing in signs. It may be inspected in particulars at the stands of **Simplex Conduits, O. C. Hawkes (Ltd.)** and the **General Electric Co.**

We wish to specially emphasise the importance of this new reflecting sign, and the influence which it will undoubtedly exercise on methods of trade developing by illumination.

The box sign still holds its own for certain classes of advertising, and deservedly so. Many examples of this will be seen exhibited at Olympia, and their efficiency has been materially improved by the use of the metal lamp. An interesting development of this class of sign may be found on the stand of the **Credenda Signs Co.** This company is manufacturing illuminated signs on the Venner principle, which, as our readers are doubtless aware, makes use of a number of glass balls at the front of a box, inside which are a few metal lamps. The balls can be arranged to form any desired lettering or design. Many of these signs are to be seen in all parts of the country, and once seen they cannot very well be forgotten. The development to which we have just referred is the application of this principle to the outline illumination of well-known posters, for instance the type of coloured advertisement used by the railway companies. The Credenda Co.'s stand is fitted up for the display of these signs, and it is possible to demonstrate the effect of use both by day and night. The day effect is practically the same as the ordinary coloured printed poster. At night time the principal outlines of the subject of the poster are picked out in small beads of light. We think that there will be a big field for this class of sign, and we hope that the company will meet with a generous amount of support from the railways. This particular principle is readily applicable to flasher signs, and some fine specimens of these are on view at the Exhibition. If a series of different coloured lamps is used in the box enclosing the sign, the glass beads can be illuminated in these colours, and an extremely pleasing effect is produced. We are pleased to see that this particular sign has been taken up with a view to extending its applications, and judging by the many excellent examples which are displayed at the Exhibition the efforts of the company should meet with the success they deserve. The modern electric sign would be a very poor thing without efficient flashers or other devices for giving either coloured effects or intermittent lighting. The flasher may appear, at first sight, to be an extremely simple thing to manufacture. One only needs to walk up and down the main streets of London or our large provincial cities to see evidence in the many changes in signs of the practical utility of the modern flasher.

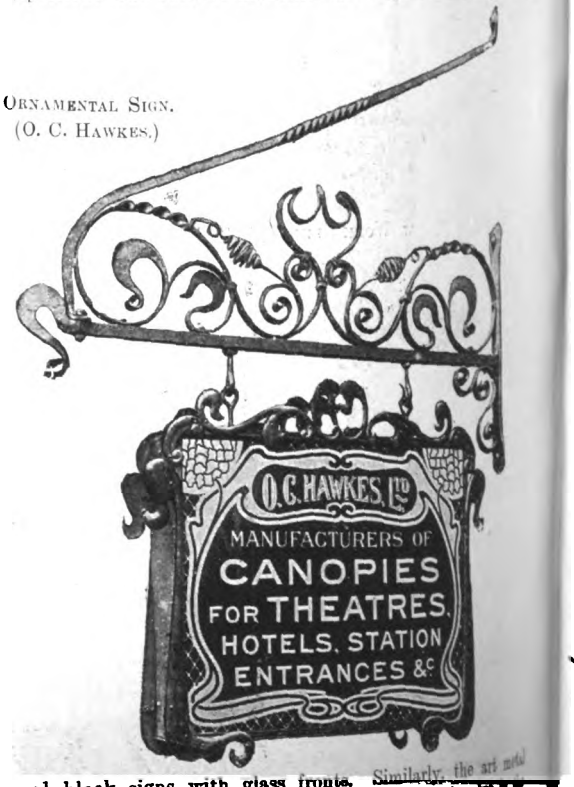
The Sun Electrical Co. has devoted a considerable amount of time and attention on the subject of sign accessories, and interested readers would find on their stand a remarkable collection of signs of all kinds, and also of sign accessories. On the three facias of the stand, changing signs have been erected which typify distinctive classes of signs standardised by the company. Over the main entrance to the exhibit is a light representation of the company's trade mark, viz., the sun itself. The orb is formed by a Holophane hemisphere which is powerfully illuminated from behind. Radiating from this central point are rays which are picked out with small lamps. By the action of a special flasher the "sun" is first switched



SUN NEW TWO-WAY THERMO-BLINK SIGN FLASHER.

on and the rays are then lighted up in circles which constantly widen until the limits of the sign are reached. After a few seconds illumination the "sun" goes out and the cycle of operations is repeated. The experience of this company with signs of various classes has been practically unique, and without prejudice to other sign makers, we may say that they are in a position to meet practically every requirement of the sign user.

The box sign is also well represented in the exhibit of **O. C. Hawkes.** This company has specialised in a class of sign which may be seen at practically every railway station not only in the Metropolis but also in the provinces. They carried out the large opal glass map signs of the Underground Railways in London, and these are exceptionally fine examples of their work. Here again we find a most comprehensive display of the sign maker's art. Day and night signs appear to be a speciality, and the effect produced when a sign is turned on, by comparison with the daylight effect, is usually surprising, not to say startling. The company has a large factory in Birmingham where they specialise in glass work of various kinds, and this experience has been of immense advantage to them in putting



ORNAMENTAL SIGN.
(O. C. HAWKES.)

forward block signs with glass fronts. Similarly, the art metal work experience of this maker has proved of great value in the combination of a good box sign with an artistic method of supporting it. A good sign can often be spoiled by an indifferent metal supporting scheme.

PELTON WHEELS & WATER TURBINES
IMPROVED DESIGN. HIGH EFFICIENCY.
PITMAN'S PATENT SPEED GOVERNOR, combining Sensitive Spring Pendulum, Servo Motor, Compensating Device, Automatic Filter and Hand Regulator. Close Speed Regulation. High-class Workmanship.
Proposed Water Power schemes surveyed and reported on at moderate fees.
PEROY PITMAN, *Pelton Wheel and Turbine Manufacturer,*
3, Wilcott Road, Acton, London W., England.

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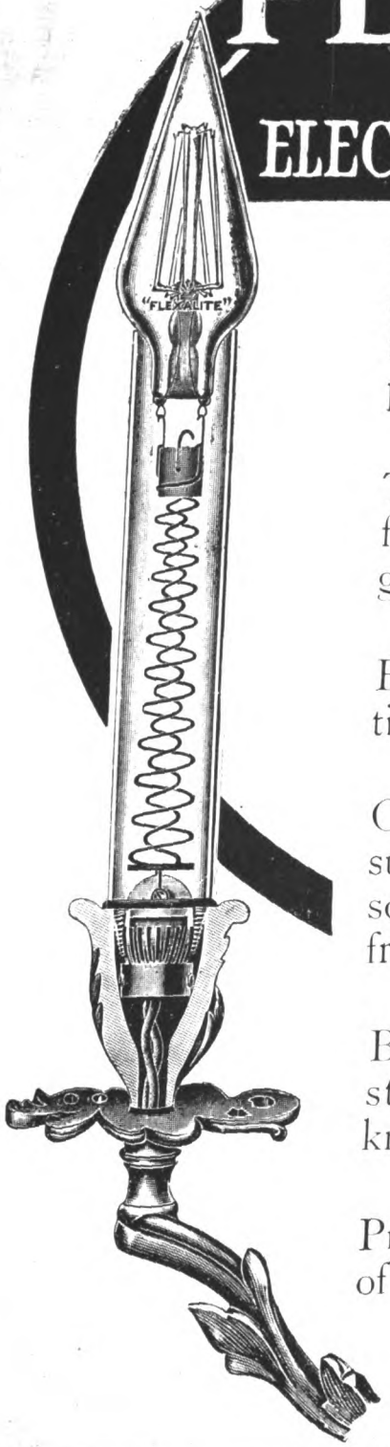
SEE IT AT OLYMPIA.

THE FLEXALITE PATENT ELECTRIC CANDLE FITTING



The perfect imitation of a wax candle, reproducing its graduating transparency.

The whole of the lamp filament is exposed and gives useful light.

Easy to fit, vertical position obtained instantly.

One size only, but is suitable for any candle sconce and any opal tube from 3 to 6 inches long.

Being flexible will withstand an accidental knock without breaking.

Price is lower than that of any similar fitting.

Ask for List No. 206.

STAND 104/111 MAIN AVENUE.

The **Sun** ELECTRICAL COMPANY LTD.

118-120 Charing Cross Road, London W.C

Telephone : 29 OLYMPIA.

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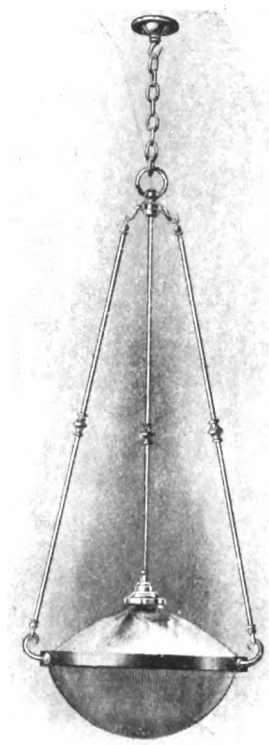
THE POPULARITY OF HOLOPHANE.

When holophane shades and reflectors were introduced a good many years ago, it was hoped that they would bring about a revolution in electric lighting. They were, however, brought out when the only small light unit was the carbon filament lamp, and it was not possible to show off the many advantages of holophane with a lamp of this character. Now that we have metal lamps which can be used in high candle-powers with economy to the light user, holophane, although it is practically the same in principle as before, is very different in practice. The metal lamp makers must be credited with this remarkable change, for it is unquestionably remarkable. The Olympia Electrical Exhibition is a model of good lighting in general, and of holophane illumination in particular. We speak, of course, mainly of the individual lighting of exhibits. Holophane is a thing which grows upon one. It may be likened to certain proprietary articles, once used always used.



A Tasteful Holophane Pendant.
(Simplex.)

The electrical contractor has not fully awakened to the business possibilities of holophane. He is, however, being stirred from his inactivity by the many enterprising firms who are making it their special business to prod him on. The general idea of holophane crystalises around **Holophane (Ltd.)**, who have arranged an attractive exhibit which is a practical and continuous demonstration of what holophane lighting is. It may be looked upon as showing the scientific and theoretical in holophane illumination as well as the practical, and the latter is also kept prominently in mind. By means of a suitably darkened room comparative results are obtained by switching on fittings with and without holophane reflectors. These reflectors can be handled and examined, so that, as the "showman" says, there is no deception. The man in the street, who is after all interested in things of this kind, has a tendency to believe that his leg is being pulled, and this characteristic, which is largely shared by we humans, is kept in mind by the organisers of the demonstrations at this particular stand. The holophane literature is replete with globes, shades and reflectors which can be used for every conceivable kind of fitting, pendants, electroliers, brackets, table and floor standards, ceiling lights, &c. The whole principle of holophane has been worked up into a complete illumination scheme which is now practically standardised and admits of every conceivable requirement of the light user being met. The essential feature of holophane is that not only is its principle scientifically correct, but it provides a practical embodiment of these principles. Holophane glassware generally is mechanically sound, and from the point of view of cleanliness it is hard to beat.

Another exhibit at Olympia which is admirably laid out for the display of holophane fittings is that of **Simplex Conduits (Ltd.)**. A conveniently arranged showroom attached to the stand is darkened, and the effect of any fittings can be demonstrated under actual working conditions. The variety of Simplex holophane fittings is too extensive to be covered in the space of this notice. Attention may, however, be specially directed to the pendant sphere and bowl fittings, which are highly ornamental in so far as their external appearance is concerned, and when lighted they furnish an effect so pleasant that the average householder to whom the fittings are shown for the first time usually goes into raptures over them. The bowls and spheres can be suspended by chains or rods from the ceiling, and the fitting can be adapted to any height of room. A particularly beautiful class of fitting is the holophane ceiling hemisphere. Every effort should be made to introduce this into new houses. The householder can make a selection from the plainest to the most artistic designs. Here again the illumination produced is restful; there is no glare and the glassware and its support can be cleaned with a minimum of difficulty. The holophane sphere and bowl have been made the centrepiece around which a large variety of special designs has been developed. These can be inspected at the Simplex stand. The same exhibit also includes what are known as holophane household glassware. These are hexagonal shades with special prisms which not only distribute the light horizontally, but also give good illumination in a vertical plane. They can be arranged for pendants or brackets, as the case may be, and the effect is pleasing in the extreme. Another beautiful form of holophane fitting is that in which the ordinary large silk shade is placed over either a holophane sphere or reflector bowl. Here again the distribution of light is soft and pleasing, and the advantages of the use of the shade are considerably enhanced. The Simplex Co. is doing an extensive business with holophane fittings and glassware, and has exceptional facilities at its disposal for supplying clients with general information on the subject.

The advantages of a combination of Tantalum and Onewatt lamps with holophane reflectors are being demonstrated at the stand of **Siemens Brothers Dynamo Works.** At the Manchester Electrical Exhibition an exceptionally fine display of "Tantaphane" was made by this company, and its effect has not been lost upon the industry. Since that time the Onewatt lamp, which has a high candle-power unit, has been introduced and has become very popular in combination with both large and small holophane shades.

A Small Size Reproduction of one of Siemens Prize Show Cards. The Design is by Mr. Sutton.

bowls, spheres and reflectors. The lighting of the Siemens exhibit has been largely carried out with holophane, Onewatt and Tantalum combinations, and visitors to this exhibit will be able to judge for themselves of the efficiency and effect of this scheme of lighting.

The general idea of holophane has permeated the electric lighting side of the industry, and it may be found embodied in one form or another on the stands of most of the fittings and lamp makers at the Exhibition, in particular, the **Edison & Swan Co., B.T.H. Co., Sunbeam Lamp Co., Brimsdown Lamp Works, Pope Lamps,** etc

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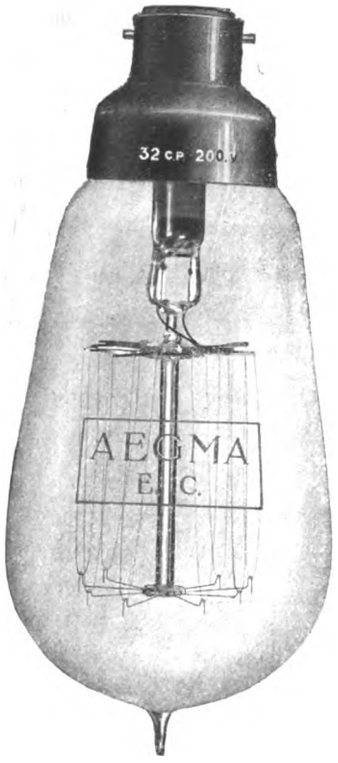
AEGMA LAMPS.



32 c.p. 200 volt Aegma Lamp.
Note the Neat Shape.

AEGMA LAMPS.

25 c.p. 100 volt Aegma Lamp.
A Popular Size.

AEGMA LAMPS

The filament used in this Season's Aegma Lamp is, in actual practice, as strong as any metal filament produced at present.

The efficiency is proved—there is none actually higher.

We can deliver from stock

Please write for copy of our new list and new discounts for this season.

1 to 1,000 c.p.
1 to 260 volts.

The Electrical Co., Ltd.,

Aegma Lamp Dept.,
122/4, CHARING CROSS ROAD, W.C.

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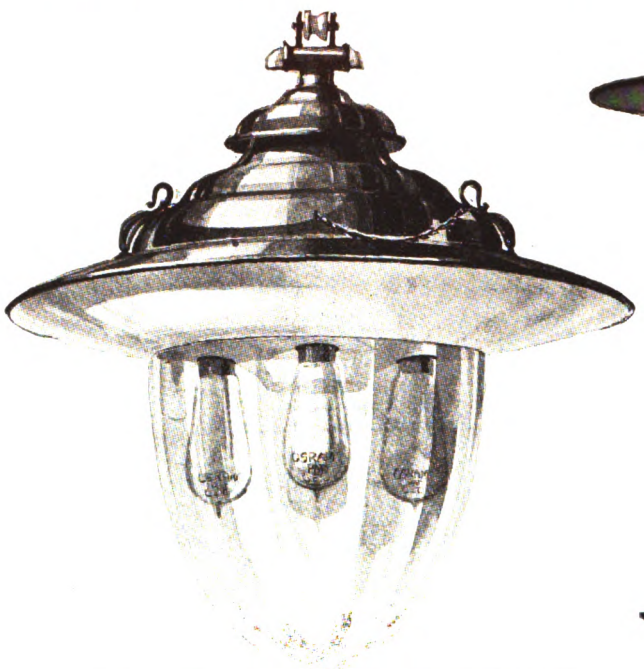
METAL LAMP CLUSTERS.

The durability and efficiency of the metal lamp have brought it into considerable use for street and shop lighting. Much of this class of illumination is now being carried out by either high candle-power metal lamps or clusters of metal lamps of medium candle-power from, say, 50 c.p. upwards. The development of fittings in which metal lamps are collected together to form a common source of light has been little short of remarkable during the past two years. The early efforts of Mr. Haydn Harrison in pointing out the advantages of the metal lamp for this class of service has been the means of rousing fittings makers to a sense of their duty in this direction. The result is shown in a remarkable manner at the Olympia Exhibition. Most of the lamp and fittings makers are displaying types of lanterns which should be the delight of the shopkeeper, the railway engineer, the factory owner, the central station engineer, and indeed almost every class of light user, though we mention these as coming first to mind. The enterprise of the last named in replacing carbon lamps by metal lamps in his street lighting lanterns has also given a marked impetus to the general application of the metal lamp to specific illumination. The shopkeeper is specially favoured in the matter of metal lamp lanterns and fittings at Olympia. If he is at present using old pattern arc lamps which require trimming frequently, and which give a poor return in light for the energy consumed, he should inspect the displays which various makers have put forward at the show. The high efficiency of these clusters is not as well understood or as widely known as it should be. We hope that the Exhibition will help to spread the light, in both senses of the term, in this respect. The shop tradesman is an important customer and presents a large section of the lamp and fittings purchasing public. We feel sure that manufacturers will be especially solicitous for his welfare at the Exhibition. By this we mean, pay him every attention in explaining the real meaning of these new fittings to him in his business.



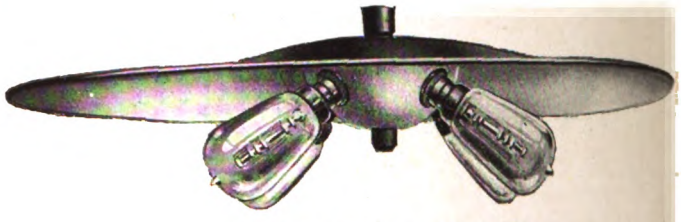
A Typical Cluster of Metal Lamps. (G.E.C.)

OSRAM-LAMPS

DRAKE & GORHAM EXHIBIT.

The exhibit of Messrs. Drake & Gorham is tastefully arranged with a display of electric-light fittings and domestic heating and electrical appliances. The exhibit is a little to the left of the entrance, and stands out prominently by reason of its brilliant display of lights. The fittings exhibited include all the most recent designs in pendant, bracket and ceiling lights, and most of the fittings are wired up and can be switched on individually or collectively. The exhibit has attracted considerable attention, especially so because the fittings and apparatus on view are displayed to best advantage. The combination of holophane glassware with metal lamps is given exceptional prominence, and visitors to the stand are given an opportunity of observing the pleasing illumination effects which can be obtained with these fittings. The advantages of properly arranged ceiling fittings and, in particular, the holophane hemisphere at ceiling level, are pointed out, this type of illuminating unit being appropriate for low ceilings where elaborate pendants cannot be introduced.

Electrical contractors and central station engineers will find interesting examples of shop lighting fittings, and especially of metal lamp clusters, which are offered by Messrs. Drake & Gorham for the use of tradesmen to replace the small pattern arc lamp. These fittings are of recent introduction, and they constitute a marked advance upon anything previously brought out. We understand that Messrs. Drake & Gorham have done a considerable amount of work in the improvement of shop illumination, and that they are prepared to advise tradesmen who have under consideration the question of the introduction of the high candle-power metal lamp or metal lamp clusters for use in the interior or exterior of their establishments. The Drake & Gorham fittings list is filled with numerous designs which have recently been developed with the idea of improving the illumination of domestic and trade establishments.



Metal Lamp Reflector Fitting.

Beautiful Examples of Drake & Gorham's Ceiling Fittings.

They have recognised the need for raising the standard of illumination in this direction, and are vigorously impressing upon light users how imperative it is that they should take advantage of the greater efficiency and economy of these advances in illuminating methods.

There is also a good arc lamp display on this exhibit, the Butt-flame lamp being especially in prominence. This is a type of lamp in which the mechanism has been reduced to the simplest, and the minimum number of parts, and at the same time the number of burning hours and general efficiency of the lamp are maintained. These lamps are shown under actual burning conditions, and visitors can, if they desire, inspect the internal mechanism.

As a conveniently arranged display of electric-light fittings and apparatus the exhibit of Messrs. Drake & Gorham may be regarded as one of the most striking in the Exhibition.

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16 C.P. HIGH VOLTAGE OSRAM

CONTINUOUS FILAMENT.

LAMPS

20 watts.

Voltage - - 200—260.

ORDER EARLY
ORDER EARLY
ORDER EARLY

Olympia Exhibition
Stand No. 61.

DRAKE & GORHAM.

Telegrams:
"ACCUMULATOR,"
LONDON, MANCHESTER,
or GLASGOW.

LONDON, 66, Victoria Street, S.W.
MANCHESTER, 47, Spring Gardens
GLASGOW, 50, Wellington Street.

Telephones:
893 Westminster (three lines),
P.O 1218 Victoria.
3700 City (2 lines), Manchester,
3858 Corporation, and
2198 Argyle, Glasgow.

BELFAST—Faraday House, Queen Street (Mr. F. W. Parkes). **BRISTOL**—5, Bristol Bridge (Mr. W. H. R. Cleave). **CARDIFF**—4, Church Street (Mr. H. Nance).
DUBLIN—Norwich Union Chambers, Dawson Street (Mr. D. J. Doolan). **LEEDS**—11, Upper Mill Hill, Boar Lane (Messrs. Casperson Bros.).
MIDDLESBROUGH—303, Linthorpe Road (Messrs. J. T. Bell & Co.). **NEWCASTLE-ON-TYNE**—1, Higham Place (Mr. F. T. Hanks).
SHEFFIELD—74, High Street (Mr. Wm. Molesworth).

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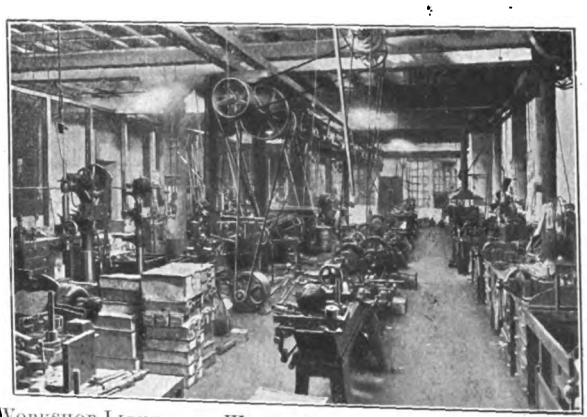
Mercury Vapour Lamps.

An exceptionally good display of the mercury vapour lamps is being made by several exhibitors at Olympia. The Westinghouse-Cooper-Hewitt Co. has a stand which is devoted entirely to this class of illuminant and we understand that it is attracting a considerable amount of attention. There are several new and interesting features which have been developed especially for the Exhibition, and are shown for the first time. In particular we may mention a special reflector which can be placed behind the tubular pattern of lamp, and it has the effect of adding red rays to the light emitted from the tube. This is an advantage because the use of the reflector does not entail an increased consumption of electrical energy and it means that a more pleasing light is available for special applications of the lamp. Hitherto the carbon lamp has been introduced in connection with the mercury vapour tube, but it has effected the electrical efficiency of the combination. The Westinghouse Silica lamp, which was introduced about 12 months ago, is given a prominent place in the exhibit. It has the special advantage of containing a short mercury tube, so that it can be enclosed in a globe of small diameter. The complete lamp also occupies a minimum of vertical space. The Silica lamp is automatic in operation, lighting up as soon as it is switched on. A large solenoid is used in the upper part of the lamp to give the effect of tilting the mercury tube. There is an automatic device which ensures the lamp burning on its correct polarity. The tubes are guaranteed by the makers for 1,000 hours' life, but the average life is in the neighbourhood of 3,000 hours. On a 250-volt circuit the lamp takes 3½ amperes and the mean hemispherical candle-power is over 3,000. With energy at 3d. per unit it will cost 1·1d. per hour, allowing for replacement of tubes, in a life of 2,000 hours. While on the subject of the mercury vapour lamp we may refer to the rectifier



Workshop Lighted by Westinghouse Cooper-Hewitt Lamps.

operating on the same principle, which is being shown at this exhibit. The rectifier itself has been known for many years, but it is only recently that the company has succeeded in producing a type which can be used in connection with projector lamps and which will strike up automatically as soon as the carbons of the arc lamp are brought into contact. This is an interesting development and it admits of cinematograph theatres converting the alternating-current supply to direct-current for the operation of the arc, in a very efficient manner. The rectifier is also shown in conjunction with mercury vapour lamps and here again possesses the same automatic features as the projector lamp pattern. From figures supplied by the company we gather that there is an actual saving of 35 per cent. in the use of these converters over the ordinary transformer which is used to reduce the supply voltage to that of the arc. This is worked out on the basis of six hours a day for 300 days and with energy at 5d. per unit. This remarkable claim should appeal to proprietors of picture palaces who will doubtless come to the Exhibition or send their electricians. We understand that the combined efficiency of the rectifier and mercury vapour lamp works out at a slightly better figure than the direct-current type of lamp, which is direct connected to its circuit. The efficiency of these mercury vapour lamps is in the neighbourhood of 0·25 watts per candle, and they may be connected on 110 or 250-volt circuits. Needless to say there is no trimming of the lamp required, so that for certain classes of lighting, where the colour of the light is not objected to, the lamp is eminently suitable on account of its intensive illumination.

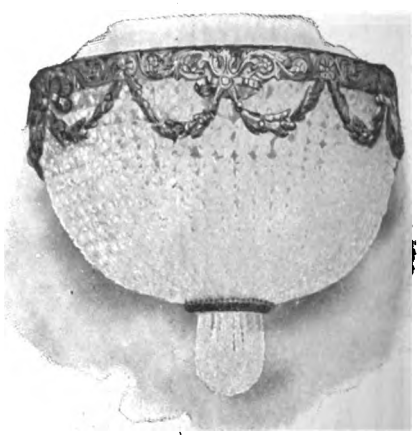
A Fittings Showroom.

One of the most neatly arranged showrooms in the Exhibition is that put up by Falk, Stadelmann & Co., a little to the left of the centre of the main hall. The idea of an exhibit on the lines of the large showrooms of this company in Farringdon-road has been admirably carried out. In particular the wiring has been carefully concealed so that the various panels on the walls and the fittings hung from the roof are models of neatness. Nothing looks worse in a showroom than the slovenly arrangement of the connecting wires. Most of the fittings on this stand are wired, and can be switched on collectively or individually.

From a detailed inspection of the exhibit we gather that the requirements of any class of fittings user can be met in the company's designs. Chased fittings of the most expensive character or plain or ornamental cast and bent metal designs are equally available. The exhibit includes typical examples of pendants, brackets, table lamps, floor standards, candle fittings, ceiling lights, &c. The

Falk, Stadelmann's Showroom.

selection of silk shades covers a wide range of designs and colours. This class of shade is most popular just now. Similarly the bead and glass tube shade is very pretty when used with metal lamps, and it figures prominently in this exhibit. It is a development of the crystal type of fitting which was all the rage during the days of candles and gas. By a strange vagary of fashion it is being revived to meet a growing demand. There are several tasteful examples in the Falk, Stadelmann exhibit. The popular taste is also admirably catered for, especially in fittings designed for flats and moderate-sized houses. Electric lighting is so much more common with this class of resident now that his needs require special attention.



Tasteful Crystal Fitting.

We would recommend interested contractors to visit the Falk Stadelmann showroom in the Exhibition, and if they can do so bring their friends and prospective customers with them.

We may also mention that the whole of this exhibit is lighted by Efesca metal lamps. This is a well-known tungsten lamp, having been on the market several years. It has a good reputation for durability of filament and efficiency, and it is supplied in large and small candle-power units for all voltages. Falk, Stadelmann offer special publicity facilities to electrical contractors for pushing the lamp, and will supply literature, show-cards and window attractions to assist in directing attention to the lamp.

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Efesca Lamps. — Strong and Brilliant. Efficient and Reliable.

Electrical Fittings — of every description and for all purposes. New and Exclusive Designs. Period Styles.

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FALK, STADELMANN & CO., LD.

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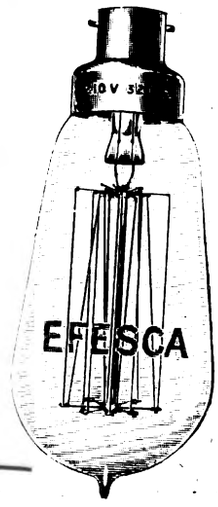

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B.T.-H. and Illumination.

The British Thomson-Houston Company has attracted considerable prominence to itself by the recent introduction of the Mazda drawn-wire tungsten filament lamp. When this lamp was put on the market we were given an opportunity of inspecting at the works at Rugby the facilities which the Company has at its disposal for the manufacture of this interesting lamp. We understand that the large factory at Rugby is now in full swing and that an exceptional demand is being experienced for this lamp. The wire filament reduces the risk of breakage in the early life of the lamp when it is transported from maker to dealer and from dealer to user. Its

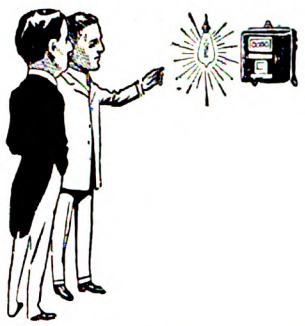
Examples of Mazdalux Reflectors.

extreme ductility and rigidity contribute to this desirable end. The B.T.-H. exhibit has been designed with the object of impressing on both the electrical contractor and the electric light consumer the necessity for method in the use of Mazda lamps in particular and electric light units in general. The stand is a striking object in this respect, and its arrangement reflects most creditably upon the management of the Company. Attention may be specially directed to the scheme of concealed lamp lighting in the roof of the stand. This is an example of illumination which can be introduced by architects who are able to start *de novo* in the illumination of a new building. It has, of course, a specific application, and must not be looked upon as suitable for general illumination.

At the time of our visit to the Rugby works we were impressed with the establishment by the B.T.-H. Co. of an illuminating engineering department. This has been placed under the charge of an engineer whose experience in this important field is, we believe, practically unique. Following upon the lines taken by well-known illuminating authorities in this country, on the Continent and in the United States, this department is developing data which cannot fail to be of the utmost assistance to architects, electrical contractors and light users generally. A scheme of this character must naturally progress slowly, and on this account certain types of illuminating devices have been developed which will meet the requirements of illumination which we in this country have undoubtedly made peculiarly our own. The science and theory of illumination are, of course, matters into which the architect and electrical contractor cannot possibly dip deeply. It is here where the assistance of the illuminating engineer is of value. He can place in the hands of the parties concerned efficient reflectors and fittings which will improve the general standard of illumination and serve to introduce on a broad basis the principles of efficient lighting. The B.T.-H. Mazdaliers are fittings of this class. Their application is practically without limit and they may be introduced with the certainty of giving satisfaction. The Mazdalux reflectors have been designed especially for use in trade and commercial lighting. They are shaped for shop-window purposes, for show-case lighting, and also for portable and table fittings. The reflector is solidly constructed of sheet steel, the outer surface is tastefully painted and the inner is treated with an aluminium coating which, while acting as an efficient diffuser, is unaffected by the atmosphere or dust, and, consequently, maintains its light-diffusing properties.

Illustrations of these Mazdalux reflectors are shown herewith. The shapes are the result of careful study and experiment, and each fulfils a particular function. This type of reflector has been found to combine the properties of a number of independent light-diffusing and dispersing devices. It has a wide field of utility, and information will be willingly furnished to interested contractors and central station engineers as to the many purposes for which Mazdalux can be used.

Through the courtesy of the company we were able to inspect a series of designs in new fittings, the object of which is to furnish a pleasing and comforting light with an entire absence of glare and with efficient distribution. These make use of inverted bowl reflectors and throw the light on to the ceiling, from which it is reflected into the room. The fittings form part of a general scheme of



"*You Find You Are Paying for Electricity*"

From a Mazda Lamp Leaflet.

illumination in which Mazda lamps are utilised as the light units. Many beautiful examples of this form of lighting exist in the States, and we hope that the illuminating engineering department of the B.T.-H. Co. will be able to impress its advantages upon light users in this country, with such modifications as may be necessary to suit English conditions. There are innumerable consumers of electricity who would welcome a variation from the pendant and bracket style of lighting, which has somehow or other become part and parcel of our home and commercial life. The illuminating engineer is here to break up these old ideas, and although it may be necessary for him to proceed slowly, if he goes about it in the right way he should achieve the object which he has in view.

A Striking Example of Reflected Lighting with Mazda Lamps.

Turning again to the exhibit of the B.T.-H. Co. at the Exhibition, we may specially remark upon the border lighting round the top of the stand and the mechanical reproduction of the company's poster, which is an imposing advertisement on the roof. The border sign is kept constantly on the "run" by means of a flasher, which switches out consecutive coloured lamps, and gives the effect of a coloured system of light passing round the stand. This is the only example of this kind of lighting in the Exhibition.

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The strength lies here - in the filament

The strength of the Mazda Lamp is where the strength of a lamp should be—in the filament. The Mazda filament, instead of being in short, brittle lengths, is in one continuous drawn wire of **pure** Tungsten. This great success has only been achieved after years of painstaking laboratory work and repeated failures. Many scientists were of the opinion that it was impossible to render Tungsten sufficiently ductile for wire-drawing, owing to its brittleness, but it is now an accomplished fact, and we are telling the public of its great advantages.

Mazda Lamps

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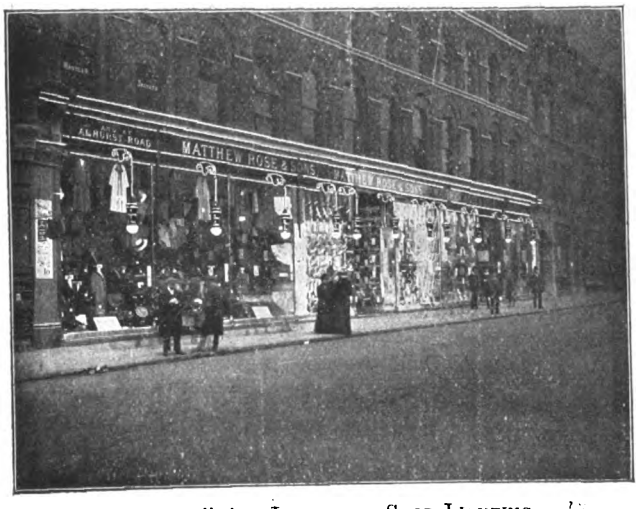
"Arcturus" Lamps in Cycle Factory.
(British Westinghouse.)

A Pretty Night Scene, Lighted by "Excello" Lamps.
(Union Electric.)



"Beacon" Arc Lamps for Shop Lighting.
(Engineering and Arc Lamps.)

FLAME ARC LAMP INSTALLATIONS.

Farringdon Street, London, Lighted by "Excello" Lamps.
Union Electric Co.)

An Example of "Quartzaliting" in an Engineering
(Brush.)

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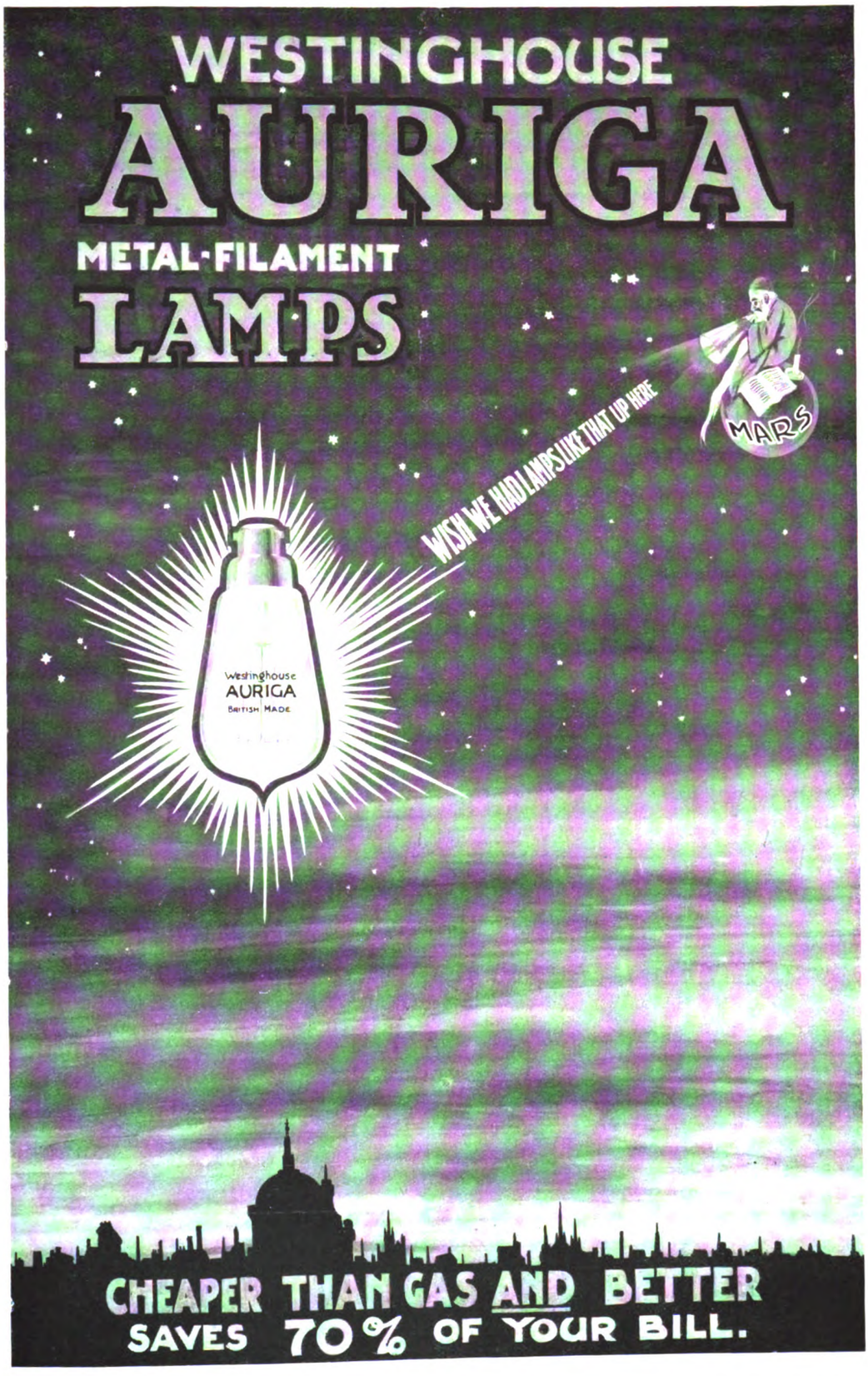

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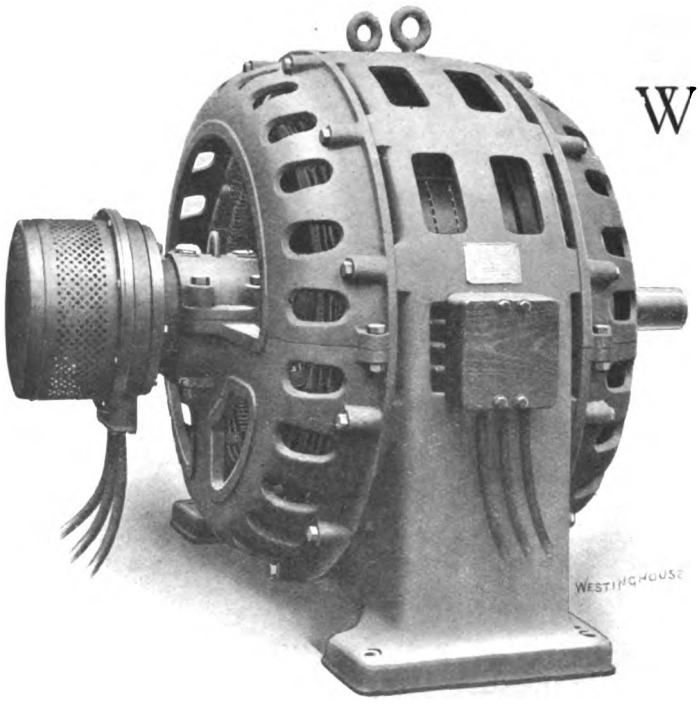

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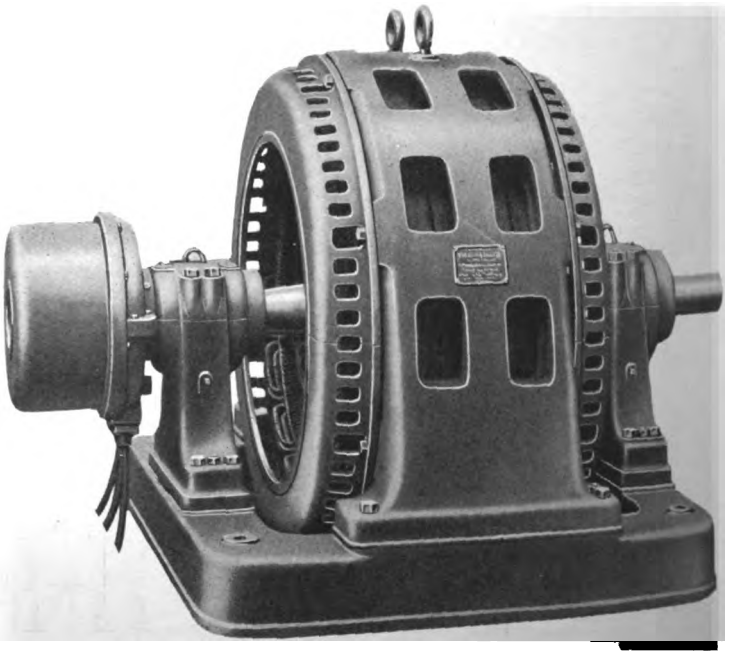

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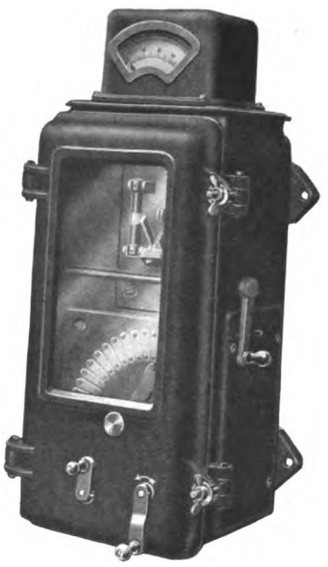

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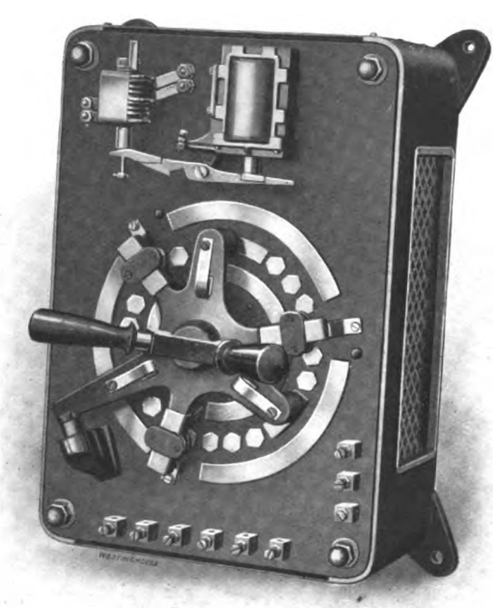

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STANDARD TYPES

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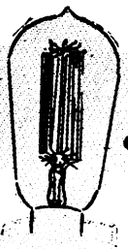
Pope Lamps



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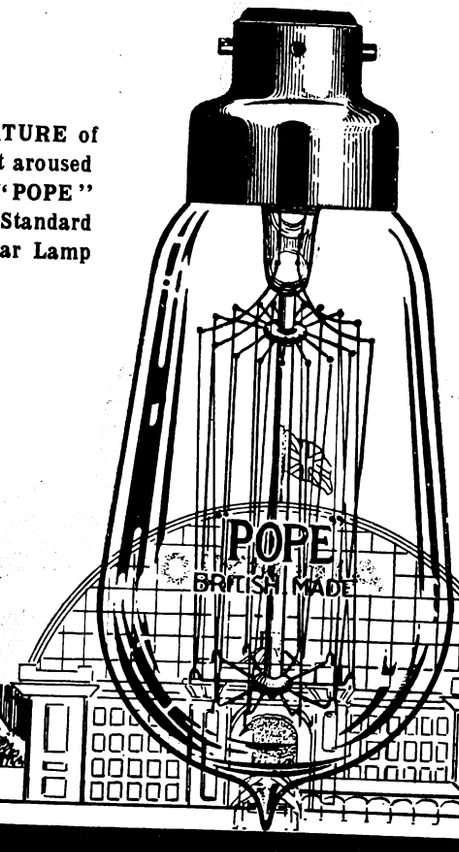
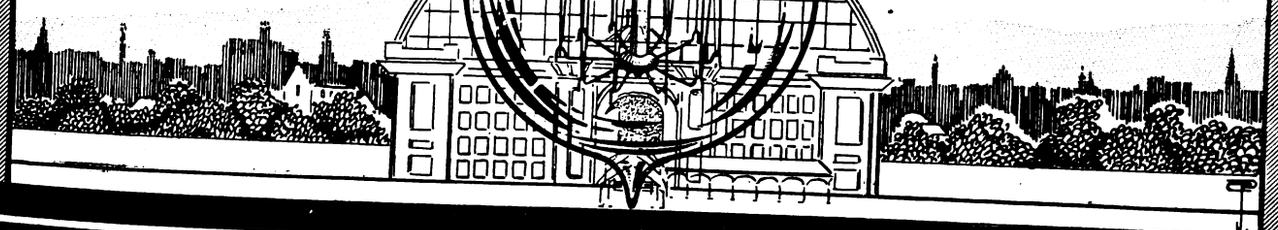


AT THE LIGHTHOUSE—Stand Nos. 207-208—you will see a variety of smart advertising literature—ask us for a quantity, and then get ready to meet the demands for "POPE" Lamps during the coming season.



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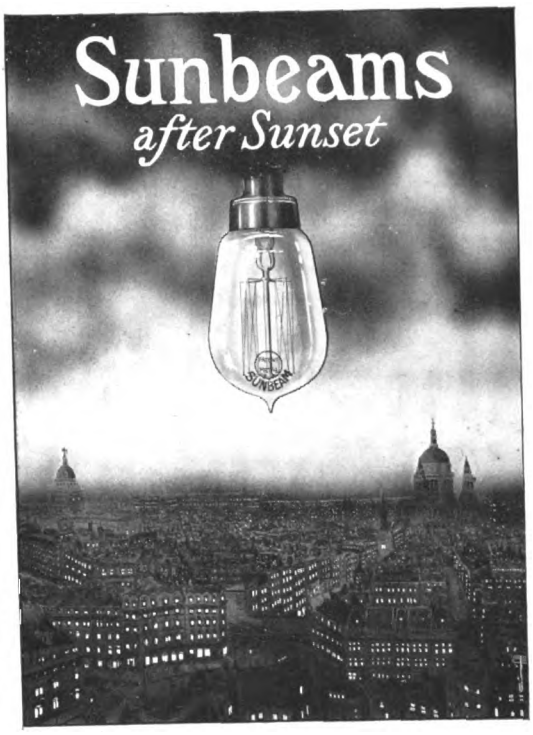

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FLAME ARC LAMP DEVELOPMENTS.

At the end of September last year, we published a special issue of this Supplement which was devoted exclusively to the subject of flame arc lamp progress. Since the issue of that special Supplement the position of the flame arc lamp has been advanced considerably in the industry, although the question of patents has considerably disturbed the composure of a number of manufacturers. Quite aside from the question of these patents, the flame arc lamp now takes up a position in which it comes in for a greater share of comparison than formerly with the metal lamp cluster. We lay ourselves open to correction in making this comparison, but for certain spheres of illumination there is no burking the fact that the competition of the metal lamp cluster and the flame arc has become, and is likely to become, much keener than heretofore. The presence and prospect of this competition have stimulated flame arc lamp makers to greater efforts in the development of their products, and we find at the Olympia Electrical Exhibition numerous examples of their enterprise in the introduction of improvements, both in the number and details of lamps. These are chiefly in the direction of the enclosure of the flame arc, and the Exhibition can show two new lamps, at least, of this design. The magazine type of flame lamp has also come in for a considerable share of attention. It is a pattern which

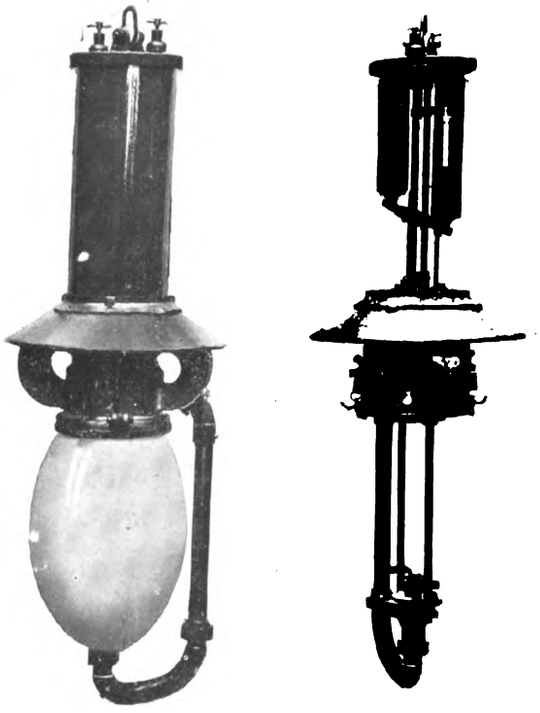
THEATRE LIGHTING WITH ARCTURUS LAMPS.
(BRITISH WESTINGHOUSE.)

enables the lamp maker to remove the essential difficulty with the flame arc, viz., the shortness of the life of the carbons. By the introduction of a number of pairs into a single lamp, and the provisions of automatic mechanism for the switching in of one of these after the consumption of its predecessor, the flame arc lamp user is furnished with a lamp which will burn up to 80 or even 100 hours.

As regards the field of utility of the flame arc, while this is likely to be narrowed down, as we have already suggested, by the competition of the metal lamp cluster and the high candle-power metal lamp, it still covers a wide area of street and open place lighting, and also shop fronts and large interiors. The efforts of the makers to simplify the lamp and also to prolong its burning life, added to the fact that the light user can obtain an efficiency as high as 8 candles per watt, should enable the flame arc lamp to keep its position in the world of illumination. It must not be thought that we are voicing the opinion that the flame arc lamp is in any sense on the decline. There are even now developments pending which should push the lamp farther ahead in the competition with other illuminants. It must still be regarded as the champion of electric lighting in comparison with high-pressure gas, and competition with gas must always be kept prominently in mind.

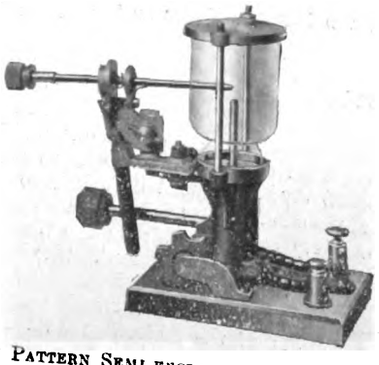
Turning now to the exhibits of arc lamps at Olympia, we may refer initially to the most noticeable novelties and improvements.

An interesting pattern of enclosed flame lamp is shown on the stand of the **Westminster Engineering Co.** An illustration of this



NEW WESTMINSTER ENCLOSED FLAME ARC LAMP.

is given herewith. The lamp is interesting on account of the fact that the cooling and condensing chamber for the gases from the arc is placed above the globe, and takes the shape of two circular channels, one on each side of the lamp. From the lower side of one of these channels a balancing pipe is taken to the lower portion of the globe, so as to balance any unevenness of pressure



NEW PATTERN SEMI-ENCLOSED PROJECTOR LAMP.

which may be created in the condensing chamber itself. This is clearly shown in the illustration. The positive carbon in this lamp is placed at the bottom, and it is a specially constructed carbon, having six concentrically arranged cores of a special metallic salts. The top carbon is solid. The control mechanism of the lamp is quite simple, and is on standard Westminster lines. Two of these lamps are shown

EXCELLO
FLAME ARC WITH UNIQUE
TWO YEARS' WARRANTY

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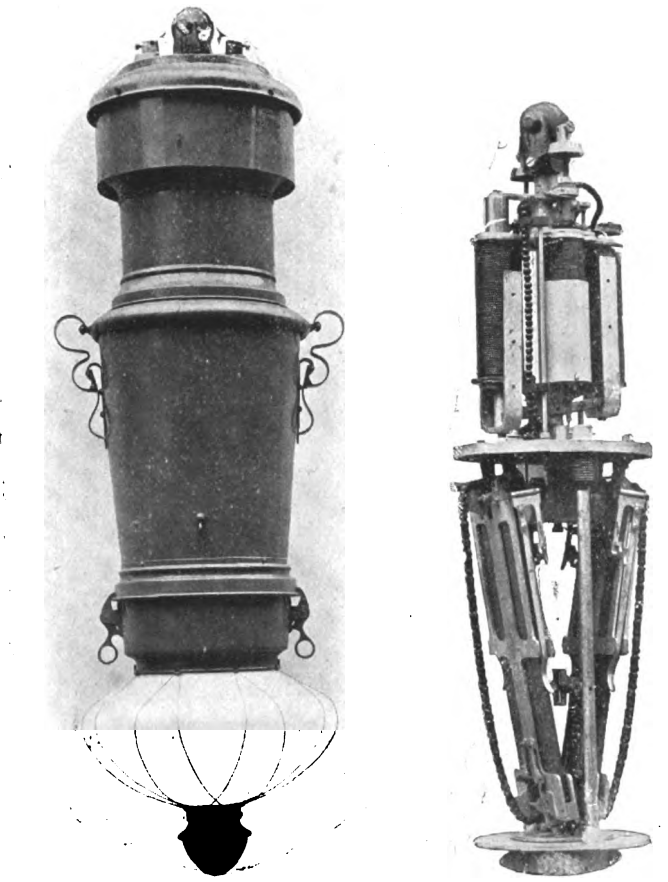
burning at the Exhibition, and they give out a powerful light of intense yellowy-white colour. At this same exhibit may be seen an interesting pattern of semi-enclosed projector arc lamp, for use in enlarging lanterns. This is illustrated herewith. The lamp is semi-automatic in action in that the arc is maintained over a considerable period, owing to its semi-enclosure. We understand that it will burn for upwards of half-an-hour without adjustment. A clear white light of from 300 to 600 candles can be obtained. The lamp measures 7 in. high by 4 in. wide by 7 in. long, and is wound for a standard current of 2½ amperes or up to 4½ amperes for autochrome signs. The lamp is suitable for alternating-current or direct-current circuits up to 250 volts.

Metroflam Lamps.

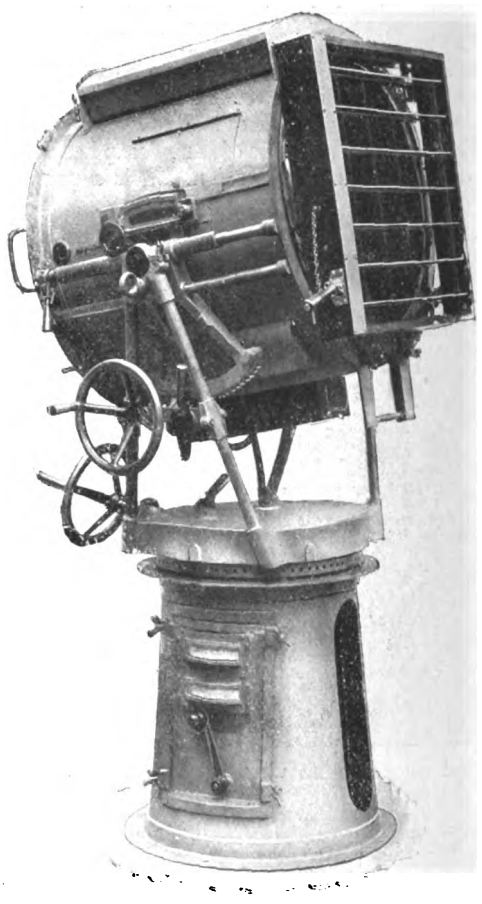
We have called attention in previous Exhibition issues to the displays of arc lighting which Messrs. Johnson & Phillips are making with their Metroflam lamp. This is one of the most interesting magazine lamps in the Exhibition, and since its introduction some 18 months ago has undergone considerable improvements. The burning life of the lamp is 80 hours and, what is the most important item of all to the makers themselves, the lamp has been installed in many places up and down the country for street, factory, railway, docks and shop lighting. Inexpensive carbons are used, and the pairs are burned down to the utmost limits. It should be noted that although the lamp is a magazine one, and it necessitates the changing over from one pair of carbons to another, this is accomplished without any interruption of the light source. The feed of the carbons and the changing from one pair to another is done in the direct-current lamp by solenoids; in the alternating-current lamp an induction motor field is introduced. The lamp is substantially made, and upkeep costs are negligible. Little attendance is needed and as the carbons are cheap the running expenses are very low. The working parts of the Metroflam D.C. lamp comprise chiefly a pair of carriers for containing the carbons, differential solenoids for striking and regulating the arc and a shunt coil system for feeding down the carbons, pair by pair, as they are consumed. The A.C. lamp is built on the same lines, but an induction motor feed is employed. Series burning lamps are provided with an auto-cutout and sub-resistance (or safety coil) to procure the continuity of the circuit, and these fittings are usually mounted within the lamp cover, so that each lamp is a complete unit. The non-extinction of the arc is secured by arranging that before one pair of carbons has ceased to burn another pair comes into contact. The arc is, therefore, at once formed between them, disappearing simultaneously from between the ends of the old pair.

Another feature of the Metroflam is its light diffusing globe, which has been patented. The globe not only distributes the light uniformly over a large area, but, in addition, remains unsoiled in use. The transparent appearance of the globe after a full run of 80 hours is most noticeable, and there is practically no diminution in candle-power at the end of this period.

The **Orb** is a simple and reliable single enclosed long-burning flame lamp, which has also been designed by Mr. James Brockie, and is shown on the same stand. It is of the shuntless type, a single series coil with a floating core for striking and regulating the arc. A simple and reliable non-slipping clutch is fitted together with a synchronous regulator, which renders it impossible for lamps burning in series to get "out of balance," so that the light emitted from all the lamps in a group is always of uniform intensity. The lamp is ornate in appearance, and looks equally finished either with or without a reflector. Both the A.C. and D.C. Orb lamps burn noiselessly and steadily, and are suitable for inside and outside use, and cheaper to run and maintain than metal lamps.



EXTERIOR AND INTERIOR VIEWS OF METROFLAM LAMP.



J. & P. SEARCHLIGHT PROJECTOR.

The projector lantern shown on the stand is a light steel drum, and its primary equipment consists of a 24 in. diameter silvered glass parabolic mirror and a combined automatic and hand-feed horizontal lamp arranged for working with a current of 80 amperes. The lamp is provided with a pair of main coils for striking the arc, and an independent coil for feeding the carbons together actuating through a ratchet gear a divided right and left hand screwed spindle and traversing nuts which engage with the carbon carriers. The automatic gear is thrown out of action for re-trimming or when operating the lamp by hand. A blow magnet is fitted for centring the arc to obtain steady burning and a well-shaped crater. One of the most recent contracts awarded to Messrs. Johnson & Phillips for an installation of this lamp was that at Manchester for the new scheme of arc and gas competition lighting. Also, the Great Central Railway Co. are installing them at their new Immingham Docks. We introduce illustrations showing the interior and exterior of this lamp which we are sure will be of interest. Readers will find numerous interesting Metroflam installations in London, particularly that in Cannon Street, where the lamps are suspended by span wires over the centre of the road.

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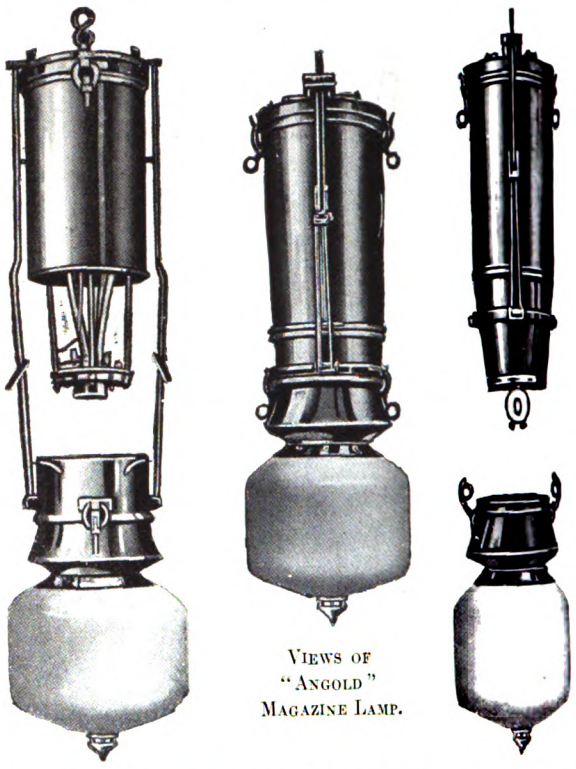
The Angold Magazine Lamp.

Some notable improvements have been made in this lamp and in particular in the mechanism for controlling the descent and changing of the carbons. This operation is effected by a solenoid which is brought into circuit by a positive action carbon contact switch. This switch is itself controlled by the shunt and series solenoids of the lamp. The whole of this mechanism is highly ingenious and reflects great credit on the inventor. At the same time it is simple and reliable in its operation. The carbon feed is extremely gradual, a pair of phosphor-bronze toothed racks over which a reversing pawl is operated being used to give this nicety of control over the movement of the carbons. When the ends of the burning pair of carbons are pushed down into the economiser, the feed mechanism reverses and another pair of carbons is brought over these ends. The feeding downwards then continues, and when the burnt ends fall into the globe the following pair take up the arc in a few seconds. This means a practically uninterrupted burning of the lamp as long as the carbons last. The life is up to 95 hours, according to the current consumption of the lamp.

The current is carried through the case of the magazine to the carbons and pitting of the guides is avoided by providing a sliding surface which is virtually four thin lines against which the carbon presses uniformly. A weighted lever holds the lower end of the carbon securely in position. The two foregoing precautions prevent sparking in the magazine.

The economiser is of cast-iron and is hinged and held up by a simple catch ; it is therefore easily swung open for cleaning. In fact all the parts of the lamp are readily accessible. An ingenious method of sealing off the globe from the upper part of the lamp has been introduced. The base ring carrying the economiser has a machined surface on its under side and this is firmly pressed against a corresponding surface on the ring at the bottom of the lamp case ; this case is suspended on rods which are so jointed that a toggle action is introduced by which the pressure on the two surfaces just mentioned is obtained. The lamp is neat in appearance, and it is suitable for the usual burning conditions. A number of lamps are burning on the G.E.C. stand at the Exhibition and they are noticeable for the steadiness and brilliance of their light.

The General Electric Co. also show the Butt flame lamp, which is an ingenious lamp having a very simple control mechanism. There is a special stop, on which one of the carbons rests, and the feed mechanism is such that the carbon descends very gradually, carrying the other carbon also with it. There is no jumping of the arc on account of this gravity feed, consequently the light is maintained steady. The lamp is recommended for the lighting of shops, windows and similar places where a small pattern of flame is needed.



VIEWS OF "ANGOLD" MAGAZINE LAMP.

A FINE VIEW OF ONE OF THE GENERAL ELECTRIC CO.'S STANDS AT OLYMPIA.

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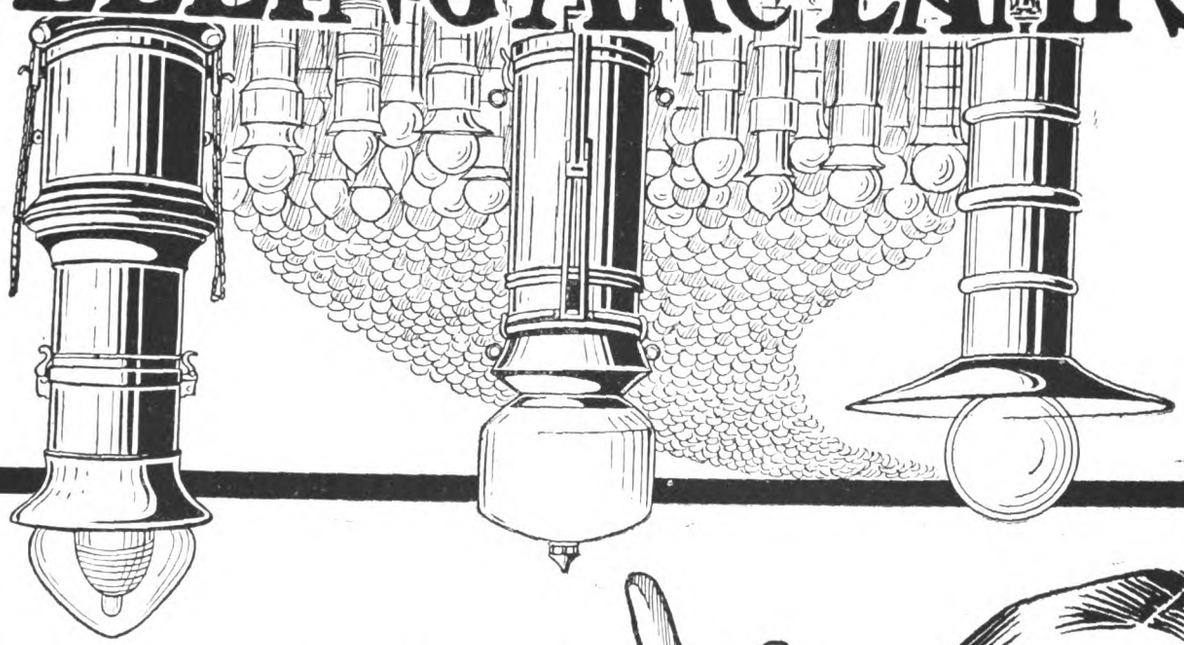
SELLING ARC LAMPS



What Lamp shall I push?

is a thought which is probably on your mind just now.

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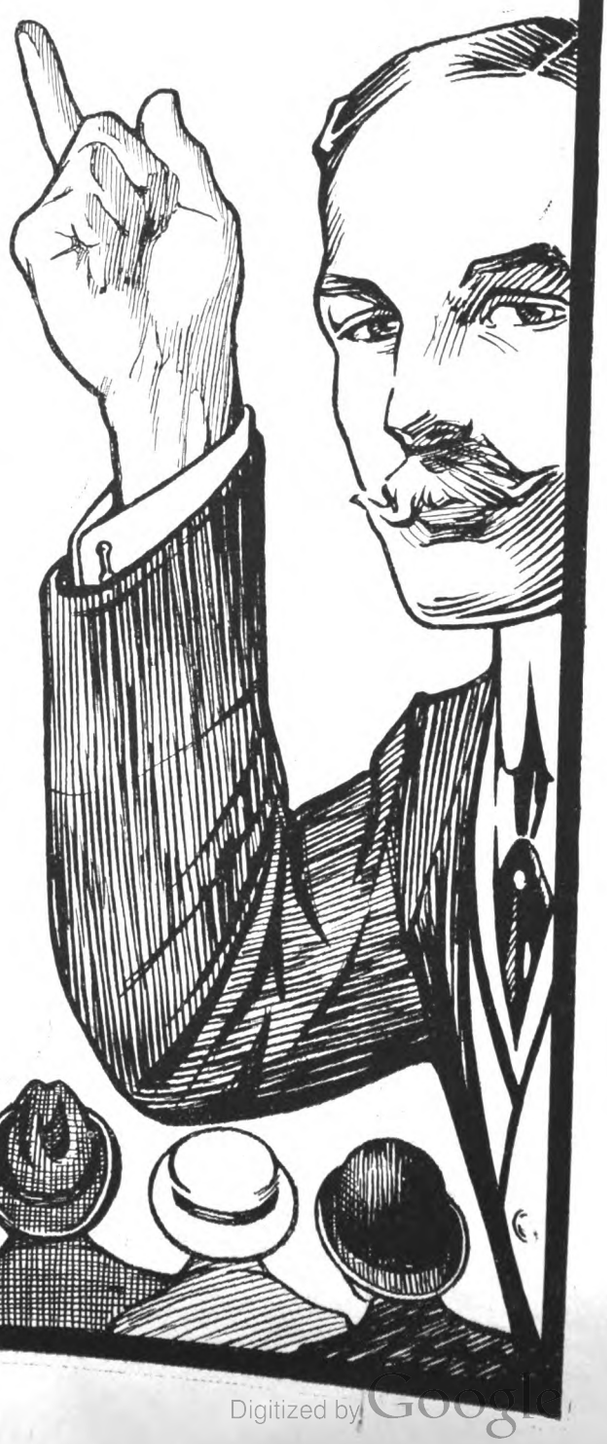

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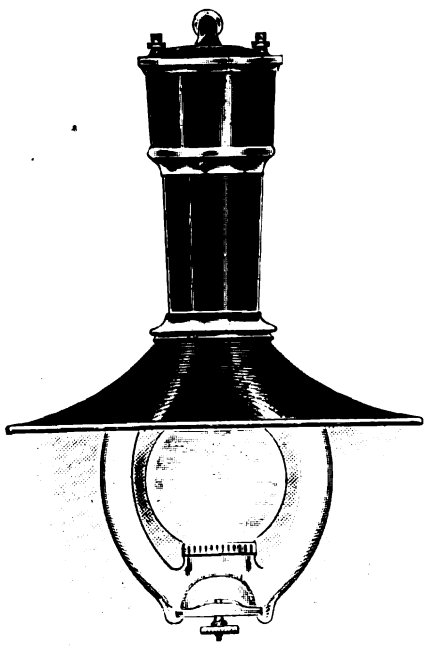
Jandus Regenerative Lamps.

The scheme adopted for the display of the Jandus lamp at Olympia has occasioned much favourable comment. A handsome fumed oak structure has been erected and surrounded by a heavy railing of the same material. The lamps themselves are let into panels in the corners of the exhibit, each pattern of lamp having a niche to itself. This arrangment allows of the inspection of each lamp without having one's attention attracted by surrounding objects. The Jandus Co., of course, specialise in one thing, and they appreciate the importance of "staging" correctly at an exhibition. The lamp itself retains all its good features, and is offered as a standard product with a minimum of working parts and a maximum of light efficiency and life. Since we last commented upon it, we understand that it has been widely taken up, and that its users are eminently satisfied with it. We may call our readers' attention particularly to the small pattern of Jandus lamp which is offered for certain classes of shop lighting, open spaces, factories, work rooms. It is a good light giver and is economical of energy.

The regenerative lamp gives a life of 70 to 120 hours. The number of burning hours is according to the particular adjustment of any one or series of lamps. Only one pair of vertical carbons is used per trim, and the carbons are mechanically strong and capable of withstanding rough handling. The efficiency of the lamp is nearly 8 candles per watt. A distinct advantage is obtained with the use of vertical carbons, as with a current as low as 5 amperes a candle-power of 4,000 is given off at an angle of 15 deg. below the horizontal. The light possesses valuable penetrative qualities, and is very suitable for murky or foggy weather. As the top carbon has a vertical feed it has been possible to do away with all clock-work mechanism. A further feature of the lamp is the flexibility of the arc, which allows it to be adjusted to suit voltages between very wide limits.



Jandus Regenerative Arc Lamp.

The small consumption lamp, to which we have just referred, is adjusted to consume only 250 watts, including loss in line resistance. The candle-power is 1,800 to 2,000 c.p. maximum and (as in all Jandus regenerative lamps) is given off at an angle of about 15 deg. below the horizontal. The lamp shows marked economies over the enclosed arc or the high candle-power metal lamp. As is well known the ordinary type of single enclosure arc lamp burns 60 to 70 hours, and gives 800 to 1,000 c.p., taking 500 watts approximately. Compared with this the small consumption regenerative lamp, burning 100 hours, gives double the candle-power for half the consumption of the single enclosure lamp. Again, a 200 c.p. metal lamp takes 250 watts approximately, while the regenerative lamp for the same consumption gives approximately 10 times the candle-power. It will be seen from these examples how the regenerative lamp can be adjusted to meet nearly every possible circuit condition.

The regenerative lamp has now been adopted for street lighting, dock lighting, railways, factories, collieries, ironworks, &c., and in having it on the market the Jandus Company have a lamp which is proving itself a boon to all who have adopted it. From the many users, reports are constantly coming in that after experience with the lamp the following points have been most pronouced and effectively proved :—

1. In plant or reduction in bulk supply for lighting.
2. In labour costs.
3. In carbon costs.
4. Adaptability and high efficiency.

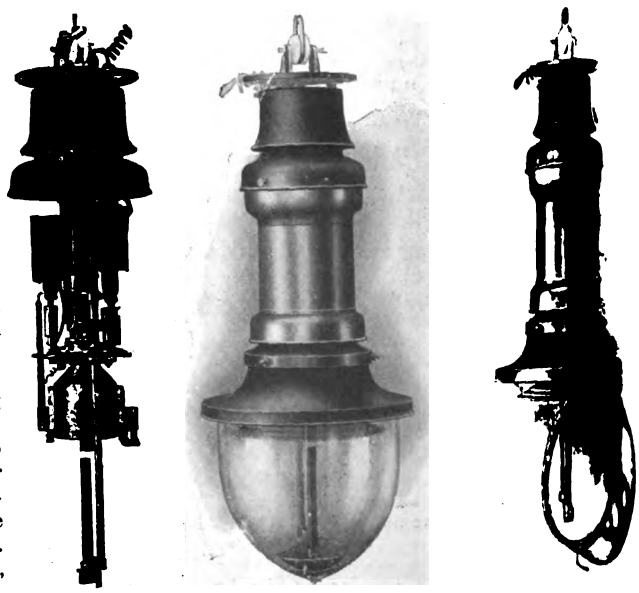
The works of the Jandus Company are situated in Holloway, close at hand, and visitors to the Exhibition can make arrangements for inspecting the actual manufacture of the regenerative lamp at any time.

Magnetite Arc Lamps.

The magnetite arc lamp is recommended for lighting areas where a large volume of light is desired, and is adapted for lighting machine shops, foundries, factory yards and places where the slight fumes given off by the lamp are not objectionable. The most striking feature is the character of the arc used, this being formed between an upper electrode consisting of a short copper bar and the lower electrode which is composed of an iron composite called magnetite. The upper electrode always remains in the same fixed position, the feeding and regulating being done through the lower electrode which moves in a vertical direction. Since the upper electrode remains stationary, the arc always remains in the same focal position. In feeding, the lower or negative electrode is drawn upward by a pair of shunt magnets until it strikes the positive electrode; the magnets are then short-circuited by an automatic series cutout, and allow the lower electrode to fall back into normal position, thereby forming the arc. When the lamp is operating, the steadying resistance and small series cutout only are in circuit with the arc. The steadying resistance is of the well-known edgewise wound type. The casing is of solid copper with black oxidised copper finish. Flexible cables have been substituted in place of binding posts, so no trouble will be experienced with the lamp from metallic dust.

The lamps give an ideal distribution of light which is maintained throughout the life of the electrodes. Inside the globe and directly above the arc is located a small reflector 11 in. diameter of sheet steel, and of the well-known inverted concentric type. With the magnetite arc most of the light is emitted by the arc stream proper in a horizontal direction, this being an important aid to good diffusion. By placing a reflector above the arc, part of the light is concentrated directly beneath the lamp, so that the maximum light and an even distribution are obtained on the working plane. Special reflectors can be furnished to throw the maximum light in either a horizontal or a vertical direction. This makes it possible to instal the lamps in low or high positions, and secure a satisfactory light distribution.

At 4 amperes the efficiency is 0·758 watt per mean hemispherical candle-power, and at 6·5 amperes it is 0·493; this, it will be seen, is remarkably high efficiency for a lamp of this character. The cost of the upper electrode can be considered negligible, as it has a life of between 6,000 and 8,000 hours at 4 amperes, and 1,000 to 2,000 hours at 6·5 amperes, with a comparatively small renewal cost. In trimming, only the lower electrode requires renewing, and, as this has a life of from 175 to 200 hours at 4 amperes, and 100 to 130 hours at 6·5 amperes, the expense of trimming is relatively low. The magnetite lamp is suitable for use on continuous circuits only. Single lamps can be operated on 100 120 volts; a subsitutional resistance is not necessary for these lamps. Lamps can be operated two in series on 200 150 volts or five in series on 500 volts, but a substitutional resistance mustbe used with every lamp when run in series. Lamps for both single multiple and series running can be supplied for either 4 or 6·5 amperes. The lamp is made by the B.T.-H. Co., as it is shown in the three above illustrations.



Views of Magnetite Arc Lamp.

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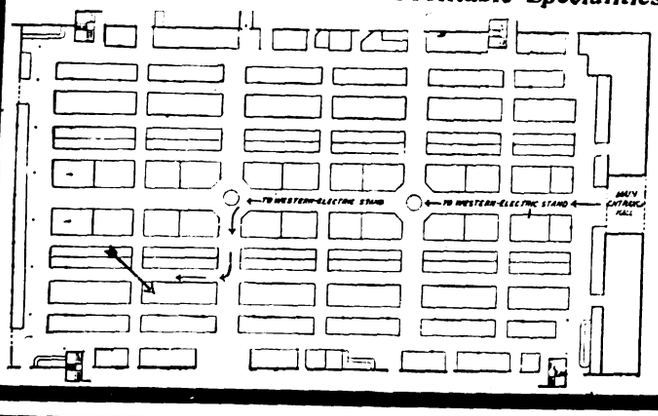

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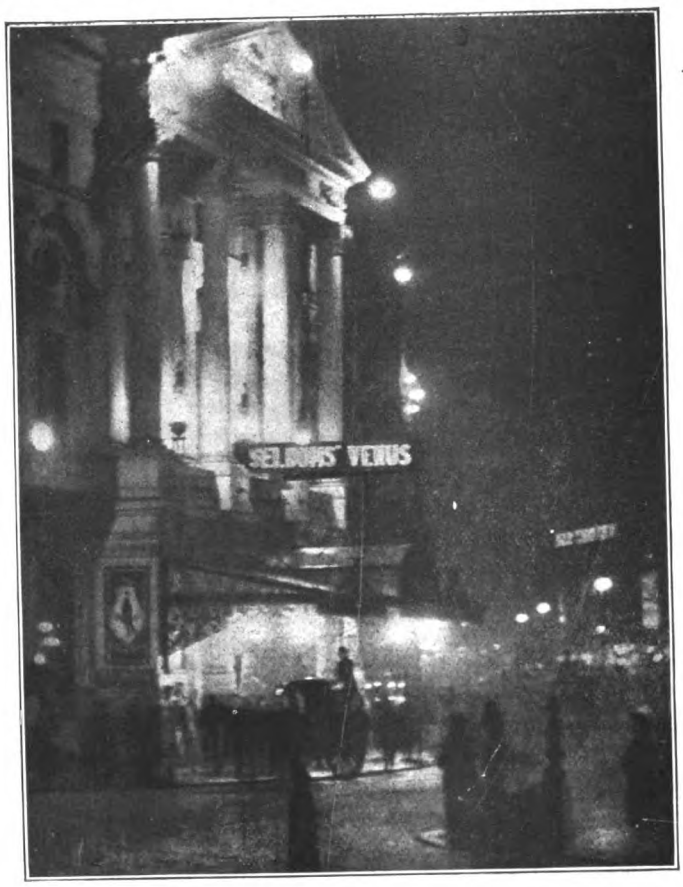
Excello Arc Lamps.

The exhibit of the Union Electric Co. may very well be termed a blaze of light. In the centre of the stand is an imposing structure surmounted by four bracket posts from which Excello arc lamps are hung. There are eight Excello lamps in all on the stand, four running with a current of 12 amperes on a direct-current circuit and four with the same current on a 50 cycle alternating-current circuit. All these lamps are fitted with the well-known deposit free cover and their burning life is from 16 to 18 hours with a single pair of carbons. Arrangements have been made for the display of the mechanism of these lamps on the stand so that visitors will have every facility for the closest possible inspection. Users of light who require to illuminate large open spaces will be interested in the Excello dioptric globe. This was introduced some years ago and has been found of great value in improving the horizontal distribution of light from the lamp. The dioptric globe is used in lamps for street, yard, railway depot, dock and wharf lighting, and in any situation where the lamps require to be spaced at considerable distances. We have described the Excello arc lamp so frequently that we feel that it is not necessary for us to enter into further details upon its many excellent points. It enjoys probably a greater vogue than any other type of lamp and may be seen almost everywhere utilised for an infinite variety of



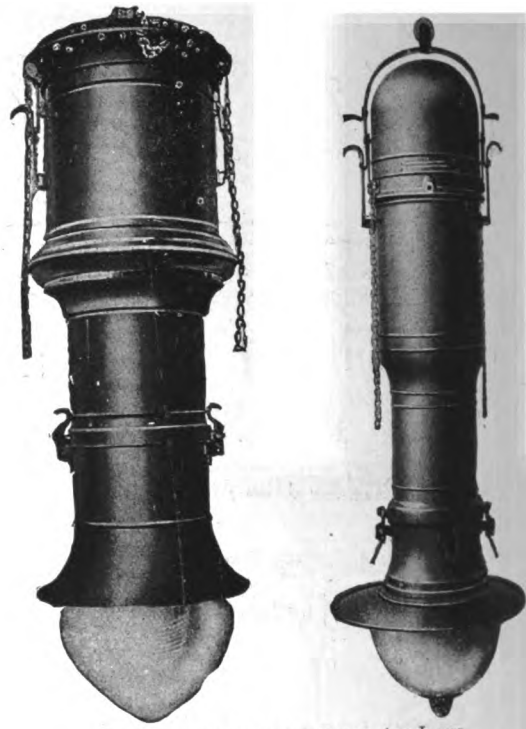
A Beautiful Lighting Effect with Excello Lamps.

lighting purposes. The parts of the lamps are all standardised and made strictly to gauge, so that they are accurate fitting and interchangeable.

The general display of enclosed lamps by the Union Electric Co. is also of interest. We may mention in particular the Koh-i-Noor pattern, there being six of these shown on the stand. With the normal running current of 5 amperes these lamps have an approximate burning life of 25 to 30 hours per trim. The lamps are suitable for direct-current and alternating-current circuits and may be fitted with a variety of different covers, making them suitable for indoor or outdoor lighting.

The Union Electric Co. has made a special study of the subject of indirect and semi-direct lighting with arc lamps, both of the open, enclosed and flame pattern. We have seen many beautiful examples of this class of lighting and it should specially commend itself to architects who have the design of new buildings in hand or the re-modelling of old buildings. Similarly, illuminating engineers should take special note of its many advantages. The circumstances under which it can be applied are of a special character, but where they are exactly suitable it is difficult to conceive of a more beautiful result.

The visitor to the Exhibition is further reminded of the presence of arc lighting specialities on the Union Electric Co.'s stand by the projector which is in constant operation during the evening. The particular pattern shown has a mirror 24 in. in diameter and the

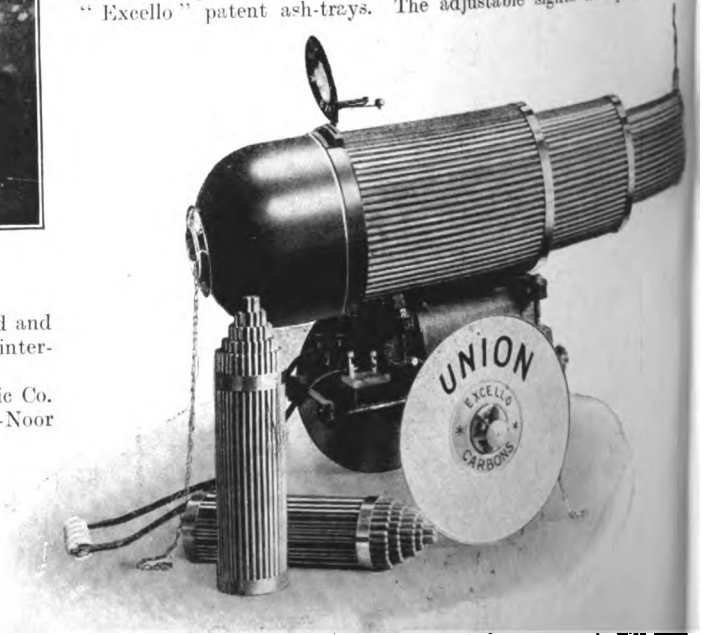


Examples of Excello Flame Arc Lamps.

lamp has an automatic feed controlled by differentially wound magnets. The projector is of a pattern which has been supplied to comply with War Office regulations, Admiralty regulations, and the conditions of the Suez Canal Commissioners. All the parts of the lamp are readily accessible. Provision is made for the inspection of the arc through obscured sight glasses.

Excello Ordnance.

The Union Electric Co. has just turned out from its works a piece of artillery which should be useful for the coming lighting campaign. This is on show at the Exhibition, and consists of a large-bore field gun, built entirely of "Excello" parts, accessories and carbons. The breach end is an "Excello" lamp cap; the carriage is an auto-transformer, supported on lamp-reflector wheels, the hubs of which are "Excello" patent ash-trays. The adjustable sights are quite a



Excello Carbons.

feature, the fore-sight being entirely different from anything now in use by any Government. The barrel is composed of entirely "Excello" patent carbons, as also are the projectiles, which are calculated to pierce an armour of prejudice of hitherto unheard-of thickness.

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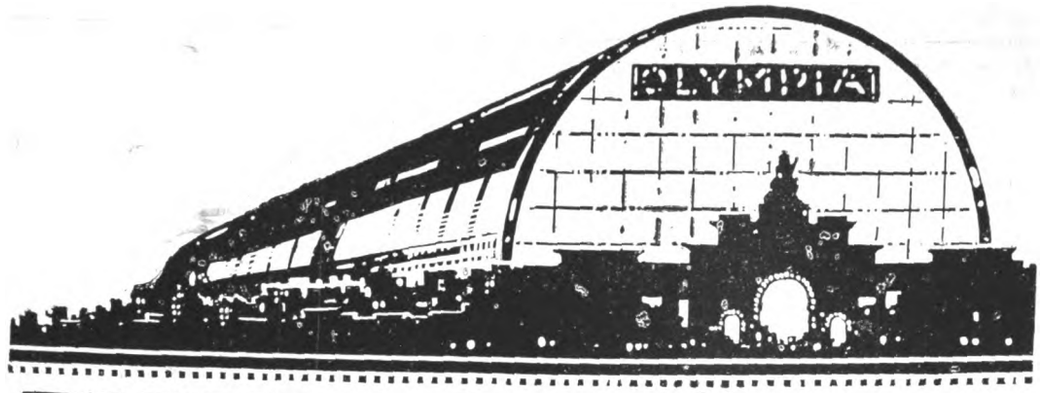

THE STAND

of interest is the "UNION" Stand at Olympia. We are showing our latest patterns of Arc Lamps, including a new and interesting Search-light projector and automatic cinematograph lamps.

We specially invite an examination of the lamps used in the UNION "EYE-COMFORT" system of Inverted Arc Lighting, which is now coming into such wide use for the interior illumination of schools, studios, workrooms, drawing offices, and shops and stores of all kinds.

We are exhibiting, also, examples of the latest developments in Dynamo, Motor, Switchgear and Instrument design.

Our engineers, in attendance at the Stand, will be delighted to show you round and give any information you desire. The Stand number is

101-114

Stand Telephone No. Olympia 46.

Union Electric Co. Ltd.

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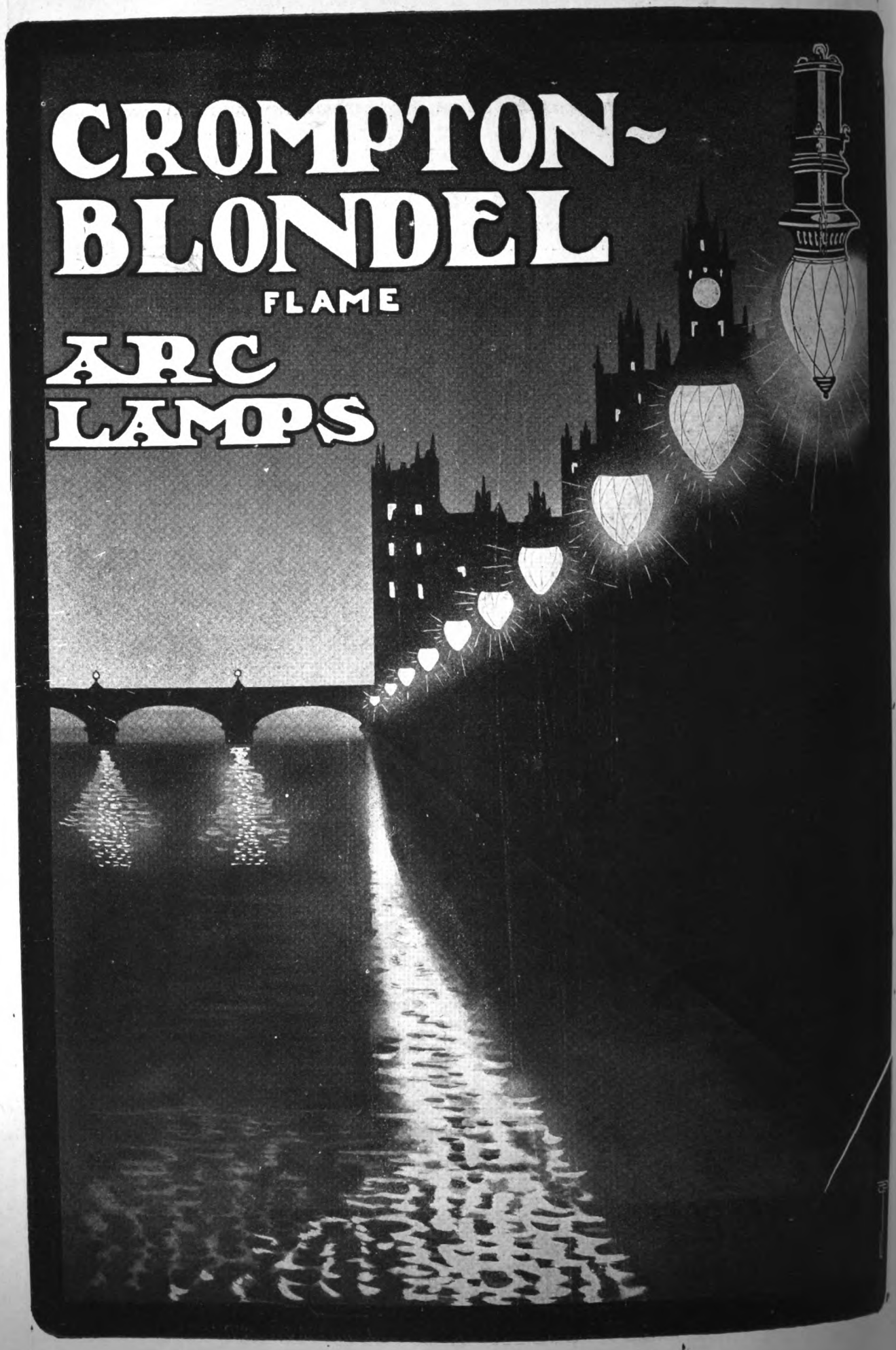

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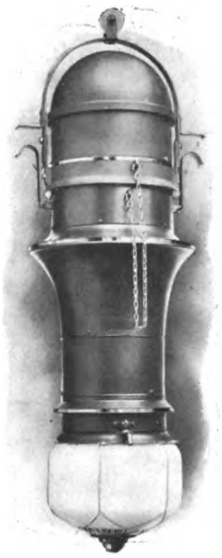

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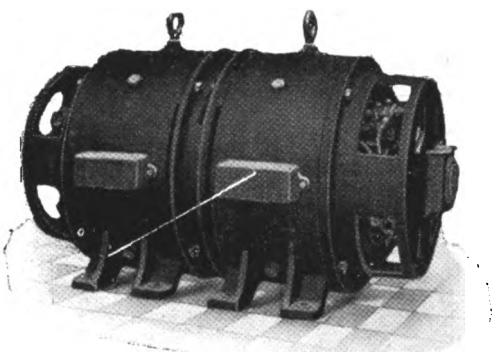
OLYMPIA EXHIBITION.—*Continued.*

Wright & Wood. (Nos. 129, 130.)

The exhibit of Messrs. Wright & Wood, dynamo and motor manufacturers, Halifax, is combined with that of Messrs. Berry, Skinner & Co. The Wright & Wood machines exhibited are of interest particularly as several new types have been introduced. We may mention in particular the duplex type cinematograph motor-generator. This is designed with the motor operating on a 460-volt circuit, and the generator giving 48 amperes at 65 volts, the speed of the unit being 1,100 revs. per min. The machine has only two bearings, and the overall dimensions have been considerably cut down. With this arrangement also the weight of the complete set is much less than if four bearings were employed. There is also, of course, less



Wright & Wood Compact Motor Generator.

maintenance cost and greater rigidity. The machine is made in 14 standard sizes, and we give an illustration of it herewith. Another interesting machine is a rotary converter fitted with ball bearings. This runs on 110-volt direct current, and furnishes alternating-current energy of 50 cycles at 71 volts, the output being 500 watts and the speed 1,500 revs. per min. A ¼ H.P. 2,000 revs. per min. plate polisher is another interesting machine and also a tiny hydro-electric set, which has an output of 75 watts, and is suitable for small installations having a low voltage lighting system. The company's cork pulleys should be inspected. These are shown in sizes from 4 in. diameter upwards, and are said to be lighter, to have no slip and wear and a larger transmission ratio. The exhibit is accompanied by a number of motor-starting devices.

Marryat & Place. (No. 150.)

This firm has secured a site in the centre of the main hall, and are erecting one of their latest pattern automatic electric lifts on a steel structure reaching to a height of 50 ft. They claim to have developed the automatic electric lift from the electrical side as no other firm has done, and have profited by this experience in mechanical details. The difficulty with push-button lifts has been that with a brake of constant strength, the floor levelling varies according to the load—that is to say, when travelling with light load the car will stop a little above floor level, and when travelling with heavy load it will stop somewhat below floor level. This floor levelling error increases with the speed of the lift. To get over this difficulty, manufacturers have contrived various floor finding switches fitted in the well.

The M. & P. arrangement gets oper the difficulty without the aid of any well switches, the whole apparatus being self-contained and fitted either at the top or bottom of the well. It is thus possible to run lifts at three to four times the speeds previously possible with automatic control. The wiring and erecting costs are greatly reduced and the whole apparatus rendered much more simple and reliable than anything which has been before put upon the market. The lift exhibited is equipped with both push-button and car-switch control, together with a two-speed apparatus, the latter being a great convenience in places where it is sometimes required to operate the lift slowly for convenience of nervous or invalid people, and at other times rapidly for general business.

H. WEIDMANN,

RAPPERSWIL, SWITZERLAND,

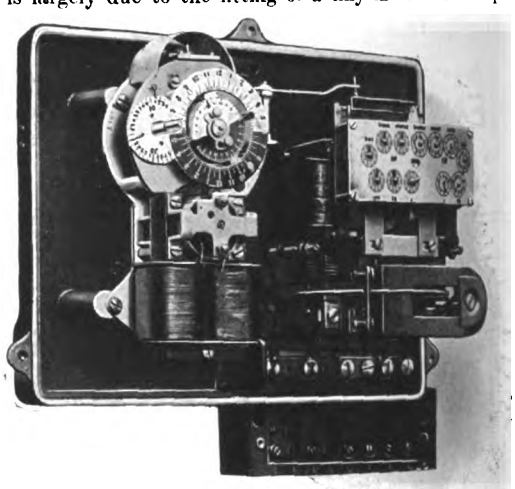
FOR

Presspahn and Insulating Material.

(See larger Advt. last week.)

Bat Meter Co. (No. 83.)

The experience of this company in the manufacture of electricity meters is demonstrated by the variety of types which they exhibit. One of the most noticeable instruments is a watt-hour meter of 2,000-amperes capacity with the shunt which carries a portion of the load. The meter is made up of a disc-shaped rotor, two flat field coils, two compound coils, a regulating coil with an adjusting iron core, and a pair of detachable silver brushes. There is no iron in the field or rotor and the meter can be used on alternating current or direct-current circuits. We understand the starting current is low and that the meter will register accurately on less than $\frac{1}{500}$th part of full load. This is largely due to the fitting of a tiny motor which imparts a



Bat Two-rate Meter.

rocking action to the brushes and counterbalances their friction with the commutator. The Bat two-rate mechanism should also be inspected and also an ampere-hour meter of the mercury type which the company has only recently placed on the market. It is stated that the temperature error, which is usually high in mercury meters, has been considerably reduced in this new pattern. It is said to be about 1 per cent. to 2 per cent. for 20°F.

IN THE GALLERY.

Although the bulk of the exhibitors are stationed in the body of the hall, there is a good show in the gallery, where upwards of 50 firms are showing.

The Electric Home. (No. 280.)

Messrs. John Barker & Co.'s "Electric Home" occupies the whole length of the gallery at the opposite end to the Addison-road entrance. The company has exceptional facilities for a display of this character, and has grouped in the various rooms of the home a fine collection of furniture, pictures, &c., which act as a suitable background against which to display various kinds of electric fittings and every conceivable type of domestic electrical appliance. The show is one which will not fail to attract the public, and the immediate proximity of a large number of easy chairs in which to rest should assist materially in bringing visitors to this exhibit.

Immediately adjoining it is a small stand of the **Kennedy Patent Bending Machine Co.**, which is a subsidiary of John Barker & Co., and which makes an effective display of Mr. Kennedy's well-known machine for bending steel and other conduits.

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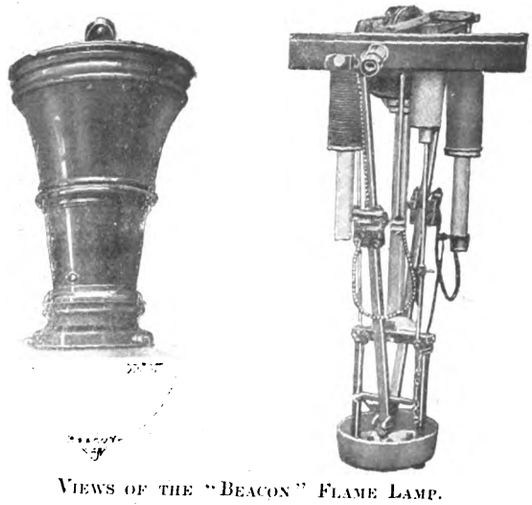
Beacon Flame Lamps.

The exhibit of Engineering & Arc Lamps (Ltd.) (stand 327, Gallery) comprises a display of Beacon and Sunrae flame arc lamps. The stand gives on to the gallery rail, and advantage has been taken of this fact to show a full blaze of "Beacons" to the public in the hall below and the gallery opposite. By this means the exhibit can readily be picked out from the main avenue of the Exhibition. In the midst of a fine display of arc lamps of all kinds, the outstanding feature of the exhibit is undoubtedly the Beacon flame lamp. The mechanism of this is so compact that it occupies a squat annular space at the top of the lamp case, and considerably reduces the overall length. The feed of the carbons (which are of the usual diverging type) is effected by a toothed wheel, gravity driven, but controlled in its rotation by a simple pawl, which is acted on by the differential solenoids. The net result is a tooth by tooth feed which is extremely gradual. In the double carbon lamp there is only a single toothed wheel to control the feed of both pairs, there being a clever throw-over device which comes into action as soon as one



Views of the "Beacon" Flame Lamp.

pair of carbons is burned out. Here, again, as with the single carbon lamp, the feed of each pair of carbons is most sensitive. Electrical men interested in the flame lamp should see the construction of the "Beacon" lamp. The exhibit will well repay a visit. The lamp has deposit free cover, and is offered with a three years' guarantee.

An exhibit of Attractor signs is also being made at this stand. The sign is fitted with an electromagnetic tapper, which knocks on the glass of the sign and positively compels attention. As soon as the passer-by has looked round the sign is lighted up, giving visual evidence of its presence and also its mission. Needless to say, these lamps and signs are of British manufacture throughout.

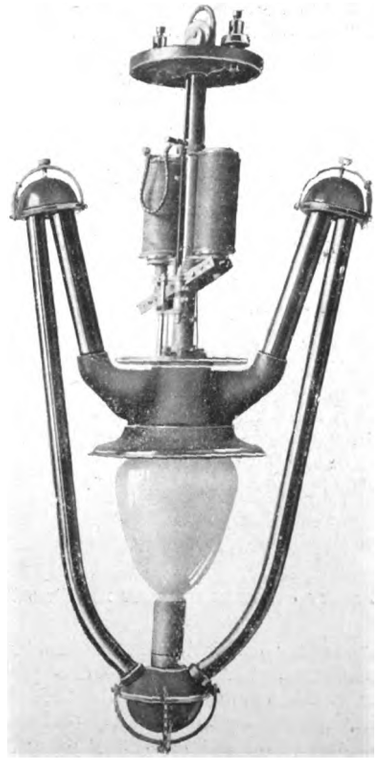
Electric & Ordnance Accessories Co.

The well-known Victor arc lamps developed by the Electric & Ordnance Accessories Co. are being shown at their Olympia exhibit. The Victor flame lamp is one in which a simple clutch mechanism controls the descent of the carbons, and there is an entire absence of clockwork or complicated mechanism. The carbons are placed at a diverging angle above the arc, and are enclosed in tubes which pass up through the controlling solenoids. The lamps are specially recommended for open spaces and factory lighting, and we understand enjoy considerable vogue. They are being exhibited under actual burning conditions at Olympia, and can be inspected in detail.

Hope's "Bi-Metal" Fuse Wire.

In the event of any misunderstanding having arisen, we are asked to point out that this new fuse wire is Mr. Vernon Hope's invention, and the patent is owned by Messrs. Parmiter, Hope & Sugden, of Hulme Electrical Works, Manchester. The fuse wire is manufactured by Simplex Conduits, Ltd., and sold by them, under licence, at the same price as the patentees.

The Abbey Electric Co. has on view, for the first time publicly, a flame arc lamp of an interesting pattern, which employs a special form of hollow carbon for one of the electrodes. The appearance of the lamp is shown in the adjoining illustration. It will be noticed that there is, immediately above the globe, a large collecting chamber for the gases from the arc. This connects on each side with a detachable elbow to which down tubes, leading to the cooling chamber at the bottom of the globe, are connected. The life of the lamp is 30 to 40 hours with one pair of candles. The efficiency of the lamp is stated to be 6 candles per watt, and the cost of the carbons ½d. per hour. The mechanism is confined to shunt and series solenoids, and there is no clockwork. The light emitted is of a pleasing colour, and appears to be quite steady and uniform; the carbons are inexpensive and the makers state that they will stand



Abbey Enclosed Flame Lamp.

a considerable amount of handling, also that when left in the open air they do not absorb moisture. The lamp is inexpensive and is of British manufacture throughout.

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Sunbeam Lamp Co. (Nos. 55, 68.)

Wire-type tungsten lamps are among the novelties of this exhibit. The company claims that these are as strong as tungsten wire, and that the filament is in one continuous length, so that jointing at the supports is entirely dispensed with. The company hope to be able to meet the undoubted demand for a lamp of this pattern, and state that the economy will be the same as that of the squirted tungsten lamps. A prominent display is made of the latter, and they are shown ranging in sizes from the small battery type to those of 1,000 c.p.

A Pretty Sunbeam Bracket for Two Lights.

The exhibit is tastefully arranged, and an item of interest is the shape employed for the office. This is a portion of a sphere, the outside of which is represented as a map of the world. This globe design figures prominently in the company's advertising, and its introduction into the scheme of the stand has been very cleverly arranged. The Sunbeam Co. is noted for its supplies of accessories and fittings, and these will be found in some profusion on the stand. Among the electrical novelties is an illuminated device for calling cabs off the rank. We may also mention the special display which is being made of the "Lux" candle.

Edison & Swan.

The display of electric light fittings for which the Edison & Swan Co. are famous is divided between two stands at the far end of the main hall. The exhibit has been tastefully arranged, and there is a great variety of fittings on view. Pendants, electroliers, brackets, standards, candle fittings, &c., are presented in great profusion. The scheme of lighting has been carefully carried out, and harmonises with the grouping of the fittings. The company's fittings designs cover a wide range of tastes, and will be found to meet the requirements of practically all pockets. It is possible to make arrangements with the Ediswan illuminating department to supply fittings to harmonise with furniture and decorations. The use of method in illuminating schemes is now becoming more general, and the facilities offered by the Edison & Swan Co. should be taken advantage of.

The whole of the illumination of the two stands is carried out by Royal Ediswan metal lamps. These are of the squirted tungsten type, and are made in the usual sizes and standard voltages. The high candle-power lamps are items of considerable interest. These are made in sizes up to 1,000 c.p. per lamp. We understand that they are being taken up widely for street and shop lighting.

Aegma Lamps.

The metal lamps made by the Electrical Co. are well known under the trade name "Aegma," and enjoy a considerable vogue. The lamps have been on the market for some years, and the makers have utilised every effort to keep the standard of illumination and efficiency at a high level. Aegma lamps are of the squirted tungsten filament type, and are supplied in all standard voltages and candle-powers. They are widely used for street lighting, and in this connection are employed in ordinary or special lanterns. We understand that the Aegma lamp has been adopted for this purpose because of its long life and ability to resist vibration.

Multax Lamps.

The Globe Electric Co. is showing a number of Multax lamps at Olympia. We give an illustration of the stand at night, showing the arc lamps lighted up. We may remind our readers that in the Multax lamp a special form of carbon known as the "bridge-core" type is employed. This has been found to considerably prolong the life of the lamp, and it also has a steadying effect on the arc. The makers state that 100 hours' burning can be obtained with a single pair of carbons. The lamp is suitable for the usual circuit conditions and may be employed on A.C. or D.C. circuits. The general details of the mechanism of the lamp and sections of the special carbons employed are shown at the exhibit. The Multax lamp has been on the market for some time, and the makers can point to a large number of interesting installations in which it is giving complete satisfaction. Contractors and central station engineers should take an opportunity of visiting this interesting exhibit.

A Night View of Stand Lighted by "Multax" Lamps.

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Electricity in Mining.

A SPECIAL ISSUE OF "THE ELECTRICIAN" DEALING WITH THE APPLICATIONS OF ELECTRICITY IN MINING WORK.

IMPORTANT NOTICE.

Extra Copies of "The Electrician" Special Mining Issue (May 12th, 1911), will be obtainable, after day of issue, price 1/- nett (post free U.K., 1/1; abroad, 1/8). After May 19th the price, post free in the U.K., will be 1/5.

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AND A SERIES OF DESCRIPTIVE ARTICLES DEALING WITH THE PLANT, MACHINERY AND ACCESSORIES USED IN MINING WORK.

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THREE YEARS' PROGRESS.

Since the publication of the first MINING ISSUE of THE ELECTRICIAN, three years ago, remarkable progress has been made in the application of electrical energy to the operation of mining plant and machinery. This progressive movement has been practically world-wide, and in particular we have to record a gratifying advancement in the mines and collieries of this country. In the present issue we have endeavoured to collate a quantity of valuable data and information bearing upon the present position of Electric Power in Mining; and we think that the special articles, each of which deals with a specific branch of the subject, together with the descriptions of modern electrical mining plant and equipment, will show what rapid strides have been made in every direction during the past three years.

The progress of electricity in mining has been unfortunately hampered by several disastrous accidents. Some of these have been due to causes quite outside electrical operations, but, on the other hand, some have been more or less directly due to the failure of that part of the equipment. When new apparatus is first introduced into a place like a mine, accidents are liable to happen, partly owing to lack of knowledge of the conditions under which the apparatus has to work, and partly to unfamiliarity with its use on the part of the men. Such accidents can, of course, be avoided to a certain extent by carefully prepared rules and regulations.

These have now been framed. Soon after our last Mining Issue was published the Home Office appointed a small committee to inquire how the existing Mining Regulations might be brought up to date and rendered applicable to modern electrical practice. Revised Rules have recently been published, and their scope is dealt with in a special article in this issue.

The new Rules are, we believe, the result of co-operation between the Home Office, Mine Owners and Plant Manufacturers. This is a logical way to set to work, for, taking the case of the switchgear manufacturers, as Mr. CLOTHIER points out, they have made many experiments to discover the best type of plant for the purpose of the numerous mining operations to which electricity can be economically and safely applied. Such co-operation can lead only to the production of apparatus best suited for the varying conditions to be met with in mines. The new Rules are concerned essentially with matters of safety, which are all-important, and in this connection the articles by Prof. W. M. THORNTON and Mr. H. J. S. HEATHER will be read with interest; they differ materially in the points of view from which they are written and refer to very different conditions of mining work.

As showing the extreme variability of the conditions that exist in mines, we may call attention to the arguments in Mr. HEATHER'S article which go to prove that earthing the neutral in South African mines is often extremely dangerous owing to the dryness of the rocks. This is directly

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opposed to our own practice, because moisture is more generally present in mines in this country.

An event of considerable importance which we can now place on record is the linking-up of the large steam turbo-electric power stations on the North-East Coast, principally with the object of giving a cheap power supply to the collieries of Northumberland and Durham. This is a progressive movement which we should like to see spread to other coalfields in this country. It has the effect of relieving the colliery owner of the initial cost and responsibility of installing plant for the generation of power for his own collieries. In the Northumberland and Durham and other areas where the Power Supply Company can support the transmission lines with large generating units, the effect has been to encourage the installation of electric winders and large haulage gear without flywheel storage or load equalising motor generators. This, again, is an economy for the colliery owner. The points in favour of bulk supply to collieries are dealt with by Mr. W. B. WOODHOUSE, of the Yorkshire Electric Power Co., in a special article.

At the same time there are groups of collieries in which small generating plants have been used for some years past at the pit head, supplying energy for light and power to a single pit. By the employment of modern steam turbo-generating plant, it is possible to give the same efficient supply to a group of collieries which are under a single management or ownership, and the arguments for such a concentration of plant are put forward by Mr. W. E. CHAPPELL in this issue. These conditions apply, of course, to a district in which a bulk service of power is not available. On the other hand, there is still a good case to be made for the use of steam turbo-electric plant at the pit head of large collieries. The improvements in steam turbines, both of the high, medium and exhaust-pressure types have entirely changed the aspect of this problem. Mr. W. B. SHAW deals with this subject in a special article, and here again the argument must be considered as applying to a district in which a cheap supply of power is not yet available.

In our first Mining Issue, we devoted a considerable amount of space to the design, construction and operation of electric-winding engines. In the present issue we are able to publish an article by Mr. GERALD HOOGHWINKEL, dealing with the progress of electric winding in England since that time. Complaint is often made that the steam system is much the simpler, but, although an electric winder requires the use of a certain amount of subsidiary apparatus, this lack of simplicity is not really a disadvantage. That electric winding is making considerable progress will be gathered from the Tables which we give in another part of this issue. It is very often thought that there are quite few mines where such winders are installed, but this, it will be gathered, is not by any means the case. It may be definitely stated that in no direction has the use of electricity in mines made more progress during the last three years.

The advances made in mining switchgear have been principally in the direction of ironclad designs, in which the whole of the protective apparatus is enclosed. The article by Mr. H. W. CLOTHIER, and also the descriptions of the apparatus made by the principal manufacturers supply an accurate record of the work done. The liquid controller and oil-immersed resistance have come more prominently to the front and merit the special attention of mining electrical engineers. The development of gate-end protective systems is also a good sign of progress. If the confidence of the men in these methods can be obtained a great deal will have been done to remove the existing prejudice of miners to the use of electrical apparatus at the coal face, for it is at this particular point that the men take exception to the employment of electrical plant. The practical operation of these protective systems should be closely followed during the next year or two. Mr. CLOTHIER draws particular attention to one of the weak points in switchgear, that at which the cables are led into the switch equipment. Great care is now being taken to provide special protection at this point. Leakage is particularly annoying on ordinary aboveground installations; in mines it becomes dangerous also. Mr. CLOTHIER shows how various protective systems which are now used exclusively aboveground can be modified to suit underground requirements.

Besides designing the switchgear so that it shall be capable of safe employment in mines, modifications must be introduced into the design of motors, especially those driving coal-cutters and similar plant in explosive areas. Mr. TALBOT DUCKITT advocates consideration of the design of motors which have been introduced to fulfil these conditions.

Mr. A. B. MALLINSON contributes an interesting article in which he discusses various points to which attention must be given in colliery wiring. The cable in process of erection is rather a tender plant, and great care must be taken how it is handled and fixed if it is not to give trouble afterwards.

Great progress has also been made in the electrical operation of coal-cutters. Here again the opposition of the miners themselves is serious. The conditions under which the motor has to operate, and the work it has to do, are by no means ideal, and much experimenting has had to be carried out before a suitable machine has at last been placed on the market. Mr. H. J. FISHER, in his article, deals also with the proper connection of this apparatus to the mains. The trailing cable comes in for hard usage; and an interesting method of getting over this difficulty is to enclose it in rubber of a quality similar to that used on pneumatic tyres.

Mr. W. MAURICE'S article shows that progress is also being made in the use of electric lamps in mines. The aggregate number of the lamps may be small at present compared with those of the oil type, and there is yet much to be done in this direction. There is no doubt that from every point of view this type of lamp should receive the consideration of all mine-owners.

In conclusion we may draw attention to the two articles by Mr. NEIL TAYLOR and Mr. C. F. MACKNESS respectively. Mr. TAYLOR deals with the present position of the electric drive in Cornish mines. These mines are, as is well known, amongst the oldest existing in this country, and it is found that electrical equipment for their operation is no less useful here than elsewhere. An interesting development illustrated in this article is the use of the Diesel engine as the prime mover in the power house. Cornwall, not having coal among its natural resources, provides a fitting field for this type of plant. Mr. MACKNESS deals with the great progress that is being made in the use of electrical apparatus in South African mines, where, as mentioned above, the conditions are considerably different from those existing in this country.

Besides these signed articles from the pens of men of large and varied experience, a number of descriptions of mining installations, and of equipment suitable for mining work, which have been supplied for the purpose by the leading makers, have been included, and we hope THE ELECTRICIAN SECOND MINING ISSUE will be found to be an accurate guide to the actual state of affairs in a department of electrical enterprise where development of this kind makes for the improvement of the working conditions of a most important branch of industry.

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Electricity in Cornish Mines.

BY NEIL TAYLOR.

Summary.—An account is given of the very special conditions existing in the metalliferous mines of Cornwall, and of the points to which particular attention must be given. Stress is laid on the importance of securing good results in pumping. Owing to the extreme conservatism of those connected with this isolated branch of mining there has been considerable difficulty in introducing electric plant, but much headway is now being made.

It is only a few years since electricity was introduced into Cornwall for the various requirements of metalliferous mining, and its progress has been comparatively slow. The older concerns have been a long time in realising its usefulness for their particular purpose. Fortunately for progress, the newcomers, or foreigners as they are locally termed (*i.e.*, anyone who hails from the other side of the Tamar), are determined to instal the most modern equipment with a view to economy.

Practically all new ventures which have been recently started in the county have contented themselves with reopening abandoned mines. Naturally, the first and most difficult problem to be faced is the unwatering of the mine. In most cases this has been a difficult proposition owing to the scarcity of reliable information and the trouble due to the shafts themselves. Old plans are of little service and cannot be depended upon. The difference in the amount of incoming water in summer and winter is very considerable, so that great care requires to be exercised in the choice of pumping plant.

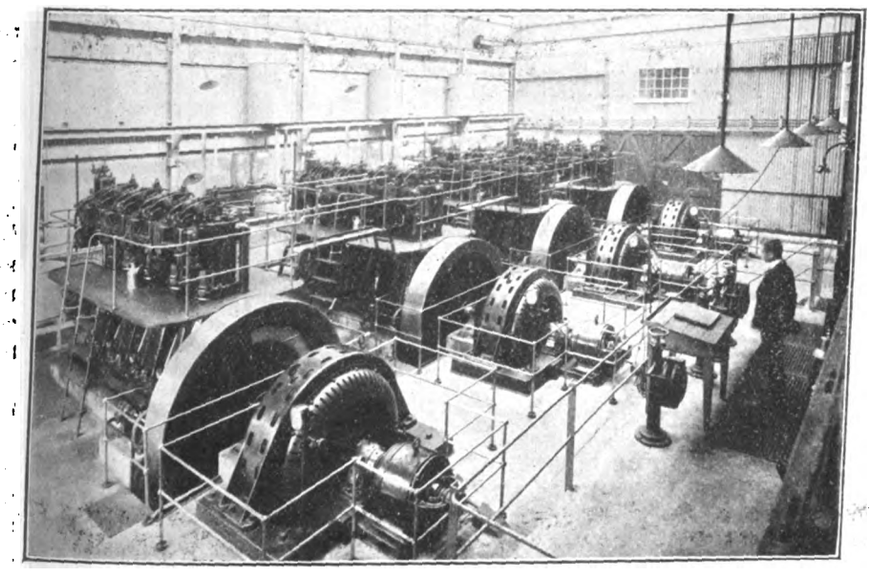

FIG. 1.—INTERIOR VIEW OF A MINE POWER STATION, HAVING FOUR SETS OF ENGINES AND ALTERNATORS, EACH SET OF 200 B.H.P. DIESEL ENGINE DIRECT COUPLED TO A 135 KW. ALTERNATOR, 650 VOLTS, 50~, THREE-PHASE WITH EXCITER.

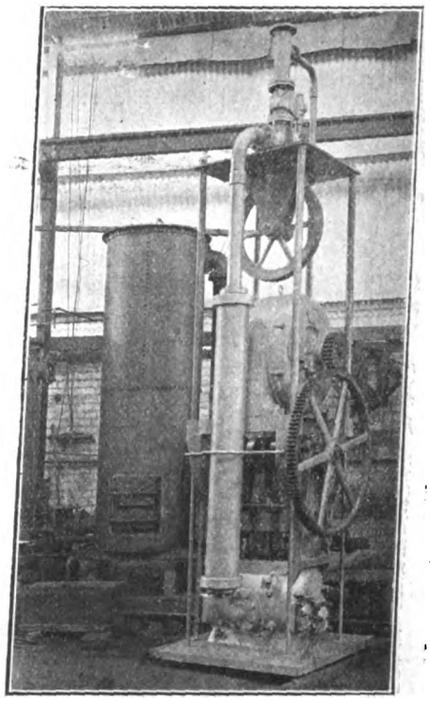

FIG. 2.—500 FT. HEAD THREE-THROW ELECTRIC SINKING PUMP, 250 GALLONS PER MINUTE.

As a rule there is no scarcity of shafts, but what they make od in numbers is entirely negatived by their size, or rather ınt of size. Shafts are rarely perpendicular for any depth d take all sorts of angles in their downward course. After ciding on the shaft which will be most suitable for pumping erations, the next point, and probably the most important, is fix on the most suitable type of pump under the adverse ıditions obtaining.

There are three schools of thought on this thorny question of proper system to be adopted for the unwatering of Cornish ies. First, the old school who know of only one pump, a nish pump, and only one prime mover, "a Cornish beam ine," and only one boiler fit to supply steam for the engine, Cornish boiler." After which we come to the so-called modern slap-up-to-date set, who maintain, with equal tenacity to first set, that electrical pumping is the only system. The term electrical pumping, at this end of the world, has become known as a combination of a high-speed motor and a turbine type of pump. Then follows the third set, who endeavour to treat each proposition on its merits and decide in accordance.

To obtain a clearer view of this knotty problem let us look at some of the difficulties :—

1. Mine full of water.
2. Incomplete data regarding coming water.
3. No data as to amount of water in the mine.
4. No reliable information as to size or inclination of shafts.
5. Chocks in shafts.
6. Acidity of water in many cases.

The chief argument used in favour of the Cornish pump is its reliability, but within recent years quite a few engines have come to grief with broken bobs, and where this has occurred considerable time has been lost in replacing the broken part. Another trouble with the Cornish pump is broken pump rods; also where shafts are small, the space taken up by rods and gear is a great disadvantage.

Electrically driven turbine pumps are found to be troublesome in upkeep, and as a rule are difficult of access for repair. Wear and tear is greater in this class of pump than with a Cornish pump, but when discussing unwatering propositions it must be borne in mind that the real object is to get at the producing stage as quickly as possible, so that although the turbine pump is more expensive in upkeep it generally gets there in quicker time.

The ordinary ram pump has probably done better work in unwatering than any other; it has the great advantage of

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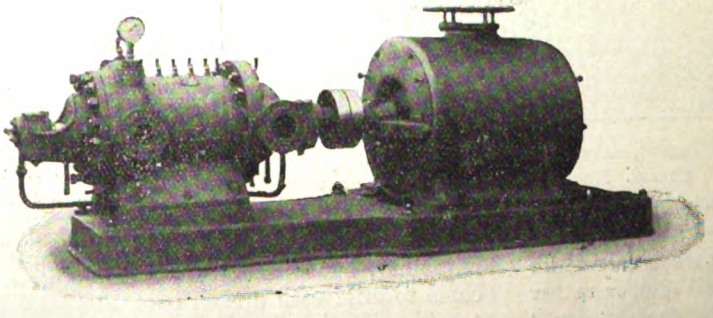

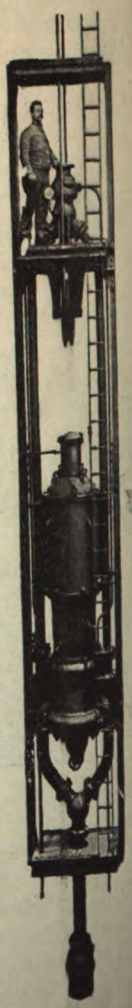

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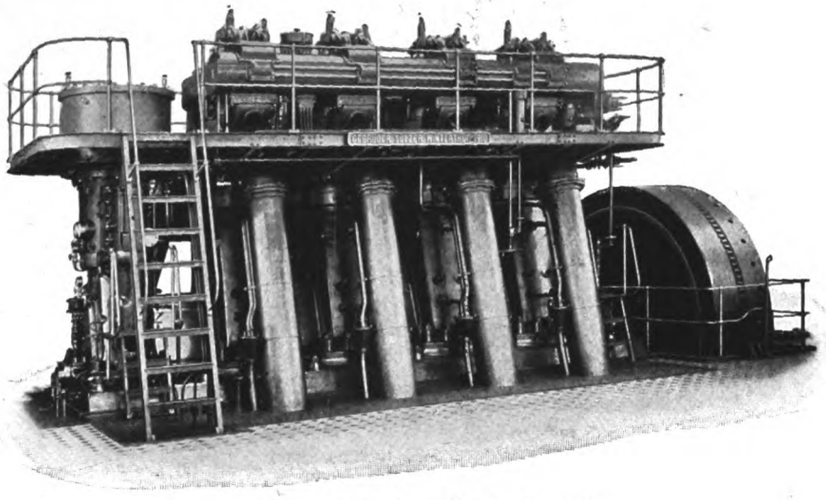

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simplicity in construction, and is less costly in maintenance. But the pump which has proved to be the best is a two or three-throw ram pump using Guttermuth valves; it is less liable to break down, is simply designed and better suited to the conditions. Not all mines are troubled with acid water, but a great many are, and notwithstanding that this is known, materials are sometimes used in construction which can only cause trouble and annoyance.

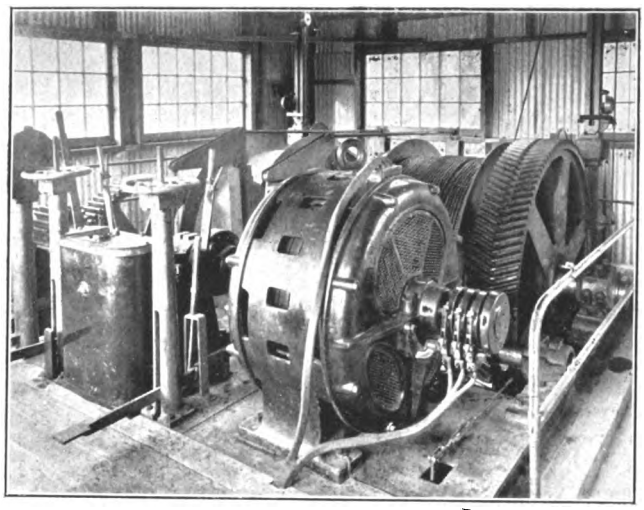

FIG. 3.—120 B.H.P. DOUBLE-DRUM ELECTRIC WINDER WITH NO-VOLTAGE BRAKE MAGNET AND OVERWINDING DEVICE.

Coming to the matter of cost, the installation required for a steam Cornish pump is much heavier in first cost than that required for electrical pumps of any type. The steam Cornish pump is mentioned because a few Cornish pumps have been electrically driven, and where the rods are properly balanced there is no difficulty in using electricity as the motive power; but at the same time it may be mentioned that there is no great saving by so doing, as efficiency is lost in the intervening gearing to reduce the speed down to the 5 to 8 strokes per minute.

To obtain a fair comparison of costs is a matter of some difficulty, but where electricity is generated on the mine and used for other purposes, or can be bought in bulk supply at a reasonable price, then there is no doubt but that the balance is very much in favour of electricity as a motive power for pumping. It is immaterial whether a pump is driven by steam or electricity, the pump will still absorb power, but the electric motor is usually more efficient than a steam pumping engine. The greatest point in favour of the use of electricity is its flexibility, and it scores heavily over steam in this respect.

Mistakes have been made in pumping schemes, but this is not to be wondered at when all the factors in the equation are practically unknown. In addition to these natural difficulties, there is a very strong prejudice against the use of electricity, and this does not tend to make for successful results. In time these prejudices will be worn down, and we may look for much better results.

Coming to the question of station pumps, the problem is a very much simpler one, and in this case there is no question as to the great superiority of the electric ram pump over the Cornish. The space occupied is much smaller, and in the shaft itself the rising main and a small cable represent the sum total of the space, whereas the Cornish pump has a great rod in addition to the rising main, and the space taken up by the poles is quite considerable; all this in a shaft, where the space is already much too small. Again, the pumping engine takes up valuable space around the shaft which could be used to much greater advantage. When long rods have to be used in deep shafts the Cornish pump becomes very troublesome and expensive owing to the rods breaking.

Where trouble is likely to arise with electrical pumping plants is generally due to the following causes. The chief consideration must be given to reliability, even before efficiency, although with careful design it is possible to obtain both. On the electrical side the most fruitful source of trouble is found in the starter. Unfortunately makers seem to think that they are all right if they turn out a good motor, and that the starter is of secondary importance; but in this as in all cases the strength of the combination of starter, motor and pump is the strength of its weakest part, and in most cases the starter is the weakest part.

As in all apparatus for underground use—chiefly abuse—attention must be paid to mechanical strength; it therefore behoves makers to put more brains into the starters for underground switchgear. Connections are not massive enough, and as a rule there are still too many screws which require the use of watchmakers' tools instead of an engineer's spanner. Distinct stops, such as one can feel, are an absolute necessity, as it is not possible to see the fine markings usually supplied; they may serve in the laboratory but are worse than useless in the mine. Connecting boxes are also much too delicate and screws are so fine a pitch that after a screw has been out once or twice the thread is spoiled and valuable time is lost re-tapping.

With motors there is a tendency to work with very fine air gaps; this, for mining plant, is simply courting disaster. In every enclosed type motor provision should be made, by fitted plugs or other means, for the insertion of feelers at three equidistant points in the circumference of the casing opposite the periphery of the rotor so, that examination can be made as to the condition of the air gap; by so doing, proper inspection can be made and much trouble and loss of time can be saved.

If makers would arrange for their designers to study conditions on the mine they would then be in a position to supply suitable plant for the severe conditions. Everything should be as simple as it is possible to make it and all useless frillings should be avoided. In the pump itself the valves should be easy of access and readily removable: it should be arranged that plungers can be taken out without dismantling three parts

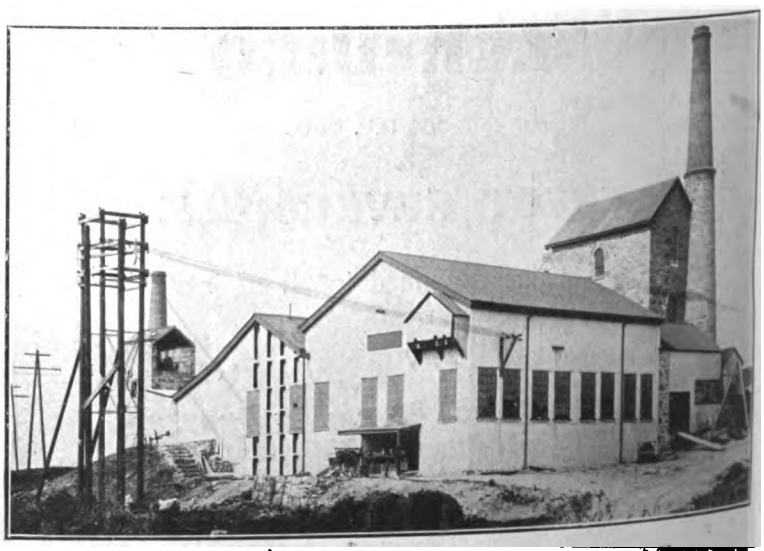

FIG. 4.—VIEW SHOWING 6,000-VOLT TRANSMISSION LINE ON A-

of the pump and electrical gear. All brasses should be easily accessible, and ought to be interchangeable.

Speaking generally, under the conditions obtaining in the county and after considerable experience in all classes of sinking pumps, the most suitable for the unwatering of Cornish mines appears to be a two- or three-throw ram pump driven through

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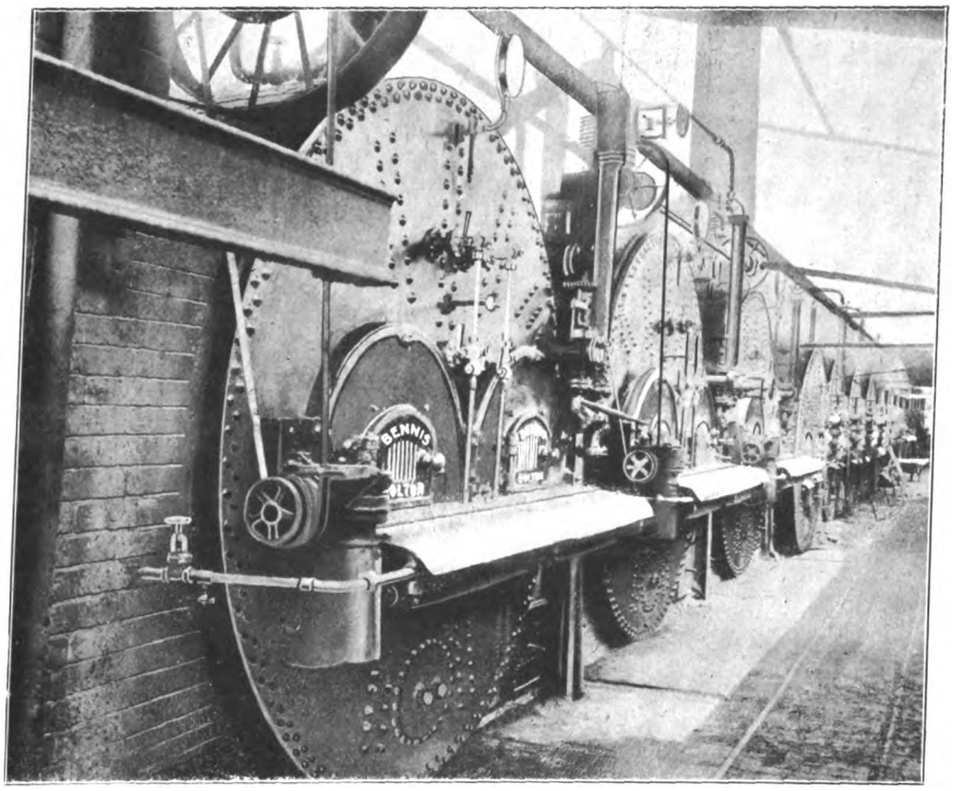

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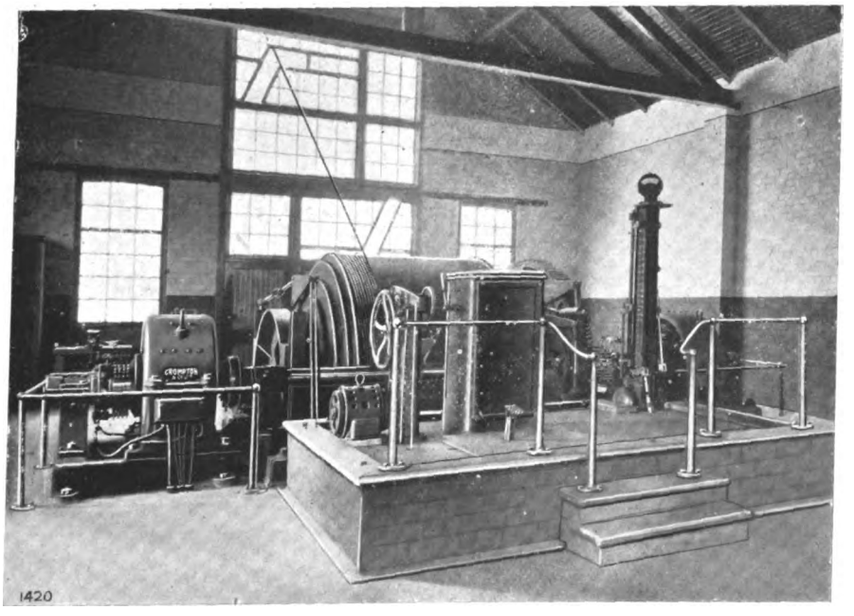

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gearing by a squirrel-cage motor, and having a very substantial starter. Such a set is shown in Fig. 2.

Simultaneous with pumping operations it is usual to instal a hoist, so that timber and other material can be raised and lowered as required. Owing to the size of the shafts and to the irregular twists in them, fast winding is impossible. Fortunately, when a mine reaches the producing stage the amount of ore it sends to the mill is comparatively small, and the slow winding does not cause serious inconvenience. Figs. 3 and 6 show electrically-driven hoist and winders, such as are used in Cornish mines.

Owing to so few of the shafts being vertical, few cages are used, self-dumping skips being more in evidence. In the majority of cases single skips are used, not of choice but of necessity, as very few of the shafts are large enough to permit double skips in addition to the other gear. The amount of ore hoisted is small; therefore small-powered hoists are in common use, 100 to 150 B.H.P. being a fair average. Depths vary from 480 to 3,000 feet. Amongst the newer concerns electrical winding gears are favoured, being more reliable and easier to control; also they can be more readily fitted with real safety devices than can steam hoists.

Air compressors are used for the supply of air for rock drills, are mostly steam-driven and situated on surface. A few electrically-driven compressors have been installed on some of the mines and are giving satisfaction, but so long as compressors are erected on the surface a long distance from the

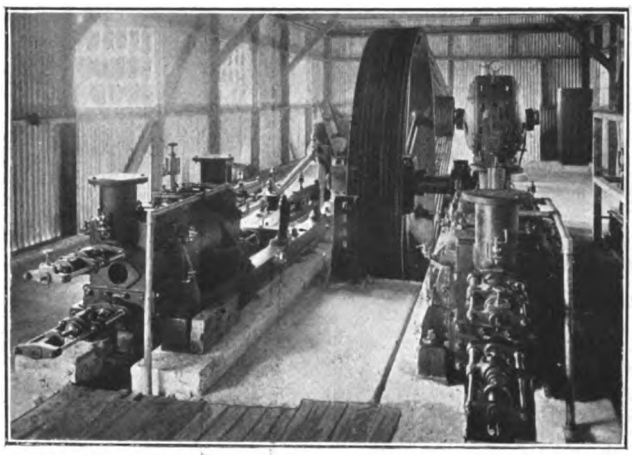

FIG. 5.—105 B.H.P. ELECTRICALLY-DRIVEN AIR COMPRESSOR.

point of use the overall efficiency will continue to be low, and even a few per cent. loss in efficiency in a machine which runs 24 hours a day represents a very considerable amount in 12 months' working. Probably, when makers realise the large field before them, they will endeavour to place a machine on the market to comply with the conditions. A sound, strong and reliable electrically-driven compressor which can be run close up to an end or stop, capable of driving three 3 in. rock drills, would form an efficient combination, and would soon pay its first cost. An electrically-driven compressor is shown in Fig. 5.

Rock drills are worked by air and the exhaust forms the only means of ventilation in such cases. The first cost of a drill is not a very heavy item, but the repair bill is very heavy, and the efficiency is low. When some ingenious inventor comes along with a simple and strong electric drill, he will find a very large field ready for exploitation. The saving in first cost of air plant would be considerable, and its flexibility would be a strong point in its favour, whilst the overall efficiency would be a long way ahead of the air-driven machine with its cumbrous pipes and expensive surface equipment.

Signalling is usually accomplished by means of a wire rope and a mechanical bell, which is not so efficient or simple as electrical signalling. With the electrical signal a more definite signal is given, and, most important of all, there is not the same liability of error.

Shot firing by electricity is practically an unknown quantity so far, but doubtless as the use of electricity becomes better known advantage will be taken of this power for this purpose.

Of underground lighting there is none, except where energy is used for pumping; then a few lights are fixed around the pumps, and in a few cases at the more important levels around the shaft. Beyond this there is little possibility of extending the lighting system, as the levels are very small.

Hauling the ore from the stopes is effected by man-power trams, and in the smaller levels by wheelbarrow. There is

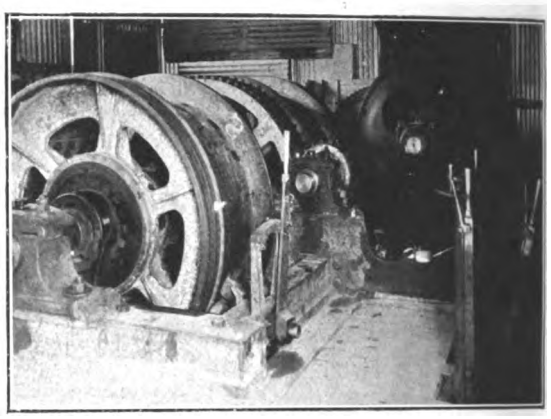

FIG. 6.—100 B.H.P. DOUBLE-DRUM ELECTRIC HOIST WITH LIQUID CONTROL.

little doubt that where electrical energy is available small in-bye haulage gears would prove of great service, and be more efficient and less costly than the systems at present in use.

Natural ventilation is depended upon, but in many of the deeper mines, where the temperature is fairly high, small auxiliary electric fans would be of great assistance in giving a good supply of fresh air. By installing small auxiliary fans throughout the workings more work could be done by the miners, with less fatigue, and would tend to a higher efficiency all round.

When the ore reaches the surface it is taken to the rock breaking station where it usually passes over a grizzley, to rid it of the fines, the over size passing through a coarse rock breaker, then over a second grizzley, the over size again passing to a second stage breaker the material falling into a bin. The position of the rock breaking station depends on local conditions, but where there are a number of shafts hauling ore it is cheaper in first cost and in running charges when this plant is centralised.

FIG. 7.—ELECTRICALLY-DRIVEN VANNER.

Coming to the mill, the ore is deposited in bins immediately behind the stamps and automatically fed into the mortar boxes. The old method of driving the stamps was by a beam engine, and a few examples of this method are still in existence, but the latest practice is to drive by electric motors (by belt). From the stamps the pulp passes through classifiers on to

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vanners, slimers, round frames, &c. In many cases where the vanner gives a middle product this is treated in a pulveriser; but the arrangement and class of table used depends on the ore to be treated.

For final treatment the concentrate is generally passed through a calciner which has a very slow movement, sometimes 1 rev. in 25 minutes. Then there are more tables, frames and buddles before the required degree of concentration is reached, and the black tin is ready for the ticketing.

For some ores a magnetic separator (Fig. 8) is used with great advantage; for example, in separating tin, wolfram and iron. This machine has been of great benefit to the mines, as it not only enables them to get a much higher price for their tin, but it also increases their income by the sale of valuable bye-products.

A strong point in favour of electrical driving of vanners, tables, and other concentrating machinery is the steady drive obtained, no such uniformity can be obtained by a steam drive. It is most important that all concentrating machinery should have an even turning moment. Fig. 7 shows a typical machine of this kind.

In the early stages of the use of electricity in Cornish mining, it was a matter of some difficulty to estimate the horse power required for the several machines to be driven, as users had a very hazy idea as to how much power was required for the plant. Later, however, when electricity came into more general use, it was a simple matter to find what power was required for driving the different machines on the mine. At the same time,

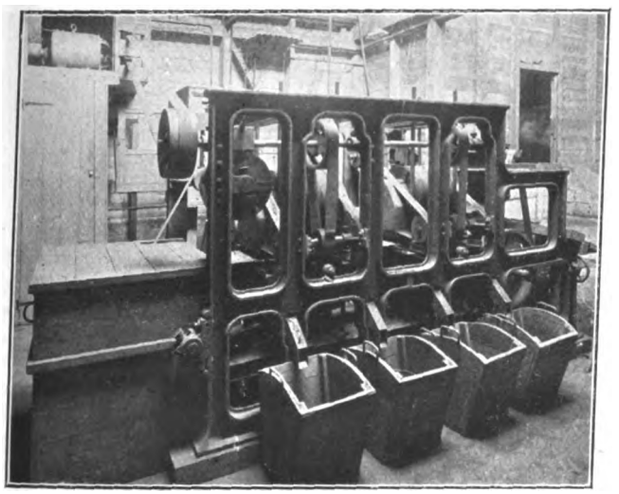

FIG. 8.—MAGNETIC SEPARATOR, ELECTRICALLY-DRIVEN, SEPARATING TIN, WOLFRAM AND IRON.

by keeping an eye on the various measuring instruments, one could tell exactly as to the efficiency of each piece of machinery under observation. Not only so, but the individuals whose duty it is to look after these machines take a much keener interest in their proper maintenance, as they can see exactly what power is being taken under varying conditions, the net result of this being, where electricity is the motive power, that not only the motors but the driven machines are kept in a very much higher state of cleanliness and efficiency than where steam-driven plant is installed.

The majority of the mines using electricity have their own power stations, but a power company is now in the field, and it will depend entirely on the rates offered whether it will pay the mines to buy in bulk or continue to generate their own electrical energy. Amongst the mines there is only one now in use (as far as the writer is aware) where steam drives the prime mover in the power station; several have gas-driven stations and one has Diesel engines using crude oil as fuel. Where the mines have their own power station three-phase alternating-current at 50 periods is the usual custom, and for general mining conditions this arrangement seems to be the most suitable. A Diesel station is illustrated in Fig. 1, while a typical overhead line is shown in Fig. 4.

The amount of power required varies according to the size of the mine, but the following will give a rough idea of the general requirements. Pumps vary in capacity from 150 to 750 gallons per minute; of course there are exceptions, some smaller and some larger. During the unwatering stage, pumping is a very expensive item, as not only has the coming water to be dealt with, but the pool has to be attacked. The actual time taken to unwater is not great as a rule, but delays occurring due to chokages and making the shaft good so that a good deal of time is often spent in one position where these hindrances are met with. Winding engines take about 100 to 150 B.H.P., whilst air compressors take about 100 B.H.P. It must be clearly understood that the figures given are fair average. Where the surface is lit by electricity, about 220 16 c.p. lamps may be taken per mine, and, naturally, where this method of illumination is used a better light is expected than where oil lamps and candles are in vogue.

Coming to rock breakers it has been found that they take about 13 B.H.P., although the starting current is rather high. Experience shows that course and fine rock breakers take about the same power. Californian stamps are more used than any other type, and the usual practice is to drive each 10-head by a separate motor. For a 10-head battery of 1,050 lbs. per head, a 30 H.P. motor is a good size to instal, the average power taken being about 22 B.H.P. A 6 ft. by 2 ft. pulverizer takes about 4 B.H.P., while vanners, slimers, tables and round frames absorb just under half a horse-power each, inclusive of line shafting. Tube mills absorb about 10 B.H.P.

Electrically-driven Belt Conveyors.

Some details of a conveyor plant which is installed at an American gold mine for bringing up the ore to the crushers are given in a recent issue of the "Engineering and Mining Journal." On two of the conveyors a Scandinavian belt was first used. These belts lasted about 18 months. They were replaced by the best grade rubber belts, which are troughed and are about 30 in. wide. Each of the belt conveyors takes the ore up a slight incline and then feeds it to a grizzly having bars 7 ft. long spaced to give 1½ in. openings and set at an angle of 30 deg. The oversized pieces from each grizzly go to a gyratory crusher. The undersized pieces from these grizzlies, after being rejoined by the crushed oversize, is either taken by conveyor or passed by chutes to two trommels, 12 ft. long and having a diameter of 2½ ft., on which a cast-iron screen ½ in. thick and having holes ½ in. in diameter is used. Each trommel feeds its oversized pieces to a gyratory crusher, which breaks the ore to 1½ in. size. This re-crushed ore then rejoins the undersize from the trommels and is taken by two Stevens-Adamson belt conveyors, 18 in. wide, up an angle of 20 deg. to one of two distributing belts, also 18 in. wide. Each of these serves half of the fine-ore bin. These distributing belts are dumped by travelling trippers that discharge the ore over the end of the belt, and in this manner an even character is assured to the ore throughout the fine bin. The fine-ore bin, which has sheet-steel sides, and, like the coarse-ore bin, is made with a flat bottom, is 580 ft. long, 22 ft. wide and 20 ft. deep, so that it holds about 16,000 tons when filled. It is in the mill building proper between the two rows of Nissen stamps, which were originally installed. In fact, the bin structure formed part of the frame for the stamps. Oversized crushers and the automatic feeders, as well as the two coarse-ore conveyors, are driven by a 150 H.P. motor, while the two gyratory crushers and the trommels are driven by a 75 H.P. motor. The two belt conveyors are driven by a 30 H.P. motor, while each of the distributing belts at the fine-ore bin is driven by a 20 H.P. motor. All of these motors are of the Westinghouse induction type, as are the other motors throughout the mill. They all operate at 440 volts on a three-phase circuit with a frequency of 20.

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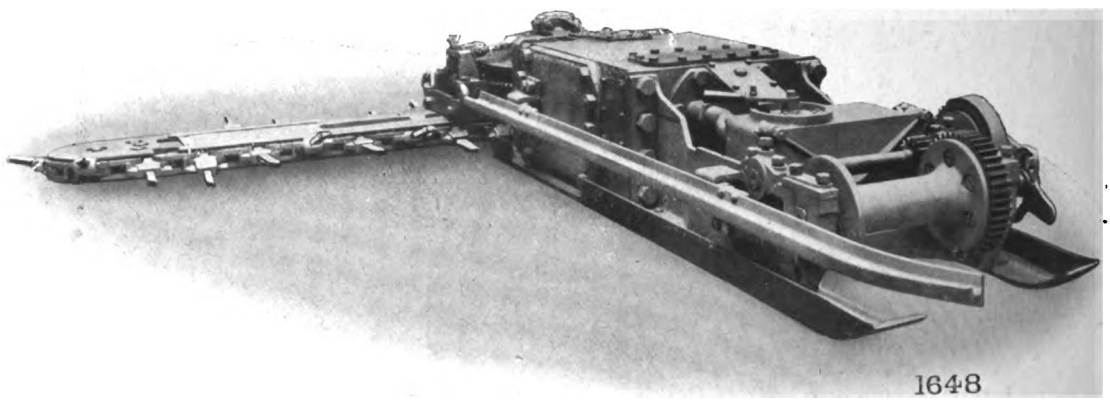

The type of Coal-Cutter illustrated above has been specially designed by us at the request of several colliery friends, with a view to overcoming several of the objections of both the Disc and Bar types of Coal-Cutter.

From the experience which we have gained in the past with Disc machines, and later with the present type of Chain machine, we are satisfied that it is possible to work a Chain type of Coal-Cutter under the most severe conditions with complete satisfaction, and in positions where we are very doubtful if any other type of machine can be satisfactorily employed.

This type of machine has been very carefully designed, and the following points are particularly of interest :—

The whole **framework** is of **cast steel,** and of great strength.

The **motor** and all the **electrical gear** is **flame-tight** and **water-tight.**

The jib is arranged to **cut both in and out of the coal automatically,** and can be slued through 180 degrees.

The **motor** is **very amply rated,** and is of special construction to withstand the vibration. It is provided with a **large number** of **inspection doors,** and can be easily dismantled.

The sides of the motor casing carry the poles with their windings, and can be removed when required without dismantling the cutter.

The full illustrated description of this type of machine will be sent on application to

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The Position of Electricity in Mining in South Africa.

BY C. F. MACKNESS.

Summary.—An account is given of the enormous progress made in the application of electricity to mining in South Africa. This is particularly noticeable in electric winding, the progress of which has quite eclipsed anything in this direction in Europe. Brief particulars are given of the public power supply systems, which have received an impetus through the advent of the Victoria Falls & Transvaal Power Co. The minor applications of electric power are also described, including locomotives, haulages, stamp and tube mills, pumps and other uses.

The continuous progress that is being made in Europe in the use of electricity in new fields hitherto untouched, keeps the attention of engineers who are interested in such developments mainly directed to what is being done in Europe, and it is probably not too much to say that few engineers in this country are conversant with the progress that is being made in our Colonies in the applications of electricity.

As most of the electrical machinery which is sent to our Colonies is manufactured in Europe, there is a natural tendency on this side to look upon Europe as being in the van of progress in electrical work, and to think of the Colonies as following our lead.

Whilst this may be generally true, the following brief account of what is now being done in South Africa will show that the engineers there are not only fully conversant with all the developments in this country and in Europe, but that they also have the courage to act up to their convictions, in making themselves responsible for the installation of electricity in the mines for power purposes, to the exclusion of every other form of power, and on a larger scale than has yet been contemplated either in Great Britain or on the Continent, or elsewhere.

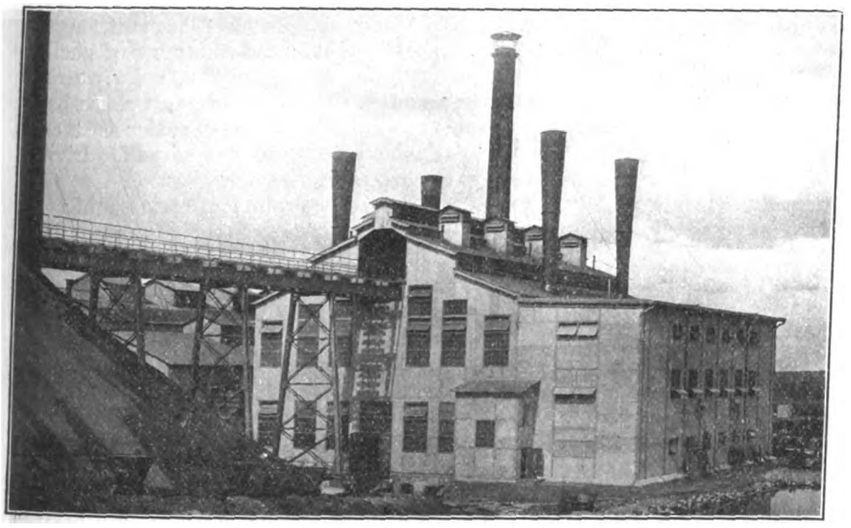

FIG. 1.—SIMMERPAN POWER STATION.

Specifications are straightforward, concise, and clear, showing that the engineers know what they want and why they want it, and the installations now being completed prove those responsible for the work to be as capable and clever a set of engineers as can be found anywhere.

General.—It can now be safely stated that steam power has practically been abandoned by the mining groups as a motive power in favour of electrical power, either generated by one or more central electric power stations supplying all the mines belonging to one group, or obtained from the Victoria Falls & Transvaal Power Co.'s mains. The smaller and isolated mines, whose requirements are small, have their machinery still driven either entirely by steam engines, or only partly by electrical power, but the bulk of the mines are now dependent entirely upon electricity for the running of all their machinery.

The use of continuous current may also now be considered as exceptional, the larger power stations supplying three-phase alternating current at high pressure, and at a frequency of 50 or 25 cycles.

Continuous current is only used on some of the smaller mines or for special purposes, such as supplying electric locomotives, &c., on the larger mines.

Power Stations.—The largest power stations on the Rand are naturally those belonging to the Victoria Falls & Transvaal Power Co. This Company has now three power stations in operation, the total capacity of which will be 175,000 H.P. when working to their full ultimate capacity.

Space does not permit of any detailed descriptions of these stations being given here, but an outline of the general arrangement of the stations and the distribution scheme may be interesting.

Three of the four power stations are now in operation, these stations being situated along the reef from east to west at Brakpan, Simmerpan and Rosherville. A fourth power station is to be erected at Vereeniging, which is some 35 miles from Johannesburg. The Brakpan power station is the smallest of the three and contains two turbo-alternator sets each of 3,000 kw. output. The Simmerpan station (Figs. 1 and 5) is at present equipped with four turbo-alternator each of 3,000 kw., but the ultimate capacity of the station will be 24,000 kw.

The third power station, at Rosherville, (Fig. 2) is not yet completed, but will be the largest of all. The generating plant will consist of five turbo-generator sets each of 12,000 kw., these sets being the largest units at present in operation. A general view of this station is given in Fig. 3. In addition to supplying electrical energy this station will also supply compressed air in bulk, for distribution to the mines belonging to the Eckstein group. The compressed air plant consists of four steam turbine-driven turbo-air-compressors, each of 4,000 to 5,000 H.P. This power station is interesting, therefore, as containing the largest turbo-generator units, and in addition to this, the largest air-compressors yet built. The Robinson Central Deep compressor station is shown in Fig. 4.

All these stations are laid out on the most modern lines, and they contain a number of interesting details conducive to economy in running and efficiency. The boilers, economiser and chimneys are arranged in units, a separate short steel chimney being provided for each pair of boilers. Induced draught is used throughout, each of the above-mentioned units having its own separate induced draught fan. The system used is novel, the principle employed being that of the ejector, so that the fan deals only with cold air, which is forced into the chimney and creates the suction for the flue gases. The boiler efficiency attained with this arrangement of the plant is excellent, in spite of the fuel used being of only indifferent quality. Chain grate stokers are used, and the coal and ash conveying arrangements are carefully designed for efficient and economical operation.

The switchgear is arranged for remote control, the high-tension switchgear and 'bus-bars being sub-divided and

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sectionalised as usual in modern power stations, and built into fireproof cells.

In these power stations one of the most unusual features, to engineers who are accustomed to British conditions, is the lightning arresting equipment. As the major portion of the transmission and distribution network consists of overhead conductors, it is essential that special care be devoted to the avoidance of all risk of disturbances of supply, due to the direct or indirect effects of thunderstorms, which are severe and frequent on the Rand at certain times of the year. Hence

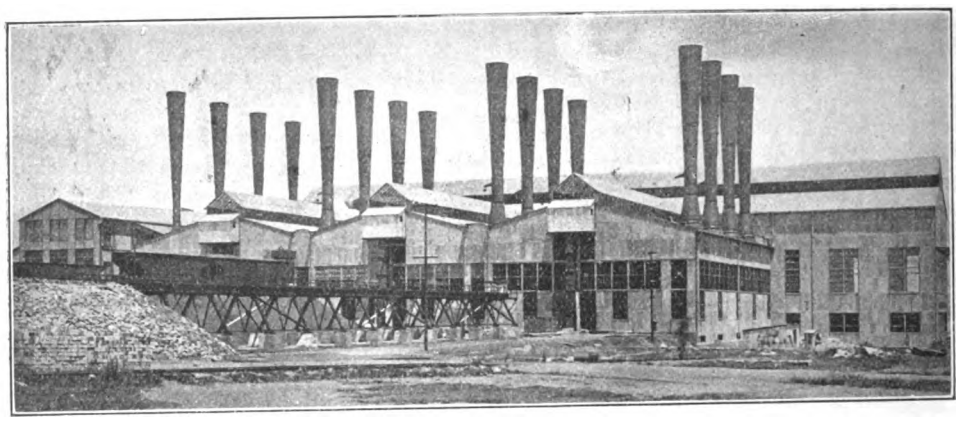

FIG. 2.—GENERAL VIEW OF ROSHERVILLE POWER STATION.

the expensive equipment of choking coils, spark-gaps, fuses and electrolytic and horn-type lightning arresters, which are unnecessary in Great Britain, is indispensable for these power stations on the Rand, where any interruption of supply means the complete stoppage of all the mines supplied by the section affected.

The Brakpan power station supplies the mines at the eastern end of the Rand through overhead lines at 10,000 volts. There is a transmission line at 40,000 volts extending along the whole length of the Rand, and in addition to this a cable distribution system is laid in the central part of the Rand, which is supplied partly from the Rosherville power station and partly from the Robinson Deep sub-station.

The energy is distributed to sub-stations at the various mines, where it is transformed to 2,000 volts or 500 volts to suit the mine requirements. There are in all some 32 sub-stations, having a capacity of 1,000 to 6,000 kw. each. At the Robinson Deep mine a main sub-station is placed, and this station is also equipped as a compressed air supply station. There are six turbo-air-compressors installed, each of 4,000 to 5,000 H.P., and these are driven by direct-coupled synchronous motors. The distance between the stations at Brakpan and Simmerpan is 15 miles, and between the latter and Rosherville about 7 miles. The sub-station at Robinson Deep is 12 miles from the Rosherville power station. The combined output from the power stations of the Victoria Falls & Transvaal Power Co. is expected to reach four hundred million kilowatt-hours per annum in the very near future.

The above will show that the formation of this Company has been amply justified, and it is quite clear that those who control the mining groups share the opinions held by their engineers as to the advantages to be gained by the mines from a cheap and reliable supply of energy in bulk, such as the Victoria Falls & Transvaal Power Co. is able to offer. There is every prospect of the working costs of the mines being reduced to the figures estimated by the engineers, when the equipments of the mines are completed and in operation.

Apart from the power stations belonging to the Victoria Falls & Transvaal Power Co., there are several large power stations built by mining groups to generate the energy required by their various mines. Of these power stations some were in existence before the bulk supply scheme was mooted, whilst others have been built on the advice of the engineers responsible to the mining groups concerned, and in the belief that such private power stations of the capacity in question (say, 6,000-20,000 kw. can give a supply of energy at lower rates than any bulk supply company can offer.

Of these stations that of the Randfontein Estates group is the largest, the plant installed aggregating 20,000 kw. in modern steam turbo-alternators. The supply is three-phase at 6,600 volts, 50 cycles, energy being transmitted by cables laid underground to a number of sub-stations in which static transformers are installed. The power station is designed and built on the most modern lines, and contains all the appliances and apparatus necessary to ensure continuity of supply and economy in running costs. The cable system is duplicated throughout, and is protected against risk of interruption by means of Merz-Price protective apparatus.

Next in point of size is the power station of the East Rand Proprietary Mines, which will ultimately be nearly as large as the Randfontein Estates power station. Three-phase current is supplied from this station at 3,000 volts, and at a frequency of 25 cycles. The plant consists of a 6,000 kw. steam turbo-alternator, and a number of smaller steam engine-alternator units. A second 6,000 kw. turbo-alternator set will be installed shortly. This station has been in operation for some years, but is being modernised and enlarged to cope with the increased output required for driving the winding engines, pumps, and other new plant.

Another power station is nearing completion, to supply the New Kleinfontein Mines (Farrar Anglo-French group). This station also supplies three-phase current at a frequency of 25 cycles. The plant consists of turbo-alternator units totalling 6,000 kw. at present. Energy is transmitted from this station to the various mines belonging to this group. Some of the mines are equipped with continuous-current motors, and motor-generator sets are being installed to convert the three-phase supply to continuous-current for supplying these motors. The township of Benoni will also be supplied with energy for lighting purposes from this station.

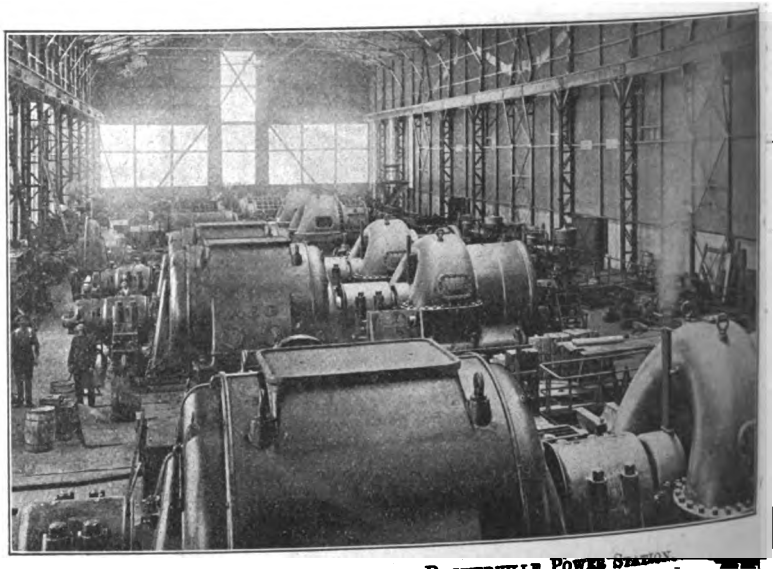

FIG. 3.—ENGINE ROOM AT ROSHERVILLE POWER [illegible]

There is confliction of opinion on the question of frequency,

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the two last mentioned groups having adopted 25 cycles, whilst the other stations have chosen 50 cycles. The higher frequency was also adopted by the Victoria Falls & Transvaal Power Co. for all their stations after very careful consideration.

The only apparent advantages of using 25 cycles are :—

1. Motors of usual outputs and speeds have a slightly better efficiency and power-factor (about 1 per cent. average).

2. Where large slow-speed motors are used the power-actor and efficiency are considerably higher than those of 50 cycle motors for the same conditions.

This affects such cases as the driving of air compressors and stamp mills by direct-coupled motors, and also is important in the case of winding engines driven by large slow-speed motors direct coupled to the drum shafts.

The chief disadvantages of the lower frequency are :—

1. The plant costs more.

2. The possible motor speeds are more limited.

3. The speed of 3,000 revs. per min. is lost, which may prevent the use of centrifugal pumps and motor-driven turbo-air-compressors.

4. 25-cycle plant not being standardised, more spare parts have to be kept, and everything required must be specially ordered.

In addition to the above, should a favourable offer be made by the power company for a bulk supply, the consumer has to suffer the conversion losses in the frequency-changers which must be installed to convert the supply from 50 cycles to 25 cycles, and which must be installed by the consumer at his own expense. Taking everything into consideration, therefore, the frequency of 50 cycles appears to be quite suitable for mining work, and its advantages outweigh those claimed for the lower frequency by its advocates.

Distribution.—In earlier days, distribution on the mines was usually effected by means of overhead wires. The tendency now, however, is to use underground cables, thus avoiding all risk of interruptions from atmospheric disturbances. The overhead mains used by the Victoria Falls & Transvaal Power Co. are unavoidable to a great extent, as cables are not yet reliable at 40,000 volts pressure, as used for the main transmission lines of this Company.

A distribution cable network at 20,000 volts is used for the central portion of the area served by the Company, as already mentioned. The overhead lines are protected by earthed guard wires run above the conductors, in addition to the lightning arrester equipments which are installed in the power stations and sub-stations. Both the cables and the overhead lines are protected on the Merz-Price protective system, to lessen the risk of interruption of supply, and the transmission and distribution systems have been carefully laid out so that, wherever possible, there are duplicate feeders to each consumer, or group of consumers. On the mines themselves, that is to say, on the consumers' distribution sytems, underground cables are now usually laid, the extra first cost being considered as a cheap form of insurance against risk of interruption of the supply.

Sub-stations.—The sub-stations are built by the mines to the designs of the power company, at least as far as concerns the high-tension side. The buildings are practically divided into two parts, the high-tension part containing the incoming feeders, lightning arrester equipment, isolating switches, 'busbars and step-down transformers, all of which are provided by the supply company. The low-tension (2,000 or 500 volt) side is usually arranged by the mine engineers to suit their requirements. The high-tension switchgear and 'busbars, &c., are arranged in fireproof cells, as is now usual.

The energy is metered to the consumers on the low-tension side of the step-down transformers, from which leads are taken out to the main low-tension distribution switchboard 'bus bars through the partition wall. The sub-stations are usually built of brick, and the arrangement of the apparatus and switchgear is equal to the best that can be seen in Europe. The sub-stations underground also compare very favourably with the best practice in this country. The switchgear is well arranged, and accessible, and the chambers are roomy, clean and well kept.

Applications of Electricity on the Mines.—The current is used above and also underground. The main purposes for which current is used are :—

Above Ground.—

For the main winding engines.
Driving air compressors.
Electric locomotives.
Haulages.
Conveyors.
Stamp mills.
Tube mills.
Crushers.
Pumps.
Shaking tables.
Also for driving a number of small-power machines used for various purposes in the treatment of the ore.

Underground.—

The principal uses found for electricity below ground are :—
For driving electric winding engines for hauling ore on the incline of the reef.
For operating pumps.
For lighting.

Of the above applications, by far the most important is that of the substitution of electricity in place of steam for driving the winding engines.

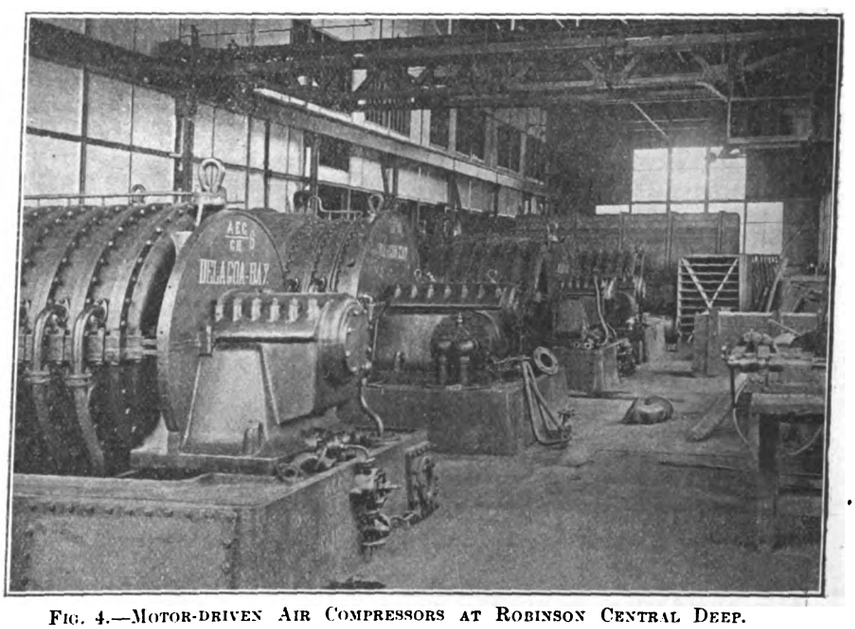

FIG. 4.—MOTOR-DRIVEN AIR COMPRESSORS AT ROBINSON CENTRAL DEEP.

The wholesale manner in which these electrically-driven winding engines are being used on the Rand has no parallel in Europe or elsewhere, either in the number of the installations or in the sizes of the motors employed. When the electrical winding engines now being installed on the Rand goldfields are in operation they will form a huge practical exhibition of this application of electricity that can only be looked upon as astonishing, when compared with the slow adoption of the electrically-driven winding engine in Europe, where it had its origin ; and this is further testimony to the enterprise and courage of the engineers responsible for the wholesale adoption of electricity for this important service. The Eckstein group of mines have converted the steam winding engines on

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their mines for electrical operation, wherever the plant was in good enough condition to warrant this.

A number of the winding engines are driven through gearing, whilst the others are driven by motors direct coupled to the drum shafts. The geared winding engines are driven by motors running at a speed of 360 revs. per min. The motor drives the drum shaft through single reduction gearing, of the straight tooth type in a few cases, but mostly of the double helical type with machine cut teeth. The slow-speed shafts are coupled to the drum shafts either by Oldham couplings or crank discs with drag links. In certain cases, where the speed of the drum shafts is suitable, the motors drive the drum shafts directly, the connection between the motor and drum shafts being made by means of couplings as mentioned above.

Several large existing steam-driven winding engines are also being converted for electrical operation by means of direct coupled motors. The peak loads on the motors of these engines vary widely, the smallest peak being about 400 H.P., and the largest peak output of the motors for winding engines for moderate loads and depths being about 2,000 H.P. The peak loads on the motors driving the converted winding engines used for heavy loads and depths of about 4,000 ft., are from 3,600 to 4,000 H.P.

In addition to these converted winding engines, a large number of new electric winding engines are being installed, having motors of varying maximum outputs from about 400 H.P. to nearly 6,000 H.P. The higher figure is the peak horse-power of the motors driving the two largest electric winding plants ever yet built, and which are capable of raising a net useful load of 8 short tons from a depth of 4,000 ft. and at a maximum speed of over 50 ft. per second. These winding engines are driven by two direct-current motors, controlled on the Ward-Leonard system, in conjunction with a motor-generator, without flywheel storage. The drums of these engines are cylindro-conical so as to reduce the peak loads to the minimum.

By far the greatest number of the winding engines on the Rand are equipped with three-phase motors with liquid rheostatic control. In special cases, where comparison between the three-phase system and the alternative system employing Ward-Leonard control and direct-current motors on the winding engine shows considerably in favour of the latter, the Ward-Leonard system of control has been adopted.

It is worthy of note that out of a total of over 100 electric winding plants, not a single Ilgner converter set is to be found, and the number of plants operated on the Ward-Leonard system is a small proportion of the total, although the two largest plants are equipped on this system. The Ilgner flywheel storage system has never been looked upon with favourable eyes by the engineers on the Rand, who, as practical men, recognise that simplicity and absence of complication in the winding plant are more valuable in the long run than a slightly lower running cost.

It might be anticipated that the power company would set limits upon the maximum momentary peaks for each consumer, so as to avoid the sudden throwing on of heavy peaks on to the station when a number of large winding engines are started together. No such limits are specified, however, as it is expected that the fluctuations in the total load on the power station will not be very considerable, owing to the large steady load due to the use of motors for other purposes on the mines, and also because the peaks from the various mines are not likely to coincide, but will cancel out to a great extent.

When all the electric winding plants now being installed are in full operation the total horse-power, and also the number of motors used for winding purposes, will be larger than can be seen within a similar restricted area anywhere else in the world. The winding problem has been boldly faced and treated with the practical common sense that is one of the characteristic qualities of the engineers on the Rand, and the systems used have been adopted, not at haphazard, nor by slavishly following European practice, but after careful study and selection of the systems best suited to the conditions of the country and its mining methods.

In closing these remarks it must not be forgotten that the conditions on the Rand are quite unlike anything met with in Europe, as many of the vertical shafts are 4,000 ft. deep, and the unbalanced loads on the engines due to the rope when hoisting from this depth are enormous. When men are being lowered down these shafts, therefore, three-phase motors have to run under counter current, and the problem of designing safe and satisfactory controlling gear for such conditions is not an easy one, owing to the large amount of energy which has to be dissipated in heat in the rheostats, at voltages considerably above the normal rotor voltage.

In the case of some of the larger winding engines on mines belonging to the Eckstein group, where these conditions are exceptionally severe, electromagnetic brakes are being provided on the motor or drum shafts, for use in case of failure of the supply, or in addition to the usual mechanical brakes. Engineers are divided in their opinions upon this feature, which is a new and untried one in winding plants, and it is still to be seen whether this brake will do what its proposers expect, or whether it would not have been safer and preferable to provide Ward-Leonard equipments for the winders in question, as recommended by the leading Continental firms, who have had a wider experience of three-phase winding plants than any of the British firms, and therefore better appreciate the peculiar difficulties to be overcome in these cases. This and many other points will be cleared up in the course of a few months, when the plants are put into operation.

Air Compressors.—Next to winding plants the largest motors are to be found in air compressor plants. As stated above, the largest air compressors are those installed in the Power Company's stations at Rosherville and at Robinson Central Deep. These compressors are of the rotary type, divided into two stages, and provided with water-jackets on the casings. The air is delivered at about 110 lb. per square inch. The characteristic curves of the rotary compressor for volume and pressure are very similar to those of the centrifugal pump, a drop in pressure resulting in the quantity of air supplied being increased, so that the load on the motor increases as in the centrifugal pump motor.

The motor-driven rotary compressors are supplied with synchronous motors of similar design to a turbo-generator, and of 4,000 to 5,000 H.P. output. The reciprocating compressors do not require anything approaching this power. The maximum is about 1,500 H.P. Motors of the synchronous type as well as the induction type are used, according to the conditions.

The object of using synchronous motors is to make these serve as power-factor improvers, by over-exciting the fields, so that the power-factor of the whole local distribution circuit is raised. Where a number of air compressors are installed in one station, both induction motors and synchronous motors are used, the latter on one or more sets only, so as to counteract the low power-factor of the compressor motors (slow-speed induction type), winding plant motors and other induction motors, at that particular sub-station. The synchronous sets are started up by special auxiliary induction motors coupled through gearing and clutches to the compressor shaft, compression being relieved whilst starting up.

Locomotives.—Until recently electric locomotives had not been much used, and the number now in use is not large. The largest and most interesting are a number of three-phase locomotives for use on the City Deep and Crown mines for pulling trucks on 3 ft. 6 in. standard gauge lines on these mines. The rating of these locomotives is about 300 H.P., which is developed by two three-phase motors each of 150 H.P. The motors are placed high on the frame of the locomotive, and drive a countershaft through spur gearing, this countershaft having crank discs at each end, which transmit the power to the driving wheels through vertical and horizontal coupling rods. Two overhead trolley wires are used, with the rails as third conductor of the system. The operating voltage on the trolley wires and motors is 2,000 volts. Each locomotive is provided with air compressor and vacuum pumps, electrically

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driven. The locomotives are each composed of two half locomotives, which are normally close-coupled together and run as one unit. When necessary the two halves can be uncoupled and used separately, each dealing with half the load which the complete locomotive could handle.

Haulages and Conveyors.—The motors used for haulages vary from about 20 H.P. to about 75 H.P., and are usually of the slip-ring rotor type; whilst conveyors require motors of 7½ H.P. and upwards. There is nothing special in this application of electrical driving.

Stamp Mills.—These form one of the largest applications of electrical power on the mines, and also one of the most important. The mills are very seldom shut down, so that the motors employed must not be too heavily rated, and must be of robust construction.

The chief requirements for motors for this use are :—Robust construction. Ample bearing surfaces, with strong shafts and automatic lubrication. High starting torque. High efficiency and power-factor.

The first requirements ensure satisfactory running for long periods without attention. The last three requirements are also vital, as they affect the running costs of the mills.

The question of the different methods of driving stamp mills has been widely discussed, and there are still different opinions as to the best type of motor and best method of driving. In the case of the East Rand Proprietary mines, the stamp mills are connected in groups to separate line shafts which operate the stamps directly. The motors run at 104 revs. per min., and the rotors are connected direct to the line shafts. As the frequency is 25 cycles, the power factor and efficiency of the motors are good, and losses in ropes, belts, or gearing are avoided.

The motors are exposed to severe vibration from the stamp mills, and in case of any breakdown the time spent in repairs means stoppage of the stamp mill driven by the faulty motor, as there is no chance of using a spare motor. A number of the stamp mills on the Eckstein mines are also driven by similar slow-speed motors. running on a frequency of 50 cycles. The large new stamp mills of the Randfontein Estates, on the contrary, are driven by high-speed motors. This is the largest stamp battery in operation on the Rand and contains 600 stamps, each weighing 1,650 lb., arranged in units of 10 stamps. Two such units (totalling 20 stamps) are driven through countershafts by motors of 100 B.H.P. These motors are of the squirrel-cage type with compensator starters.

The new stamp mills of the Roodepoort United Main Reef G.M. Co. (General Mining & Finance Corpn.), containing 100 stamps, each of 1,901 lb. weight, are driven by 50 B.H.P. motors of the squirrel cage type with starting compensators, each motor driving by belt on to a countershaft, working 10 stamps. The preference shown for the squirrel-cage type of motor for this work, is due to the absence of slip-rings and sliding contacts in these motors. There is always a certain amount of vibration present, and this, combined with grit, sooner or later causes trouble with the slip-rings. The efficiency of the squirrel cage motors used is somewhat lower than that of the slip-ring type, owing to the necessity of designing the motors to give a high starting torque—the difference in efficiency is of the order of 1½ to 2 per cent. in favour of the slip-ring motor. This is considered as compensated for, however, by the reduced risk of stoppages obtained by using the squirrel-cage type of motor.

Tube Mills.—Tube mill motors are required to fulfil practically the same conditions as for stamp mills. The starting torque requirements are, however, even more severe than for the latter, 200 to 250 per cent. of normal full-load running torque being often necessary to start the tube mills. Slip-ring motors are perferable for this duty, and have given entire satisfaction. The motors are usually of 60 to 100 B.H.P. and run at 600 revs. per min.

Pumps.—The number of pumps employed in the surface plant of a gold mine is considerable, and this forms quite a good motor load in itself. For a surface plant comprising 100 stamps, the total horse-power of the motors installed for pumps may reach 600 B.H.P. The pumps are mostly centrifugal pumps of the "Morris" type, driven by direct-coupled motors. A pump is usually installed as a spare for the tailings wheel, so that the latter can be cleaned or repaired without stopping the mill.

Tailings Wheels.—The motors used for driving the tailings wheels are of 35 to 50 H.P., usually driving by belt on to reduction gear, as the speed of the wheels is very low. Owing to the large amount of inertia to be overcome when starting the tailings wheel, high starting torque is required, making the slip-ring motor most suitable for this work.

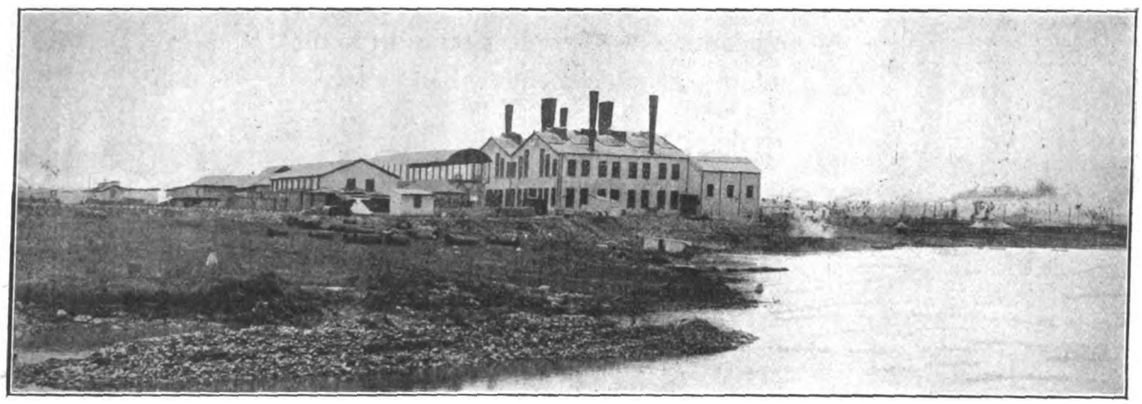

FIG. 5.—GENERAL VIEW OF SIMMERPAN POWER STATION.

Other Uses.—In addition to the applications mentioned, motors are used for many other purposes, such as driving crushers, sorting belts, shaking tables, rock hoists, elevators, extractor house plant, &c., but there is nothing of particular interest in these uses.

Underground Uses.—Owing to the great depth to which the Rand mines are now being worked, it is necessary to do the hauling of the ore in two stages in some of the deeper mines. The deepest vertical shafts are just over 4,000 ft. in depth, and it is intended to work down the slope of the reef to an ultimate depth of about 10,000 ft. Winding engines are therefore being installed underground at the bottom of the main shafts, to haul the ore up the incline and deliver it to the main winding engines which haul the ore to the surface.

These underground winding engines are also being electrically driven. Owing to the comparatively small depths from which they are at present hauling, the motors required are not of the same large sizes required for the surface winding engines, but in the near future the power requirements for underground haulage will increase very considerably. The only special point of interest in these winding engines arises from the fact that the whole machine must usually be sectionalised, to enable the parts to pass down shafts of limited dimensions. This affects the whole design of the plant, in limiting the sizes of the drums, and, therefore, indirectly settling the speed and type

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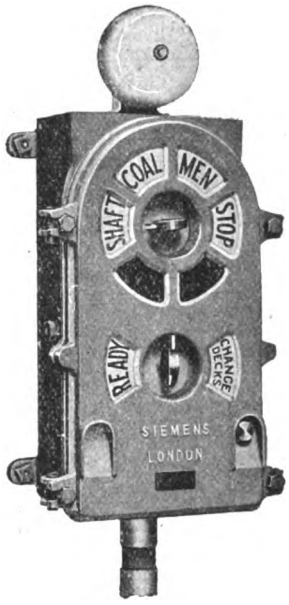

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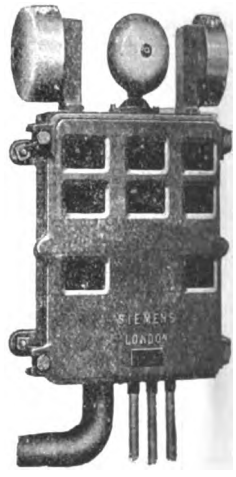

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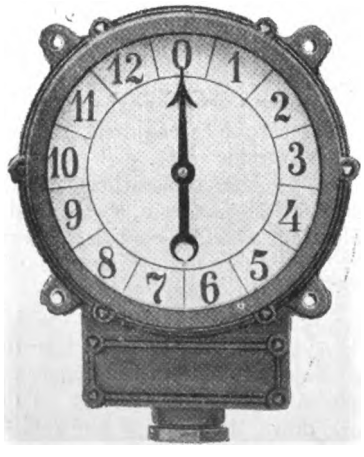

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of motors, and often making the use of gearing compulsory. It is probable that most of the underground winding engines installed will be driven by three-phase motors. There are a number already in operation and more in course of erection.

Pumping Plant.—Up to the present time the centrifugal pump does not appear to have met with much favour on the Rand for underground pumping. The plunger pump is widely used, and appears to have given every satisfaction.

There are signs of a more extended use being made of the centrifugal pump, and should the results prove as satisfactory as they have elsewhere, this type of pump will probably be much more widely used.

Locomotives Underground.—Electric locomotives are not used anywhere underground on the Rand (so far as the author knows), and although trials have been made with petrol locomotives, no information is yet available regarding the results. There appears to be a number of cases where electric locomotives could be employed underground with advantage, but labour appears to be so cheap that engineers are doubtful whether electrical haulage could be substituted with economy.

This question appears to be receiving consideration by the engineers, however, and probably it will not be long before a trial installation will be put down somewhere, where the conditions appear to be favourable. In view of the large number of successful installations of underground locomotives on the Continent, there is certainly good reason to anticipate that the introduction of electric haulage underground would be economical on the Rand in mines where favourable conditions exist. Apart from the above purposes, electricity is only used underground for lighting.

The foregoing gives an idea of the great developments that have taken place on the Rand in the extensions of the use of electricity. There is no gainsaying the fact that the formation of the power supply company has to a great extent accelerated these developments, and in the absence of a cheap supply of electrical energy in bulk, the Rand would not occupy the position which it very soon will, as the best equipped goldfield in the world, containing more new applications of electricity, and these on a larger scale, than any other mining centre can boast of.

Diamond Mines.—The conditions existing in diamond mines, and the plant required, are essentially different from those met with in gold mines, and there is not so large a field for the application of electric driving. The De Beers Company have a large power station equipped with turbo-generators for supplying energy to the mines, and also for lighting the town of Kimberley. Electric winding is not used either on these mines or on the Premier Diamond Mine. Motors are used for driving haulages, conveyors, crushers, washing plant and for pumping and lighting.

The conditions of hoisting are not so favourable to the use of electric winding plants under present conditions as those existing in gold mines. In the Premier Diamond Mine the ground is hauled from the mine, which has open (quarry) workings, by an endless wire rope haulage, which is driven by an economical type of steam engine, running on a practically constant load; this engine is installed in the power station. Under these conditions it is not easy to make out a good case for electric winding. As the mine increases in depth, however, the conditions will be unfavourable for any extension of this system, and more favourable for the use of electrically-driven winding plant.

The quantity of blue ground hoisted per day is about 50,000 short tons, and from this the magnitude of the plant required can be gauged. Electrically-driven haulages are used in the workings as feeders for the main haulage, and a number of motor-driven centrifugal pumps are in use. The workings are lighted by arc and incandescent lamps. The power house has been in operation for some years, and is not, therefore, worth special mention.

Rhodesian Gold Mines.—Such far-reaching developments as have taken place on the Rand goldfields cannot be anticipated in a country like Rhodesia where the gold mining industry is now only in its early youth, as compared with that of the Rand. In fact, there are underlying differences between the mining conditions in the two fields. The Rand gold bearing reef has been closely delimited, so that its contour, extent, and slope are fairly accurately known, as is also the grade of the ore. Under these circumstances, mining becomes practically a purely commercial proposition, working expenses on the one side, and value of the gold recoverable per ton of ore being known, whilst the grade of the ore is known to be practically uniform within narrow limits.

In Rhodesia no reef at all resembling the Rand Reef has been located, the majority of the reefs at present worked being much richer than the Rand reefs, but patchy and variable in depth. Moreover, water is mostly scarce in Rhodesia, and coal is very dear. In consequence of these conditions, a mine with a 40-stamp battery is a large mine in Rhodesia, where the majority of the mines have five, 10, and in a few cases 20 stamp plants. For such small plants there is, of course, practically no scope for the use of electricity.

The bigger mines, however, have put in electrical power plants, where the conditions are suitable. The mining centres are widely scattered, and this condition is not favourable to the installation of central power stations for giving a bulk supply of power to the different mining centres.

Owing to the scarcity of water and cost of coal a number of the mines have installed suction gas engine plants for driving their machinery. The fuel used is wood charcoal, but many of the mines are already finding difficulty in obtaining sufficient fuel, having denuded the country of timber round the mines, and thus having ever-increasing fuel transport charges to face.

The Bushtick Mine has a large suction gas engine plant, comprising two 230 B.H.P. gas engines with producers, belt driven, 60 cycle, alternators, and a number of motors. The generator units are run on separate circuits and cannot be operated in parallel, which must detract from the flexibility and economy of the plant. The working costs are low, and the attendance required by the plant is confined to the periodical stoking of the producers by native labour. Difficulties have been experienced in a number of these plants owing apparently to the effect of the altitude upon the engines not having been sufficiently appreciated by designers, but, on the whole, such installations appear to operate satisfactorily.

Electrical driving is also extensively used on the Globe and Phœnix Mine, Giant Mines and Jumbo Mines, which have steam-driven generating plants, and motors for driving most of the surface plant except the winding engines, which are steam driven.

Sufficient has been said to show the present position of the Rhodesian mines as a field for the operations of the electrical engineer, and whilst large developments are not to be expected for the present, yet the mining resources of the country are comparatively speaking so unexplored that no one can safely foretell to what extent electricity may be applied in the mines of Rhodesia in the future when this country has been really prospected and its mineral resources opened up.

In closing this necessarily brief account of some of the work that has been carried out by our brother engineers in South Africa during the last two or three years, the writer tenders his thanks to the mechanical and electrical engineers responsible for the installations referred to for their courtesy in furnishing information concerning their installations.

If the relations between engineers in this country were as free and easy and untouched by professional jealousy as is the case in South African engineering circles, it is probable that both the engineering industry and those connected with its well-being would be the gainers, and that progress would be accelerated. Mutual exchange of ideas, friendly criticism, and discussion between the engineers engaged in tackling the various comprehensive schemes of electrification on the Rand, have certainly helped forward the progress of electrification.

The results of the working of the several large electrification schemes now nearing completion will, no doubt, be watched with great interest in this country, as well as in South Africa, and it is to be hoped that the enterprise and boldness displayed by all those concerned in the initiation and carrying out of the work will be crowned with well-merited success.

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The Elimination of Risk in the Use of Electricity in Mines.

BY PROF. W. M. THORNTON, D.SC., D.ENG., M.I.E.E.

Summary.—The risks that are here particularly considered are those from explosion and from shock. Risk of explosion from switch boxes and fuse boxes can be eliminated by adopting a simple flame-proof method of construction. Danger would be eliminated if the supply of electrical energy were cut off whenever gas is present, and automatic apparatus for this purpose has been devised; but this has to stand the test of practical working before it is generally adopted. There does not seem to be much risk from electric oscillations giving rise to sparks (from armoured cables) of sufficient energy to cause ignition. Danger arises from coal dust as much as from gas, but risk from the former may be eliminated by certain precautions. Risk of shock can be overcome by effective earthing. It is suggested that a certain number of mining electrical engineers should be appointed amongst the new sub-inspectors.

The Report of the Departmental Committee recently issued marks the end of the second stage in the use of electricity in mines. The first was that of direct current on a small scale for pumping and haulage, with some lighting, ending with the Report of the Committee appointed in 1902. The last seven years have been remarkable in the history of coal mining in this country and abroad, for the introduction of electrical power on a scale unthought of 10 years ago. The special features of this increase have been the emergence of the three-phase system, and a very necessary improvement in the mechanical construction and enclosure of machines and distributing gear.

It was inevitable with so flexible and powerful an agent placed in the hands of men who, as attendants, could not be, by the nature of the case, highly skilled in the working of electric plant, that risks should be taken which, it is not too much to say, would not have been taken in well-equipped workshops above ground. The old-fashioned switchboard, for instance, consisting of a wooden panel with a few open-type switches and fuses, placed across a corner to give access behind, and guarded or not in front by a hand rail, which was and is still to be seen in medium pressure colliery installations, was only safe because of the small power handled, its limited range of application and the few men required. To have extended such a system a hundred-fold would have been to court disaster, and it speaks well for the quick response of the electrical industry that, when large powers and higher voltages came into use, the generating and distributing systems rapidly improved. But even in the few years that electricity has been used in mining, habits have had time to be established. In the old days, before electricity, it was the chief duty of the colliery engineer to design apparatus to be made at the colliery. This habit, good in many ways in mechanical engineering, has been extended in the present day to electrical gear, with results which are not so good. In fact, it may be said that at the present time the greatest risk in the use of electricity in mines lies in the number of home-made or designed use, switch or distribution boxes and similar devices to be found in almost every installation. The design of these is sometimes excellent, but more often primitive, and so long as this class of apparatus remains in use there is risk from it. If there is one part of mining plant of which the quality fluctuates more with price than another it is the electrical. The difference between "that will do" and "that's a good thing" does not, as a rule, mean 25 per cent. on the total capital cost of auxiliaries as distinct from the main machines, and it is generally worth it in the underground equipment.

The first thing, then, to do in the third stage of electrical development now beginning is to eliminate risks due to imperfect gear accumulated in the past, whether in ignorance of possible danger or from false economy. This is emphasised by the new Report under the head of "Proper Construction and Good Maintenance necessary for Underground Work." The present would be a suitable time for a manager having doubts about any part of his equipment to revise it in the light of the Report.

The specific dangers which may arise in the use of electricity below ground are (1) ignition, (2) shock. The gas (methane) given off by coal seams is readily ignited. Like all inflammable gases, its behaviour when ignited may be regarded in two ways. In the first place, if an enclosure is quite full of a mixture of air and gas, in which the proportion is about 20 per cent. or more of gas, a flash or flame will not ignite it provided the flash takes place within the gas. The mixture has not enough oxygen to support combustion. If, again, a flash takes place at the lower surface of a body of gas which has accumulated slowly, there is not a violent explosion; the flame travels along the gas layer, picking up its oxygen as it goes, often returning and even passing to and fro several times, disturbing the gas by its heat and movement, until, if there is a sufficient quantity of the latter left, an explosive mixture is formed and there is a detonation. Since these slow accumulations are invariably near the roof—methane being much lighter than air—it follows that where there is even the remote possibility of the presence of gas, fuse boxes, switch boxes, even distribution boxes without fuses, should be kept *as low as possible* and never placed high against the roof.

Wherever it is absolutely necessary to use such boxes in places where gas may enter it is, however, possible to prevent danger entirely from anything of the nature of a flash or miniature explosion which may take place within the box. The improved boxes are known as flame or explosion proof, and are based on the simple device of providing the cast-iron containing box and lid with a planed flange about 1¾ in. wide, so arranged with bolts not more than 5 in. apart that the lid flange beds uniformly all over its surface, metal to metal. No rubber joint is necessary, or indeed advisable, the essential principle upon which the construction is based being the cooling of the flame and hot gases of the internal explosion to such a degree that when they blow out through the exceedingly narrow space between the lid and box they cannot be seen, nor can they ignite gas outside the box. Like other good things, these boxes are not, however, quite fool proof. They depend upon having flanges clean when bolting up, upon having the bolts well and truly secured, and upon the efficiency of the leading-in stuffing boxes; but they are an enormous advance on much that is in present use.

The simplest way of eliminating danger from gas is to cut off the electrical supply the moment gas is observed near the electrical gear, and to do so at some remote point—not at the gear in question unless fully enclosed. This rule (15) if rigorously obeyed would go far to remove the objection which is sometimes expressed to the use of electricity anywhere in coal mines. If the gas is in small quantities it can generally be removed quickly. Needless to say, large quantities should not be present, unless they occur accidentally by reason of a fall or sudden break of roof. Except under conditions of urgency, such as might occur in dealing with a rush of water, it is difficult to justify in general the risks taken in the use of electricity in places where gas may be present in an explosive mixture. It cannot, however, be too widely known amongst mining men that electrical apparatus can be made, and is made, to work under any conceivable conditions with perfect safety; but until such apparatus is universally used, and is fool proof, greater safety lies in keeping electricity at a distance from gas, as the rules direct.

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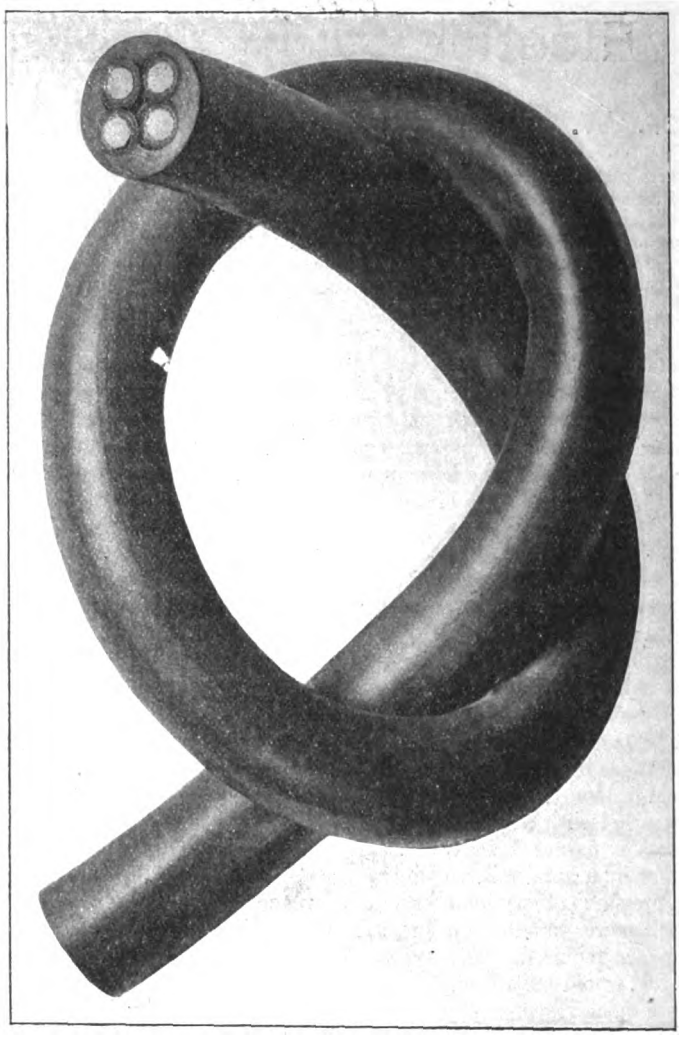

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A device has been recently introduced for the purpose of automatically cutting off electrical pressure by the heating of a platinum wire operating a switch relay when gas accumulates in dangerous quantities. If this can be made to work under all conditions of hard usage, with pilot cables thoroughly safe and the gear operated by current at low pressures, it will be most useful. Before, however, it can hope to be generally adopted it must be demonstrated that there is absolutely no risk in its use or under any condition of working.

A suggestion has been recently made that there might be sparks from electrical oscillations induced on the sheath of a lead-covered or armoured cable by the high-frequency oscillations of current which occur at the moment of interrupting a circuit by a switch. The suggestion is one which must be considered, for to prevent such oscillations the earthing of a sheath has to be continuous—that is, every few yards should be earthed! The only question is whether the energy of a spark formed in this way could be sufficient to fire gas. From experiments by the writer it appears that short, thin, high-tension sparks between copper wires in an explosive mixture do not ignite gas provided that the wires are nearly touching. There seems to be, as it were, a certain volume of spark necessary to ignite gas, in the same way that there is a minimum flash for the ignition of coal dust. On the other hand the sparks obtained from conductors upon which electric waves from a wireless transmitter impinge, can readily ignite gas. A risk of this kind may be classed as remote in practice, but until definite experimental tests have been made on a large scale it cannot be dismissed. Should the induced sparks be found in any case strong enough to ignite gas there is no remedy but to remove the plant. In the opinion of the writer there is not, from the preliminary trial, much likelihood of this being necessary, especially with three-phase systems.

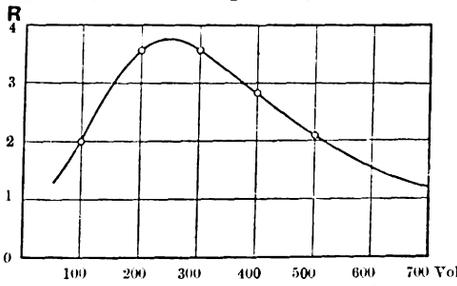

FIG. 1.—COMPARISON OF SAFETY OF ALTERNATING AND DIRECT CURRENTS.
R=Ratio of least Alternating to least Direct Current to produce ignition of Coal Dust.

Although it has been known for over 30 years that coal dust is an active agent in transmitting mine explosions, it is only within the last year that it has been shown to what degree it may be ignited directly by electric flashes. Any powder containing volatile matter, provided that it is finely divided and freely supplied with oxygen, can, under suitable conditions, burn so rapidly as to give a detonation. To cause this to take place a certain size of flash or flame is necessary. In general it may be said to be about the size of a safety lamp flame, though there are no records of dust being ignited by a sound safety lamp in the absence of gas. The dust which can be shown to be most sensitive to ignition is the very fine powder found on the roof and timbers. If by an accident such as a fall of roof there is enough vibration, either of the ground or air, to shake some dust down into suspension, the conditions are right for the transmission of a flash occurring at a broken cable, or a fuse blowing in consequence of damage done by the fall. Two steps, however, are usually necessary—the disturbance of the dust and the flash following. Under certain conditions these may be merged into one. There may be fixed, close to the roof, a fuse box which is not flame proof, or one in which there may be a short-circuit between the line terminals or to the frame, set up by the blowing of the fuse. Such a violent arc is of the nature of a miniature explosion, and can be shown to disturb dust in its immediate neighbourhood. If this is of a highly combustible nature—and most of the great dust-transmitted explosions of late years have been in seams giving readily ignited dust—the flame is continued by a small external ignition, not a detonation. This disturbs more dust, and the process continues, with the flame travelling and the pressure rising, until the ignition becomes a detonation and the great damage begins.

The first point in the elimination of risk by direct ignition of coal dust by an electric flash is the provision of cables, fuse and switch boxes of such a design that no flame can emerge though there may be flashes within. In addition to this there should be no possibility by the omission of insulating fins or by imperfect design, of so violent a short-circuit developing that the box is broken. Such things are not unknown.

Where unarmoured cables are secured to the roof timbers they should be far enough apart to render remote the possibility of their ends coming into contact in the case of a fall breaking the cables. In addition to this, they may be at the time carrying current. In the case of medium pressure direct current the flare may be considerable, especially if the break draws out slowly. There is no remedy for this. Unarmoured cables are out of place in a mine, unless they can be fixed in such a position that there is no danger of their being broken, or that there is no coal dust or gas in their neighbourhood.

The risk of ignition depends very greatly on the electrical pressure used. Figs. 1 and 2 (which are reproduced by permission from the "Transactions" of the Institute of Mining

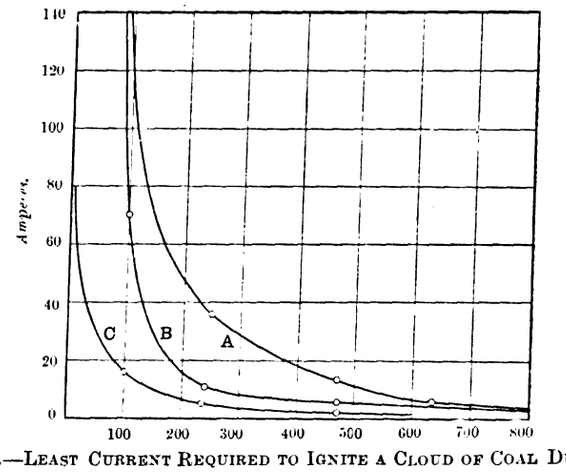

FIG. 2.—LEAST CURRENT REQUIRED TO IGNITE A CLOUD OF COAL DUST WHEN THE CURRENT IS INTERRUPTED BY A QUICK BREAK SWITCH.
A, Alternating Current Power Factor, 0·8; B, Direct Current, Non-Inductive; C, Direct Current with some Inductance.

Engineers) show very clearly the advantage of the use of low pressures, especially with alternating currents. They also illustrate the very great gain by the use of alternating currents, so far at least as the risk of igniting coal dust by their interruption is a determining factor.

The amount of coal dust necessary to transmit a dust explosion is about one gramme per cubic metre of air. Such a quantity is frequently found, especially where high-speed haulage is used. The most direct way of obtaining safety from it is by preventing its formation. This can be done at the start by the use, for example, of hydraulic power to bring down the coal wet, and by enclosing tubs as thoroughly as possible. It can be removed to some extent by brushing, or, much better, by a fan collector. It can be kept down by sprinkling with water, or, a more recent suggestion, by the use of a binder, such as soap or caustic soda with water glass in the water. In a mine with the coal dust either removed or fixed, the danger of a local ignition of gas spreading through the workings would be entirely removed. This would not, of course, lower the standard of electrical plant, for all the conditions which apply to safety against ignition extend to prevention of shock.

It is probable that many explosions are initially propagated, though not started, by a weak mixture of gas and dust. This is more dangerous than either alone, for while it requires about 6 per cent. of gas to be dangerous, or a dense local cloud of dust, from 1 to 2 per cent. of gas is sufficient, when mixed with dust, to continue an ignition with violence. These points do

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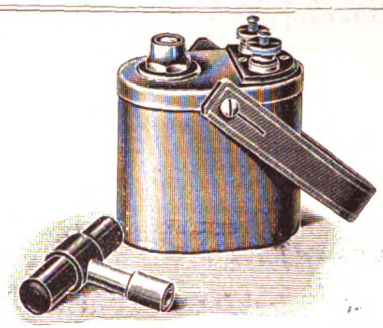

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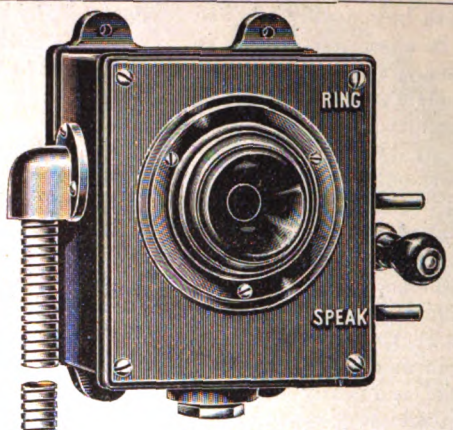

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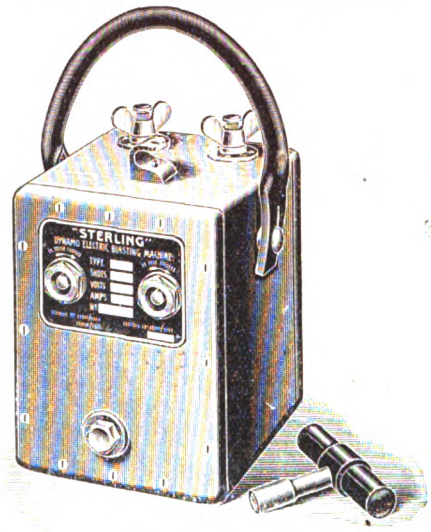

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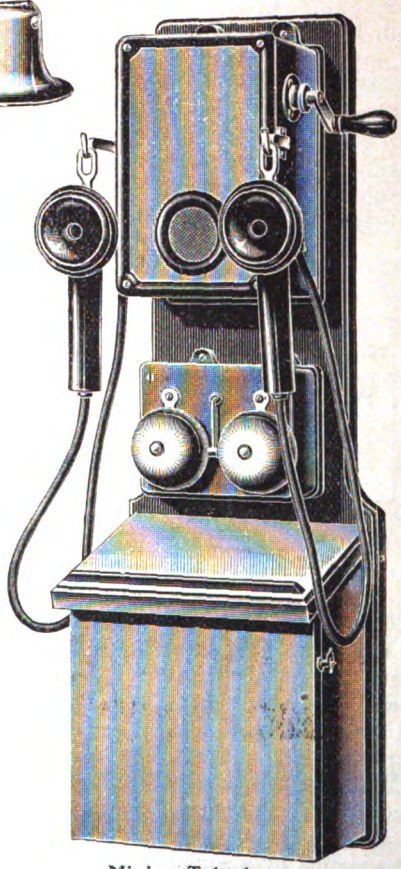

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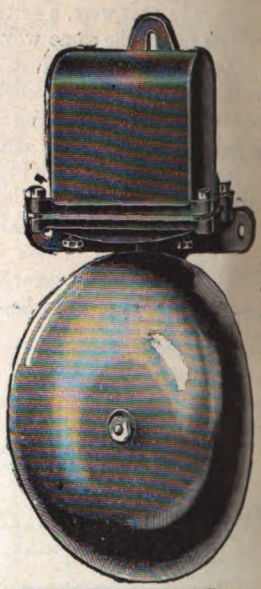
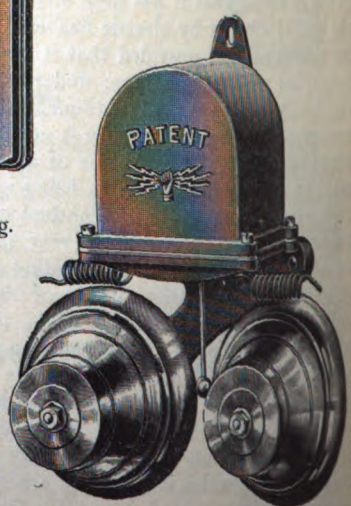


No. S 6105.—Iron Bell (Battery Ringing) Gas & Watertight.

No. U 2602.—Blasting Machine, 10 Shots.



No. S 6148.—Iron Bell (Magneto Ringing) Gas & Watertight.

THE STERLING TELEPHONE & ELECTRIC CO., Ld., 200, Upper Thames Street, LONDON, E.C.

Works—DAGENHAM, ESSEX.

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not seem to be quite fully appreciated either by mining men or electrical engineers. Danger from safety lamps may be said to begin when kept alight in 6 per cent. of gas ; but a much weaker mixture in a dusty place would be ignited with ease by a flash, whether electrical or otherwise, of the size of a match flame. This should be demonstrated in every colliery centre.

With regard to risks from shock, Appendix B to the Committee's Report shows the proportion of deaths from shock to those from electrical ignition to be seven to one. It should be known that the intensity of a shock is not in the first instance proportional to pressure. In other words, it is current that kills, so that a low pressure operating on a person whose resistance has been lowered by working in a moist atmosphere or by freely perspiring, may be fatal. From 80 to 100 volts is the lowest which, under the most unfavourable circumstance, may be regarded as dangerous. A severe shock can be had from 50 volts with hands moistened with slightly acid water ; and with a weak heart there might even then be danger.

If every part which could be touched by the hands were efficiently earthed under all conditions of normal working danger from shock would be eliminated. An analysis of the cases of shock in the above appendix shows that out of 53 cases in which there was no doubt of the cause 27 were from abrasion of cables, 19 from apparatus, switches, controllers, &c., and seven from machines, chiefly coal cutters. In view of the increasing number of deaths from shock the merit of the new rule as to armouring cannot be questioned, though it will no doubt be felt by some to be stringent. One of the first duties of the new sub-inspectors, so far as the use of electricity is concerned, will be to learn the details of efficient earthing.

In reference to this it may be opportune to point out that rarely in the progress of any industry has there been such an opportunity for ensuring that new rules should be efficiently carried out. An important part of the inspectors' work will be the review of the electrical plant ; but unless each one has special electrical knowledge this is likely to miss fire. Would it not be possible to appoint amongst them six men not primarily miners, but mining electrical engineers, one for each of the great divisions (Scotland, the North of England, Yorkshire, the Midlands, Lancashire and South Wales), whose first duty should be to go round with and instruct the others in electrical matters ? A year or two of instruction of this kind would do more to raise the level of general knowledge of electrical work amongst mines inspectors than much indirect experience, and would no doubt benefit manufacturers by improving the demand for higher class apparatus. Since the Committee have decided not to approve officially certain types or designs of apparatus, it is all the more necessary that some uniformity of standard should be more or less agreed upon by those whose work it will be, amongst other things, to inspect plant. The confusion at present is infinite ; every variety of electrical apparatus, from the best to the worst, is found in coal mines, and although it is perhaps impossible to expect the same standard of outlay in a small struggling colliery as in great combines, there is no reason why the worst should be anywhere permitted.

The six general heads under which the Committee summarise their work show that they consider the time has come for a general "tuning up" of the use of electricity in mines. It has of necessity to be withdrawn where there is risk of ignition ; mechanical construction shall not favour an ignition in a motor room spreading ; shock is to be avoided by complete earthing ; switchgear is to be efficient and under a responsible person ; both switchgear and cables are to be made mechanically stronger ; the manager must formally appoint an "electrician," who will systematically report to him. These are so great an advance from the point of view of safety and reliability that it is not too much to say that they mark a new era in the use of electricity in mines in this country. It only remains for workmen, managers, manufacturers and inspectors to co-operate in making them effective.

Special Risks in the Application of Electricity to Mining Work under S. African Conditions.

BY H. J. S. HEATHER, M.I.E.E.

Summary.—Attention is drawn to the special conditions prevailing in South African mines, and the subject is discussed from the points of view of (1) safety as regards life, (2) safety as regards plant, and (3) safety as regards continuity of service. These points of view are each liable to be given extreme importance, depending upon the position of the individual. In South Africa, ignorance, curiosity and wilful tampering are important factors. A table is given showing the conditions under which shocks may be received, and the question of protection by earthing is considered, the conclusion being reached that the neutral of a three-phase system should not be earthed.

In its capability of being safely operated by unskilled attendants, when once it has been properly installed by skilled engineers, electric plant exhibits one of its greatest virtues. But the skilled engineer must remember to guard against the defects which this quality involves ; the ignorance of the unskilled attendant in mining work can, and does, attain proportions that at first sight would seem quite impossible. The writer's experience may, perhaps, in this direction be wider than that which most people have had the opportunity of collecting. He has had to deal not only at home with the English miner, but in the Transvaal with Boers, Kaffirs and Chinese, and he has found that the degrees in which astuteness and simplicity are combined in these different classes of labourers present an extraordinary amount of variation. He has had cases where it has been found necessary to keep bare copper overhead wires alive in order to prevent them being cut up to make bangles, and where leather belts have been kept running 24 hours a day so that they might not become boot soles. An ignorant white colonial attendant has suggested to a mine manager, to whom energy was being sold by meter, that putting a solution of sal-ammoniac into the meter would cause it to read slow, to the great advantage of the consumer.

The failure to realise the danger that may lie in touching electrical wires and apparatus is, of course, not to be wondered at. The dread of great heat is perhaps by now instinctive in the human race ; but in all probability, if this is so, we have only got at present far enough to dread heat when it is accompanied by light. One still has to learn that in a tropical climate one cannot pick up pieces of iron that have been lying in the sun, just as the newcomer on a mine has to learn that drills in the sharpening shop may be unsafe to handle. For very many years to come, therefore, we cannot expect that the ordinary person will look upon the wire or terminal as an object of suspicion because it may be electrically charged.

The question of safety in using electricity for mining operations can properly be divided into three headings :—

1. Safety as regards life.
2. Safety as regards plant.
3. Safety as regards continuity of service.

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According to the point of view from which one looks at these three requirements, one or other of them is liable to assume undue prominence. The Government Inspector, for instance, sees the first very much in his foreground, and the second and third nowhere. To the consulting engineer the second assumes exaggerated proportions, and the mine manager is often liable to pay too little attention to the first and second, and to regard the third as the only justification for the existence of the electrical plant. Now, although one fears that one may be accused of callousness if one questions the correctness of the Government Inspector's view, the real fact is that the whole question is one of probabilities, and a balanced idea of the relative importances of the various objects can only be obtained by a man who has had a long and intimate experience of the risks involved.

This, of course, does not apply only to mining. No one, for instance, would question the advisability of periodically painting steel bridges, which means choosing to take the small chance of losing a man employed to do the dangerous work, in preference to the practical certainty of having to pay for expensive deterioration. In all businesses chances must be taken; but as, according to the insurance companies, mining is one of the employments most dangerous to life, and, according to Stock Exchange quotations, it is also one of the most risky investments for capital, it is clear that the risks that have ordinarily to be taken in electrical mining work, both as regards fatalities and plant breakdowns, are likely to be greater than those that have to be met in the application of electricity to most other work. The art has to suffer from the circumstances of its environment, and it is likely that this state of affairs will be, to a great extent, permanent, for although some of the extra risks are avoidable, others must be regarded as more or less inherent.

Amongst the latter are to be included those due to the fact that in a mine cables have very generally to be put in such positions that throughout their length they are within reach of the passer-by. The dampness of the normal atmosphere underground, the acidity of the mine water, in some places dust, the presence of non-conducting as well as conducting strata, falls of roof and sides of shafts, blasting in metalliferous mines and darkness, all contribute to the unavoidable risks.

Amongst the risks that we may hope we shall some day prove to be avoidable may be put those arising from bad work, temporary work (which very often is bad work), rough handling, ignorance and carelessness.

These avoidable risks have to be dealt with in various ways. There is no reason whatever why bad work should continue to be put in. It can at once be eliminated by employing none but skilled and conscientious workmen, and keeping them up to the mark.

The temporary work question is a little, but only a little, more difficult to deal with. Pressure is constantly being brought to bear upon the electrical staff on a mine, with the object of getting work done quickly without due regard being paid to the point as to whether it is done satisfactorily. To withstand this pressure successfully strength of character is required; it must be kept in mind that work that is originally intended to be purely temporary very often comes to be regarded as permanent, or at least semi-permanent. It is usually very difficult to persuade the non-technical mining man that there can be any necessity for stopping plant that is, to outward seeming working satisfactorily in order to effect what is to him a highly problematical improvement. His habit of thought, as a mining man, forces him to the opinion that accidents must occur, and that, particularly in connection with electrical work, the proper way to look at them is to a large extent as "acts of God." His inclination, therefore, is always to "let well alone." The easiest way to deal with this frame of mind is for the electrical engineer never to need to make improvements on running plant. He should set himself one standard as regards safety—namely, the best he knows of—and he should maintain this standard whether he thinks the work he is doing is permanent or temporary.

Other risks, those, for instance, due to ignorance and carelessness, will take far longer to eliminate. Education and experience can only extend by slow degrees, and they are needed to prevent the rough handling that is another source of danger to underground electrical plant. To the miner, the hammer takes the place of the spanner, and dynamite that of the screw jack; so if electrical plant is to be left in his hands at all it should be so designed as to be able to stand up against this sort of idea.

Amongst non-European workers curiosity may be a danger to be seriously taken into consideration. In this respect the writer has found in his experience on South African mines that the native Kaffir gives little trouble. His mental level is so low that practically all the white man's machinery produces in him an intellectual stupefaction. Everything alike is simply "tagati," witchcraft, and the things that appear to him the most wonderful are those that he can most nearly understand: that is to say, the very things that appear to us the least surprising. The consequence of this is that curiosity is almost atrophied in him. He has no desire to look inside anything because he has no reason to suppose that an investigation will leave him any wiser than he was before. The case was quite different with the Chinese during the time they were allowed to be imported into the country to make up the deficiency of native labour. Their inquisitiveness knew no bounds, and, as may easily be imagined, it formed a constant source of trouble on electrical plant. It may be regarded as a fortunate thing for many of them that they concentrated their attempts at research work largely upon the mine bell-signalling systems. Of course, with increased experience of the danger of meddling with electrical plant, there is no doubt that this curiosity would be held in check by a wholesome dread of possible results.

It would appear, therefore, that, so far as the uncivilised races of the world are concerned, it is quite possible that at a certain stage, an increase in intelligence among workmen may for a time increase instead of decrease the difficulties of running electrical machinery. If this stage exists it will not be of long duration, but apparently it will have to be passed through; there is no way of avoiding it.

In addition to this curiosity and ignorance, wilful tampering with electrical apparatus has to be guarded against. In the Transvaal the use by unauthorised persons of the shaft signalling bells has caused so many accidents that lock-up systems are being generally adopted, the keys being held only by those men who may properly convey instructions to the winding engine drivers. It is also not uncommonly found that switches of the air-break type, with covers that are easily removable, are put to illegitimate uses. In wet places underground they are found to form handy receptacles for anything that the miner wishes to keep dry. In metalliferous mines, candles, dynamite, matches and so on are often tucked away in them; in collieries most types of air-break switches are generally inadmissible, because of the possibility of gas or coal dust getting into them. To prevent the improper use of such switches as boxes, anything in the nature of a lead seal is quite useless. A fragile seal is only of value amongst persons in whom the respect for rules and regulations is strongly developed, and this cannot be said to be the case with the miner, whether white, black or yellow. The only way to make use of such switches is to make it really difficult to open them, by avoiding such things as wing nuts, making special box spanners necessary, and so on; but as in the writer's opinion most of these switches are radically objectionable underground, for reasons which will be mentioned later, he thinks that for power work in mines the extra cost of oil-break switches is always justified.

In the Transvaal the use of three-phase systems underground is so universal that up to the present the question of continuous-current switches in such situations has hardly had to be considered.

Practical joking is another direction in which ignorance finds a congenial outlet. It is often thought highly comic to give the unsophisticated Kaffir a shock. The direct danger to life in this sort of amusement is quite considerable, owing to

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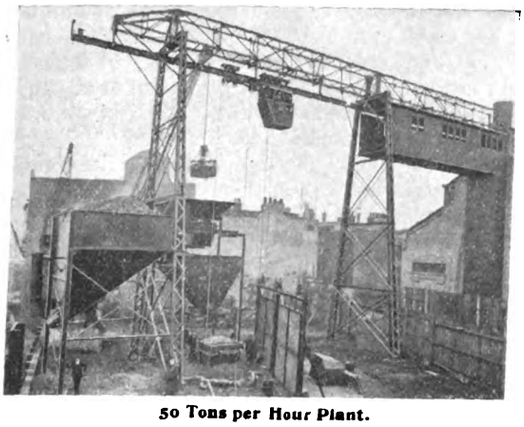

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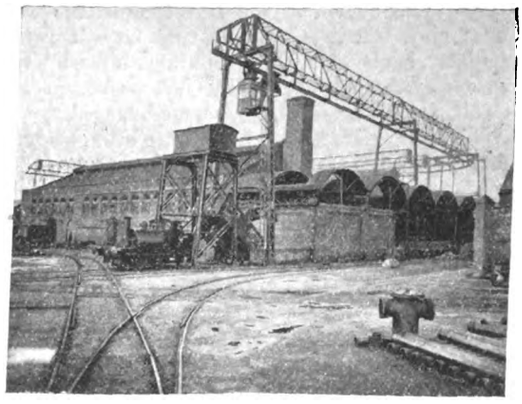

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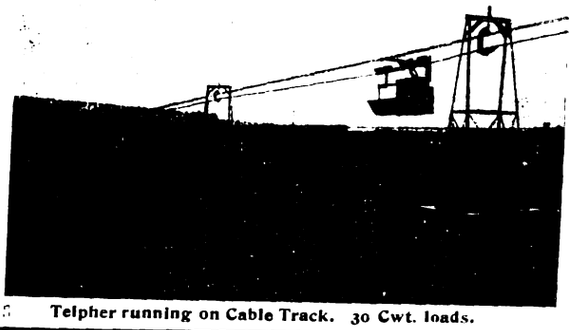

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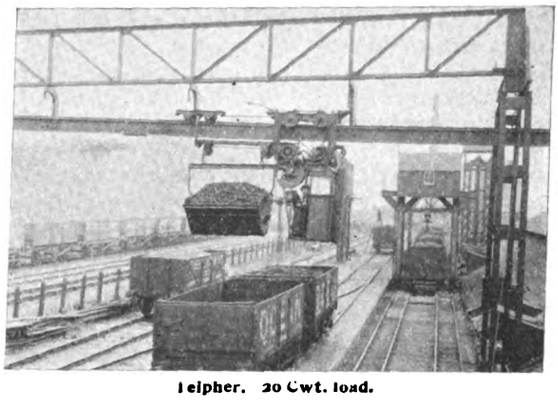

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very different degrees in which different persons are susceptible; but, besides this, there is the indirect danger to be kept in mind. It is very likely that the Kaffir or Chinese will give a private repetition of the performance the white man has taught him, and it is unlikely that he will discriminate, even roughly, between a dangerous and a harmless voltage (if any voltage at all can really be considered harmless). Besides this, again, the sudden movement caused by an electric shock, which is in itself not dangerous, can often be quite unsafe in a mine working.

Proceeding now to consider the unavoidable risks, there is not much to dwell on in regard to darkness. The want of light makes it sometimes difficult to detect when things are not as they should be, and also makes it more likely that a man may inadvertently touch parts of machines, wires, &c., with which he had no intention of coming into contact. Exposed terminals should, therefore, be avoided as far as possible, and where they cannot be dispensed with they should be placed quite out of reach or in cages. It is quite wrong to imagine that safety to life can be secured by the use of any of the low voltages that are suitable for power work. Numerous cases of fatal accidents with voltages of 200, and even 100, will have come before anyone with much experience. In many cases it is practicable and advisable to put in better lighting, and with this, the protection of terminals and the use of increased care, the question of bad light is disposed of as far as it is possible to do so.

Falls of rock and blasting seldom do damage except to cables. Heavy armouring is a considerable protection. Whenever blasting is going on current should be cut off from any cable that is within the danger zone, not so much because of the fear of a short-circuit, as the circuit-breakers ought to take care of this, but from the danger of an exposed live core falling into water lying on insulating rock.

This brings up the combination that to the writer's mind constitutes the most serious of all the risks to life in underground work, that is the combination of an exposed live wire or terminal, water or conducting ground, and non-conducting rock. In all probability high resistance strata are more commonly met with in metalliferous than in coal mines, so that the risk now referred to applies with greater force to the former class of work. The climate of Africa, too, with its dry season of six months and an evaporation that is very high all the year round, tends to produce similarly dangerous conditions on the surface of the ground. A great many instances of the results of the rapid fall of potential over a short space might be given. In one case that occurred on a 10,000-volt plant in the writer's charge a native was killed by attempting to step over a live wire that had fallen from an overhead line and was lying for at least 70 yds. on the surface of the ground. In another instance a dog approaching a similarly fallen wire found when he got within a few yards of it that there was sufficient difference of potential between his front and hind feet to warn him that there was something wrong, and he fled, howling. On other mines where there has been no pressure in use above 500 volts it has been found impossible to step off the rock forming the floor of a drive on to a flat sheet lying on that floor without getting a shock, and one man was actually killed, apparently through touching the roof or side of a drive with his hand whilst standing on a heap of drills. Both he and all the drills were several yards distant from any electric cable, and there also the pressure in use was only 500 volts alternating.

There is, however, no need to multiply examples of the danger that may attend a leak that is not a leak to earth; that is quite common knowledge. What does, however, need emphasising is that this danger is particularly pronounced in mining work.

The principal reasons for this will also bear insisting upon. They are: The necessity of having long lengths of cable in easily accessible positions, the likelihood that the continuity of the armouring of the cables may be broken by the action of the acid mine water, and the fact that the hangers supporting the cables often have to be fixed in highly insulating rock.

The objectionable action of the mine water is, of course, not confined to the armouring of cables. Earth wires from the frames of machines are often eaten through, and leaks are established from any terminals to which a film of water can gain access. For this reason all such terminals should be supported on porcelain, and it should be kept in mind that even the water that condenses from the air is likely to be acid, as it will contain nitrous fumes from the dynamite used. It is this also that causes the writer's objection to air-break switches, with their accessible terminals.

But although the effects of mine water are deleterious not only to cable armouring, it is in this connection that they are the most likely to be serious, for the considerations given above show that when there is a leak to the armouring of a cable it is quite likely that a long length of the external surface may be raised to line potential and constitute a wide-spread danger. To avoid this some engineers decline to use armoured cables altogether, but this does not get over the difficulty, for the acid water running down a cable is often, in the event of a leak, just as dangerous as an armoured covering, and has, in the writer's experience, caused several fatalities even with the low pressures used for incandescent lighting.

It is this ever-present possibility of a wide-spread distribution of the line potential that makes the writer hold the opinion that for underground power work the neutral of three-phase systems should not be earthed, though he is aware that he is here treading on controversial ground. The argument that it is better to take a large risk of getting a shock at a certain voltage rather than a small one of receiving 1·7 times that voltage is not one that can have any practical application except over a very limited range of pressures; and the range where it might make a difference whether one got the higher voltage or the lower is below that at which any power transmission, except on the smallest scale, can be carried out. The extent of the danger to life may, therefore, for practical purposes, be said to depend upon the chance of getting a shock, and it will accordingly, perhaps, be useful to put down in tabular form the circumstances under which shocks may be received with the neutral earthed and with the neutral insulated.

It is assumed in this comparison that the earthed neutral system is fitted with releases on all three legs, and the insulated neutral system with releases on two legs, so that a single earth on the lines disconnects the former, whilst to disconnect the latter either two earths are required or a short-circuit between the legs. It is also assumed that the capacity current is not large enough to be dangerous, this being usually the case on mine systems with voltages not exceeding 3,000. Leaks or faults are divided into two classes, one being the ordinary leak to earth, and the other such leaks as those above mentioned, to an accidentally insulated section of a cable sheath, or to a machine frame with disconnected or useless earth wire. This second class of leak, besides being by no means uncommon in mines, is one which there is no easy way of detecting from the surface. In order to save space in the table, this class of fault is called a leak to sheath, though, of course, it includes more than this. The word "terminal" also is used to include live wire. The table is divided into three headings: I., where there is supposed to be no fault; II., where one exists; and III., where there are two.

The table might, of course, be extended, as any number of "sheath leaks" are simultaneously possible without the circuit-breakers opening. It goes, however, far enough for practical purposes.

Of the various accidental contacts made causing deaths the writer has found those described as being between earth and sheath to be far the most frequent underground, whilst those between earth and one terminal have been next in point of number. On the surface those between earth and one terminal have been the most numerous. These have all been with the insulated neutral; that is to say, underground, most accidents have occurred under line 9, next under 3 or 10. On the surface the greatest number have been under 3 or 10.

It is impossible to say how these accidents should have been divided up as between 3 and 10, but of course, on an ordinary

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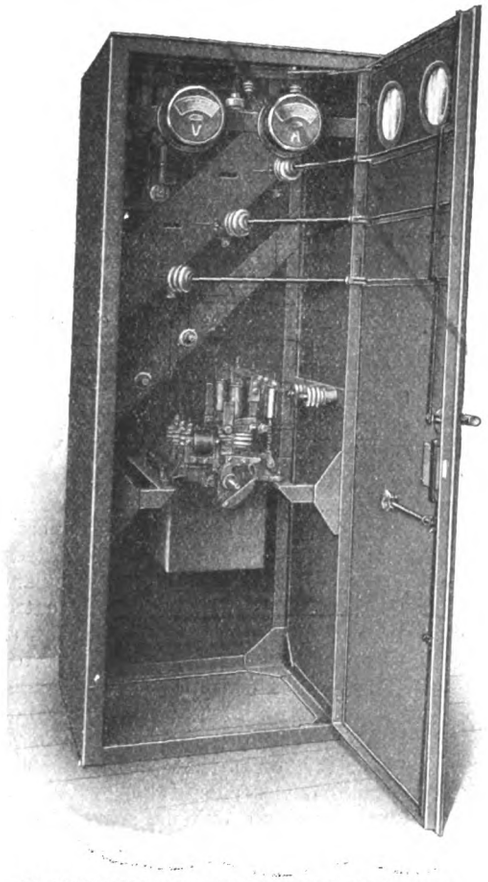

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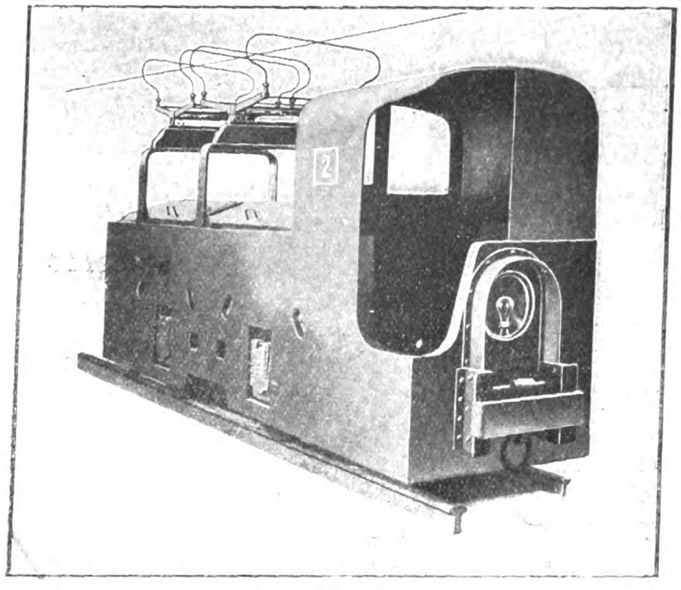

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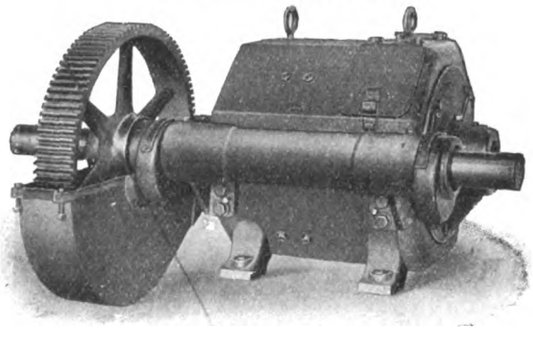

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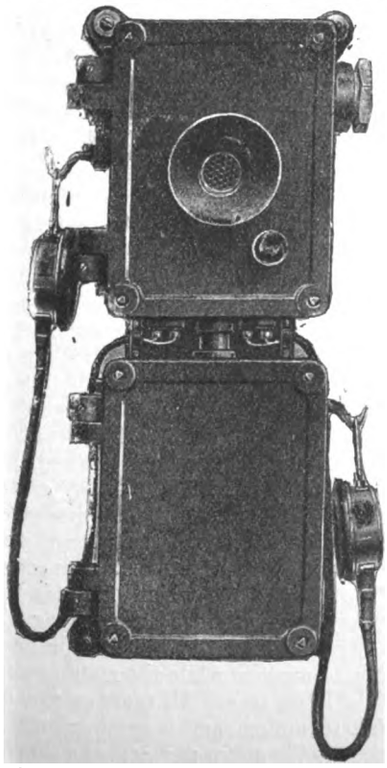

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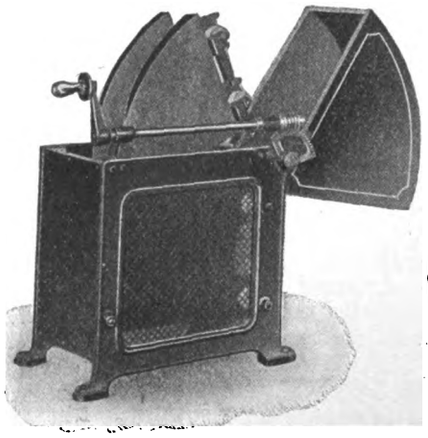

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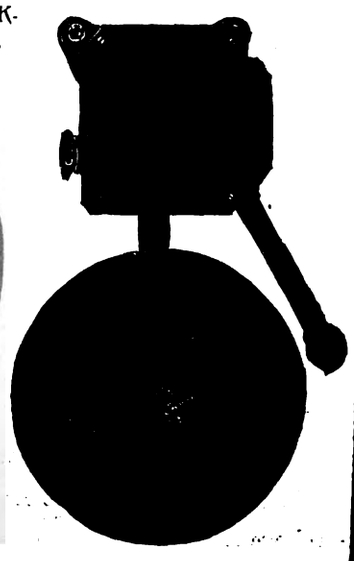

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Table.

Nature of fault.		Earthed neutral.	Insulated neutral.
		Danger to life in making contact between :	Danger to life in making contact between :
I. No leak	1	Any two of three terminals	Any two of three terminals 1
	2	Any one of three terminals and earth	— 2
II. One leak : To earth	3	Impossible : interruption of service	Either of two terminals and earth 3
	4	„ „ „	Any two of three terminals 4
To sheath	5	Sheath and earth	— 5
	6	Either of two terminals and sheath	Either of two terminals and sheath 6
	7	Any two of three terminals	Any two of three terminals 7
	8	Any one of three terminals and earth	— 8
III. Two leaks : earth and sheath	9	Impossible : interruption of service	Earth and sheath 9
	10	„ „ „	Either of two terminals and earth 10
	11	„ „ „	Either of two terminals and sheath 11
	12	„ „ „	Any two of three terminals 12
Sheath and sheath	13	Sheath and sheath	Sheath and sheath 13
	14	Either sheath and earth	— 14
	15	Either sheath and either of two terminals	Either sheath and either of two terminals 15
	16	Any two of three terminals	Any two of three terminals 16
	17	Any one of three terminals and earth	— 17

well maintained plant, the time when no leak was on (heading I.) should be the greatest part of the whole; then would come II., with one leak; and then III., with two leaks. It is, therefore, probable that of the accidents classed as under line 3 or 10 there would be more under 3 than under 10.

The reason for the frequency of those under 9 is unquestionably the wide area over which the consequences of the combination of an earth leak and a sheath leak might extend.

Now, out of all the accidental contacts that were made, it is certain that some were made when no leaks existed at all, or where no leaks existed affecting the particular contacts made.

But what would have been the probable results if the neutral had been earthed?

All the fatal contacts on line 9 would have been harmless, for the circuit-breaker would then have cut the circuit out. These fatal contacts depended, of course, actually on there being two faults simultaneously. But a contact between sheath and earth would have been fatal when only one fault existed on a system with earthed neutral (*see* line 5). If, therefore, it is fair to assume that two faults would exist on a system for a smaller fraction of the whole time than one fault, it is clear that more fatalities would have occurred with the earthed than with the insulated neutral. This is, of course, on the supposition that the voltage of transmission is such that its reduction in the ratio of $\sqrt{3}$ to 1 does not make any difference in the proportion between fatalities and contacts, a supposition which seems justifiable in practice.

Similar reasoning applies to the accidents under line 3 of the insulated neutral column, but an extra factor comes in. If the neutral had been earthed these particular accidents would not have occurred, for the circuits would have been interrupted at the time. But similar accidents would have occurred in greater number under line 2; greater, firstly, because heading 1. represents a larger fraction of the running time than heading II.; and, secondly, because there would have been three terminals instead of two to take chances from.

To give a concrete example. Suppose heading I. represents 80 per cent. of the running time, heading II. 15 per cent., and heading III. 5 per cent., that the voltage of transmission was 2,000, and that 50 shocks were received at this voltage in a period of five years with the insulated neutral, under the conditions of line 3. The number of shocks that might be expected to have occurred during the same time with earthed neutral under line 2 would have been $\frac{80}{15} \times \frac{3}{2} \times 50$—*i.e.*, 400; but the voltage received would have been 1,156 instead of 2,000.

If any of the accidents which have been put down under line 3 really occurred under line 10, with the insulated neutral, the same reasoning shows that more would have happened under line 8 with the earthed neutral, as this line only requires one fault, and there would still be those under line 17 to be added to the list with the earthed neutral to get the probable total.

The full comparison of all the lines comes out thus:—

The risks under lines, 1, 6, 7, 13, 15 and 16 are identical under both systems.

Under lines 2, 5, 8, 14 and 17 no danger exists with insulated neutral, but it does with earthed neutral.

To lines 3, 9 and 10 with the insulated neutral correspond the more probable contingencies of lines 2, 5 and 8 respectively with the earthed neutral.

There are left lines 4, 11 and 12 which are impossible with the earthed neutral and dangerous with the insulated neutral. These risks cannot, of course, be sufficient to balance those under lines 2, 4, 8, 14 and 17 with the earthed neutral.

It seems, therefore, that earthing the neutral on a mine is likely to increase largely the number of accidents to life and to add a certain number of interruptions to the service.

Whether these increases would be paid for by the possible reduction of cost of repairing breakdowns seems to the writer highly doubtful. His opinion is that the neutral should not be earthed, that mine cables should be lead-sheathed and armoured, and that no pains should be spared to make sure that such sheathing is kept continuous and in connection with the frames of machines.

The question of safety in the application of electricity to mining depends upon good work, the increase of technical knowledge, and the maintaining of an outlook that is neither hysterical nor brutal.

The Electric Drive in Gold Dredging.—An article in a recent issue of the "Engineering and Mining Journal" states that electric motors and equipment are being extensively used in operating the gold dredging plant at Ruby, Montana. At No. 4 dredge the bucket line consists of 80 buckets of 16 cubic ft. capacity, each bucket weighing about 4 tons. For raising and lowering this bucket line and ladder a 600-ton hoist is placed on the lower deck, inside the house, and is driven by a separate motor of 20 H.P. The motor is of the variable-speed reversible type, and is connected to the drums by a series of reduction gears. The first reduction shaft is fitted with an automatic brake that permits the ladder to be raised, lowered and secured in any position by the manipulation of the motor controller only. This feature is a great improvement in elevator placer-mining dredges. At the present time many dredges are constructed with this hoist connected to the digging motor. The main drive which operates the bucket line consists of heavy steel castings and gearing directly connected to a 300 H.P. induction motor. The main driving gear on this drive is 25 in. diameter, while the main gears are 14 in. diameter and have a 14 in. face. All gears on this drive have cut teeth. The first reduction shaft is equipped with a friction clutch which disengages the motor and acts as a slipping device. The drive complete with the motor weighs 93 tons.

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The Gas-tight and Flame-proof Motor Problem.

BY TALBOT DUCKITT.
(Of the General Electric Co.)

Summary.—Attempts have been made to produce motors which are gas-tight and also those which are explosion-proof and flame-tight. The author commences with a description of the totally enclosed type of motor, and the development of the flame-tight machine. He then passes on to discuss water-cooled and pipe ventilated motors. Details of totally enclosed motors, armatures, brush gear and commutators, slip-rings and also of explosion-proof motors are given.

When perusing the report issued by the Electricity in Mines Committee in 1909-10, we cannot help noticing the small number of fatal accidents enumerated in the appendix which have been directly caused by the electric motor. For example, in a period extending over five years, out of a total number of 68 accidents, only two were due to faulty machines. Nor would it appear impossible that even these might have been averted if in the one case more attention had been bestowed upon the motor, and in the other there had been better supervision.

Considering the varied, and in some cases almost impossible conditions which exist underground where motors have to be installed, and the enormous increase in the use of electric power for mining purposes of late years, it is a matter for congratulation that the electric motor has reached this stage of reliability.

Though the conditions are not always such as to require specially designed machines, yet in many cases the ordinary type of motor would be quite unsuitable. This fact has been apparent to manufacturers all along, and from time to time special designs have been brought out to meet the particular requirements when working in dangerous positions. The chief feature in the development of these designs has been the attempt to produce either *a reliable gas-tight motor*, or one which would be *absolutely explosion proof and flame tight*. Even the earliest forms of these designs showed a considerable amount of ingenuity and were so suitable for this class of work that many of the present-day types are practically constructed on the same lines.

The early types of such special motors were all direct-current machines, and it was not until later that the superior alternating-current motor was introduced for mining purposes. These special motors can be classed under the following headings :—

1. *Totally enclosed motors*, popularly known as *gas-tight* motors.
2. *Gauze enclosed motors*, known as the *flame-proof* type.

In addition to these two main divisions there are also many designs where only a part of the motor—*e.g.*, commutators, brush gear, &c.—is made gas-tight or flame-proof.

Before proceeding further it should at once be pointed out that, strictly speaking, it is impossible to make a truly gas-tight motor for practical use, for to be gas-tight the motor case must be absolutely air-tight ; and, even assuming such a machine could be turned out of the workshop, all its gas-tight properties would vanish after it had once been opened for inspection, &c., in a mine. Again, although it may be possible to seal up hermetically certain portions of an electric installation, such as switchgear, &c., it is, however, quite impossible to do so in the case of a motor, for with the latter heating up while running and cooling down again when at rest air will be caused continually to leave and enter the motor shell. This transference will, in a shorter or longer period of time, depending upon the intermittent running of the motor, cause the quality of the atmosphere inside the machine to become exactly similar to that surrounding it. In reality, therefore, the gas-tight machine does not exist, it is merely a name given to a strongly built totally-enclosed motor which may, or may not, be capable of withstanding internal explosions of fire damp.

I.—Totally enclosed Motors.

The first attempts at enclosing motors were made by encasing the ordinary open types in wood, sheet iron or cast-iron boxes ; but later this was improved upon by making the shell of the motor form its own case, the bearings being either made in one with the shell and the combination split in two halves through the horizontal centre line, or the shell being cast in one piece, having facings at each end for bolting on the bearings. Both the latter forms of motor, though not strictly gas-tight—as explained above—are exceedingly useful in wet or dirty situations, and when strongly made form the ideal article for the rough usage generally meted out to them in a coal mine. Some were also made of sufficient strength to be *explosion proof*, so that in the event of gas finding its way into

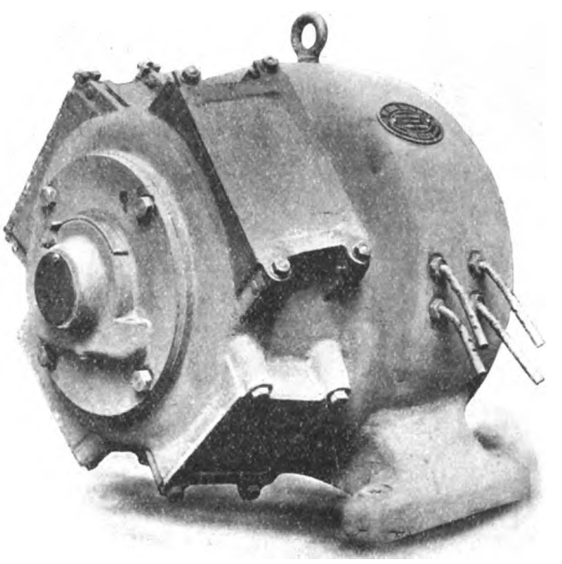

Fig. 1.—General Electric Co's. Gas tight Motor.

the case and exploding no damage resulted to the motor. Unfortunately, such motors have a very serious drawback—viz., the reduced rating for a given size ; for, being totally enclosed, the only means for getting rid of the heat produced in the motor is through radiation from the outside surface. This reduction of output may be as much as 50 per cent. of that given by an open-type machine with the same overall dimensions. Nevertheless, the totally enclosed gas-tight motor is still put forward by many firms, and there is no doubt that for small outputs, positions where space is not a limiting factor, or intermittent running, it is quite a desirable machine. It can always be kept dry and clean inside, and therefore presents the smallest chance of breakdown. This type of machine should always be provided with substantial inspection doors, preferably hinged to the case to prevent them being taken off and not replaced. Experience has proved, however, that these alone are not sufficient ; firstly, because they do not provide for inspection during working, and, secondly, owing to the trouble of removing doors each time, sufficient inspection is seldom given to the motor. Indeed, it has not infrequently

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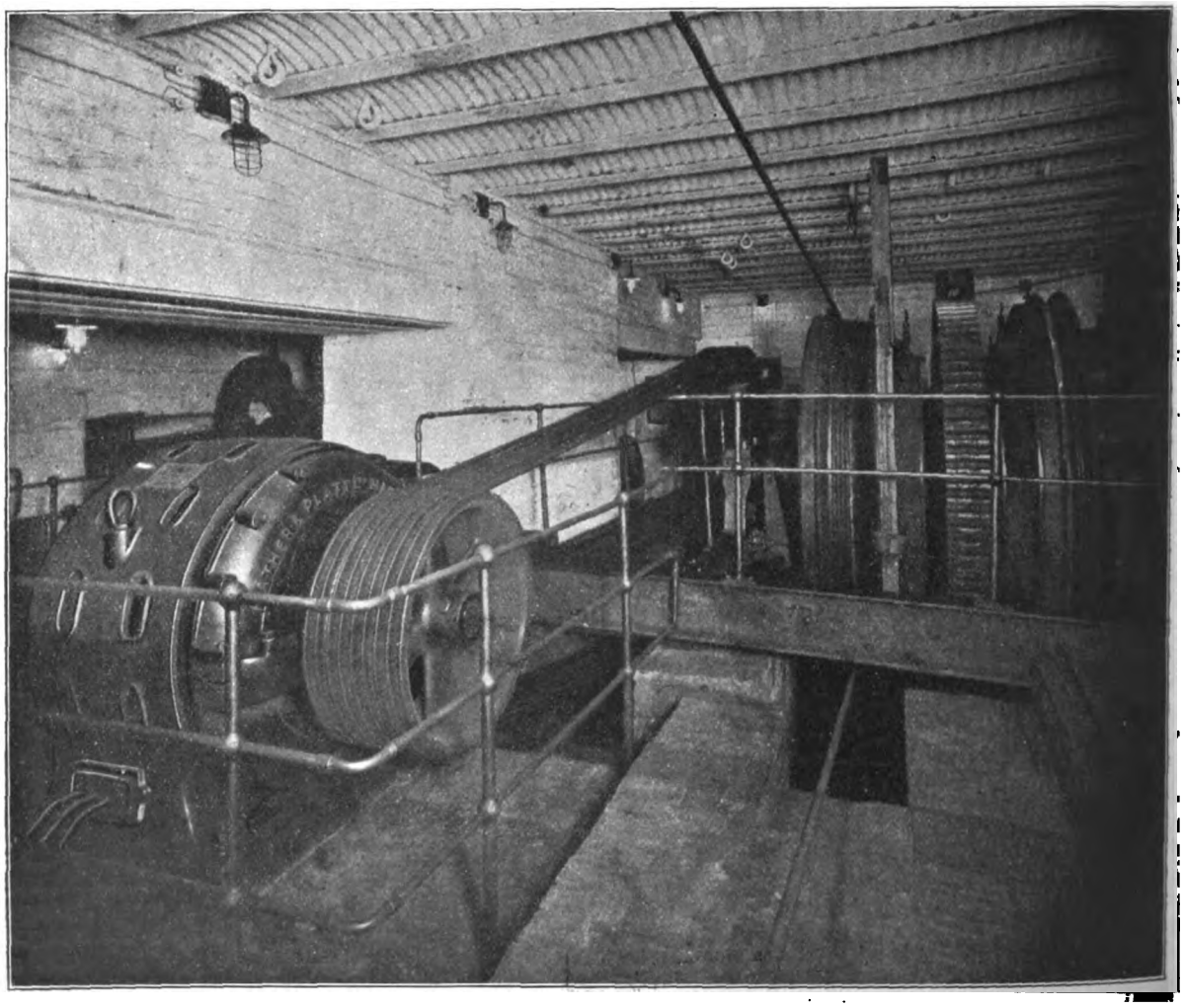

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happened that inspection has only taken place when it has become necessary due to an actual breakdown. For this reason gas-tight glass windows should always be provided, these being placed so that the parts requiring inspection can be seen at all times.

Fig. 1 shows a type of direct-current totally enclosed motor for mining work manufactured by the General Electric Co. It is very strongly made, and designed so as to be capable of withstanding an internal explosion of fire-damp without suffering damage. Some makes of totally enclosed motors have numerous ribs cast on the shell, or inspection doors, or both, in order to act as radiators for getting rid of the heat

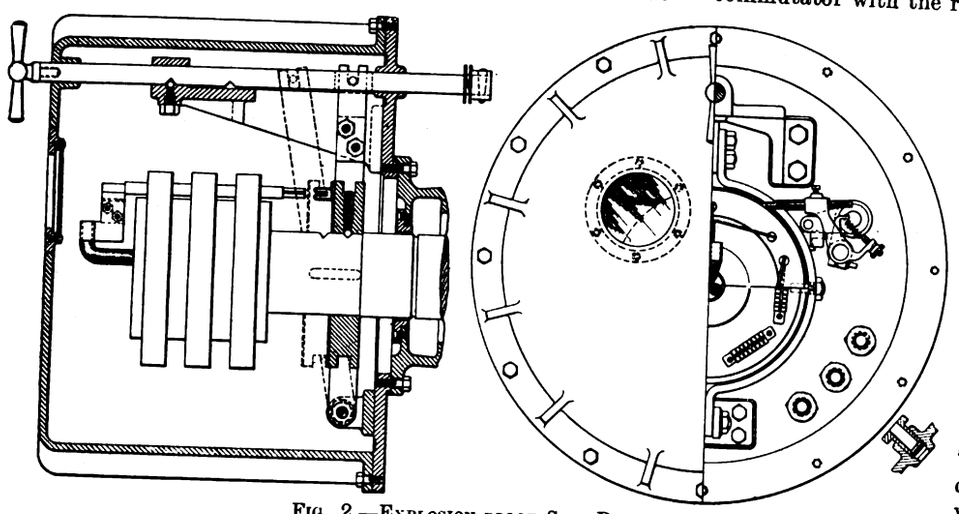

FIG. 2.—EXPLOSION-PROOF SLIP RINGS.

generated inside the motor. These also act as stiffeners for strengthening the shell in case of internal explosions. It is an open question, however, whether the small amount of extra radiation thus obtained will compensate for the increased capacity thus given to the motor for collecting dirt and dust in all the pockets and crevices formed between such ribs. The adoption of ball or roller bearings in conjunction with this type is also desirable, for not only do they reduce the friction loss, but also assist in making a gas-tight job, whilst, further, the very common trouble of oil leakage from the bearings is easily overcome with this arrangement.

Another direct-current gas-tight motor is shown in Fig 7. It has been specially designed for use on coal cutters and is very strongly made, the whole outer case being constructed of steel castings. It will be observed, that to keep the overall height as small as possible, two of the four poles are consequent poles, also that to prevent the field coils from getting damaged through vibration they have been rigidly bolted to the shell. To simplify the problem of making the bearings flame-tight, grease lubrication has been adopted; this at the same time allows the coal cutter to be worked on a gradient without causing oil troubles. The shaft is made exceptionally strong and provided with large thrust collars at the driving end bearing, which is split horizontally to allow of assembling. The motor terminals are inside, and glands are provided through which the connecting cables are taken. At the commutator end two hinged doors are attached, each of which is provided with a strong plate glass window for inspection purposes.

Enclosed Armatures and Brush Gear.—Other devices for totally enclosing have been tried with a view to reducing the available space where gas might accumulate, and an explosion might occur. Thus, instead of making the protecting shield to envelop the whole machine, only the armature, commutator and brush gear may be enclosed, the covers being made to leave minimum clearance between themselves and the armature, and forming a running fit where they surround the shaft at the inside ends of the bearings. This arrangement, though allowing the covers to be of a much lighter structure on account of the reduced force of an explosion, makes it necessary for the brush gear to be very complicated and inaccessible.

Enclosed Commutators.—Another arrangement on the same lines, but intended to minimise still further the cubic capacity of gas liable to explosion, is to encase the commutator only. In this device the brush gear is made in one with the cover, slots being provided for the brushes to pass through. The advantages and defects of this method are the same as those of the enclosed armature, only more pronounced. A reversed commutator with the running face of the segments inside and internal brush gear has also been suggested, and is claimed to have worked very satisfactorily in actual practice. The enclosed vacant space was made so small that it held no more air than an ordinary Davy lamp. Obviously, under these conditions, the motor could only give a small output and be worked at very low voltages.

The chief improvement in mining work in recent years is undoubtedly due to the substitution of *alternating current* for direct current; indeed, so complete is the change that the former has almost ousted the latter from the market in this branch of engineering. This is not to be wondered at when one considers how well adapted in every way is the alternating-current motor for mining work. With it we have all the good qualities for starting and running which can be claimed for the direct-current machine, whilst at the same time we altogether dispense with the chief disadvantage of that type—viz., the commutator. There is no need to make a detailed comparison between the direct-current motor and the three-phase alternating-current motor. For work of this nature the latter is obviously so superior and readily adapts itself to any form of enclosing.

Of course, the squirrel-cage is the nearest approach to the ideal, and this, coupled with the improved method for thoroughly drying and impregnating the coils and insulation, the superior quality of the insulating material now obtainable, together with the absence of any sliding contacts, gives us a machine

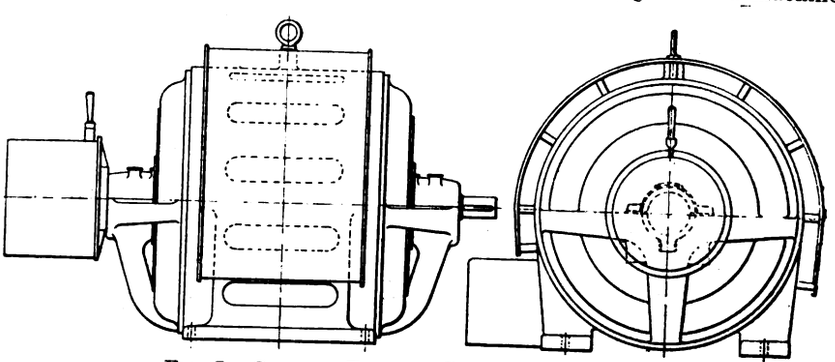

FIG. 3.—GENERAL ELECTRIC CO.'S 315 H.P. MOTOR.

which requires only the minimum amount of attention, so that, in moderately dry and clean positions, this motor is about as reliable as anything that can be desired. Even in positions where the squirrel-cage motor is unsuited to the class of work, and slip-ring motors have to be installed, the alternating-current machine still shows a marked superiority over its direct-current rival, because it is not necessary for the slip rings to be inside the motor, as is the case with the commutator. They can, for example, be placed on an extension of the shaft, outside the bearing, and, if required, be provided with a short-circuiting and brush-lifting device, leaving no sliding contacts

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to cause trouble while running. The whole slip-ring gear can thus be enclosed in a case of any suitable design, entirely apart from the machine, while the motor proper may be left open like a squirrel-cage motor, with very little risk of causing trouble. Should it be required to enclose both motor and slip rings, this can also be done without having any connection between the two which would allow the air to pass from one chamber to the other.

Fig. 2 shows a set of slip rings with short-circuiting gear and brush-lifting device in a totally-enclosed explosion-proof cover. These were designed by the writer, and are used by the General Electric Co. on some of their alternating-current motors. The drawing explains itself; it need only be mentioned that by the single movement of pulling the handle in a horizontal direction the slip-rings are short-circuited and the brushes raised, and vice versa. For preventing the passage of a flame through the oil channels in the bearing, should any gas accumulate inside the slip-ring cover and get fired, a grooved baffle plate is screwed to the bearing nose, the clearance between this and the shaft being such that, although the gases have a free vent, no flame can pass. Although the chances of explosions taking place inside the slip-ring cover have been found in actual practice to be exceedingly remote, yet at the same time this type of enclosure is very effective as a dust screen, and by constructing them of sufficient strength to withstand the shock of an explosion of fire-damp it also ensures that they are not too fragile for their locality.

The pressure set up in an enclosed chamber by an explosion of fire-damp may be taken to range between 60 lb. and 120 lb. per square inch, though under certain conditions this pressure may be exceeded.

In positions where dripping water is the only objectionable feature to contend against, a very serviceable protection is obtained by attaching to the motor a cover made as shown in Fig. 3. It consists of a No. 14 gauge steel plate, beaded on the edges to give extra stiffness. This is carried far enough down on each side to prevent any possibility of the water getting inside the machine. At the same time it is kept a sufficient distance away from the motor shell, so that the ventilation will not be hampered in any way. A cover so formed takes up very little extra room, while at the same time it is also self-contained with the motor.

It will be thus seen that, with the use of alternating current, open-type motors can be used at their normal ratings, and at the same time the factor of safety in working is greatly improved.

Water-cooled Motors.—The exigencies of mining have produced one evolution of the totally enclosed motor which has done yeoman service in connection with pumping plant, more especially in conjunction with sinking pumps. This particular form is the *water-cooled motor*. It is constructed with a shell having hollow walls, through which either the whole of the water raised by the pump is passed, or else a by-pass from the discharge pipe, or one of the stages when using a turbine pump, is connected to it, and a certain portion of the water pumped is allowed to run through the motor to waste. The first case is only possible with low heads, as otherwise the motor shell would have to be made abnormally strong. In the second case, as the water has a fairly free passage through the motor shell, the pressure in the discharge pipe is not transferred to it. The channels may pass directly through the motor shell from end to end, which is the general arrangement in the former case, or they may be arranged in the form of a spiral to circulate the water round the shell, as is usually done in the latter method. To obtain the best results from this method of cooling it is a good plan so to arrange the internal construction of the motor that the imprisoned air may be kept constantly in motion. By placing suitable channels in the rotor and stator cores, and introducing baffles in other positions, a good circulation can be kept up, which will cause the heated air to impinge on the water-cooled surface of the shell. Should it be impossible to spare the space for such channels, fan blades must be fixed to each end of the rotor, and by this arrangement keep the air in motion.

Fig. 4 is reproduced from a photograph of a 190 H.P. three-phase sinking pump motor which runs at a speed of 1,450 revs. per min., and is constructed on the by-pass cooling principle. The motor is one of a number of this class manufactured by the British Electric Plant Co., Alloa, N.B.

Pipe Ventilated Motors.—Whenever possible, it is a desirable practice to arrange the position of the motors in a mine so that they may be ventilated by intake air. In some cases, to do this, the motor rooms have had air passages connecting them with the downcast shaft, giving very beneficial results. Such a scheme brings before our notice the claim of the *pipe ventilated* motor as a type to be considered as suitable for mining work. Considering the demand there has been since its introduction for installing it in factories where inflammable materials are manufactured, such a claim appears to be quite reasonable. Where, for example, numerous motors are required near the shaft bottom, pipes from the intake airway and the upcast shaft could be connected to them without much difficulty. In many mines this particular locality is not by any means free from dust and moisture, so that the introduction of the pipe ventilated type would provide reliable machines which could not by any chance cause a fire. A motor thus connected would be for all practical purposes gas-tight, and, being gas-tight, explosion-proof, ventilated, flame-tight, and at the same time totally enclosed to keep out dust and moisture.

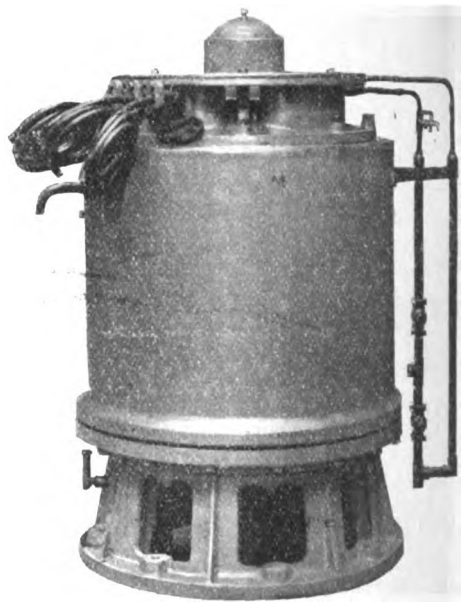

FIG. 4.—B.E.P. THREE-PHASE SINKING-PUMP MOTOR.

The motor is constructed upon the same principle as if it had to act as a heating device—that is, one end of it is connected by means of a pipe or other suitable duct to a source of cool clean air, which is drawn into and through the motor by a fan self-contained with the armature or rotor, and having taken up some of the heat generated in the machine is expelled from the opposite end, either into the atmosphere or through another pipe or duct into a suitable exhausting place.

In designing this motor it is necessary to bear in mind that there are two directions in which the air may be passed through the machine. Thus the air can be taken in either at the commutator or slip-ring end, and out at the driving end, or vice versa. The first is the simpler arrangement, but a drawback presents itself in the cases of direct-current motors and alternating-current motors with the slip-rings inside the shell, for all the dust from the commutator or slip-rings is drawn into the windings. This defect can, however, be overcome by placing the entering orifice so that the air is drawn into the

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motor *through* the commutator, instead of over it. When this solution is adopted it is also advisable to resort to ball or roller bearings, as the air current in all probability will cause considerable oil leakage from the ordinary ring lubricated journal bearings.

II.—GAUZE ENCLOSED MOTORS.

The chief claim put forward for this type is its *flame-tight properties*. The gauze enclosed type consists of the addition of fine mesh gauze windows to the totally enclosed examples; these are usually placed in such a position that the commutator and brush gear can be viewed, and at the same time aid the ventilation through the machine as far as possible. The original idea was that the gauze would act in precisely the same way as with a Davy lamp, and allow any gas which percolated through to the inside of the motor and became fired by a spark on the commutator to burn inside or even explode without the flame igniting the gas outside. Thus the flame-proof motor was regarded as an advance on the gas-tight motor.

To show this, experiments have been carried out from time to time with this form of motor by placing them in a chamber containing an explosive atmosphere of air and gas and firing the mixture. It has been claimed that these experiments have, in most cases, shown satisfactory results; but in some, where the burning of the gas has been maintained for any length of time, the gauze has been destroyed. This phenomenon is known as *after burning*. In actual practice the fine gauze has also proved itself to be too fragile and unsuitable a material to deal with, for even if sufficient attention could be bestowed upon it to prevent it from being actually broken, yet it soon becomes silted up with coal dust, and in that state one can realise that it is extremely dangerous instead of being a protection.

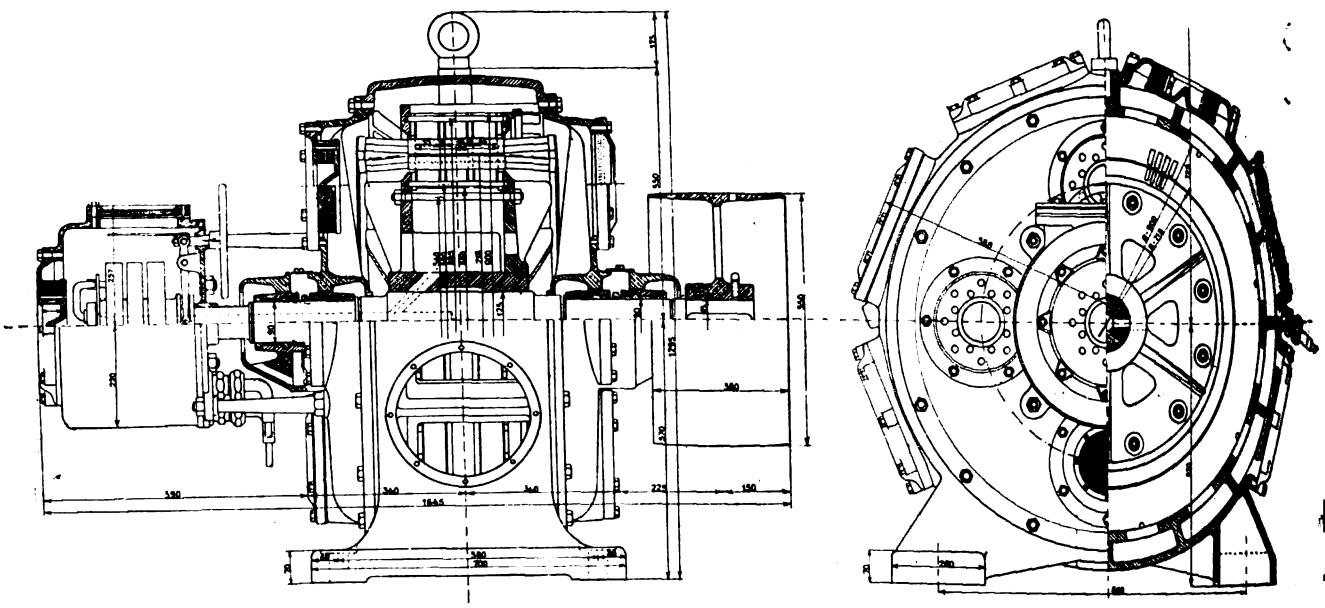
The following data relating to gauze enclosing covers have been derived from the results of tests made with motors in different explosive mixtures of gas. The gauze should be composed of phosphor-bronze wire, about No. 30 standard wire gauge with about 30 meshes per inch. It should on no account be soldered when being made up into covers for attaching to the motor, but secured in place by screwing to perfectly flat machined facings round the apertures, and reinforced round the edges by a sheet metal supporting rim or washer. For protection against external damage it is essential that a stout perforated iron cover should be placed over it, but at a sufficient distance away from the gauze so as not to hinder the ingress and egress of the air. To give a requisite amount of ventilation there should be from 1½ sq. ft. to 2 sq. ft. of gauze surface to every cubic foot of volume inside the motor. As a safeguard against breakage it is advisable that each opening should have at least two layers of gauze. The openings should be numerous and small, as these give better protection against after burning than a few large ones. A fan attached to the armature improves the ventilation considerably by keeping the air inside the motor in motion, but it is detrimental in case of an explosion, as it tends to increase the effect.

Even with the foregoing precautions it is only possible to put any dependence upon the protection thus afforded while the machine is quite new, with every part of it perfectly clean and in good working order.

If, on the other hand, the gauze and the working parts of the motor are allowed to become silted up with dust and oil, the flame-proof properties are no longer the same, and, under certain conditions, such a motor may really be a source of danger.

Owing to the unreliability of gauze as a protection, laminated plate covers or guards have also been adopted.

The latter forms of flame-proof motors have emanated from Germany, where considerable care has been expended in the attempt to get out a realy reliable design. Such a motor is illustrated in the second edition of the "Handbuch der Elektrotechnik," Bd. IX., by Niethammer, from which the following description is taken. The motor was manufactured by the V.E.G. (Vienna), and was put through a series of severe tests at Gelsenkirchen to try its effectiveness when protected alternately with gauze and laminated plate covers. The motor is of the ventilated type and wound for three-phase alternating current. It is provided with slip-rings and short-circuiting device, but not brush lifting. Sections of this machine are shown in Figs. 5 and 6, from which it will be seen that six holes are provided round the periphery of the shell and four holes in each of the two bearing shields for obtaining the necessary ventilation. All the other passages leading from the outside to the inside of the case—viz., the three openings where the cable leads enter and the two where the shaft passes through the bearings—are sealed up. The ventilation holes, both in the shell and bearing shields, have a machined face surrounding them to which the flame-proof covers are screwed. The covers consisting of gauze protection which gave satisfactory results on test are constructed as follows: Three layers of fine bronze wire gauze, 144 meshes to the square centimetre, and made with 0·35 mm. wire, are built up alternately with four separating washers about 5 mm. thick, thus ensuring a space between each layer



FIGS. 5 AND 6.—SECTIONS OF V.E.G. FLAME-PROOF MOTOR.

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5 mm. On top of this, to protect from external damage, a strong perforated plate, dished to leave a space between itself and the gauze, is placed; the cover thus formed is then riveted together and drilled for the fixing screws. The laminated plate covers are constructed with bronze plates 0·5 mm. thick, the centre portion of which has been stamped out, leaving a washer with a radial breadth of 50 mm. These are built up into packets consisting of 50 plates each for use on the shell openings, and 40 plates each in the case of those on the bearings. Between adjacent plates in each packet separating strips are inserted to make a clearance of 0·5 mm. The packet is then clamped between two strong supporting castings, the whole being riveted together to form a complete cover. The covers are then drilled for fixing screws similar to the gauze ones, and fixed over the openings, as shown on the illustration, where both types of covers can be seen. The three cable lead holes are provided with screwed glands and packing, which grip tightly round the cable and prevent any leakage at these points. The vent holes at the bearings, which necessarily cannot be sealed up, are protected inside the motor by turning grooves in the inside edge of the bearing shroud, where it surrounds the shaft. The shroud is bored 1 mm. larger than the diameter of the shaft, thus leaving only 0·5 mm. clearance space for a flame to pass through. This clearance was found to be a perfectly safe limit. The facings where the covers are screwed on, and also those where the bearings are attached to the shell, are made of ample width and truly machined, so that no possibility of flame leakage will occur at these points. Thus the only channels left are those through the specially constructed protection covers.

On again referring to the illustrations it will be seen that the slip-rings are in a cover which is separated as far as practicable from the machine, so that the effect of an explosion in either chamber cannot be transferred to the other. One passage, however, must remain; this is the hole in the shaft through which the cables pass from the rotor winding to the slip-rings. To close this, soft rubber washers are passed over the cables at the slip-ring end and squeezed together to make an air-tight joint with a cap, which is screwed on to the shaft end.

The cables from the brushes pass through glands similar to those on the motor shell, and where the cover fits round the shaft, protection is provided similar to the grooved baffles adopted on the bearings. Only one ventilator is placed in the slip-ring cover, and this is attached to the outside end. On the top a flat removable cover with a strong plate-glass window is arranged so that the working of the brushes, &c., can be inspected.

The ventilating air that passes through the motor is taken in at the bearing covers and discharged through those in the shell. It is kept in circulation inside by large fan blades attached to the rotor spider to make it as effective as possible. The area of the cover is 81 sq. cm. to every litre of air capacity inside the motor, and it is stated this was 62 per cent. more than was requisite. Although the gauze covers gave perfectly satisfactory results on test, it is claimed that the plate system is superior on account of its greater stability.

One point very noticeable about this machine is that no provision has been made to keep out moisture, consequently it would require extra protection similar to that shown on the open-type motor in Fig. 3. Another query, and a very important one, presents itself to those acquainted with mining work; that is, how long will plates only 0·5 mm. thick, and separated by a maximum distance of 0·5 mm., remain in their original state? Also, what is going to prevent coal dust from caking these crevices up solid, and so turning the motor from a ventilated into a totally enclosed type?

If gas were the only danger to provide against, then there is no doubt that this type of motor would solve the problem. Unfortunately, this is not the case, and it is very questionable whether motors of this class are suitable machines for mining purposes.

We have now practically reviewed every kind of motor put forward for mining work, and it may not be out of place to summarise briefly the general conclusions arrived at. Where there is no risk from gas explosions, then an open-type machine suitably protected against moisture and periodically cleaned to remove the dust is the best solution. Should a possibility of gas have to be guarded against, a strongly totally-enclosed motor, or, where possible, a pipe ventilated motor, should be installed. Where, however, there is a constant danger of explosions from accumulations of gas, then, a *totally* enclosed flame-proof motor actually strong enough to withstand internal explosions without bursting appears to be the only reliable form to adopt. On the other hand, if the conditions are seriously dangerous, then, of course, the question necessarily arises whether considered from all points of view it is not advisable to sacrifice the use of the electric motor altogether.

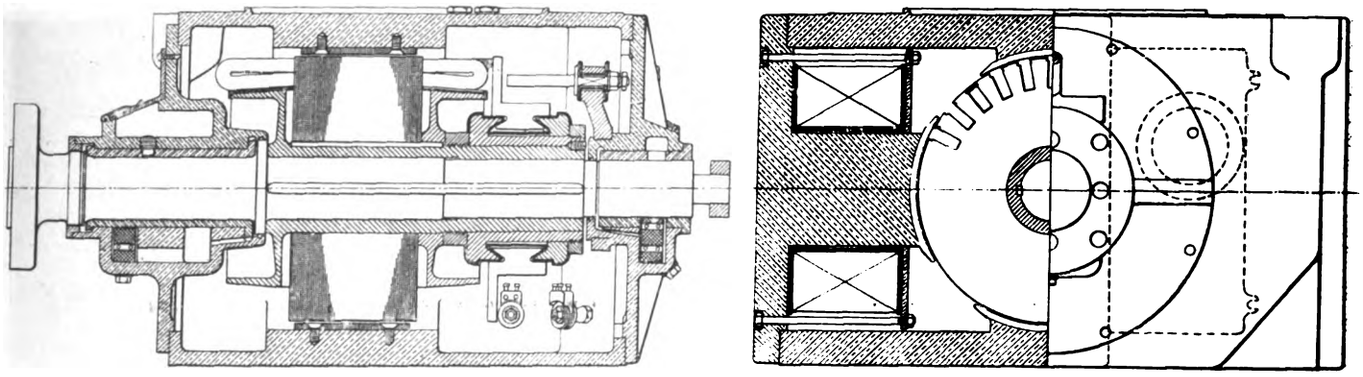

FIG. 7.—GENERAL ELECTRIC CO.'S COAL CUTTER MOTOR.

With respect to the totally enclosed motor, the writer has no experience of a case of one bursting due to an explosion of gas inside it, nor has he been able to trace any record of such an accident taking place. This, of course, may be largely due to the fact that motors are seldom installed in such dangerous positions, but, at the same time, it also confirms the reliability of this type.

With reference to the ventilated flame-proof motor it will be interesting to watch the progress of the special forms, such as the laminated plate protected type now on the market, and to see what amount of extra attention these machines require on account of the more complicated nature of their construction. In any case we may expect further developments to be made with this type of machine.

Looking at the problem as a whole, though it cannot be said all the difficulties have been overcome yet the line of progress has been such as to make us hopeful of a complete solution of the problem before engineering ingenuity is finally exhausted.

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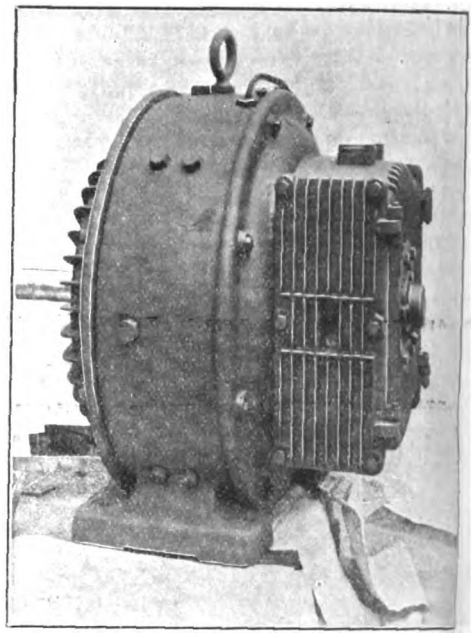

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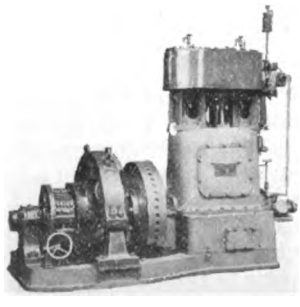

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The New Electric Mining Rules.

SOME PRACTICAL CONSIDERATIONS.

(FROM A SPECIAL CORRESPONDENT.)

Since the publication of the New Home Office Rules for Electricity in Mines, to which we devoted an editorial article on February 17th, there has been time for considering more in detail some of the technical points raised in the Report. It is especially important to see the more important directions in which the new rules differ from the old rules.

Rule 1.—The old rules, No. 4 (second paragraph), prohibited the use of high-pressure current in parts of mines in which general Rule 8 of the Coal Mines Regulations Act applies, but allowed the use of medium and low-pressure current anywhere; of course, under certain specified safeguards. The revised rules prohibit the use of current in any form "where such use would be dangerous," but allow its use at any desired pressure in properly-constructed apparatus in places where, though not usually dangerous, "open sparking" might cause risk.*

The change is one of form rather than one of substance, for if electricity were used to any extent in dangerous places in mines to-day its accident record could not be so good as it is. On the whole it may be said that the accidents which do occur are, in the main, due to badly constructed apparatus more than to insufficient supervision. The Committee state, page 7, that they "know of no place below ground in which electricity is in use to-day where both kinds of accident would not be avoided if the best present-day practice as regards construction and maintenance were complied with." In the main the effect of this new Rule should not be unduly restrictive.

Various experiments and actual experience over a series of years have shown that if proper automatic cut-out gear whether of the overload or balanced type is installed, and, provided a proper metallic sheath surrounds the cable sufficient to take care of any current due to a fault, especially on the high voltage circuits, the faulty cable is usually cut out before there is actually any open sparking. While the ordinary overload devices have been used in many cases in colliery work, extended experience in Northumberland and Durham has shown that the balanced protective gear, of the Merz-Price type, is really much more suitable for colliery work, because it is a far more certain preventive of overload sparking. The ordinary overload device cannot safely be adjusted with sufficient nicety to cut off the current in case of a fault until it has grown to two or three times the full load current; but in the case of balanced gear the device acts immediately there is a leakage of current of any kind or magnitude, and the faulty circuit is eliminated before there is any serious danger of a big arc. Possibly the best combination of metallic sheaths to ensure this result is provided by a lead sheathed and armoured cable; but the Committee seem to have thought it necessary to provide for alternative methods of construction in view of the prejudice which often, rather unreasonably, exists among some colliery electricians against lead. It is to be noted that if a lead-sheathed and armoured cable is used, protected in accordance with the requirements of the Rules, that is to say, so that the thickness of the lead sheath and armouring respectively are in accordance with the Engineering Standards Committee's recommendation, such cables fulfil the requirements called for by the Rules as to conductivity of the metallic sheath. In cases, however, where a lead sheath is not used, a double armouring may be necessary to comply with the requirements as regards conductivity, and in some cases it would seem that such armouring would have to be thicker than that called for by the Engineering Standards' Committee. It will, therefore, be cheaper in the exceptional cases where double armouring is not sufficient, to increase the thickness of the armouring rather than to provide a special return conductor. Cable makers will, no doubt, be able to give their customers information as to the maximum resistance which can be assumed for the metallic sheaths of their cables. Electricians, however, who need a really first-class job, should give special consideration to the question of lead-sheathed and armoured cables, for such cable, whatever objections may be urged against it, certainly provides a most perfect safeguard against open sparking.

Rules 2 *and* 4.—The notice forms and the notices for workmen have been extended and brought together so that each set of notices forms a separate Rule.

Rule 6 calls for the fire-proof construction of motor rooms and apparatus. Some definition of "inflammable material" is called for. This Rule has been a good deal criticised, but the evidence given before the Committee indicates its desirability.

Rule 8 is more stringent as regards the earthing of motor cases than the old Rule 1c. The requirement that earth plates shall be sunk at the surface for providing an earth connection for the casings of all in-bye apparatus by means of the metallic sheath of the cables, or failing this, by means of a special earthing cable, is new, and has been somewhat criticised on the score of expense. Here again, however, the evidence appears to show that in the opinion of the witnesses it is the only reliable means of securing a good earthing connection for motor cases, &c. The new Rules in general extend the requirements as regards earthing. The earthing of the casings of portable apparatus was not required under the old Rules, but is required for all pressures under the new Rules. One result will be a greater margin of insulation for live parts than some makers of portable apparatus have been in the habit of providing in the past. Colliery managers have been known to complain that when casings are earthed there is more trouble from faults, but it cannot be said to be a common fault.

The Memorandum which accompanies the Report is intended primarily for the information of owners and managers, but one or two of the practical points dealt with therein may be noted; more especially the remarks on the construction of motors (pages 1 and 4); the method of securing an efficient earthing system; the construction of switchgear and cables (pages 5 and 8); and the recommendations as regards the use of low-pressure for all portable apparatus (page 9.)

Pressure.—The limits of low, medium and high pressure as defined in the old Rules are undisturbed in the new ones. The use of high-pressure current is prohibited in motors under 20 H.P. in both codes of Rules, but small transformers of any pressure are allowed under the revised code. Perhaps the most novel suggestion in the Report is the reference to the use of low voltage. Here the Report touches on a development which has not by any means been universally adopted as yet, but which, with the increasing use of alternating current, seems likely to be adopted more and more in the future owing to the various advantages offered. The small wires, lamp-holders and switches used with 250 volts and higher pressures are a nuisance, while the current taken by metal filament lamps, even with voltages as low as 25, are so small as not to add materially to the cost of installation. The Committee's investigation tends to make one believe that there will be a considerable development in the near future in the construction of really suitable transformers of all capacities from one lamp capacity upwards, combined with joint boxes or sealing boxes for tapping the main cables when supplying the lighting at low voltage. In many cases such small transformers may conve-

* "Open sparking" is, we believe, a new term now first introduced, and the definition of which is of interest.

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niently be combined with a switch and possibly disconnecting links, either on the high or low-tension sides. The words "switch transformer" proposed by the Committee in their report will probably soon be a recognised term for such apparatus. Such developments should facilitate the construction also of three-phase coal cutters, for the lower the voltage the less the room then taken up by the windings, and therefore the smaller the motor. It is well known that the use of three-phase coal cutters in thin seams has hitherto been a difficulty on account of the large diameter of the three-phase motor compared with a direct-current motor. But this should not prove an insurmountable difficulty to a designer if he can get rid of commutators and high voltage.

In *Rule* 10 (switchgear) an attempt is made to get out general rules which should be complied with in the construction of apparatus used for the controlling the supply of current, but there is purposely no attempt to specify details lest developments should be hampered.

Rule 12 gives the conditions under which armoured cables should be employed, and provides that where mechanical damage is likely protection should be of a substantial nature. This is not always the case with armoured cables at the present time, nor are armoured cables, in practice, always finished off properly at the ends as is provided by sub-section F.

In *Rules* 10 *and* 12 attention is directed to the design of apparatus which can in all circumstances be depended upon to prevent open sparking, and this is dealt with in more detail on pages 5 and 8 of the Memorandum and page 11 of the Report.

While it is not an easy task to provide rules which will provide a proper safeguard to life and at the same time not be irksome to the owner, the new Rules on the whole steer a middle course. Every electrical engineer knows how much more trouble is given by small apparatus than by large, and how much more dangerous it is because of its being more delicate and more easily broken down. With this in mind the Report lays great stress on the importance of low voltages for lighting and for coal cutters, this resulting in a more substantial class of apparatus less likely to go wrong. On the other hand, when it comes to a question of large apparatus or transmission of a large amount of power, the Committee does not hesitate to advocate the use of voltages really suitable for the purpose and which are admittedly safer taking everything into consideration. On these points Mr. Trotter of the Board of Trade gave some useful evidence.

The net result of the new Rules will be to raise the standard of work expected in colliery installations, and to enhance the reputation of electricity in the pit for reliability and absence of trouble.

Public Electric Power Supply to Collieries.

BY W. B. WOODHOUSE, M.I.MIN.E.

(Of the Yorkshire Electric Power Co.)

Summary.—It is shown that a source of public supply has several advantages over a private generating station, among which may be noted the ease with which large motors can be switched on (even winding engines), owing to the large reserve of power, without affecting other plant; the colliery avoids obsolescence of station plant; the capital cost per kilowatt of plant installed in a large station is much less than in a small one, and a larger demand can be supplied per kilowatt installed than is possible in a private station, owing to diversity factor. Consequently the capital charges per unit are much reduced. In regard to generating plant, the author does not look upon exhaust steam turbines with much favour. Finally it is pointed out that there are three ways in which advantage may be taken of a public supply: (1) As the sole source of energy, (2) as a user of surplus power, and (3) as a standby.

The question whether taking a public supply is preferable to generating electricity at a colliery is one which can be answered only when all the conditions of price and circumstance are known in each individual case, but the steady growth of the use of public supply is evidence that there is a large number of cases in which conditions are favourable to purchasing electricity rather than generating it.

At the end of last year (1910) some 140 collieries in various parts of the country were making use of the public supply offered by power companies to the extent of 50,000 H.P., and the number is rapidly growing.

Incidental Advantages.—In a lengthy experience of the use of electricity in mines the writer has been impressed with the great value to a colliery of being able to meet extended demands for power readily and cheaply. It is rarely possible to predict the amount of power which may be required some years ahead, and for this reason many colliery generating stations contain a large number of small and inefficient machines. These for the first few years are very much underloaded, and afterwards, as additions come to be made, the tendency is to instal similar small machines.

One important advantage of public supply is the freedom it allows to users to start or stop large motors without affecting the remainder of the machinery.

Where the generating plant is small the starting of a large motor has a serious effect on the pressure, and sometimes on the engines; usually it can only be done by using expensive starting apparatus. This may be dispensed with where the public supply is used, and in Durham and South Wales examples of winding motors of 1,700 H.P. and 1,000 H.P. respectively are taking a supply from the public mains direct.

The use of electrical winding gears would undoubtedly have spread more rapidly but for the cost of the load equalising arrangements which are necessary; if on a large power system these may be dispensed with, the saving is very considerable, and the necessity to use steam in any form at a colliery disappears.

Obsolescence.—The development in the design of generating machinery has been very great in recent years; that of the steam turbine alone has been so rapid that early machines as compared with those of the present day are quite inefficient and expensive. Gas engine development is also making headway, and the gas turbine is confidently talked of for the future.

The result is that, as compared with electrical apparatus, generating machinery has rapidly become obsolete, and if it be remembered that even now a steam plant only converts 8 per cent. of the heat of the coal into electrical energy, the field for future improvements must be recognised as a very wide one.

As an example of the development that is taking place, a 200 H.P. non-condensing engine of a few years ago required 40 lb. of steam per kilowatt-hour; now a 5,000 kw. turbine* can be bought taking only 14·5 lb. of steam per kilowatt-hour.

On the other hand, 10 years ago cables were as well made as now, and did not differ much in price; electric motors were as efficient, though not as cheap, and the possibility of improving machines having a 90 per cent. efficiency is not great.

Convenience and security are valuable arguments in favour of a public supply, but the question of public supply versus private plant must be decided primarily on the score of cost,

* Recent tests on a 6,250 kw. turbo-alternator at Dunston Power Station, shewed a steam consumption of only 11·8 lbs. per kilowatt hour. (*See* THE ELECTRICIAN, March 10th.)

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and as the advantages above mentioned are not of fixed value they must be regarded separately.

A clear understanding of the advantages and disadvantages incidental to public power supply is necessary for one to appreciate how it is that current may be purchased more cheaply than it can be made at a colliery, and to obtain this understanding a consideration of the items which go to make up the cost of energy is necessary.

Cost of Electricity.—The cost of generating electrical energy is made up of—

1. Interest on capital expended on generating plant.
2. Depreciation allowance.
3. Cost of fuel.
4. Cost of wages.
5. Cost of oil, stores, water, &c.
6. Cost of repairs.
7. Proportion of management expenses, rent, rates, &c.

These items occur whether the supply is generated by a colliery company for their own use or by a power company;

FIG. 1A.—COLLIERY LOAD CHART.

but in the latter case an additional charge occurs, namely, the cost of distribution, which must be offset against the advantages incidental to a public supply. In the majority of cases these advantages very largely outweigh the extra cost.

Of the advantages possessed by the public supply the first is the reduced capital cost of generating machinery in large sizes as compared with small sets. Taking average figures, the cost of plant per kilowatt installed in a generating station of 600 kw. will be from 30 to 40 per cent. greater than in a station of 6,000 kw., and twice as great as in a 30,000 kw. station—that is to say, the large station gets twice the capacity of machinery for the same money.

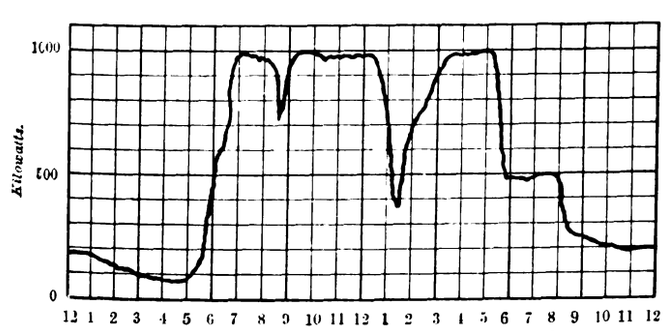

FIG. 1B.—TEXTILE FACTORY LOAD CHART.

The second advantage is the reduction in the amount of spare plant required. In every generating station security calls for one spare generator and boiler at least, whilst economy in first cost and running costs dictates that each machine shall be of as large an output as possible. Therefore in a small station two or three generating sets are usually installed, one being spare; whilst in very large stations the generating plant may be divided into, say, 10 sets without any loss of efficiency. To keep one spare set, therefore, means sacrificing half or one-third of the capacity of the small station and but one-tenth of the large station.

In addition to these advantages possessed by large stations, a power company's supply possesses another, the diversity of its customers' requirements. Each class of power user has characteristic hours of working, fluctuations of load and time of maximum load. For example, collieries, steel works, textile mills, railways and tramways, and town lighting each have different hours of use, and in each case the maximum or peak load occurs at a different hour in the day.

Fig. 1 illustrates this. The characteristic load curves of (A) a colliery, (B) a textile mill, (C) a tramway, and (D) a lighting supply, are each taken as having a maximum demand of 1,000 kw. By the combination of these loads and other industrial loads on one generating station the full benefit of diversity is obtained. In practice it is found that maximum load on a central power station is between one-half and two-thirds of the individual power users' loads added together, the station load is steadier, and its working is more efficient.

Centralisation, then, reduces the proportion of spare plant required for security, and supplies with the same machinery a greater load, and these advantages increase as the power station becomes larger. In the cases considered above, whilst

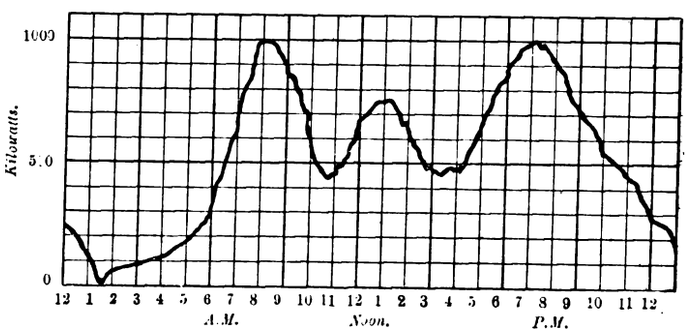

FIG. 1C.—TRACTION LOAD CHART.

the 600 kw. station must keep at least one-third of the machinery spare, the 30,000 kw. station, with one-tenth spare, has a greater margin of safety, as each of the remaining generators is capable of dealing with small overloads sufficient to maintain the full output with one set idle.

Allowing a 10 per cent. overload capacity in each case, and taking the diversity of the load on the large station as being such that the station maximum load is two-thirds of the sum of the consumers' loads (a conservative figure), we have (in the Table below) a comparison of the loads which may be dealt with by each station.

That is to say, for every 100 kw. installed, a demand for

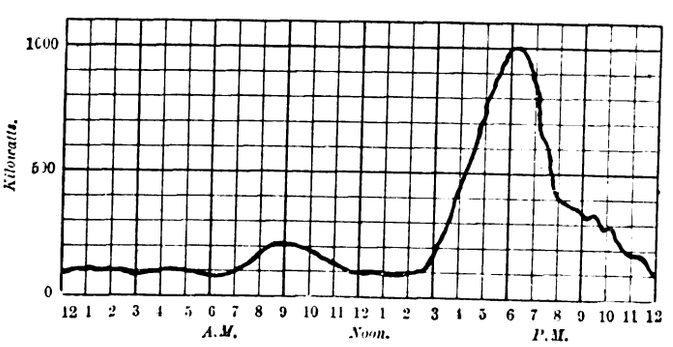

FIG. 1D.—LIGHTING LOAD CHART.

power of 73 kw. can be met by the small station and a demand of 148 by the large station. The proportional cost per kilowatt installed in the two cases may be taken as two to one, and therefore the cost per kilowatt of *demand* for power, which is

Table.

Plant installed. Kw.	Safe load on station. Kw.	Spare plant. Kw.	Sum of consumers' loads. Kw.
600	440	200	440
36,000	29,700	3,000	44,500

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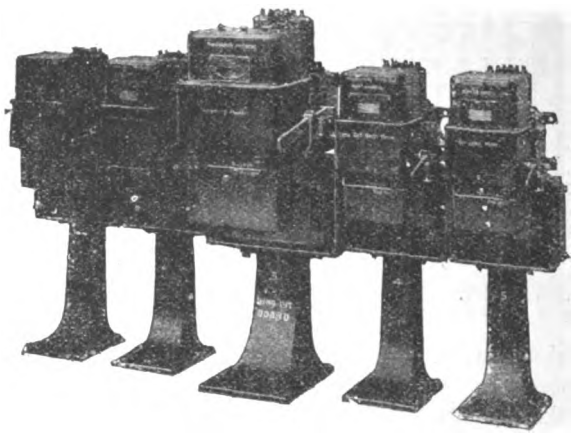

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the figure that determines the cost of supply, becomes four to one.

Or, briefly, the central power station possesses three advantages bearing on capital cost :—

1. Large machines are proportionately cheaper.
2. The spare plant necessary for security is a smaller proportion of the whole.
3. The diversity of demand from power users allows a larger supply to be given than if dealt with by separate stations.

The net result is that a central power station can supply a given load with only one-fourth of the capital expenditure that would be necessary on individual stations.

The rapid obsolescence of generating plant has been mentioned, and the necessity to provide for this must be taken into account in both large and small stations ; but the power company, due to the advantages above mentioned, only has to consider the scrapping of machinery, costing one-quarter of the corresponding machinery in a small station, to take advantage of whatever developments in generating machinery may take place.

Of the running costs that of coal is the most important

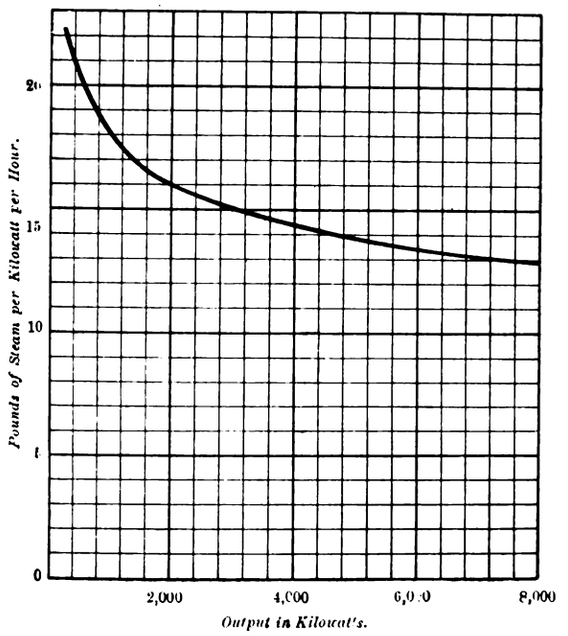

FIG. 2.—FULL LOAD STEAM CONSUMPTION FOR VARIOUS SIZE TURBINE SETS.

individual item ; but undue importance must not be attached to it, as it rarely exceeds one-third of the total charges. This should be borne in mind in considering the advantages of installing new machinery, as the saving in fuel may be outweighed by the annual charges on the capital which must be spent.

The comparative steam consumption of steam turbines of different sizes is shown in Fig. 2. The advantages of large machines are counterbalanced to a greater or lesser extent by the fact that the colliery company have no carriage to pay on the coal they use ; though, of course, its value must be taken as its selling price at the pit, and not at its bare cost.

The amount of coal used to produce a unit of electricity depends on the steam consumption of the engines or turbines ; but a comparison made on the basis of those given in Fig. 2, which compares steam consumptions at full load, would be unreliable unless the very important effect of the steadiness of the load were taken into account.

For every hour a boiler is under steam or an engine is running there is a certain amount of heat energy required to meet the internal losses, quite independent of the load on the machine. That is to say, the amount of coal or steam used per hour may be divided into two parts, one constant, the other varying in strict proportion to the load.

For example, Fig. 3 shows the total steam consumption of a 200 H.P. engine at various loads. A line drawn through the points of full load, half load, &c., cuts the ordinate corresponding to no load at a figure equal to 38 per cent. of the full load consumption. This is the fixed proportion of steam consumption, and it is obvious that if the engine is running on an unsteady load this consumption is a larger part of the total than if the load were steady at full load.

The diversity of demand which occurs in a public supply, in consequence of the reduced maximum load which it brings about, causes the load on the station to be steadier than the individual loads (*see* Figs. 1 and 2), with the result that the coal consumption per unit is decreased.

The value of this extra steadiness of load is very considerable. As a typical example, the coal consumption per unit was taken in a generating station when supplying a variable load, such that the load factor was 22 per cent., and was found to be 5 lb. per unit. By altering the load so that the steadiness was increased to make the load factor 44 per cent. the total number of units generated was doubled with an increase of only 40 per cent. of the coal consumption.

Test figures of coal and steam consumption are, for the reasons indicated above, likely to be an unreliable forecast of actual conditions, and from the writer's experience such figures are frequently doubled under working conditions.

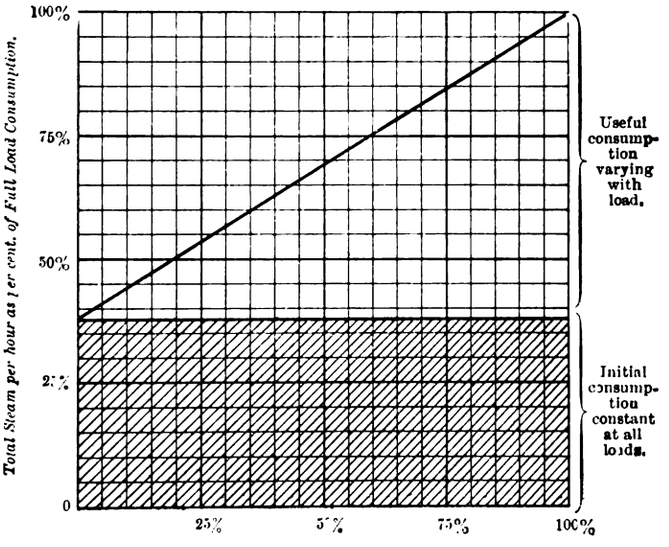

FIG. 3.—LOAD AS PER CENT. OF FULL LOAD.

On all the other items of cost the large station has an advantage over a small one. The labour required to attend to a 5,000 kw. turbine is no greater than that for a 500 kw. machine, and the cost of labour per unit becomes a very small item in a large station. More skilful and continuous attention can also be given to the working of the station without any serious increase of cost.

Exhaust Turbines.—In the last few years much has been heard of the value of the exhaust steam turbine, and wonderful figures of cost have been produced by the simple artifice of neglecting capital charges and the cost of steam, it being argued in defence of the latter omission that as steam is being used which would otherwise go to waste its cost is nothing. This argument, if carried to a logical conclusion, might be made to show that the more wasteful in steam was the winding engine the more power would be obtained for nothing.

It is hardly necessary to say that the exhaust steam turbine, at the best, is an expedient which in many cases would not be adopted if a full consideration had been given to economies in the use of steam in the first instance. The fact that mixed-pressure turbines are now being more generally installed points to an obvious disadvantage of the exhaust steam turbine ; but it has a greater one in its great dependence on a good vacuum for efficiency. An exhaust steam turbine takes practically

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twice as much steam per unit generated as a high-pressure live steam turbine of the same output.

In the latter case, a difference in vacuum from 28 in. to 23 in. will require an increased steam consumption of 30 per cent. per unit; in the exhaust steam turbine the increase is 50 per cent. That is to say, if the vacuum is good the steam consumption is twice that of a live steam turbine, but on a low vacuum, such as is frequently met with, the steam consumption is three times as great. Where the load is variable matters are still worse. The initial steam consumption of a live steam turbine is 10 per cent., of an exhaust turbine 30 per cent. of the full load consumption; therefore, unless the exhaust turbine is being used to its full output, the utilisation of the steam is even more wastefully carried out than is shown above.

The supply of suitable water for boiler purposes is a serious difficulty at many pits, but the amount of water required for condensing purposes when turbines are used introduces an additional difficulty. Condensing water to the amount of 50 times the turbine's steam consumption is required if a good vacuum is to be ensured (75,000 gallons an hour for a 300 kw. machine), and in the majority of cases it becomes necessary to erect cooling towers to deal with this. Apart from the extra capital cost, the use of such towers requires pumping machinery which under average conditions will absorb 10 per cent. of the

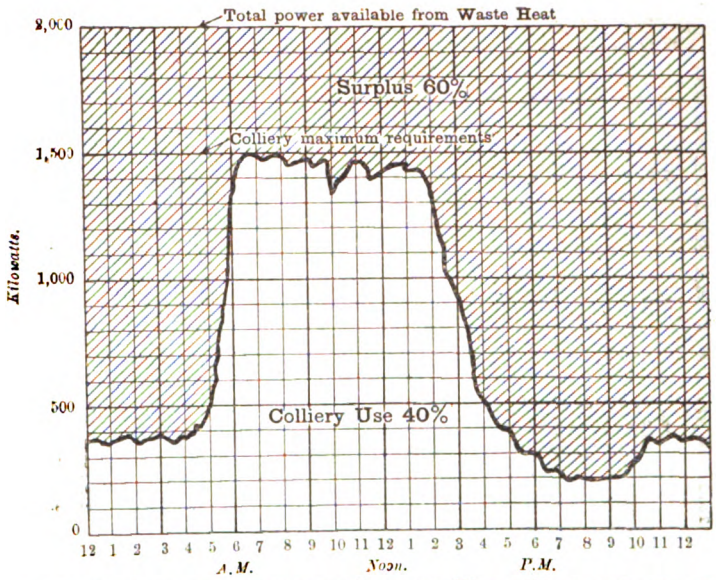

FIG. 4.—SURPLUS POWER FROM COLLIERY WASTE HEAT AVAILABLE BY CO-OPERATION WITH POWER COMPANY.

output of the turbine. The cost and maintenance of auxiliary machinery in connection with exhaust steam turbines are serious drawbacks.

There are, however, some cases in which exhaust steam is available to a sufficient amount to justify its use, but full benefit can only be taken if the use is continuous and steady, and colliery conditions rarely permit this. In such cases, and in those mentioned below, co-operation with a power company offers a satisfactory solution.

Co-operation.—The important effect steadiness of load has on working costs has been mentioned above, and the reasons why the load is steadier on the large supply have been indicated.

The "load factor" (or the proportion the current actually generated in a given time bears to the amount which would have been generated at continuous full load in the same time) of a colliery supply varies very considerably, depending on the use to which the current is put; if current is used for all purposes, including winding, the load factor rarely exceeds 25 per cent. A public power supply station can depend on a load factor of 50 per cent., and the result is a great increase in economy. An increase in the load factor from 15 to 60 per cent. results, of course, in an output four times as great. In a typical case the writer found this increased output obtained with twice the working costs, or the cost per unit was halved, and more productive use was made of the machinery.

Advantage has been taken of this saving by co-operation between power companies and colliery owners, or iron masters, having available a supply of waste heat from engines as exhaust steam, or from coke ovens and blast furnaces as gas. Where waste heat is available continually from coke ovens it may, of course, be made use of by the colliery company to supply their own needs; but in such a case it is necessary to instal spare machinery, and not to depend on the gas to its maximum amount, on account of fluctuations which occur in the supply. The use made will vary during the day, and will be much reduced when the pit is "playing," so that a large portion of the gas is wasted.

Where such fuel is used in co-operation with the power company generating machinery is installed just sufficient to utilise the fuel to its full amount, and it is run at its full load continuously day and night, the current not required by the colliery company being delivered into the power company's mains for use by other consumers. The connection with the power company allows the stand-by to be provided at the company's principal station, and thus full use is made both of capital and fuel.

Fig. 4 illustrates this. The power obtained from the gas is represented by the height of the horizontal line, the power the colliery use by the curved line, the difference in the areas enclosed representing the amount utilised by co-operation which would otherwise have been wasted. A number of stations are in operation on this principle in conjunction with the power companies in Durham, and the results obtained have been beneficial to both parties.

Where a sufficient supply of exhaust steam is available from a winding engine the same principle may be beneficially applied, the colliery company delivering surplus power to the power company when winding is going on and receiving power from the mains at other times, as at night and week-ends. In this case, again, no spare generating plant being necessary, the colliery company's expenditure is considerably reduced.

A third and growing possibility is that of burning low-grade fuel and shale in gas producers and to recover the ammonia, the gas which is generated continuously being supplied to the power company.

To summarise, the public supply can be used in three ways:—

1. As the sole source of supply.
2. As a user of surplus power generated from some source of cheap fuel.
3. As a stand-by.

Whichever use is made of the supply, the general principle remains unaltered—that public supply, like the public supply of water or of transit facilities, is a form of co-operation in which advantage is taken of certain economic conditions to reduce cost.

This principle is often obscured by a consideration of details such as the relative efficiencies of various types of generating machinery; but it is firmly established on sound economic grounds, and the future must see an enormous extension of the use of the public supply.

Hydro-Electric Mining Plant.—The "Mining World" states that the Cleveland Cliffs Iron Co. is adopting electricity as the motive power wherever it is possible to use it in the operation of machinery at its mines on the Marquette range. Power is to be obtained hydraulically, to develop which two centrally located generating stations of large capacity have been erected and equipped, and are in commission; miles of transmission lines have been built and electrical power is conveyed to practically all of the mines operated by the big independent corporation. One of the generating plants will be at Marquette. There is a rapid fall all the way to the shore of Lake Superior, and providing the plans for water storage work out as expected, this one water-power will yield in the neighbourhood of 7,000 H.P. Later on still other streams will be harnessed in a similar manner. The leading officials of the company have devoted much time to personal investigation of water-power development both in Canada and Europe, and they have procured much valuable data.

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Power Supply from a Private Plant.

BY W. BOLTON SHAW, M.Sc., A.M.I.E.E.

(Late Electrical Engineer to the Hulton Colliery Co., Ltd.)

Summary.—After considering in a general way the advantages of a private supply as compared with supply from a power company, the author discusses the various types of plant available. Steam plant is generally preferred, and if the installation is above a certain size the steam turbine has distinct advantages. The size of units to be adopted requires careful consideration. Curves are given showing the growth of power at a particular colliery and the relation the consumption bears to the kilowatts of plant installed. Finally, figures of running costs based on actual results are given and the general working of the plant is considered from the point of view of reliability.

In arranging a scheme for the electrification of a colliery, the first point, and one of the most important, to be considered is the question of the generating plant. To the majority of collieries the choice between the alternatives of a private plant or supply from a power company is not open, because as yet no companies' mains are available to them. There are, on the other hand, a large number of collieries, particularly those in the north-eastern counties, which are within reach of a power company's supply, and in their case the relative advantages and disadvantages of supply from a private plant, as compared with a power company's system, require very careful consideration.

Generally speaking, in the case of small collieries, where the ultimate amount of electricity likely to be used is of the order of, say, half a million units per annum, the advantage probably lies with the power company's supply. The figure at which power could be obtained from most companies would be lower than that at which it could be produced by a private plant, and the reliability of the company's supply as regards continuity would in most cases be greater, although this last consideration does not usually carry quite the same weight in the case of a small plant as in that of a large one.

Where there is a probability that at some later date the plant may be considerably extended this probability should be given due consideration in deciding on the source of supply, and if the decision is in favour of the company's supply, it is advisable, if possible, to make such terms as will leave a way clear for changing over to a private plant at the time when the extensions are likely to be proceeded with, since it is quite possible that experience may point to the private supply being then the more advantageous arrangement.

For large collieries, in which an extensive installation is contemplated, with the prospect of an annual consumption of power amounting to, say, two or three million units or more, a careful comparison made between the proposals of a power company and what is possible with a well-designed private generating plant, properly installed and under proper supervision, would, the writer ventures to think, in most cases show the advantage to lie with the private plant.

The main advantage which the colliery possesses over the power company is its ability to produce power at a lower cost. This is largely due to the small commercial value of the fuel used in its boilers, and also to the fact that with the high load factor obtainable the interest and depreciation costs are low. The charge for land occupied is very small; the cost of buildings can be kept low, especially where the colliery has its own brickworks and can erect its buildings with its own staff; the power is generated where it is to be consumed, or within a short distance; and where it has to be transmitted in most cases an overhead line can be erected across the colliery company's own land. The cost of expensive underground mains is, therefore, eliminated; there are no interest charges or heavy legal and Parliamentary expenses to be added to the other items of generating costs, and the management charges are low, since the officials concerned devote only a comparatively small portion of their time to the generating plant.

The generating cost with a plant such as that referred to may be brought down to so low a figure that the difference between it and the price which would be charged by a power company will result in a saving per annum of a thousand pounds or more.

The reliability of a large private plant as regards continuity of supply can be maintained at a level probably as high as that of the mains of most power companies. There is also the possibility, in the event of anything going wrong with the generating plant, of giving some warning of it, and, by being in touch with the trouble, of being able to form a definite idea as to what steps it may be necessary to take in order to cope with the situation created.

In comparing the cost of private generation with the power company's rates account should be taken of the higher cost for the first year or two, while the load on the private plant is being developed. The power company's charge covering this period may be substantially lower, and the difference between it and the private cost must be deducted from the saving in subsequent years. As, however, the total power used during the period is relatively small, the actual difference will in a few years' time be wiped out by the later saving on the private plant. The cost at which it is possible to generate at a colliery is dealt with later.

TYPE OF PLANT.

The installation of a private generating plant having been decided on, the next point to be settled is whether direct or alternating current shall be adopted. For small plants the superiority of one system over the other is not always very definite, but depends largely on the special purposes for which power is to be used and the conditions already existing at the colliery. For large mining installations the three-phase system possesses so many advantages with regard to generating, distributing and operating, as well as safety, that its use may now be looked upon as standard practice in this country.

The type of prime mover to be adopted requires careful consideration, for on its commercial efficiency and reliability the success of the installation mainly depends. Steam plant at present practically holds the field for colliery work, although a number of gas plants have been installed, and more headway appears likely to be made in the near future with this type of plant. The principal, and practically the only, claim of any weight which can be urged in favour of the gas engine in preference to steam is its greater fuel efficiency. As, however, the coal cost for a large steam plant will usually only amount to about one-third or one-fourth of the total cost, a reduction in fuel may easily be counterbalanced by an increase in the interest and depreciation charges, owing to the greater capital expenditure, and in the wages and stores cost on account of the greater expense in operation and maintenance.

The producer and cleansing plant form a further addition to the great variety of apparatus for which the colliery engineer is already responsible, and when these are to be supplemented by a bye-product plant, with the trouble of dealing and finding a market for materials having no commercial relation to coal, it is hardly surprising that the general feeling has been against the introduction of gas plants at collieries.

Another point which places the gas engine at a disadvantage is that the higher fuel efficiency is questionable when commercially considered. Except in very large producer plants the employment of inferior coal, screen pickings and washery settlings, the fuel ordinarily burnt in colliery boilers appears to be impracticable for successful operation of the gas plant, owing to the difficulty of efficiently cleansing the gas.

Improvements in the design of producer plants which will get over this difficulty are to be looked for in the near future, and when their successful operation is assured the gas engine will no doubt stand on a better footing with regard to colliery work than it does at present.

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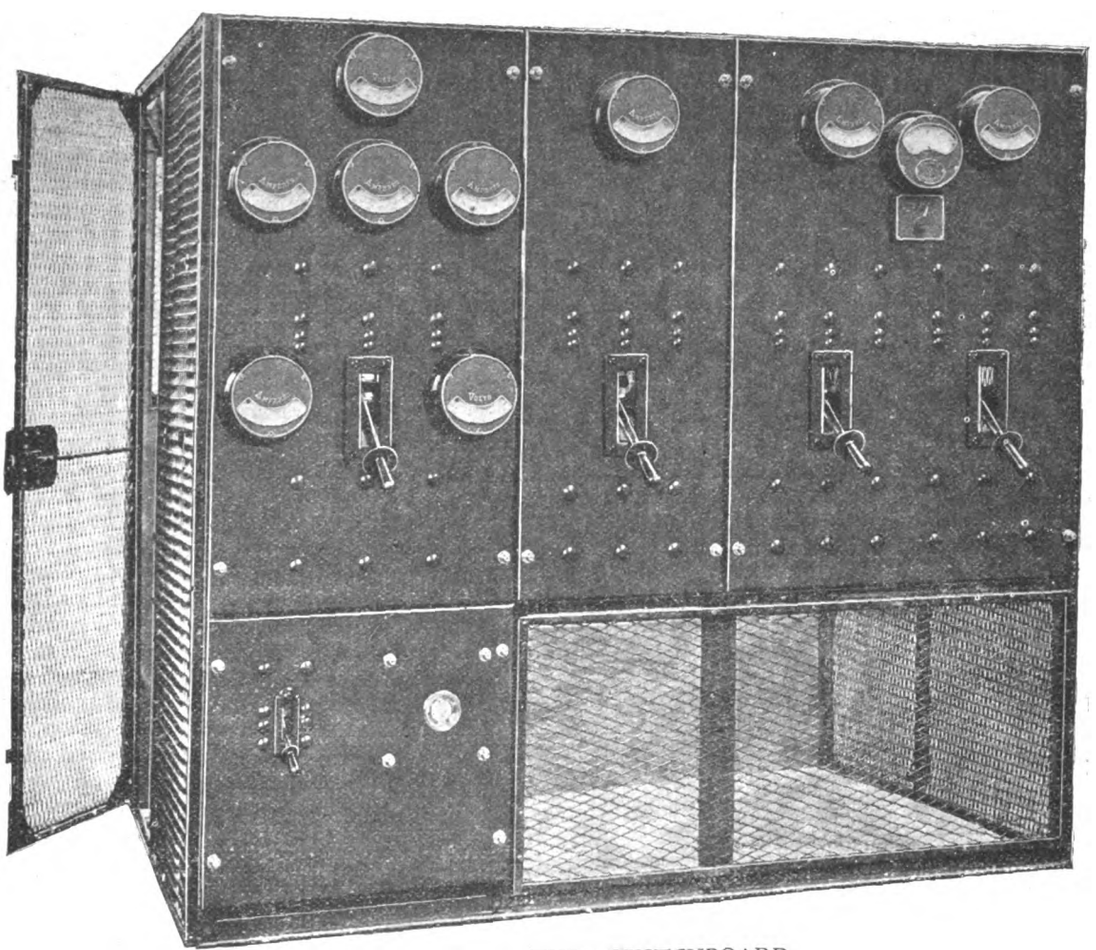

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With steam plant the choice lies between slow-speed horizontal engines, high-speed vertical engines and turbines.

For small sets, up to, say, 250 kw. capacity, the type of turbine which at present seems likely to hold its own commercially with the reciprocating engine is the single-wheel impulse turbine; but by far the greater number of small colliery sets are engine driven, the preference being about equally divided between horizontal and vertical.

There is no doubt that the horizontal slide-valve engine commends itself to the average engineer at a small colliery, because of its cheapness and simplicity, and, being of the same type as his winding and other engines, it fits in well with the general scheme of things. It can be run by almost any sort of handy man, and ordinary repairs to it can be carried out by the type of fitter accustomed only to colliery work. The fact that it will continue to run even when in serious need of overhauling is often taken advantage of to keep down the cost of repairs, and generally results in an enormous waste of steam.

A pair of 120 I.H.P. engines of this class, tested by the writer some years ago in their ordinary working condition with 80 lb. steam pressure and running non-condensing, showed a full load consumption of 60 lb. per kilowatt-hour for one engine and 69 lb. for the other. The no-load consumption was not very much less than that at half load.

The horizontal engine requires very heavy foundations and large engine room space. This space can be somewhat reduced by a reversed drive—*i.e.*, by placing the generator behind the cylinder—but such an arrangement exposes the generator to the risk of serious damage should the cylinder cover be knocked off or the cross-head or connecting rod break. Small high-class horizontal engines of the Corliss compound or Stumpf type give lower steam consumptions than high-speed engines or turbines, but the cost of engine is considerably higher. The heavy cost, large foundations and great amount of floor space required practically put them out of court for a large colliery installation. A rope or belt drive, though always objectionable, is usually adopted owing to the very much greater cost of the slow speed generator required for direct coupling.

Advantages of the Steam Turbine.

With the tendency to greater efficiency and a higher standard of engineering which is now observable at a great many of our collieries, the adoption of high-speed engines or turbines in preference to horizontal slide-valve engines is likely to become more general. The high-speed engine-driven set has the advantage of occupying, in the smaller sizes at any rate, even less floor space than the turbine, but it loses to some extent the advantage due to its small floor space by requiring greater head room than either the turbine or horizontal engine, and where provision is made for lifting, as it should be, the cost of the engine room is appreciably increased by the greater height required. The foundations are smaller than those for a horizontal engine, and the efficiency is more likely to be maintained for a longer period, one reason for this being that, owing to the high speed of reciprocation, the engine soon calls attention to any wear that has taken place in the moving parts.

For small plants the turbine does not show up to the same advantage compared with the engine as in large plants. Its cost below a certain size is higher; it is questionable whether its consumption is any better than a high-class engine, taking into account the power required for condensing and cooling; and in the present state of engineering knowledge existing at small collieries there is no doubt that the man responsible for it requires to be of a somewhat higher grade than for the reciprocating engine. It is not so much that the turbine is a more intricate machine or more difficult to understand than the engine—it is in many respects simpler; but the engine is a common object of the colliery or any other industrial works, while the turbine is as yet a long way from being so, and thus almost every man who has had any mechanical training at all is more or less familiar with the engine, while the same can be said of comparatively few men with regard to the turbine. The rapidly increasing number of turbines installed in this country is, however, bringing about a change, and the last five years have shown a remarkable spread in the general knowledge of turbine engineering.

Notwithstanding these disadvantages, there are, no doubt, many small installations having sets of, say, 150 kw. and upwards, where turbines could be shown to be the best type of prime mover taking all the conditions into consideration. For larger installations the turbine has many advantages over the engine, advantages so generally recognised that for sizes over 500 kw. it is becoming almost standard practice. From 300 kw. to 500 kw. the high-speed engine is still able to give a good account of itself; but it is probable that as confidence in the turbine grows with improved design on the part of the manufacturer and increased knowledge on the part of the colliery manager and engineer, the size of set for which engines and turbines stand on an equal footing will tend to become considerably smaller than at present.

The special features of the turbine which make it particularly suitable for colliery installations are the low capital cost of turbine and generator, as well as of engine house and foundations, low steam consumption, small wages cost for operating and small maintenance cost for stores and repairs. Against these must be set off the somewhat higher cost of condensing and cooling plant as compared with reciprocating sets.

The simplicity and reliability of the turbine when operating either singly or in parallel, its ability when once run up to take care of itself automatically, and its immunity from damage under heavy overloads tend to reduce the amount of attention necessary and so keep down the cost of engine-room wages.

The small floor space occupied makes possible a very compact lay-out of the engine room, so that the driver is always within easy access of any set. Added to this, the small height of the machines enables him to have the whole of the plant under observation from almost any part of the engine room, so that the amount of plant which can be controlled by one driver is brought to a maximum. With turbines it is possible to have the engine room arranged on a girder and concrete floor some 12 ft. or 15 ft. above ground level, and to place the condensing plant on the floor level below. The unoccupied portion of the ground floor, which will probably amount to half or more, can be made use of as a workshop, and is in many ways a convenient arrangement, one special advantage being that the foreman or electrician-in-charge, as well as the principal workmen, being located there, the power house is always more or less under supervision, and in case of anything going wrong there is someone at hand to give assistance at once if required. Where the power house is run by a single driver this is particularly advantageous.

Another feature of the turbine, and one of particular importance in colliery work, is its ability to make use of exhaust steam and to run on live steam when no exhaust steam is available. Roughly speaking, the amount of steam exhausted from the winding engines of a group of pits is generally sufficient to generate enough electricity for the complete electrification of all machinery above and below ground except the winding engines at that group of pits. By installing mixed-pressure turbines a large amount of fuel can be saved during working hours, but it should be kept in mind in estimating the effect on the generating costs that against the saving in fuel must be set the increased capital charges on the accumulator, low-pressure steam piping, more expensive turbine and larger condensing and cooling plant, these latter also requiring more power for pumping.

There is also to be taken into account the somewhat higher consumption of the mixed-pressure turbine when running on live steam as compared with what would be obtained with an ordinary high-pressure turbine, and a still more important consideration is the increased steam consumption of the winding engines which may result from the back pressure put on them by the friction of the exhaust pipe line and head of water in the accumulator, added to the working pressure of the accumulator itself.

Size of Units.

Having decided on the type of generating set, the next point to be settled is the size of unit to be adopted. The best policy

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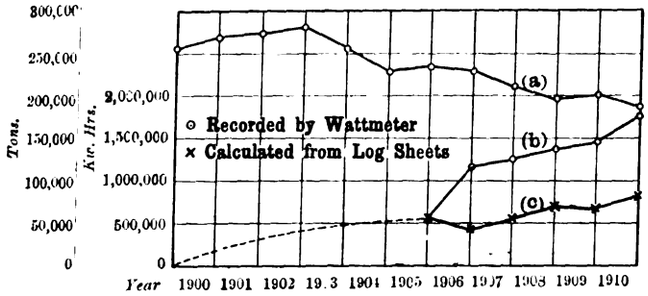
is to adopt such a size that subsequent extensions to meet increasing load requirements can be made by the addition of sets of similar size.

Special circumstances or requirements may afterwards render it advisable to depart from this scheme, but adherence to it will give uniformity in the lay-out and design of the power house and in many details of the plant, including steam and water pipe work, condenser and cooling pumps, cooling plant, switchboard panels, &c., as well as simplifying the arrangements for stand-by plant.

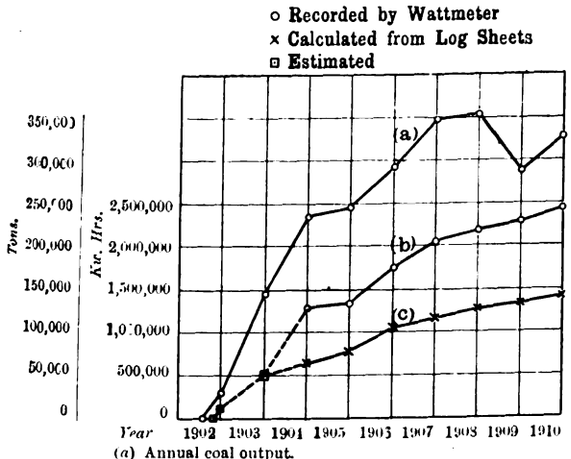
One determining factor in settling the size of units should be the provision of sufficient capacity that, from a careful con-



(*a*) Annual coal output.
(*b*) Annual electrical output including power for fans.
(*c*) Annual electrical output excluding power for fans.

FIG. 1.—ANNUAL OUTPUT, "A" PITS.

sideration of the probable rate of growth of the load, it does not appear likely that any additional unit will require to be put down within a period of less than four or five years. Otherwise the power house hardly recovers from the state of disorder produced by the extension before it is again in a state of upheaval. The size of unit should also be determined by the size of the manufacturers' standards. Special sizes can be obtained from some makers without much difficulty, but, unless there are very special reasons for not doing so, much is to be gained by keeping to the makers' standards. Some consideration should also be given to the fact that in the early years, before it becomes necessary to run the second set, the first set will have to run for a considerable portion of the time on small loads, and the steam consumption on such loads will be higher the



(*a*) Annual coal output.
(*b*) Annual electrical output including power for fans.
(*c*) Annual electrical output excluding power for fans.

FIG. 2.—ANNUAL OUTPUT, "B" PITS.

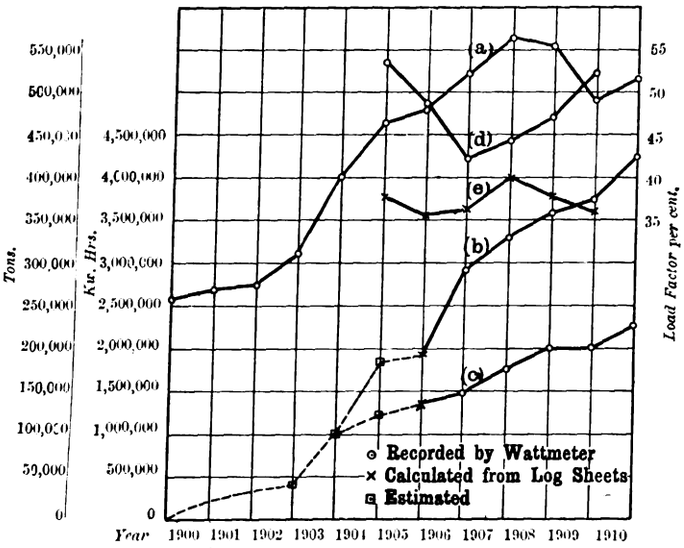
larger the set. The difference, however, between one set and the next standard size, when run on small loads, even for long periods, would be hardly appreciable in the fire hole. In addition to this, the consumption after the second set is required—*i.e.*, with loads above half-load, would be lower for the larger size of unit, and any extra fuel burnt on account of the large unit in the early years would no doubt be more than made up for afterwards.

Standby plant is, of course, an absolute necessity, and there will, therefore, always be one set in excess of the number necessary to deal with the load. Looking ahead as far as possible, say for 10 years, and estimating the size of the plant required then, a consideration of prices of different sized sets will show that there is one size, or possibly two, for which the necessary equipment, together with a spare set, will cost the least money. In making this estimate, the cost of the condensers and auxiliaries must be taken into account. Due consideration of these various factors will enable a suitable size to be decided on, which will most nearly meet all the conditions.

ESTIMATES OF POWER.

An estimate of the power requirements over a considerable period is a somewhat difficult matter to arrive at, and even for the first year or two it is quite possible for the estimate to be considerably out. The most satisfactory way of making an estimate is to obtain figures giving the annual electrical consumption of other collieries having similar installations to that proposed, and to make what deductions or additions appear necessary for obvious differences in the equipments. With so many collieries now electrically equipped it should not be difficult to obtain these figures.

The curves given in Figs. 1 and 2 show the consumption of electrical power at two groups of pits, distinguished as A and B pits, at a colliery having a large electrical installation.



(*a*) Annual coal output.
(*b*) Annual electrical output including power for fans.
(*c*) Annual electrical output excluding power for fans.
(*d*) Load factor including power for fans.
(*e*) Load factor excluding power for fans.

FIG. 3.—TOTAL ANNUAL OUTPUT, "A" AND "B" PITS.

The corresponding coal output for each group of pits is shown on the top curve (*a*). At the A pits the use of electricity dates back to the year 1900, and it will be noticed that the output of coal had then nearly reached its maximum. The electrification of these pits was only partial, and was more or less gradually developed. The B pits were, with the exception of the winding engines, completely equipped electrically from the first, and the supply commenced with the winding of coal.

At both groups of pits the ventilating fans were eventually changed over to the electrical drive, and it will be seen that a considerable portion of the power consumed was absorbed by these motors. As motor-driven fans would not be included in the electrification scheme of some collieries, and as their influence on the load is very considerable, the curves (*c*) have been drawn showing the output to the rest of the installation apart from the fans. It will be noticed with regard to curves (*c*) that both for the completely and for the partially equipped pits, the electrical output tends to reach a steady value when the coal output of the pits has passed its maximum.

Fig. 3 shows similar curves for the combined output of the two groups of pits. It should be mentioned that in 1906 the generating plant at the A pits was shut down, and the whole of the supply concentrated at the B pits. Curve (*b*) in Fig. 3 may

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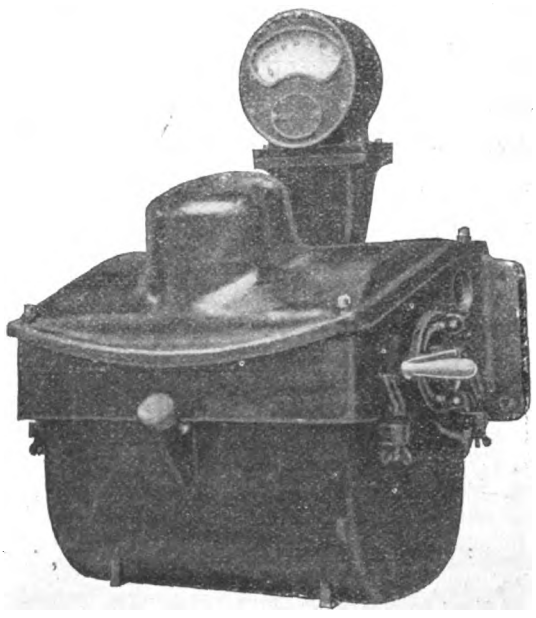

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be taken as representative of a large colliery installation, and curve (*c*) in Fig. 1 of a small one.

The growth of the load is dependent on three principal factors :—

1. The period occupied in changing over to electrical driving from steam. This may possibly amount to five years or more before the change is complete, and its progress will depend largely on the confidence of the management in proceeding with the electrification, and also on whether the state of the coal trade justifies the necessary expenditure.

2. The natural increase in the power required by the increased get of coal, if the mines are comparatively new at the time of electrification.

3. The effect of the workings getting further in. This increases the power taken for haulage, ventilation, and possibly also for pumping. With longer roads the work done in haulage per ton raised is naturally greater, and, in addition, if the seam is on the dip with the main roads level, the coal on the higher side is usually taken out first. All haulage of this coal to the main road is gravitational, and no power is therefore required except along the level. Later the coal faces on the lower side are developed, and power is required for hauling up the brows, the amount increasing with increased output from these lower faces and also with the greater length of brow as the faces are advanced down the dip.

With the opening out of more roads and districts more air is required for ventilating the mine, and as the roads lengthen out their resistance is increased, so that, as time goes on, both the quantity and water gauge of the fan are increased, and with them the demand for power to drive the fan.

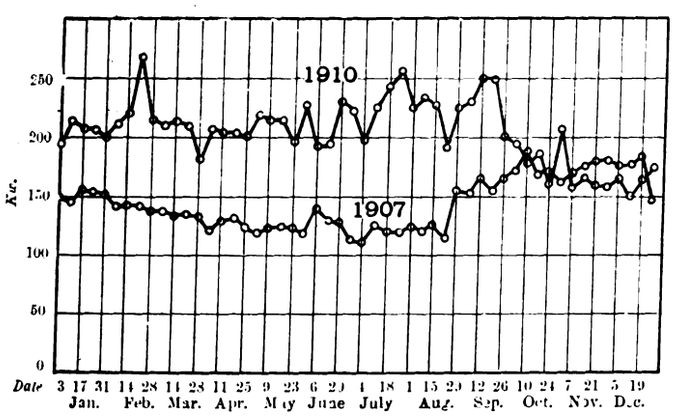

FIG. 4.—WEEKLY AVERAGE LOADS OF "A" PITS FOR YEARS 1907 AND 1910.

If much water is made in the mine the opening out of the lower faces tends to increase the quantity, or, if not to increase it, to cause it to be made at a lower point, and thus require to be pumped against a greater head, with a corresponding increase in the power taken by the pump.

As a mine passes the zenith of its working life the output of coal begins to fall off, but the workings get further in, and the net result is that the consumption of power tends to remain stationary, or even to go on slightly increasing until the mine is very near to finishing, and only then is the consumption likely to fall off seriously. In the meantime the output of coal from other mines is increased to compensate for this falling off in order to keep up the supply of coal to the market. The tendency is, therefore, for the power consumption to keep on increasing until the total coal output of the whole colliery begins seriously to fall off—that is, until the life of the colliery is coming to an end.

In estimating the amount of power likely to be required at a colliery contemplating electrification, the general tendency is to over-estimate the amount in the initial years and to under-estimate it for the later ones. The first is a fault at any rate in the right direction, but the second may result in a good deal of unnecessary expense and inconvenience, owing to sufficient allowance not having been made for subsequent extensions to buildings, boilers, pipework, cooling plant, &c.

Having arrived at an estimate covering as long a period as it is possible to forecast, the corresponding curve of average load can be obtained for each year by a process of simple arithmetic. It is necessary, however, in fixing the size of the generators to determine the maximum load to be carried, and this will depend on the load factor to be expected.

The load factor for any year is usually defined as the ratio of average load, taken over the whole year, to the maximum load on the generators at any time during the year. The term, however, is somewhat indefinite, because of the difficulty of deciding on the method of determining the maximum. A mere momentary overload can hardly be regarded as a maximum to be seriously considered, because the expectation of it would have no effect in deciding on the capacity of the plant to be run. The question then arises how long must a temporary overload persist to be seriously considered as a maximum. In the curves (*d*) and (*e*) shown in Fig. 3 the maximum is taken as the highest hourly reading recorded on the power-house log sheets. As a heavy overload coming on momentarily or for a period of a few minutes only would divert the attention of the driver from taking his readings to looking after his volts, such an overload would not be recorded amongst the ordinary readings. It may be taken, therefore, that these readings are of sustained working loads, existing perhaps for a quarter or half an hour or even more, and are such as must be taken into account in determining the capacity of plant to be run.

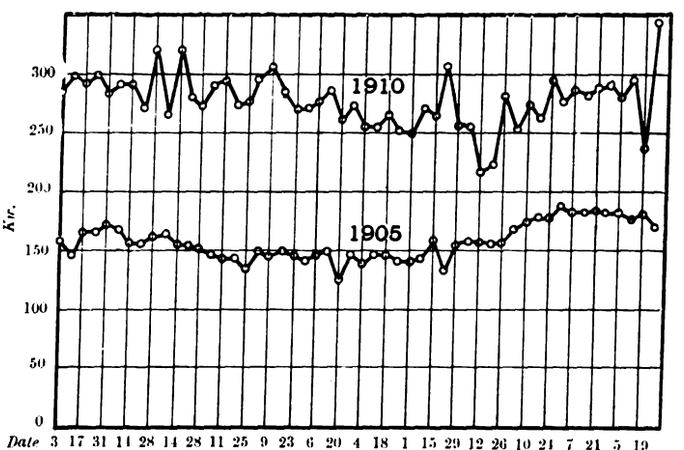

FIG. 5.—WEEKLY AVERAGE LOAD OF "B" PITS FOR 1905 AND 1910.

Curve (*d*), Fig. 3, shows the load factor for the combined load of A and B pits, with power for ventilating included; curve (*e*) shows the same with ventilation excluded. It will be seen that, as might be expected, the load factor is very considerably improved by the addition of the fan load. The somewhat large drop in (*d*) in 1906 is due to the installation of a large stand-by fan which was only run up occasionally, and thus added considerably to the maximum load without having much effect on the average load. In later years the power taken by this fan has been reduced and the period during which it is run increased, so that its effect on the load factor has gradually become less prejudicial. For large installations with electrically-driven fans or other important continuously running plant probably 40 to 60 per cent. would be safe limits within which to take the load factor, and for one without continuously running plant from 30 to 45 per cent. For small installations 25 to 35 per cent. is probably as good a figure as can be expected.

Taking curve (*b*) in Fig. 2, the output at the end of 1906—*i.e.*, after four years' working—is 1·75 million units, giving an average load of 200 kw. Assuming a load factor of 48 per cent. (the average of curve (*d*), Fig. 3), the maximum load would be 415 kw., and for this installation the choice of generating plant would probably lie between 350 kw. and 500 kw., as the nearest standard sizes.

It may be urged that the maximum load might be taken care of by the overload capacity of the plant, but it should be borne

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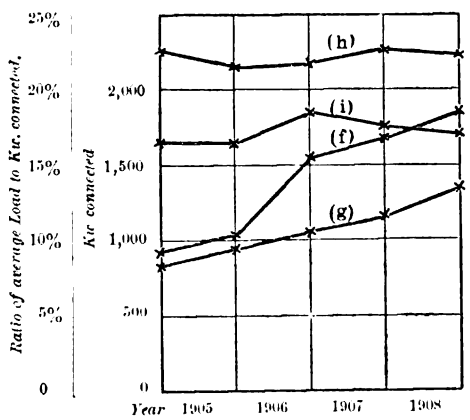
in mind that the maximum load recorded may be sustained for an hour or two, and may only be some 5 or 10 per cent. in excess of the load preceding and succeeding it for several hours. Generally speaking, it is advisable to make it a rule always to have sufficient plant running to keep the working load, under all ordinary conditions, within the rated capacity of the generators, and only take advantage of the overload capacity to deal with sudden peak loads and cases of emergency. By insisting on this rule being observed there is an avoidance of the risk entailed in the driver using his own judgment as to how long it is safe to run on any particular overload.

The maximum load may generally be expected in midwinter, when the output of coal is greatest and the lighting load is heaviest. It usually occurs in the early morning after work has got into full swing, and before the surface lights have begun to go off.

Where two day shifts are worked, under the Eight Hours Act, a second maximum may occur late on in the afternoon, after the lighting comes on again and before the workshop and other machinery which only runs one shift has gone off.

Figs. 4 and 5 give curves showing the average load plotted weekly over the whole year for pits A and B respectively. In each case two curves are given showing different years. It will be seen that the tendency of the load is to fall off somewhat in the summer months.

A method by which the probable load might be checked to some extent is by making an estimate of the total rated capacity of motors and lights likely to be connected up and taking the average load as a certain proportion of this.



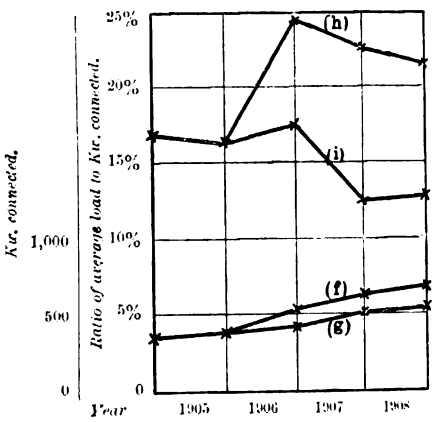
(*f*) Total connections including fan motors.
(*g*) Total connections not including fan motors.
(*h*) Ratio of average load to connections including fan motors.
(*i*) Ratio of average load to connections not including fan motors.

FIG. 6.—TOTAL CONNECTIONS AND AVERAGE LOAD "A" AND "B" PITS.

It will be seen from the curves (*f*) and (*g*) shown in Fig. 6 that the ratio between these two quantities, taken for A and B pits combined, is practically constant over a period during which the total kilowatts of motors and lights increased 100 per cent., as shown by curves (*f*) and (*g*). Without the fan motors the ratio is naturally smaller, but still remains practically constant. Including fans it averages 22·1 per cent., and excluding them 17·1 per cent. Taking the two groups of pits individually, the value of the ratio is more variable, especially for A pits. Curves of these values are shown in Figs. 7 and 8; the average, including fans, over the same five years is 20·5 per cent. and 23·1 per cent. for A and B pits respectively; and without the fans 15·3 and 18·6 per cent.

Probably a safe figure to take would be from 15 to 25 per cent., according to the size and character of the installation, the proportion of continuously running plant, if any, and whether the motors carry loads reasonably near to their rated full-load capacity. In the pits referred to, especially at the B pits, care has always been taken to avoid putting in motors with too large a margin of capacity over their working load. As showing how consistently this policy has been adhered to, it may be mentioned that the power factor on the generators has been maintained at an average of over 0·84 per cent. for the last seven years, and the lowest value obtained was 0·825 in the earlier part of that period.

For small installations and for the immediate requirements of large ones a rough estimate of the probable load to be carried by the generator may be made by taking the total load on all the motors and lights likely to be working at the same time of the day when work is at full swing and multiply this total by a "diversity factor." Where there are a large number of intermittently working motors, as, for instances, those driving haulages, screens, saw benches, coal

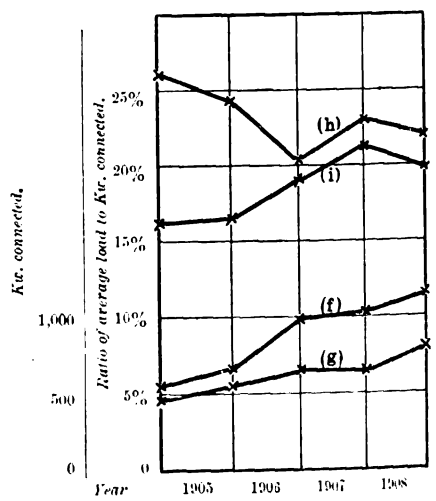


(*f*) Total connections including fan motors.
(*g*) Total connections not including fan motors.
(*h*) Ratio of average load to connections including fan motors.
(*i*) Ratio of average load to connections not including fan motors.

FIG. 7.—TOTAL CONNECTIONS AND AVERAGE LOAD. "A" PITS.

cutters, &c., the natural tendency is for the individual loads to dovetail into one another, and so give a smaller total than their sum. The value of the diversity factor will depend on the relative horse-powers of the steadily loaded motors and of those intermittently loaded. A value between 60 and 80 per cent. would probably be obtained on an average installation with, say, 20 or more motors.

It is not proposed here to go into a detailed consideration of the merits and suitability for colliery work of different types of boilers, condensing and cooling plant, switch-



(*f*) Total connections including fan motors.
(*g*) Total connections not including fan motors.
(*h*) Ratio of average load to connections including fan motors.
(*i*) Ratio of average load to connections not including fan motors.

FIG. 8.—TOTAL CONNECTIONS AND AVERAGE LOAD. "B" PITS.

boards and other items which go to make up the complete generating plant. It may, however, be said that in deciding on the type of plant to be installed, special consideration should be given to those features which make for simplicity and reliability. Preference should be given to plant which is simple in design and method of working, so that the man who operates it may not require to possess a high degree of skill or technical

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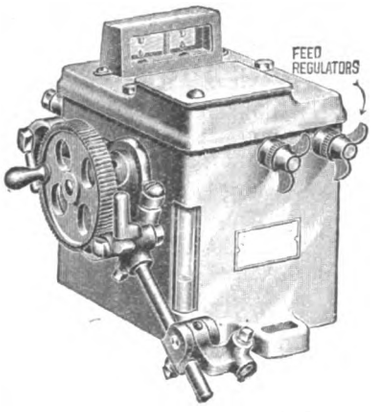

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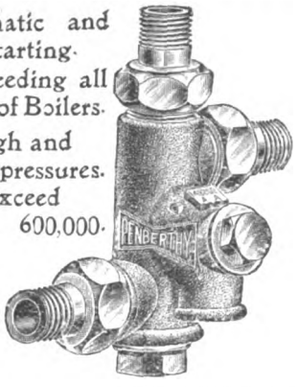

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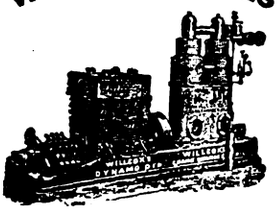

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knowledge; and, further, the plant should require as little attention as possible in the way of cleaning and overhauling. The absence of parts which wear or corrode is an important consideration.

In the general lay-out and design of the plant as a whole special attention should be given to "directness." By this is meant the avoidance of arrangements which lead to confusion and serious mistakes, and the placing of accessories and apparatus so that, as far as possible, their interconnection is obvious. The aim should always be so to lay out the plant that the man operating it is within easy reach, and with as little moving about as possible, within sight of all the levers, hand wheels, instruments, gauges, &c., which affect the operating of the machines or indicate their normal or abnormal working.

Attention to details of this sort makes for increased efficiency of the men, reduced risk of breakdowns and stoppages, and a minimum loss of time in dealing with the latter when they do occur. For simplicity's sake it is advisable to make each unit self-contained as far as possible, each set having its own exciter, steam separator, condenser and condenser pumps. The pumps for the cooling plant should also for this reason be in sets each of sufficient capacity to deal with the water from one condenser. The generator and exciter panels of each set should be so arranged relatively as to form one unit easily distinguished from the next one to it, and should be so placed and labelled that their connection with the generator to which they belong is conspicuous and unmistakable.

Cost of Generation.

The main items in the cost of generating are interest and depreciation and coal. In addition to these there are the charges for wages, stores and replaces, as well as for management, rent, rates, insurance, &c. The figures for generating costs sometimes put forward as having been obtained at collieries should be accepted with a certain amount of reserve. Unless great care is observed in keeping the costs it is extremely easy, where both labour and materials for general purposes are so plentiful, for quite considerable items to be omitted from the cost of generating and charged to the general colliery or mine costs. These items may be quite large enough to appreciably affect the generating costs if correctly charged and yet be unnoticed in the much larger general costs.

The question of capital cost also requires some consideration as to where the line is to be drawn between it and maintenance. Generally speaking, any work carried out in addition to the actual installation of the plant, if in the nature of alteration or extension with a view to improving the working of the plant or obviating some defect, should be regarded as capital expenditure, while the replacing of parts worn out by ordinary wear and tear or damaged through breakdown, as well as the work of periodically overhauling and cleaning, should be charged to those items which go to make up the maintenance cost.

Large items of what are strictly speaking repair or maintenance work, such as the re-lining or re-boring of engine cylinders, the complete re-blading of a turbine or the re-winding of an armature rendered necessary as the result of deterioration from continued service, may reasonably be charged to capital account, especially when the depreciation charges are based on a period shorter than the average life of the machinery concerned.

The question as to what rates should be charged for interest and depreciation on the capital expended on generating plant is one which could be discussed at considerable length; but the amounts now usually accepted—namely, 5 and 10 per cent. respectively—probably represent a fair figure for most collieries. Five per cent. is a small rate of interest compared with what is being earned on the capital of some collieries; but it should be borne in mind that the nominal capital of a colliery undertaking often does not represent anything like the amount of expenditure which in other concerns would be charged to capital. In the development of new mines much of the money spent in sinking, opening out and equipment may be provided by the sale of coal raised in the early period of working. It may also be objected that the figure taken for depreciation (10 per cent.) is somewhat high, having regard to the life of such plant as boilers, turbines, high-class engines, generators, switchboards, centrifugal pumps, pipe work, buildings, reservoirs, &c. The life of a colliery or group of pits should, however, be the determining factor, and 20 years is probably a fair average to take for this. When the colliery is finished the plant will have little more than scrap value, even if in good condition, and it is therefore advisable that all capital expenditure should by then be paid off by depreciation. As the capital will almost certainly continue to be expended on extensions to the plant up to, and probably beyond, the end of the first half of the colliery's life, it will be admitted that 10 per cent. is not an unreasonable figure.

The cost of coal is also a matter somewhat difficult to determine accurately owing to the indefinite commercial value of the fuel usually burnt in the boiler fire hole. At some collieries, where there is absolutely no sale for this class of fuel, its value can only be calculated by the cost of handling it on the surface and the amount of money which would be saved in underground costs if it were not brought to the surface. Under these conditions values varying from 2s. to 3s. 6d. have been estimated. On the other hand, there are collieries at which small amounts of inferior coal can actually be sold at prices possibly as high as 5s. or 6s. per ton, and at these collieries the coal burnt in the boilers would be charged at the same rate. The charging of the full market value is, however, open to some objection on the score that the placing on the market of considerable quantities of this low-grade fuel might create a demand which would affect detrimentally the prices obtained for the higher grades.

The table on p. 63 shows a series of annual generating costs extending over a period of 11 years for a large colliery with an output increasing uniformly to a maximum of 5 million units in 10 years' time. The figures are based on actual working costs obtained in connection with the central generating plant referred to above as being installed at B pits. The plant for which the table is set out is assumed to consist of turbine sets of 500 kw. capacity, of which two are put down at the outset. Ejector condensing plant is allowed for, and Lancashire boilers with economisers and small superheaters. Provision is made in the power house for ultimately installing two further sets, and these are assumed to be put down in the sixth and ninth years. Two boilers are installed at first and three others later, about the end of the sixth and ninth years. The cooling plant allowed for is a large reservoir to serve for the first two years, with subsequent provision of spray nozzles when necessitated by the greater amount of cooling required for the larger quantity of steam condensed. The main switchboard, with all distributing as well as generating panels, is included, and also all necessary accessories, pipework, &c. A 27½ vacuum with water at 75 deg. is allowed for, and also a small degree of superheat, say 50 F. The steam pressure is taken at 150 lb. and a load factor of 50 per cent. is assumed. Coal is taken at alternative prices of 5s. and 3s. per ton placed in the fire hole, and costs are given for both prices. The figures assumed for coal per kilowatt-hour follow closely those obtained in practice with the inferior classes usually burnt at collieries.

It will be seen that the interest and depreciation costs per unit are very heavy in the first few years, giving a high total figure, and the coal cost is relatively small. In the 11th year there is a very large fall in the depreciation cost, owing to the wiping out of the first instalment of capital expenditure. The average cost per unit, taken over the first 10 years, amounts to 0·418d. for coal at 5s., and to 0·366d. for coal at 3s.

The effect of the first few years in raising the general average cost is seen when the latter is compared with the cost in the second half of the 10 years.

Taking the subsequent 10 years on the assumption that the life of the colliery is 20 years, and that, as is probable, the power used will remain practically stationary, from, say, the 10th to the 15th year, and then fall away at the same rate as it has risen, it is obvious that the average cost per unit will be very con-

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Table.—*Generating Costs for Large Colliery Power Station.*

500 kw. Turbo-alternators; Ejector condensers; Lancashire boilers; Spray coolers. Load factor 50 per cent.

Year of working	First.		Second.		Third.		Fourth.		Fifth.		Sixth.		Seventh.		Eighth.		Ninth.		Tenth.		Eleventh.	
Capital expenditure up to beginning of year	£12,500		£12,500		£13,500		£13,500		£14,000		£17,500		£18,500		£19,000		£22,500		£23,500		£23,500	
Units generated	500,000		1,000,000		1,500,000		2,000,000		2,500,000		3,000,000		3,500,000		4,000,000		4,500,000		5,000,000		5,000,000	
	Total.	Per kw.-hr.	Total	Per kw.-hr.	Total.	Per kw.-hr.	Total.	Per kw.-hr.	Total.	Per kw.-hr.	Total.	Per kw.-hr.	Total.	Per kw.-hr.	Total.	Per kw.-hr.	Total.	Per kw.-hr.	Total.	Per kw.-hr.	Total.	Per kw.-hr.
Coal consumption	Tons. 1,270	Lbs. 5·7	Tons. 2,320	Lbs. 5·2	Tons. 3,350	Lbs. 5·0	Tons. 4,290	Lbs. 4·8	Tons. 5,580	Lbs. 5·0	Tons. 6,430	Lbs. 4·8	Tons. 7,500	Lbs. 4·8	Tons. 8,400	Lbs. 4·7	Tons. 9,450	Lbs. 4·7	Tons. 10,500	Lbs. 4·7	Tons. 10,500	Lbs. 4·7
Coal cost at 5s. ton	£318	0·153d.	£580	0·139d.	£837	0·134d.	£1,072	0·129d.	£1,395	0·134d.	£1,608	0·129d.	£1,875	0·129d.	£2,100	0·126d.	£2,363	0·126d.	£2,625	0·126d.	£2,625	0·126d.
Coal cost at 3s. ton	£191	0·092d.	£348	0·083d.	£502	0·088d.	£643	0·077d.	£837	0·080d.	£965	0·077d.	£1,125	0·077d.	£1,260	0·076d.	£1,420	0·076d.	£1,575	0·076d.	£1,575	0·076d.
Depreciation at 10 per cent.	£1,250	0·600d.	£1,250	0·300d.	£1,350	0·216d.	£1,350	0·162d.	£1,400	0·134d.	£1,750	0·140d.	£1,850	0·127d.	£1,900	0·114d.	£2,250	0·120d.	£2,350	0·113d.	£1,100	0·053d.
Interest at 5 per cent.	£625	0·300d.	£563	0·135d.	£550	0·088d.	£483	0·058d.	£449	0·042d.	£545	0·044d.	£508	0·035d.	£440	0·026d.	£520	0·028d.	£458	0·022d.	£340	0·016d.
Wages, stores, repairs, insurance, management, rent, rates, &c.	£600	0·288d.	£650	0·156d.	£750	0·120d.	£900	0·108d.	£1,050	0·101d.	£1,200	0·096d.	£1,325	0·091d.	£1,450	0·087d.	£1,600	0·085d.	£1,725	0·083d.	£1,725	0·083d.
Total cost with coal at 5s.	£2,793	1·34d.	£3,043	0·730d.	£3,487	0·558d.	£3,805	0·457d.	£4,285	0·411d.	£5,103	0·409d.	£5,558	0·382d.	£5,890	0·353d.	£6,733	0·359d.	£7,158	0·344d.	£5,790	0·278d.
Total cost with coal at 3s.	£2,666	1·28d.	£2,811	0·674d.	£3,152	0·504d.	£3,376	0·405d.	£3,727	0·357d.	£4,460	0·357d.	£4,808	0·330d.	£5,050	0·303d.	£5,790	0·309d.	£6,108	0·294d.	£4,740	0·228d.

Total kilowatt-hours for 10 years = 27,500,000.

Maximum annual output = 5,000,000.

Average cost for 10 years with coal at 5s. = 0·418d.

Average cost for 10 years with coal at 3s. = 0·366d.

siderably lower than in the first 10 years, seeing that additions to capital may be taken to have ceased and that the amount of depreciation will become less every few years, while the interest charge is decreasing all the time.

It will also be noticed that the coal cost as well as the maintenance cost per unit tend to become stationary, which points to the fact, apparently recognised with regard to power stations in general, that after a certain output is reached the works cost per unit cannot be further reduced. The minimum reached will be lower, and reached later, the larger the size of generating unit adopted.

It should be pointed out with regard to the costs set out in the table that these are per unit generated, and must be increased to allow for the power taken by the auxiliaries. If we assume the total power taken by all the auxiliaries to amount to 6 per cent. of the capacity of the generating sets running at any time, and the average load on a set to be 60 per cent. of full load, then the power taken by the auxiliaries will amount to 10 per cent. of the total units generated, and the costs obtained must be increased by 10 per cent.

In comparing these figures with those at which power can be obtained from a company the latter should be increased by interest and depreciation charges on the main switchboard and on the building which must be provided for it, as well as the wages charge for any attendance and inspection that may be required for the board. If a proper system of log sheets is kept hourly, as is usually the case in a power house, an attendant will be required for this work, and his wages, or the proper proportion of them, ought to be charged to the cost of power.

The very much lower costs to be obtained after the first 10 years have elapsed, owing to the large depreciation charge on the original outlay coming to an end, and the probability of a considerably larger total consumption of power in the second decade, for reasons referred to previously, should be given due weight in considering alternative schemes, as both these factors tend to produce largely enhanced saving compared with the first decade.

Reliability and General Working.

Important as the economical working of a colliery plant undoubtedly is, equal consideration should also be given to the question of reliability. By reliability is meant not only freedom from breakdown but also freedom from temporary stoppages, causing even momentary discontinuity of the supply.

If the value of the coal lost by stoppages of the haulage plant, &c., due to discontinuity of supply, be charged to the generating costs, it will not require many hours' stoppage in the course of a year to appreciably increase the latter. The loss cannot, of course, be taken as the selling value of the coal, but the difference is probably fairly accurately represented by that value after deducting the price paid to the collier and such items as commission, &c., which are a fixed rate per ton. If this nett value is taken at 5s. per ton, the loss by an hour's stoppage at a pit winding, say, 100 tons an hour would amount to £25, and if several other pits on the colliery are also affected in the same way the total monentary loss incurred will soon assume considerable proportions.

Apart from this commercial aspect of discontinuity, there is the still more important question of safety. In the case of electrically-driven fans the stoppage of the ventilation for any considerable period becomes a serious matter, particularly if it occurs during working hours, when all the men are down the mine. Even if the question of safety does not come in to any great extent, there is at any rate the detrimental effect on the general discipline and efficiency of the mine produced by frequent stoppages.

The question of reliability should therefore be given every consideration in laying out the generating plant, particularly if the installation is a large one. The features which make for reliable working, and to which special attention should be given are :—

Care and foresight in the general lay-out of the plant.
Sound quality and design of the machinery to be installed.
Good methods of working.

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Competent supervision and strict observance of proper discipline.

Personnel of the staff.

The question of the general lay-out has already been dealt with at some length, as has also that of quality and design of the machinery, so that little more need be said with regard to these points. Price and first cost are so often regarded as the determining factors, not only because it appears economical to spend as little money as possible, but probably also because, in deciding between various alternative schemes and proposals, it is a much simpler matter to consider the few figures represented by their relative costs than to go carefully into the multitude and variety of details necessary for a consideration of their respective merits from the technical and engineering point of view, this usually entailing a very considerable amount of work, and often requiring experience and knowledge of the machinery under consideration only to be obtained by calling in expert advice.

To obtain economy and reliability it is necessary that the plant should be run in a methodical and businesslike way, and it is only possible to get the very best results from it by strict and constant attention to even the smallest details.

The keeping of generating costs is of course essential, and in keeping them great care should be exercised to ensure that everything chargeable is included, so that they may be of real value as a guide to what electric power is actually costing the colliery, and not merely approximate figures for show purposes, erring, and often erring considerably, on the low side. Unless the costs are very accurately kept it is impossible to gauge by means of them the effect of small alterations or improvements on the economy of the plant.

It is, perhaps, more important than anything else for reliable running that defects in the machinery and plant should be attended to and remedied at once, or as soon as it is possible to get at them, and the necessity of being able to do so should be kept in view in considering the lay-out and design of the plant.

The generating sets should be run in regular sequence or rotation, and the period of running of each should be short. If it can be conveniently arranged, it is a good plan to change at least one machine a day. This makes cleaning at frequent intervals possible, and it also ensures that attention to details is not shelved, and possibly forgotten, by letting the faulty machine stand for an indefinite period.

The keeping of a log of the readings of all instruments and gauges in the power house, by the driver, is also an essential feature of good management. Its advantage as a record is obvious, and it also keeps the driver continually in touch with every part of his plant, so ensuring his attention being drawn to any irregularity or fault developing in the running. For a large switchboard and several sets, once an hour is usually sufficiently often for readings to be taken. If they are taken too frequently, the man has hardly got round all the readings before he must start again, so that his energy and attention become devoted mainly to reading instruments instead of to looking after the general running of his plant.

The complete overhauling of each set with its accessories should be carried out at definite intervals of, say, 12 or 18 months. After several overhauls, experience will indicate whether this period may safely be increased, or whether it is advisable to shorten it.

In the boiler house, boilers, economisers and flues should be cleaned at regular intervals, the frequency of which will depend largely upon the quality of the feed-water and the amount of ash content of the coal. Boilers worked at higher pressures require more frequent cleaning than those worked at lower pressures.

A daily record of the quality and quantity of the coal put into the bunkers should be kept. Trouble from steam getting down is nearly always due to the quality of the coal that is being burnt at the time, and the keeping of an accurate and detailed record of coal supplied, besides being necessary for the keeping of costs, also supplies the information required for arriving at what it is possible to burn in the way of fuel without running any great risk of getting the steam down. It further enables the blame to be fixed in the right quarter when there has been trouble from this source.

Proper instructions and standing orders should be in existence with regard to the supply of coal to the bunkers for the week-end as well as for non-working days and holidays, so that there is no danger of the bunkers running empty before the men responsible for filling them are back at work again.

Rules and regulations, though they may be comprehensive and well thought out, are, however, not sufficient in themselves to maintain a high standard of efficiency unless they are supplemented by careful supervision and constant watchfulness on the part of the engineer-in-charge. General slackness, untidiness and wastefulness are sure to result if proper discipline is not strictly maintained.

The question of "personnel" is one which depends to a certain extent on local conditions. The difficulty of getting hold of the right class of man in the boiler house is due to the low wage usually paid, which only attracts an inferior class of man, and to the long working hours, which result in poor firing and general inefficiency, often accompanied by intemperance and frequent "days off." A good fireman is worth his wage, and although his work does not require the same mechanical knowledge as the driver in the power house, he must be able to understand the arrangement of feed and steam pipes and valves, often by no means a simple matter. In addition to this, he has it in his power by his skill and care, or his want of them, to affect greatly the economy of the plant—far more so than the power house driver, who can only do so to a very slight degree. Generally speaking, it is better, where possible, to employ local men; that is to say, men born in the locality or who have lived in it long enough to be regarded as natives, as they are naturally more likely to settle down to their work than the man from another part of the country. The latter usually also labours under the disadvantage of being looked upon more or less as a sort of foreigner, with whom the local men are not always inclined to work quite harmoniously. This may result in misunderstandings between men taking succeeding shifts, by information of occurrences in one shift not being handed on to the man in charge of the next shift.

In the power house the difficulty is to get the right class of man, who will settle down to what becomes more or less a monotonous job, usually noisy, and in the summer time very often exhausting. Probably the best class of man for steam-driven plant is one who has had previous experience of engine driving, and, if possible, also of boiler firing. If he has also a knowledge of how to manipulate switches it is always an advantage, but otherwise he must have sufficient intelligence and interest in his work to learn how to operate the switchboard. He should be so accustomed to running machinery that in the event of anything abnormal occurring he will know how to act properly without losing his head. Too young men do not usually make good drivers; they are often in too great a hurry to act instantly when something has gone wrong without considering whether they are doing the best thing under the circumstances. They rarely seem to appreciate the fact that it is generally better to do nothing at all than do the wrong thing.

It is much the best plan to put the driver on shift in charge of both steam and electrical plant in the power house, and make him entirely responsible. Any other man required for running the plant should be his assistant, working under him.

For a turbine plant, and also for a small engine plant provided the work of opening and closing the valves is not too heavy, one driver can manage by himself so long as only one set is required to be run. If the plant is in good order there is usually no difficulty in his running up, paralleling and changing over to a second set, and the changing over can often be arranged to be done at the change of shift when the two drivers are together. When two sets have to be run in parallel there ought to be an assistant with the driver all the time the two sets are running.

Eight-hour shifts are, of course, the only really satisfactory arrangements for continuous running. In the early days when the load is light and it may be possible to shut the plant

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down regularly at the week-ends, it is sometimes feasible to work with two drivers instead of three: but even with the break at the week-ends it almost inevitably entails longer hours per week than the men ought to be expected to work. Of course, it is quite customary for winding engine men to work 12 hours every day in the week where there is only one working shift at the pit; but although during winding hours the work is trying and carries with it, part of the time, responsibility for the safety of human life, active winding only lasts about nine hours, and there is usually little work during the night time and at the week-ends.

An arrangement which may be feasible in the early days of the plant, and which is less objectionable than working with two drivers, is to have three drivers, two of whom take day and night shifts in the power house, and the third works as a handy man with the wiremen and fitters. In this way the men get a change from the power house every third week, and may learn something of electrical and mechanical work and repairs, as well as keep in touch with the arrangement of the plant to which the power house supplies power. This outside experience improves the handiness and general efficiency of the men as drivers, and the arrangement has the advantage over only two drivers that the power house can still be run with two men in case the third is off work. The time of the driver who is working outside should, of course, be charged to the job he is working on, and not to the cost of generating.

Centralisation of Power in Collieries.

BY W. E. CHAPPELL.

(Of the Staveley Coal & Iron Co., Ltd.)

Summary.—The author shows that the generation of power for supply to collieries is now being concentrated in large stations which can supply a group of pits in contradistinction to each pit having its own plant. The difference in the problems that have to be faced when direct or alternating currents, or a combination of both, are used are discussed, while in this connection the various classes of load met with in colliery working are described. To obtain satisfactory results the various requirements must be accurately judged and balanced one against the other.

The use of electricity in connection with coal mining has seen, within recent years, a remarkable expansion, and the consideration of the relative merits of the various methods of coping with the problems presented by this class of work is of considerable interest in the light of past experience and present conditions.

Colliery owners who adopt electricity as a motive power are, at the outset, confronted with the difficulty of deciding whether it is best to generate the power required for each colliery in a generating station on the site, or to generate at some central point and distribute by means of high-tension transmission to each pit, and thus obviate the necessity of having more or less responsible charge hands at the various stations by centralising the control under one head. A right decision on this point is of the greatest importance in every way to companies who have a large number of pits within a more or less circumscribed area, and the following considerations are put forward with a view to the comparison of the two methods outlined above, on theoretical as well as on the practical grounds of experience.

The object to be aimed at in the development and installation of a power scheme for colliery work is to secure the largest output with a minimum of capital expenditure and the lowest possible operating and maintenance costs of the plant per ton of coal raised.

In order to arrive at an adequate estimation of the value of one method of power generation and distribution against another it is essential that some detailed consideration should be given, not only to the total requirements of each particular pit so far as power is concerned, but also the varied character of the component parts of the total load entailed by the diversity of operations at the pit, the disposition of these loads during a working day, and the possibility, over a system of pits in the case of a centralised scheme, also of balancing the varied operations in order to secure a steady and continuous load for the generators.

In actual practice it is common to find in the electric equipments of pits, even in very circumscribed areas, that each has been provided with its own generating plant, with capacities ranging from 250 kw. to 1,000 kw., and frequently the plants are duplicated. Speaking generally, however, it may be said that the plants are usually of ample capacity plus a margin of 25 per cent.

There is here, however, indicated a certain amount of provision with regard to possible future requirements when the inevitably extended application of electrical energy has proved itself an advantage to the owners from an engineering and financial standpoint. In actual practice, however, the extension is generally so rapid that such plants are soon running under a 10 per cent. overload, or often more for 15 to 18 hours per day, a state of affairs which is reached before the company may consider itself justified in providing spare generating units. Under circumstances of this description the plant will be allowed to struggle through; and so long as it is fairly able to maintain the output there is quite a strong inducement to owners to temporise and argue about the inutility of spending money on new plant when the old will just about manage to cope with the work.

From the engineering point of view, however, this is a scarcely desirable state of affairs, and brings us to the consideration of the points in favour of a consolidation of power, bearing in mind the desiderata indicated above. For this purpose it will be well to consider: (*a*) Collieries employing direct current; (*b*) collieries employing alternating current; and (*c*) collieries employing a combination of both. The principal factor to be borne in mind is the choice of the site for the station, a choice which is not necessarily so dependent upon geographical considerations as upon the financial. The pit which winds the greatest tonnage is, however, therefore, in the writer's opinion, the most favourable location for such a station for two important reasons: The largest amount of exhaust steam available for the turbine, and the amount of slack available for use under the boilers, though it must be often borne in mind that a third factor to be taken into consideration is the amount of water available for condensing purposes. This last, however, while it may in some cases modify, does not seriously affect the general accuracy of the proposition.

Taking case (*a*), that of a company owning a number of pits within a limited area, each provided with an independent direct-current equipment:—

The concentration of direct-current plants of this character, at their respective voltages, generally 500, would apparently be prohibitive on account of the excessive cost of the transmission lines, though the writer has in mind at least one instance of such a concentration, carried out during the last six months, which is effecting a substantial saving, and this in spite of the initial cost of the line, of 400 kw. capacity, having been £2,500 per mile.

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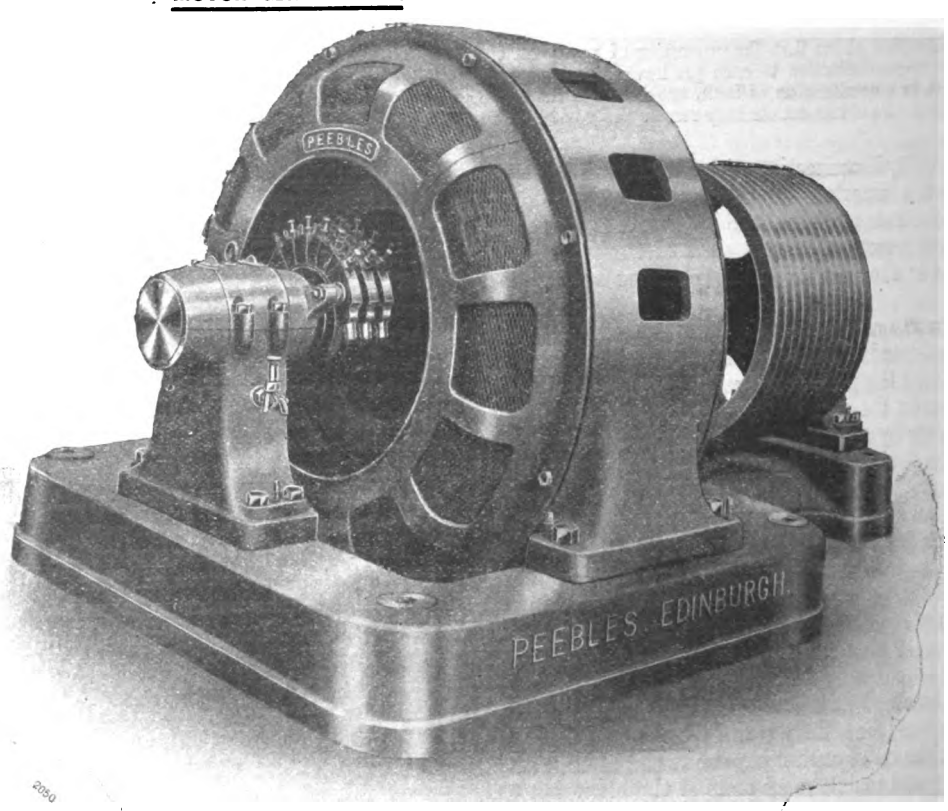

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The cheaper and more satisfactory method of connecting pits with direct-current plants is by converting to alternating current, transmitting at 6,000 to 11,000 volts, converting again to continuous current at the receiving end by means of rotary converters. Such a system, moreover, would give the option of taking alternating current down the mine for haulage and other purposes, while confining the application of continuous current to the surface plant. The overall efficiency of such a transmission scheme, using 500 kw. rotaries and transmitting at 6,600 volts, is 78 or 79 per cent. A comparison of the cost of the transmission of 400 kw. a distance of 2 miles yields the following figures :—

Direct Current only.—2 miles at £2,500	£5,000
Combined.—Two 400 kw. six-phase, 50 frequency converters, complete with transformers, switchgear and connections	£2,800
2 miles of transmission line at £365 per mile	£730

A cost per mile of £2,500 for direct-current transmission only, as against £1,765 for the combined scheme.

From the above costs it will be quite obvious that, for the transmission of any considerable amount of power for so short a distance as 2 miles, the alternating-current method has the advantage both in point of cost and the ease with which the voltage may be stepped either up or down and adjustments made to secure the supply of a maintained voltage at any point of application of power. With the increase of the amount of power transmitted the results will, of course, be correspondingly improved.

On the other hand, it is quite feasible to use high-voltage direct-current transmission, and at the present time there is one experimental line actually in operation in this country; but, unfortunately, no data in connection with this have yet been made public, though it is certain that all engineers would be extremely interested if the publication of the results obtained in the operation of the scheme in question were possible.

Turning now to case (*b*) :—There are a considerable number of collieries in this country which are equipped with generating plants coming under this heading, some proving highly successful, others indifferently so, whilst a small minority have proved absolute failures. The failures are attributable to various causes, the most usual of which is the practice followed by engineers of putting down their alternating-current motors of a size more than amply large enough for the service they are called upon to give. This is done under what is proved to be an erroneous impression that such a precaution is necessary for the good of the plant taken as a whole. In other words, the kilovolt-ampere rating of the generator has been reached when the power factor is actually 0·5 to 0·6. A little closer theoretical study, or even a "cut and try" method, would, however, have demonstrated that superior results could have been obtained. These conditions of affairs, however, seem to have been brought about by the endeavour on the part of colliery proprietors to limit the number of different sized motors employed. If, for instance, a load required 22 H.P., they would put in a 30 H.P. machine to do the work, whereas a 20 H.P. would have been ample, as very few manufacturers of machinery have their margin cut as fine as 10 per cent. The following table, which has been compiled from actual tests, will serve to demonstrate these facts, and, furthermore, the last column gives the remedy for overcoming the practical difficulties.

B.H.P. of motor.	Type.	Full load current.	Load on motor. amps.	Alteration.
30	SC	39·0	20	Replaced by 15 H.P. slip-ring.
75	SC	97·5	50	,, 40 H.P. squirrel cage
50	SC	65·0	20	,, 15 H.P. ,,
20	SC	26·0	14	,, 10 H.P. star delta
75	SC	97·5	30	Replaced by concentrating drive on another unloaded 75 H.P. motor and driving through a friction clutch
30	Star delta	39·0	20	Replaced by 15 H.P. squirrel cage motor
10	SC	13·0	6	Replaced by 5 H.P. squirrel cage motor
50	SR	65·0	30	Replaced by 20 H.P. star delta

In a recent case under the author's notice the power factor of the load was 0·62 under these circumstances; but by the substitution of motors of more suitable capacity and the concentration of two or more haulages on a single motor, the power factor was raised to 0·78. It may be further observed that the power factor of this particular plant would be improved by the installation of a rotary converter for lighting purposes, or a self-starting synchronous motor which should be connected to a drive which does not require the motor being started up against a heavy load, such as a centrifugal pump.

Adopting either of the above alternatives, with over-excited fields, the power factor of the system would be raised.

In order to illustrate what has actually been attainable by concentrating electrical power in a system of pits, take two pits situated 1½ miles apart, each provided with its own alternating-current generating plant.

The plant at one pit consists of two sets of 375 kw. and 150 kw. capacity respectively, the other pit having two sets of 225 kw. capacity each. In the first instance the 375 kw. set is only loaded to the extent of 80 per cent., and this only when running during the heavy shift, the 150 kw. set being used for the light load and week-end operations. By a re-arrangement of the motors, the kilovolt-ampere load on the 375 kw. set was brought down to 70 per cent. of full load, and plant No. 2 was loaded to the extent of 60 per cent.

An extende dseries of records (Figs. IA and IB) taken on the two stations and the resultant curve (FIG. IC) plotted demonstrates clearly that only very rarely did the peak loads of the two stations coincide, and by taking advantage of the overload capacity of the 375 kw. set to take care of the peaks, it has been possible to concentrate the power on plant No. 1.

To achieve the concentration in question, a high-tension transmission line was erected for 6,600 volts working pressure, and step-up transformers employed of 400/6,000 volt rating, the line being No. 3 S.W.G. hard-drawn copper with insulators suitable for 11,000 volts working pressure, these latter being used in order that, should the capacity of the line need to be increased at a future date, the only alteration required will be that of replacing the transformers.

The result of this concentration has been the complete shut down of plant No. 2 and the elimination, not only of the cost of six attendants, the reduction of generating costs per unit generated at No. 1 owing to a better load factor, but also of the transfer of control to one point instead of two.

Not only from an electrical point of view, but also from the financial, has this concentration been a complete success, the saving effected paying more than cent. per cent. on the investment, while leaving available for development work at other pits the complete plant of No. 2, consisting of generating sets, switchboards, boilers, &c. Fig. Ic shows the load on No. 1 plant after the concentration of power. This brings us to the consideration of the concentration of power for a greater number of pits, and here, again, the advantages gained are correspondingly great, even more important than the case cited above, as the consumption of steam per kilowatt decreases as well as the initial cost per kilowatt of plant installed, while the question of labour, training of staff and the maintenance of plant resolves itself into a very simple proposition. Whilst dwelling on the advantages attached to concentration such as is outlined, it must be borne in mind, as has been already indicated, that such treatment of power at collieries involves the most careful consideration, more especially in the case of each group of pits, since each group presents special difficulties which can only be effectively surmounted by a close study of the local conditions, due regard having been paid to the possible future development of the particular coal field in which they are situated.

The capacity of the plant should be determined by the disposition of the load, and by arranging to perform certain

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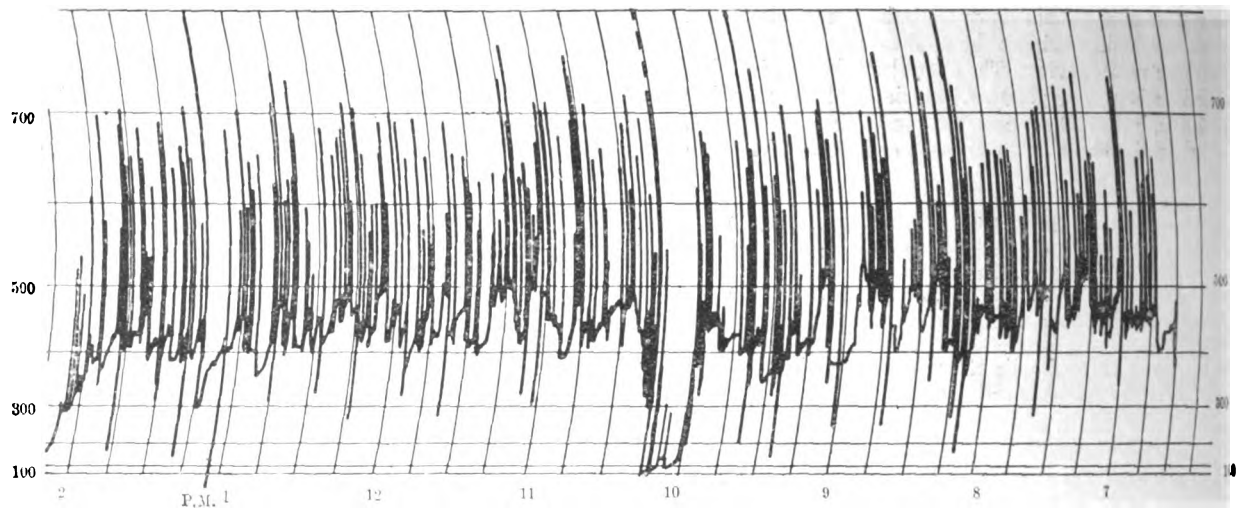
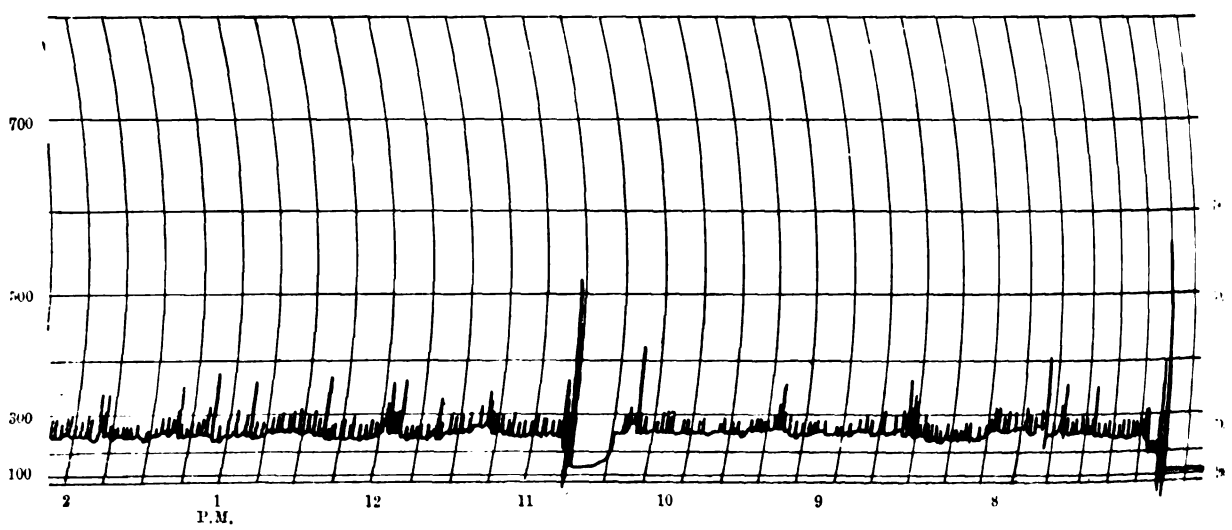
operations at certain stated hours, it is possible to have an excellent load factor and to limit the peaks. The load of a pit resolves itself into surface work—that is, screening and works

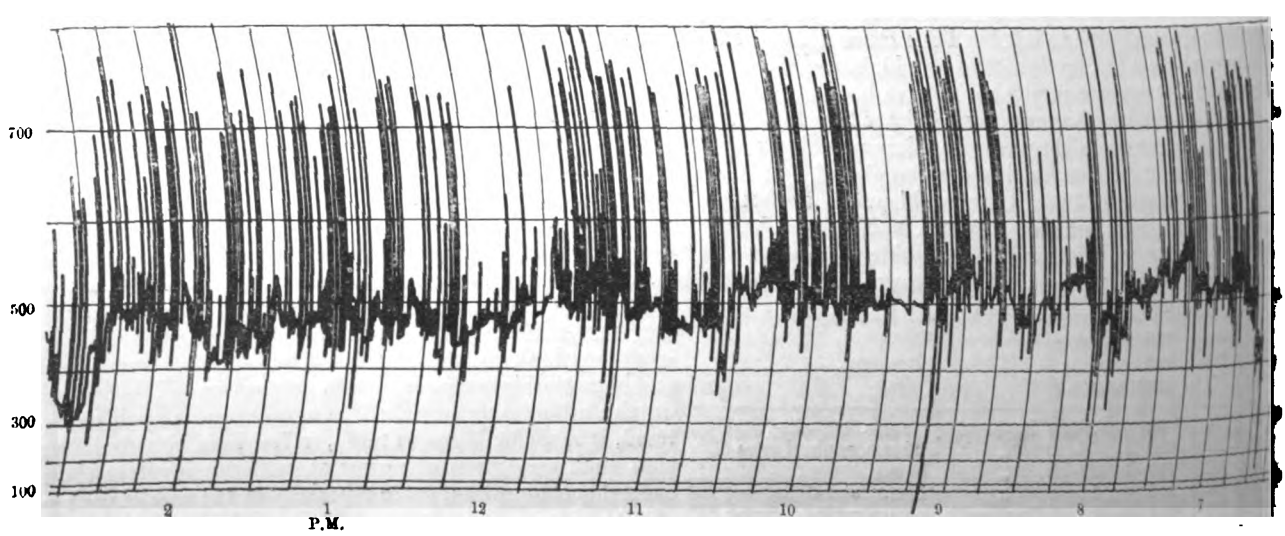
It may be taken for granted that, as a general rule, the surface work is dependent to a great extent on underground operations, the screening and washing plant motors being inopera-



CURVE 1A.—SHOWING LOAD ON PLANT NO. 1 BEFORE CONCENTRATION.



CURVE 1B.—SHOWING LOAD ON PLANT NO. 2.



CURVE 1C.—SHOWING FINAL LOAD ON PLANT NO. 1 AFTER CONCENTRATION.

driving, the last named embracing the boiler feed pumps, repair shops and saw mills; underground work—that is, haulage and coal cutting, and heavy pumping underground.

tive when the raising of coal has ceased. The surface load may therefore, be maintained for 24 hours per day in the case of three shifts, or for only two eight-hour shifts.

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The underground work being of an intermittent character, the majority of fluctuations in power are traceable to the haulage motors. As these motors are continually starting and stopping, this class of drive is decidedly detrimental to motors of the squirrel-cage type owing to the line disturbances caused in starting up. Drives such as these should be provided with explosion-proof slip-ring motors, and with the finest type of oil-immersed switchgear it is possible to purchase.

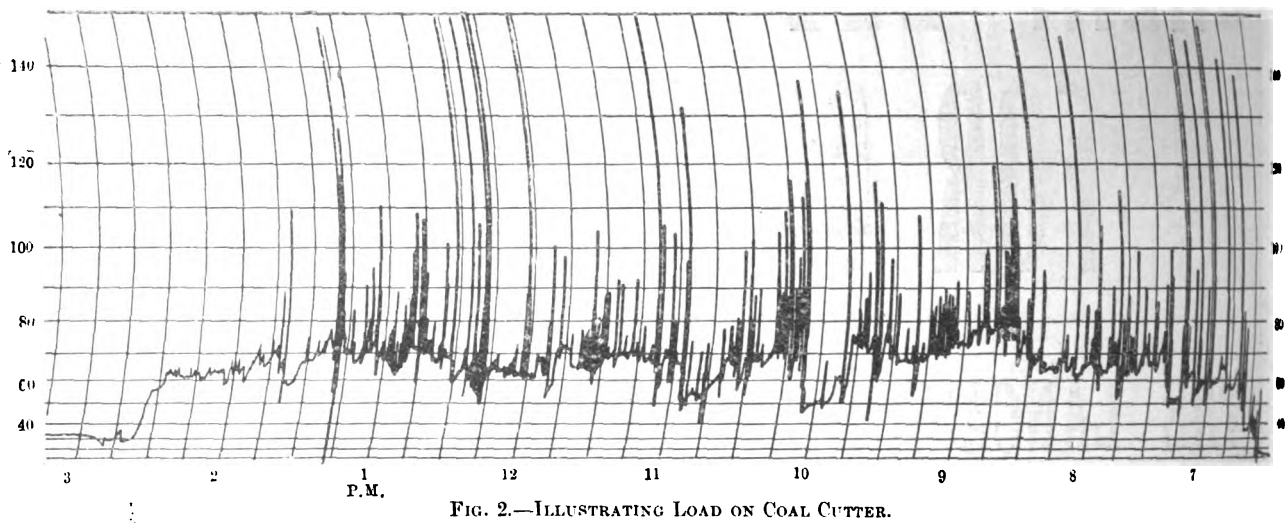

FIG. 2.—ILLUSTRATING LOAD ON COAL CUTTER.

While on the question of haulage motors and their drives, it seems almost unnecessary to add that all such machines should be provided with an efficient clutch, so that where the motor is of the slip-ring type it can be started up against any load, so that it creates the minimum of disturbance on the line, the gradual engagement of the clutch imposing the load upon the motor in a very uniform manner, so that if the load is advanced by any predetermined amount beyond the output of the motor the automatic device will efficiently protect the machine by opening the circuit. Too often haulage motors are not provided with any automatic control gear, while the fuses are worse than useless, as, owing to their constant blowing at periods of overload, the attendant will, to save himself trouble, often insert a piece of copper wire without any regard whatsoever to the blowing capacity of this improvised "fuse." It is practically impossible, except on main haulages, to determine with any accuracy the size of motor with respect to its normal load conditions, as here the personal element enters so largely into the question. At one moment the haulage may be working with perhaps only 20 tubs on the rope, while at the next the number will have been increased to double that figure or, worse still, one of the tubs may be off the rails, being dragged along, thus putting a very heavy load on the motor. There is, of course, not much remedy for contingencies of such a nature, so that in the selection of machines for haulage work it is imperative that they should be large enough not only to do the immediate work of the pit but also to cope with any future developments that can be foreseen. In other words, it may be absolutely unavoidable to put down a 75 H.P. motor for an initial load of 30 H.P., owing to the knowledge that in three or four months' time the load will have increased to 40 H.P. or perhaps more, while if the development of the mine has been rapid it may have come up to nearly full load.

Coal-cutting motors provide both a constant and intermittent load, according to the type of cutter employed, one type probably working for hour after hour without giving any trouble whatever, while others are continually starting and stopping, owing to troubles occasioned by the cutter choking and causes of an allied nature. With a coal cutter operating continuously, however, the load is in reality slightly intermittent, as the appended curve (Fig. 2) demonstrates, the motor in this case being well adapted for its work, as is seen by the fact that the most efficient point on the load curve as regards power factor is three-quarter load, and the motor in actual practice operates during the greater portion of its periods of service at 70 to 90 per cent. of its full load capacity.

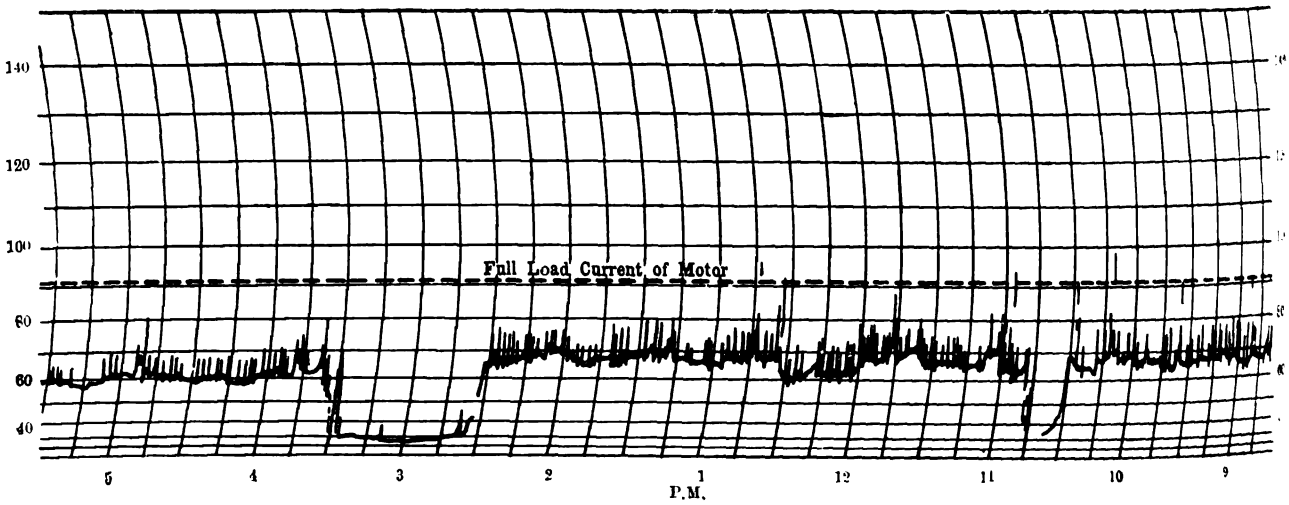

FIG. 3.—SHOWING DISPARITY BETWEEN SIZE OF MOTOR AND ACTUAL LOAD ON MOTOR.

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In coal cutting it is possible to do all the cutting on the light shift, and by so doing the load on the generating station is equalised.

With heavy pumping underground it is necessary in designing a power scheme over a system of pits—having duly in mind the centralisation of the power generation—to provide as nearly as possible a constant load on the system if the greatest advantages are to be derived. The ideal load on any system is, a short period; and, in fact, in planning a transmission scheme, this point should be kept in mind in order to provide the desired equalised load for 24 hours, as this will admit of a smaller installation, with a consequent reduction in capital expenditure, also a cheaper cost of production in consequence of the constant nature of the load on the plant.

Motors driving screening plant may, as a rule, be arranged to run constantly during the shift, although the load on some

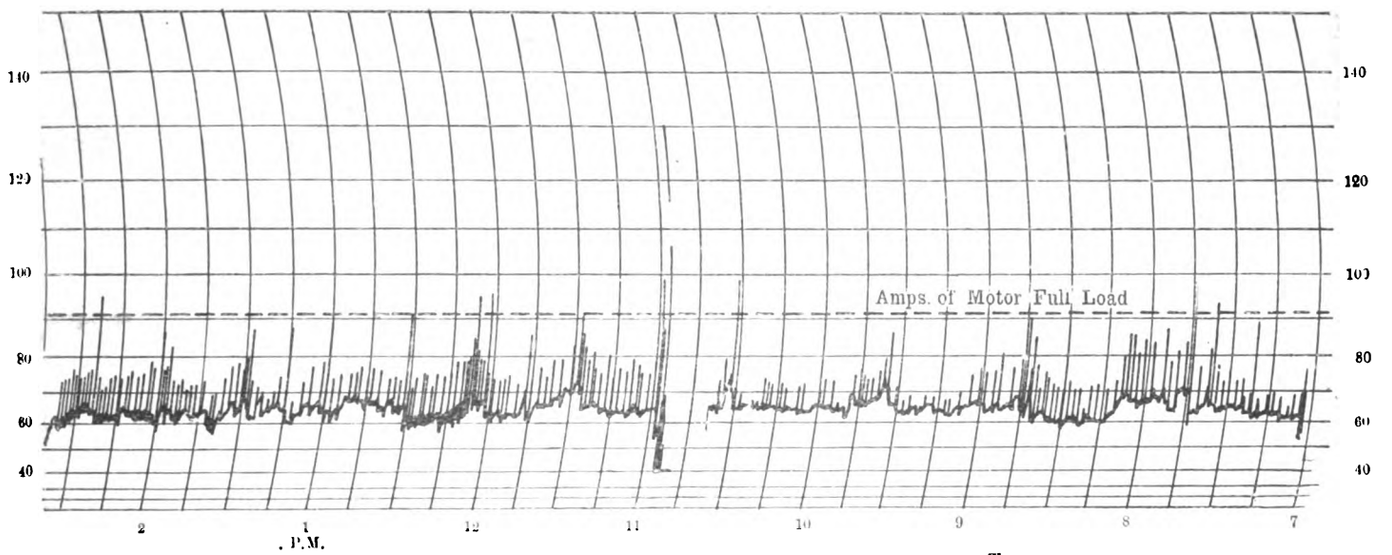

FIG. 4.—FULL-LOAD CURRENT OF MOTORS AND ACTUAL AMPERES TAKEN BY THEM.

of course, a constant load during the 24 hours, though such conditions are rarely obtained except in the case of chemical works and others of a similar nature. It is quite possible, however, in adopting a centralised scheme such as has been outlined, so to arrange the load that it will be nearly constant during the 24 hours of the day. This is especially the case if there is a certain amount of pumping work to be done in the pits.

of the motors, such as those operating the tipplers, and the chutes, will be of an extremely variable character. It is possible, however, by having these fitted with good friction clutches to operate them continuously, which method tends, furthermore, to reduce the shocks on the transmission system. On the other hand, on such motors as those employed for raising and lowering the chutes, the load being of such an intermittent nature it is advisable to instal motors with as small a

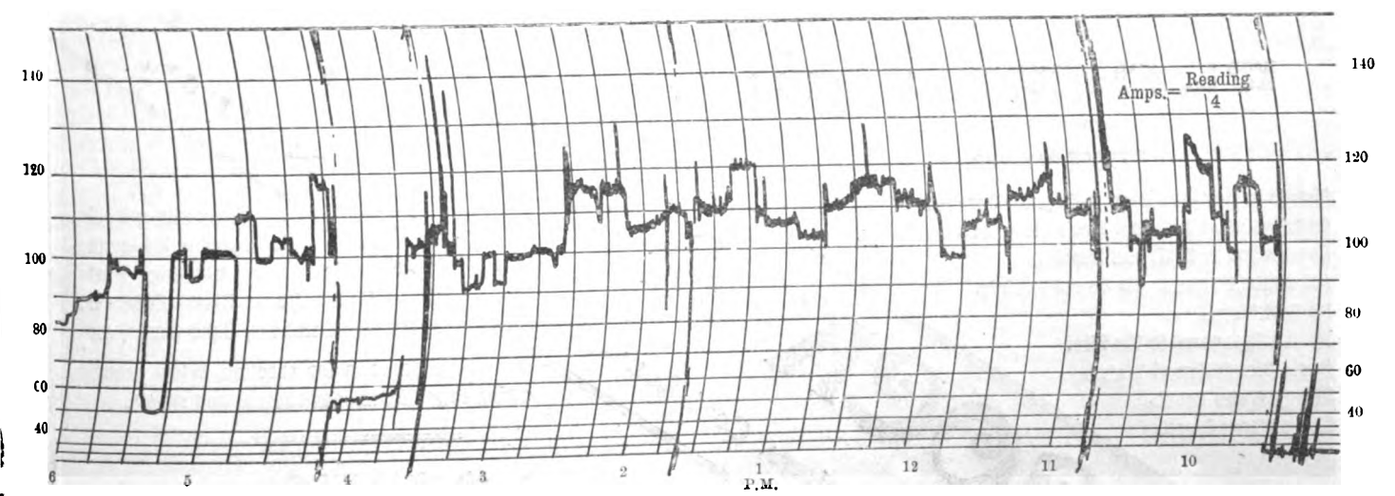

FIG. 5.—ILLUSTRATING LOAD ON ELECTRICALLY-DRIVEN FEED PUMP.

If sufficient standage is afforded for the water, it is possible to carry out the underground pumping at periods of what would ordinarily be light load, thus providing an equalisation of load on the day's work. Taking, for example, a pit accumulating water at the rate of 200 to 300 gallons per minute; by providing an adequate standage it is quite feasible to pump the water at the rate of 800 to 1,000 gallons per minute during

margin as possible and allow the overload capacity to take care of the excess load. This, in the case of alternating-current plants, is very important, as it ensures a fairly good power factor on the motors. The screening belts provide a very constant load on the motors which drive them, and this is one of those instances where, by adopting the common practice of putting down motors more than large enough for the

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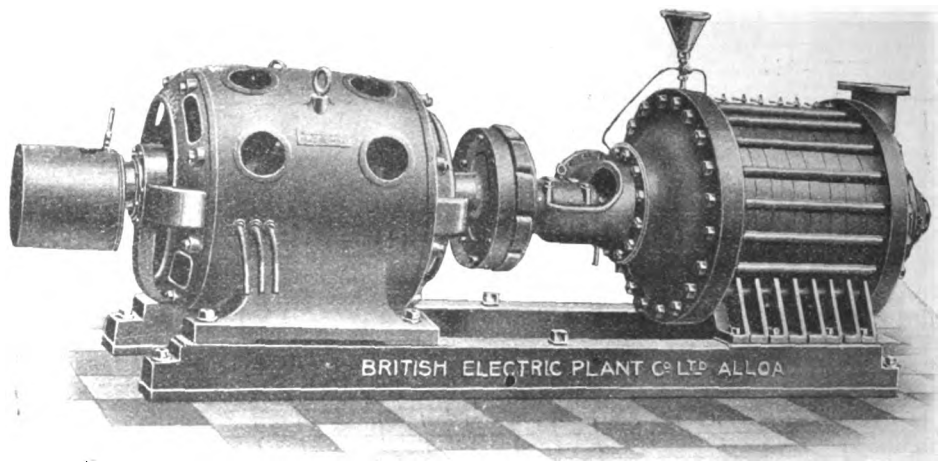

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work the power factor is likely to be considerably reduced, as the Figs. 3 and 4 will demonstrate. The dotted line drawn through the curve represents the full load of the motor, while the irregular line shows the actual load existing in practice. While on the subject of motors operating constantly, the curve (Fig. 5) illustrates the load imposed by an electrically-driven feed pump. In one such instance, by putting in a boiler feed pump well adapted for its work it has been possible to reduce the steam consumption in the colliery plant to such an extent that one boiler has been laid off, and there is, further, no doubt that the superiority of an electrically-driven over a steam-driven pump is very great.

If the ventilating fans are electrically driven, the greatest care must be exercised in choosing the motor, and such a drive is an ideal one for a synchronous self-starting motor, and confers the advantage of having on the transmission line a synchronous piece of apparatus, thus affording every opportunity for improving the power factor of the system. One prominent manufacturer has on the market to-day a self-starting synchronous motor which readily lends itself to such drives as those of centrifugal pumps and ventilating fans. This motor is started up by switching it direct on to the line, and after picking up speed, the exciter (which is usually wound for about 35 to 40 volts) is switched on to the rotating field, and by adjustments of the field strength it is possible to raise the power factor to a very good figure indeed. Ventilating fans are what might be termed "dead" load, as there is practically no fluctuation in the powers taken by them.

It is most important to have the motors driving machine tools operating at constant load, owing to the varied character of the repair operations carried out. Individual driving would tend to improve the load conditions on the plant, but in ordinary pit work it is impossible to capitalise the pit with such an expense as individual motor driving of all tools. Ninety-five per cent. of the fitting and repair shops, it would be safe to say, are driven by a single prime mover, and wherever enquiries upon this point have been made there has always been elicited the same opinion—*i.e.*, that individual motor drives have not been applied simply because of the great initial cost. The smith's fan, however, should be always independently driven.

From the foregoing brief analysis of the characteristic load of a colliery installation it will be seen that, if an intelligent view is taken of present needs and future possibilities, it is possible to connect up a number of pits in a general scheme, and to secure as a result of such a concentration lower costs per unit, because of cheaper steam production, the possibility of using larger generators, the ability to balance the various loads in the day's work, more efficient control and staff, less labour costs in a central station than in the total of individual stations, generation and transmission at high voltage and flexibility as against the waste incurred in capital expenditure on so many different stations, none of them fully loaded in the true sense of the term, but still taxed to their utmost capacity owing to excessive margins in the motors, with an intermittent and ill-adjusted load, supervised by separate staffs with their heavy labour cost.

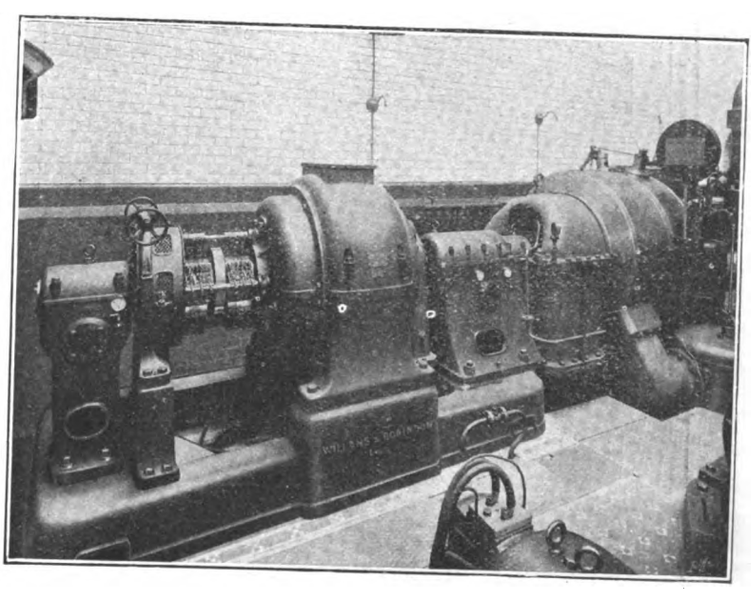
In conclusion, the writer would say that, in his opinion, the whole question of the centralisation of power generation and transmission resolves itself not so much into hard and fast rules as in taking a broad though none the less exhaustive view of the factors presented by any system of pits, accurately judging the requirements of each, the nature of the load at different periods of the day, the balancing of these requirements as far as possible one against the other, the arrangement of various operations so as to provide uniformity in load, the adjustment of the machines to the work they have to perform and the selection of the most efficient motors and control gear. Given such an appreciation of the problem presented, there is no obstacle to the creating of such a centralisation as will give the highest possible efficiency with a minimum of cost.

The advantages of such a method over that of individual plants will be and are at the present time apparent in the great annual saving effected in wages, maintenance and repair, not forgetting capital expenditure, a saving which may mean all the difference between an indifferent and a substantial dividend for the shareholders.

Finally, it may be remarked that the employment of exhaust or mixed-pressure steam turbines in connection with colliery work has given a great impetus to electrical driving, by the adoption of which drive there is no reason to doubt that substantial improvement could be effected in 90 per cent. of the colliery undertakings now operating their own plants. Given the willingness of colliery companies to meet the first outlay with regard to such a scheme and plant as has been outlined, there is no question that a careful investigation of the claims made for this method of dealing with colliery power is fully justified by actual practice and results.

Impulse Disc and Drum Mixed Pressure Turbine.

Among recent improvements in turbine design, one of the most important is the combined impulse and re-action turbine. Messrs. Willans & Robinson, of Rugby, have adopted this design as their standard for all high-pressure and mixed pressure work, and the accompanying illustration shows the plant which has been installed in the power station of the Bridlington Corporation.



300-KW. WILLANS MIXED PRESSURE TURBO-GENERATOR AT BRIDLINGTON.

The electrical generator is of the Siemens standard direct-current type, being fitted with ventilated commutator and having a normal output of 300 kw. at 440 to 500 volts, when running at a speed of 2,700 revs. per min. The full output can be obtained when the turbine is supplied with exhaust steam from the existing engines, or any mixture of exhaust and live steam. The turbine will also give its full load, 25 per cent. overload, and a non-condensing output of 250 kw., on live steam.

Although the plant has not been installed for more than a short period, very satisfactory results from the economical point of view are being obtained with the combined plant, as compared with the engine-driven sets alone. Even when running on high-pressure steam the results are much better than when the engines alone were run condensing.

Messrs. Willans & Robinson have installed a large number of similar machines which are giving equally good results. Among those working at collieries may be mentioned the mixed-pressure sets at the Blairhall Colliery, Fife; the Rothervale Collieries, near Sheffield; and the Tredegar Coal and Iron Co.'s Collieries in South Wales; also the plain exhaust set at the Pleasley Colliery, near Nottingham.

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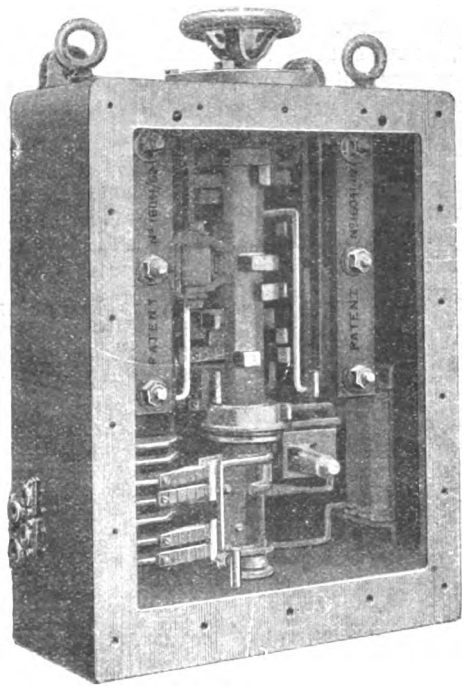

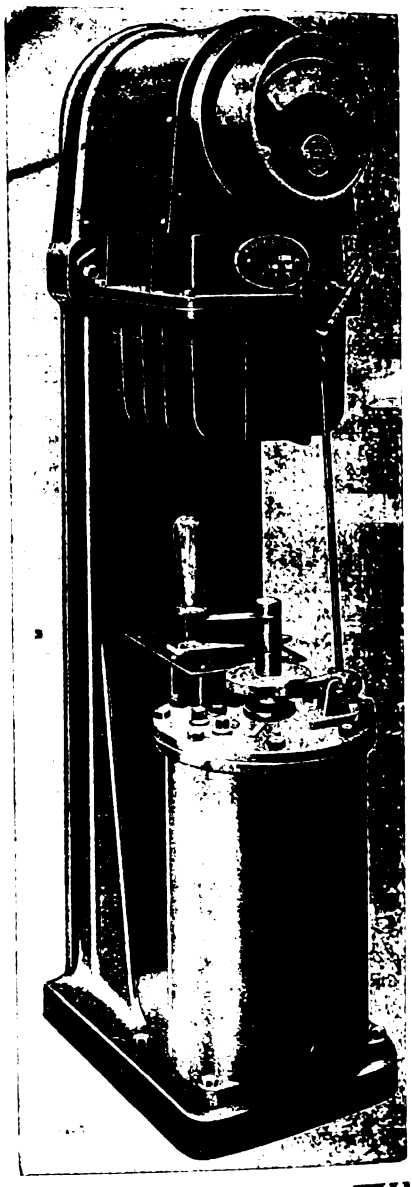

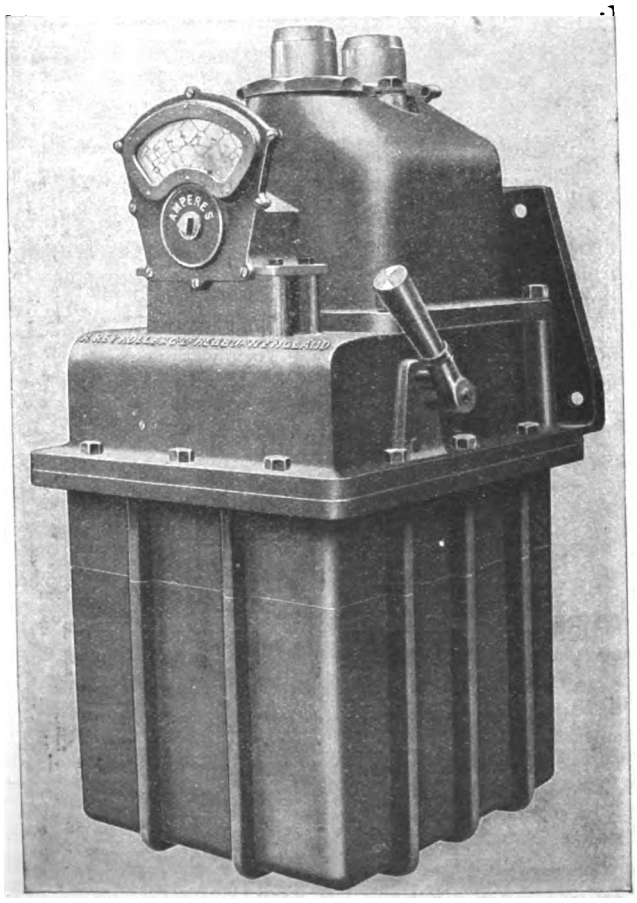

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Notes on Switchgear for Use Underground in Mines.

BY H. W. CLOTHIER, A.M.INST.C.E., A.M.I.E.E.

Summary.—After referring to the events of the last two or three years and their bearing on the design of electrical plant for mines, the author deals with "explosion-proof" gear and points out its limitations. The proper provision of cable connections is then emphasised and the combination of plant, such as switch-gear and transformers, is discussed. A pit lighting system is introduced. Continuous-current automatic switches present difficulties, if of the air break type, owing to their bulk when enclosed; on the other hand, if oil is used it carbonises, but this seems the better solution of the two. The problem of automatic protection, a "balance system," meets many cases, and warrants the special consideration of mining engineers, particularly as applied to leakage devices. Finally, a general lay-out is briefly described.

In the last special Mining Issue of THE ELECTRICIAN, an article was contributed by the writer on the subject of "Switchgear for Mines." Since then several historical events have occurred, including the memorable mining tragedies at West Stanley, Whitehaven and Hulton. Neither of these catastrophies have been attributed to the use of electricity, but they have had the effect of bringing home to everyone concerned the necessity for the most stringent precautions in the design of electrical equipment. The three years which have passed have been eventful in other ways. For instance, the appointment of a Chief Electrical Inspector of Mines and a Departmental Committee to enquire into the working of the special rules for the use of electricity in mines, and to consider any amendments required. Moreover, the large Engineering Institutions have devoted several discussions to the use of electricity in mines, and an entirely new and active organization has been formed by mining electrical engineers, one of the first objects of that Association being to consider means for minimising the risks attending the application of electricity to mining, and to promote the adoption of new methods and devices tending to increase safety.

It is natural that such events should reflect themselves upon the design of apparatus, therefore, and it is of interest to consider the present position as compared with that recorded in the 1908 issue. For this purpose it may be permissible to quote the following requirements which were said to apply to switchgear construction.

1. Accidental contact with metal whilst alive must be impossible.
2. The insulation must be able to withstand any excessive pressure that is liable to arise, even under abnormal conditions.
3. The design should not allow dust, dirt, moisture, or vermin to diminish the insulation.
4. Fire risks must be reduced to a minimum.
5. There should be a minimum amount of cleaning necessary to maintain the gear in a good condition.
6. Parts requiring inspection and cleaning must be capable of ready and absolute detachment from the gear to enable such operation to be carried out with safety.
7. The sectional area of conductors must be such as to carry without deterioration the maximum overload to which they are liable.
8. Moving parts, such as switch mechanisms, must be situated where they can be observed, and chance of switches sticking must be reduced to a minimum.
9. Automatic protection to be included which will isolate a faulty section without interference with healthy sections.
10. The construction to be mechanically strong in order to resist rough usage and accidental impact.
11. The switches must be capable of breaking, without disturbance to other parts, the maximum power which may instantaneously pass through the switch when acting under the worst fault conditions.
12. The simplest construction is required consistent with economy in operation and maintenance costs."

In the light of recent experience there is nothing in the above points which does not apply at the present time for ordinary mining purposes, but it is necessary to enlarge upon these in order to arrive at a correct understanding of switchgear and accessories as required underground.

The main risks are due to shock, fire and explosions. The fire and stock risks are common to any electrical equipment, whether below or above ground, and it is of interest to observe that adequate provisions against explosions form at the same time the best safeguard against risk of shock and fire.* Broadly speaking, therefore, the ideal is obtained by an explosion-proof construction.

The term "explosion-proof" as applied to switchgear is of more or less recent introduction, and its meaning might well be questioned. If it is intended to carry with it a guarantee against explosions in mines, it is certainly an ambitious term, although it is perhaps more legitimate than the description "safety lamp." "Flame-proof" is a more modest definition, but it is hardly broad enough. The requirement really is for an apparatus which must be flame-proof when an explosion of the maximum force occurs inside; that is to say, under no circumstances whatever should there be an external flame or spark sufficient to ignite gas. "Open-sparking" is a new

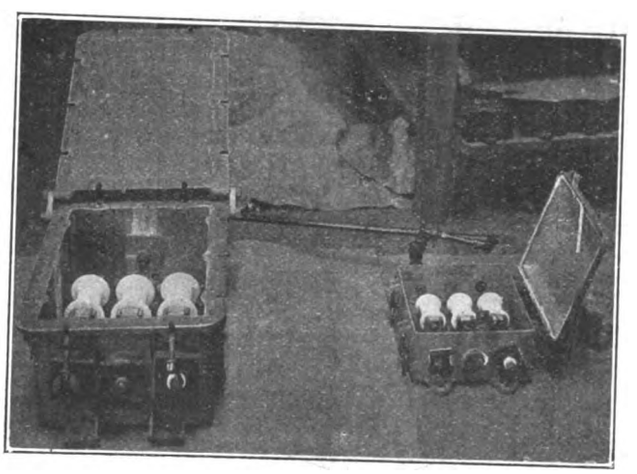

FIG. 1.—AN OLD EXPERIMENT WITH AN "EXPLOSION-PROOF" AND A NON-GASTIGHT JOINT RESPECTIVELY.

definition which occurs in the recently revised rules, and there it is said to mean sparking which, owing to the lack of adequate provisions for preventing the emission of inflammable gas external to the apparatus, would ignite such inflammable gas. In course of time this may introduce the term "open spark proof," or perhaps "sparkless," apparatus. Whatever is the outcome, it is at present obvious that the old definition "gas-proof" will die out as the difficulty of making any apparatus which would be permanently gas-tight in a mine is now fully recognised. The development in this direction is partly due to the experiments which were made at Messrs. Reyrolle's works upon apparatus shown in Fig. 1, by which it was found possible to ignite the most explosive mixture of town gas and air inside the larger box without any visible flame, whereas a similar ignition in the smaller box with the gasket joint a flame protruded outside at every test. In consequence of this experience† strong boxes were made which

* Mr. Robert Nelson, "Electricity in Mines—The Avoidance of Accidents," read before joint meeting of the Colliery Managers' Association and the West of Scotland Branch of Association of Mining Electrical Engineers in Glasgow on April 1, 1911.

† THE ELECTRICIAN Vol. LXII., p. 854.

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were calculated to withstand an internal pressure up to 200 lb. per square inch. This was considered sufficient in all ordinary circumstances to justify the term "explosion-proof." An example of an air compressor motor starter designed on these lines is shown in Fig. 2, and a switch-fuse box in Fig. 3. The same form of enclosure as used for automatic oil-breaks witches is shown in Fig. 4. In this instance the switch is mounted upon a pillar for controlling a three-phase motor. Incidentally, it should be noted that the illustration also shows a double three-core terminal box suitable for receiving metallic covered cables.

Obviously it is preferable to reduce the space inside any box to a minimum in which gas could accumulate, more especially as, unless the cubical contents of the box are kept within reasonable dimensions, the thickness of the metal necessary to resist the pressure occasioned by an internal explosion becomes prohibitive. For that reason, it is better to enclose all conductors in oil or in compound, thus precluding as much air as possible. This condition mitigates against the use of fuses, particularly for distribution boxes where there may be a large number of ways. It is, of course, not suggested that explosion-proof apparatus is essential in all mines or even at all places in any mine. On the contrary, in places where there are no risks of explosion due to gas or coal dust, it remains only to provide apparatus which will guard against risks of

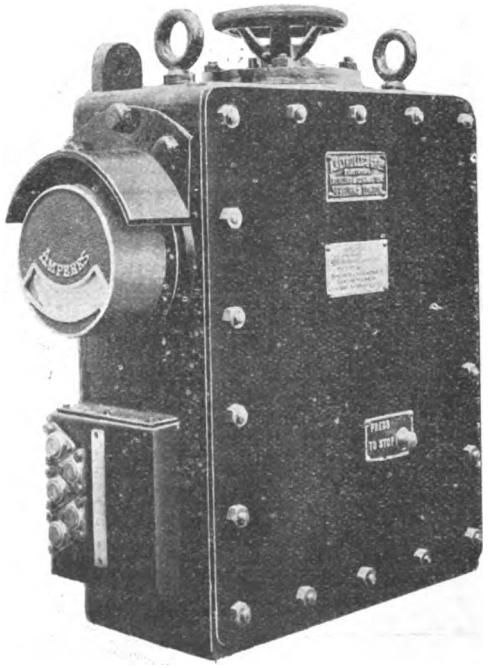

FIG. 2.—CONTINUOUS CURRENT DRUM TYPE MOTOR STARTER, FOR PORTABLE AIR COMPRESSOR. MOUNTED IN "EXPLOSION-PROOF" CASE.

fire and shock, and it would appear that these contingencies are best met by a properly earthed metallic armouring; some saving may therefore be effected in the initial cost of switchgear by installing apparatus which, though not explosion-proof, is properly ironclad or otherwise enclosed. In many mines, however, in view of the difficulty in discriminating whether there are risks of explosion or not, it would be the best practice to use explosion-proof type throughout for underground work.

Cable Connections between Plant.—The time for the universal adoption of the "all-armoured" installation seems now nearer to hand. The conductors of a trailing cable in a mine appear to be the only ones where any real difficulty is met, and even some trailing cables have been made with a copper earth screen wound in a spiral over the dielectric and protected by rope, leather, or other covering. One of the essentials to the "all-armoured" installation is that the switchgear and accessories should be properly designed to accommodate the cables which are to be connected up. This is, in fact, an essential feature in ironclad design, and its importance is sometimes overlooked by the manufacturer and user of the apparatus. For instance, it is sometimes solely in consequence of this oversight that unarmoured cables have to be resorted to for connections between switchgear, transformers and motors respectively on installations which are in other respects all-armoured. In the writer's opinion there should be no need for this. Motors and transformers and switchgear can be easily fitted with proper terminal boxes. Fig. 5 is intended to illustrate the interconnection between switchgear and motor; connections to static transformers can be treated in a similar way, provided the necessary study is given to the terminal design.

FIG. 3.—INTERLOCKED SWITCH FUSE BOX, WITH WIDE METAL-TO-METAL JOINTS.

FIG. 4.—MOTOR CONTROL PILLAR WITH "EXPLOSION-PROOF" OIL SWITCH

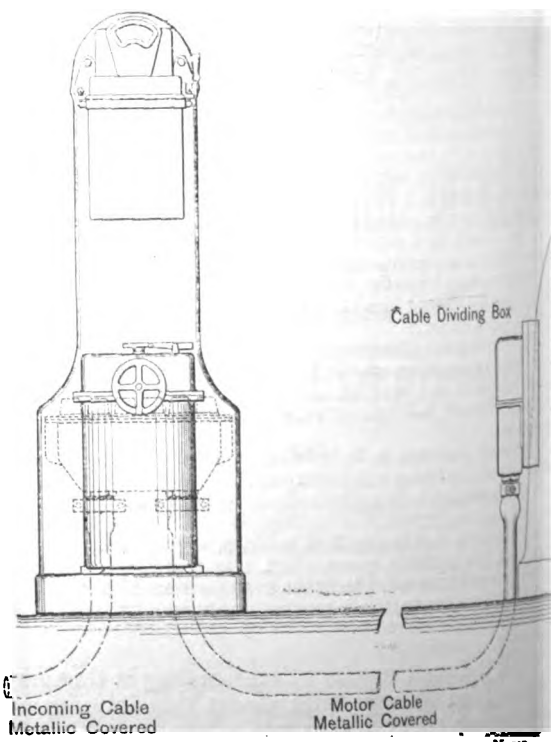

FIG. 5.—CONNECTION BETWEEN SWITCH PILLAR AND MOTOR.

An alternative method for dealing with connections between switchgear and static transformers, particularly applicable to

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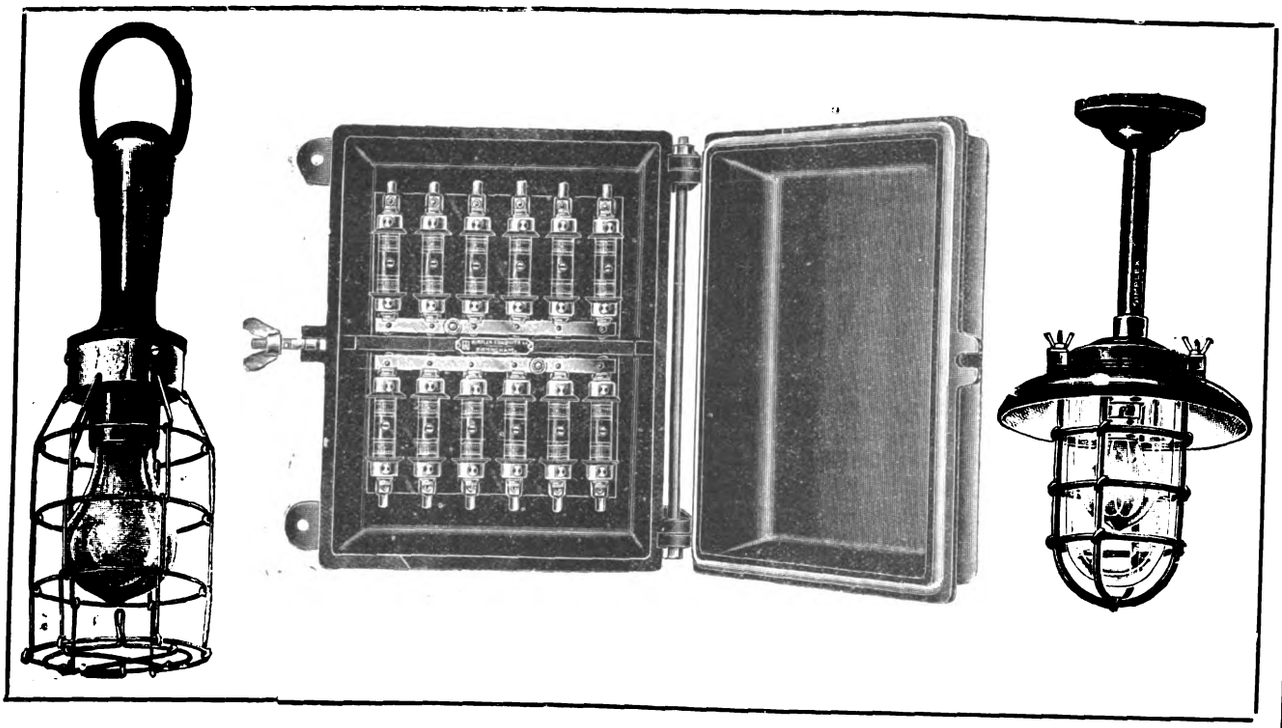

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the smaller sizes of transformers, is to combine the transformer and switchgear into one mechanical apparatus. In Fig. 6 the switch is mounted on the case enclosing the transformer, the combined apparatus being mounted on wheels, plugs into 'bus-bar or terminal connections.

For pit lighting where very small transformers are used it is possible, by devoting special attention to the winding insulation in order to ensure against breakdown, to dispense with switchgear entirely on the high-tension side of the transformer. A simple arrangement is shown in Fig. 7. In this connection it

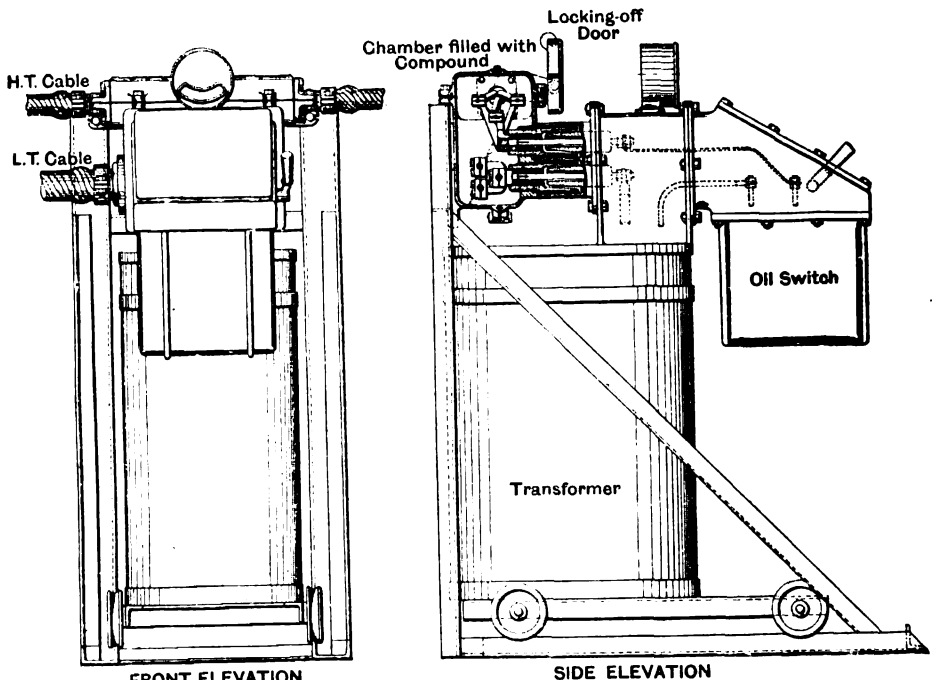

FIG. 6.—COMBINED TRANSFORMER AND OIL SWITCH

FIG. 8.—EXPLOSION PROOF AUTOMATIC SWITCH FOR LIGHTING CIRCUITS.

is well to remember that the use of metallic filament lamps simplifies the problem by reducing to some extent the output of the transformer.

An automatic switch for lighting-circuits is recommended in preference to fuses, and a suitable type of switch for this purpose is shown in Fig. 8. The case of this switch is so constructed that the circuit cannot be operated whilst the lid is open. It

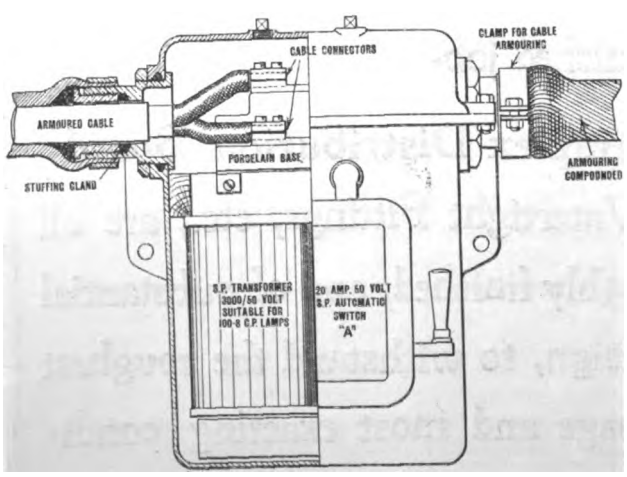

FIG. 7.—COMBINED CABLE JOINT BOX, TRANSFORMER AND SWITCH FOR PIT LIGHTING.

will be noted that the lid is provided with a machined metal flange joint similar, but on a smaller scale, to the explosion-proof apparatus described above.

The Inspection of Switches.—The isolation of parts of switches prior to inspection has received special consideration in the design of switchgear. In some cases isolating switches are provided for the purpose of disconnecting the conductors in a panel from the 'bus-bars, but undoubtedly the most effectual means for ensuring safety in this respect is obtained by the "draw-out" type of switch. Examples of this form are shown in Figs. 9, 10 and 11. These panels may be constructed for use as single panels with cables leading in and out horizontally or vertically to suit the particular situation in which they are placed, or, as shown on Fig. 11, a row of panels may be lined up to form a distribution switchgear, the 'bus-bars being enclosed in a chamber made up in sections and run up solid in insulating compound.

Direct Current Automatic Switches.—The type of automatic circuit breaker for use on direct-current circuits in mines calls for some special consideration. Considered from a circuit

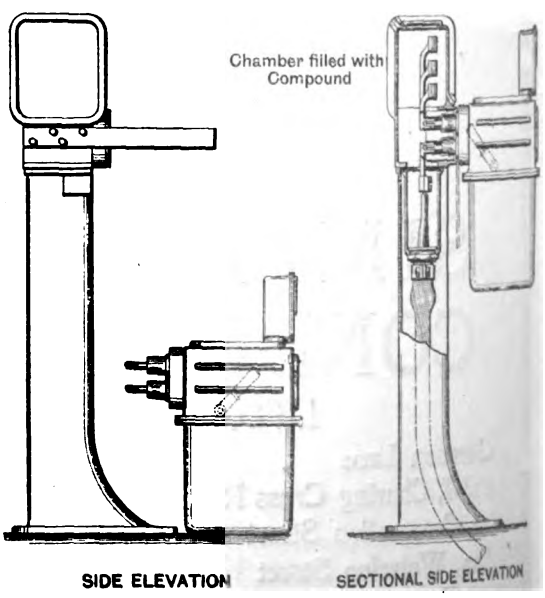

FIG. 9.—SOLID TYPE ARMOURED PILLAR SWITCHGEAR.

rupturing point of view, the approved practice is to use circuit breakers with a long break across carbon blocks in air. For large capacities, however, it is difficult to enclose such breakers in metallic cases owing to the clearance required over the break to avoid arcing to the case. Breakers with magnetic blowouts overcome this objection to some extent, but even this involves enclosure in boxes having a large cubic capacity of air

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and, as in the case mentioned above, to be explosion-proof this necessitates very heavy castings. In the natural course of events one resorts to an oil break in consequence of its universal use on alternating-current circuits. It has been found that the principal objection is the excessive carbonization of the oil when the switch is called upon to break heavy currents frequently. The reason for the extra precipitation of free carbon as compared with alternating-current circuits is due to the fact that a direct current arc generally hangs on longer and is more intense than an alternating-current arc when rupturing an equivalent circuit. The adoption of the oil-break principle for direct-current switches, therefore, necessitates more frequent inspection and renewal of the oil, and preferably a construction of more liberal dimensions.

It was at one time thought that the use of oil-breaks on direct-current switches was prohibited by the risk of dangerous pressure rises on heavy inductive loads. This argument still prevails in some circumstances, but very rarely in actual conditions of working in mines where the average load is sufficiently non-inductive to ensure against a pressure rise likely to puncture ordinary insulation, and, indeed, oscillograph records have recently been shown* to prove that the pressure

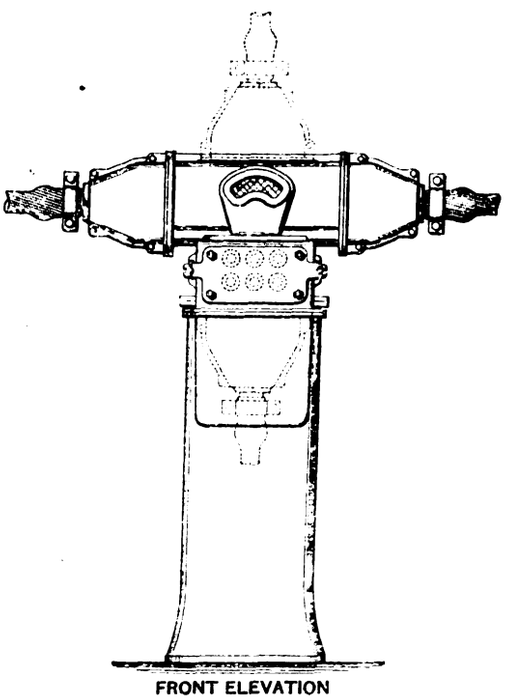

FIG. 10.—ARMOURED PILLAR SWITCHGEAR.
(Dotted lines show alternative positions for cables.)

rise on an oil-break switch is no more than that occasioned on rupturing a circuit by means of a strong magnetic blowout. Subject therefore to effective maintenance, an oil-break switch bids fair to be a useful direct-current accessory, more particularly when it is essential that the switch be of the explosion-proof type.

Automatic Protection.—As a general rule it may be taken that it is more difficult to prevent switches tripping out at times when they should hold in than it is to make a switch trip out at the right time. The "Merz-Price" balance system of protection which has been evolved for the purpose of isolating faulty sections without interfering with sound ones, is hardly applicable for universal use underground on account of the initial cost of the pilot wire and the maintenance of the same. When considering transmission above ground, and the interconnection of sub-stations, it is another matter, as the necessity of maintaining a continuity of supply to consumers under all conditions warrants the expense, but ring mains and duplicate feeders are not always possible in mines; and, although it may be inconvenient to shut down one section of the mine for a fault on another, it is not generally so serious a matter as the isolation of one consumer on a power company's network on account of a fault on a cable connecting another consumer. At the same time the more nearly a mining equipment approaches the ideal transmission equipment in regard to automatic protection the better, provided, of course, no complicated apparatus costly to maintain is thereby introduced. For this reason it has been suggested that the setting of relays and the methods of protection adopted at different parts of the connections under-

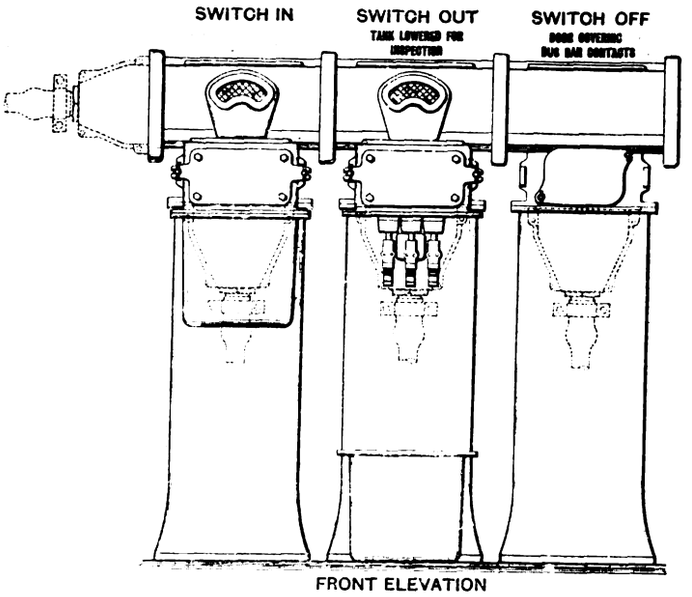

FIG. 11.—REYROLLE IRONCLAD MINING PANELS.

ground might well receive more attention. It is now a regulation that a proper plan should be kept in the office at each mine showing the position and sizes of all fixed apparatus in mines, and the plan must be kept reasonably up-to-date. It is very little extra trouble to add to this plan particulars of the automatic protection, the blowing capacity of fuses, the setting of overload or leakage protection tripping devices, &c.

Leakage Protection.—It will be observed that the introduction of leakage protection devices into discussions on mining

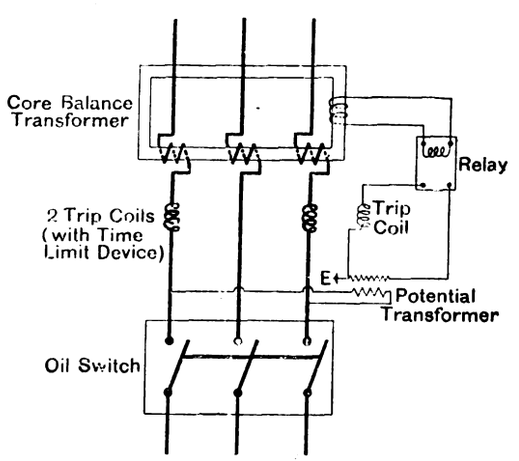

FIG. 12.—LEAKAGE OR CORE BALANCE PROTECTION WITH RELAY FOR LIGHT SETTING.

apparatus has occurred during the past two or three years, and it is questionable whether much headway has been made in practice. There is no doubt, however, that more attention will be given in the future to this subject on account of the recommendations contained in the report of the Electricity in Mines Committee. One of the main objects of leakage protection is to isolate instantaneously a circuit upon which a fault to earth has occurred, more particularly with a view to

* Mr. Alfred G. Collis, "Breaking High and Low Potential Circuits," read before the South Wales Institute of Engineers in Cardiff on February 23, 1911. THE ELECTRICIAN, Vol. LXVI., p. 869, 894.

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avoiding the risk of "open-sparking" at the fault. Hitherto the switches with so-called instantaneous overload release have had the objectionable feature of tripping out on temporary overloads, whereas leakage protection can be provided to trip out at an earth fault amounting to a small percentage of the normal load, say 5 per cent., whilst it holds in for any transitory overload. At the same time it has the advantage that it may be incorporated with a time limit release for protection against persistent overloads and faults between phases. An example of the connections is shown on Fig. 12. A relay is used here for the light setting, but in an alternative method the current in the protective system, induced by a fault to earth, operates directly upon the tripping

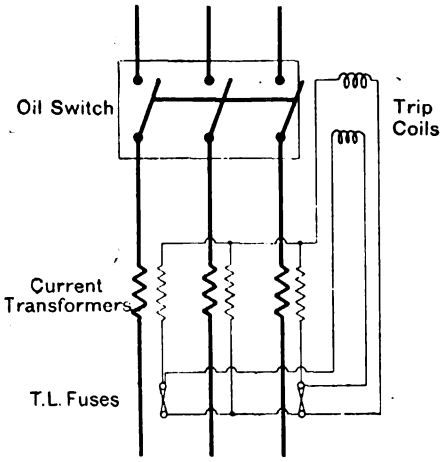

FIG. 13.—INSTANTANEOUS LEAKAGE AND TIME LIMIT OVERLOAD PROTECTION (WITH DIRECT TRIP).

mechanism of the switch. In this case the connections are somewhat simplified as shown in Fig. 13, but owing to the amount of power required to trip the switch, the setting is less sensitive. Under ordinary circumstances there is no difficulty in setting the gear to trip at a fault current of about the same amplitude as the normal working current per phase.

Many automatic overload switches are now constructed with series trip coils for voltages up to 3,000. In some of these cases the use of leakage protection involves the addition of

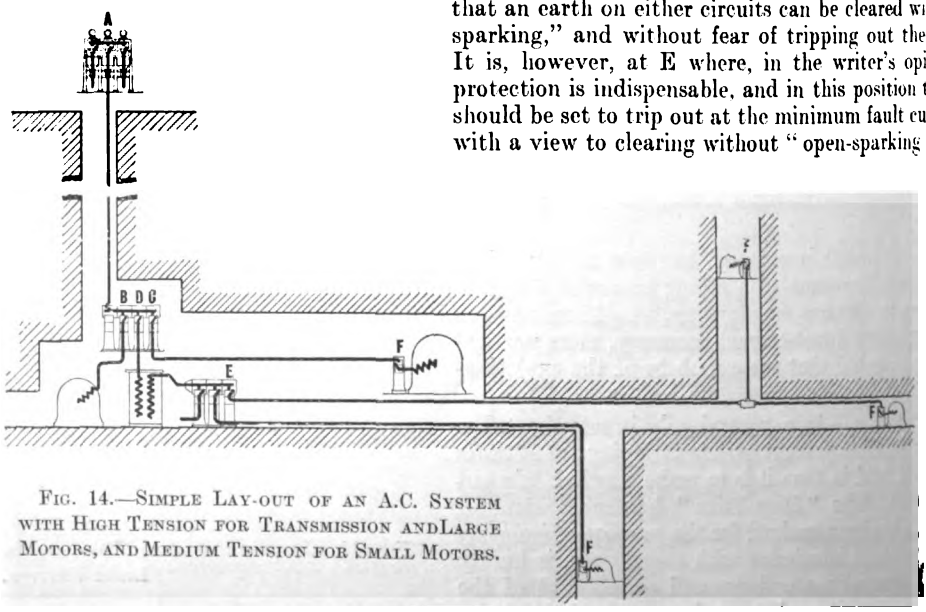

FIG. 14.—SIMPLE LAY-OUT OF AN A.C. SYSTEM WITH HIGH TENSION FOR TRANSMISSION AND LARGE MOTORS, AND MEDIUM TENSION FOR SMALL MOTORS.

current transformers. With this exception, however, the system is no more complicated than ordinary overload protection. In order to study the application of leakage protection it is necessary to consider the general lay-out of the system. The diagram in Fig. 14 is taken as a typical case. It is supposed that there is only one shaft cable, and that a 3,000-volt supply is taken directly to large motors near the shaft bottom, and a medium pressure supply is distributed to smaller motors in bye. It is assumed that all conductors are armoured, and that the armouring is connected to a proper earthing system at bank, the neutral point on both the high and medium pressure being earthed. The several points at which protective devices could be installed are at A, B, C, D, E and F. The switch at A controls the whole supply to the pit, and the protection, to be ideal, should not trip unless there is a serious fault on the bus-bar at the pit bottom or on the shaft cable. In all probability the circumstances are such that there is very little risk attending such faults and, moreover, the situation is such that no serious

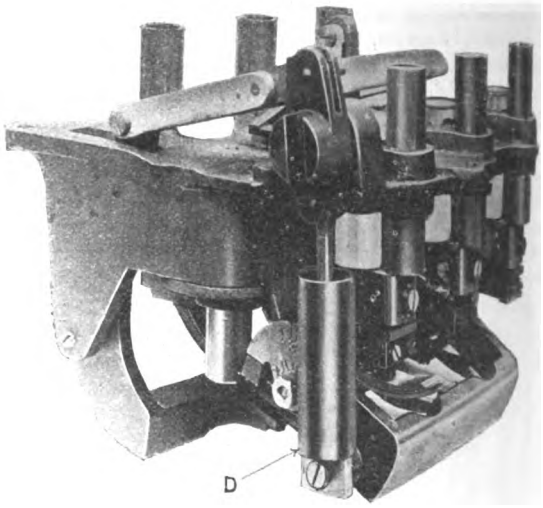

FIG. 15.—WORKING PARTS OF SWITCH, SELF-CONTAINED AND DETACHABLE FROM THE CASE.

D = Dash-pot for automatically grading the setting of the overload release between starting and running positions.

harm would result from the remote chance of the fault hanging on for a second more or less. The protection at A might, therefore, well be set for overload time limit to trip with a persistent overload of two to three times the full load current. The switches at B, D and C should have their overload setting at least one-third that of the switch at A, in order that each circuit may have the chance of opening for a fault on itself without interference with the others. At these places leakage protection at full load setting might be used to advantage so that an earth on either circuits can be cleared without "open-sparking," and without fear of tripping out the switch at A. It is, however, at E where, in the writer's opinion, leakage protection is indispensable, and in this position the protection should be set to trip out at the minimum fault current to earth with a view to clearing without "open-sparking" a fault such as would be occasioned by a fall of roof on the cable. At F (*i.e.*, the motor panels), ordinary overload protection is sufficient, the setting being lighter than the overload setting at E in order to reduce the chance of E tripping out for a simple overload on the motor. (According to one method adopted in switches for small squirrel-cage motors, the overload setting at F can, by a simple device, be made self-adjustable from a heavy setting at the starting position to a light setting

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running. The method of accomplishing this is shown in Fig. 15. The lever controlling the position of the core of the tripping magnets is raised by the dash-pot in the operation of closing the switch, and the dash-pot allows the core to drop gradually whilst the motor is running up to speed.) As an alternative to the above sequence of protection the switch A might be the only one fitted with leakage protection. This may be simpler but, on the other hand, it has the objection that the whole electrical equipment in the pit would be shut down for a small leakage in any section.

Duplicate Feeders and Ring Mains.—Let us now consider a case of a mine using more electrical power, including a number of large motors for underground haulages, pumps, &c. A lay-out of this kind is represented in Fig. 16. A complete stoppage would be a more serious matter and, in order to deal with the power required, it is assumed that it would be a good commercial proposition to have duplicate shaft cables. Then it is essential to consider some different system of protection from either overload or leakage protection, and the only satisfactory solution so far is to use the well-known balance system with pilot wires. The pilot wires in this case are not so formidable an objection because the pilots for both of the main shaft cables can be combined in one armoured cable. The switches therefore at A and B need not have any overload protection, but they should have some

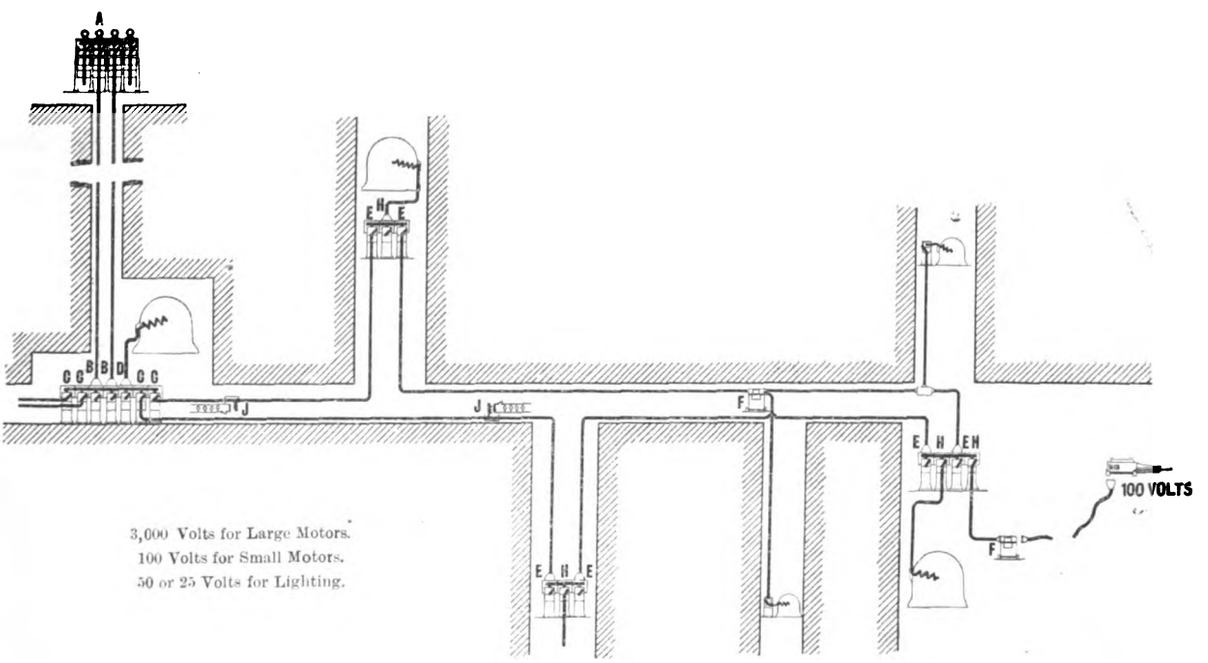

FIG. 16.—HYPOTHETICAL LAY-OUT OF A.C. SYSTEM WITH LARGE AND SMALL MOTORS, ELECTRIC COAL CUTTERS AND ELECTRIC LIGHTING.

balanced system which would trip out the switches instantaneously at each end of the individual cable developing any kind of fault, in such a way that no other switch should be affected at the same time. Between the switches at A and the generators there should be some overload device with a long time limit in order to guard against the continuance of a 'bus-bar fault on other distribution switchgear at the pit bottom, as the balance gear would not trip out on that occurring. A fault of that kind should be very remote occurrence indeed, and particularly on properly constructed switchgear having all its conductors run in solid in compound or oil.

The switches, C, on the distributors at the shaft bottom form part of separate ring main systems. The ideal protection would be the balance system, and if the ring main were above ground with a similar load the balance system would probably be adopted; but underground, as discussed before, the question as to the advisability of the pilot along the roads enters into the consideration. Unfortunately a proper balance system without the use of a pilot has yet to be developed but in its absence the ring main can be run with one of the switches E, open; in the event of any section of the cable being put out of commission by a fault, the supply could be quickly re-established throughout by manipulating one or more of these switches in order to open the ring at another place. The same points, therefore, as regards the use of leakage protection apply here as for the lay-out with single cables, so that at C a leakage protection of light setting, say 10 per cent. of normal full load, incorporated with a time limit overload to guard against faults between phases would probably give the best results. Automatic protection on the switches at E might well be dispensed with, and a lighter leakage and overload protection would fulfil the requirements of switches in such places as those marked H on the diagram. The same remark would apply to the switches at F. Incidentally it should be stated that the places at which these are fixed are those where the writer suggests the combined switch and transformers of the type shown on Fig. 6 could be used to advantage. For instance, greater safety might be effected in the running of electric coal cutters by the use of such an arrangement at the gate end, whereby the coal cutter could be supplied at low pressure, say 100 volts. J represents transformers and switches for the lighting of roads of the type described above (*see* Fig. 7) The switches here would be set to trip out instantaneously on an overload of sufficient magnitude to be likely to be injurious to the winding of the transformer.

Conclusions.—The engineering advantages obtained by the use of electricity in mines are fully recognised, and fortunately the accidents from electrical causes have been very few in proportion to the accidents from other causes. At the same time it is true that the extension of this immense field for electricity depends very largely upon the freedom from fatal accidents. It is difficult to find any consolation for the remorse which follows the preventable loss of life; it is no use to call the victim of a mistake a "fool." To err is human, and the best-informed person is apt to make a fatal mistake in a moment of forgetfulness. It is, therefore, the best policy to encourage the design of apparatus which eliminates the risks, and in the long run this is also the cheapest policy, as it will be found that the substantial construction and enclosure of live conductors, whilst reducing risks, at the same time lessens the maintenance costs. It is gratifying to note how carefully the conditions appertaining to safety in switchgear designs are now considered in all quarters, and, given the necessary attention to the details on the other plant, including terminals on transformers and motors, the entire electrical installation can be made perfectly safe without extra cost in the long run.

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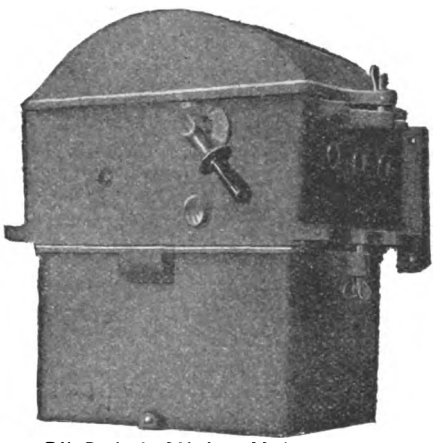
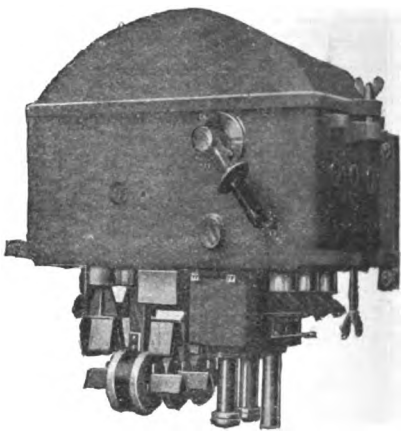
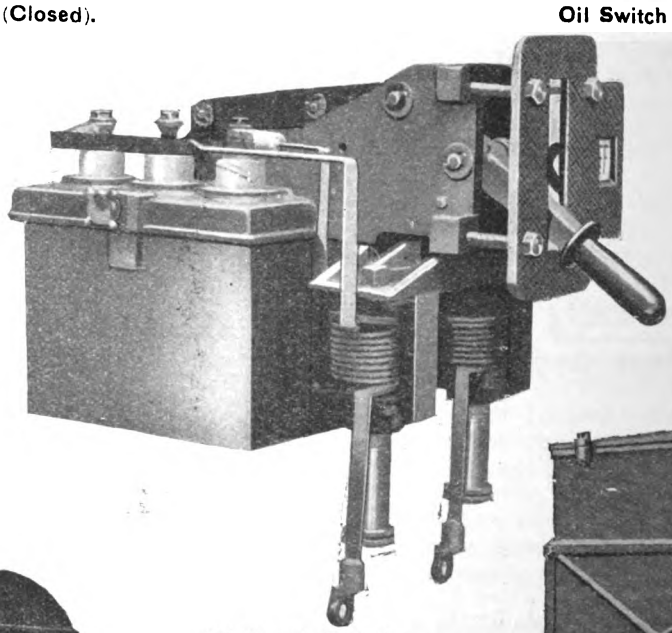


Oil Switch Mining Unit (Closed).



Oil Switch Mining Unit (Open).



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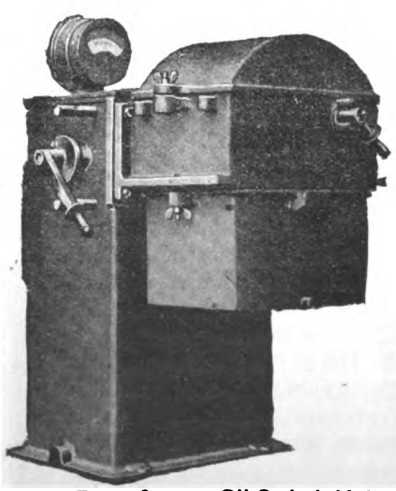

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The Progress of Electric Winding in England.

BY GERALD HOOGHWINKEL, M.I.E.E., M.INST.M.M.

Summary.—The points which are usually taken into account in considering the advantages of the steam, as compared with the electric winder, are low capital cost, simplicity and low cost of winding. As to capital cost, no general rule can be stated. If electric driving is being used for other purposes, there is not much difference in the cost of the two systems, even with a private installation; and with a public supply, the electric system is the cheaper. The exhaust steam turbine is now a factor in the case, but must not be pushed too far. Experience has shown that the less directness of the electric winder is not a disadvantage. The question of the cost of winding is one on which reliable information is not easily obtained, because the figures for steam are not readily separated. Costs are given for the electric winding plant of the Maritime Pit of the Great Western Collieries. In conclusion, the author describes briefly the different electric systems now available and gives details of electric winding plants in Great Britain.

The subject has been frequently treated, by the present writer as far back as 1905, when he read a Paper at Newcastle, which was afterwards re-discussed at a London meeting of the Institution of Electrical Engineers. Much progress has been made in this country since then, and many points which were carelessly brushed aside by mining engineers have now been established by actual results obtained by collieries at home. The object of the present article is to review the progress which has been made during the last few years, and to touch on a few points which may lead to a more rapid replacement of the wasteful steam winder by economical and handy electrical apparatus.

The points which were made over and over again on behalf of the steam winder were :—

1. Low capital outlay.
2. Simplicity, there being a direct application of the driving power.
3. Low cost of winding.

1. The first point is in reality the principal one, and practically the only one which is being considered by the colliery owner. Only the larger concerns, mostly limited companies, have recently adopted the electric winder, thereby following Continental practice. The fact that most of the collieries on the Continent are owned by limited companies with vast means has been the cause of the far more rapid progress of electric winding across the Channel.

The difference in first cost, however, between a modern steam winder and an electrical one is not as much at present as it used to be four or five years ago, and, if properly allocated, the total outlay for a new colliery with an output of, say, 3,000 to 4,000 tons, will be almost equal whether electric winding is used, or steam winding, taking for granted that all other plant will be run by electricity, with the exception, perhaps, of fan and air compressor, in the case of steam-driven winding plant. Of course, if electric power is obtainable from a power company, as is the case with a large new colliery the writer is connected with, the first cost of the all-electric colliery is even lower. Much depends on the locality, and the proportion of power required for winding, and for other purposes, such as hauling and pumping. A general rule, therefore, is impossible, and each case should be taken on its own merits.

The introduction of the exhaust turbine, however, has introduced a new factor, and its advent was seized upon by the advocates of steam winding, and, of course, also by the timid ones, as the saviour of steam winding by the one, and a step in advance by the other. The writer wishes, therefore, to utter a warning against the adoption of the exhaust turbine in this capacity, as its adoption in connection with new winding engines will only lead to disappointment, and discredit a most useful addition to our colliery equipment, with its proper customers. The exhaust turbine is an apparatus which turns into useful (mostly electrical) energy the wasted exhaust steam of existing non-condensing steam plant, but it is quite another proposition to create this exhaust steam to be used in a steam turbine, if its creation can be avoided. It is even more economical to use a compound steam winder and a live steam turbine for the electrical requirements than to put down a non-condensing engine exhausting into an exhaust turbine, the difference being about 5 to 10 per cent. in favour of the former combination.

In the outlay of a new colliery the exhaust or mixed turbine has no place, and it is the writer's opinion that not only will the capital charges be higher in the end, but also the running cost. They have, on the other hand, their very useful place in improving the efficiency of existing colliery plant.

The most unfavourable case for electric winding at first sight would appear to be in such cases where electric power has to be generated in a new power station, which should be started before sinking is commenced, but even in such instances a good case can be made out if one large turbine set is put down (as will be explained later) to provide power to supply the sinking engine motors, and also for the further requirements of the sinking, such as pumps, haulage (of materials), compressors. Later on, when the permanent winder is installed, a continuous-current generator can be added to drive the winder.

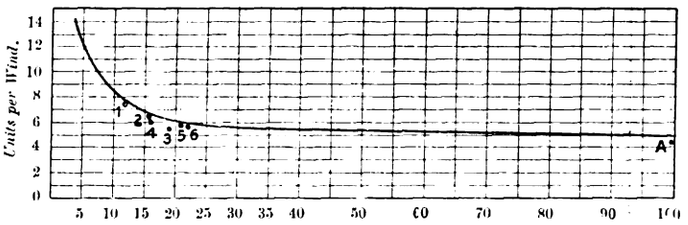

FIG. 1.—MARITIME ELECTRICAL WINDER.

Curve (estimated).—Units per wind under varying conditions of load factor.
Points (actual).—Units per wind under varying conditions of load factor (fortnightly).

SUBSEQUENTLY ADDED.

Points Nos. 1, 2, 3, 4, 5, 6.—Actual results over successive complete fortnights in 1909
Point A.—Actual full load test over one hour.

No. 1, 7·48	units per wind,	12	per cent. load factor.		
No. 2, 6·60	"	"	16	"	"
No. 3, 5·61	"	"	19	"	"
No. 4, 6·13	"	"	16	"	"
No. 5, 5·70	"	"	21	"	"
No. 6, 5·69	"	"	22	"	"
No. A, 4·15	"	"	100	"	" for 165¾ tons =4·78 for 175 tons per hour.

The only way in which to arrive at a reliable conclusion, in the case of a new pit, is that of making a complete estimate of the capital outlay for power plant at the colliery (buildings included) on either system, providing plant in either case of a similar character as regards simplicity and accessories, and with an equivalent margin of spare plant included in each estimate. Where power can be obtained from a power company there is no question what the result will be; the all-electric system will come out the cheaper, as against the all-steam, or as against steam winding with exhaust steam turbines and the rest electric.

2. The second point has been for a long time the sheet anchor of the colliery engineer, and at each discussion the writer was asked how it was possible that electric winding could be more economical and reliable than steam winding seeing that there were dynamos, flywheel sets, cables and motors between the winding drum and the steam engine. The best answer to this is, if long arrays of figures are to be avoided, that it has been found to pay in every other application such as traction, rolling mills, factory driving, &c.

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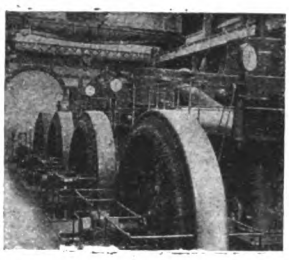

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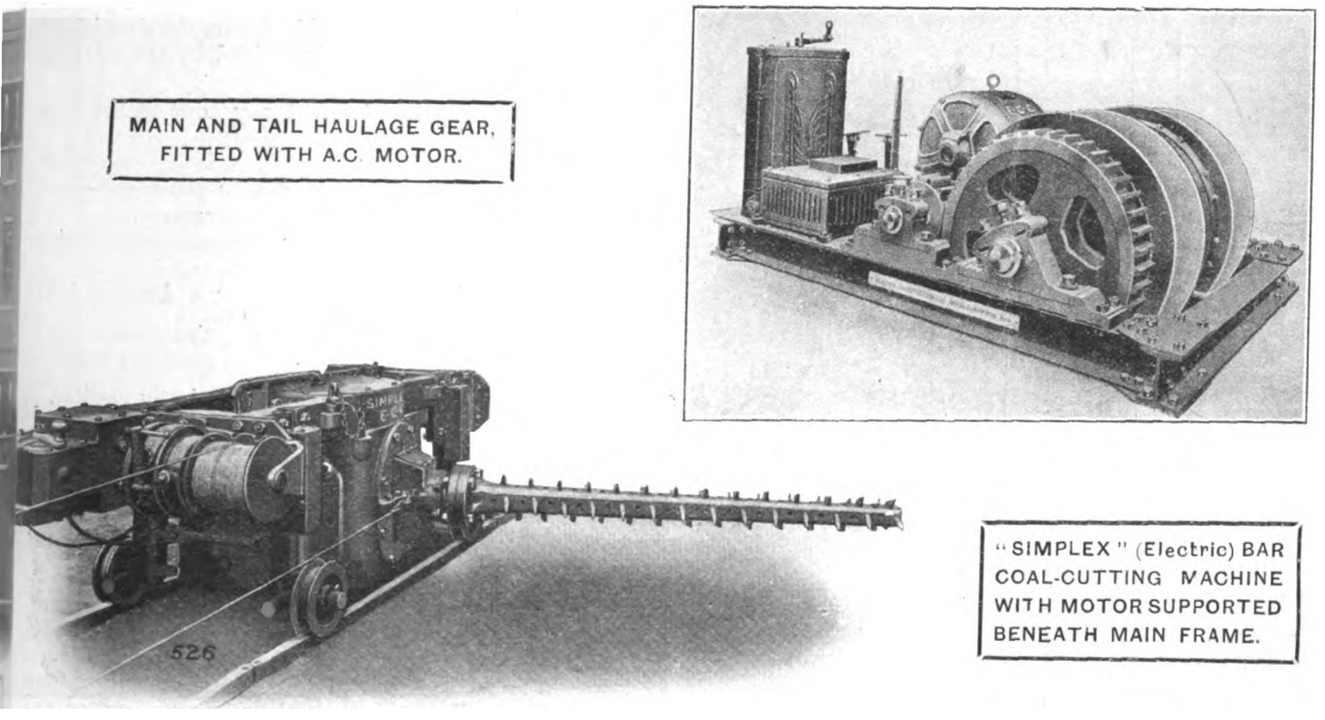

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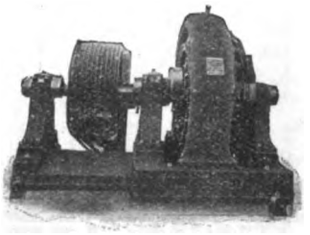

WOLVERHAMPTON.

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As to reliability, experience has shown that there are no grounds for increased apprehension. Electrical winding plants of all kinds have been running for some time without serious mishap. It is now quite practicable to make electric winding almost automatic. The colliery engineer is gaining knowledge of electrical plant, and the electrician is rapidly becoming a more responsible person. Electrical winding plant is also being immensely simplified; unnecessary appendages are falling into disuse and are being removed. In the case of the winding plant at the Great Western Colliery a flywheel equalising gear was supplied, and was in regular use for some months, but the colliery has since discarded it, with the concurrence of the power company.

Motors of a simpler construction are being rightly advocated. High-tension three-phase motors with their expensive windings are giving place to more robust low-tension machines, and electrical engineers are alive to the fact that simplicity and reliability must be achieved at all costs.

3. As to the cost of winding, this is a complicated calculation, and it is here that the staunch advocates of steam winding have gone hopelessly wrong. At the most the figures per ton of coal wound or per useful horse-power-hour in the shaft are hardly known or even guessed at. The few attempts to provide these figures from some of the best-known collieries in the north by a well-known advocate of steam winding have resulted in entirely misleading and incorrect figures. At best these figures gave an indication of what the steam

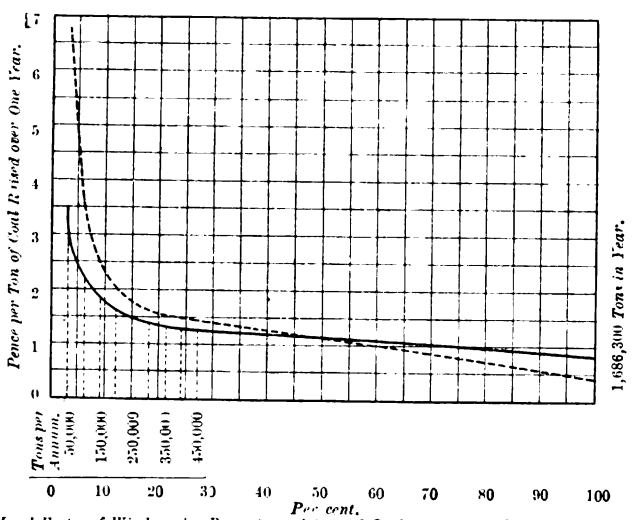

FIG. 2.—COMPARATIVE CURVES FOR STEAM AND ELECTRICITY, VIZ., FOR ESTIMATED COST PER TON OF COAL RAISED OVER YEAR FOR POWER ONLY.

consumption might be during the period of winding. But it is just here that electricity offers the all-important advantage that it does not waste energy during the time the machinery is idle.

What about the inefficient boiler house at collieries compared with a battery of boilers in a power station? What about the boiler and engine losses during the night, at week ends; in fact, during the 6,400 hours a year the plant is standing? These points were always forgotten by the steam men. On the contrary, with electric winding, these costs can be calculated in advance to a nicety, and at the Great Western Colliery, with which the writer is connected, the results have exactly confirmed the calculated figures drawn up in advance, and established a decided saving in cost over steam winding.

The results obtained with the electric winding plant at the Maritime Pit of the Great Western Collieries may be of interest, as this is the only electric winder in this country which has now been at work for two years and from which figures over a complete year are available.

The winder has been fully described by the writer in a former Paper, and it will be sufficient to say that it is on the Westinghouse principle with a light flywheel set in parallel which can be disconnected. The guarantee of the makers for a full load of 70 trips per hour was 4·8 units per wind with 17 tons of coal raised per hour. The influence of the load factor on this figure can be seen from the curves in Figs. 1 and 2, that in Fig. 1 giving the calculated curve and the actual results, and the curves in Fig. 2 giving the comparison between steam and electricity over a full year (1909) at various load factors. The steam curve has been carefully compiled from actual results at existing collieries drawing coal from the same depth and using good steam smalls at 7s. 6d. per ton. Electric power is obtained from a power company at about 0·6d. per unit, so that there is no doubt as to the cost with electric winding in this case. The curves have been prepared by Mr. H. Bramwell, the general manager of the colliery company.

The actual results during 1910 were as follows:—

Units consumed and paid for to the power company for winding only	448,000
Total number of winds of all sorts	122,724
Tons of coal raised	141,865
Tons of rubbish raised	65,512*

At 70 winds per hour the number of possible winds per year is 613,200, giving a load factor of about 20 per cent. The cost of power per ton of material raised is therefore slightly over 1d. and for coal alone about 2d. The costs of maintenance and repairs on the winding engine have been practically nil apart from oil.

The further advantages of electric winding may be enumerated briefly, as most of them are evident from the electrician's point of view and have been amply verified by the writer in actual practice.

1. The ability to run odd trips at any hour without the warming of the cylinders, &c.
2. More delicate control.
3. Less space is required for the winding plant, the motor being fixed on the top of the headgear if necessary.
4. Greater facilities for applying automatic protective devices.
5. Special shafts, for intermittent use at a distance from the main plant, are more easily provided for.
6. Steadier winding.
7. Power to control the acceleration.
8. Higher rates of deceleration are economically possible.
9. Heavy conical drums are seldom necessary.

DIFFERENT SYSTEMS EMPLOYED.

Many different electrical systems have been developed, which may be grouped under the following heads:—

(*a*) *Winding Motors (worked either by Continuous or by Alternating Current) connected direct to the Supply Mains without any Machinery for Equalising the Load on the Supply Mains.*—This system can be adopted where the maximum winding load is small compared with the whole output from the generating or sub-station. If a balance-rope be used and if the masses to be accelerated be not excessive, this system is often feasible. It has the two great merits of simplicity and cheapness, but is not always the most economical, as a large amount of energy is wasted in resistances. A good instance of the system is to be seen at the Harton Colliery, South Shields.

(*b*) *Continuous-current Systems with Batteries and Rotary Boosters.*—This system is, perhaps, entitled to rather more consideration than it has hitherto received. Where a continuous-current supply is available, it should not be lightly discarded. A great point in its favour is its undoubted reliability. If the winding motor be divided into two units and controlled on the series parallel system, as used for trains, there is practically a duplicate system throughout. It would always be possible to do a good deal of winding when any one item of the plant had broken down, even if that one were the main supply from the power station, and by adopting this system several winds could be made at any hour

* New workings opened up underground.

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the day or night whether steam were available or not. The greatest objection to the system is on the score of cost, but this is being gradually reduced, and a reliable battery and booster plant can now be obtained for about £6 per electrical-horse-power. This figure, however, is excessive, if charged entirely against the winding plant, but it may be justified in some cases, when it would undoubtedly effect great economy in the whole power supply costs, particularly where exhaust steam turbines are in use. Agreements for the maintenance of the battery can usually be made with the manufacturers on quite reasonable terms.

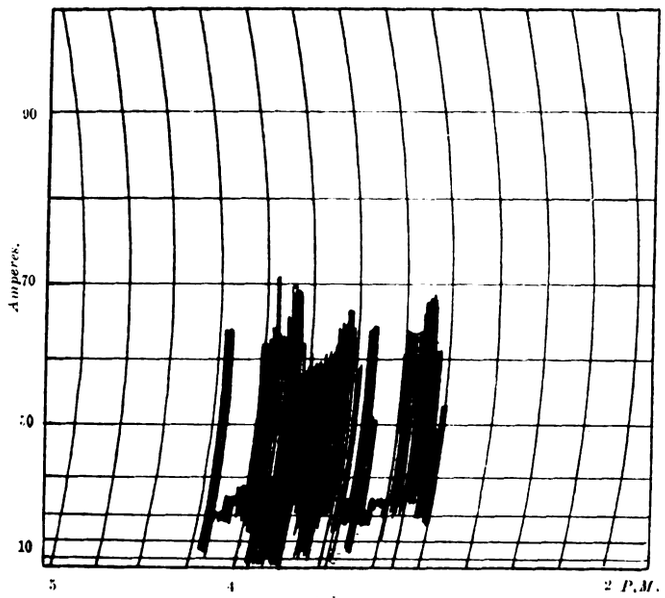

FIG. 3.—POWER COMPANY'S CURRENT RECORD DURING OFFICIAL TEST.
Readings × 0·8 = load at 11,000 volts.

(c) *System with Flywheel-equalising Machinery connected in Parallel with the Winding Motor across the Supply Mains.*—The best known example of this system is the plant erected at the Great Western Colliery, Pontypridd. Of those systems which make a constant demand on the power supply mains, it is probably the cheapest in most cases. A large portion of the energy goes direct from the mains to the winding motor, and the equalising machinery is only called upon to supply that portion of the peak load which is above the mean; therefore this gear need be neither so large nor so costly as that in the next system to be described. It also has greater claims to reliability, seeing that it is possible to wind without the equalising machinery. Another advantage, which will appeal to the electrician, lies in the better power factor which can be secured with this system. The disadvantages are: (1) The large current to be handled by the controller and (2) the inability to store energy in the flywheel during retardation, involving in some cases either conical pulleys, balance ropes or wasteful braking.

(d) *Systems in which the Winding Motors are driven entirely from Equalising Machinery.*—In this case the currents to be handled by the controller are very small, and great delicacy of control is secured. As little or no energy is wasted in resistances, the system is in many cases the most efficient. Energy can be restored to the flywheel during deceleration, so that there is more latitude in the design of the winding gear for a given output. In many ways the system is ideal from the electrician's point of view, except that each item of the plant is, as it were, a link in a chain, and failure of any one portion incapacitates the whole. It is also rather more costly in most cases than system (c). There are several examples of plant of this description in this country, and there will probably be more in the near future, both for colliery winding and for reversing rolling mills, owing to the verdict in a recent patent action in connection with the system.

(e) *Cascade System.*—This system is new, but is now being developed, and has some conspicuous advantages. The cascade motor may be described as two motors in one, there being two windings in the stator and two in the rotor. By manipulating the reactions of the two sets of windings on one another it is possible to run the motor at two different speeds without the use of any resistances; and at the same time, it possesses the property of the ordinary induction motor, of starting up with a large torque when resistances are inserted, with the advantage that only about half the energy is wasted in the process, whilst the torque is from 40 to 50 per cent. greater. There is a greater economy when braking, as the motor will act as a generator for part of the time, and return energy to the line. The adoption of this motor will undoubtedly improve the overall efficiency where the winds are short and the acceleration losses important. The power factor is high and the slip very small. The motors are also by nature specially suitable for low speeds, and have the advantage of being quite controllable when running dead slow. At low speeds they also possess the property of developing, for a given consumption of energy, a greater torque than at high speeds, so that the acceleration of the load is reduced automatically as speed is gained—a special advantage for winding purposes, as will be seen later. The cost of the motors is but little more than that of the ordinary type, and they should entirely remove the necessity for expensive equalising gears in most cases.

(f) *Continuous-current Motor supplied by a Combined Continuous and Alternating-current Generator.*—In this system, which has been worked out independently by the writer and Messrs. Brown, Boveri & Co., advantage is taken of the peculiar properties of large steam turbines, especially of the impulse type, as regards close speed regulation and large overload capacity. The turbine has coupled to it a three-phase alternator, which supplies the ordinary power load of the colliery, and also a continuous-current generator, the armature of which is permanently connected to that of the winding motor. The control of the winding is effected by varying or reversing the field of the generator, as required, on what is known as the Ward-Leonard principle. This system, therefore, embraces all the advantages claimed by system (d). The rating of the turbine should be suitable for the average load of the two

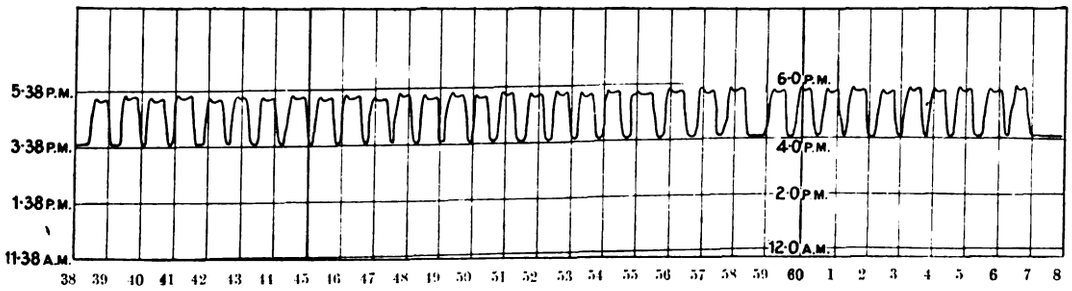

FIG. 4.—"KABLICK" INDICATOR DIAGRAM, SHOWING NUMBER OF WINDS TAKEN DURING OFFICIAL TEST.

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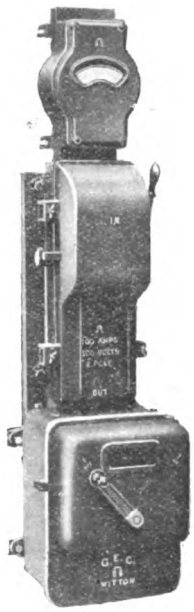
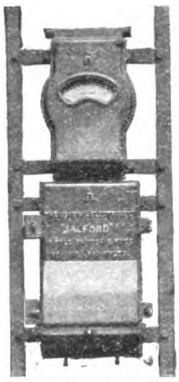
G.E.C. SWITCHGEAR

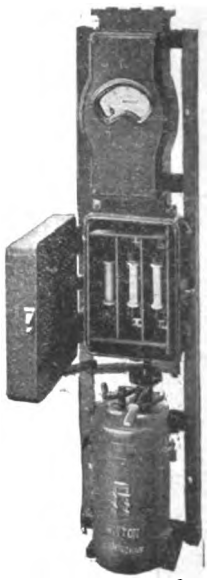
FOR MINES, COLLIERIES, ETC.



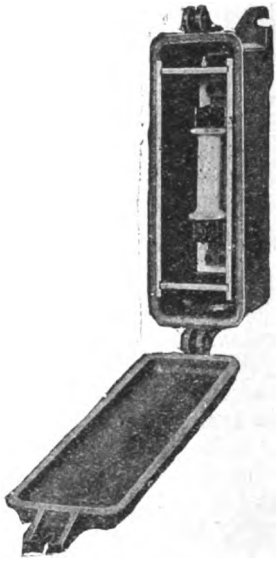
'Witton' Motor-starting Panel
DOCKYARD TYPE.



Ironclad Control Panel.



Three-Phase 'Witton' Motor Panel with Reversing Switch.



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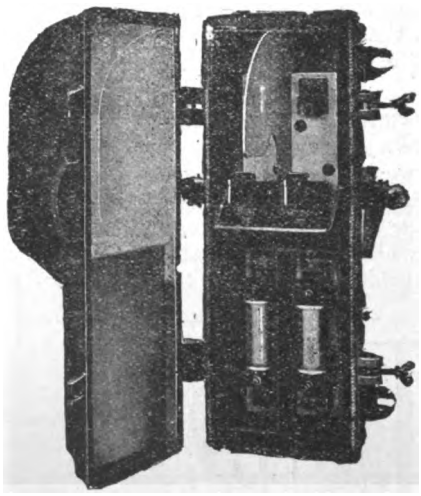

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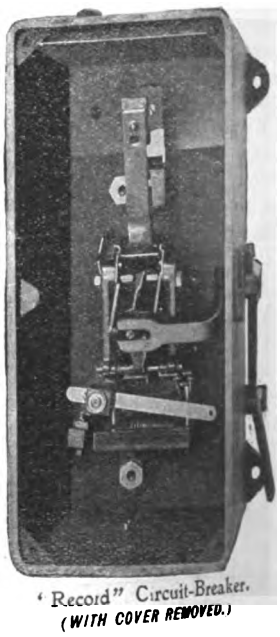

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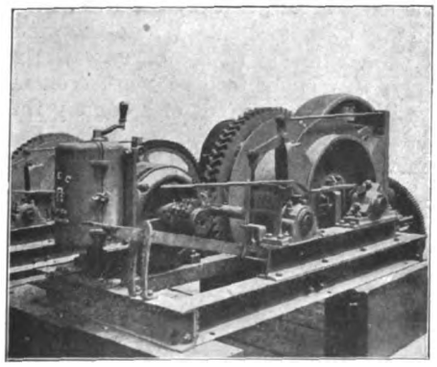
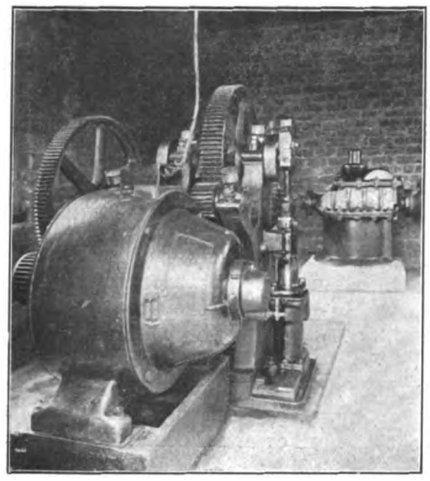
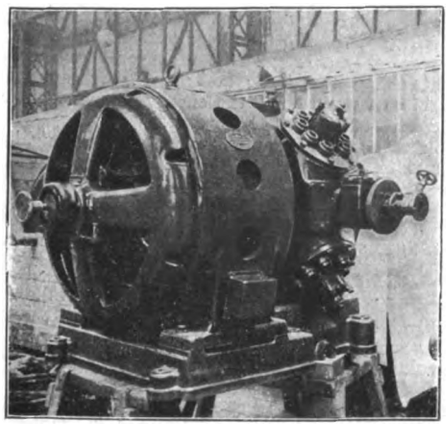


Three-Phase "Witton" Motor coupled to Single-Drum Haulage Gear.



Totally Enclosed, 'Witton' Motor, driving Pump.



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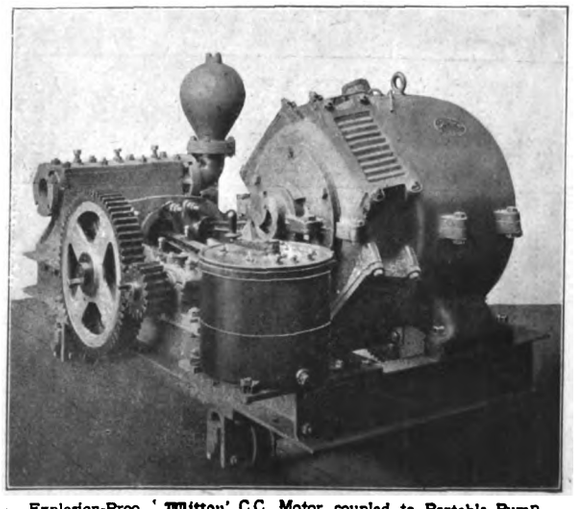

Explosion-Proo 'Witton' C.C. Motor, coupled to Portable Pump for use in Fiery Mines.

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Table.—*Details of Electric Winding Plant in Great Britain.*

Particulars.	Great Western Colliery Company's Maritime Pit.	Ferndale Colliery Company's No. 9 Pit.	Powell-Duffryn Company's Abercwmboi Pit.	Powell-Duffryn Company's George Pit.	Harton Coal Company.	Great Western Colliery Company's Cwm Sinking.	Mickelfield Coal Company's Ledstone Luck Pit.	Sir Samuel Sadler's Etherly Dene Sinking.	Cynon Colliery	Trede-gar Iron & Coal Company.	Trede-gar Iron & Coal Company.	Plenmeller Collieries.	Dunstan Gares-field Colliery.	Wath Main Colliery.	Tinsley Park Colliery.	Pease & Partners' Esh Colliery.	Swal-well Colliery
Date of starting to work	June, 1908	March, 1909	...	...	August, 1909	Proposed plant	Under construction	Under construction	...	...	...	...	...	...	...	...	...
Depth of shaft, in yards	370	516-560	230	490	428	780	280-300	70	200	80	363	266	152	290	100	54	40-60
Weight of each rope, in tons	2	4·0	1·1	...	3·5	6	1·32	0·195	...	...	...	...	...	0·2	80·0	0·122	0·109
		(approx.)															
Weight of each cage, with chains and tubs, in tons	5·35	4·9	2·5	...	7	7·35	3·57	1·5	...	1·5	1·5	2·25	1·0	2·5	2·6	1·6	...
Weight of coal per wind, in tons	2·5	3	2·7	3·0	4·25	6·1	1·8	0·7	2·25	1·5	...	...	...	2	2·4	0·7	0·5
Total weight on rope, in tons	9·85	11·9	6·3	...	14·75	19·45	6·69	3·195	...	...	...	...	...	4·7	508	2·422	...
Type of drum	Spiro-cylindrical	Cylindrical	Cylindrical	...	Cylindrical	Spiro-cylindrical	Cylindrical	Cylindrical	...	...	...	...	...	...	...	...	...
Weight of balance-rope, in tons	None	4	1·1	...	4·75	None	1·32	None	...	...	...	...	...	None	None	None	None
Average acceleration, in feet per second per sec.	4·4	2·8	2·9	...	...	...	3·13	0·54	...	...	...	...	...	1·11	0·33	1·9	...
Maximum speed, in feet per second	40	63·2	2·6	9·8	...	60	41	3·8	25	...	31	23	21	11·1	6·6	19	...
Average deceleration, in feet per second per sec.	5·7	4·4	3·7	...	...	...	3·13	1·91	...	...	...	...	...	2·2	0·66	6·3	...
Time of a wind, in seconds	36·5	44	35·5	...	4·8	50	35	60	...	...	...	...	...	75	60	15	15
Average number of winds per hour	14	66·6	72	20	...	60	85	...	...	...	...	...	...	40	...	144	180
,, time for banking, in seconds	15	10	15·5	...	...	10	7·5	20	...	...	...	...	...	15	...	10	5
,, output per hour	23·8	200	194	...	240	366	152	...	100	...	...	...	...	80	...	100	90
,, tons per wind	1·69	3	2·7	...	...	...	1·8	0·7	...	...	...	...	...	2	...	0·7	0·5
Units consumed per hour	51	518	247	...	...	1,350	250	...	...	...	...	...	...	...	...	...	...
,, ,, wind	3·65	7·8	344	...	...	22·5	2·95	0·245	...	...	...	...	...	...	...	...	...
,, ,, ton	2·16	2·58	1·275	...	...	3·7	1·64	0·35	...	...	...	...	...	...	...	...	...
Shaft efficiency, per cent.	44·5	50	46	...	1,700	54	46·5	50	...	...	...	...	...	...	...	...	...
Average maximum load on motor, in horse-power	1,300	1,790	587	...	...	3,600	808	28	...	...	...	...	...	...	...	...	...
,, ,, supply-mains	455	430	...	...	...	1,800	290	16·21	...	...	...	...	...	...	...	...	...
System of working	Westinghouse Converter-equalizer.	Ilgner	3-phase direct	3-ph. direct	...	Ilgner	Ilgner	Geared direct	...	(Geared direct	Geared direct	Ward-Leonard	Geared direct	Geared direct	...	...	...
Voltage	2,200	2,200	3,000	3,000	5,500	2,200	2,000	440	...	500	500	600	400	500	...	...	...
Periodicity	25	25	50	50	40	25	50	40	...	40	40	50	40	50	...	...	...

generators, the boilers forming the storage of energy. T... turbine runs at a high efficiency, with a fairly constant ... ing load, and provides the peak loads required for the ... with very little drop in either speed or efficiency. Th... cost of the plant is low, and there is less machinery to ... than with any other system. Where the winding load ... excessive, in proportion to the other power requirements ... the colliery, this is by far the most economical system ... supplying all the power needs of a colliery that has yet been devised.

The limitations of winding of any system seem to be reached between 3,000 ft. to 4,000 ft. on account of the large amount of coal to be lifted per wind, and the increasing weight of the rope. Although the rope makers are prepared to admit a lowering of the factor of safety hitherto adopted on account of increased quality, the advent of the electric winder has really been responsible for an all-round reduction in the figure, viz., from 8 to 5. This was due, of course, to the dynamic stresses being considerably reduced due to reduction of acceleration, even turning moment and decreased acceleration as speed increases.

It seems, however, that with increasing depths some other method of winding will be required, such as continuous winding with a bucket-chain, or pumping water and equalising coal wound by water, as is frequently seen with funicular railways.

With steam windings these limitations are sooner reached on account of the rapid increase in dimensions of the drums and engines. The electric motor, however, has enabled us to wind from greater depths on account of the permissible lowering of the static factor of safety of the rope and the fact that the limiting factor of the electric motor is the heating which is governed by the *average* speed and not the average maximum turning moment. These conditions may be still further improved by the use of a Koepe pulley and balance ropes, but for some reasons these have found no favour in this country, although they are largely employed on the Continent. The introduction of the Koepe pulley would considerably cheapen the first cost of the installation on account of the smaller masses which have to be accelerated.

The accompanying Table gives a list of the electric winders at present at work or under construction in this country.

NOTES RELATING TO THE TABLE.

I.—Great Western Colliery Co. (Ltd.), Maritime Pit.

The figures relating to the output and units consumed are the actual working results for the whole of the year 1909.

The weights include all the coal and rubbish raised, but no ... is made for the winding of men. It will be noted that the plant is capable of 70 winds, or 175 tons per hour. As the output (spread over whole year) only averages 23·8 tons per hour (exclusive of ...) load factor may be said to be only 14 per cent. When the ... raising 175 tons per hour, the energy consumed is 1·75 units ... giving a shaft efficiency 54½ per cent.

The capital cost of this plant was £7,450, or roughly £5 14s. per ... mum horse-power, equal to £31. 12s. per shaft-horse-power.

II.—Ferndale Colliery Co., No. 9 Pit.

These figures are taken from the published results of the test ...

III.—Powell Duffryn Colliery Co. (Ltd.), Abercwmboi.

The figures in this case relate to the average working ... plant, as run at full load. The winding motor is connected ... 3,000-volt mains without any equalising gear.

IV.—Great Western Colliery Co. (Ltd.), Cwm Sinking.

These figures relate to a proposed plant for this shaft, the ... of which, exclusive of buildings, but including flywheel, ... drum and shaft, with all accessories, is £19,000, equal to ... maximum horse-power, or £19. 5s. per shaft-horse-power.

The flywheel equalising set is required in this case, as ... large in comparison with the other requirements of the colliery.

V.—Mickelfield Colliery Co. and Etherley Dene ...

These columns give the estimated results of the plant ... under construction for these pits) when working at full load.

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Coal Cutting.

BY H. J. FISHER.

Summary.—The author discusses the conditions under which electric coal cutting should be carried on to show success, and refers to some of the various types of machines that are at present available. Some references also made to the accessory apparatus connected with coal cutting. Finally a brief account is given of the chief electrical coal cutters at present on the market.

The mechanical cutting of coal was first heard of about the year 1761, when the first patent for this process was taken out by Mr. Michael Menzies, of Newcastle-on-Tyne. This patent was granted for a mechanical contrivance for cutting coal, which was to be driven by ropes or chains connected to a steam engine, or, as they called them in those days, a fire engine, or to a water-wheel or horse gin. It was not, however, until about the year 1870 that we hear of any real progress being made. The first machine to be driven by electricity was installed about the year 1887 at Bowers Allerton Colliery, in Yorkshire. The motor was not coupled direct to the machine, but was situated some distance away, power being transmitted from the motor to the cutter by means of ropes. Since that date electric coal cutters have made rapid advance, but have not up to the present caught up in numbers to their great rival, the cutter worked by compressed air.

Of late years great strides have been made with the art and practice of winning coal by mechanical means. Very great progress has been made in the use of machinery in mines, and in no branch has there been more progress than in coal cutting and conveying machinery. If a judicious choice be made in the first place, and sufficient care be taken with the maintenance and upkeep of the plant, still greater success will be attained.

There is no doubt that the winning of coal in the thin, and more especially in the deeper, seams will at no distant date be rendered a pleasanter and less hazardous task than it is at the present time. It should also, if the proper steps be taken, be a more profitable one for the owners.

The first thing to consider is the condition under which the machines will have to work, and the best methods of operation, so as to combine the maximum output with a minimum of repairs and upkeep. The success of coal cutting does not necessarily depend upon the number of yards cut by the machine on a certain day, but upon regular and systematic output. This can only be attained by a thorough, and at the same time expert, supervision, both on the part of the mining officials and the mechanical and electrical staff.

There are practically only two methods used for driving coal cutters, electricity and compressed air; of these two, electricity is by far the more efficient, being, in practice, three times as efficient as compressed air. The disadvantages of compressed air are greater initial cost, the trouble, owing to the movement of the ground, of keeping sound joints on the pipe system, and the greater cost of upkeep as well as the inflexibility of the system. The advantages are that it assists ventilation and that there is a great factor of safety from explosion.

The use of electricity in mines is regarded with some fear at the present time, but if proper care and attention were paid to details and good plant in the first place, and supervision were in the hands of a thoroughly reliable man, we should hear less about the possible dangers.

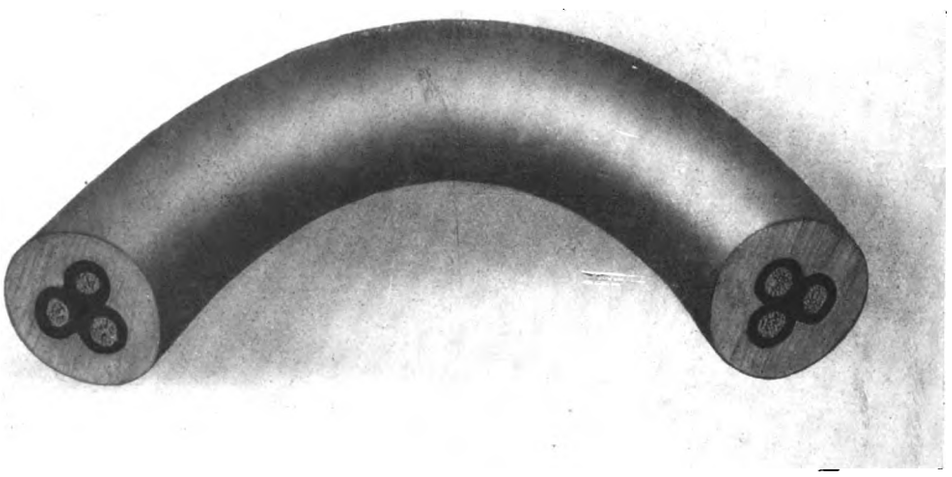

FIG. 1.—"CAB-TYRE SHEATHED" TRAILING CABLE. (St. Helens Cable & Rubber Co.)

Let us look into some of the dangers that may arise. Taking first the question of shock, this can be nearly eliminated providing that a proper system of earthing is carried out. In the old rules the earthing of portable machines was not compulsory, but in the new rules just issued this has been made so. In using the words "nearly eliminated" I was taking into consideration the fact that whatever rules may be drafted it is impossible to provide for the meddlesome or careless person, and this class of person has always to be reckoned with.

The next danger is that from sparking. This can be practically got over in the first place, for all modern machines can, without any great amount of trouble, be made perfectly flame-tight, a flame-tight joint being preferable to a gas-tight one. The word "gas-tight" is often misleading, as a joint may be gas-tight when new, but after a time the perishable nature of the material used for making the joint renders the apparatus practically useless against gas.

Cables are now made that are practically proof against external sparking, even under the influence of "dead shorts."

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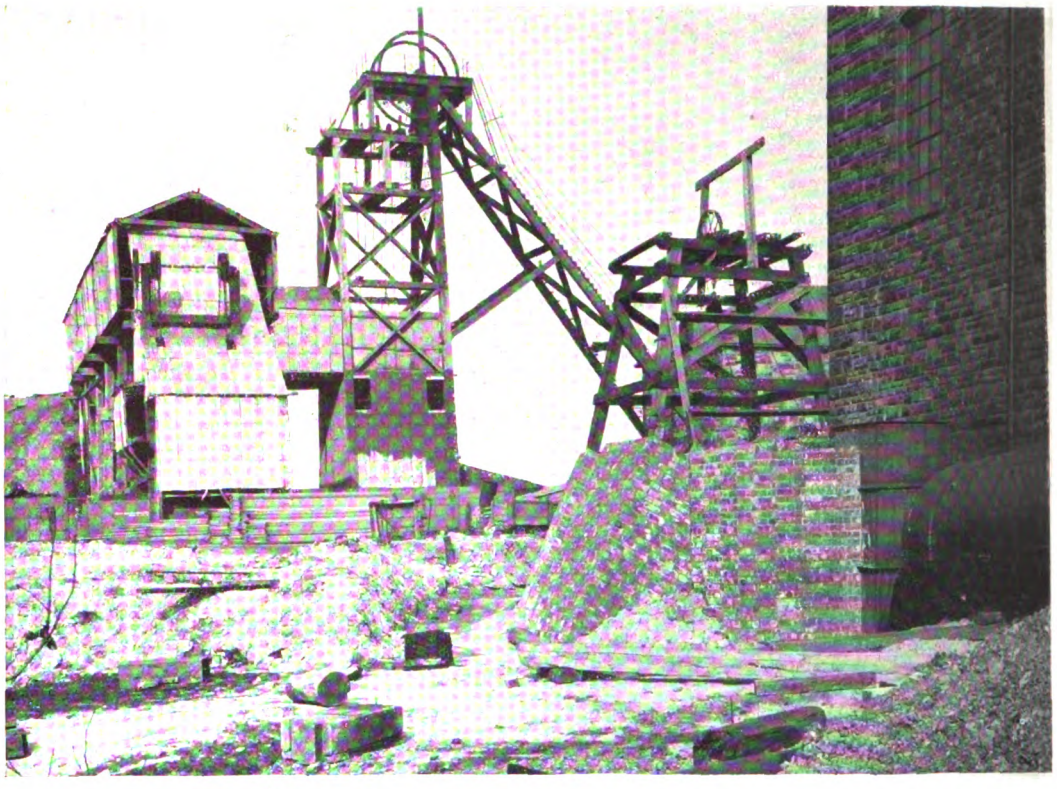

"Vickers-Ordnance" Mine Fan Ventilating a Colliery in S. Wales.

"VICKERS-ORDNANCE" MINE FANS

are unexcelled for high efficiency.

The construction is more rigid, and the wear on all moving parts is less in the "Vickers-Ordnance" Fan than in any fan of similar type; therefore the cost of upkeep is lower and the life longer than that of any other fan.

Gives greatest volume of air per revolution at all pressures, and

Maximum pressure is maintained, as the air does not slip back between the blades, hence the greatest possible efficiency is obtained.

Can be supplied for rope drive, or direct coupled to steam engine or electric motor, and

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Trailing cables are also made in the same way, the cores being insulated with vulcanised rubber and sheathed with bitumen and provided with a protective layer of tarred rope, this class of cable being made by Messrs. W. T. Glover & Co. There is also a new type of trailing cable which has been introduced by the St. Helens Cable Co. In this cable the cores are insulated with rubber and then sheathed with their well-known brand of cab-tyre rubber, as shown in Fig. 1. This class of cable is very light and flexible, and the makers claim for it distinct advantages over all other classes.

To adopt successfully mechanical means of cutting coal certain factors must be borne in mind. The choice of a machine depends mainly upon the nature of the coal, whether this is hard or soft, or if the machine is to cut in a band of stone, seggar or splint, for what may suit one seam will not suit another.

The choice may lie with either disc, bar or chain type of machine, and in all cases will depend upon the local conditions. For seams where the coal is hard and not likely to crumble and fall, the disc type of machine will best meet the requirements, or the chain type may be used. Where the coal is of a soft

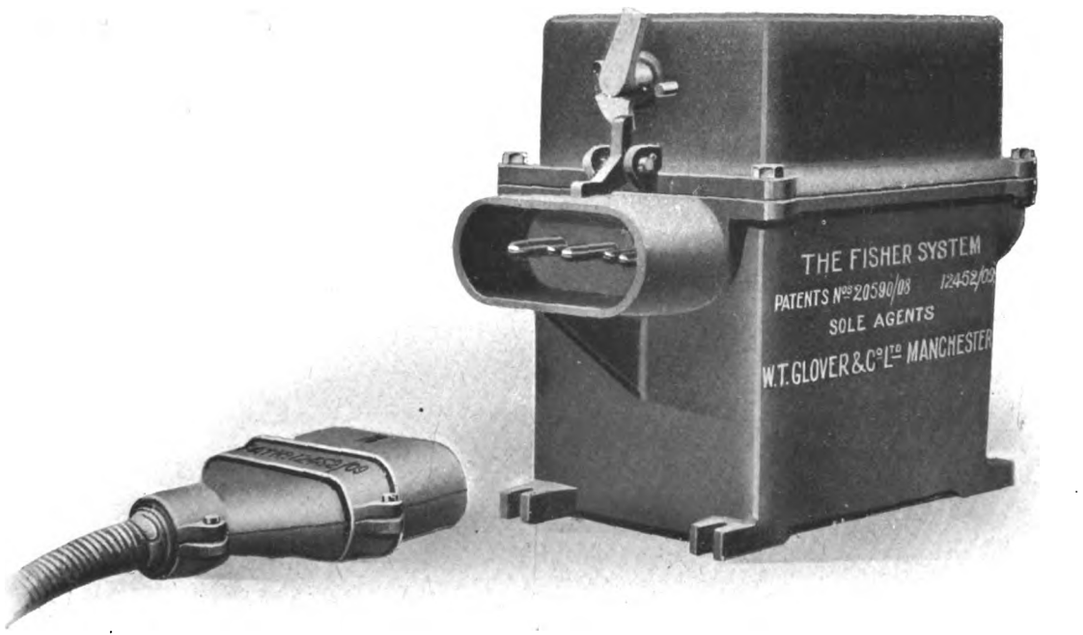

FIG. 2.—FISHER'S GATE END SWITCH.

There are now several excellent gate-end panels on the market; the switches for alternating current break under oil, and are flame and fool-proof. The plugs also are interlocked with the switch—a very desirable precaution indeed, as the plug cannot then be withdrawn unless the switch is in the off position.

A thing that is very necessary in connection with gate-end switches is that they should be automatic in action, and fitted both with overload and no-volt releases. The absence of fuses is a distinct advantage, as it obviates the necessity of the machine attendants replacing fuses (which is not a very pleasant task in the confines of the mine), besides preventing great waste of time; it also enables the switch box to be securely locked against tampering. Fig. 2 shows an ideal switch and Fig. 3 a diagram of the connections of the same, designed by the author, and embodying many important features which were described in our last mining issue.

and crumbly nature the bar type of machine will be most suitable.

Again, in choosing a suitable machine, care should be taken that it is not too light for the work to be done. Many coal cutters that the writer has come across have been far too light for the work they have had to do; in the majority of cases it has been principally amongst the minor details that this has occurred, but in some cases it has been the motor itself that has been too small for the work. For example, a machine sent out to under-cut 5 ft. 6 in. was found to be cutting only 20 yds.

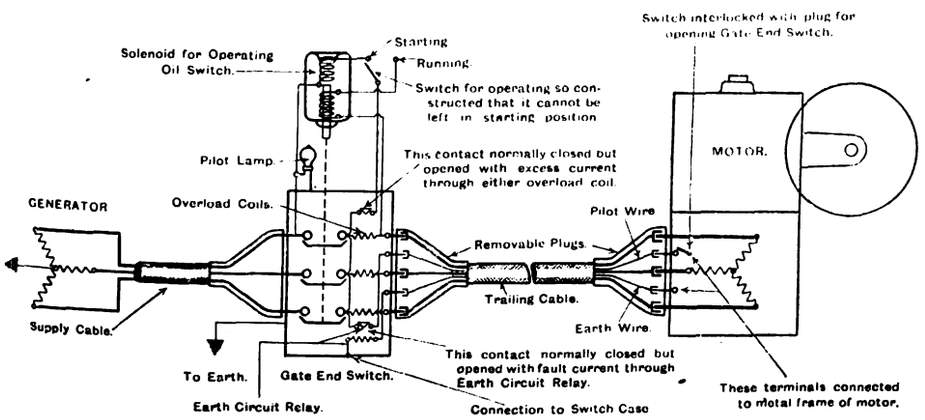

FIG. 3.—DIAGRAM OF FISHER'S GATE END SWITCH.

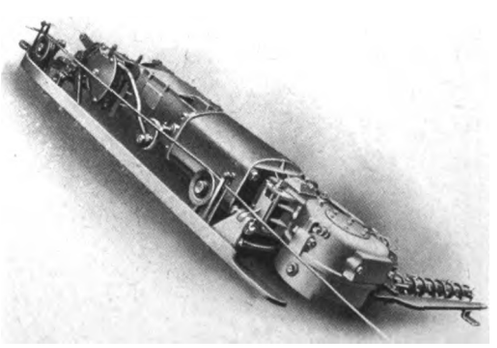

FIG. 4.—DIRECT CURRENT BEN COAL CUTTER.

to 30 yds. per shift of eight hours, and the troubles on the machine were endless. The cutting wheel or bar was changed, and the machine made to under-cut 4 ft. 6 in. Most of the troubles then disappeared, and, moreover, the machine has cut from 80 yds. to 100 yds. per shift.

As to the performance of coal cutters, the figures in Table I.

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are results of tests, and Table II. is from data published by Messrs. Mavor & Coulson.

Table I.

Time.	Depth of under-cut.	Yards cut.	Units used.	Units per lineal yard.
2 hours	4 ft. 6 in.	40	12·0	0·3
3 hours	4 ft. 6 in.	60	20·0	0·33
1 hr. 54 min.	4 ft. 6 in.	35	11·9	0·34
2 hrs. 15 min.	5 ft. 6 in.	40	24·0	0·6
2 hrs. 20 min.	5 ft. 6 in.	45	25·0	0·55
1 hour	5 ft. 6 in.	28	15·5	0·55

Table II.—*Data by Messrs. Mavor & Coulson.*

Period of working.	Depth of cut.	Energy per sq. yd. cut.	Energy per ton produced.	Total cost d/d to haulage.	Previous cost by hand holing.	Saving by machine.
		Unit.	Unit.	Per ton.	Per ton.	Per ton.
One year.....	5ft. 3in.	0·53	0·35	2s. 5d.	3s. 11d.	1s. 6d.
One year.....	3ft. 10in.	0·26	0·24	1s. 8½d.	2s. 9d.	1s. 10½d.

One of the greatest drawbacks to coal cutting is the large amount of mechanical damage that occurs, but this can, to a very great extent, be overcome. There are three reasons for this trouble. Firstly, bad design; secondly, careless handling; and, thirdly, the absence of systematic overhauling of the machine and frequent inspection. In many mines there is a little too much of the haphazard spirit displayed in the inspection of machines, men being quite content to sit down and wait for trouble.

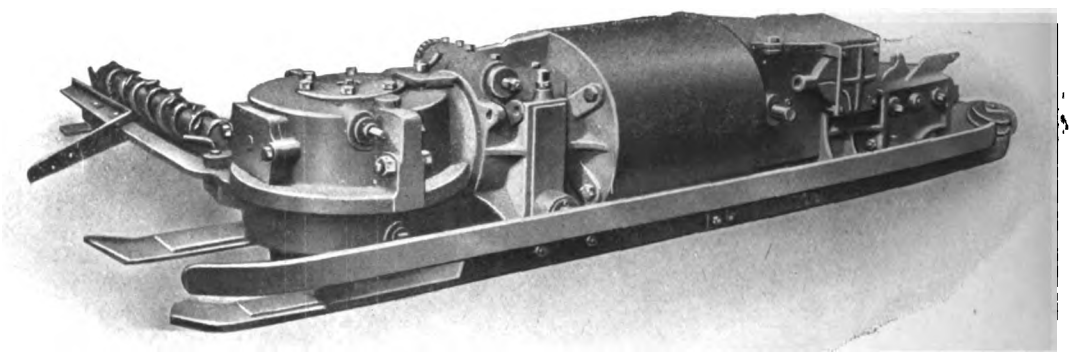

FIG. 5.—THREE-PHASE COAL CUTTER. (Mavor & Coulson.)

It has been found that the best practice, where the number of the machines in use would warrant it, is to employ a special man and to give him entire charge of both the mechanical and electrical parts of the machines. And to attract the right sort of man a good wage must be offered; it will pay over and over again.

Each machine at the beginning of each shift should be inspected, necessary adjustments made, and loose nuts and bolts tightened up. At stated and regular intervals whole machines should be brought to bank and thoroughly overhauled, a spare machine being kept to enable this to be done, and to prevent the loss of coal consequent upon a machine standing, or to prevent a machine being rushed back to work before the overhauling is satisfactorily completed.

Where coal cutters are situated considerable distances inbye, or where the use of electricity at the face is restricted, electro-air compressors have been introduced into the mine. These compressors are situated in an engine house in the main intake airways, some distance from the face. Such machines, however, work with a very poor over-all efficiency. In fact the power taken by the air compressor, just to keep the up pressure alone, has been found in practice to be as much as 45 per cent. of its full load. The power costs for cutting by these means work out at about six times as much as the costs of electric coal cutters. Notwithstanding the low over-all efficiency of the electro-air compressor, there is an ever-widening field for these machines; but the machines in use at the present time are principally small ones, and are chiefly used for supplying power to heading machines, pneumatic drills and percussive cutters.

It is very surprising how backward British mine owners are in adopting mechanical means of cutting coal, and this is found to be especially the case when comparisons are made with the number of machines in use in the United States.

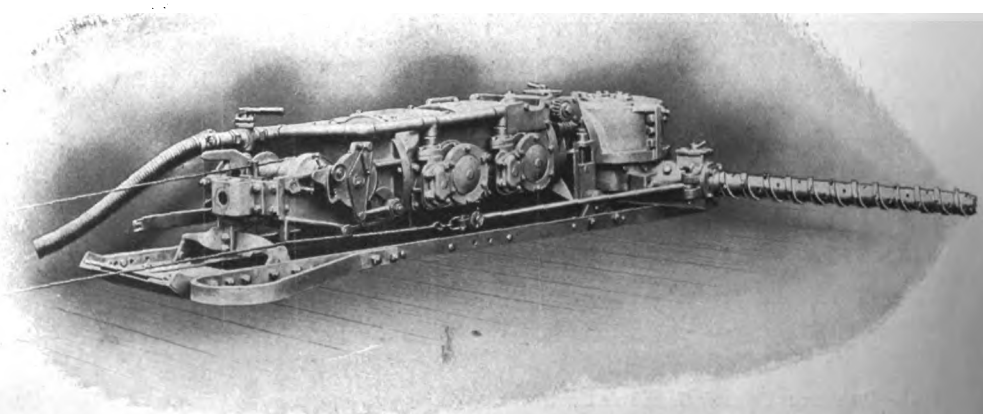

FIG. 6.—BEN TYPE CUTTER.

Taking the year 1901, there were 4,341 machines at work in the States and only 311 in Great Britain; in 10 years the increase in the number of machines in the United States was 3,796. Out of 3,000 collieries in Great Britain only just over

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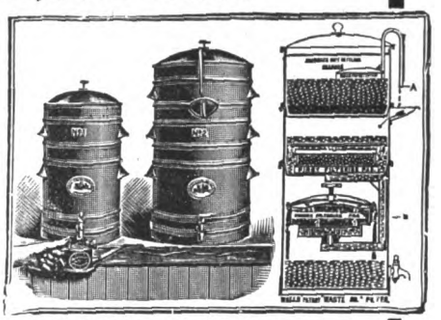

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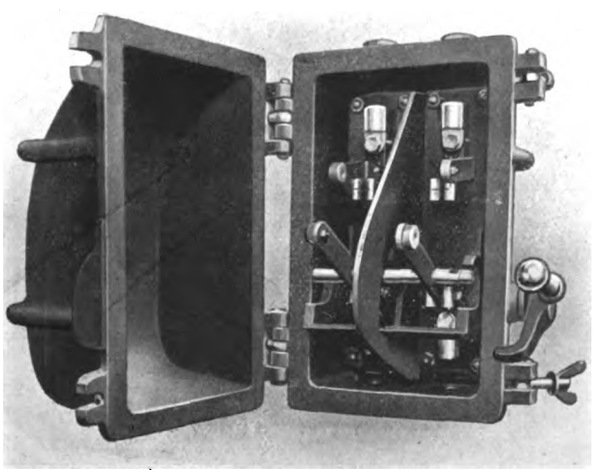

Interlocked Explosion-Proof Switch.

Interlocked Oil Switch, with Three-phase Liquid Starter. Cover removed.

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100 are using coal cutters, showing what a tremendous field there is for development in this branch of mining.

Seeing that direct current has been applied to coal cutters for about 24 years, it is not to be wondered at that the majority of machines are driven by this means. Alternating current has only been applied to coal cutters during the last eight or nine years. Alternating current has certain advantages over direct current, especially where squirrel-cage rotors are used, as there is less likelihood of sparking; but at the same time there is the disadvantage of the heavy starting current taken by this class of motor. This means that if fuses are used the machine has to be very heavily over-fused, and to get over this difficulty time limit automatic overload releases must be used. It is impossible to use a device to short-circuit automatically the fuses on starting, as these are situated some distance away from the machine, in the gate-end panel. If alternating current is used the author prefers a wound rotor, as by this means the majority of the starting troubles are overcome; very successful work is now being done by this class of machine. With direct-current machines the majority of the troubles are with commutating, and with short-circuits caused by the collection of coal and carbon dust.

Fig. 5 shows a three-phase machine of the well-known bar type invented by Mr. F. Hurd and manufactured by Messrs. Mavor & Coulson, of Glasgow. This type of machine is made in three different sizes to suit various requirements. In construction all three machines are the same, the coal being cut by a tapered steel bar, the cutting tools or picks being wedged into holes drilled into the bar; a spiral thread formed on the bar acts as a conveyor for the cuttings, and brings this dirt from the back of the cut. The bar fits into a socket which permits of bars of varying length being used. The socket for the bar, together with its gear, is carried upon a moving turntable which admits of the bar being swung round to any angle

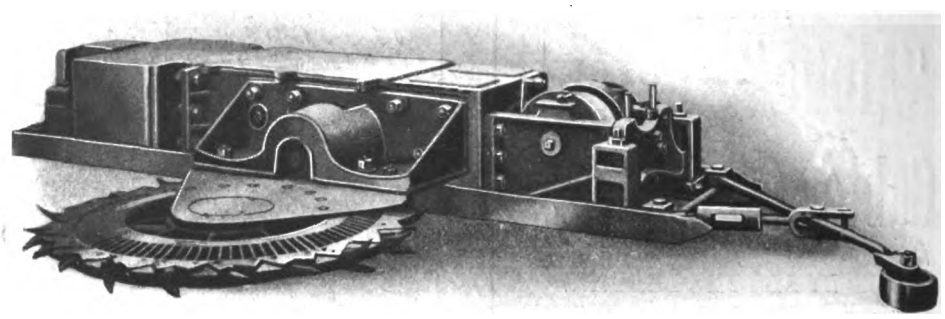

FIG. 7.—DISC TYPE COAL CUTTER.

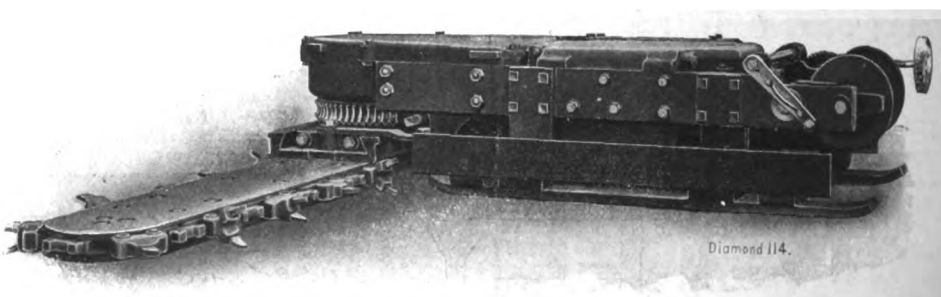

FIG. 8.—LONG WALL CHAIN MACHINE.

tilted up and down while at work. This arrangement allows the machine to cut at either side, and also to open up its own cut. The bar is run at a speed of about 500 revs. per min., a reciprocating motion being imparted to the bar as well as a rotary one. This produces a chipping or picking action, and is most effective when the machine is cutting in coal. The bar can be arranged to cut at floor level or above. The travel of the machine is arranged in exactly the same way as with the disc machines, by means of a haulage drum worked by a ratchet and pawl.

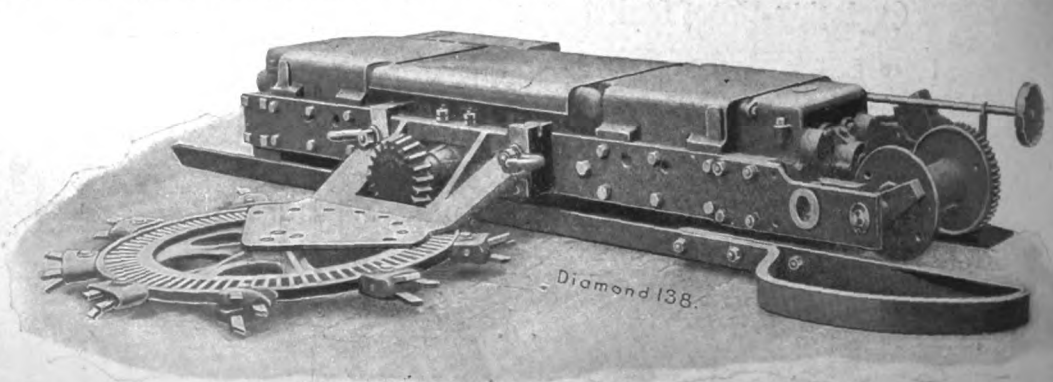

FIG. 9.—DIAMOND TWO MOTOR DISC MACHINE.

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Fig. 4 shows a direct-current bar coal cutter, and Fig. 6 a compressed air bar-type cutter, both made by Messrs. Mavor & Coulson. Fig. 7 is a disc type of coal cutter which Messrs. Mavor & Coulson have recently put upon the market. This machine is called the Samson, and has been designed for cutting in very hard material. The machine is of great strength and rigidity, the working parts combining the essential requirements of strength and durability; ample protection is provided from injury from falling material, all parts are easily accessible and readily interchangeable.

Fig. 8 illustrates a long-wall chain machine which is made by the Diamond Coal Cutter Co., of Wakefield. This machine is made for both alternating and direct current. The jib carrying the cutter chain can be swung through an arc of 180 deg., which enables the machine to travel either to the right or the left. Great care has been taken to make the motors and switchgear flametight, the latter being fitted with safety devices to prevent accidents. Machine-cut gears are used throughout and are run in a steel case containing oil or grease.

Fig. 9 illustrates a standard Diamond two-motor direct-current disc machine. This is fitted with motors of 12 H.P. to 18 H.P., connected in series; the motors and switchgear are fitted in flame-tight cases, with the latest safety devices. There are more machines of this type in use than all the others put together.

Fig. 10 illustrates a standard single-motor direct or alternating-current disc machine, the motors ranging from 25 H.P. to 30 H.P. The alternating-current motors are fitted with ball bearings, and the larger size direct-current motors are fitted with four wound poles and ball bearings. The ball bearings are certainly a decided improvement upon the old type of brass or white metal bush. All the machines are fitted with special safety devices and automatic earth connections to comply with the new regulations; the plugs on the trailing cable are interlocked with the starting switch, by which means it is impossible to withdraw the plug and produce a spark while the machine is running.

Fig. 11 illustrates a standard pattern direct-current starting switch fitted with safety devices, the case being flame-tight and having machined faces 1¼ in. to 1½ in. wide; the lid slides into position and is interlocked with the switch, and cannot be opened while current is passing.

In connection with coal cutting, and more especially in thin seams, face conveyors are used, the best known type being the Blackett. This is continuous in its discharge, operating as it does by means of an endless scraper chain running along a U-shaped trough. The motors for these conveyors are designed to give 10 H.P. These conveyors are capable of delivering 30 tons per hour. A good roof and a rapid, and at the same time regular, advance of the face is an essential feature for the successful working of these machines.

Another type of conveyor is the Ritchie, which has an intermittent discharge. It consists of a belt 20 in. wide, and this is caused to reciprocate one-third the length of the face in a light steel troughing. The principle is something like a planing machine, in which the return idle stroke is considerably faster than the useful movement, thus avoiding needless loss of time.

Fig. 12 shows an interesting device made by the Diamond Coal Cutter Co. This is an earth leakage current release switch, in which the earth current passes through a fuse that holds the distribution switch in the "on" position. This is specially designed for the protection of circuits having coal cutter and other isolated motors which cannot be earthed other than through a practically insulated line.

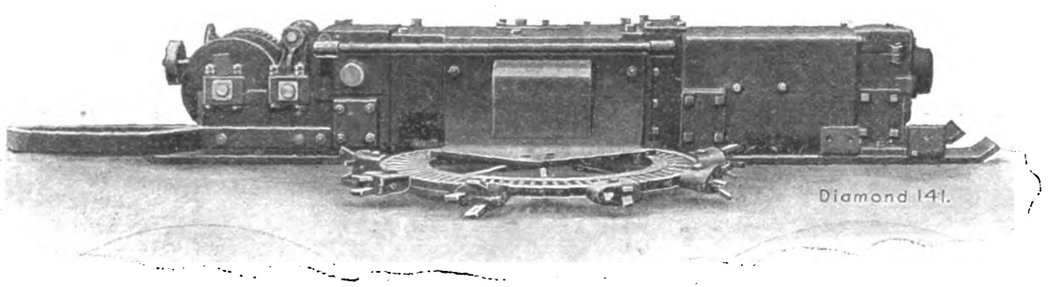

FIG. 10.—ONE MOTOR DISC MACHINE.

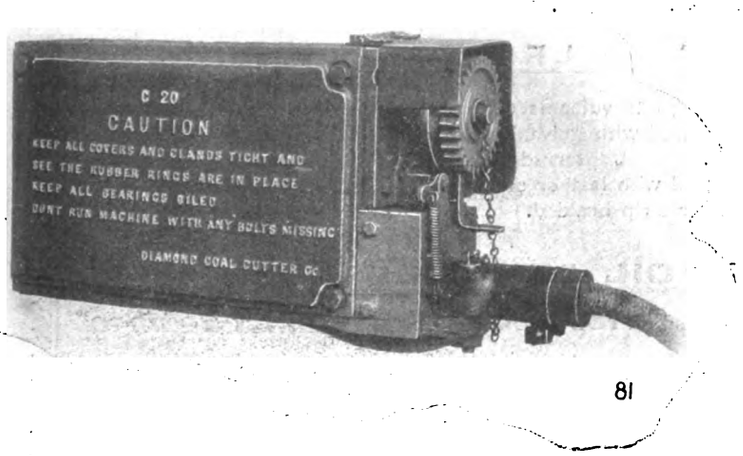

FIG. 11.—STANDARD PATTERN DIRECT-CURRENT STARTING SWITCH.

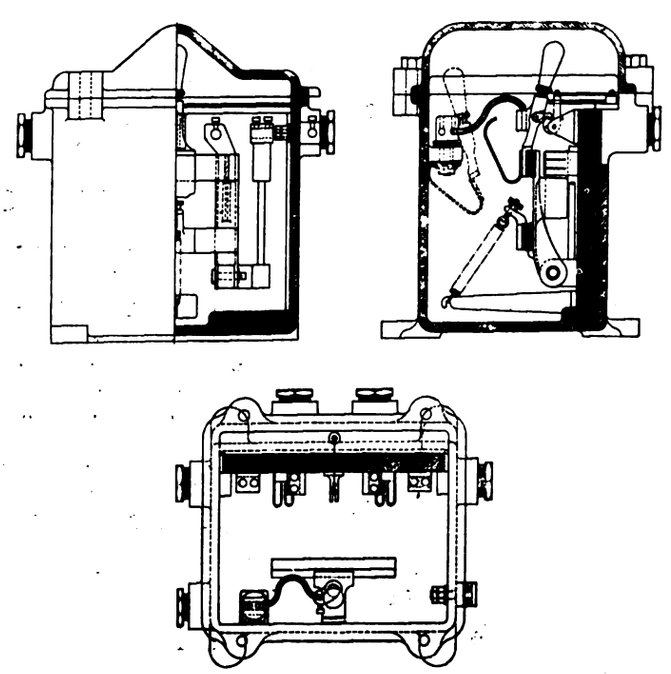

FIG. 12.—GENERAL ARRANGEMENT OF DIAMOND EARTH LEAKAGE SWITCH.

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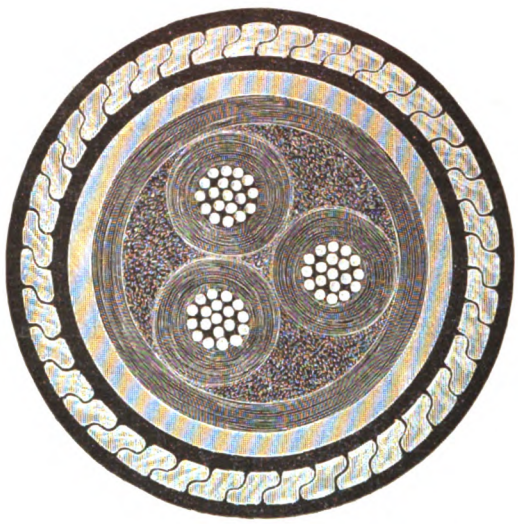

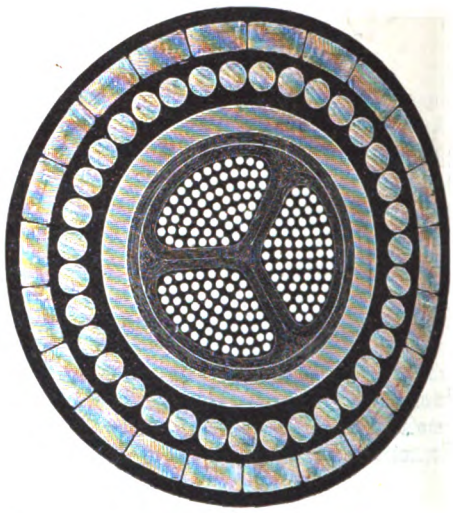

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Underground Colliery Wiring.

BY A. B. MALLINSON, A.M.I.E.E., A.M.I.MECH.E.

(Of Messrs. Mather and Platt, Ltd.)

Summary.—The author discusses the various points to which attention must be given to ensure a satisfactory system of colliery wiring, and he deals particularly with the selection of the cable, its handling, its erection in the shaft, the erection of in-bye cables, earthing, wiring for lighting and finally, the maintenance of the system.

General.—This subject is perhaps the most vital, and yet at the same time the most abused, of the whole of the links connected with the instalment of electricity in mines. Electrical appliances for underground use, *i.e.*, motors, switchgear, fittings and cables, &c., have now reached a high degree of perfection, and, provided they are correctly installed, and have reasonable attention given in maintenance, their safety, reliability and life will equal that of any other prime mover.

Motors and switchgear, being complete in themselves, can generally be relied upon when they are put to work underground to be in the condition in which they left the test-plate. With cables, however, everything depends on the way the cable is handled during erection, and the manner in which it is finished off. The possibility of trouble here is amplified by the practice, which is common in many collieries, of ordering the material from the various manufacturers, the instalment being carried out by the permanent staff at the pit, and so reducing the capital expenditure. It is under these conditions that the link known as the "wiring" is liable to suffer, and a few wrinkles on this particular branch of the work should, therefore, be of general interest.

To confine attention, three-phase equipments only will be considered, starting from the pit head. A typical wiring equipment of this kind is shown diagrammatically in Fig. 1. The subject can be divided up into eight sections :—

1. The selection of the proper type of cable
2. Hints on the handling of cable.
3. The erection of shaft cables.
4. Erection of in-bye cables.
5. The ends of cables.
6. Earthing.
7. Underground lighting wiring.
8. Maintenance.

1. Selection of the Proper Type of Cable.

For three-phase work all power cables would, of course, be three core. The insulating material can be :—

Rubber, by which it is inferred that the actual insulating medium is a combination of pure and vulcanised rubber.

Bitumen, in which the insulating medium is a non-hygroscopic compound.

Paper, in which the insulating medium is wrapped round the cable and impregnated with a hygroscopic substance.

Perusal of cable makers' lists will show an amazing variety of cables, but they all boil down to one or another, or a combination of two of the above.

Rubber is practically out of court for three-core cables on account of price, its use now generally being confined to trailing cables, where great flexibility and tenacity of insulation is essential and for small single-core cables. The word "rubber" (like the actual article) has a most elastic meaning, and the purchase of this class of cable for underground use must, therefore, be effected with great care. While for insulator wiring in workshops, &c., above ground, a cheap grade of rubber cable is undoubtedly quite reliable, the risks underground are obviously such that none but the best quality of material should be permitted.

Turning to bitumen and paper insulated cables, the relative good points can be got from any manufacturer's list. The question for the mining engineer is, "Which is the best for colliery work?" While paper-insulated cables have, in certain collieries, been successful, even their most rabid supporters must admit that they are essentially an electrician's cable, and require the most careful handling by expert jointers to ensure satisfactory installation.

The main objections raised to bitumen cables are :—Liability to decentralise, and low insulation tests. With the even temperature underground (when electric power is used), decentralisation, provided the cables are not excessively loaded, may be ignored. Low insulation tests are not fatal to the working of a plant, and, for the general run of colliery requirements, they cannot be said to be such as to preclude the satisfactory use of bitumen cable. If, however, this is objected to, one of the combination cables can be used, whereby the insulation resistance will be doubled or trebled. In this connection, a cable made of a combination of rubber and bitumen, *i.e.*, both non-hygroscopic materials, known as "reinforced bitumen," which is now being put on the market by one of the leading firms, should be of value for colliery use.

The factor of safety of any wiring system is dependent upon the number and workmanship of the joints. It is here where the hygroscopic cable is liable to fail. The bitumen (or non-hygroscopic group of cables) are therefore recommended as the most reliable all-round cables for mining purposes.

2. Hints on Handling of Cables.

While bitumen cables are, generally speaking, of robust construction, they require a reasonable amount of care in handling.

If possible, the cable should be taken to its site on the drum as received from the maker's.

Don't handle the cable above ground in frosty weather as the bitumen is then brittle.

When lifting up the end of a cable, never let it fall, but lower it gently to the ground, otherwise the bitumen sheath may be shattered, and sooner or later cause a failure.

No three-core cables should be bent round a diameter less than 20 times the diameter of the actual cable.

Particularly watch for kinks in erecting the cable.

In preparing the ends ready for jointing, do not force out the three cores unduly from the centre. If this is done there is considerable likelihood of fracturing the insulation where it leaves the solid worming.

3. Shaft Cable.

For shaft cables, the type recommended is a solid bitumen core, double wire armoured, canvas or jute served (see Fig. 2).

At the pit head the cables should be brought out well away to avoid any possibility of fouling by the winding ropes when new ropes are being lowered down the pit. Fig. 3 illustrates a common way of carrying the cable away from the shaft head, and shows also the type of suspension to take the vertical weight of the cable. In the shaft itself, the position for fixing the cable should be selected where the cable will be most out of the way and least liable to damage by any falling material out of the pit cages.

For three-core cables, supports every 40 to 50 yards are advisable, a good construction being shown in Fig. 4, which is a support for a 0·2 sq. in. three-core 2,600-volt solid bitumen cable, taken about 400 yds. from the surface. The smaller leads shown in this photograph are respectively signalling and low-tension lighting cables.

The erection of shaft cables is a comparatively simple matter, provided it is undertaken in the right manner. There are two ways in which it can be done :—

(*a*) To sling the drum below the cage, and lower out the cable, cleating it as the cage is lowered. In this case there should be a loop of cable hanging below the cage as a safeguard. This is only applicable where the shaft is sufficiently large to take the drum.

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(*b*) To lower the cable from the surface, suspending it as it is lowered by clamping it temporarily to a wire rope about every 30 or 40 yards, leaving the cable slack between each clamp so that the weight is taken on the wire rope. After so lowering down, permanent clamps can be fitted.

If the latter method is adopted, be careful to have all appliances at hand before starting. Mount the cable drum on trestles, and provide a means for breaking it as the cable is drawn off. Operate the tension rope from either a steam or hand winch, in either case having good brakes. Anchor everything securely, and above all don't skimp the labour available. Three or four pounds wasted here is nothing compared with the loss that would occur if the cable overcame the men and went down the shaft.

At the bottom of the shaft bring the cable into the workings with the minimum of horizontal length actually in the shaft. Every foot of cable in this position is more liable to damage from falling material than 100 yards of vertical cable.

Immediately after erection the whole of the shaft cables and suspenders should be well treated with Stockholm tar.

4. Erection of In-bye Cables.

For fixed positions underground "Three-Core Bitumen Single-Wire Armoured and Served Cables" are most suitable. Where flexibility is required, such as for coal cutters, heading pumps and the like, a "Rubber Insulated Four-Core Hard Cord Braided Cable" makes the best job, the fourth core being used for the earth connection. For the erection of in-bye cables no hard and fast rules can be recommended. Everything depends on the nature of the roof, the facilities underground for erection, class of mine, and size of cable.

For main roads close to the shaft bottom, if brick walls and reinforced concrete roofs are used, the cables may be supported on bearers built into the brick-work. Further from the shaft, in the actual workings, to comply with the Mines Regulations, flexible suspensions are necessary. The old raw hide suspenders are hard to beat in this way, provided they are put in of sufficient size to carry the weight of the cable and not pitched too far apart. Canvas suspenders are also good, particularly those which are made with a wide base to distribute the load on the cable. Spring clips have not made much headway, and can hardly be said to be commercially practicable for any but the driest mines. The support for the cable can easily be taken from an ordinary pit nail driven into the timbers, or, where such do not exist, into a plug in the side of the road.

In running power cables down dips on suspenders it should be remembered that the ordinary leather thongs are not well adapted for taking the weight of the cable on a dip, and provision ought, therefore, to be made every 30 or 40 yards to anchor the cable.

The getting of cables in-bye is, with larger sizes, often a matter of considerable difficulty. If the roads are big enough the cable may be unwound going down the road, being cleated up immediately behind it. If, however, as is often the case, a cable drum cannot be got down the workings, it will mean handling by hand, and here again the importance of ample labour should be emphasised. Five or 10 years can easily be taken out of the life of a cable by dragging it along the roads with blocks and tackle, whereas, with sufficient labour, it could have been carried down and thus ensured freedom from damage.

5. The Ends of Cable.

To an inspector on the lookout for safety of a system, the ends of the cable are points which immediately attract attention. It is no use having highly insulated cables if care is not taken where the armouring ends to protect in some way the single conductor leading to the switch or motor. This point is where wiring underground has been liable to develop weakness. The illustration in Fig. 5 is a typical example of the way in which

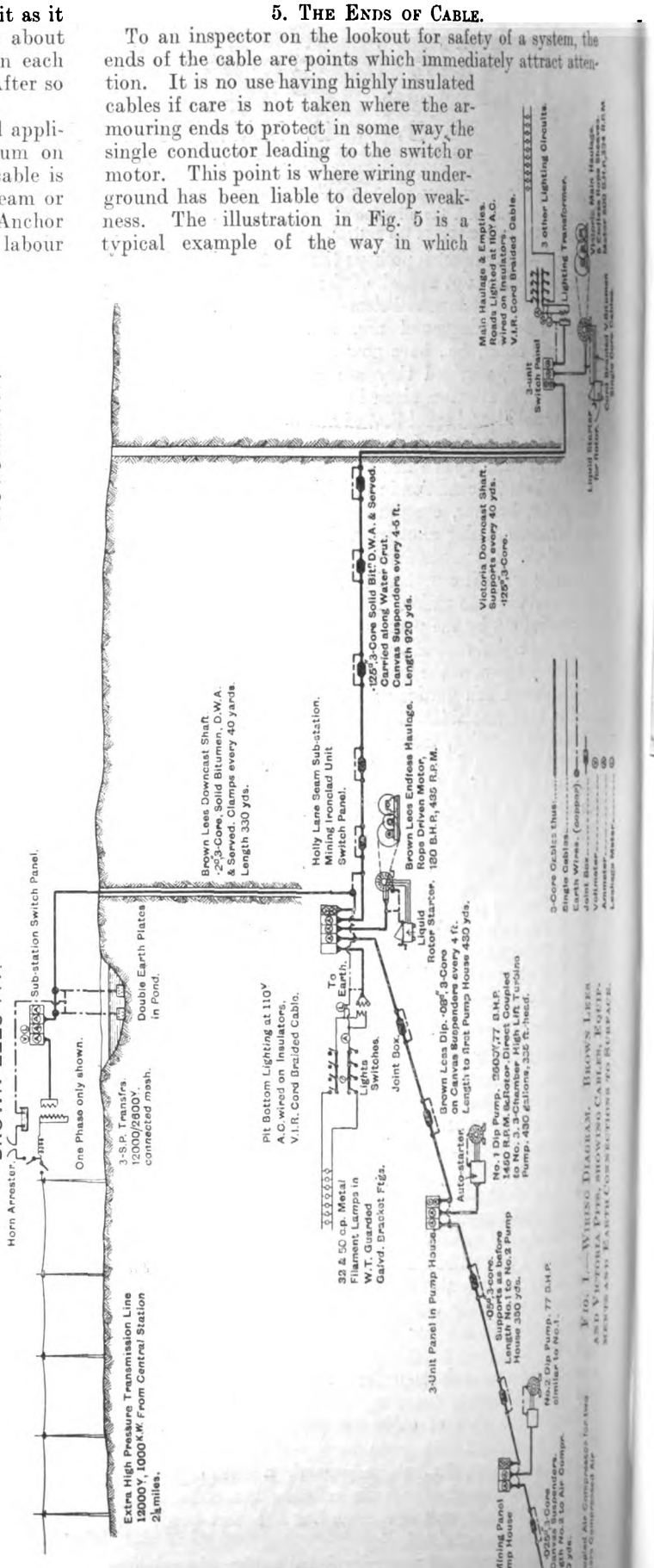

FIG. 1.—WIRING DIAGRAM, BROWN LEES AND VICTORIA PITS, SHOWING CABLES, EQUIPMENT AND CONNECTIONS TO SURFACE.

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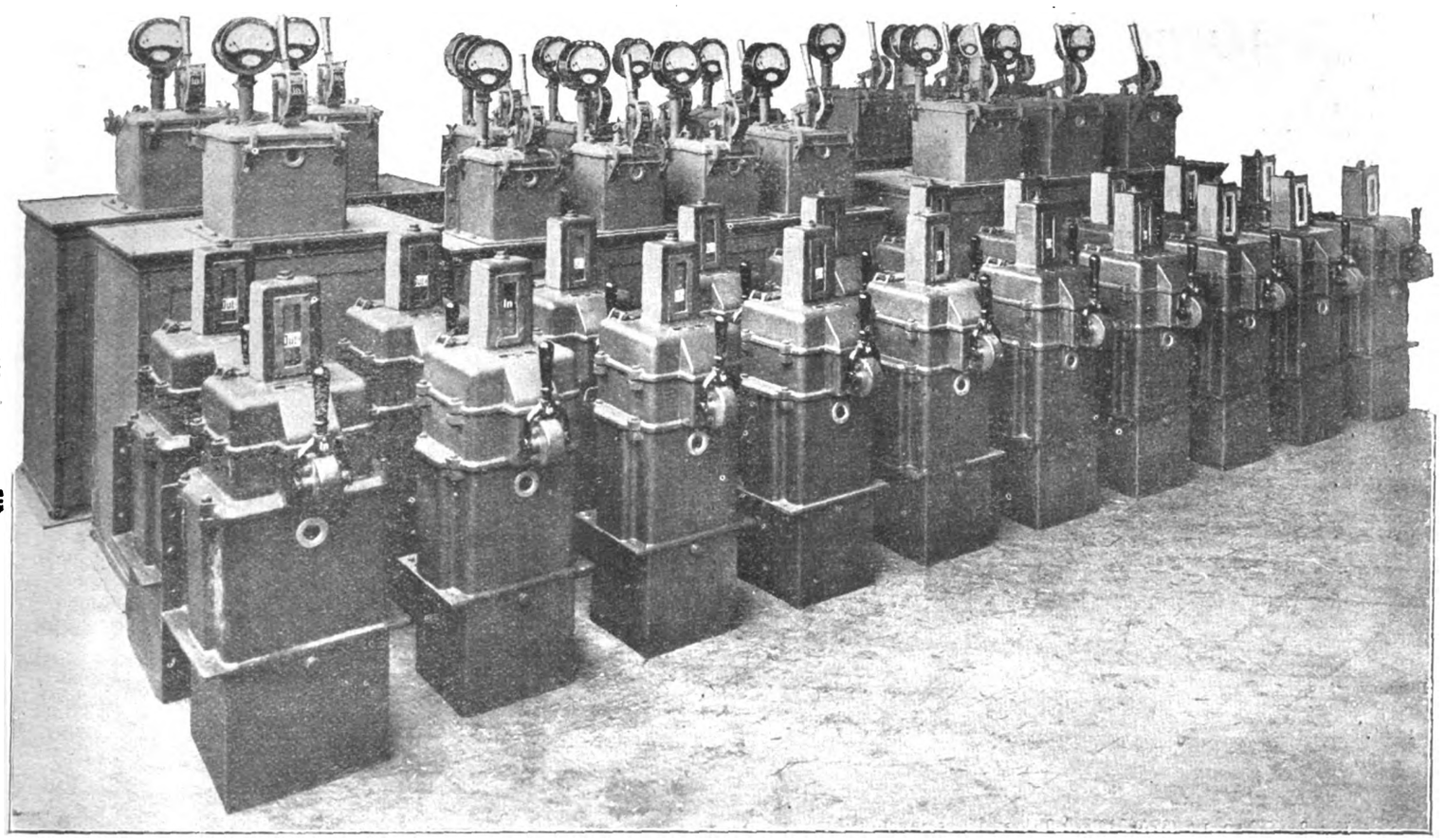

MINING Switchgear.

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connections up to the machine from the switch are sometimes left exposed and liable to damage.

To any engineer wishing to know whether his system is sound, the writer would say "examine the ends of your cable."

The obvious remedy for this weakness is, if possible, to do away with exposed ends of cables, *i.e.*, by running a three-core armoured cable right into the motor or switch or whatever it is to connect up to. With switchgear this is now generally being provided for, and it at once eliminates one of the prin-

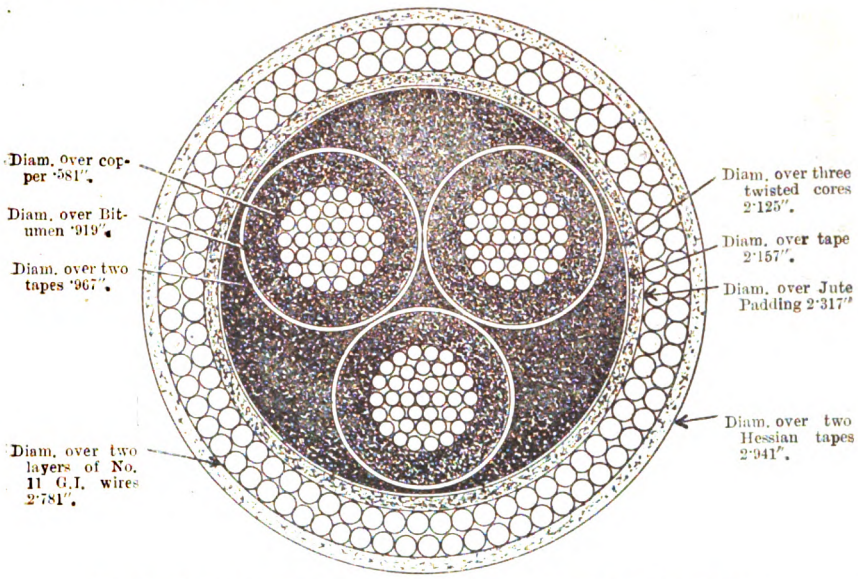

FIG. 2.—0·2 SQ. IN. (37/0·033 IN.) 3-CORE HIGH-TENSION VULCANISED BITUMEN CABLE. 3,000 VOLTS WORKING PRESSURE, WORMED CIRCULAR WITH BITUMEN, DOUBLE-WIRE ARMOURED AND SERVED. Full size.

cipal weak points. At the motors, however, the case is not so simple as it would at first sight appear. The temperature rise of the motor during running may be such as to liquify the com-

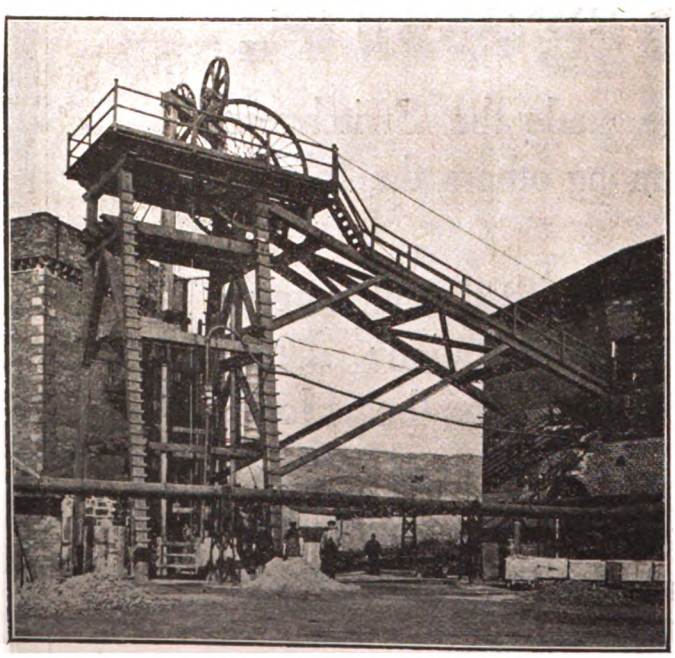

FIG. 3.—PIT HEAD GEAR; 1,000 H.P. HIGH-TENSION CABLE BEING TAKEN DOWN SHAFT.

pound in the trifurcating box if this is actually fixed to the motor. For this reason, mainly, few engineers recommend the fixing of trifurcating boxes actually on the motor frame.

If there must be an exposed length of unarmoured cable, then it is a good policy to use, for the rubber tails, cord braided cable. This class of cable is soundly protected mechanically and makes a much better job than the ordinary rubber tails taped and braided.

The use of trifurcating boxes is, of course, essential on high-tension wiring systems, but for 500-volt and lower pressure equipments, there is, with bitumen cables, no need to use a

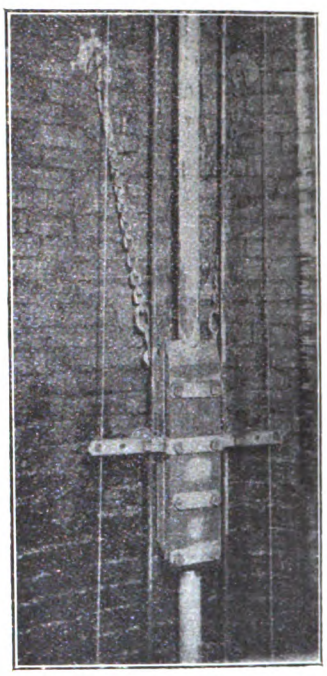

FIG. 4.—1,000 H.P. HIGH-TENSION CABLE SUSPENDED IN SHAFT, ABOUT 400 YDS. FROM SURFACE.

dividing box, provided the cable is made off in a suitable manner. A method adopted for this class of work by the writer's firm for many years has been to bend over the armouring and bind it back, as shown in Fig. 6, the three bitumen cores being separated, taped with Empire tape, and then the whole tightly bound with whip-cord braiding from the armouring right up to the ends of the single cores.

The use of sleeve terminals is now becoming very general among makers of electrical machinery. While they make a good electrical joint, and are neat when installed, they are liable to produce a risky point in the installation unless care-

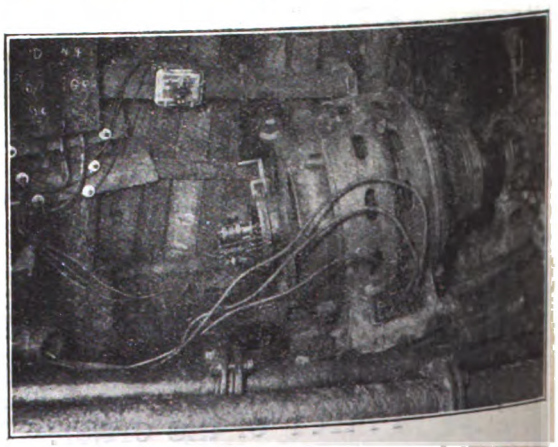

FIG. 5.—AN EXAMPLE OF RISKY WIRING UNDERGROUND.

fully guarded. The general principle is to tape over the terminal after it has been made permanent, which gives a perfectly sound job. This, however, is liable to prove a weak spot if the machine is disconnected (say for testing), as it does not always follow that the electrician has suitable tape with him to remake the joint. Terminals, therefore, which have a

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loose rubber or other sleeve which can be easily bound over the bare portion and so insulate it, are preferable.

6. EARTHING.

Considerable stress has been laid by the Committee investigating the conditions of Electricity in Mines on the importance of sound earthing, and the alterations in the proposed new rules will be drastic in this respect. Earthing, in the past, has certainly, in too many cases, been looked upon as a sort of afterthought, and carried out in a very unmechanical, and certainly unelectrical, manner.

It is not sufficient to leave it to the discretion of the wireman how to attach his earth connections on to the machine: there should be a proper earthing terminal fixed for this purpose. All earthing must start from the surface. There ought to be at least two earths there, both connected in a sound mechanical manner to the armouring of the shaft cable. In-bye the armouring of the cables can be used for earth purposes, but it must be remembered that every joint in the armouring is liable to add resistance to the earth return, and, consequently, the fewer there are the better. Every care must be taken in making off the armouring to ensure a good metal-to metal joint. It is safer to bond from armouring to armouring with a stout copper earth connection and carry from it any earth wiring required to the machines at that point. The practice sometimes adopted of earthing one machine on to the other in series is bad. There is too much risk of a bad contact and increased resistance in the earth

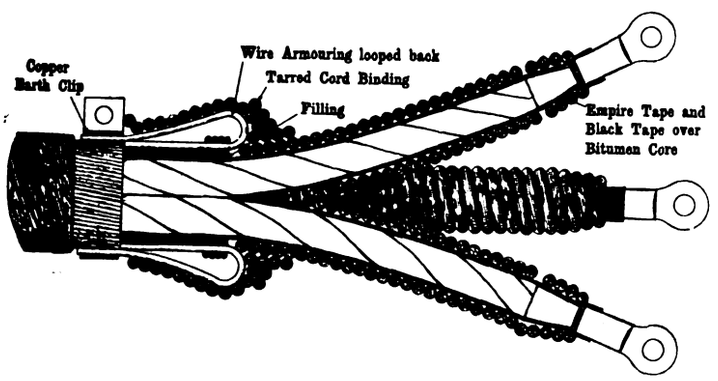

FIG. 6.—METHOD OF MAKING OFF BITUMEN INSULATED CABLES UP TO 500 VOLTS.

connection. Also, any possible removal of an earth wire for a short time disconnects the whole of the remaining equipment further in-bye.

The section of all earth wires should be such as to carry easily the overload current of the machine to which it is connected without any possible danger of fusion.

7. UNDERGROUND LIGHTING.

Electric lighting underground requires as much consideration as power wiring to ensure safety. Many systems have been proposed and tried, with varying degrees of success, but the general trend of opinion appears to be that the simplest systems are turning out the most reliable and safe in practice. The writer recommends insulator wiring absolutely. Pipe wiring is of no use whatever underground. The pipes rust, condensation occurs, and in few cases can one guarantee that the wires when they are in a pipe are in the condition they are supposed to be. On the other hand, insulator wiring, provided it is done on the right lines, is easily put up, and always in view, and therefore, under inspection.

Guarded fittings should always be used with the lamps, surrounded with a water-tight well glass as a protection against mechanical damage. A convenient way of fixing these to the pit timbers is to carry the water-tight bracket fitting on a "U" iron frame, about 2 in. from the timber, so that the wires themselves can be looped into the pipe and out again. The wires can be supported on the usual porcelain insulators, pitched about every 8 ft. They should, of course, be kept as far apart as underground conditions will allow. For lighting wiring, cord braided cable is recommended as giving a greater mechanical factor of safety than is provided for in the ordinary taped and braided cable.

The voltage of supply should be kept down, on no account exceeding 100 volts. It is far better policy to keep to low voltage and put in small step-down transformers in the motor rooms adjacent to where light is required. The lower the voltage on the lamps, the bigger the factor of safety all through for lighting. For this purpose, 25-volt lamps should always be borne in mind for the lighting of in-bye machine houses, &c., where it is not necessary to light over any extended area.

Where lighting through step-down transformers, it is advisable to earth one side of the system as a safeguard against any failure of the transformer. Lighting through transformers underground in this manner will, of course, entail the use of leakage indicators for each circuit, which, however, can be fixed in the machine houses and read by the men in charge, in accordance with the Regulations.

8. MAINTENANCE.

Having once installed the equipment, a systematic maintenance, which need not be expensive, will ensure it being kept in good order. All cables underground ought to be treated every two or three months with Stockholm tar as a preservative. All earth connections should be checked each week when the insulation tests are taken of the equipment underground. The main earth points above ground are the most important of all. The fact that they are out of sight must not allow them to be out of mind. If the earth is made into water, particularly watch the wires leading into the water to see that they are not corroded through.

Do not countenance any temporary wiring, for if once allowed it may become a regular thing, and introduce a weak link into the system.

Take in hand at once the slightest defect reported. A whole length of cable can easily be ruined through allowing a fault to go too far.

To summarise the whole matter of colliery wiring, the importance of using the best materials installed in the soundest manner cannot be over-estimated. A few pounds saved in the installation can be lost many times over by the most minor trouble which could occur in a colliery wiring network.

Recent Extensions in the Yorkshire Electric Power Co.'s Supply to Collieries.

Among recent extensions of the Yorkshire Electric Power Co.'s supply to collieries we may mention several interesting installations. These include the Micklefield Coal Co., who are sinking a new pit at Ledston, where it is proposed to use electric power throughout. The winding machinery is of the Ilgner type. The screens will be situated some distance from the pit near the Company's Peckfield Colliery, and these and other machinery at the older colliery will also be operated electrically.

The New Silkstone & Haigh Moor Co., at Allerton Bywater, are using the power company's supply for a great variety of purposes, including two underground winding gears, haulages, pumping, screens, washer and other machinery. Extensions are being made by the installation of an electrically-driven air compressor.

The Old Silkstone Collieries, who are erecting a battery of 80 by-product coke ovens, are under agreement to supply the waste heat from these ovens to the power company. Their existing electrical machinery will be driven from the power company's supply. The large washery and screens which are being erected adjacent to the coke ovens will be operated electrically, and also a considerable amount of pumping and haulage at the Dodworth, Higham and Stanhope pits.

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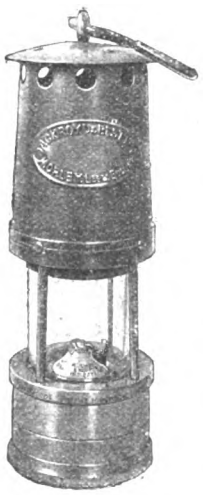

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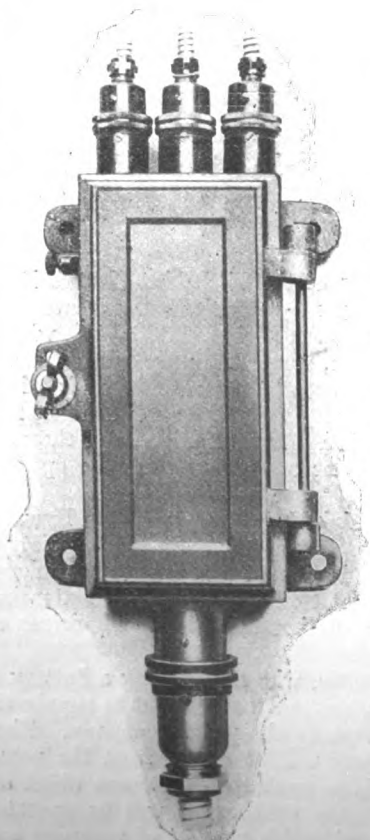

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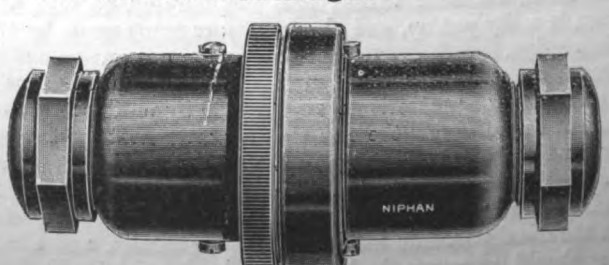

Cable Coupling.

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Electric Hand Lamps for Collieries.

BY WM. MAURICE, F.G.S., M.I.E.E.

Summary.—The author first considers the use of electric lamps, as now compulsory, for rescue purposes, and then discusses the desirable qualities in a lamp for ordinary mining use. Figures of cost are given and it is pointed out that a fire-damp detector is not an essential adjunct of such a lamp.

The production of a satisfactory portable electric lamp has been the aim of numerous inventors ever since electricity began to have commercial possibilities. Designs comprising the use of both primary and secondary cells have been evolved in hundreds; many have never passed beyond the "paper" stage; most have had their little day and disappeared; few, if any, have come to stay. At intervals of a few years there is a revival of interest in the subject arising either out of the appearance of a new and apparently promising lamp, or by reason of the undoubted demand calling more urgently for that supply which it is supposed to bring forth.

Some such urgent demand now clamours to be satisfied, but unless the writer's experience of hand lamps, even though it spreads over the past 20 years, has failed to bring him into touch with some improvements of sound practical value, it is difficult to imagine that the era of electric hand lamps has yet arrived. It must be admitted that it is now possible to obtain portable lamps in great variety and of ingenious construction which are fairly satisfactory for individual purposes.

The great field which awaits development is, however, in colliery and mining applications, where the necessity for improved illumination is slowly coming to be recognised as one of the three primary conditions of safety.

Demand has also been accelerated by recent specific recommendations, culminating in an Act of Parliament which will make compulsory the provision of electric hand lamps for certain purposes.

Since the occasion referred to is the first, probably, in the history of electric lighting—certainly the first in the history of electric hand lamps—upon which the provision of such apparatus has taken the form of a definite legal obligation, it may be useful to ascertain precisely what the law requires.

Electric Hand Lamps for Rescue Work.

In October, 1910, a committee, known as the Mines (Rescue and Aid) Committee, was appointed by the Home Secretary to consider the organisation of rescue and aid in cases of accidents in mines. This committee held four meetings and on Feb. 8, 1911, submitted the draft of an Order which they recommended should be made under the Mines Accident (Rescue and Aid) Act, 1910. The Order, after specifying the numerical strength and conditions of training and qualification of rescue brigades and determining the provision and maintenance of portable breathing apparatus at every mine, proceeds with the condition, among others, that "there shall also be provided and maintained at every mine . . . two electric hand lamps for each brigade, ready for immediate use and capable of giving light for at least four hours."

In addition to this rule for the provision of two lamps at every mine, "there shall be kept and maintained in every Central Rescue Station . . . 20 electric hand lamps."

It will thus be seen that whether electric hand lamps have reached a satisfactory degree of perfection or not, mine owners are compelled to obtain a definite number of them and see that they are kept in usable condition.

Observing that the Order also requires the provision and maintenance of "a safety lamp for each member of the rescue brigade for testing for firedamp," it may be presumed that the committee have recognised that there is not yet any electric hand lamp which carries an entirely satisfactory device for indicating the presence of firedamp.

The requirements attaching to the use of electric hand lamps for the use of rescue brigades differ to an appreciable extent from those which an ordinary miner's lamp calls for—the principal points of difference being in the degree of intensity of light and in its duration. Rescue lamps are not required to supply light for so long a period as miners' lamps—it will have been noticed that a four-hour lamp is specified in the Order—but the light must be as brilliant as possible, and, although the Order does not say so, it is obviously a fundamental necessity that the lamp should undergo no diminution of brilliancy whilst in use.

Very exhaustive experiments have been made at Camphausen, in Germany, for the purpose of determining the reliability and duration of various types of lamps designed for the use of rescue brigades. A few notes on these tests, which were specially directed to the choice of a lamp suitable for working in an atmosphere of combustible or unbreathable gases, firedamp and after-damp, may advantageously be taken from Herr Rossenbeck's report, for the use of English designers who may perhaps not be fully conversant with the difficulties which have been experienced in practice.

The principal requirements are summarized as follows:—With the greatest possible brilliancy and duration of light the ideal lamp must combine the least possible weight. Its size and circumference must be such as to permit of easy handling; wherefore projections and sharp angles are to be (as far as practicable) avoided.

The switch arrangement must so work that there is no possibility of ignition in gaseous mixtures by means of an initial or terminal spark.* The same consideration should also be borne in mind when it becomes necessary to screw on a fresh lamp bulb. The entire structure of the lamp must be such as to enable it to withstand unalterably the rough usage to which it will be infallibly subjected in the course of everyday work down the pit.

The first experiments were carried out with a couple of Richter lamps which took 12 hours to charge and discharged continuously for eight hours.

It was found that these lamps might be allowed to stand unused for eight days after charging without the duration of illumination being thereby affected. But for any more lengthy period a marked decrease in duration was observed, becoming more marked as the interval between charging and use was extended.

The lamps were tested in conjunction with the pneumatophore breathing apparatus and proved unreliable and unsuitable for use in the pit. The same makers thereupon brought out another lamp which differed from the earlier pattern in the arrangement of the accumulators and the incandescent lamp bulbs. It was also of smaller dimensions and lighter to carry and special care had been taken to secure easy interchangeability of parts.

The trouble with this one was that which English, and in fact all, makers of hand lamps have found so hard of solution, namely, the difficulty of preventing oxidising or incrustation of the switch and other metallic parts owing to the action of acid and acid vapours escaping from the cells of the accumulator.

Accordingly, a dry accumulator weighing about 6 lb. and burning 10 to 15 hours was tried, but these were found to deteriorate after storage for a year or two. It was further reported that in the course of the drilling of rescue classes, setting up dams against fires, and similar operations, the lamps had proved very unequal; some burnt well, while others would not burn at all.

Trials were next made with the Adolf-Bohres lamp (which was exhibited in England a few years ago). This was one of

* In this connection a useful note by Mr. R. Nelson, H.M. Electrical Inspector of Mines, will be found on p. 27 of the Official Report (Cd. 5824) on the Causes of and Circumstances attending an Explosion or Underground Fire which occurred at the Wellington Pit, Whitehaven Colliery, on the 11th May, 1910.

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the earliest lamps to be fitted with an osmium filament, the introduction of which rendered possible the production of single-cell accumulator lamps. The makers of this lamp, and indeed almost every maker of portable lamps, hailed the application of metallic filaments as though it had finally solved all hand lamp problems, but the old corrosion trouble again blocked the path of progress. Later research has resulted in the production of a metal alloy on which diluted sulphuric acid has only a small and slow effect, but, next to the usual internal troubles with which all users of storage batteries are familiar, this question of terminals and contacts remains the most difficult of solution.

HAND LAMPS FOR MINERS.

First consideration has been given to the production of a rescuer's lamp because this represents an actual and immediate demand. Many of the British rescue stations for which they are required are already built and equipped, while several others are now in course of erection. The total requirements for this purpose are numerically negligible, although it is probable that at least 3,000 lamps will be required.

This figure, although doubtless satisfactory to lamp makers, who have hitherto sought in vain for extensive markets, pales into insignificance when compared with an estimate of the numbers which would have to be produced if it were possible to oust the gauze capped safety lamp from British mines. There are over 600,000 safety lamps in daily use in this country, and there are some 1,700 mines (employing two hundred odd thousand persons), where naked lights are yet in use, but which will no doubt require hand lamps at no distant date.

Out of the 600,000 lamps in use, not more than 3,000 are electric lamps, and these are confined practically to the two mining districts of Durham and Liverpool and N. Wales.

The Murton Colliery installation, where 500 lamps were put to regular work in October, 1897, and the number made up to 1,000 by October, 1899 (and 1,200 in 1902) is probably the earliest instance of the use of electric hand lamps in mines on a practical and fairly extensive scale.

The Sussmann lamp was then in use and cost 18s.

The cost of working the lamps over a period of several months, including all charges except interest on capital and the cost of running the dynamos, was stated in a Paper read before the North of England Institute of Mining and Mechanical Engineers (Trans. I.M.E., Vol. XXII, 1900-1) to be as follows :—

All labour, at basis rates, including superintendence, cleaning, making ready, maintenance, &c.	2·19d.
Material for renewing batteries, repairing and maintaining the lamps in every part, and lamp glasses	1·00d.
Lamp bulbs	0·60d.
Total per week	3·79d.

The life of the battery was stated to average 10 months.

By 1903 the number of lamps at Murton had been increased to 1,400, and the cost was then stated by Mr. W. O. Wood to be about 3s. per lamp per annum more than that of the ordinary oil lamp.

It is thus seen that since one colliery can by now account for more than half the total number of electric lamps used in Great Britain, the present field of application is exceedingly limited. The reason for this is twofold. In the first place the charging and repair of hand lamps on a large scale is very troublesome, except, perhaps, as in such instances as that which has been quoted, where the use of electric hand lamps has been specialised. In the second place the capital outlay on an average installation—say 1,500 lamps—is so far in excess of the cost of ordinary safety lamps that few colliery companies will be found prepared to incur the additional expenditure unless there are special local reasons for doing so. The cost of renewals too is ordinarily excessive and there being no immediate prospect of radical improvement in this respect the only way of reducing this important item is to use a smaller battery.

It is very probable indeed that it would "pay" to expend the extra amount, because increased illumination would tend both to enhance the individual efficiency of the workers and to lessen the number of accidents; but the majority of mine owners are not sufficiently enlightened to understand that money may be frequently saved by judicious spending.

If lamp makers wish to extend the use of electric hand lamps in mines—and the writer ventures to assure them that in so doing they will be promoting a very important advance in mining practice—it is necessary that they should design lamps which can compete on as nearly equal terms regarding costs as possible with the ordinary safety lamps which are in use to-day.

The ordinary safety lamp is supplied to collieries either by outright purchase or on a hire or hire-purchase basis.

The outright cost of a safety lamp varies with the make but may be placed at 6s. to 7s.—say an average of 6s. 6d.

On a hire-purchase basis lamps may be obtained at from 5¾d. to 6¼d. per lamp per month, including oil, wick, repairs and renewals. The lamps become the property of the colliery company after a period of five years.

Some exceedingly useful figures, which may be taken as representative of good colliery practice relative to the cost of lighting by safety lamps were given by Mr. J. P. Kirkup at a meeting of the National Association of Colliery Managers in October, 1908. A test was carried out on "Marsaut" type lamps electrically lighted and locked, with a mineral oil having a flash point of 300°F., weighing 8·25 lb. per gallon, and costing 7½d.

It was found that one quart filled 14 lamps, and that each lamp so filled burned 20 hours. Assuming that each lamp is burned for the full period of 48 hours per week, then, since (14 × 20) 280 lamp-hours cost 1·93b. one lamp burning for 48 hours costs 0·332d. per week.

Lamp wick is consumed at the rate of 12 yards for 750 lamps in 14 days at a cost of 5d., making a cost per lamp (for 48 hours) week 0·0028d. The cost of minor repairs is taken at one-half of a man's time on 750 lamps, at 30s. per week, equal to 0·24d. per week.

Charging batteries (used to operate the lighting up and locking apparatus) absorbed 10 amperes at 120 volts for 50 hours per week, equal to 56 units for 750 lamps. At 1d. per unit this equals 0·074d. per lamp per week. Wear and tear and renewals are taken at 1s. per lamp per annum, equal to 0·23d. per week. Interest on capital at 12 per cent. on the cost of the lamps at 7s. each is equal to 0·19d. per week. Owing to the time lost by workmen, which may be taken at, say, 15 per cent., the actual cost of oil will be reduced by that amount, or 0·049d. from 0·332d., leaving the net cost at 0·283d. per lamp per week.

Summarising these figures :—

Oil	0·283d.
Wick	0·003d.
Repairs	0·24d.
Batteries	0·074d.
Wear and tear	0·23d.
Interest on capital	0·19d.
Total (per lamp per week)	1·03d.

Thus the cost of oil illumination for miners' lamps works out to about 1d. per lamp per week.

If the cost of oil lamps at Murton Colliery approximates the same figure, it would appear from the statement already quoted, to the effect that the increased cost of electrical illumination is about 3s. per lamp per annum, that it is practically possible to instal and use electric hand lamps in substitution for ordinary safety lamps at a cost of about 1½d. per lamp per week. It will, of course, be recognised that such a cost is only possible in the case of a large and skilfully managed installation.

It should be observed that the cost per electric lamp at Murton (3·79d.) already given, referred to a period three or four years earlier than that to which the increased cost per annum over oil refers.

The interest on capital is not, however, included in these estimates and it is clearly not an item that can be left out of consideration. Fifteen hundred to two thousand lamps is a very ordinary supply for a colliery to stock, and consequently the initial outlay and heavy depreciation charges will make substantial additions to the cost of operation.

Advance in the use of electric hand lamps in mines has been

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and continues to be retarded owing to the failure of the makers to produce a design which adequately satisfies mining conditions and which can be supplied at a cost of, say, 7s. to 10s. It is not essential that an electric lamp should be designed to imitate a gauze lamp, nor is it necessary that a lamp for general mining use should give an illumination of several candle power. It is quite possible to make and sell a pea lamp giving, say, 0·75 to 1 c.p. for 10 hours for less than 10s. and it is such a lamp that the mining industry requires. It should be noted that there must be no diminution of candle power within the working period. This is where every lamp known to the writer fails after a very short life. If soundly constructed, and the usual troubles—leakage, corrosion of conducting parts, badly made contacts, and inability to withstand rough usage and a certain amount of neglect—were effectively surmounted, there would come a "boom" in electric hand lamps which would eventually settle down into a large and steady annual demand.

It has frequently been objected that the electric hand lamp can never come into general use because it contains no means of indicating the presence of fire-damp. Numerous inventors have consequently sought, by providing spiral wires coated with salts of platinum and in other similar ways, to meet this supposed essential condition.

To attempt to find a satisfactory fire-damp indicator is, however, merely to delay the general introduction of electric hand lamps, and there is not the least necessity for such an addition to a miner's lamp. There is no reason why one gauze lamp should not be handed out with each batch of electric lamps, and hung in the working place where it can be easily seen, and where any outburst of "gas" would be most likely to occur.

This should satisfy those who think it is the proper thing to do; but it is perhaps worth while to observe that in a mine wholly worked by electric lamps the "safety" lamps which were retained to indicate the presence of fire damp would themselves be almost the only remaining source of explosive risk.

The extended use of electric hand lamps underground has been too long delayed. The dying cry of Goethe for "more light!" is felt in a very literal sense underground, where for 40 years men have laboured under practically the same lighting conditions, going to and fro and performing their daily tasks aided only by the dismal caricature of a flame derived from the thing called a safety lamp.

No other radical change in mining practice which is immediately discernible is so laden with promise—promise which will appeal alike to owners and to work people—as that of superseding the safety lamp for purposes of illumination.

No other change is so greatly desirable, and it is to be hoped that its consummation will not be long delayed.

Collieries and Power Supply.

THE PROFITABLE USE OF WASTE HEAT.

Summary.—The principal sources of waste heat are referred to and the most profitable method of utilising waste heat described. While the waste heat can be utilised in an independent installation the fact that the load factor of the power demand and the waste heat output do not coincide makes profitable use of the waste heat impossible without the co-operation of some independent user of the waste heat. Some of the chief waste heat stations in the North of England are described, and the success of the movement generally is indicated.

The great advantages which electric power offers in connection with almost all the operations performed in and about a pit are now generally recognised. This is shown not only by the various descriptions of installations contained in other parts of this issue, but also by the returns of the large electric power companies. On the North-East Coast alone some 40,000 H.P. is now being supplied from the power system of the Newcastle and allied companies for collieries alone. Remarkable, however, as are these figures and startling as has been the growth, there are still a very large number of pits which continue to utilise more or less antiquated machinery. In part this is due to the natural objection of the coal owners to scrap costly machinery which is not yet worn out (although it may be less efficient than electric power), and in part to conservatism.

And even where electric power has been adopted it is not always obtained in the cheapest possible way. Isolated and self-contained as a colliery usually is, it is only natural that the instinctive tendency is for it to produce its own electric power in the same way as it supplies many of its other requirements. As a matter of fact practical working experience has shown that in the exploitation of the waste energy resources of collieries, and the production of power therefrom co-operation with a large electric power company is most desirable, and in fact is the only way in which the owner of the waste heat can make the most profitable use of it.

There are four main sources of waste energy in the North of England, namely:—

1. Waste heat and surplus gas from coke ovens.
2. Exhaust steam from blast furnaces, blowing engines, &c.
3. Surplus gas from blast furnaces, and,
4. The less important and more miscellaneous cases of exhaust steam from winding engines, air compressing plant, fan engines and other plant.

At the present time comparatively little use has been made in this country of the waste gases from blast furnaces, although both in America and in Germany some considerable installations are now on trial; but in the other two directions a number of very interesting installations have been established, more especially in the Durham coalfields and on the Tees where it is the usual practice for the waste heat owners to co-operate with the Waste Heat Company. The latter is an intermediary between the coal owner or iron master and the power company, and the power station for the utilisation of waste heat is usually and most advantageously the joint property of the two parties first mentioned.

When it is a question of making use of waste heat there are four definite advantages obtainable, and only obtainable from a co-operative scheme. These are:—Firstly, the sale of all waste heat; secondly, a standby supply of power in case of breakdown, or of variation of output or shut-down during holidays and strikes; thirdly, technical assistance of the power company; and fourthly, the saving of capital expenditure.

As regards the first it must be remembered that the output of the waste heat is usually a very variable quantity. In coke oven practice the output although it may be fairly steady during the 24 hours, or during the week, may have other variations due to the variations in the output of coke due to the state of the iron trade or to labour troubles at the colliery. In connection with winding engines there are, of course, times when these are not running and when nevertheless electric power is needed for pumping, ventilating and other purposes. Unless there be some outside source of power available, the putting down of an independent installation of boiler plant, &c., is necessary. At first sight it often appears as if this is more economical than purchasing from an outside supply. Makers of machinery and others are naturally anxious that coal owners

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should put down their own installations; but the fact is often overlooked that the actual cost of the machinery often represents only about half the total outlay necessary to obtain a complete and reliable installation. If the matter be gone into as carefully as a chartered accountant would do, it will usually be found that the interest and depreciation charges upon the total capital expended is such as to make the cost of the power of an independent plant, with sufficient spares to insure reliability, 20 per cent. to 50 per cent. more than the cost of an electric supply depending upon the conditions.

So much for the cost. Co-operation, however, has the additional advantage that it enables a waste heat owner to dispose of the whole of his waste heat. It rarely happens that the waste heat owner is able to dispose of the whole of his waste heat in his own works or to find anyone in his vicinity, except a power company, whose load

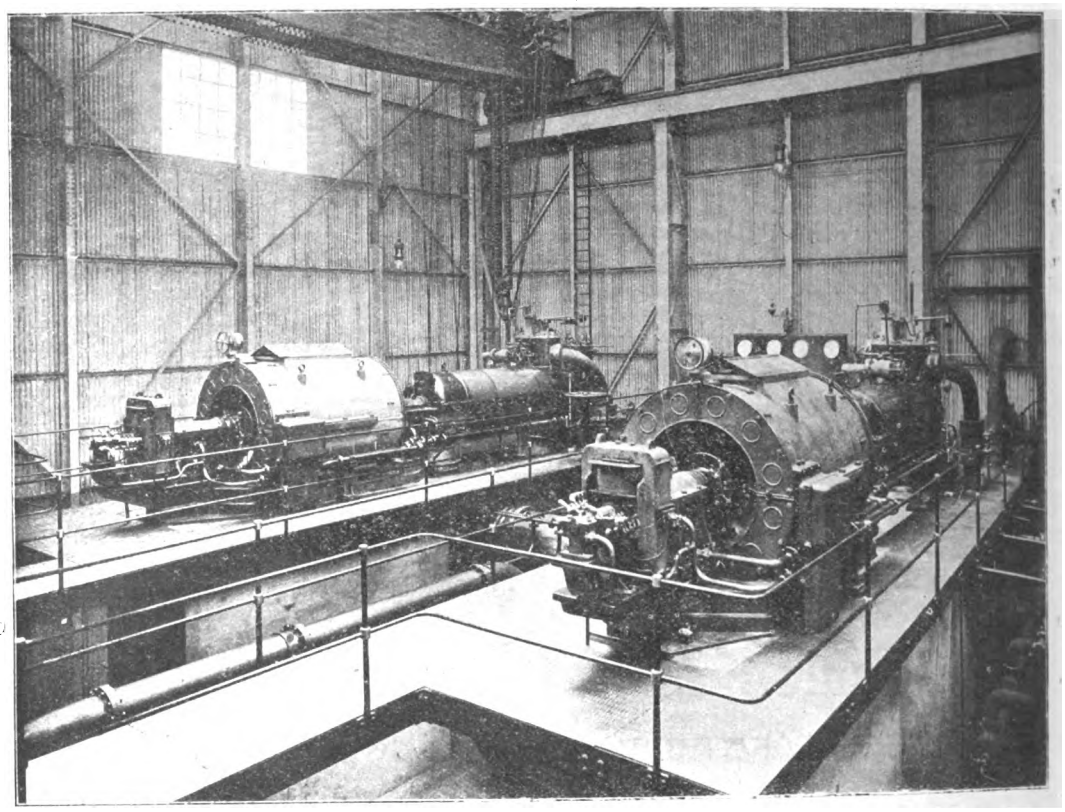

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Fig. 1.—Blaydon Power Station. Capacity, 5,700 h.p.

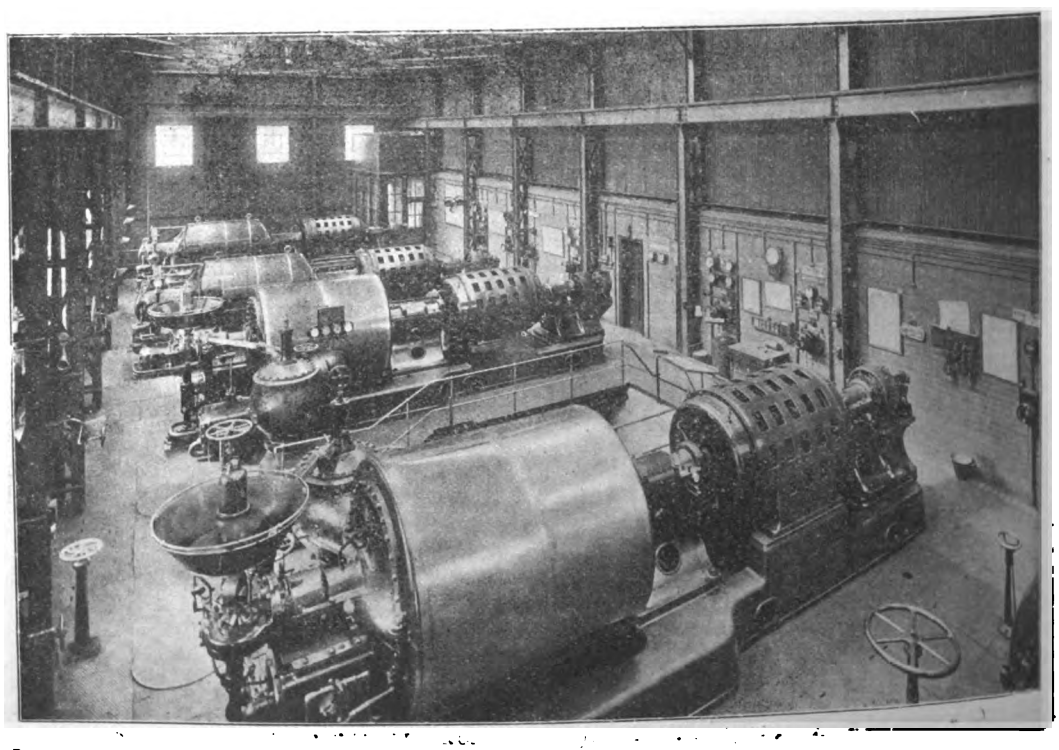

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Fig. 2.—Newport Power Station.

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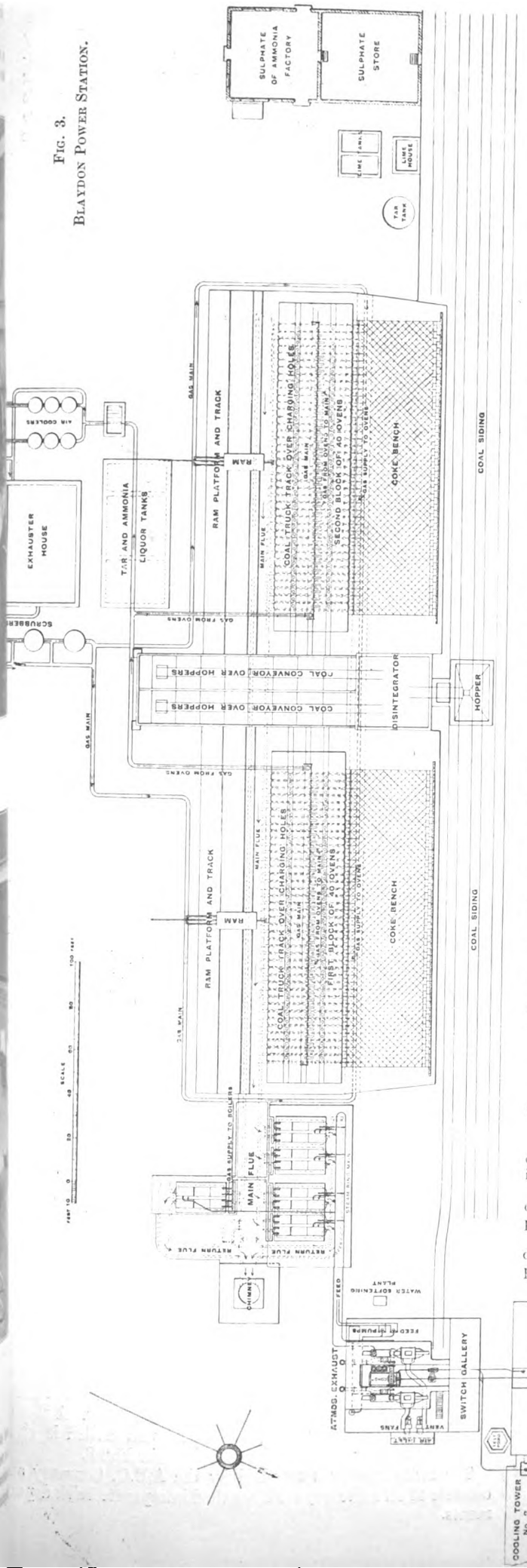

Fig. 3.
Blaydon Power Station.

coincides exactly with his own output of waste heat. Thus, however efficient and perfect a plant may be put down, a considerable proportion of the waste heat produced during the 12 months remains waste heat if the plant be an isolated one. A large power company, however, with a network extending over hundreds of square miles, has such a variety of demands on its system that it is able to make use of all the waste energy it can obtain day or night, week-ends, Sundays and holidays. If the proportion of its power derived from waste heat increases, it merely burns less coal at its coal fired generating station and *vice versa*. In other words it can use every bit of waste heat it can buy. This, the fact that he sells the whole of his waste heat, is therefore another factor that has to be considered by the waste heat owner in comparing an independent installation with the co-operative scheme. Thirdly, the advantages of a stand-by supply and technical assistance in cases of trouble are all, of course, ones that are obvious enough to electrical engineers, and becoming more and more appreciated by colliery managers. The fact that the supply of power to the mine is totally unaffected by the operation of the colliery machinery or the coke ovens is one that obviously conduces to efficient working.

In view of these various considerations it is not surprising that the majority of the owners of waste heat upon the North-East Coast have gone in for co-operative schemes. Waste heat stations have been erected at Blaydon by the Priestman Power Company in connection with the Priestman Collieries, where coke oven gas is used, at Spennymoor in connection with the Tudhoe Ironworks of the Weardale Iron & Coal Co., at Newport in connection with the blowing engines and blast furnaces of Sir B. Samuelson & Company, at Teesbridge in connection with the blowing engines of the Teesbridge Iron Works, at Bankfoot, in connection with the coke ovens of Messrs. Pease & Partners, while additional installations are in hand at Bowden Close, Port Clarence, Aryesome, Lackenby, Stobton and Hordern.

The Blaydon Station (Figs. 1 and 3).

The principal plant at the Blaydon Station, the earliest to be put down, consists of :—

Boilers.—Five Babcock land-type boilers of 4,780 sq. ft. fired by gas and waste heat.

Feed Pumps.—Two Weir's steam-driven feed pumps each of a continuous capacity of 50,000 lbs. per hour.

Turbo-alternators.—Two Parsons 1,400 kw. Turbo-alternators running at 2,400 revs. per min., and generating at 5,750 volts.

Condensers.—One Mirrlees-Watson surface condenser of 4,300 sq. ft., and one Cole, Marchant & Morley surface condenser of 2,500 sq. ft. each fitted with motor-driven Edwards three-throw air pumps.

Cooling Towers.—Two enclosed type, built respectively by Richardson-Westgarth and the Midland Engineering Company.

Switchgear.—A 5,750-volt board by Brown, Boveri, and 440-volt board by Reyrolle & Co.

Transformers.—A 1,300 kw. British Electrical Transformer Co.'s three-phase oil cooled transformer supplying at 440 volts to the colliery and several smaller transformers to supply the station auxiliaries, &c.

Spennymoor Station.

The principal plant at the Spennymoor Station consists of :—

Boilers.—Four Richardson-Westgarth "Nesdrum" boilers of 5,320 sq. ft. fired by gas.

Economiser.—Green's type, 640 tubes.

Feed Pumps.—Two Clarke, Chapman steam-driven feed pumps of a continuous capacity, together of 150,000 lbs. per hour; steam exhausting into hot well.

Turbo-alternators.—Four Richardson-Westgarth Parsons-type turbine coupled to 1,250 kw. Westinghouse Alternators, running at 2,400 revs. per min., and generating at 2,875 volts.

Condensers.—Two Richardson-Westgarth "Contraflo" surface condensers of 4,400 sq. ft. each with motor-driven Edwards three-throw air pumps, and motor-driven centrifugal circulating pump.

Cooling Towers.—Two Richardson-Westgarth enclosed type.

Motor Generators.—Two 150 kw. for supplying direct current for lighting.

Switchgear.—A 2,875-volt board by the A.E.G. Company; also a 440 alternating-current enclosed type, and 500 volt direct-current board by Reyrolle & Co.

Sub-station.—This contains five step-up oil-cooled transformers from 2,875—20,000 volts. Two of the transformers are by the A.E.G. Co. The three others are by the Westinghouse Co. All surplus current over and above the requirements of the colliery &c., is transformed as above to 20,000 volts, and delivered into the cable networks.

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THE NEWPORT STATION.

The principal plant at the Newport Station (Figs. 2 and 6) is as follows :—

The capacity of this station is 5,500 kw. The main equipment consists of four 1,250 kw. turbo alternators which are driven by exhaust steam from two main sets of blowing engines situated in Messrs. Samuelson's Works some 200 and 1,000 ft. away from the turbines respectively.

The turbines are of Messrs. Parson's type, two sets being of Messrs. Willans & Robinson's manufacture and remaining two sets of the British Westinghouse Company's manufacture. The steam after exhausting from the blowing engines and before reaching the turbines is superheated by independent superheaters fired by blast furnace gas and designed to impart about 150 degs. superheat to the steam. A 500 kw. high-pressure Brush Company's turbo-alternator is also installed in the power station. This machine is driven by high-pressure steam surplussed over from Messrs. Samuelson's high-pressure steam range. This turbine is arranged to exhaust into the low pressure steam main supplying the exhaust turbines. Each low pressure turbine exhausts into its own surface condenser supplied by the turbine manufacturers.

The condensers for the turbine supplied by Messrs. Willans & Robinson are provided with Messrs. Parson's Augmentor Condensers and Edwards air pumps. The condensers for the turbines supplied by the Westinghouse Company are provided with Leblanc rotary air pumps and rotary water extraction pumps. The circulating water for the condensers is obtained from the River Tees, a pump house being built on the River side quay where three pumps each capable of dealing with 636,000 gallons per hour are installed. Two of these are continually in service, the third pump being available as spare to the other two. The pumps are of Messrs. Worthington's manufacture, and are of the submerged type. They are connected to the motors in the pump house overhead by means of vertical shafts. The motors are of the three-phase type, and of the British Thomson-Houston's Company manufacture. With the barometer at 30 in., each of the condensing plants is capable of maintaining under normal conditions a vacuum of 29½ in.

All four main alternators are built by the British Westinghouse Company, and are designed to run at 2,400 revs. per min., and generate electrical energy at 2,875 volts 40 cycles per second. The 500 kw. alternator was manufactured by the Brush Company. The large alternators are duplicates of those at the Weardale Station (Fig. 4). This size is chosen because it is the largest machine that can be built to a speed of 2,400 revs. per min. a relatively high speed favourable to turbine economy. A plan of this station is given in Fig. 8.

The switchgear was supplied by the A.E.G. Company, consists of oil switches, each installed in separate brick compartments.

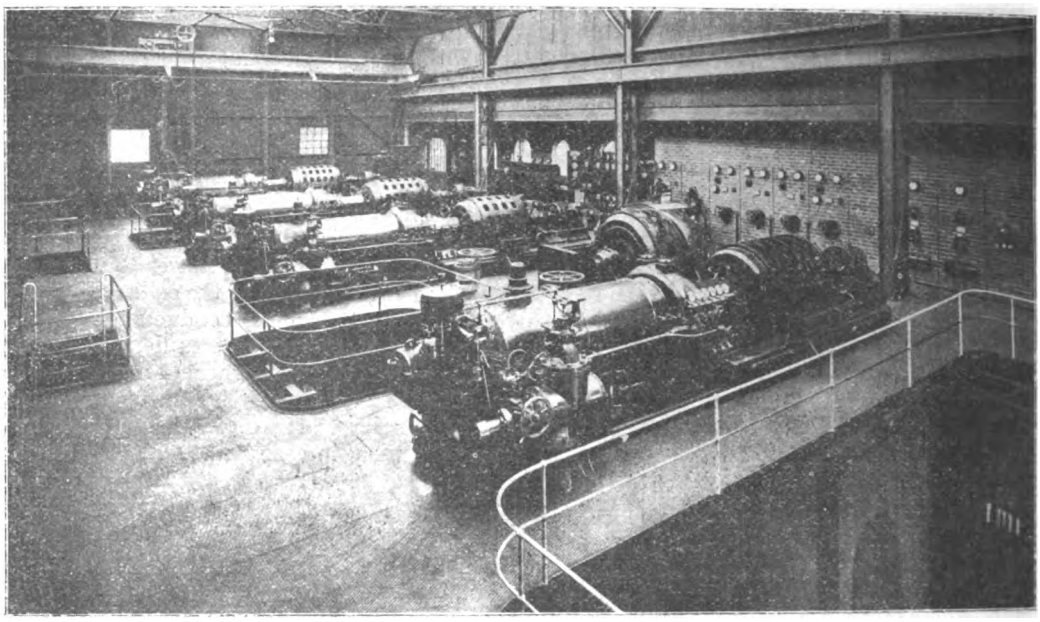

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FIG. 4.—WEARDALE WASTE HEAT STATION. CAPACITY, 7,330 H.P.

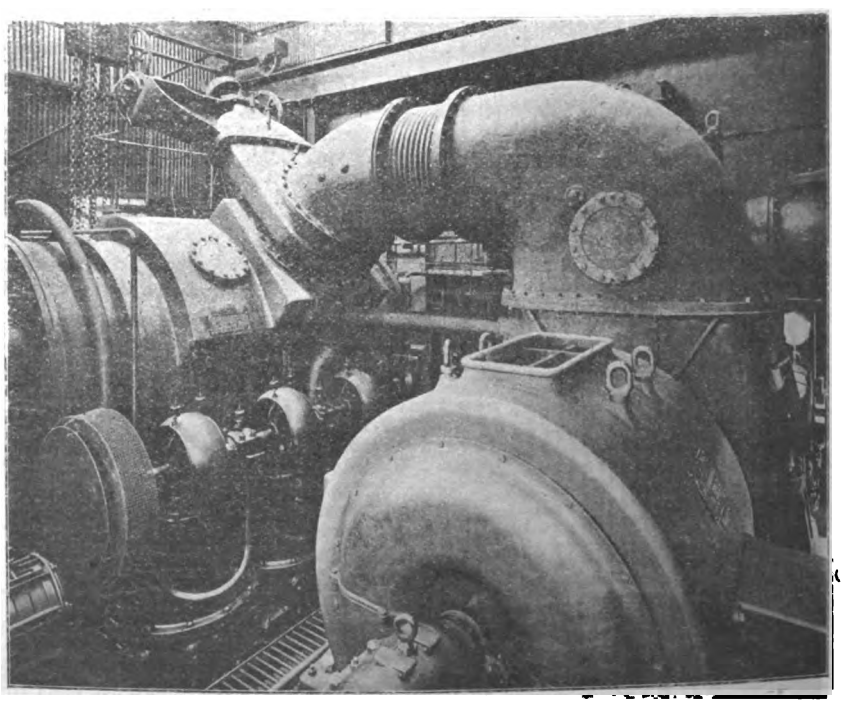

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FIG. 5.—CONDENSING PLANT TEESBRIDGE POWER STATION.

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Three feeders fitted with Merz-Price protective gear and each consisting of three 1 sq. in. three-phase cables in parallel, carry the current from the power station to the Cleveland and Durham Power Company's sub-station situated at the west end of the works. From this point some of the current is used directly in the local 2,750-volt network, but the greater proportion is transformed up to 11,000 volts by five 1,000 kw. oil-cooled Westinghouse transformers, and fed into the Power Company's network of high tension mains.

The station is the property of the Waste Heat and Gas Electrical Generating Stations Ltd.

The Bankfoot and Teesbridge Stations.

The principal plant at the Bankfoot Station consists of:—Five land type Babcock boilers, two 1,200 kw. Richardson-Westgarth-Parsons type turbines, and Westinghouse alternators and Reyrolle ironclad switchgear, but large extensions are contemplated.

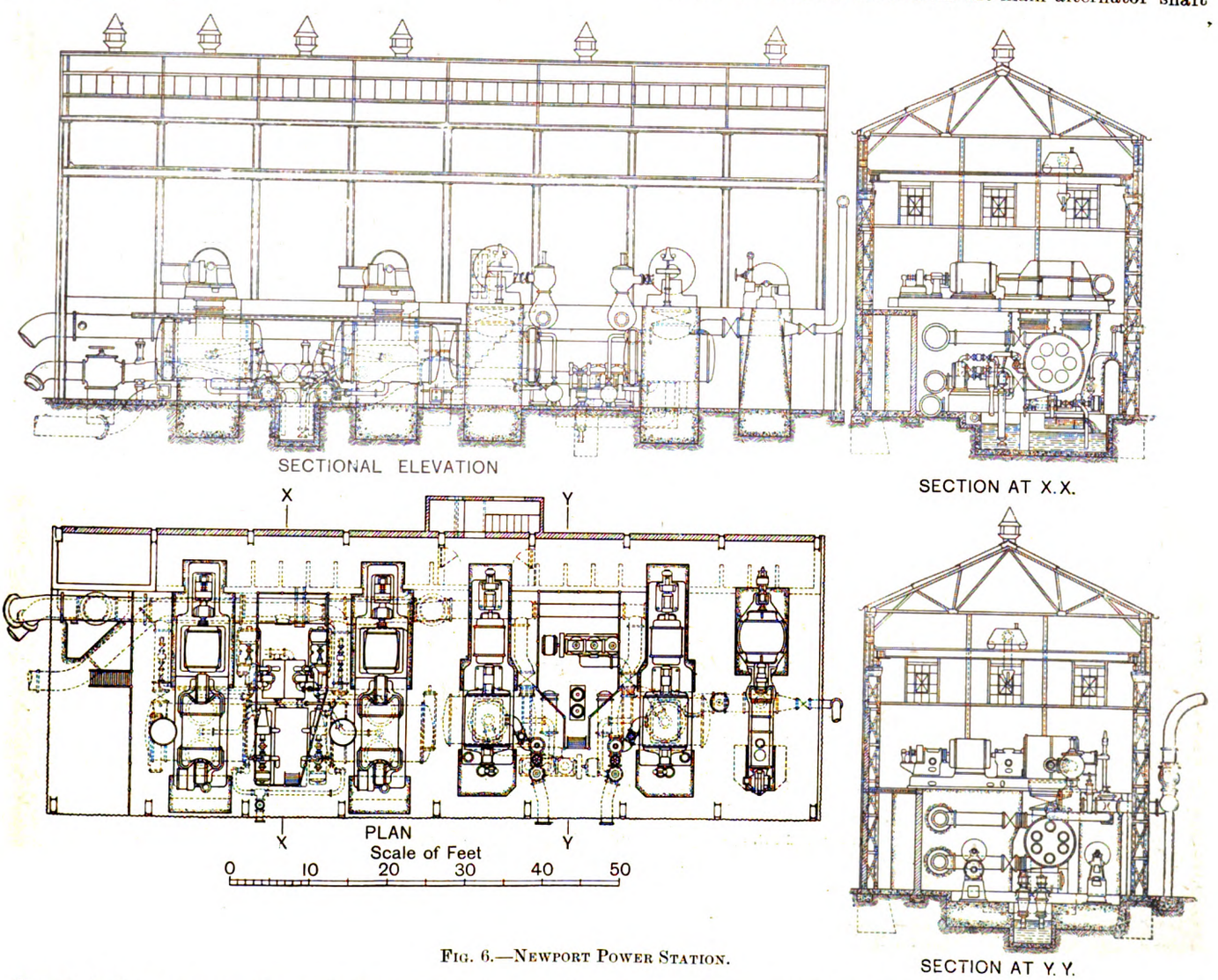

FIG. 6.—NEWPORT POWER STATION.

One of the latest among the waste heat stations is a small exhaust steam plant, using the steam from the blowing engines at the Teesbridge Iron Company's Works.

The plant installed consists of one horizontal "Curtis" turbine manufactured by the British Thomson-Houston Company, and coupled direct to a British Thomson-Houston Company's three-phase alternator. The normal output of the turbine is 1,250 kw. at 2,750 volts and 40 cycles when running at a speed of 2,400 revs. per min., and when supplied with dry saturated steam supplied to the stop valve, at atmospheric pressure.

The condensing plant (Fig. 5) is of the surface type manufactured by Messrs. Mirrlees-Watson & Company, and is provided with three-throw Edwards air pumps. The capacity of the plant is such as to enable 91·66 per cent. perfect vacuum being maintained when dealing with the full amount of steam required to run the turbine on normal load, and when supplied with 5,500 gallons of circulating water at a temperature of 80°F.

The circulating water pump is of Worthington's manufacture, driven direct by a British Thomson-Houston three-phase motor, and draws water from the cooling ponds situated about 100 yds. away from the station. The cooling pond occupies about one-third of an acre, and is provided with spraying nozzles of Messrs. Gjers & Harrison's patent type. The connection between the cooling pond and the station is made by means of 18 in. pipes.

For the make-up water supply to the cooling pond a separate 6 in. pipe service has been run to the river Tees, where a small 5 in. centrifugal pump is fixed which draws water from the river at low tides, the reason for pumping at low tides being that the water is generally fresh at such times.

The exciter is driven direct from the main alternator shaft the current generated by the exciter being at a pressure of 70 volts.

The exhaust steam from the turbine is taken from three blowing engines which previously exhausted into the atmosphere. The steam is collected from these engines by an 11 in. and 20 in. exhaust main provided with atmospheric valves which open up to the atmosphere in the event of the exhaust steam pressure rising above a predetermined value. The steam after being collected in this exhaust main is passed through an oil separator and from thence direct to the turbine; the working pressure at the turbine stop valve being as near as possible equal to the atmosphere.

Contrary to usual practice, all synchronising and switch gear is fixed in the main sub-station situated some 200 yds.

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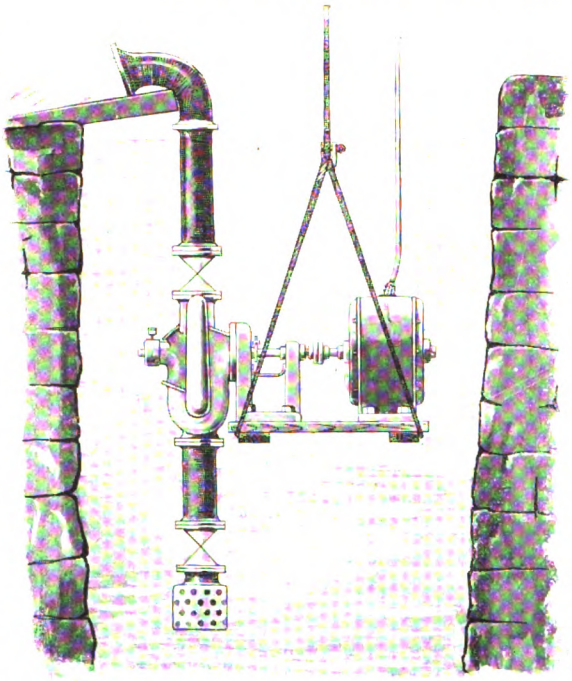

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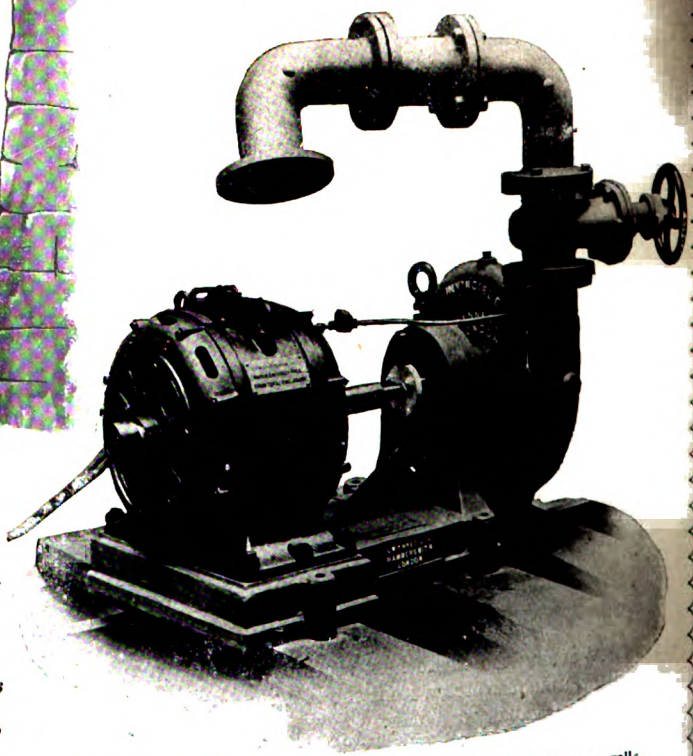

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away from the power station, there being only a meter panel in the power station. The regulation of the machine for synchronising is effected by means of a small electric motor attached to the governor spring. This motor is operated by the switchboard attendant who is synchronising in the distant sub-station referred to. At the sub-station the current generated is stepped up to the system pressure of 11,000 volts by means of static transformers.

The plant at the other stations is, as a rule, of the same general type.

Advantages of Utilising Waste Heat.

The objects for which the Waste Heat Company exists may be summarised as follows :—

(*a*) To erect waste heat generating plant.
(*b*) To acquire the waste heat from owners.
(*c*) To sell the surplus output to the Power Company.

1. The principal advantage to the Waste Heat owner of an arrangement with them is that he is saved capital outlay; this is due partly to the fact that he in general finds only half the capital for the plant, and partly to the fact that the cost of the plant is low, since no standby units are necessary.

2. The second advantage to the Waste Heat owner is that for his own power requirements he gets first call upon a com-

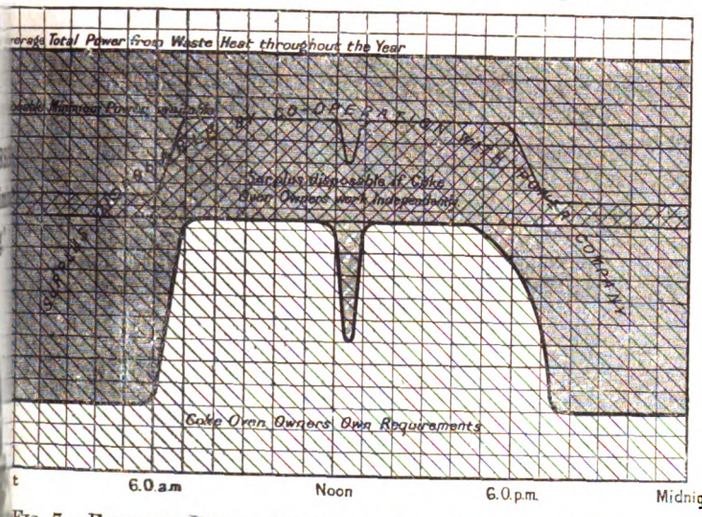

Fig. 7.—Estimated Daily Output and Load Curve of Waste-Heat Station at Crook.

Electricity utilised by coke-oven owners at mines and ovens = 5½ million Board of Trade units per annum. Maximum surplus available for outside sale, if coke-oven owners work independently = 2½ million Board of Trade units per annum. Surplus disposable by co-operating with power company = 10 million Board of Trade units per annum.

paratively large and well-arranged power plant, which is not only a very reliable one in that it works under the most favourable conditions for any power plant, namely day and night at full load, but is, in addition, connected to the cable system of the electric power companies so that standby current is instantly available in the event of any accident to the local plant.

3. The third advantage to the Waste Heat owner of a joint arrangement is that all surplus output not required by him is delivered into the electric power companies' system of mains, and it is this source of revenue which makes the outlay in these generating plants so profitable to owners of waste heat.

4. The power requirements at no colliery, nor even at any group of collieries, represent anything like a constant load. The pumping and ventilating is steady, but the other often larger demands are subject to momentary variations and extend to most over 16 hours a day. In the case of blast furnaces the requirements are in some cases 24 hour ones, but the momentary variations in load are considerable.

5. The output from waste heat plant, though steady over 24 hours, is subject to considerable variations due :—

(*a*) To repairs to the coke ovens or blast furnaces.
(*b*) To variations in state of trade.
(*c*) To climatic conditions.

6. Nothing but a diagram can properly bring out the want of coincidence between the power requirements and the power output either of a colliery or ironworks; such a diagram as Fig. 7 shows at a glance the enormous advantage of connecting up the local waste heat and generating plant to the power company's system of mains into which the surplus

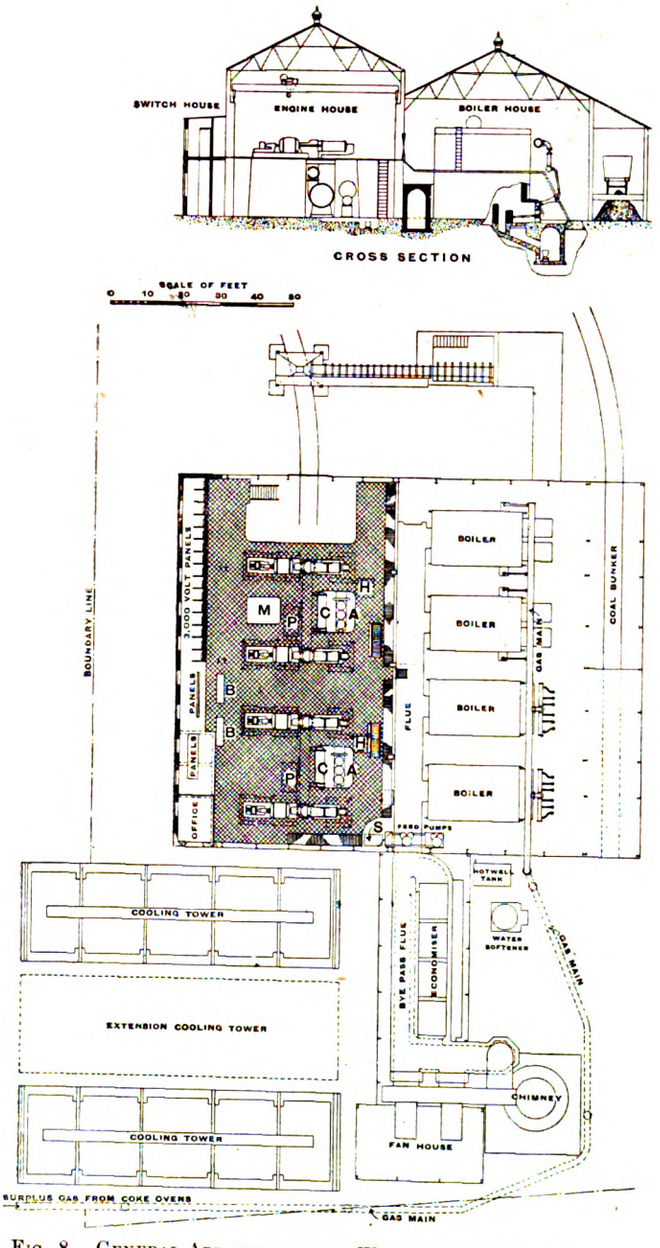

Fig. 8.—General Arrangement of Weardale Waste Heat Station.

T = Turbo Generators. M = Motor Generators. C = Condenser. A = Air Pumps. B = Balancer. P = Circulating Pumps. S = Make-up Sump. H = Hotwell Pump Pit.

can be generated, and from which a deficiency of power is easily made up instantaneously.

It is interesting to note from the third and latest report issued by the company—the Waste Heat and Gas Electrical Stations, Ltd.—that it is rapidly increasing its profits and extending its operations. Dividends of 8s. are now being earned while the whole of the cost of stations is written off during the term of the agreements—a very sound policy. No new stations are erected unless and until long term agreements have been entered into with the owner of the waste heat on the one hand and the power company on the other, by which the latter purchases all the power produced. The waste heat company thus bears none of the cost of distribution or obtaining consumers and fills the profitable role of an intermediary.

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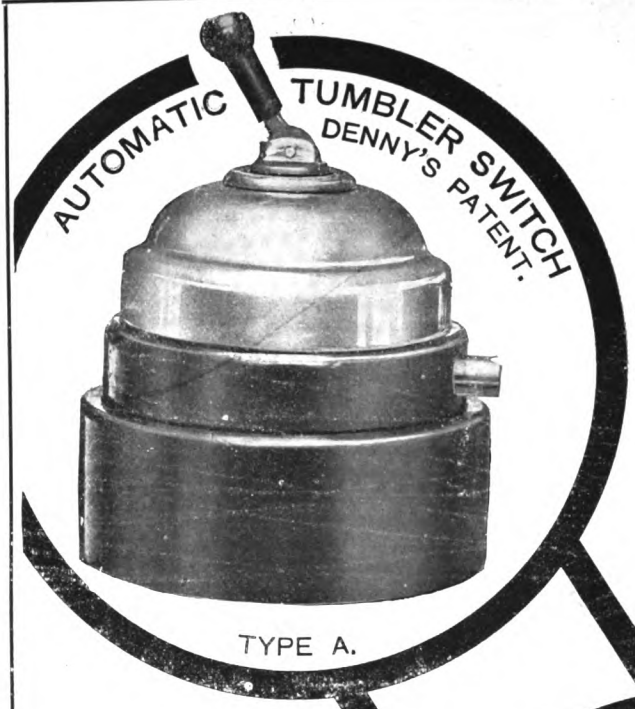

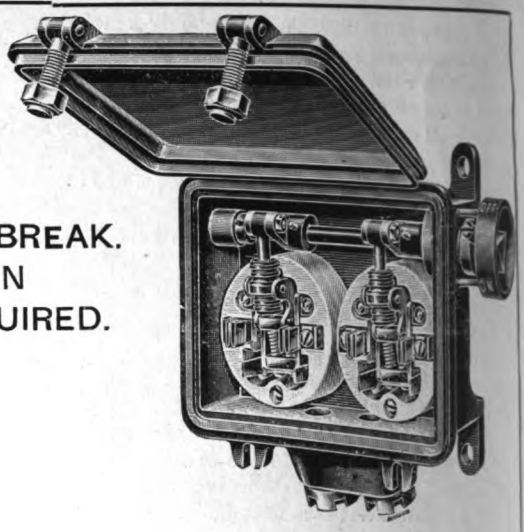

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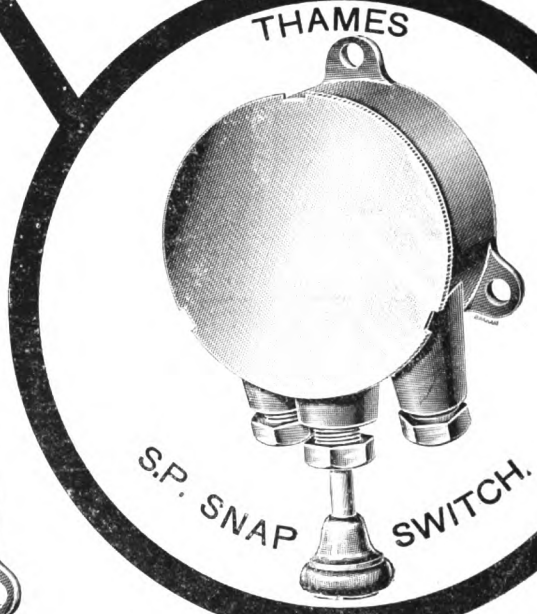

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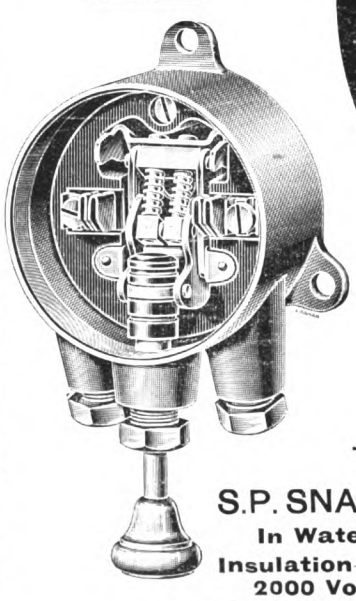

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Recent Electric Power Developments in North Staffordshire Collieries.

In general, the North Staffordshire coalfield is badly handicapped as regards competition in the open market on account of its difficult underground conditions. It has been necessary, therefore, in order to enable owners of collieries situated in this area to compete satisfactorily with those in other parts of the country, for them to adopt the most up-to-date means of working, and thus to reduce their costs of production to as low a figure as possible. A short description of one or two recent equipments in this area will, therefore, we feel sure, be of great interest to colliery engineers and electrical engineers who specialise in colliery equipment. Through the courtesy of Messrs. Robert Heath & Sons and the Birchenwood Colliery Co., and particularly their agent, Mr. Jas. R. L. Allott, under whose personal supervision the whole of the work has been carried out, we are able to give a short description of the equipments at their pits as far as they are at present in operation.

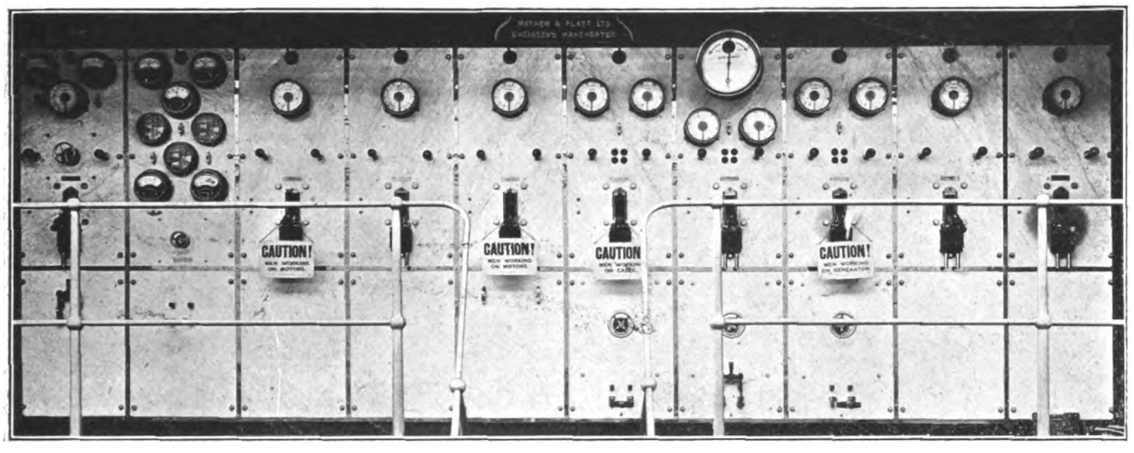

FIG. 1.—FRONT VIEW OF SWITCHBOARD.

The Birchenwood Colliery prior to 1908 was entirely steam driven, there only being a small electrical plant for surface and pit bottom lighting. Power was obtained from several ranges of boilers, fired in some cases by waste gas from bee-hive coke ovens and in the others with slack. This colliery labours under the double disadvantage of having a large amount of water to

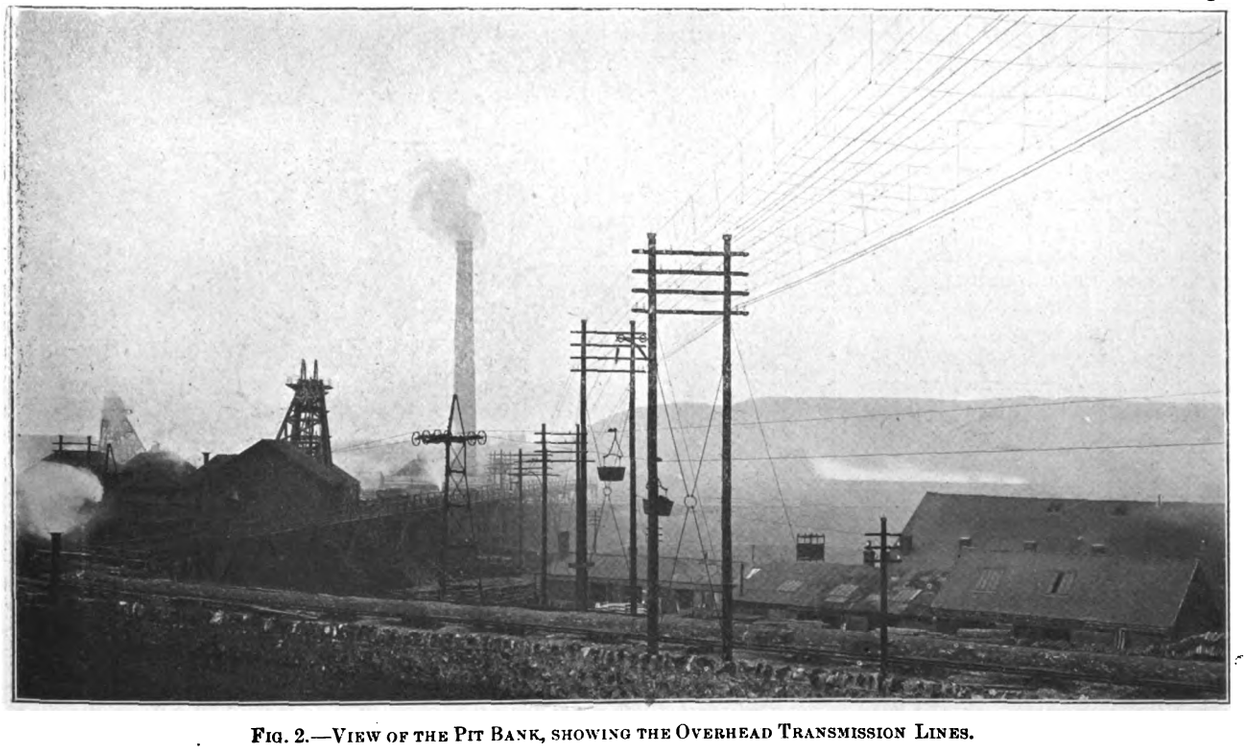

FIG. 2.—VIEW OF THE PIT BANK, SHOWING THE OVERHEAD TRANSMISSION LINES.

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deal with, and steep inclinations in the workings, necessitating a considerable amount of power to bring the coal to the shaft bottom. The pumping was mainly done with spear-rod shaft pumps, steam driven, and compressed air pumps inbye.

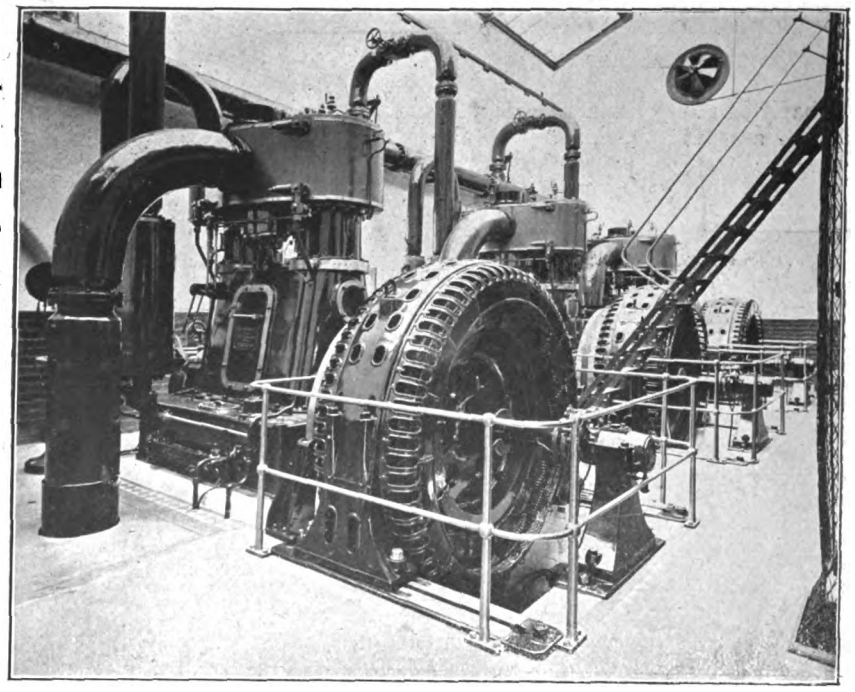

FIG. 3.—POWER HOUSE AT BIRCHENWOOD COLLIERY.

As now remodelled, the steam still supplies the source of power, but instead of several isolated units of boilers the outlying plants have been shut down, and the power is transmitted electrically to motor-driven turbine pumps. Owing to the nature of the mine, compressed air is still retained for the in-bye power, but, on the other hand, the electric drive has been made use of for the main road haulages in the principal pit. In addition, on the surface, all the extensions which have been recently made are electrically driven, and various small isolated engines have thus been replaced by electric motors.

This, in general, is an outline description of the Birchenwood present equipment. The plant has been running for a period of about 1½ years, and has given very good working results. Turning now to a more detailed description, the power house is built at the gable end of the air compressor building. In it are installed three Belliss & Morcom–Mather & Platt combined sets, each having a capacity of 430 B.H.P. when running at a speed of 375 revs. per min. The engines work at 90 lb. steam pressure, and are arranged to run either condensing through ejector condensers, or non-condensing. Steam is taken off the main range supplying the winding engines. The three-phase alternators supply current at 2,600 volts and a frequency of 50. Fig. 3 gives a very good idea of the lay-out of the power house. The condensers are supplied with cooling water from a pond under static head, the water being returned after going through the condensers by two Mather & Platt low-lift turbine pumps each having a capacity of 1,500 to 2,000 gallons per minute with a 70 ft. head.

The switchboard, to suit the lay-out of the building, has been raised on a gallery down one side of the engine room. Figs. 1 and 4 show respectively the front and back of this board. It is a good example of a high-tension slab board, and comprises circuits for the three main alternators, two circulating pumps, one motor-generator, one steam exciter, one rotary convertor and two main feeders for the pits.

The rotary convertor, which has been supplied by the British Westinghouse Co., is of 75 kw. capacity, and has been installed to enable the steam lighting plant to be shut down and the existing continuous current lighting supplied from the new three-phase plant.

A particular point to which attention may be called in connection with this equipment is the way in which the power has been carried from the power house to the points where it is required. The engineers responsible for this work have kept the obvious fact well to the foreground that one weak link in the chain of the complete equipment would lower the efficiency of the whole plant to a considerable degree. The transmission of the power, therefore, both overhead and underground, has been carried out on the best possible lines. Fig. 2 is a typical view of the colliery bank, showing clearly the arrangement whereby the high-tension supply is transmitted overhead. As the supply for the colliery had to cross not only many railway sidings, a ropeway and an overhead bridge, as well as public rights of way, it was particularly essential that satisfactory guard netting should be adopted. The whole distance of the overhead transmission (about ½-mile) has, therefore, been guard netted in a thorough manner, as will be seen from Fig. 2.

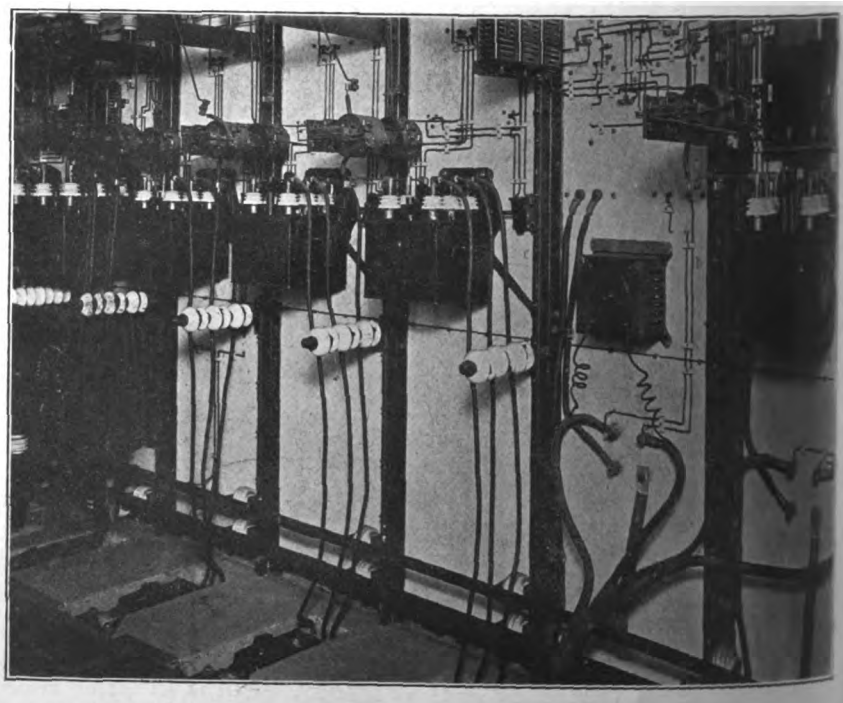

FIG. 4.—BACK VIEW OF SWITCHBOARD.

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The transmission line is supported on H poles, which vary from 40 ft. to 60 ft. in height, and below the guard net low-tension lighting wires are run.

Two overhead circuits run from the power house. The first supplies the shaft cable for No. 18 pit. This shaft, which is 430 yds. deep, is supplied by a 19/16 three-core solid bitumen double-wire armoured and served cable. The cable is supported about every 30 yds. on long oak clamps with swing suspension. Half way down the shaft is a pump house, in which is installed a Mather & Platt single-chamber high-lift

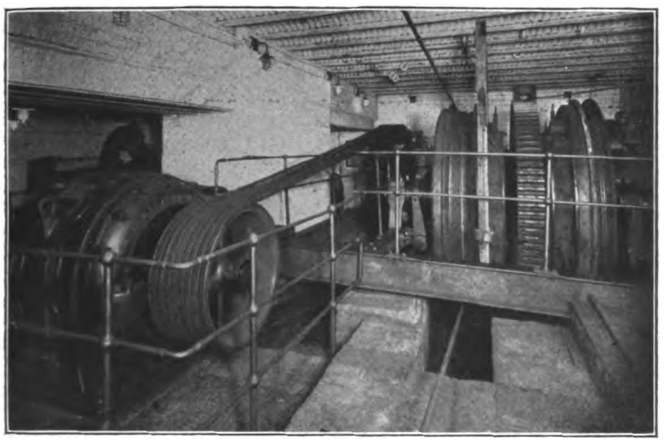

FIG. 5.—MOTOR-DRIVEN ENDLESS ROPE HAULAGE.

pump having a capacity of 500 gallons per minute with a 120 ft. head. This pump is driven by a high-tension 27 H.P. motor. The pump house is of the massive construction characteristic of the whole of this installation for the underground machine houses. The Birchenwood Colliery Co. held the view that if a machine was installed in the first instance in good surroundings then it was an incentive to the attendant and all concerned to keep it in perfect order. The actual results are certainly bearing this view out.

At the shaft bottom the cable goes inbye a short distance

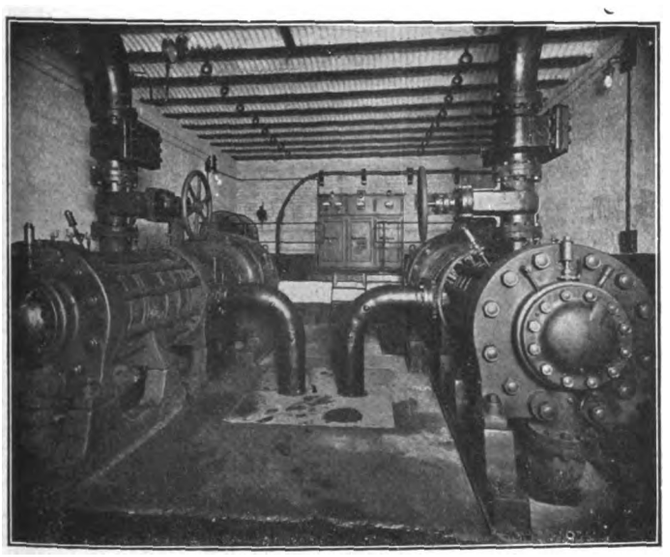

FIG. 6.—PUMP HOUSE AT BIRCHENWOOD COLLIERIES.

into a large machine room containing a haulage engine and another turbine pump. Fig. 5 illustrates the endless rope haulage with its motor, the pump being behind the motor. This haulage is of the two-rope endless type running at 2 miles per hour. One rope works the main road, the other winds up a steep dip from the lower workings. The pump is a Mather & Platt five-chamber turbine pump having a capacity of 500 gallons per minute at a total head of 570 ft. It is driven by a high-tension 130 H.P. motor.

The other overhead circuit goes right across the colliery yard to No. 14 shaft. Here it divides up into four feeders, which supply (1) a 90 H.P. motor driving a draining band in the washery plant, (2) a 100 k.v.a. transformer stepping down to 500 volts for the motors on the surface in this vicinity. These motors comprise one 30 H.P. on the aerial ropeway, two 35 H.P. on the coke-oven charging rams, two 10 H.P. on the same work, one 9 H.P. driving the small screening plant, and one 6 H.P. driving the grease-making plant. The transmission to these

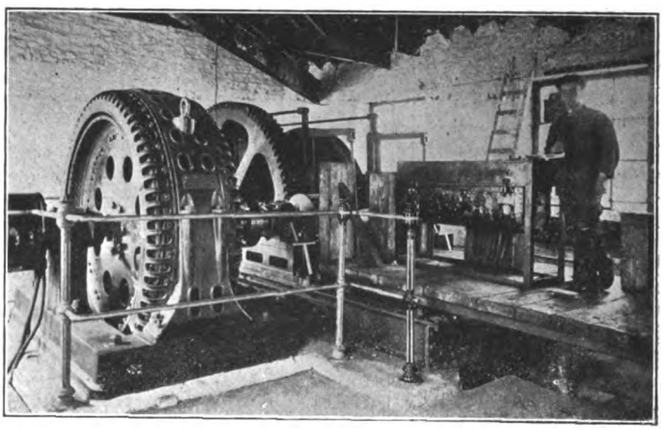

FIG. 7.—WINDING ENGINE AT OAKWOOD DIP.

motors is, in general, overhead; but in one or two cases it consists of a three-core unarmoured cable slung by suspender wire. (3) This feeder goes across country to the Nelson Pit, a distance of about a mile, where it supplies a pumping plant. This circuit is run overhead, bare wire being used except where the roads are crossed. The pump is a Mather & Platt combination, of a capacity of 500 gallons per minute to a head of about 250 ft. This plant lifts surface water up to the colliery for boiler feed purposes. The fourth and main supply from the No. 4 bank is the feeder down No. 4 shaft. This is essentially a pumping shaft, the power being entirely used for this purpose. The shaft cable is of 1,000 H.P. capacity. Part of

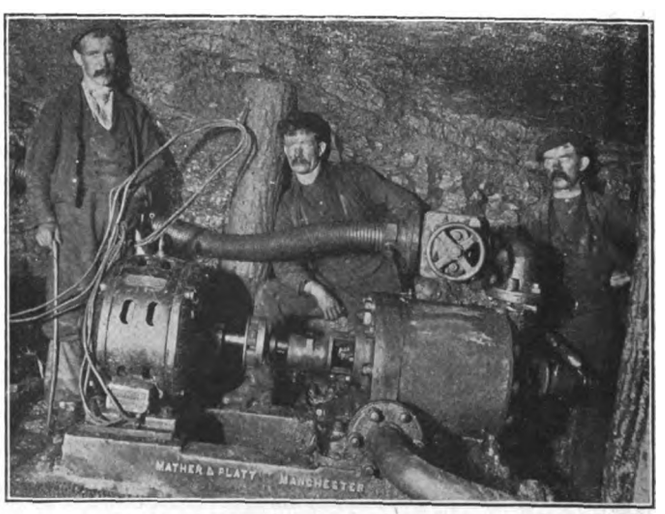

FIG. 8.—AN EARLY MATHER & PLATT MULTI-CHAMBER PUMP.

the way down the shaft it is taken inbye to feed a pump lifting water brought over from the old ironstone pits. This water is very corrosive, and the pump to lift it has, therefore, been made entirely of gunmetal. For this part of the installation the pump house has been built about 20 yds. from the shaft. The pump is of 500 gallons capacity, the motor being 130 H.P. At the shaft bottom is a large pump house, which is illustrated

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in Fig. 6. The two pumps in it are each capable of delivering 900 gallons per minute to a total head of 900 ft., being driven by 375 H.P. motors. The pump house is a very large, well-constructed room, as will be seen from Fig. 6.

Besides this plant there are also large extensions in hand at this colliery, of which we shall hope to publish a description in due course. We may say, however, that the engineers responsible for this scheme are erecting at the present time three two-cycle gas engines driving alternators direct coupled, the capacity of each set being 500 H.P. These will be worked from a large gas power plant which is now being installed. The gas will be made mainly from refuse. Further, about 100 motors, of capacity varying from 4 H.P. to 750 H.P., including two huge pumping units, each having a capacity of 1,800 gallons per minute to a head of 950 ft., are being installed in a central pumping station which will deal with several pits. Power will be transmitted at extra high pressure from this colliery to other collieries belonging to the same company, where it will be led underground for pumping, hauling and coal cutting. The equipment at the Birchenwood Colliery will, therefore, in about two years' time, rank among the most extensive in the United Kingdom.

The shaft cable is 0·25 solid bitumen double wire armoured 3-core and is laid underground from the power house to the shaft. It is supported in the shaft in the standard manner adopted by the engineers. Adjacent to the shaft bottom is a pump room where the shaft cable terminates. Here a Mather & Platt patent turbine pump, with a capacity of 500 gallons per minute at a 725 ft. head, is driven by a 186 H.P. motor. The cable is also taken inbye to drive a 40 H.P. endless haulage, and goes down a dip to supply two turbine dip pumps mounted on trolleys, each pump being about 200 gallons in capacity.

In addition to the above plant the engineers have also in hand for the Norton Colliery a complete electrification scheme, the power for which will be obtained from two 600 H.P. two-cycle gas engines, the motors being employed for driving haulages, pumps and for ventilating purposes.

The whole of the above equipment has been carried out by Messrs. Mather & Platt, of Park Works and Salford Iron Works, Manchester, to the specification of Mr. J. R. L. Allott. We understand that Messrs. Mather & Platt have also very large orders in hand for collieries both at home and abroad, and for power equipments of various natures. At present they have

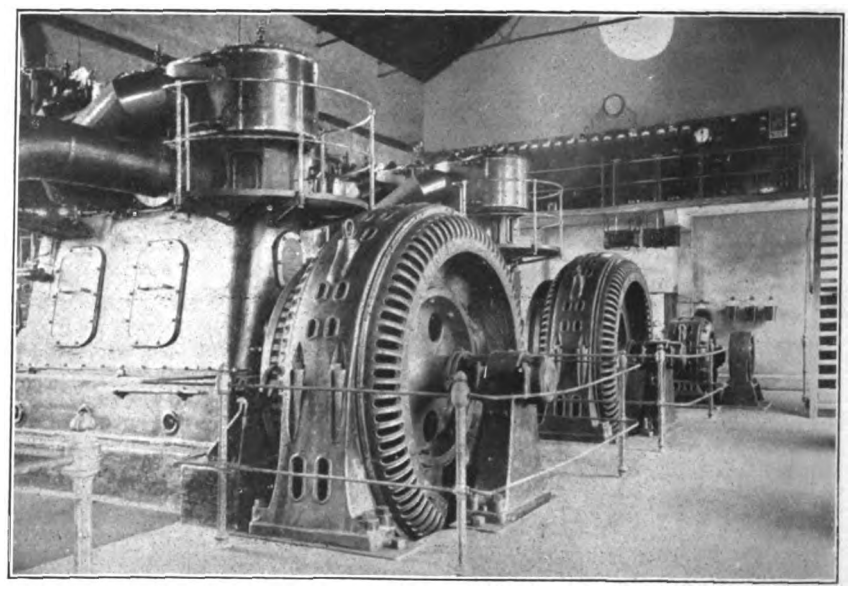

FIG. 9.—POWER HOUSE AT BRYN COLLIERY.

Although a much smaller, and therefore to many a less interesting, plant, is the complete equipment which has recently been started up at Messrs. Robert Heath & Sons, Grange Colliery, Burslem. The power house has been built adjacent to the existing Cornish pump, so that the same man can look after the three engines. In it are two Belliss & Morcom–Mather & Platt generator sets, each of a capacity of 250 H.P. when running at 428 revs. per min. The engines, which work at 90 lb. pressure, are arranged to run condensing or non-condensing at will. Condensing is effected by ejector condensers, the water used being that which is pumped out of the pit. To get the necessary head a cast-iron tank has been built on the top of the power house, and the whole of the pit water is lifted into this tank, whence it flows, after straining, to the condensers. On account of the small size of the colliery, 500 volts has been chosen for the supply pressure. Adjoining the engine house is a Walker Bros.' patent mine fan of about 50,000 cubic ft. capacity; this fan is driven direct by a 40 H.P. motor. The brick works are also driven electrically by a 90 H.P. motor. The whole of the pit bank and buildings have been lighted electrically through a step-down transformer. The calcining rucks are also lighted by 1,000 c.p. metal filament lamps, thus doing away with the large amount of coal used in the fire pots which had been used for illuminating purposes.

in their works about 40,000 H.P. of machinery in progress for colliery purposes only. In the South Wales district this firm have installed some very important equipments, and during the recent labour troubles, both at the pits of the Glamorgan Coal Co. and at the Coytrahen Park Colliery, the running of their pumps was essential in order that the owners might keep the mines dry during this trying period.

Fig. 9 illustrates the power house of Messrs. Baldwins, of Bryn Colliery, which contains two 650 H.P. Belliss & Morcom-Mather & Platt generators and sundry auxiliary machinery. The main switchboard is on a gallery, and is of a very extensive order, remote control, mechanically operated switchgear being used. At this colliery a considerable number of machines have been installed, among them being three single-rope haulages of massive size, which are provided with 250 H.P. motors capable of exerting as much as 750 H.P. on emergency. The robust construction of these machines is perfectly intelligible from Fig. 7, which illustrates a gear of this size used for winding up the Oakwood dip.

Fig. 8 is interesting in that it contains one of the earliest of Mather & Platt's multi-chamber pumps, which was installed many years ago in one of the South Wales collieries, and is still doing excellent service.

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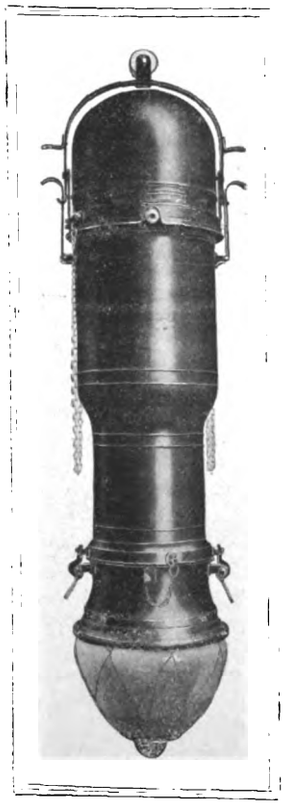

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The Transmission of Power.

The great increase in the electrification of colleries and mines, which are usually situated away from the routes of the electric supply mains, has directed considerable attention to the methods available for the transmission of power to the points of use. The subject has also come into prominence recently through the issue of the Home Office Committee's Report on the Use of Electricity in Mines, in which much attention is paid to the above subject.

In the shafts and workings insulated cables only may be used for transmitting energy. In a few instances rubber-insulated cables have been used, but they are very costly. More usually, paper or bitumen-insulated cables are employed. In the shafts, either type should be double wire armoured.

Inbye.—Wire-armoured cables also offer many advantages because of the ease with which the armour can be made electrically continuous and so an earthed circuit can be obtained to the surface for earthing motor frames and switchgear. In addition to affording considerable protection from mechanical damage, the armour assists materially in preventing "open sparking" and the risk of explosion (if gas is present) in the event of a leakage of current from a cable. The Home Office Committee also recommend the use of a lead sheath over the cable below the armour as a great protection against open sparking. With bitumen cables a copper tape below the armour may be employed for the same purpose and to give the required conductivity. In the case of paper-insulated cables, a lead sheath is to be preferred to a bitumen sheath although it is somewhat heavier. Objection has sometimes been taken to lead-covered cables in collieries because of the corrosive effects of some waters, but it should be quite clearly understood, it is pointed out, that leading English cable makers know how to protect the armour and lead against corrosion. In all usual sizes single wire-armoured lead-sheathed cable (*see* Fig. 1) built to Engineering Standards Committee specification will comply with the new Home Office Committee recommendation as to conductivity. Objection has also been taken in some quarters to bitumen insulated cables because of the action of alkaline waters (which often occur in mines) upon the prepared bitumen. To overcome this defect, the British Insulated & Helsby Cables have patented a cable, called the reinforced bitumen cable (*see* Fig. 2). In it the bitumen sheath is protected by a special sheath which is unaffected by water with an alkaline reaction.

On the Surface—To bring the electricity to the pit mouth, it is often not commercially possible to transmit it except by means of overhead wires of copper or aluminium. The necessary cables, if of considerable length, would be costly and the ground to be traversed is often difficult to cross. In many cases, therefore, the use of overhead wires is indispensable. They should always be protected at each end by kicking coils and lightning arresters, well earthed through a resistance to limit the discharge current and consequent rise in pressure. Wherever the section of overhead wire exceeds, say, 0·075 sq. in. of copper, it is possible to effect a saving by using stranded aluminium instead, because, *for the same current-carrying capacity*, although the area of aluminium conductor required is 67 per cent. greater than that of copper, it is only one-half as heavy.

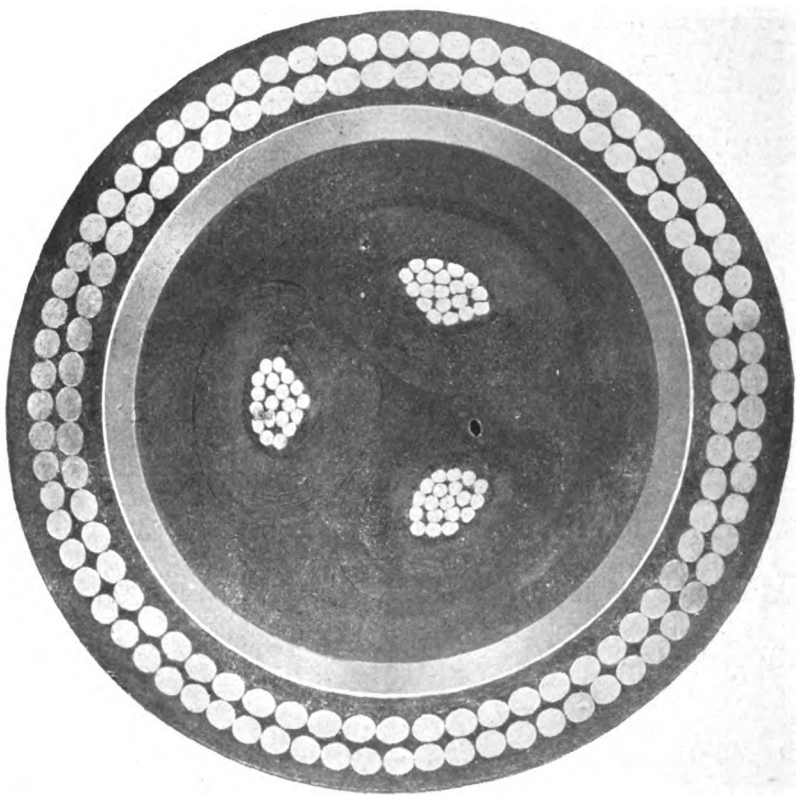

FIG. 1.—"BRITISH INSULATED" ARMOURED LEAD SHEATHED CABLE.

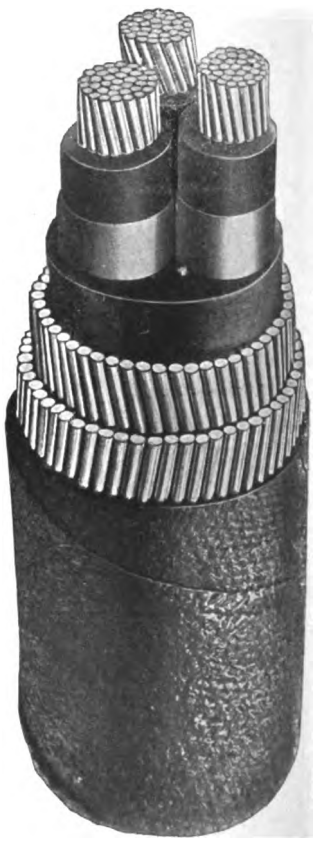

FIG. 2.—REINFORCED BITUMEN CABLE.

Fig. 3 shows a 3,000-volt three-phase line erected for the Weardale Steel, Coal & Coke Co., from Thornley to Wingate Collieries. The capacity of this line is about 1,000 H.P. The conductors are 19/10 aluminium, and the cost per mile is about £500. If insulated underground armoured cables had been used, the cost per mile, including trenching, would have been about £1,000.

Fig. 4 shows a 600-volt two-wire d.c. aluminium line erected for Newton Chambers & Co., from Rockingham Gas Works power house to Tankersley Park Colliery. Its capacity is about 550 H.P. The conductors are 1·4 sq. in. in section and are of aluminium. The total cost per mile of such a line is about £1,200. If equivalent copper conductors had been used

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the cost per mile would have been about £1,800; had insulated and armoured aluminium cables been used underground the cost per mile would have been about £2,200.

These figures show very clearly the saving that can be effected by using overhead lines instead of underground cables; by using high-pressure lines instead of low-pressure ones; by using aluminium instead of copper. Aluminium conductors have, in fact, been extensively used for 10 years past in the United States and Canada for transmission line work, and in the United Kingdom it has been used, among others, by the War Office at Aldershot, the Glantawe Electric Supply Co. at Ystradgynlais, and the Fife Coal Co. Large insulated aluminium cables made by the British Insulated & Helsby Cables have been used underground by the Manchester and Bolton Corporations, who have nearly 11,000 yds. in successful use.

FIG. 3.—3,000-VOLT LINE FROM THORNLEY TO WINGATE COLLIERIES.

The British Insulated & Helsby Cables make, in fact, a speciality of the installation of cables in collieries and of the erection of transmission lines. The company has in hand, at the present time, contracts for both cables and overhead lines for continuous working at 20,000 volts alternating, and they have just laid, and put into service, several miles of single conductor cable for working at 120,000 volts direct-current on the Thury system.

The following are some of the pole lines they have in hand or just completed in connection with the transmission of power to collieries in addition to the two already illustrated: (1) From Black Fell Engine, about 1 mile from Birtley, to Harraton Colliery, Durham. The length of this line is 1½ miles, and the size of conductors 0·1 sq. in. copper strand. (2) From the Rising Sun Colliery, near Benton, to Backworth sub-station, Northumberland, a distance of 2 miles. (3) From East Holywell sub-station, for a distance of 2½ miles, to Seghill Colliery. The above three lines are working at a pressure of 6,000 volts and the conductors are arranged to form an equilateral triangle, the sides of which are 4 ft. long. (4) From Seaton Delaval sub-station, for a distance of 3½ miles, to Newsham sub-station, Northumberland. This line works at 11,000 volts. (5) From a point outside Wallsend to the Newcastle Electric Supply Co's Burradon sub-station, a distance of 3½ miles. This line works at 20,000 volts. (6) From Pelton to Shield Row Colliery, a

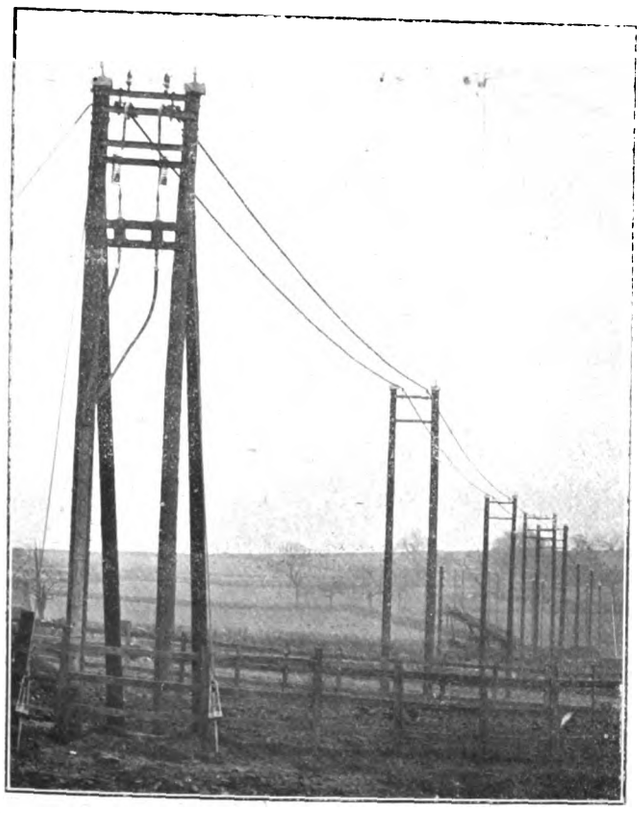

FIG. 4.—600-VOLT DIRECT-CURRENT LINE FROM ROCKINGHAM GAS WORKS POWER HOUSE TO TANKERSLEY PARK COLLIERY. ALUMINIUM WIRES.

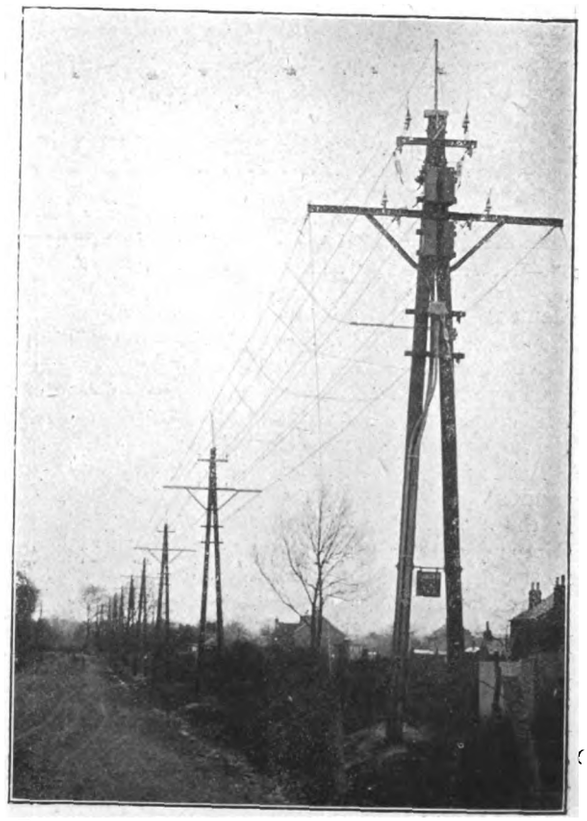

FIG. 5.—3,000-VOLT THREE-PHASE LINE, WITH ALUMINIUM CONDUCTORS.

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distance of 2½ miles. The pressure of this line is 11,000 volts. (7) Ackley Head sub-station to Tater House Colliery via Framwell Gate Moor Colliery, a distance of 1¼ miles, alongside waggon ways. The voltage here is 6,000. (8) South Pelaw to Pelton Fell, for a distance of ½ mile. This line works at 11,000 volts.

Fig. 5 shows a 3,000 volt three-phase four-wire line with aluminium conductors, just completed for the War Office at Aldershot. On the terminal pole can be seen the method of connecting the underground paper-insulated wire-armoured cable to a terminal sealing box, and thence through kicking coils to the overhead line wires. The horn arresters are also shown. These are connected to earth through resistances which will limit the amount of current which can flow to earth in the event of a rise of pressure or lightning causing the arresters to flash over. The illustration also shows a good example of cradle guarding to catch and earth any broken high-pressure conductor.

Electric Winding for Collieries.

Electric winding in collieries is a subject which has been before colliery owners and colliery engineers for some time part and therefore some particulars of the electric winding plant recently put down at Messrs. Dunn & Stephen's South Kenmuir colliery will doubtless prove interesting, as this installation probably marks the commencement of a series of important changes which are likely to take place in the near future in several colliery districts.

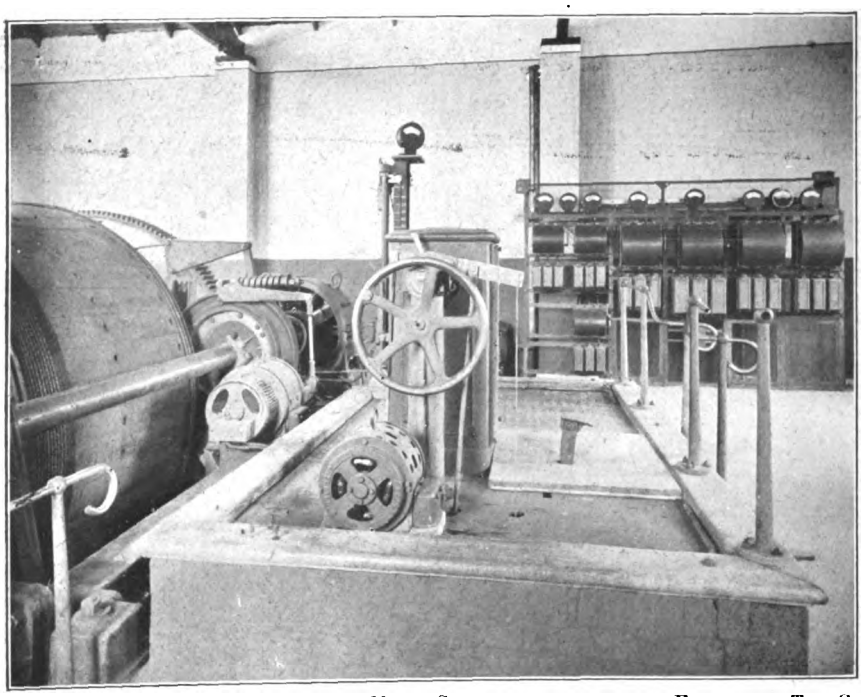

FIG. 1.—VIEW SHOWING BRAKE MOTOR AND MOTOR SOLENOID FOR OPERATING EMERGENCY TRIP GEAR.

It may be said that the advent of electric winding has been facilitated by the appearance in the colliery districts of the Power Supply Companies. The short hours now in force in most colliery districts also have a considerable bearing on the problem. Owing to these short hours the amount which has to be charged to the winding costs to cover depreciation and interest on capital is now a very considerable item, and the saving of a large proportion of these capital charges which is effected by taking electricity from the power company makes a considerable difference to the net cost per ton of raising coal.

The winding gear at Messrs. Dunn & Stephen's pit is designed for winding eventually from a depth of 160 fathoms though at present it is only working from the 90 fathom level. Each cage carries two hutches with a total of 17 cwt. of coal, the empty hutches being lowered in the other cage, and as a winding schedule of 65 winds per hour can be obtained the gear is capable of dealing with 55 tons of coal per hour.

The main winding drum is of the spiro-conical type, in which at the commencement of the wind the ascending rope is on a part of the drum, which has a diameter of approximately 5 ft., while the descending rope is on the centre of the drum whose diameter is 10 ft. This arrangement has the effect of minimising the effort required from the electrical plant during the period of acceleration, the rope being transferred to the part of the drum with the larger diameter towards the end of the accelerative period by a cast-iron spiral formed in the drum cheek. To this drum are geared two 105 H.P. continuous-current motors.

The electrical equipment is constructed on the well-known "C.M.B." system, which is manufactured by Messrs. Crompton & Co., of Chelmsford. This system involves the use of a motor-generator, which converts the three-phase alternating current taken from the Clyde Valley Electrical Power Co. to continuous current.

This motor-generator is further so designed that the characteristics of the continuous-current supply are exactly suited to the demands of the driving motors, so that a direct electrical connection may be made between this motor-generator and the

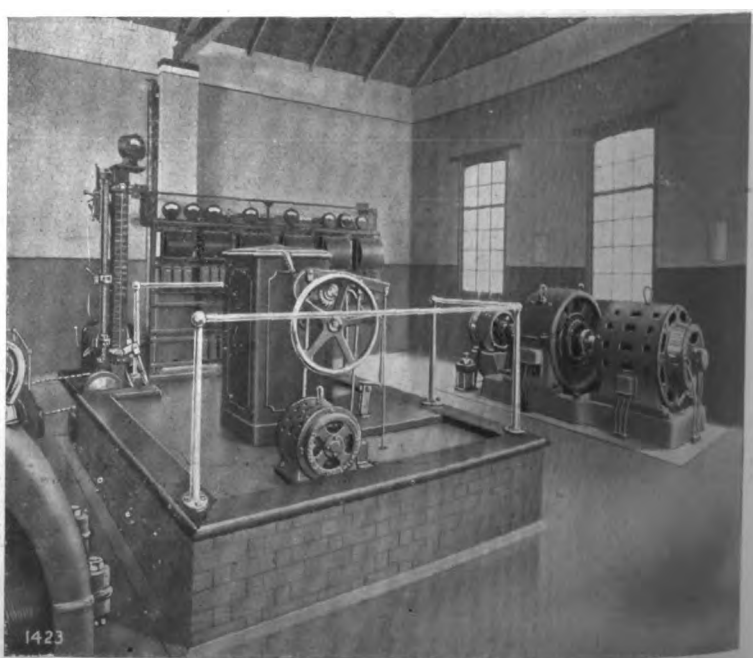

FIG. 2.—CONTROL PLATFORM AND "C.M.B." MOTOR-CONVERTER, SOUTH KENMUIR COLLIERY.

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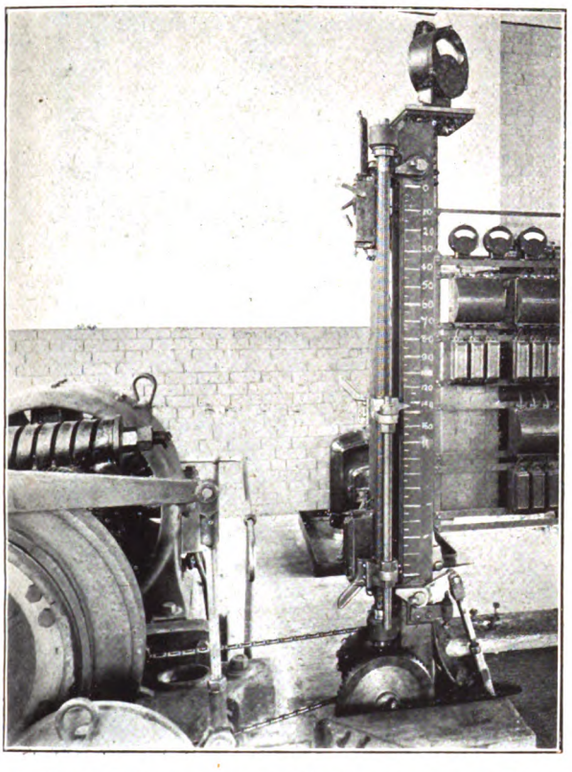
motors without the insertion of any controller or resistance, such as is common in most forms of electrical driving.

The motor of the motor-generator is of the Crompton standard type, with wound rotor and slip-rings for use in starting, a liquid starting resistance being employed. An ampere-meter and a voltmeter are provided in the alternating-current circuit, and a voltage coil is connected from the incoming leads to the emergency trip gear, which is connected to the brake. The above motor is coupled direct on the same bedplate to a continuous-current generator whose fields are wound with three coils in order that it may give a constant current characteristic. In circuit with the dynamo field is a shunt resistance of special type, which forms the principal controller. By it the dynamo voltage can be regulated from nothing to its maximum value. It is also provided with a special trip coil, which compels it to return to the "off" or "no voltage" position in the event of any of the trip switches opening c



IG. 3.—DEPTH INDICATOR SHOWING METHOD OF OPERATING LIMIT SWITCHES.

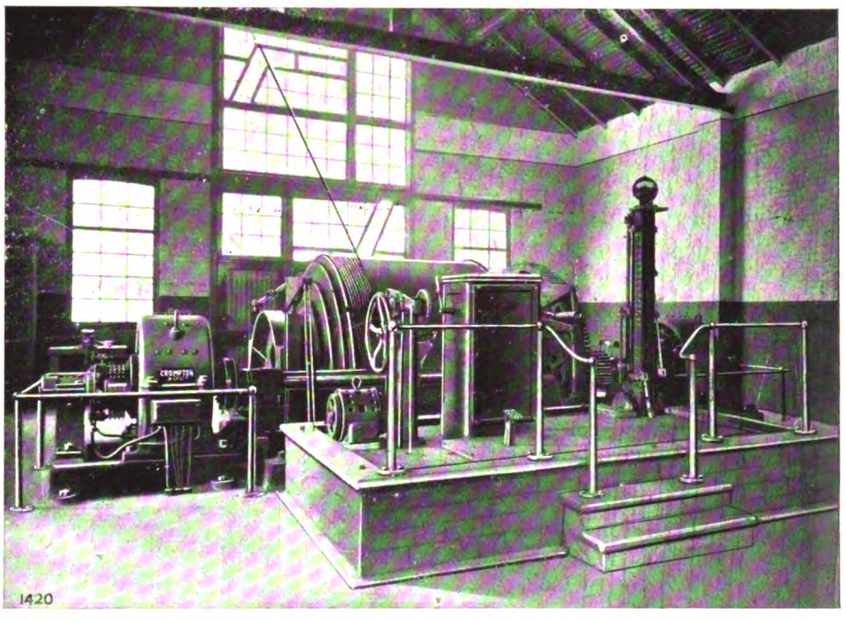


FIG. 4.—GENERAL VIEW OF WINDING PLANT AT SOUTH KENMUIR COLLIERY.

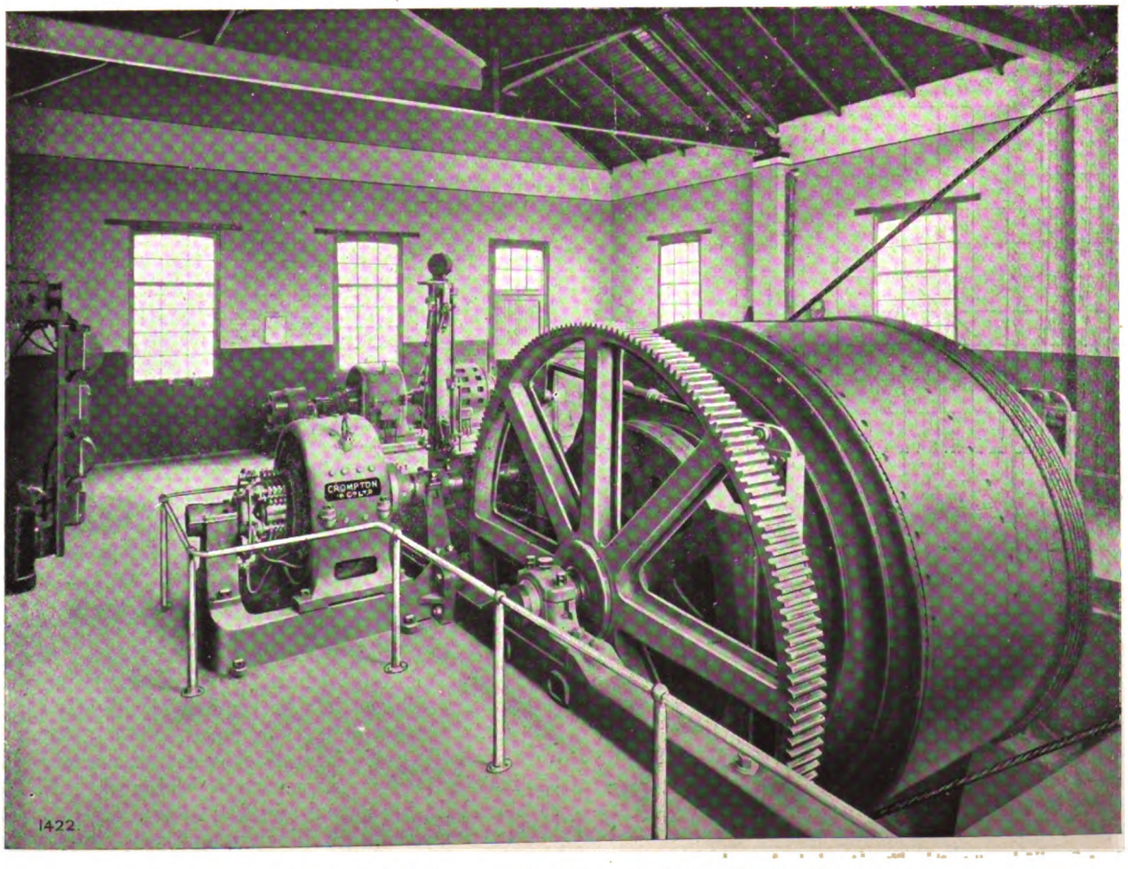


FIG. 5.—"C.M.B." WINDING EQUIPMENT AT SOUTH KENMUIR COLLIERY.

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certain accidents occurring. A demagnetising coil is provided, which does away with the necessity for series resistances, as it automatically adjusts the dynamo voltage to whatever voltage may be required by the motors, no matter what the speed may be at which they are running. The two motors connected to the winding gear are fitted with specially wound field magnets.

The following table gives details of the operation of a "C.M.B." electric winding set :—

Retardation period	8 seconds
Banking period	10 ,,
Time required for each wind	55 ,,
Maximum winding speed	1,360 ft. per min.
Total weight of coal per hour	55 tons
No. of working hours per day	8 hours
Total weight of coal per day	440 tons
Capacity of motors	0–150 B.H.P.
Speed of motor	0–400 revs. per min.
Output of motor-generator	120 kw. at 0–400 volts
Supply circuit particulars	440 volts by 25 ∽, 3 phase

The combination of the motor generator and motor field windings, Messrs. Crompton inform us, give speed torque characteristics which are well suited to the requirements of the winding gear and to a restricted power demand ; thus it is possible, they claim, with this system to provide the heavy starting and accelerating torque with only a limited increase of power from the main circuit, to give natural speed variations changing from one set of conditions to another without any shock whatever either to the mechanical or electrical parts of the equipment, and to produce complete control of the gear by the movement of one switch, which is the regulator in series with the B coil of motor generator.

The mechanical gear is provided with two double shoe brakes of the usual type, which may be applied by foot power or by an emergency brake, which is released in the case of an overwind or the failure of the power supply through the agency of the trip coil. In addition to these brakes there is a working brake on the first motion shaft which is brought into operation to a small extent at the end of every wind. It is magnetically

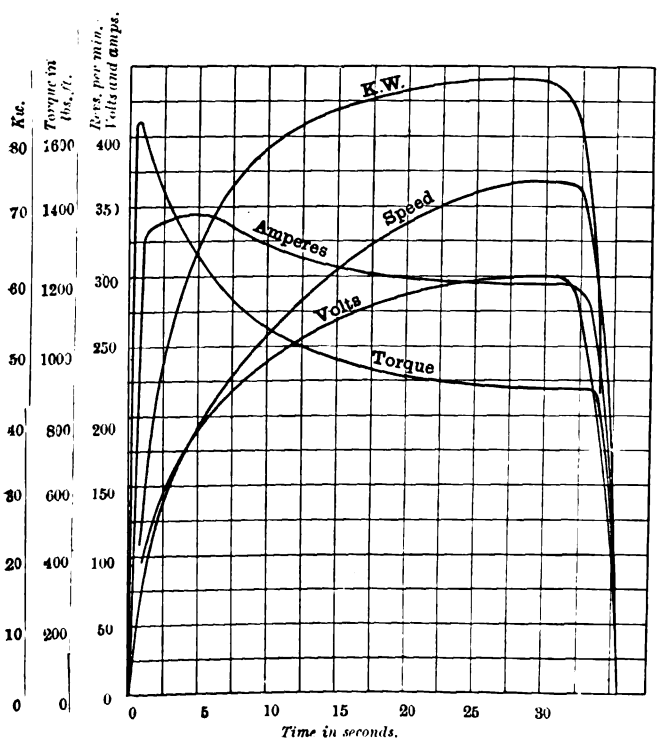

FIG. 7.—CURVES SHOWING THE OPERATION OF THE WINDING ENGINE AT THE SOUTH KENMUIR COLLIERY.

controlled by a motor. When stopping the cage the controller is gradually brought back, and the current through the field of the brake motor is decreased, so that the brake comes on quite gradually until the cage comes to rest. This brake also acts as a safety device, as it will come into action in the event of the exciting set losing its voltage or the exciter circuit being opened ; in the event of the motor circuit being opened, or of the motors running away and tending to return power into the motor-generator.

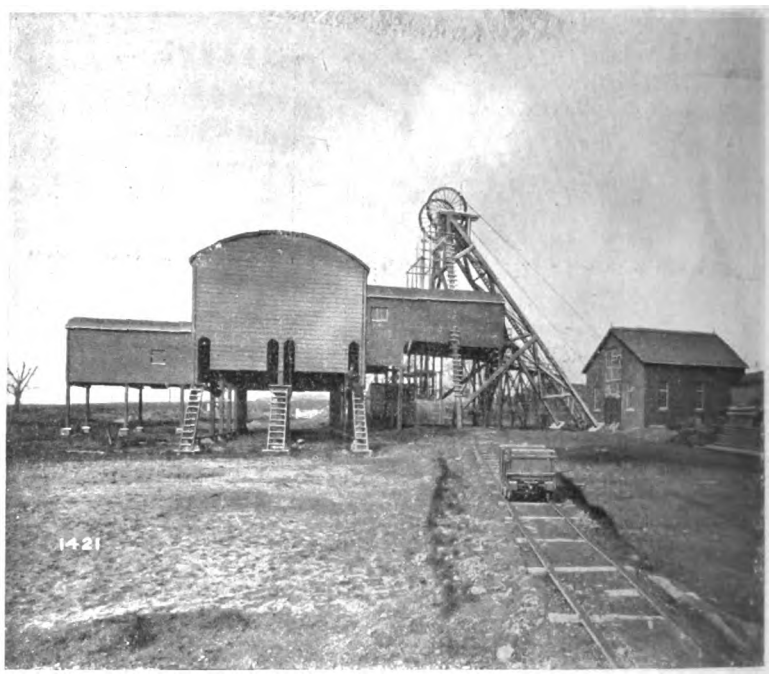

FIG. 6.—SOUTH KENMUIR COLLIERY, NR. GLASGOW, WHERE THE COAL IS RAISED BY THE "C.M.B." PATENT SYSTEM.

In order to reverse the direction of movement, a main circuit reversing switch is provided. It changes from one set of connections to the other without opening the motor circuit. By this arrangement the cages are always held in position electrically, for even while changing from one set of contacts to the other the armatures are short-circuited while the motor fields are fully excited.

Pilot contacts are provided on this reversing switch which are connected through the limit switches and the voltage coil on the controller of the motor-generator to the exciter voltage. These pilot contacts ensure that if the reversing switch is moved improperly at the wrong moment the controller will return to the "off" position ; the pressure of the motor-generator will fall to zero, and any tendency which there might be for sparking or excessive currents will be immediately negatived. These pilot contacts also work in conjunction with the limit switches, so that if one limit switch has been passed the reversing switch may be pulled over and the pilot switch will then make a circuit through the other limit switch, enabling the gear to be run in the other direction and the cages brought back into their place. The limit switches are worked by a depth indicator gear connected to the main winding drum, and an indicator is provided so that the driver may know the exact position of the cages at every moment.

It is estimated that the maximum demand for power from the supply circuit will not exceed 120 kw., and that the consumption of electrical energy per ton of coal will be approximately 1·5 units per ton raised. Assuming that electrical energy can be purchased at the rate of ¾d. per unit, the cost for power of winding coal from this depth is slightly less than 1·1d. per ton, a figure which, it is claimed, will compare very favourably with the cost of winding by steam, especially in view of the fact that only one man is required, and that he only needs to attend during actual winding hours.

The accompanying illustrations show various views of Messrs. Crompton & Co.'s winding gear at the South Kenmuir Collieries together with a curve giving the operation of equipment.

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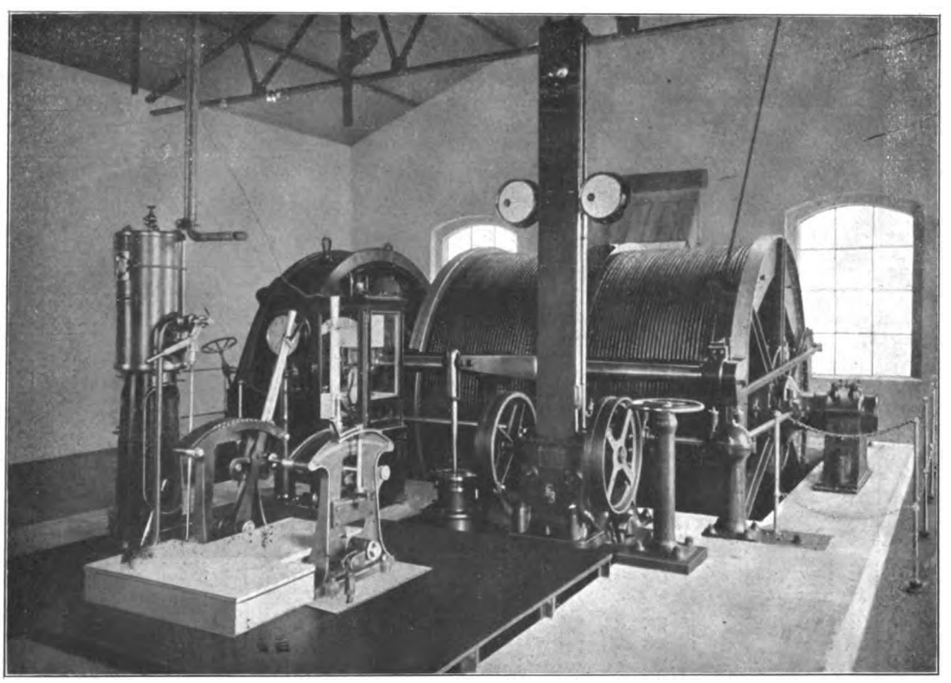

Comply in all respects with the requirements of the new Coal Mines Bill now before Parliament.

Patent Depth-Indicator automatically limits rate of acceleration and retardation, shows position of cages in shaft at any time, and makes

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ELECTRIC WINDING ENGINES.

In the following Tables we give particulars of the electrically-driven winding engines at present in existence in various parts of the world. We cannot claim that these Tables are quite complete, though every care has been taken to make them so; but it will nevertheless be agreed that the entries are numerous enough to show what great progress has been made in the application of the electric drive to winding plant. A few years ago, had we given such a table, the entries would have been extremely meagre, now they amount to over 150. Yet there is an idea abroad that very little is being done in this direction. We have to thank the various makers mentioned in these tables for supplying us with the particulars given. Further details of some of these plants will be found in the article by Mr. G. Hooghwinkel on another page of this issue.

Owners.	Name of pit.	No. of sets.	Motor. H.P.	Motor. Revs. p. min.	Supply. Syst.	Supply. Volts.	Supply. ~	Shaft length in ft.	Speed in ft. per min.	Net load in lb.	Rope diam.	Maker.	Type of winding Motor.
Priestman Collieries, Newcastle-on-Tyne	Axwell Park, Co. Durham	...	39	...	3-ph.	5,500	40	...	480	...	0·95″	Siemens	Ilgner.
Cynon Coll. Co., Port Talbot, South Wales	Cyno Colliery, Port Talbot	...	271	...	3-ph.	2,200	25	...	1,500	...	1·0″	,,	,,
Pease & Partners, Darlington	Peases West Colliery, Crook	...	231	...	3-ph.	2,750	40	...	1,140	...	1·273″	,,	Ward Leonard.
		...	75	...	3-ph.	2,750	40	...	600	...	0·95″	,,	,,
Lambton Colliery, Ltd., Durham	Lumley 3rd Pit, Penshaw	...	535	...	3-ph.	5,500	40	...	1,980	...	1·5″	,,	,,
Duffryn Rhondda Coll. Co., Port Talbot	Duffryn Rhondda, No. 1 Pit, Port Talbot	...	1,420	...	3-ph.	2,200	25	...	3,000	...	1·843″	,,	Ilgner.
United Alkali Co., Widnes, Lancashire	San Luis Shaft, Soteil Prov., Huelva, Spain	...	73	...	3-ph.	3,300	25	...	300	...	1·062″	,,	,,
	San Antonio Shaft, Soteil Prov. Huelva, Spain.	...	33	...	3-ph.	3,300	25	...	250	...	1·812″	,,	[set with flywheel
Clyde Navigation Trustees, Glasgow	No. 1 Hoist, Rothesay Dock, Glasgow	...	300	...	...	...	...	...	103	...	36mm.	,,	Ward Leonard st. dvn.
	No. 2 Hoist	...	300	...	...	...	...	...	103	...	36mm.	,,	,,
	No. 3 Hoist	...	300	...	...	...	...	...	103	...	36mm.	,,	,,
	No. 4 Hoist	...	300	...	...	...	...	...	103	...	36mm.	,,	,,
Guest, Keen & Nettlefolds, Cardiff	No. 1 Hoist, Dowlais-Cardiff Works, Cardiff	...	145	...	D.C.	350/500	...	...	320	...	1·5″	,,	Ilgner.
	No. 2 Hoist	...	160	...	D.C.	350/500	...	...	320	...	1·5″	,,	,,
General Mining & Finance Corpn. Johannesburg	No. 1 Shaft, Rand Collieries, Transvaal	...	1,300	...	3-ph.	6,000	50	...	3,300	...	1·125″	,,	Ward Leonard.
	No. 1 Shaft, Rand Collieries, Transvaal	...	2,450	...	3-ph.	6,000	50	...	3,300	...	1·375″	,,	,,
	No. 2 Shaft	...	2,450	...	3-ph.	6,000	50	...	3,300	...	1·375″	,,	,,
Harton Coal Co., South Shields	Harton Main Pit, South Shields	...	1,700	...	3-ph.	5,500/5,000	40	...	2,460	...	1·625″	,,	.....
Denaby & Cadeby Main Colls., nr. Rotherham	Denaby Main, nr. Rotherham	...	686	...	3-ph.	3,000	40	...	1,950	...	1·27″	,,	.....
Ebbw Vale Steel, Iron & Coal Co.	Cumcarn Colliery	...	1,322	...	3-ph.	6,000	50	...	2,160	...	1·687″	,,	Ilgner.
Powell Duffryn Steam Coal Co., Aberdare South Wales	Pengam Colliery	...	1,253	...	3-ph.	10,000	50	...	1,575	...	2·125″	,,	,,
		...	4,320	...	3-ph.	10,000	50	...	1,575/4,338	...	2·125″	,,	,,
		...						Metals.	Metres.	Kg.			
The Harton Coal Co.	Harton Main Shaft, Tyne Dock	...	950/1,700	51	3-ph.	5,000	40	395	11·6	4,271	...	,,	Direct coupled.
H. Eckstein & Co.	Robinson Central, Deep Main Shaft	...	450/1,020	375	3-ph.	2,000	50	1,189	10·2	1,825	...	,,	Motor geared.
	Ditto	...	665/1,320	375	3-ph.	2,000	50	1,189	10·2	3,650	...	,,	,,
	Nourse Mines, No. 2 Shaft	...	525/990	375	3-ph.	2,000	50	732	10·2	2,730	...	,,	,,
	Rose Deep, No. 3 Shaft	...	430/1,000	375	3-ph.	2,000	50	885	10·2	1,365	...	,,	,,
	New Modderfontein G.M. C., No. 10 Shaft	...	340/806	375	3-ph.	2,000	50	805	10·2	2,730	...	,,	,,
	Langlaagte Deep, No. 2 Shaft	...	930/1,550	107	3-ph.	2,000	50	309	13·4	3,640	...	,,	Direct-coupled motor.
	Ditto	...	970/1,630	107	3-ph.	2,000	50	309	13·4	3,640	...	,,	,,
	Nourse Mines, No. 2 Shaft	...	1,080/2,060	94	3-ph.	2,000	50	498	14·65	3,400	...	,,	,,
	Nourse Mines, West Shaft	...	825/1,300	125	3-ph.	2,000	50	480	13·7	2,720	...	,,	,,
	Crown Deep, No. 1 Shaft	...	560/1,440	375	3-ph.	2,000	50	1,215	10·2	2,720	...	,,	Motor geared.
	Crown Deep, No. 2 Shaft	...	565/1,410	375	3-ph.	2,000	50	988	10·2	2,720	...	,,	,,
	Crown Mines, Longlaagte Deep, Section No. 2 Shaft	...	633/1,280	375	3-ph.	2,000	50	625	10·2	4,540	...	,,	,,
	Ditto	...	633/1,280	375	3-ph.	2,000	50	625	10·2	4,540	...	,,	,,
	Nourse Mines	...	400/870	375	3-ph.	2,000	50	760	10·2	4,540	...	,,	,,
Randfontein Estates Gold Mining Co.	Randfontein South	...	505/1,050	375	3-ph.	2,000	50	1,005	8·12	3,170	...	,,	,,
Kgl. Berginspekt III. Buer, b. Essen	Schacht, Scholven I.	...	505/1,050	375	3-ph.	2,000	50	1,005	8·12	3,170	...	,,	,,
Denaby & Cadeby Main Coll., Rotheram	Schacht Scholven II.	...	175/380	375	3-ph.	3,100	50	600	10	1,200	...	,,	,,
Union A.G. Dortmund	Parkgate Staple Pit, Conisboro.	...	175/380	375	3-ph.	3,100	50	600	10	1,200	...	,,	,,
Soc. An. d. Carb. Kessales	Grube Wohlverwahrt	...	375/750	300	3-ph.	3,000	46	238	9·9	2,032	...	,,	,,
Gew. Felsenfest Südharz	Jemappes sur Meuse	...	205/360	500	3-ph.	2,000	25	1,500	5	6,000	...	,,	Double-geared motor
Gew. Hildesglück	.....	...	150/300	150	3-ph.	3,000	50	330	4	1,650	...	,,	Single-geared motor.
Ditto	.....	...	300/565	750	3-ph.	2,000	50	850	6·5	2,000	...	,,	Double-geared motor.
H. Eckstein & Co., Johannesburg		...	180/347	500	3-ph.	220	50	1,000	6	1,800	...	,,	,,
Gelsenkirchener Bergwerks A.G., Rheinelbe	Rand Jen Cons. M. Ltd., Central Shaft	...	180/347	500	3-ph.	220	50	1,000	6	1,800	...	,,	,,
Kgl. Steinkohlenbergwerk Schacht Friedrich Heinrich	Zeche II	...	1,310/2,300	375	3-ph.	2,000	50	1,220	15·3	4,540	...	,,	Motor geared.
Kgl. Steinkohlenbergwerk Schacht Friedrich Heinrich	König Wilhelm II	...	...	...	D.C.	500	...	500	29	4,200	...	,,	Direct
Gelsenkirchener Bergwerks A.G. Rheinelbe		...	...	...	3-ph.	2,000	50	188	7	1,400	...	,,	,,
		...			3-ph.	2,000	50	350	5	1,000	...	,,	Battery

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Owners.	Name of Pit.	No. of sets.	Motor. H.P.	Revs. p. min.	Supply. Syst.	Volts.	~	Shaft length in. Metres.	Speed in metres per min.	Net load in kg.	Rope. diam.	Maker.	Type of winding Motor.
Gewerkschaft Mathias Stinnes, Carnap	Pit III.	...	...	...	3-ph.	5,000	50	800	14	4,800	...	Siemens	Ilgner.
Mansfeld'sche Kupferschieferbauende Gewerkschaft, Eisleben	Hermann	...	...	...	3-ph.	3,000	50	500	12	2,200	...	,,	,,
Donnersmarckhütte, Zabrze, O.S.	Concordia	...	...	...	3-ph.	1,000	50	360	8	1,250	...	,,	,,
Steierische Montan-Werke, Leoben	Piberstein	...	...	...	3-ph.	3,000	42	120	3·5	800	...	,,	,,
Les Petits-Fils de Fois de Wendel & Cie., Hamm	Heinrich	...	...	...	3-ph.	3,000	50	900	18	5,600	...	,,	,,
Brüxer Kohlen-Bergbau-Gesellschaft, Brüx	Gisela	...	...	...	3-ph.	2,000	50	152	4	1,600	...	,,	,,
Gräflich Larisch-Mönnich'sche Berg-Direktion, Karwin	Tiefbau	...	...	...	3-ph.	3,000	30	530	12	3.050	...	,,	,,
Magistrat der Stadt Görlitz	"Stadt Görlitz"	...	...	...	3-ph.	500	50	100	6	900	...	,,	,,
Steinkohlenbergwerk Rheinpreuben, Homberg	Pit IV.	...	...	...	3-ph.	5,000	50	800	18	2,200	...	,,	,,
Schwadowitzer Bergbau-Ges., Schwadowitz	Karl	...	...	...	3-ph.	3,000	50	400	5	1,700	...	,,	,,
Priestman Collieries, Newcastle-on-Tyne	Axwell Park Colliery	...	...	...	3-ph.	5,500	40	76	2·44	1,585	...	,,	,,
Kaliwerke Friedrichshall, A.-G., Sehnde	Sehnde	...	...	...	...	steam	...	900	10	2,800	...	,,	Iffland.
Königliche Berginspektion V., Sulzbach	Kolonieschacht	...	...	...	3-ph.	5,000	50	465	10	1,575	...	,,	Ilgner.
Witkowitzer Steinkohlengruben	Salomonschacht	...	...	...	3-ph.	3,000	50	1,060	13·9	5,100	...	,,	,,
Graf Franz von Ballestrem'sche Bergwerks-Verwaltung, Ruda, O.S.	Castellengo	...	...	...	3-ph.	1,000	50	260	12·5	2,300	...	,,	,,
Königlich Bayerische General-Bergwerks- und Salinen-Administration, Munich	Barbara, Amberg	...	...	...	D.C.	500	...	140	5	650	...	,,	,,
Gewerkschaft Johannashall	Curt., Beesenstedt	...	...	...	3-ph.	5,500	50	800	10	1,800	...	,,	,,
Bergbau-und Hütten-A.-G. Friedrichshütte	Grube St. Fernando	...	...	...	3-ph.	2,000	50	775	6	900	...	,,	,,
Ver. Stahlwerke van der Zypen und Wissener Eisenhütten, A.-G., Wissen a.d. Sieg	Grube Petersbach,	...	...	...	3-ph.	10,000	50	600	4	1,600	...	,,	Battery.
Gewerkschaft Deutscher Kaiser, Hamborn	Schacht VI.	...	...	...	3-ph.	5,000	50	700	15	4,640	...	,,	Ilgner.
Donnersmarckhütte, Oberschlesische Eisen- und Kohlenwerke A.-G.	Neue Abwehrgrube	...	...	...	3-ph.	1,000	50	280	15	2,600	...	,,	,,
Oberbayerische A.-G. für Köhlenbergbau	Hausham	...	...	...	3-ph.	2,000	50	750	16	2,800	...	,,	,,
Gewerkschaft Mont Cenis, Sodingen	Schacht III.	...	...	...	3-ph.	2,000	50	600	20	3,600	...	,,	,,
Fried. Krupp A.-G., Essen	Emscher-Lippe	...	...	...	3-ph.	3,000	50	900	20	6,000	...	,,	,,
Verwaltung der holländ. Staatsminen	Wilhelmina	...	...	...	3-ph.	2,000	50	500	12	2,200	...	,,	,,
Union A.-G. für Bergbau, Dortmund	Friedrich	...	...	...	3-ph.	2,000	50	570	6	2,000	...	,,	,,
A.-G. Deutsche Kaliwerke, Bernterode	Preuben	...	...	...	3-ph.	5,000	50	572	15	1,700	...	,,	,,
Eisenerzgrube S. N. Kolatschewsky, Kolatschewskoje, Gouvernement Jekaterinoslaw	New Pit Nr. 2	...	...	...	D.C.	440	...	170	3·5	3,300	...	,,	,,
Steinkohlenbergwerk Rheinpreussen, Homberg	Pit V.	...	...	...	3-ph.	5,000	50	600	18	3,300	...	,,	
Kaliwerk Krügershall A.-G., Halle	Teutschenthal	...	...	...	3-ph.	500	50	750	19	1,500	...	,,	,,
Georg von Giesche's Erben, Schoppinitz, O.S.	Carmer	...	...	...	3-ph.	2,000	50	400	15	4,400	...	,,	,,
		...	...	...	3-ph.	2,000	50	400	15	2,200	...	,,	,,
Königlich bayerische General-Bergwerks und Salinen-Administration, Münich	Mittelbexbach	...	...	...	3-ph.	500	50	250	9·5	1,000	...	,,	,,
Nordböhmische Kohlenwerks-Gesellschaft	Tegethoffschacht I.	...	...	...	3-ph.	2,000	50	263	7·5	1,700	...	,,	,,
Steinkohlenbergwerk Rheinpreussen, Homberg	Pit V.	...	...	...	3-ph.	5,000	50	600	18	3,300	...	,,	,,
Gewerkschaft Mathias Stinnes, Carnap	Pit IV.	...	...	...	3-ph.	5,000	50	800	14	4,800	...	,,	,,
Trifailer Kohlenwerks-Gesellschaft, Vienna	Kisove	...	...	...	3-ph.	3,000	50	76	4	800	...	,,	,,
Gelsenkirchener Bergwerks-A.-G., Rheinelbe	Zeche Zollern II.	...	...	...	D.C.	500	...	500	11	4.200	...	,,	,,
Kaliwerke Salzdetfurth, A.-G., Salzdetfurth	Pit II.	...	...	...	3-ph.	3,000	50	820	15	3,400	...	,,	,,
Société des Mines d'Albi, Albi	Pit I.	...	...	...	3-ph.	5,000	25	211	6	1,600	...	,,	Convertor.
Cynon Colliery Co., Port Talbot	Pit II.	...	...	...	3-ph.	2,200	25	183	7·6	1,270	...	,,	Ilgner.
Les Petits-Fils de Fois de Wendel & Cie, Abteilung Zeche de Wendel bei Hamm, Westf	Heinrich, Pelkum	...	...	...	3-ph.	3,000	50	900	18	5,600	...	,,	,,
Gewerkschaft Glückauf, Sonderschausen	Pit II.	...	...	...	3-ph.	5,000	50	750	15	2,000	...	,,	,,
Société Houillière de Liévin, Liévin	Pit VI., Lens	...	...	...	3-ph.	500	50	800	15	4,200	...	,,	,,
Bergwerks-und Huttenverwaltung der Grafen Hugo, Lazy	Clara, Tarvis	...	...	...	3-ph.	5,500	33⅓	260	8	900	...	,,	,,
Les Petits-Fils de Fois de Wendel, Steinkohlengrube Klein-Rosseln	Pit Simon	...	...	...	3-ph.	3,000	50	440	16	6,000	...	,,	,,
Gewerkschaft des Steinkohlenbergwerks Gottfried Wilhelm, Essen	Rellinghausen Nord	...	...	...	3-ph.	5,000	50	600	16	4,200	...	,,	,,
Mansfeld'sche Kupferschieferbauende Gewerkschaft, Eisleben	Hermann. Pit II., Eisleben	...	...	...	3-ph.	3,000	50	520	11	2,200	...	,,	,,
Rio Tinto Co.	Guillermo, Rio Tinto,	...	...	...	3-ph.	3,000	50	275	7	2,850	...	,,	,,
Messrs. Pease & Partners, Darlington	Peases West Colliery, Crook	...	...	...	3-ph.	2,750	40	94	6	917	...	,,	Convertor.
Mährisch-Ostrauer Steinkohlengewerkschaft Marie-Anne, Marienberg	Oderschacht	...	...	...	3-ph.	2,000	33⅓	530	10	3,000	...	,,	Ilgner.

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ELECTRIC WINDING ENGINES—*continued.*

Owners.	Name of Pit.	No. of sets.	Motor. H.P.	Motor. Revs. p. min.	Supply. Syst.	Supply. Volts.		Shaft length in Metres.	Speed in Metres per min.	Net load in kg.	Rope diam.	Maker.	Type of winding Motor.
Fried. Krupp, A.-G., Essen	Emscher Lippe	...	...	...	3-ph.	3,000	50	900	20	6,000	...	Siemens	Ilgner.
Graf Franz von Ballestrem'sche Bergwerksverwaltung, Ruda	Castellengo	...	...	...	3-ph.	1,000	50	380	10	2,250	...	,,	,,
Société des Salines de St. Laurent, Einville	Einville	...	...	...	...	...	...	128	4	1,500	...	,,	Direct drive.
Königl. Säch. Steinkohlen, Zauckerode	Prinz Georg	...	...	...	3-ph.	500	50	560	6	900	...	,,	,,
Nordböhm. Kohlenwerks-Gesellschaft, Brüx	Tegetthoffschacht II.	...	...	...	3-ph.	2,100	50	263	7·5	3,600	...	,,	Ilgner.
Bergverwaltung Piberstein, Köflach	Köflach	...	...	...	3-ph.	220	42	96	4·5	2,100	...	,,	,,
Königl. Berginspektion I., Königshütte	Erbreich.	...	...	...	3-ph.	6,000	50	170	10	2,000	...	,,	,,
Gew. Deutscher Kaiser, Hamborn	Pit VI.	...	...	...	3-ph.	5,000	50	660	15	4,400	...	,,	,,
Ilseder Eisenhütte	Pit B, Bülten-Adenstädt	...	...	...	3-ph.	10,000	50	75	4	2,500	...	,,	Direct.
K.K. Bergverwaltung Dolnja-Tuzla	Neuschacht Vilma II.	...	...	...	3-ph.	3,000	50	200	12·5	1,600	...	,,	Ilgner.
Cie. des Forges de Chatillon-Commentry et Neuves Maisons à St. Eloy	St. Eloy	...	...	...	3-ph.	3,600	50	600	2·5	1,600	...	,,	Direct.
Société des Mines de Saint Pierremont	Mancieulles-Bellainvillers	...	...	...	3-ph.	2,000	50	195	16	3,000	...	,,	Ilgner.
Union, A.-G. für Bergbau, Eisen-und Stahlindustrie, Dortmund	Gotthelf, Barop	...	...	...	3-ph.	5,000	50	480	10	4,200	...	,,	,,
Gräflich Schaffgotsch'sche Werke, G.m.b.H., Kons. Paulus- u. Hohenzollern, Beuthen	Gräfin Johananaschacht	...	...	...	3-ph.	2,100	50	400	12	5,200	...	,,	,,
Société des Mines de Jarny, Jarny, Dep. Meurthe-et-Moselle	Pit I., Conflans-Jarney	...	...	...	3-ph.	2,000	50	215	10	3,000	...	,,	,,
Trifailer Kohlenwerks-Gesellschaft, Vienna	Guido III.	...	...	...	3-ph.	3,000	50	105	3	3,400	...	,,	,,
Donnersmarckhütte, Oberschlesische Eisen- und Kohlenwerke A.-G.	Gefrier.	...	...	...	3-ph.	1,000	50	388	16	5,000	...	,,	,,
A.-G. für Bergbau und Hüttenbetrieb "Saturn"	Pit I., Sosnowice	...	...	...	3-ph.	2,000	50	196	10	3,900	...	,,	,,
	Pit II., Sosnowice	...	...	...	3-ph.	2,000	50	196	12	1,300	...	,,	,,
Donnersmarckhütte, Oberschlesische Eisen- und Kohlenwerke A.-G.	Gefrierschächte	...	...	...	3-ph.	1,000	50	502	16	5,000	...	,,	,,
Gew. Amélie Wittelsheim	Pit I.	...	...	...	3-ph.	5,000	50	600	10	2,500	...	,,	,,
Gelsenkirchen. Bergwerks-A.-G., Rheinelbebei Gelsenkirchen	Bonifacius	...	...	...	3-ph.	5,000	50	600	20	5,200	...	,,	,,
Duffryn Rhondda Colliery Co., Port Talbot	Port Talbot	...	...	...	3-ph.	2,200	25	610	15·2	4,050	...	,,	,,
Verwalt. der holländ. Staatsminen, Limburg	Wilhelmina	...	...	...	3-ph.	2,000	50	500	12	2,200	...	,,	,,
General Mining & Finance, Johannesburg	Rand Collieries	...	...	...	3-ph.	6,000	50	905	16·8	5,460	...	,,	Convertor.
Fürstl. Pleb'sche Verwaltung, Emanuelsegen	Emanuelsegen	...	...	...	3-ph.	3,150	50	125	8	2,120	...	,,	Ilgner.
Königl. Perub. u. Fürstlich Schaumburg-Lippe'sche Steinkohlenbergwerke, Obernkirchen	Schacht W.F. 2	...	...	...	3-ph.	6,000	50	166	5	1,000	...	,,	,,
General Mining & Finance Corpn.	Rand Collieries	...	...	...	3-ph.	6,000	50	905	16·8	2,730	...	,,	Convertor.
		...	...	...	3-ph.	6,000	50	990	16·8	5,460	...	,,	,,
Gräflich Schaffgotsch'sche Werke, G.m.b.H., kons. Paulus- u. Hohenzollerngrube	Godullaschacht	...	...	...	3-ph.	6,000	50	335	14	2,200	...	,,	Ilgner.
		...	...	...	3-ph.	6,000	50	335	10	2,250	...	,,	,,
The Lambton Collieries Co., Durham	Lumley Third Pit	...	...	...	3-ph.	5,500	40	201	10	2,600	...	,,	Convertor.
United Alkali Co., Widnes	San Luis, Huelva	...	...	...	3-ph.	3,300	25	148	1·52	2,000	...	,,	Ilgner.
	San Antonio, Huelva	...	...	...	3-ph.	3,300	25	148	1·27	1,000	...	,,	,,
Konsolidierte Alkaliwerke, jetzt Gew. kons. Archibald, Westeregeln	Pit V., Westeregeln	...	...	...	3-ph.	500	50	700	18	3,000	...	,,	,,
Whitworth Collieries, Cardiff	Blaenavon Valley Sidings	...	...	...	3-ph.	3,150	50	350	14	3,000	...	,,	,,
Königl. und Herzogl. Communion Berginspektion des Rammelsberges, Goslar	Richt., Goslar	...	...	...	D.C.	550	...	384	5·11	1,300	...	,,	,,
Gräflich Schaffgotsch'sche Werke, G.m.b.H., kons. Paulus- u. Hohenzollerngrube	Hans Ulrich	...	...	...	3-ph.	2,000	50	400	12	5,200	...	,,	Ilgner.
Société Nouvelle des Mines de la Lucette, Genest, Dep. Mayenne	Puits Henri Portier, Genest (Frankreich)	...	...	...	D.C.	220	...	600	10	1,400	...	,,	Converter.
Gelsenkirchener Bergw.-A.-G., Rheinelbe Gelsenkirchen	Alma V.	...	...	...	3-ph.	5,000	50	700	20	8,800	...	,,	Ilgner.
Kaliwerke Ummendorf-Eilsleben, Gew. Alleringersleben	Marienborn	...	...	...	3 ph.	15,000	50	532	14	3,500	...	,,	,,
K. K. Bahnenverwaltung, Wieliczka	Franz Joseph	...	...	...	3-ph.	2,000	50	200	9	1,000	...	,,	Converter.
Steirische Montan-Werke des Freiherrn Franz Mayr von Melnhof, Leoben	Bergverwaltung Tollinggraben, Leoben	...	...	...	D.C.	330	...	70	2·4	800	...	,,	Ilgner.
Königliche Berginspektion Viennburg	Pit II	...	...	...	1-ph.	3,000	...	154	8	950	...	,,	,,
Königliche Berginspektion St. Ingbert	Maybach	...	...	...	1-ph.	3,000	...	1,000	7·4	7,000	...	,,	,,
Königliche Bergrevierbeamte, St. Ingbert													

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Owners.	Name of pit.	No. of sets.	Motor. H.P.	Revs. p. min.	Supply. Syst.	Volts.	~	Shaft length in Metres	Speed in Metres per min.	Net load in. kg.	Rope diam.	Maker.	Type of winding Motor.
Gewerkschaft Einigkeit, Ehmen	.....	...	...	...	3-ph.	2,000	50	200	4	1,500	...	Siemens	Ilgner.
A.-G. Thiederhall, Thiede	Thiede	...	...	...	D.C.	550	...	200	8	1,500	...	,,	,,
Gewerkschaft Glückauf, Sondershausen	Brüggemann	...	...	...	3-ph.	500	50	670	4	1,000	...	,,	Convertor.
	Pit II.	...	...	...	3-ph.	5,000	50	750	6·0	1,000	...	,,	,,
Lothringer Hüttenverein Aumetz-Friede	Havingen	...	...	...	3-ph.	5,000	50	112	4	2,000	...	,,	Ilgner.
Rio Tinto Co.	Roberto Minas de Rio Tinto	...	...	...	3-ph.	3,000	50	260	4·3	1,270	...	,,	,,
	New Victoria Minas de Rio Tinto	...	...	...	3-ph.	3,000	50	260	4·3	1,270	...	,,	Converter.
	Alicia Minas de Rio Tinto	...	...	...	3-ph.	3,000	50	330	4·6	1,270	...	,,	Ilgner.
	Contramino Minas de Rio Tinto	...	...	...	3-ph.	3,000	50	140	2·4	2,850	...	,,	,,
Société des Charbonnages de Bouches du Rhone, Marseille	Gardanne	...	...	...	3-ph.	13,500	25	138	5	2,000	...	,,	Convertor.
Messrs. Pease & Partners, Darlington	Peases West Colliery, Crook	...	...	...	3-ph.	2,750	40	122	3	764	...	,,	,,
Bergverwaltung Georg von Giesches Erben, Schoppinitz	Ulrich, Königshütte	...	...	...	3-ph.	3,000	50	250	8	1,750	...	,,	,,
Steinkohlenbergwerk "Hedwigs Wunsch," Pächter A. Borsig, Borsigwerk	Biskupitz	...	...	...	3-ph.	330	50	32	3	1,100	...	,,	,,
Gräflich Larisch-Mönnich'sche Bergdirektion, Karwin	Tiefbau	...	...	...	3-ph.	3,000	30	550	6	1,525	...	,,	Ilgner
Société des Mines de la Lucette, Genest	Hensi Port	...	...	...	D.C	440	...	500	3	600	...	,,	Converter
Lothringer Hüttenverein Aumetz-Friede	Havingen	...	...	...	3-ph.	5,000	50	250	3	3,600	...	,,	Ilgner.
								ft.	ft.	lb.			
Markham's Steam Coal Co.	Markham Pit	...	1,400	...	3-ph.	6,600/6,000	50	...	2,900	...	1·625"	,,	,,
	Ditto	...	1,400	...	3-ph.	6,600/6,000	50	...	...	...	...	,,	,,
Markham Steam Coal Co.	Old Duffryn[3]	...	200	...	...	3,000	50	560	450	3,300	...	A.E.G.	Double reduct. gear.
	Aberewmboi[3]	...	312	...	3-ph.	3,000	50	11,000	1,500/510	3,300	...	,,	Single reduct. gear.
	Ditto[3]	...	630	...	...	3,000	50	730	1,590	6,000	...	,,	Direct coupled.
	George Pit[3]	...	450	...	3-ph.	3,000	50	1,500	600	6,600	...	,,	Double reduct. gear.
Pelton Coal Co., Chester-le-Street	Tribley Pit[3]	...	80	...	3-ph.	6,000	40	130	492	2,200	...	,,	Single reduct. gear.
Tredegar Iron & Coal Co.	.....	1	250/500	380	3-ph.	500	40	240	...	3,360	...	Westinghouse	A.C. geared.
Great Western Colliery Co., Pontypridd	.....	1	700/1,500	58	3-ph.	2,200	25	1,110	2,640	5,600	...	,,	A.C. WestinghouseCon
Dunstan Garesfield Collieries,	.....	1	150/300	230	3-ph.	400	40	456	1,250	2,000	...	,,	A.C. geared. [Equal
General Mining & Finance Corpn.	West Rand Consolidated Mines	2	800/1,600	60	3-ph.	2,100	50	3,000[1]	2,000	12,000	...	,,	Ward Leonard.
		1	480/1,000	60	3-ph.	2,100	50	3,000[1]	2,000	6,000	...	,,	,,
H. Eckstein & Co.	New Heriot Gold Mining Co.	1	500/1,000	365	3-ph.	2,000	50	1,080 incl.	2,000	5,000	...	,,	A.C. geared.
	Bantjes Consolidated Mines	1	960/2,000	365	3-ph.	2,000	50	2,500 incl.	2,000	6,000	...	,,	A.C. geared.*
	Village Main Reef Gold Mining Co.	1	575/1,200	365	3-ph.	2,000	50	1,430 incl.	3,000	3,600	...	,,	,,
Consolidated Gold Fields of South Africa	Jupiter Co., Ltd.	4	875/2,000	525	3-ph.	2,000	50	4,500 incl.	2,000	12,000	...	,,	A.C. geared.
Tredegar Iron & Coal Co.	.....	1	250/500	230	3-ph.	500	40	1,089	1,900	3,360	...	,,	,,
Plenmeller Collieries, Haltwhistle	.....	1	240/500	200	3-ph.	600	50	800	1,375	5,040	...	,,	Ward Leonard.
H. Eckstein & Co.	Jumpers Deep, Ltd.	1	960/2,000	365	3-ph.	2,000	50	4,892[2]	2,000	6,000	...	,,	A.C. geared.*
General Mining & Finance Corporation	Cinderella Deep	4	180/360	585	3-ph.	500	50	3,000	1,000	3,000	...	,,	,,
Consolidated Mines Selection Co.	Brakpan Mines	2	1,450/3,000	96	3-ph.	2,100	50	3,800	3,500	10,000	...	,,	Ward Leonard.
		1	1,450/3,000	96	3-ph.	2,100	50	3,800	3,500	10,000	...	,,	A.C. direct coupled.
Randfontein Estates G.M. Co.	Randfontein Gold Mining Cos.	5	100/200	570	3-ph.	500	50	630	520	2,000	...	,,	A.C. geared.
H. Eckstein & Co.	Geldenhuis Deep	2	960/2,000	365	3-ph.	2,000	50	4,000 incl.	2,000	10,000	...	,,	,,
Randfontein Estates G.M. Co.	Langlaagte Estates G.M. Co.	1	170/385	208	3-ph.	2,000	50	3,800 incl.	1,000	5,000	...	,,	,,
H. Eckstein & Co.	Village Deep, Ltd.	2	1,600/3,400	98	3-ph.	2,000	50	4,000	3,500	10,000	...	,,	A.C. direct coupled.*
	City Deep, Ltd.	2	1,600/3,400	98	3-ph.	2,000	50	4,000	3,500	10,000	...	,,	,,
	Village Deep, Ltd.	1	1,600/3,400	98	3-ph.	2,000	50	4,000	3,500	10,000	...	,,	,,
	City Deep, Ltd.	1	1,600/3,400	98	3-ph.	2,000	50	4,000	3,500	10,000	...	,,	,,
Randfontein Estates G.M. Co.	Langlaagte Estates G.M. Co.	2	450/1,000	360	3-ph.	2,000	50	4,000 incl.	1,510	12,000	...	,,	A.C. geared.
Pease & Partners, Ltd.	Windlestone Colliery	1	300/600	290	3-ph.	2,750	40	780	1,590	4,928	...	,,	,,

[1] 800 ft. vertical, 2,200 ft. inclined. [2] 1,392 ft. vertical, 3,500 ft. inclined. [3] At Old Duffryn the drum is 10 ft. in diameter, at Aberewmboi 10 ft. and 7 ft. respectively, at George Pit 21 ft., and at Tribley Pit 8 ft. At Old Duffryn the capacity of the engine is 45 tons per hour, at Aberewmboi 90 and 194, at George Pit 60 and at Tribley Pit 120. The number of tubs is 1 on the first two winders and 3 on the remainder.

Note.—Winding engines have been supplied by the Lahmeyer Co. to Messrs. D. Davis &Sons, Ferndale, South Wales, the Micklefield Coal & Lime Co., Micklefield, near Leeds, the Blackett & South Tyne Colliery Co., Haltwhistle, and Sir Sam Sadler (Ltd.), Middlesbrough. The last two are worked by direct-coupled, three-phase motors, and the first two on the Ilgner principle.

* Conversion of existing steam winders.

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The Power and Telephone Equipment of the Llanharran Colliery.

The Llanharran Colliery, owned by the South Rhondda Colliery Co., is one of the latest to be electrically equipped throughout, and a short description of the cable system, embracing as it does power and telephone circuits, will, therefore, undoubtedly be of interest to our readers. For the details which we are enabled to furnish we are indebted to the courtesy of the consulting engineer, Mr. John Wayne-Morgan, and to the contractors. Messrs. W, T. Henley's Telegraph Works Co.

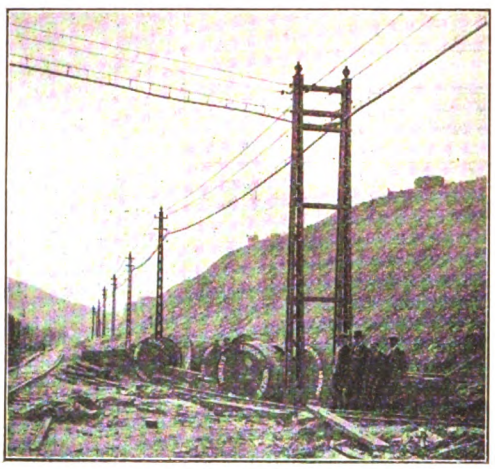

FIG. 1.—DOUBLE LATTICE POLE CONSTRUCTION AT LLANHARRAN COLLIERY.

The power installation is worked at a pressure of 2,200 volts three-phase, the frequency being 50. The cables above ground are carried on 31 ft. lattice poles embedded 4 ft. deep in concrete. These lattice poles carry a 0·09 three-core vulcanised bitumen wire-armoured cable on a 7/10 S.W.G. steel suspension strand, having a breaking strain of 80 tons per square inch, and they proceed from the generating station to a point where two 0·046 three-core vulcanised bitumen wire-armoured cables are tapped off. At this point a double lattice pole is provided, with a platform to hold the necessary "tee" junction box. This double pole is shown in the foreground of the accompanying illustration (Fig. 1), which was taken while the work was in progress. One of the 0·046 cables is carried on further lattice poles to the motor house of the brickyard about 210 yds. away, and the other is connected with the washery, being supported on brackets fixed to the washery screen girders. The lattice poles are fitted with brackets to carry the telephone cables, and cross arms to take the lighting and suspension wires. The cables are suspended with Henley's patent cable suspenders throughout.

FIG. 3.—AT THE PIT HEAD.

For supplying power in the workings a 0·2 sq. in. three-core vulcanised bitumen wire-armoured cable is carried from the generating station to the pit mouth on similar lattice poles to those already referred to. Thence it is held by a clamp at the head and by cleats to the side of the shaft, and is carried to a sub-station at the pit bottom. We show an illustration (Fig. 5) of the 0·2 sq. in. cable suspended. The section of cable, suspenders and suspension strand are all shewn half size. We also give illustrations, very much reduced (Figs. 2 and 4) of the clamp and cleats used, the latter being fixed

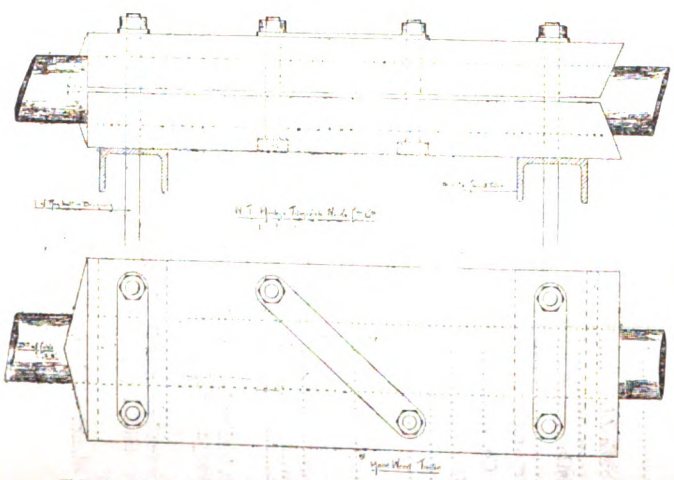

FIG. 2.—CLAMP USED AT LLANHARRAN. (Illustration very much reduced.)

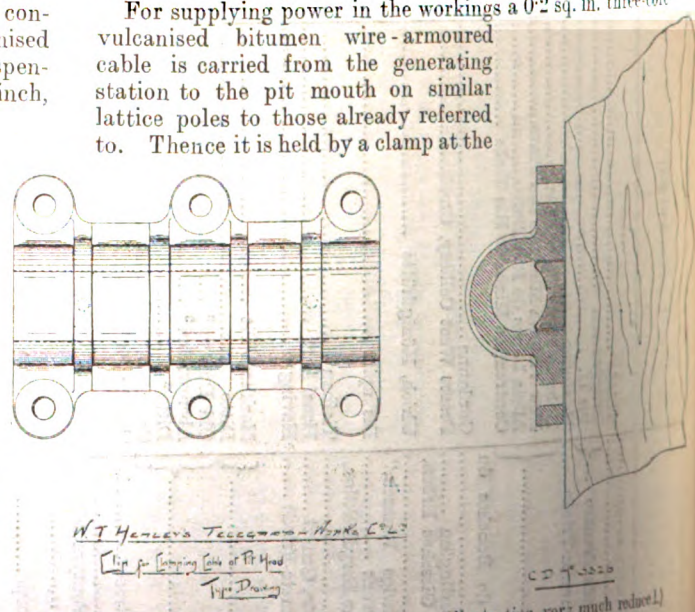

FIG. 4.—CLEAT USED AT PIT HEAD. (Illustration very much reduced.)

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30 ft. apart in the brickwork of the shaft. From the sub-station vulcanised bitumen three-core wire-armoured cables, suspended to the timbering by eye-bolts and Henley's

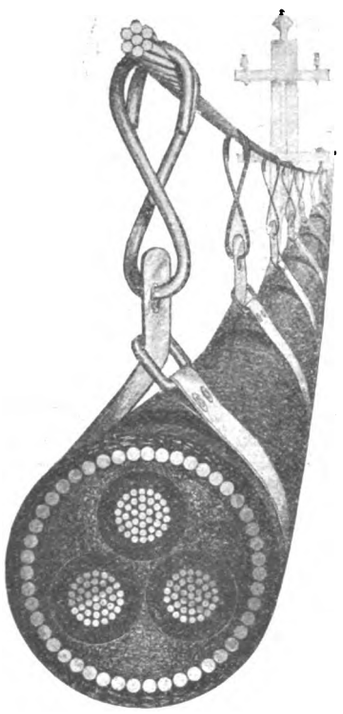

FIG. 5.—0·2 SQ. IN. CABLE, 7/10 STRAND AND HENLEY PATENT CABLE SUSPENDER. All shown half-size.

patent cable suspenders, connect with various districts as follows: a 0·066 sq. in. cable to a pump room 1,050 yds. distant and a 0·0229 sq. in. cable from this pump room to another 150 yds. further on; a 0·066 sq. in. cable to a second district 1,100 yds. away, and from thence a 0·0128 sq. in. to a pump room 150 yds. further on, and a 0·035 sq. in. cable to a third district 400 yds. away. The whole of the armouring and suspension wire is efficiently bonded and earthed by means of a copper earth plate at the generating station end. Fig. 3 shows the cable about to be laid.

In addition to the power equipment a complete telephone installation has been erected. This is a 10-way system, the switchboard being in the generating station. It connects the generating station, offices, brickfields, washery, the sub-station at the shaft bottom and three points in the workings, thus allowing two spares, one above and one below ground. The telephone cables are carried on the lattice poles above ground, are cleated to the side in the shaft, and suspended in the workings from eye spikes by means of Henley's patent cable suspenders (Fig. 5). The cables are five pair No. 18 S.W.G. paper-insulated, vulcanised bitumen sheathed and wire-armoured for the above-ground ramifications to the sub-station at the bottom of the pit, and 18 S.W.G. twin cables of similar construction to the several points in the workings.

Various types of telephones are installed to suit the different situations, those below ground being battery ringing waterproof mining telephones. The whole of the parts in the latter type are fitted in a cast-iron waterproof case provided with a stuffing gland through which the line wires are lead. The bells in connection with these instruments are of the gas and watertight type. The terminals are fitted inside the iron case, which is provided with stuffing glands for the wires, and the motion of the armature is transmitted to the hammer through a metal diaphram. When the cover is screwed down the whole of the movement is enclosed in an hermetically sealed chamber, rendering it impervious to atmospheric influences.

Messrs. Henleys supplied and carried out the whole equipment, including cables, lattice poles, telephones, switch panels, boxes, cells, &c.

Pumping Plant for Mines.

At the present time there is considerable rivalry between the centrifugal and reciprocating types of pump for mining work, and it is therefore of interest to compare some of the more recent installations of both types of pump in collieries. Generally speaking, the ram type of pump is most suitable for positions where it is required to raise a comparatively small quantity of water to a considerable height. On the other hand, a centrifugal pump, owing to its low first cost and the small space it occupies, is more suitable when large quantities of water have to be raised against comparatively low heads.

Messrs. Ernest Scott & Mountain, of Close Works, Gateshead are a firm that have had considerable experience in the manufacture of both classes of pumping plant, and they have recently carried out several large installations employing one or other of these types. A particularly interesting

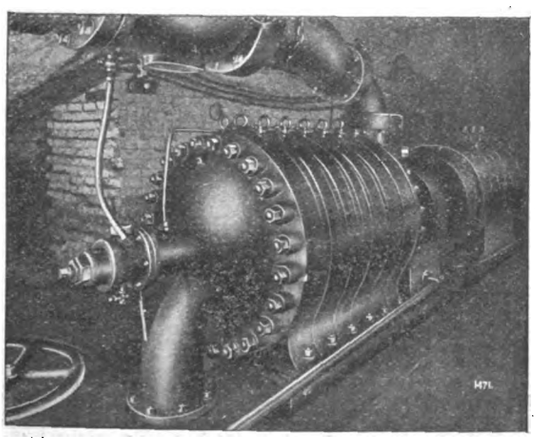

FIG. 1.—AN EARLY CENTRIFUGAL PUMPS AT A DURHAM COLLIERY.

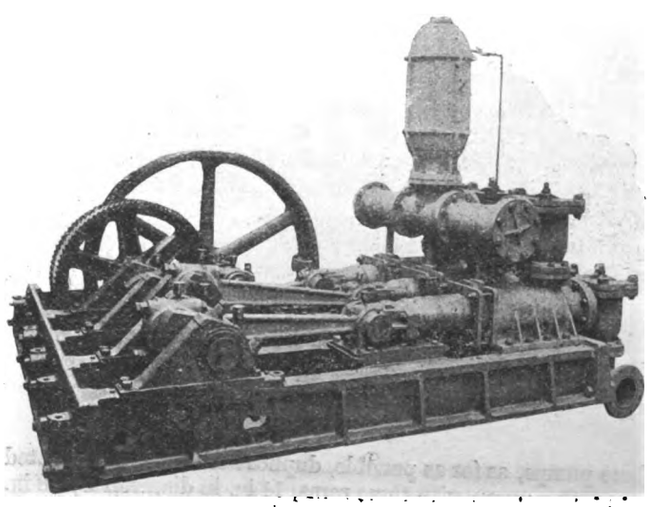

FIG. 2.—ONE OF THE NEW RAM PUMPS AT THE SAME COLLIERY.

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installation of ram pumps has recently been supplied to a colliery in the county of Durham, the original equipment in this case consisting of centrifugal pumps. There were two sets of pumping plant, one made up of two units each designed to raise 1,200 gallons per minute against a 690 ft. head, and the other made up of two similar units arranged to deliver 750 gallons per minute against 950 ft. head. The centrifugal pumps which were of Messrs. Scott & Mountain's manufacture, dealt quite satisfactorily with these duties: but after they had been running for some time it was found that the wear and tear on the internal parts was excessive, while investigation showed that the water contained a considerable amount of impurities.

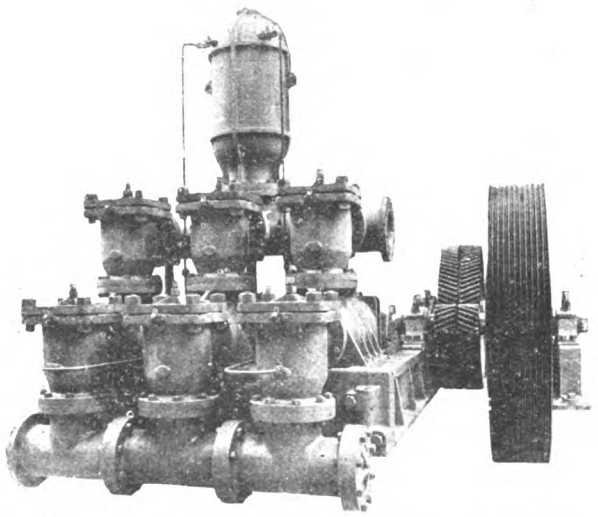

FIG. 3.—ANOTHER VIEW OF THE SAME PUMP, SHOWING THE VALVE BOXES.

After running for some years, the colliery company decided that the conditions were not suitable for working with centrifugal pumps, and it was therefore decided to instal one ram pump in each position, and to keep one of the centrifugal pumps in each case as a standby. In Fig. 1, one of the original centrifugal pumps with its motor is shown. The motors were of the three-phase type, working on a 2,750-volt circuit with a frequency of 40 supplied from the County of Durham Supply Co.'s mains. Each motor exerted 375 effective H.P. when running at a speed of 1,160 revs. per min.

The order was placed with Messrs. Scott & Mountain for two ram pumps for the duties stated, and it was arranged to make these pumps, as far as possible, duplicates. The sizes adopted were: One pump with three rams, 14 in. in diameter by 18 in. stroke, delivering 900 gallons per minute against 690 ft. head, and one pump having three rams, 11 in. in diameter by 18 in. stroke, delivering 550 gallons per minute against 950 ft. head. By keeping the stroke the same in the two pumps it was possible to duplicate a very considerable proportion of the two pumps, this being the case with the bed plate, crankshafts, connecting rods, gearing, bearings, &c. A general view of one of these pumps is shown in Fig. 2, and a further view of the same pump taken from behind the valve boxes is shown in Fig. 3. These pumps are of the makers' standard type, being fitted with solid gunmetal rams, with gunmetal glands and stuffing boxes, and provided with independent and interchangeable ram chambers and valve boxes. The arrangement is clearly shown in Fig. 3, and it will be seen that the whole of the valve boxes on the suction and delivery sides are interchangeable. A large air vessel is fitted on the delivery side, and a special air charging device is provided, of a type introduced by Messrs. Scott & Mountain. This device consists of two pipes led from the outer rams to the air vessel, and so arranged that on each stroke of the pump a small amount of air is fed into the air vessel, and thus all possibility of the air vessel becoming solid with water, is avoided. The pumps in both cases were arranged for rope drive between the pump and motor, and between the pump countershaft and crankshaft, machine cut helical gearing was provided.

FIG. 5.—3,000-GALLON CENTRIFUGAL PUMP.

In the makers' opinion this class of driving is most suitable where sufficient space is available, as, with high class machine cut gearing such as this, there is practically no noise, and the rope drive of the motor prevents any vibration reaching the electrical gear, the whole combination forming a most elastic and suitable drive. It is, however, not always possible to obtain space for this arrangement, and in Fig. 4 a similar pump set is shown to the foregoing, but provided with a gear drive from the motor and having the pump bedplate extended to carry the motor. This pump was also installed recently in a colliery in the county of Durham.

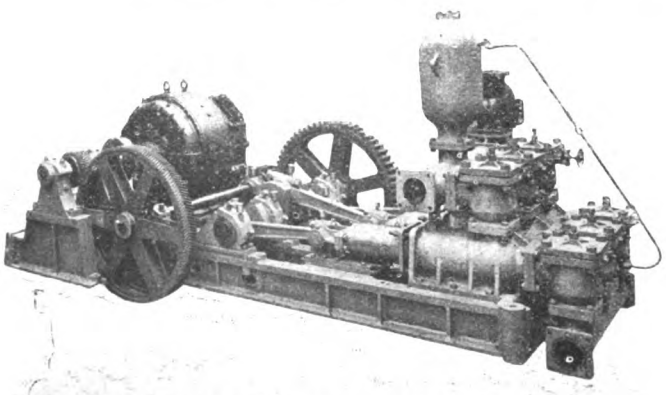

FIG. 4.—RAM PUMP AND MOTOR ON THE SAME BED PLATE. MOTOR DIRECT COUPLED.

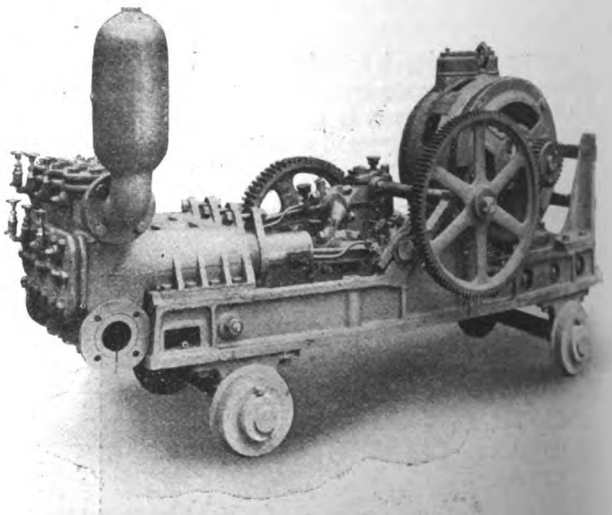

FIG. 6.—PORTABLE RAM PUMP.

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These illustrations and descriptions indicate briefly what may be considered the latest practice in ram pumps for colliery work, and undoubtedly the pumps described are the most suitable class of machinery for dealing with severe conditions. On the other hand, there are a large number of collieries in which it is possible to pump a considerable quantity of water against low heads, and in such cases the centrifugal type of pump is making very rapid advances. The same firm have recently completed a large centrifugal pump for a colliery in the Newcastle district, to deliver 2,500 gallons per minute against a head of 170 ft. This pump is being installed to replace an existing steam pump, which is at present working practically constantly, but the new pump is of sufficient capacity to do the whole of the work in approximately six hours per day, exclusive of week ends. A very considerable saving can be effected by this means, and a large number of collieries are at present considering such pumping schemes with a view to performing the whole of the pumping in one 8-hour shift, as, of course, under the new Eight Hours Bill it is necessary to provide two or three shifts of pump attendants if this time is exceeded.

The pump in question is of particularly massive construction, and is run at the very moderate speed of 800 revs. per min., this speed being decided upon as the pump has to be worked without a standby, and it was desired to reduce the wear and tear of the parts to a minimum. The pump is of the makers' latest standard type, and is arranged so that the whole of the working parts, that is the impellers and diffusers, can be withdrawn for inspection or repairs without interfering with either the delivery or suction pipes. The pump is of the two-stage type, and is fitted with a special type of balancing disc to compensate for the end thrust due to the pull on the suction side. The motor driving the set is of the direct current type, supplied with current at 480 volts from the Newcastle-upon-Tyne Electric Supply Co.'s mains, and is arranged to develop 200 H.P. constantly at a speed of 800 revs. per min.

In Fig. 5 a somewhat similar pump is shown, this set being arranged to deliver 3,000 gallons per minute against a 200 ft. head. It was constructed for a colliery in the same neighbourhood. This pump is of the double inlet type, and is provided with two impellers placed back to back so that the end thrust of the suction is balanced. It is arranged to run at a speed of 1,160 revs. per min., and is driven by a three-phase motor worked on a circuit with a frequency of 40.

The above illustrations and descriptions exemplify a few of many such installations which are at present being carried out in various parts of the country, and serve to show the general practice for main shaft pumping by means of electricity in collieries.

There is also at the present time a considerable demand for similar electrically driven portable pumps for dip working, and the advantages obtained by the use of electricity in this class of work are even more marked than in the case of main shaft work, as it is practically impossible to obtain steam in remote places, and the losses on compressed air working over considerable distances are extremely heavy. In Fig. 6, a pump set arranged for this class of working is shown. These pumps are usually required for heads not exceeding 200 ft., and for quantities of water varying from 10 up to 200 and 300 gallons per minute. They form an extremely compact unit, the pump, motor, and motor switchgear being all mounted upon a common bedplate which in turn can be mounted on trolley wheels if desired. Centrifugal pumps have also been adopted for this type of working, but are not so suitable owing to the fact that a centrifugal pump only works economically when delivering against the particular head for which it is designed, whereas the ram pump is not affected to any appreciable extent by variations in head.

Some Cable Makers' Problems in Mining Work.

The following remarks deal very briefly with some of the more salient features which face the cable maker in catering for colliery work. They have been kindly supplied us by Messrs. W. T. Glover & Co., of Trafford Park.

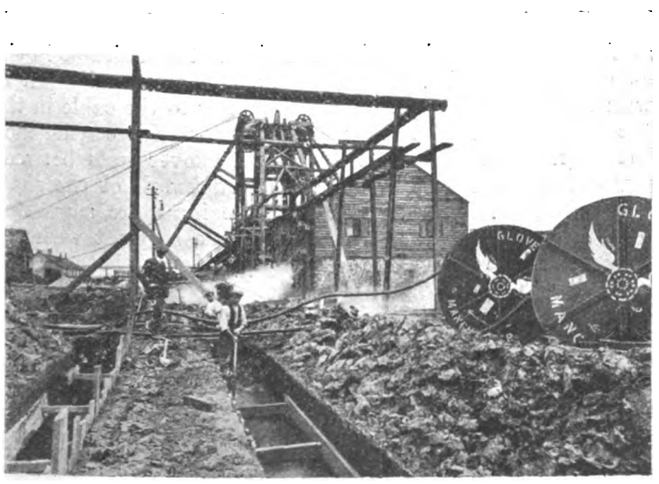

FIG. 1.—PREPARING TO LAY SURFACE CABLES SOLID.

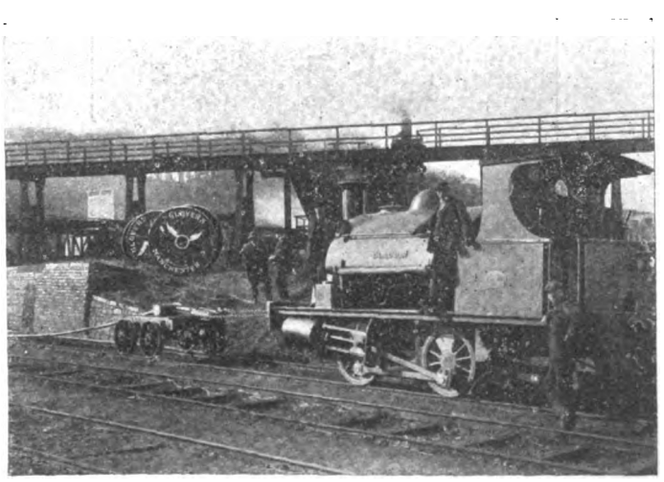

FIG. 2.—LOWERING SHAFT CABLE BY MEANS OF LOCO.

Firstly, as regards the type of cable which has come most prominently into use during the last few years. In the opinion of Messrs. Glover, the general trend has undoubtedly been to instal cables of the bitumen type, supplied in their own case in nearly all instances with patent solid filled strand (Fig. 3). For shaft work this firm have for long advocated the use of double wire armoured, in preference to unarmoured or steel tape armoured, conductors, thereby anticipating in this, as also in their strong advocacy of more mechanical, though possibly more expensive, accessories, the lines laid down in the

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recent report of the Home Office Departmental Committee. Not only does wire armouring lend itself to much more effective bonding at the joints, but in case of serious leakage it provides a path to earth of a much greater area than that supplied by a double tape. Generally speaking the only troubles met with on the above class of cable have been due to the application of excessive heat, owing to the presence of steam pipes or vents in close proximity. In most cases troubles of this description

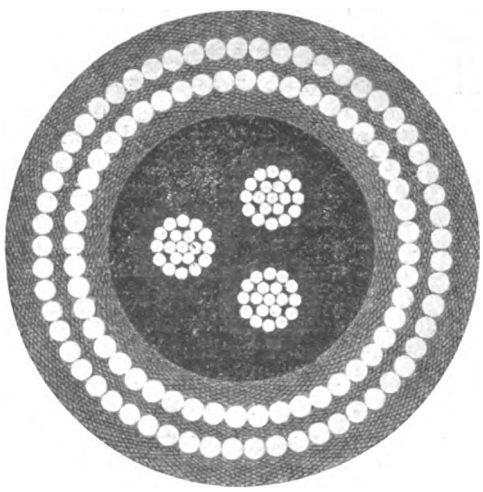

FIG. 3.—THREE-CORE BITUMEN CABLE WITH SOLID FILLED STRAND

have been confined to surface work, and to avoid running through the steam-saturated ground which is usually present in the vicinity of colliery workings, many managers are now arranging either to carry their surface conductors overhead or to lay them in trenches in the manner depicted in the accompanying illustration (Fig. 4), such trenches, of course, being readily covered with checkerplate where their being left open would constitute a danger. Fig. 1 shows trench being prepared for cable about to be laid solid.

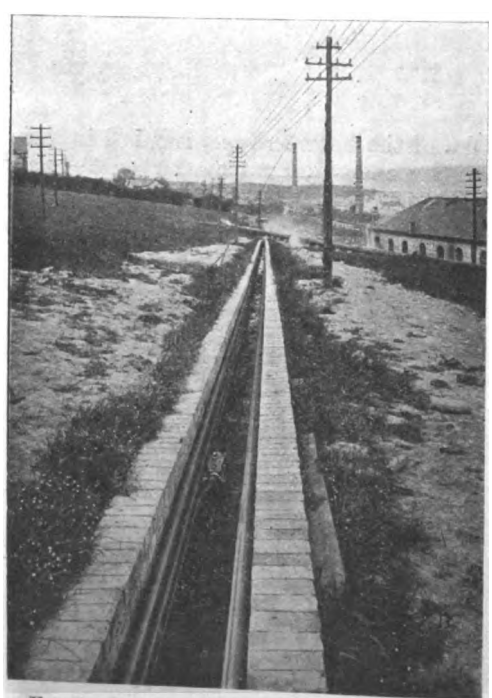

FIG. 4.—PERMANENT SURFACE CABLE TRENCH.

The great resisting power of wire armouring to falls is borne out in the case of the late deplorable disaster at the Pretoria Pit, where Glover wire-armoured cables of the paper and lead-covered type lay throughout the entire length of the North Plodder district under falls which have probably never been surpassed. The armour of these cables, though bruised, has in no place been severed, and we understand that the cables are now being re-slung without it being necessary even to take them to bank for examination or repair.

The second great question which confronts the mining electrical engineer is that of shaft suspension. Obviously no definite rule can be laid down, as much depends on local conditions; but there is little doubt that of the various methods employed, such as single suspension, double wire rope suspension, cleating with rag bolts, cleating with short chains or clamping by sitting cleats, the last named is, under average conditions, much the most satisfactory. Single suspension can, in fact, only be advocated where there are grave reasons for having no fittings of any kind in the shaft, and where the cages have rope guides. The greater the weight of the cable borne by its armour on one single fitting the more risk there is of a pinching stress on the dielectric, which experiments have shown to be most acute at a point about 12 in. below the suspending apparatus.

To clamp wooden cleats between two suspended steel hawsers, although it gives all the flexibility of direct single suspension, possesses the disadvantage of unequal expanding and contracting ratios between such wire ropes and the cable. To support wooden cleats by rag bolts or by short lengths of chain depending from the sides of the shaft is to set up a shearing

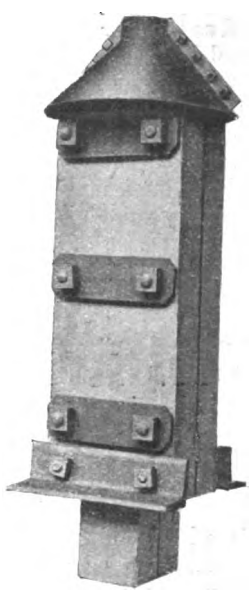

FIG. 5.—SITTING CLEAT.

FIG. 6.—LIGHT TYPE SUSPENDER FOR IN-BYE CABLES.

FIG. 7.—HEAVY TYPE SUSPENDER.

strain on the supporting bolts which is most undesirable in the case of falling bodies. These short chains are usually put in with the idea of giving a certain flexibility to the cable in the event of such mishap. To provide against this contingency the sitting cleat advocated by Messrs. Glover rests between two channel irons coming out of the brickwork of the shaft at right angles. The outer ends of the irons are supported on a large channel or H girder forming a segment with the curvature of the shaft, into the brickwork of which both its ends are built. The individual cleat should be from 2 ft. 6 in. to 4 ft. long, designed on the principle of a friction clutch. It should not embody a pinching grip—that is to say, the hole should be bored out to the exact diameter of the cable, and after the cleat has been cut through the saw cut and planing up of the two halves should allow $\frac{1}{4}$ in. clearance, a space which will amply provide a firm hold. For an average size of cable such cleats as the above may be conveniently spaced from 25 yds. to 35 yds. apart.

Means of actually lowering the cable into position are so many and varied as to be impossible of description here. Much depends on the time during which winding can be stopped, on the size of the cage and the diameter of the shaft. Given favourable conditions, perhaps the easiest method is to lower

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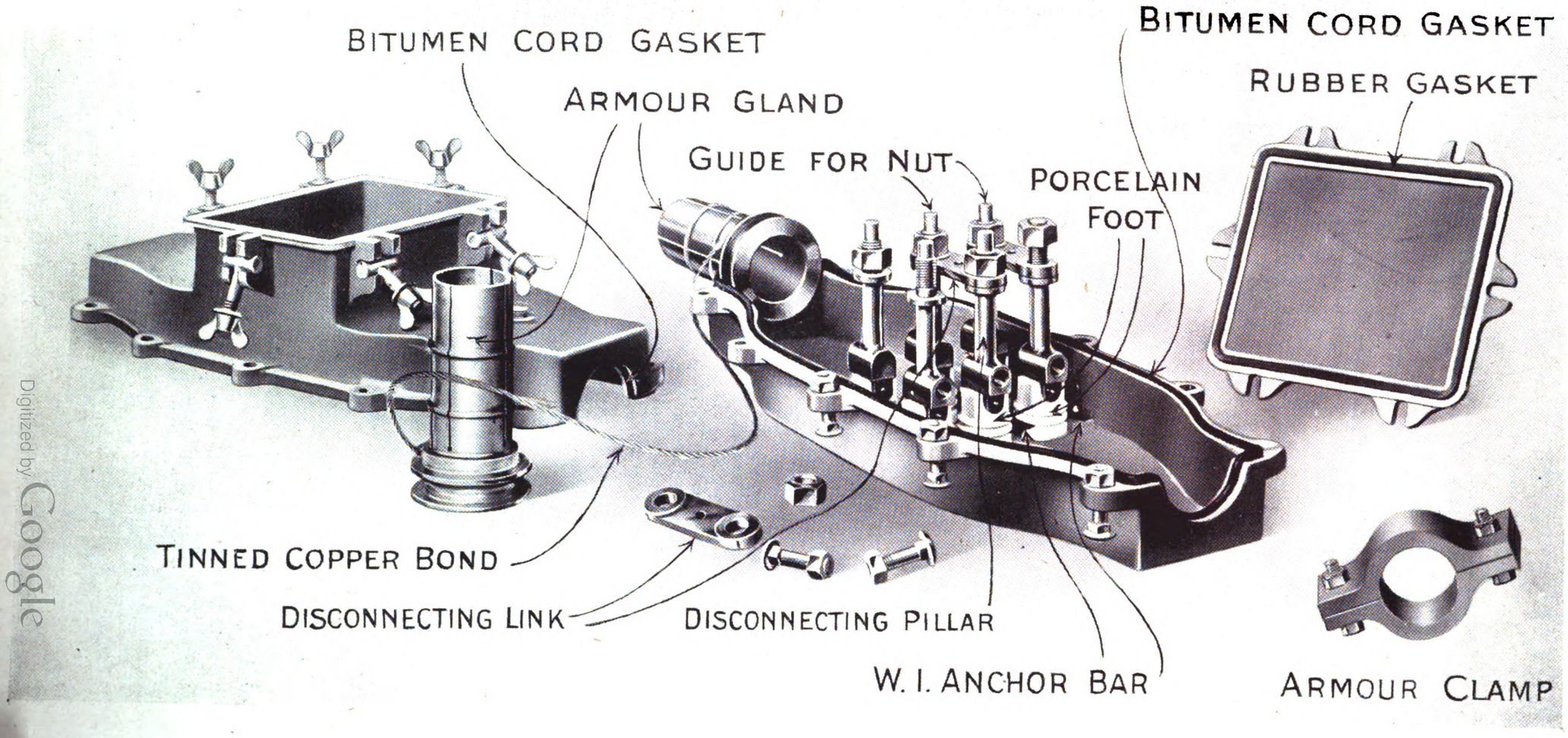

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a steel rope to which the cable is attached, say, every 15 ft., with hemp lashings. The slowness of this operation can be reduced by rigging up various stagings at equal distances from the pit head, on which men can carry on the lashing process simultaneously. Much can be said for other methods, such as raising from pit bottom, lowering from under or from inside the cage. On several occasions Messrs. Glover inform us a locomotive has been used to do the work (Fig. 2).

After lowering a cable into the shaft it is advisable to let it adjust itself to the new temperature conditions before finally cleating it up. As an additional aid to the friction of the grip

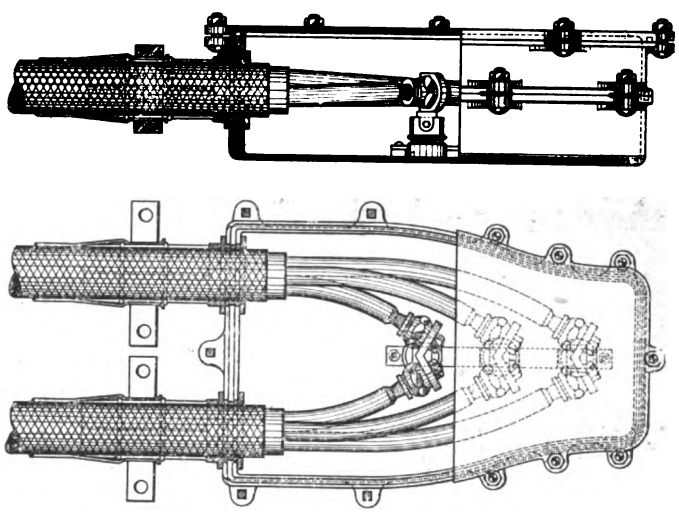

Fig. 8.—Horizontal Box for Shaft Cables.

it is advisable to wrap the cable inside each cleat with proof tape. Water and falling bodies can be further guarded against by providing the top of the cleat with a wrought-iron roof bolted together in two halves, as in the accompanying illustration (Fig. 5).

The question of jointing, whether in the shaft or inbye, is one of the utmost importance, and Messrs. Glover have experimented widely with a view to attaining the best practice in this direction. For shaft work a vertical box of any description is to be deprecated. Except where extensive tubbing exists, it will generally be found that the headings to various seams can be utilised as convenient recesses for the installing of horizontal boxes which will convey no strain to the incoming and outgoing cables, while they are protected from anything getting adrift in the shaft. Should no such

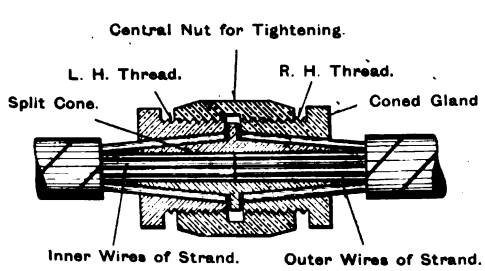

Fig. 9.—Patent Mechanical Connector.

heading exist, a recess can be readily built into the brickwork. An illustration of a box of this description is shown (Fig. 8). Its salient features are absolute water and compound tightness, long bearing and bonding surfaces at the glands, a very sound type of mechanical connector (Fig. 9) to join up the strands in places where it is unsafe to sweat, and porcelain feet supporting the connectors, which feet are themselves anchored by a wrought-iron strap to the carcase of the box.

Split boxes are provided with grooves top and bottom, carrying bitumen cords. These cords, under compression, unit in such a way as to make leakage a physical impossibility. Compounding, especially when the presence of heat cannot be permitted, is effected by the use of insulating mediums of low melting point, carried into the mine in vessels packed with sawdust and poured into the joint through a funnel, patented by Messrs. Glover, fitted with an external heating jacket.

The very vital point of earthing all machine carcases and switchboards below ground through the medium of the armour has been anticipated on all work carried out by Messrs. Glover for some years identically on the lines laid down by the recent Home Office suggestions. The means of earthing advocated at bank are never to rely entirely on buried earth plates, which, being out of sight, are soon forgotten, and which, if efficient (that is, surrounded by breeze in a moist position), will, through their very effectiveness, last but a very short time. They have made it a point for some years to carry heavy bonds from the armour sheathings at the supply end to not less than three lugs bolted to the flanges of cast-iron water pipes, which are never empty of water.

Armour has always been advocated for roadway or inbye cables, and special suspenders have been designed of an almost indestructible canvas material to take the place of the perishable pig-skin suspenders, with their accompanying eyelet difficulty, generally used for such cables a few years ago. The illustration (Fig. 6) shows this light type of suspender, in which the non-resisting portion, recommended by the Home Office to cater for falls, is embodied in the 8-shaped link, which is manufactured in such thicknesses of galvanised wire as will only just carry the weight to be borne, drawing out when any excess occurs. A heavy type of sling (Fig. 7) is also shown for use on suspension work in the neighbourhood of coke ovens. Protective devices form too big a subject to enter into in a short article, but a very effective gate-end arrangement, known as the "Fisher-Reyrolle" device, is supplied by Messrs. Glover. This is described in the article on "Coal Cutting," by Mr. H. J. Fisher, which appears in another part of this issue.

Recording Tachograph for Winding Engines.

One of the types of recording tachograph on the English market is that made under Dr. Horn's patents for use in connection with winding and hauling engines. These tachographs work on the double-weight spring-controlled centrifugal principle. On either side of the driving spindle are two weights connected in pairs by diagonal rods. These rods are pivotted on the spindle and are kept in an almost vertical position by means of a spiral spring the ends of which are fixed to each of the diagonal rods. When the spindle revolves, the weights move into a position more or less horizontal, which is determined by the speed at which the spindle is revolving. This motion is transmitted to a small plunger which can move up and down inside the spindle and which revolves at the same speed as the spindle. Inside this plunger is a small ball fixed to the end of the rod connection to the pointer and recording pen. It will thus be seen that the actual rubbing connection between the moving and stationary parts presents a very small surface and in consequence vibrations are reduced to an absolute minimum. A special form of damper is fitted to eliminate the very small variations that are always present, and therefore an absolute variationless sitting of the pointer and needle is said to be ensured. The recording drum of this instrument is fixed inside the casing, on the top of which is the dial. This drum is arranged vertically so that any portion of the record can be seen through the inspection glass. The chart is made to revolve by means of clockwork and the drum itself is lowered as it revolves, the record itself thus appearing spiralwise on the chart.

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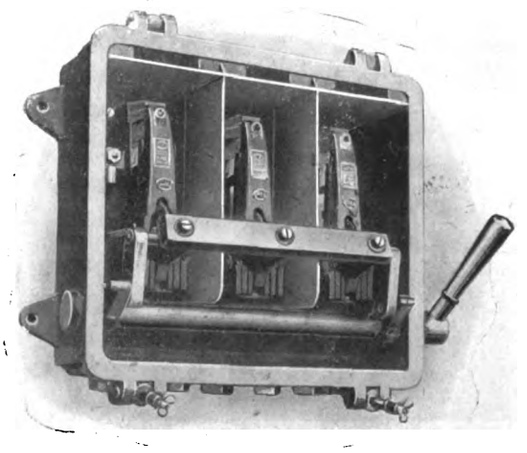

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Switchboards of the New Kleinfontein Consolidated Gold Mining Co.

As has been pointed out in other parts of this issue, not the least important part of the mining electrical equipment is the switchgear. In its design certain conditions have to be fulfilled in order that the operation of the whole plant may be satisfactory. The following brief description of the high-tension and extra-high-tension switchgear, supplied by Messrs. Ferranti Limited, for controlling the electrical power apparatus at the group of mines worked by the Kleinfontein Syndicate will enable our readers to determine how far this has been accomplished in this instance.

The main generating station of the group is situated at New Kleinfontein, from which the sub-stations, five* in number are fed by overhead transmission lines, the system employed being three-phase, and the pressure 20,000 volts. The switchgear in the main generating station is designed with a view to controlling eventually six three-phase generators working at 3,000 volts, six three-phase transformers stepping up the pressure from 3,000 to 20,000 volts and six out-going overhead

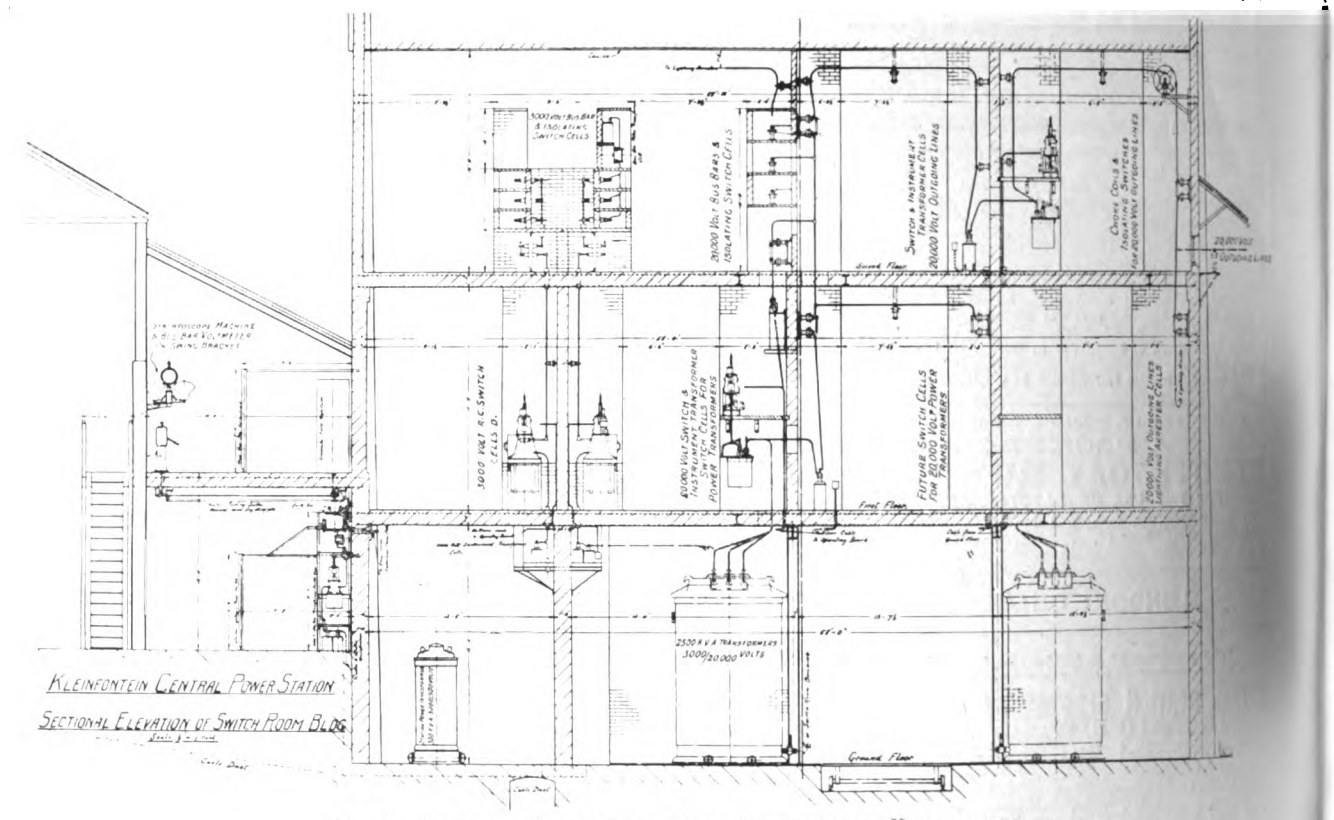

Fig. 1.—Sectional Elevation of Main Switchgear at Kleinfontein.

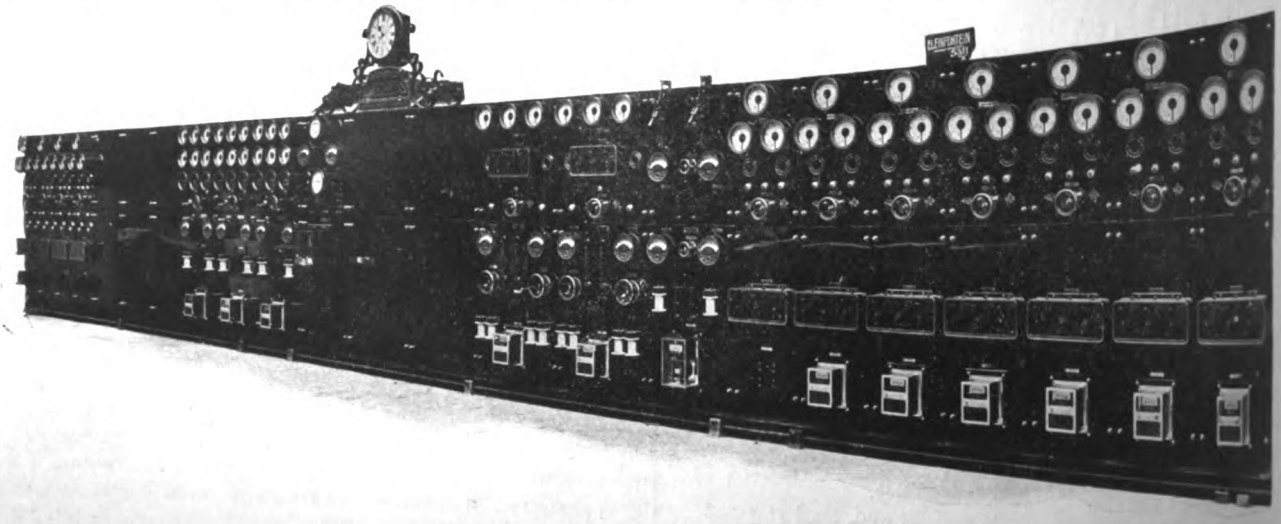

Fig. 2.—View of Main Operating Panels at Kleinfontein.

* Apex Gold Mining Co., New Boxsburg Mining Co., Rand Klipfontein Mining Co., Benoni Mining Co., New Kleinfontein Mining Co.

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feeders. At the present only three generators are installed and these are rated at 3,000 kw. each. They are turbine-driven and generate current at 3,000 volts with a frequency of 50. The excitation is provided for by common exciter bars which are fed from motor-generators, and also by a battery of 66 cells having a capacity of 120 ampere hours. The present transformer installation consists of four step-up transformers, each having an output of 2,500 kw. These are wound mesh on the primary and star on the secondary side, and transform the current up from a pressure of 3,000 to 20,000 volts. The neutral point of the extra-high-tension system is not earthed whilst the neutral point of the high-tension system is directly earthed without the insertion of a resistance. Each generator has its neutral point brought out, and by means of a non-automatic hand-operated oil switch all these points can be connected to a common earthing bar. It is proposed at a future date to instal an automatic earthing arrangement by means of which it will be impossible to earth more than one generator neutral point at the same time.

FIG. 3.—AUXILIARY SWITCHBOARD.

A sectional elevation of the main board is given in Fig. 1. The switchgear consists of two main portions: the operating panels (Fig. 2) which are erected on a gallery across the whole width of the engine room, and the high-tension and extra-high-tension switchgear which is erected in a separate switch house; the auxiliary switchboard (Fig. 3) for the main station is placed underneath the gallery. From the operating panels in the engine room the high-tension and extra-high-tension switchgear in the switch house is electrically controlled. The high-tension and extra-high-tension apparatus are arranged in cells built up of brick and reinforced concrete. Each three-phase circuit on the 3,000-volt system is separated from its neighbour by a 4½ in. brick wall, whilst in the 20,000-volt switchgear not only the circuits but also the phases are separated from each other by similar walls. The 3,000-volt switchgear is erected on the low-tension side of the switch house, the various cells being arranged back to back on each side of a vertical 14 in. brick wall. Commencing from the ground floor, the three-core cables from the generators end in trifurcating boxes, fixed to the 14 in. brick wall. From these cable receivers the bare copper rod connections pass through horizontal concrete slabs into the current and potential transformer cells. The conductors pass thence through the second floor into the switch cells, and from the switches through the third floor into the isolating switch cubicles and 'bus bar compartments. The 'bus bars are divided from one another by horizontal concrete slabs and form a complete ring. Proceeding downwards from the 'bus bars on the other side of the vertical wall there are first the isolating switches on the third floor, the automatic oil switches on the second floor, and the current transformer cubicles on the first floor opposite the corresponding apparatus on the other side of the wall. The primary terminals of the 2,500 kw. transformers are connected by means of bare round copper rods to the terminals of the current transformers.

From the secondary (20,000-volt) terminals the connections pass through large holes in the second floor to the automatic-oil switches, thence through the vertical wall to the current transformers, and through the third floor into the 'bus bar compartment. The oil switches for controlling the outgoing feeders are all erected on the third floor in a separate set of

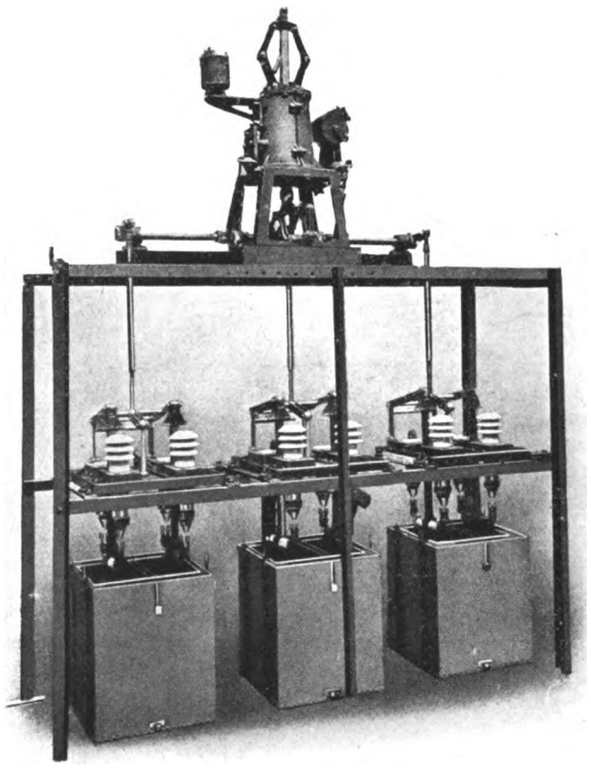

FIG. 4.—20,000-VOLT MAIN SWITCH.

cells. The conductors from the 'bus bars pass through isolating switches overhead fixed to the roof of the current transformer cells, from there through the auto-oil switches to the choking coils fixed against the main outside wall and then the conductors leave the building through isolating switches and suitable openings in the main wall. Proceeding downwards from where the lines enter the building, connections pass through the third floor into isolating switches and thence to the lightning arrester cells, all of which are erected on the second floor. The operating board as at present equipped consists on the low-tension side of four power transformer panels, three blank panels for future generators, three generator panels, one panel for automatic voltage regulation, two blank panels for future exciters, two exciter panels, one continuous-current motor generator panel, one group feeder panel, one pumping station panel, one 3,000-volt outgoing feeder panel and four outgoing overhead feeder panels. Each generator panel is equipped with three ammeters, one voltmeter, one indicating wattmeter, one power factor indicator, three reverse relays, one fool-proof controller for the reverse-current switch, two indicating lamps for this switch, one field ammeter, one field

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voltmeter, one double-pole field switch, two fuses, and one three-phase unbalanced wattmeter. In front of each generator panel is an iron pedestal containing the handwheel of the field regulator and the handle of the neutral point oil switch referred to above. The motor-generator panels controlling the continuous-current side of two motor-generators contain: two automatic direct-current carbon circuit-breakers, two ammeters, two voltmeters, two double-pole quick-break knife switches, four fuses, two shunt regulators and one direct-current watthour meter. Each main transformer panel contains: three ammeters, one fool-proof Ferranti controller for operating the two main switches, viz., one primary and secondary switch at the same time or one after the other by means of plugs, one overload relay installed on the primary side and one Merz-Price relay for the protection of the transformer. Each outgoing 20,000-volt feeder panel contains: three ammeters, one fool-proof controller, one set of indicating lamps, one overload relay and one three-phase unbalanced load watthour meter. The group feeder panel and the pumping station panel, as well as the outgoing 3,00-volt feeder panel, contain exactly the same apparatus and instruments as the 20,000-volt feeder panels The two exciter panels each contain at the top: three alternating-current ammeters for the alternating-current side of the motor-generator, one overload relay, one fool-proof controller and one set of indicating lamps, one direct-current ammeter, one direct-current voltmeter, one handwheel for the liquid starters for starting the motor-generators from the direct-current side, one handwheel for the shunt regulator, one double-pole field switch two fuses, and one three-phase unbalanced watthour meter. Underneath the switchboard gallery in the engine room is erected the switchgear for controlling the power and lighting supply of the station itself. It consists of a high-tension switchboard containing three panels for the control of the power and lighting transformers situated immediately at the back behind the main wall and of a low-tension switchboard containing the apparatus for controlling the low-tension side of the transformers and the power and lighting distributors.

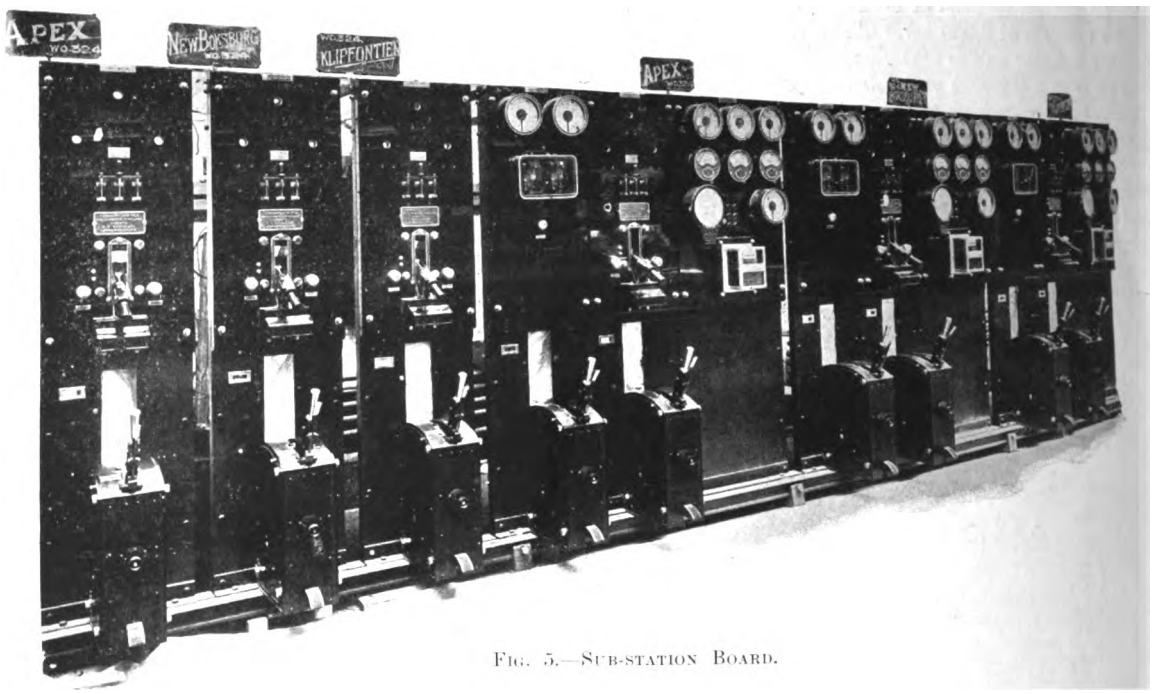

Fig. 5.—Sub-station Board.

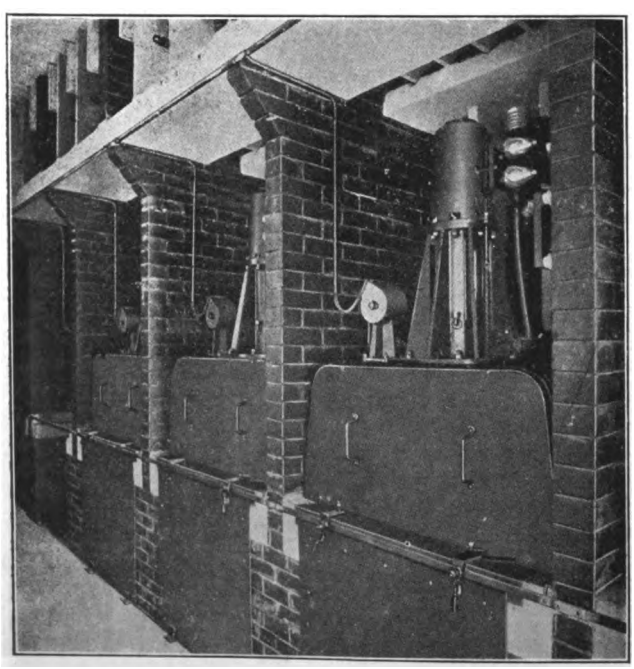

Fig. 6.—3,000-volt Main Switch.

The switchgear generally possesses all the automatic protective devices which are now considered to be up-to-date and efficient. The generators have been provided with reverse power relays only. The main transformers are protected by means of the discriminating Merz-Price system and with overload protection on the primary side only. The group feeders and outgoing extra-high-tension feeders are also provided with auto-time limit overload devices.

Having dealt with the general arrangement, it may be of interest to describe some of the apparatus in greater detail. The main switches naturally take first place. As already shortly indicated, all the main oil switches are electrically operated and are of the well-known Ferranti-Field design They are solenoid operated the co ilsbeing energised at 100 volts, by the battery referred to above. The 3,000-volt main switches are all of the same size as far as breaking capacity is concerned. They are of the largest size yet manufactured by Messrs. Ferranti, and are capable of breaking 30,000 kw. without the least difficulty. They only differ from one another as regards current-carrying capacity in order to suit the normal loads of the various circuits. As will be seen from the illustration (Fig. 6) each phase is interrupted in a separate tank, the total break per phase being 18 in. under oil. The 20,000-volt switches (Fig. 4) are of Messrs. Ferranti's standard 30,000 volt size. They are different from the 3,000-volt switches in that each phase has

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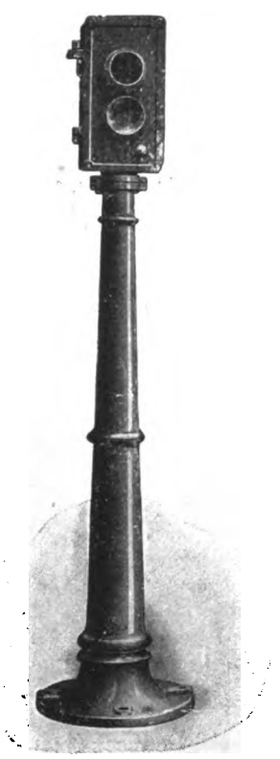

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a separate switch erected in a separate cubicle. On top of the switches and separated therefrom by a horizontal concrete slab is fixed the operating gear, consisting of a powerful solenoid which by a suitable arrangement of levers operates the three-single-phase switches at the same time. In each switch cubicle there is mounted against the wall a suitable terminal board to which are connected the ends of the steel armoured multi-core cable, thus forming the link between the fool-proof controller on the operating panel and the switch, the multi-core cable being connected to similar terminal boards at the back of the operating panels. The isolating switches are of Messrs. Ferranti's standard design and are very substantially built. As already indicated above, the 'bus bars are on the ring main system and suitable isolating switches are installed in the run of the 'bus bars in order completely to isolate not only a particular circuit but also that part of the 'bus bar to which that circuit has connected. The 3,000-volt 'bus bars have each a section of 3 sq. in. They are of the laminated type and are supported by substantial insulators cemented into the wall. The 20,000-volt insulators used throughout are of Messrs. Ferranti's standard 30,000-volt size, and are of the built-up type having two "petticoats."

All current and potential transformers are of the enclosed oil-cooled type, and altogether the whole switchgear has been designed to withstand the South African climate. The metal framework of the operating board and that of the high-tension and extra-high-tension compartments, as well as the cases of all transformers and switches, the cable receivers, and the secondaries of all instrument transformers, are effectively earthed by means of bare copper strips which are connected to the main earthing bar of the station. The switchgear in the five sub-stations (Fig. 5) is of similar design to that of the main station, with the exception that all the oil switches are of the mechanically remote controlled type. The whole of the switchgear in the main station and sub-stations were designed and built by Messrs. Ferranti in their Hollinwood works, and it goes without saying that the work turned out by them is throughout of first-class finish and workmanship.

G.E.C. Electric Haulage Gear.

The great development of electrically driven haulage gear in mines cannot be better exemplified than by referring to some typical installations which have been supplied by the General Electric Co. We give below details of two such installations which they have recently carried out.

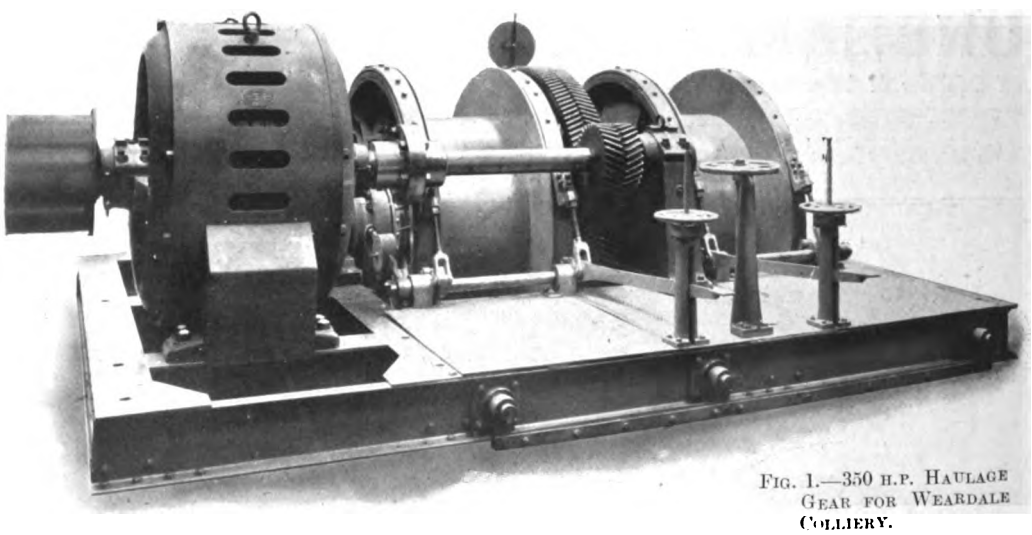

FIG. 1.—350 H.P. HAULAGE GEAR FOR WEARDALE COLLIERY.

Fig. 3 shows the 20 H.P. main and tail haulage gear supplied by them to the Thornbury Colliery. This gear is driven by a 20 H.P. three-phase slip-ring motor running at 760 revs. per min. and working on a 450 to 500 volts circuit with a frequency of 40. The gearing is proportioned to give a rope speed of 6 miles per hour. The motor has gas-tight slip-rings and is supplied with an oil immersed controller for regulating the speed. Fig. 2 represents a 7 H.P. squirrel-cage motor working on a 440-volt circuit with a frequency of 40. It runs at 1,160 revs. per min., and drives through gearing a three-throw portable ram pump, which is capable of delivering 100 gallons per minute against a head of 100 ft. The rams are 5 in. in diameter of the trunk type, and have a 6 in. stroke. The motor is of the squirrel-cage type, and is started by means of an oil-immersed auto-transformer. Fig. 1 shows the 350 H.P. haulage gear supplied to the Weardale Coal Company. The motor is 350 H.P., and works on a 3,000-volt 40-frequency circuit. It runs at 335 revs. per min., and its controller is capable of starting it against full-load torque once in every 7 minutes, and also of regulating the speed down to one-seventh of the full-load speed for one hour. The gearing is so proportioned that the speed of the ropes is 14 miles per hour, and the drums are capable of accommodating 2 miles of rope.

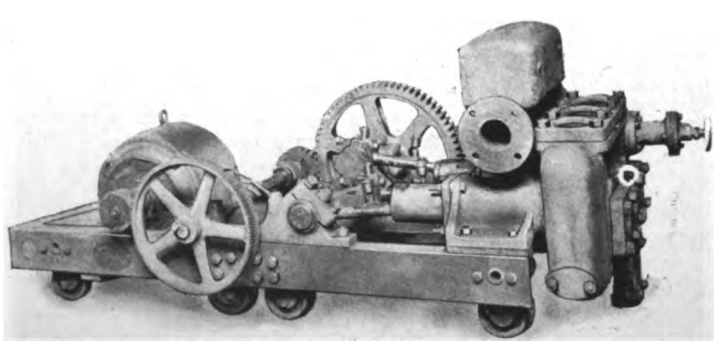

FIG. 2.—G.E.C. PORTABLE PUMP.

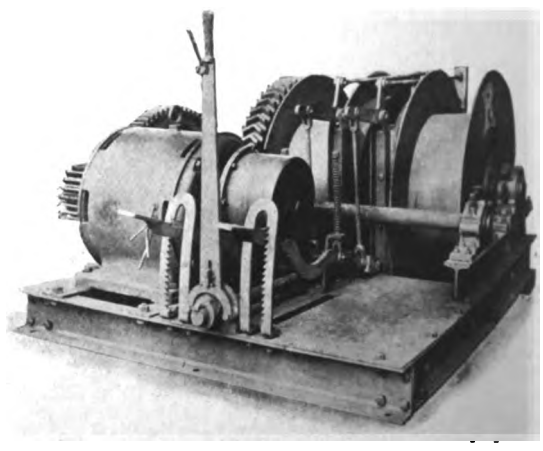

FIG. 3.—MAIN AND TAIL HAULAGE GEAR AT THORNBURY COLLIERY.

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Controllers and Resistances in Mines.

BY EDMUND GARSIDE.
(Of Engineering Instruments, Ltd.)

In view of the Report of the Departmental Committee and their suggestions for the modification of the existing Special Rules for the use of electricity in mines, it will be necessary for designers to consider the question of resistances to comply with the rules.

In the application of motor driving in coal mines the most difficult conditions which require fulfilling in regard to resistance design are for resistances for use with controllers operating large motors driving main and tail haulage gears. In this class of drive, in many cases, it is necessary to run the motor dead slow with very light loads, and also at all speeds from 15 per cent. of full speed up to full speed, with varying conditions of load, from practically no load to full load. Considerable difficulty has been experienced in meeting these conditions owing to the space required for the resistances and their high cost. The type of resistance usually used is of the cast-iron grid type in ventilated cases, this having been the standard type of resistance for controller work for industrial purposes.

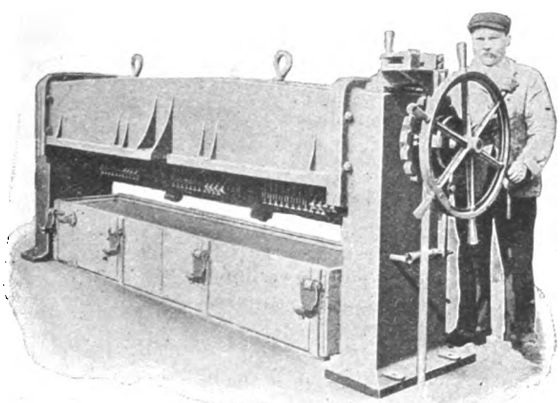

FIG. 1.—MINING CONTROLLER.

Owing to the above difficulties the tendency during the past few years has been in favour of using a liquid controller, the controller and resistances being a self-contained piece of apparatus. This type of controller has been used largely for haulage work, but owing to the fact that liquid has to be employed it has several disadvantages which do not exist with properly designed, controllers with metallic resistances. In the later designs of liquid controllers for large motors where a large amount of control is required, and consequently where a large amount of energy has to be dissipated in the resistances, water-cooling circulating pipes have been employed to cool the liquid of the controller, water being pumped through the circulating pipes by means of a small centrifugal pump fixed on the haulage bed plate and driven from the haulage gear.

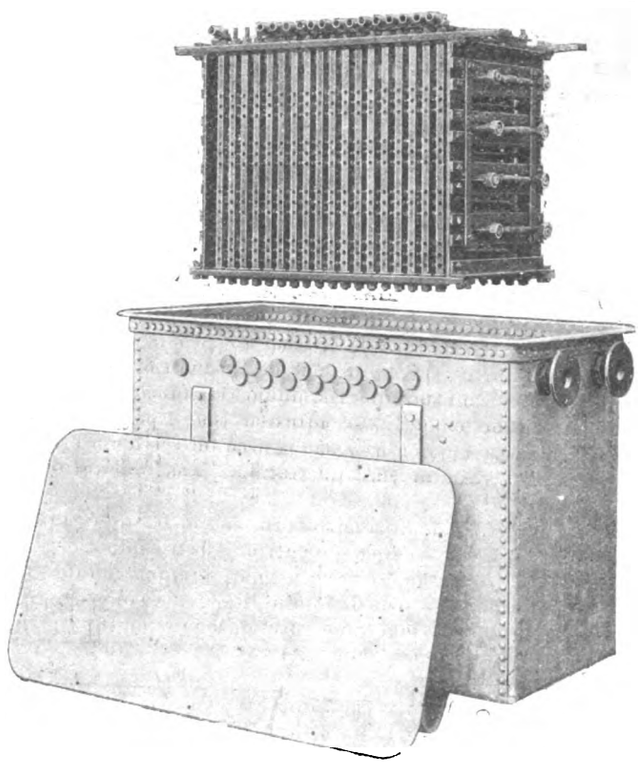

FIG. 2.—OIL TANK, WITH RESISTANCE.

This method of dissipating the energy expended in the resistances in heat has proved very satisfactory owing to the fact that when the haulage gear is running light, and at a high speed, a greater quantity of water is circulated through the tubes, and thus cools the resistances between the runs. The amount of active material, therefore, in the resistances is

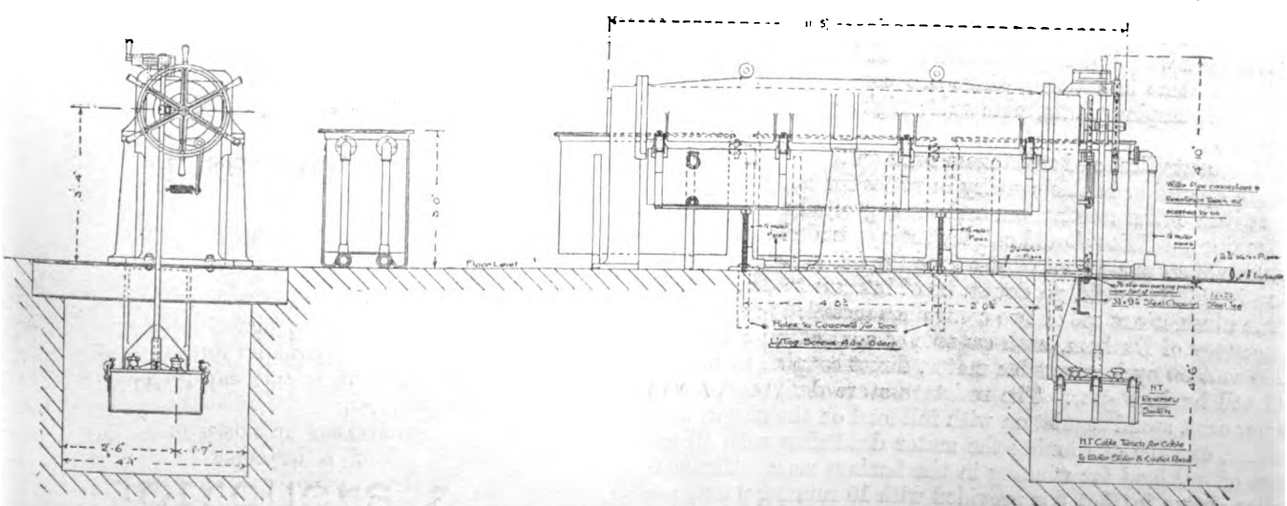

FIG. 3.—ELEVATION OF HAULAGE CONTROLLER GEAR.

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reduced to a minimum, with a resulting saving in space occupied and also in cost.

The liquid controller, however, has serious disadvantages owing to the presence of the liquid, making it extremely difficult to obtain efficient insulation. Also, there is considerable loss of liquid by evaporation at temperatures which exist in mines, and also loss due to steam being generated in the controller when the liquid is called upon to dissipate any considerable amount of energy. In situations where resistances have to be totally enclosed it would, therefore, appear that the employment of liquid controllers offers difficulties which will be by no means easy of solution.

In the liquid type of controller it is usual to arrange for the dipper plates never to break circuit; there is, therefore, a danger, if periodical inspection is not maintained, as the loss of liquid by evaporation will so lower the level as to cause the dipper plates to open circuit when the controller is in the position where all the resistance should be in circuit.

It would appear, therefore, that the type of controller and resistances for the control of motors in mines to comply with the suggested modifications of the Special Rules should be so designed that the controller contacts and the resistances be totally immersed in oil, the resistances being of the metallic type contained in totally enclosed oil-filled tanks. Water-cooling circulating pipes should then be provided in the resistance tanks having sufficient area to keep the oil at a normal temperature when the resistances are dissipating the maximum amount of energy required. The circulating pipes should be fed with water by a small centrifugal pump driven by the haulage gear. The amount of water required will, of course,

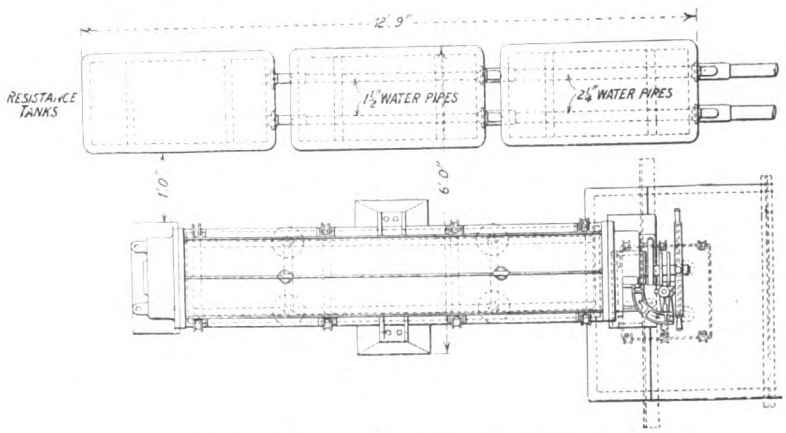

FIG. 4.—PLAN OF HAULAGE CONTROLLER GEAR.

depend upon the energy to be dissipated, and in some cases a water tank would be required with a ball tap to maintain the level. In some situations, where the controllers are in the vicinity of pumping plants, mine water might be used for cooling purposes.

A few controllers and resistances built on this principle have been in operation in this country in mines for some years and have given entire satisfaction, and the suggested modifications to the Special Rules should call for their extended use. As an instance of an equipment of this type the following particulars of an installation will, no doubt, be of interest to designers.

The illustrations are of two controllers installed in a mine in the county of Durham, each capable of controlling a 400 H.P. 2,750 volt 50 cycle reversible motor, direct coupled to a main and tail haulage gear. The resistances are designed to give 50 per cent. speed regulation with full load on the motor, and, further, capable of running the motor dead slow with 10 per cent. of full load for winding in the haulage rope. The controller shown in Fig. 1 is provided with 15 running points per phase, all the contacts being oil immersed, each breaking point being effected by a quick make-and-break switch, the speed of the make-and-break being out of the control of the operator, the length of break being 4½ in. The controller is connected to the rotor resistances, the rotor being wound for 500 volts. The high-tension reversing switch is mounted in the foundations below the floor level, and is interlocked with the controller hand wheel. All the high-tension switching arrangements and cables are, therefore, below the floor level in the cable trenches.

The resistances shown in Fig. 2 are of the unit type divided into three sets, one tank with its resistances being provided for each phase. The resistances are entirely immersed in oil, each tank containing four sets of copper circulating coil pipes connected in parallel with the main water supply provided by the centrifugal pump on the haulage bedplate. The general arrangement of the lay-out of the controller, together with the resistances, is shown in elevation on Fig. 3 and in plan on Fig. 4.

With the above arrangement of the resistances, perfect cooling can be maintained, and there is no danger of arcing in the event of the resistance burning out, as any arc so formed is immediately damped by the oil. This type of apparatus, while being slightly more costly in the first instance, provides every security to the mine, renders open arcing an impossibility and meets the requirements of the Special Rules.

Progress in Mining Switchgear.

One of the most noticeable features in recent development of mining switchgear has been the total abolition of the use of slate or marble for supporting the various apparatus. In a

FIG. 1.—INVERTED TYPE MINING PILLAR.

modern colliery such material is only to be found in the generating station, where appearance may sometimes warrant

FIG. 2.—100 AMPERE LOW VOLTAGE UNIT FOR UNDERGROUND WORK.

its inclusion. The present-day form of iron-clad switchgear had its rise in the now old-fashioned inverted type pillar (*see* Fig. 1). As will be seen from the illustration these were

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extremely clumsy in their construction when compared with modern apparatus for similar purposes, and, moreover, the apparatus contained within was so cramped as to render access to details for purposes of adjustment a matter of some difficulty. Their principal advantage over the still older forms of mining switchgear was that they were so strongly constructed that they could well withstand the extremely rough usage which was to be expected, and they were moreover arranged with interlocking devices so as to prevent the operation of the isolating switch before the oil switch circuit was opened, and also to prevent the door being opened until both these switches were previously opened. As a direct descendant of this in-

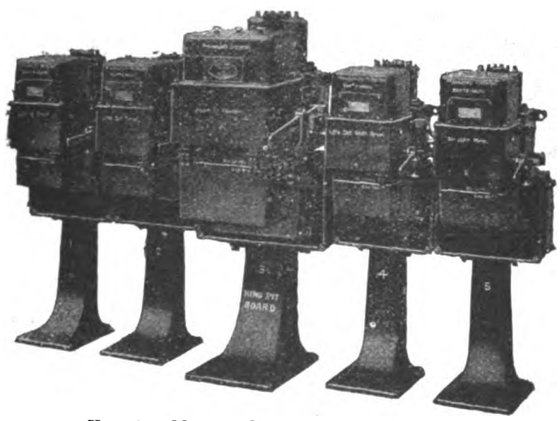

FIG. 3.—MINING DISTRIBUTION BOARD.

verted type of pillar there came the sheet iron or wardrobe construction which, in various forms, has now been taken up by the majority of the leading manufacturers in this country and abroad. In this class of apparatus the chief object has been not so much to secure economy in space, but rather to ensure that all apparatus is so arranged as to be fool-proof in operation, while it is spaced within the sheet-iron cubicles as widely apart as would have been the case had the ordinary form of cellular construction been adopted. This class of gear is primarily

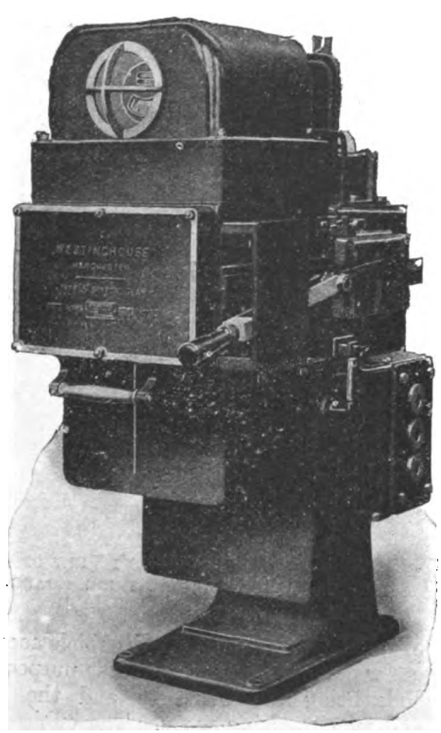

FIG. 4.—6,600-VOLT MINING PILLAR.

intended for sub-station service where the head room occupied is not an important item.

For use underground, the British Westinghouse Co. have, within the last few years, developed a new form of apparatus, which they term their type "S" switchgear. In its simplest and original form it is shown in Fig. 2, which illustrates a 100-ampere low-voltage unit. The most noticeable feature of this type of apparatus is its extreme flexibility, the completed units being built up of separate interchangeable portions, most of which are so ingeniously designed as to be usable for several different purposes.

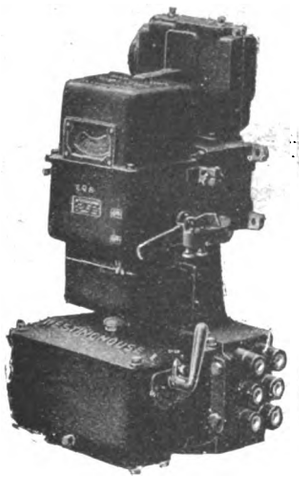

FIG. 5.—ANOTHER TYPE OF MINING PANEL.

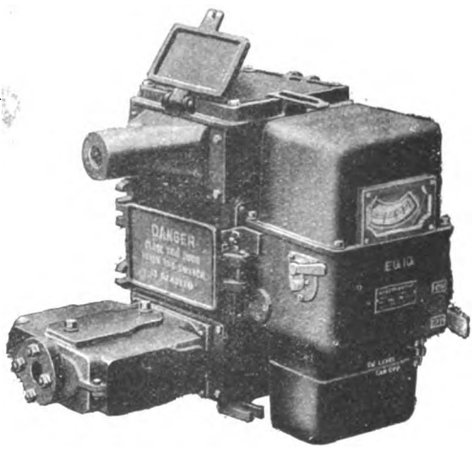

FIG. 6.—STANDARD GATE END BOX WITH ANDERSON BOYES TRAILING CABLE PLUG.

Thus, in Fig. 3 is shown a complete distribution switchboard arranged for a 200-ampere incoming circuit, and four outgoing circuits of 100 amperes. The total height of this switchboard need not exceed 44 in.; it will thus be seen that this apparatus is suited for use in very shallow headings indeed.

Further forms of this apparatus are shown in Fig. 5, which

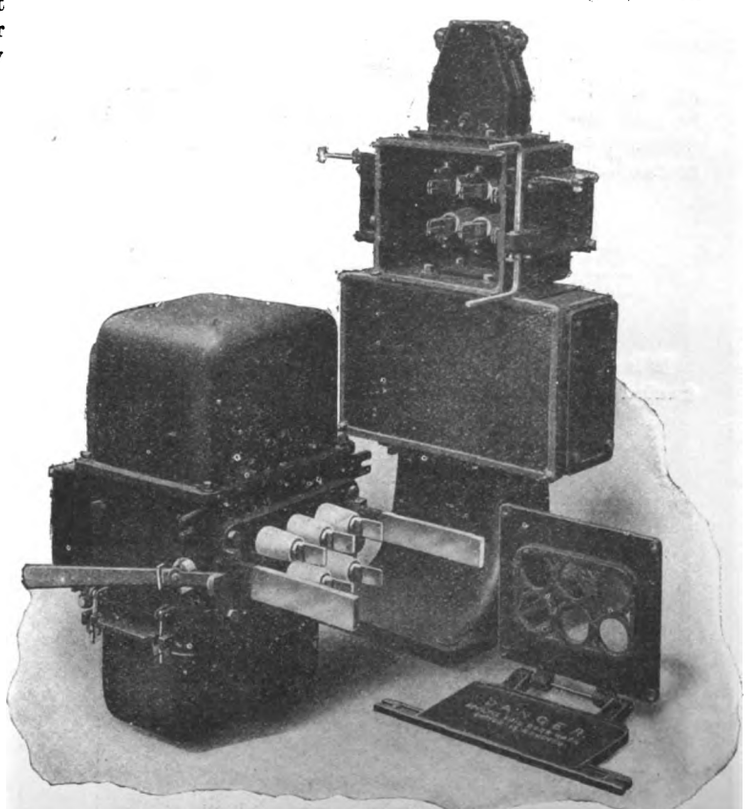

FIG. 7.—3,300-VOLT PILLAR SHOWING PARTS.

illustrates a low-voltage switch working in conjunction with an oil-immersed star delta starter, and also Fig. 6 which shows the standard gate end box complete with an Anderson Boyes trailing cable plug. In this case the total height of the appa-

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ratus is 20 in. This apparatus is also built for use on higher voltages, Fig. 4 showing the arrangement of the 6,600-volt pillar, while Fig. 7 shows a 3,300-volt pillar. This latter illustration also serves very effectively to illustrate the arrangement of isolating plugs which are so important a feature of the "S" type switchgear. The apparatus is so designed that access cannot be obtained to any of the current-carrying parts of the switch until the switch is actually isolated from the line, and also from the outgoing cables. The interlocking devices included are complete in every particular, and, it is claimed, render it an absolute impossibility for the operator to receive a shock.

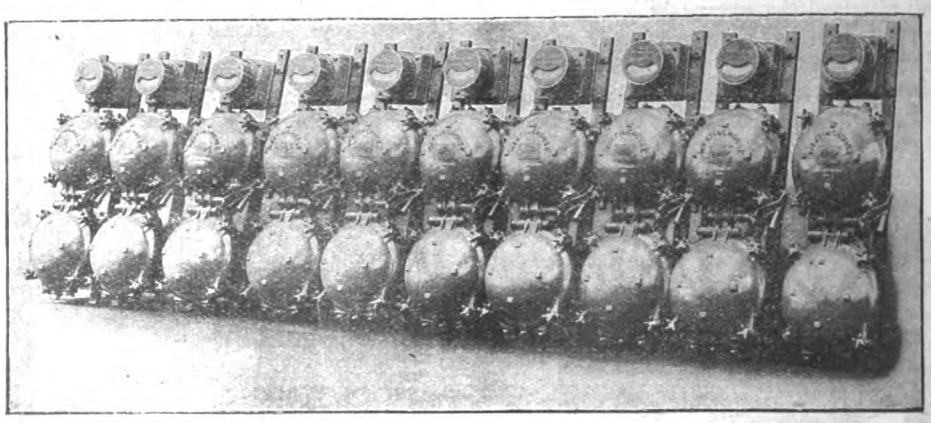

FIG. 8.—WESTINGHOUSE DIRECT-CURRENT FLAME PROOF SWITCH UNITS.

For direct current service, the Westinghouse Company still employ their well-known flame-proof switch units which are illustrated by Fig. 8. The principle on which these units is constructed is to build the fixed and hinged portions of each switch or fuse unit in such a manner that a circular V-shaped tongue on the one fits into a corresponding circular V-shaped groove in the other. By this means any flame which might be caused by an arc within the switch case cannot be transmitted to the atmosphere without, as it would first of all have to pass between closely fitting metal surfaces for a long distance, and these would effectually cool the gases so as to render them harmless.

An Up-to-date Mining Switchboard.

It is obvious that electric installations in mines have to be treated from an altogether different point of view than ordinary surface installations, as a breakdown in the motive power of a mine will probably have disastrous consequences. Therefore every precaution must be taken to make the installation safe regardless of expense.

Hitherto one of the most likely places for a fault to occur has been the switchboard, with its numerous connections, cables and other apparatus. The board shown in the illustrations, which has been designed and manufactured by the General Electric Co. for colliery work, is a very good example of an up-to-date mining switchboard. The term "switchboard" is rather misplaced when applied to an installation of this description, which has, as will be seen, very little in common with the old time-honoured marble and slate boards. As a matter of fact no marble or slate is used whatever, steel plates having taken their place.

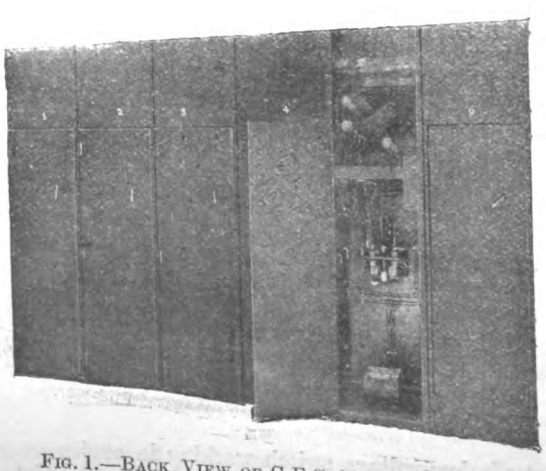

FIG. 1.—BACK VIEW OF G.E.C. MINING BOARD.

The "board" consists of six cubicles formed by steel plates bolted to an angle iron framework. Each cubicle accommodates one set of gear which serves one particular purpose, the only connecting link being the 'bus bars and the low-tension instrument and synchronising wires. The cubicles from the right to the left of the observer, looking at the front of the board, deal with the following duties :—

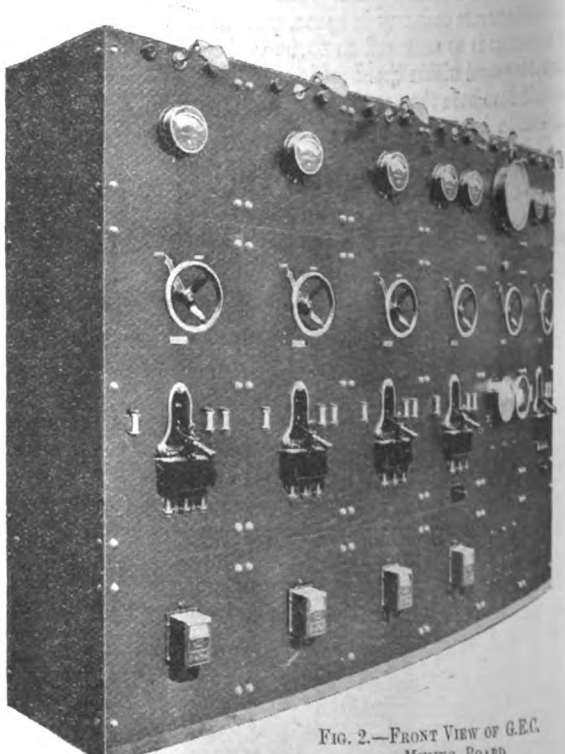

FIG. 2.—FRONT VIEW OF G.E.C. MINING BOARD.

No. 1 : One 750 kw. 3,000-volt three-phase turbo-alternator, for which is provided one maximum release oil switch, three series transformers, an ammeter, one potential transformer, a voltmeter, synchronising plug, and high-tension disconnecting links. No 2: High-tension disconnecting links, three-phase potential transformer, synchroscope, hot

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age indicator, and indicating wattmeter for the alternator on No. 3. No. 3: One interconnecting feeder. The gear provided is the same as on No. 1, with the addition of a watt-hour meter in place of the indicating wattmeter, Nos. 4, 5 and 6 are for three feeders, two of 750 kw. and one of 150 kw. capacity. The gear provided for each is a three-pole disconnecting link, three series transformers, one three-pole maximum release high-tension oil switch, an ammeter and a watt-hour meter.

All the oil switch trip coils are provided with time limit fuses across their terminals. These fuses are of the porcelain handle type, and can be seen in the front view of the "board" (Fig. 2).

The 'bus bars are carried in three horizontal chambers running along the whole length of the top of the "board." The chambers are formed by steel plates on the top and sides, and they are open below. Directly under the 'bus bars in each cubicle are mounted the disconnecting links on the side plates which separate two adjacent cubicles. The access doors at the back of the cubicles only reach just below the lower or hinged contacts of the isolating links while the upper contacts, which are connected to the 'bus bars and which form the only live metal parts in the cubicle when the disconnecting links are switched out, are covered up by steel plates bolted to the angle irons forming the frame. This can be plainly seen by referring to the back view (Fig. 1). The three disconnecting links of each cubicle are connected together into a three-pole switch in the manner shown in Fig. 3, which illustration shows a cubicle

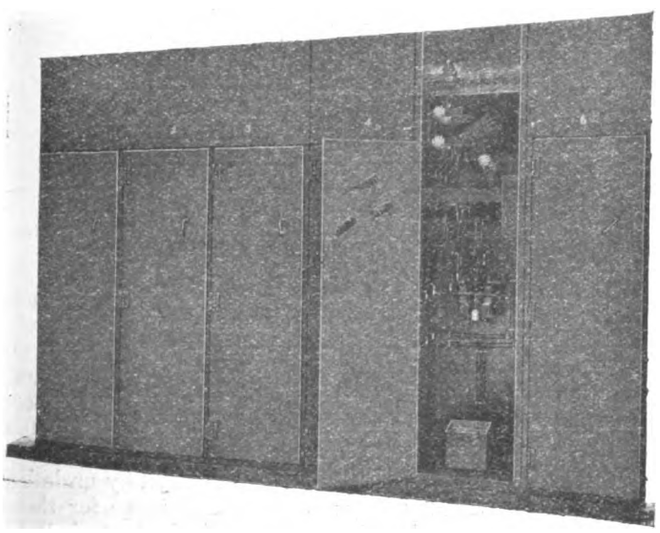

FIG. 3.

with a number of steel plates removed. It will be seen that no coupling bar in the ordinary sense is used, and that each individual link is attached to a ribbed vitreous porcelain insulator which is in turn attached to a crank on the common operating shaft.

This method, it is claimed, ensures perfect insulation, and at the same time does away with the necessity of cutting slots in the partitions between the links to make room for the coupling bar. The operating shaft cubicle in front (*see* Fig. 2) is interlocked with the door in the rear in such a way that it is impossible to open the door as long as the disconnecting links are switched in, and to close the disconnecting links as long as the door is open. The oil switches are mounted on the front steel plate of the cubicle under the operating shaft of the isolating links, and are interlocked with the latter in such a way that they can only be closed if the isolating links are switched in, while, if they are closed, they lock the isolating links. This system of interlocking makes the board quite fool-proof, for it is impossible to break the circuit with the disconnecting links, as they are locked as long as the oil switch is closed, and it is also impossible to open the doors of the cubicles as long as the disconnecting links are switched in. Furthermore it is impossible to switch in the disconnecting links as long as the door is open.

Some New Oil-break Switches for Mining Work.

The ever-increasing application of electricity to mining, and the need for safety and reliability—more especially the necessity of complying with the requirements specified by the recent

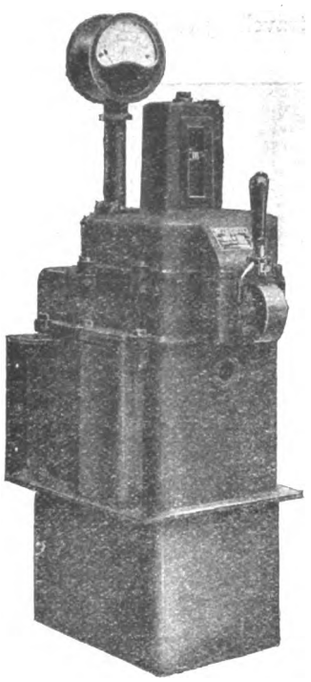

FIG. 1.—TYPICAL "UNION" OIL SWITCH FOR MINING WORK.

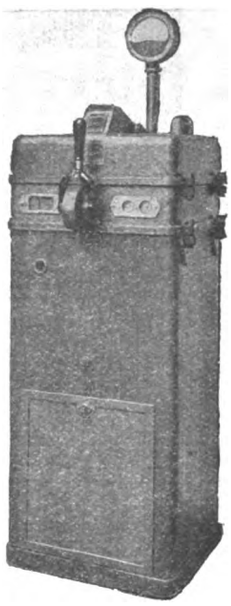

FIG. 2.—H.T. OIL BREAK SWITCH.

Royal Commission—have resulted in improvements in, and new types of, switchgear to adequately control the supply of electrical energy.

Each application of electrical power to a new industry calls

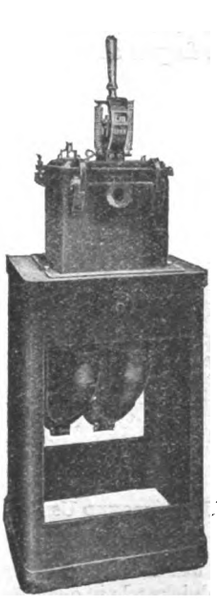

FIG. 3.—METHOD OF ATTACHING CABLE JUNCTION BOX TO OIL CONTAINER.

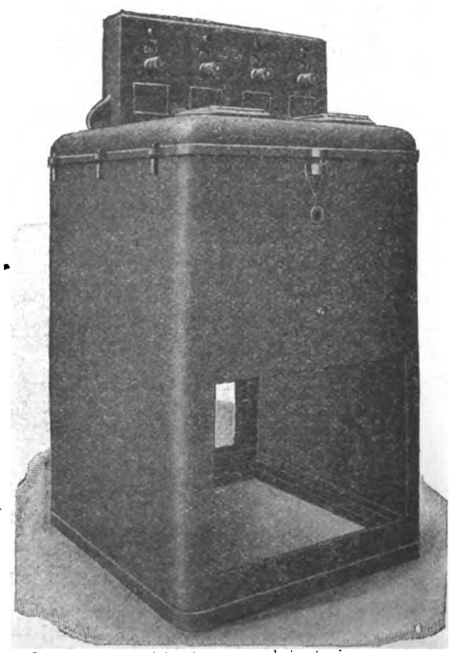

FIG. 4.—OIL BREAK ISOLATING SWITCH BOX WITH CABLE AND SEALING BOXES.

for special designs of machines and switchgear; and it is essential, for mining purposes, that the switchgear shall be solid in design, capable of use without damage by unskilled labour

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and flame-proof. It is now some seven years since the Union Electric Co. commenced the manufacture of special types of oil-break switchgear having the above characteristics and suitable for severe working conditions; and they adopted the then exceptional feature of placing all circuit terminals in the base of the oil-container. A typical switch of this pattern is shown in Fig. 1. It is a triple-pole, oil-break, flame-proof switch, which is generally used in the Union switchboards of the carriage type. In these cases the switch units are mounted in cast-iron frames with wheels travelling on cast-iron canti-

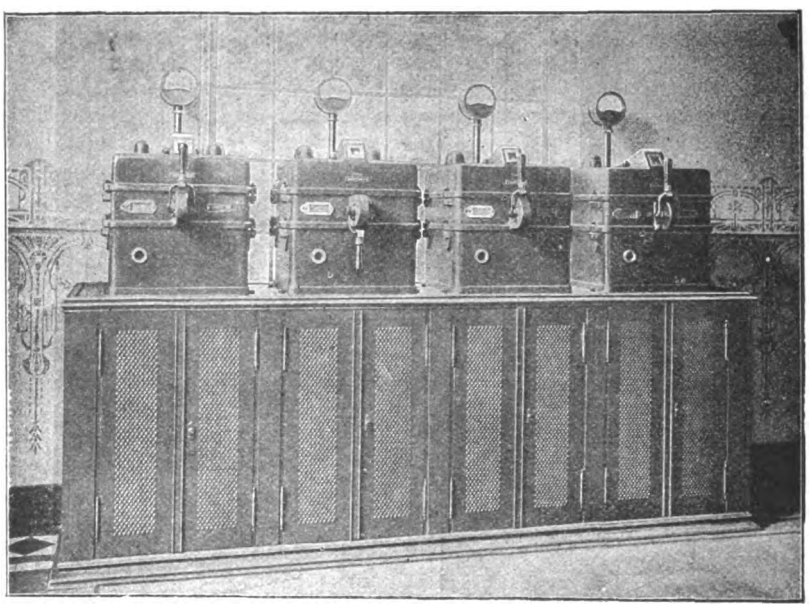

FIG. 5.—"UNION" MINING FEEDER BOARD.

lever brackets, behind which are the chambers for 'bus bars and isolating links. This system embodies the Union Electric Co.'s latest improvements for securing absolute safety when used in underground positions. By the special system of electrical and mechanical interlocking, it is said to be impossible under any conditions for live parts to be exposed. This result is obtained as follows:—Connection between the switch unit and the 'bus bars is made through switch-fingers at the back

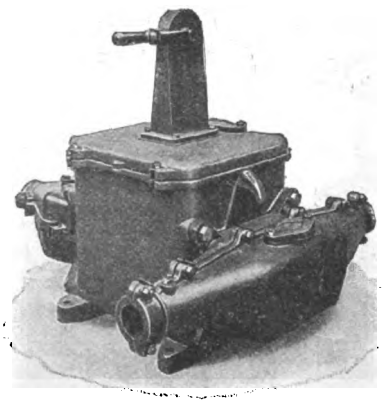

FIG. 6.—SECTION INSULATOR FOR UNDERGROUND USE.

of the unit, and at the front of the 'bus bar chamber. Connection to the no-volt trip-coil of the switch is made in a similar manner. The lever for withdrawing the switch carriage is so arranged that the no-volt trip contacts are disconnected by the slightest movement towards the "out" position; while, conversely, the no-volt trip contacts are closed last thing.

Supposing the switch to be "in"; any attempt to break circuit by the isolating link will first break the no-volt release circuit, causing the oil switch to trip out automatically. On the other hand, if the carriage is "out" the switch cannot be closed, as it will be instantly tripped by the no-volt release, this effect being maintained until the carriage is right home and contact is established with the 'bus bars. If the carriage should have to be withdrawn for any purpose, the opening in the 'bus bar chamber is closed by a sliding panel, and secured with a padlock; enabling the rest of the board to be used with entire safety.

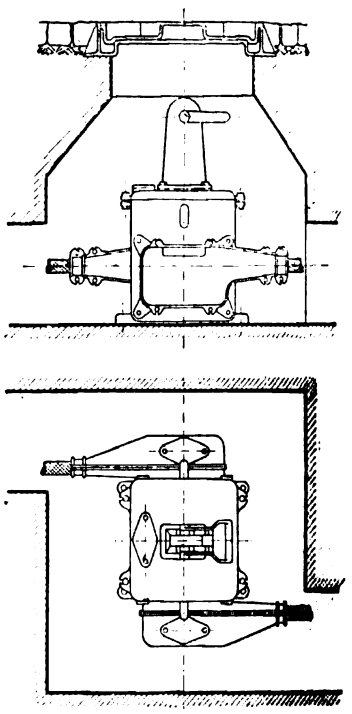

FIG. 7.—DIAGRAM OF SECTION INSULATOR FOR UNDERGROUND USE.

The overload coils are in the high-tension circuit and oil-immersed, securing better insulation and thus ensuring freedom from breakdown; owing to the direct operation there is, it is claimed, less complication than in the case of transformer-operated overload trips. The use of undertype circuit connections gives every facility for compact assembly of the switch units.

A switch system of this type is easily handled by unskilled operators with perfect safety; a great advantage for those power users who require that the electrical plant shall be controlled by unskilled workmen.

Figs. 2 and 5 show switches similar in design to the previous one, but suitable for higher pressures and larger currents. We illustrate in Fig. 5 a feeder board composed of these units. In special cases the overload trips can be supplied to secure a definite time-lag irrespective of the value of the overload current, so that it is possible to ensure that the switches shall be released in a definite order. In this type of switch design the cable junction-box may be attached directly to the oil-container, as shown in Fig. 3. This form of construction has been very largely adopted in gassy mines.

Fig. 4 illustrates an oil-break isolating switch-box with cable and sealing boxes. A number of isolating switches are assembled, with the requisite 'bus bars, in a large oil tank. For each set, cable-end sealing boxes are provided. The switches are operated by a loose key, and are fitted with an indicating device showing the "in" and "out" positions. The principal advantages of this arrangement are that the distributing gear occupies a very small space, while, owing to the complete enclosure of live parts, the apparatus can be used in gassy positions.

Figs. 6 and 7 show a section isolator for underground use with cable-end sealing boxes attached. This consists of a triple-pole oil-break sectionalising switch, mounted in a cast-iron sealing chamber. In use it is sunk in the cable trench, the cover and operating handle being accessible through a manhole.

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Westinghouse Liquid Control Gear for use in Mines.

There exists at the present time a strong objection on the part of many engineers to liquid control apparatus. This objection is probably due to the fact that this type of gear can be manufactured for a very much lower price than metallic apparatus, and consequently the market has been flooded with cheap liquid starters and controllers which make no pretence at liberal rating in their design. As a result, liquid control apparatus has come to be regarded as representing the cheapest possible practice, a condition obtained at the expense of quality.

Liquid control gear, notwithstanding, possesses many advantages over metallic apparatus while its disadvantages practically disappear if the design is suitable. The most general objection raised is the "messy" nature of the resistance element, which gets spilt and boils, the steam condensing on the insulation and possibly breaking it down. A little consideration, however, will show that the resistance solution is no worse as regards spilling than the oil in oil immersed apparatus, which it is absolutely necessary to use in many cases for colliery or high-tension work. With regard to the latter objection it should be remembered that no boiling and very little steaming should occur when gear is properly rated for the work it has to do. It may be assumed, therefore, that if boiling or steaming does occur that the gear is too small.

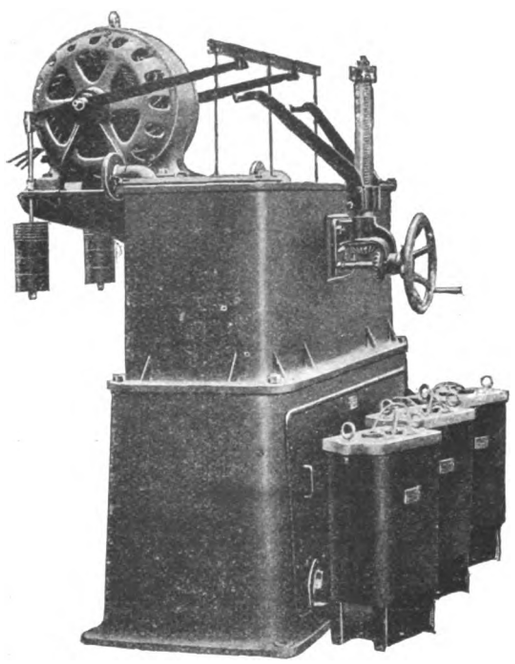

FIG. 1.—REVERSING LIQUID CONTROLLER FOR 1,500 H.P. MOTORS.

The British Westinghouse Co. have kept the above objections in view when designing their present line of liquid controllers, and although their apparatus is in general no cheaper than their metallic control gear, they claim that when used on the specified ratings the trouble of excessive steaming or boiling of the resistance liquid is wholly absent. Further, this class of apparatus gives uniform speed acceleration without jumps, while the speed adjustment is as wide as can be desired. As regards repairs, these are small, and can be effected on the site, while, owing to the simplicity of the contacts and connections, any work that has to be done on them is absolutely straightforward. Also with a liquid controller the resistance of the liquid can be altered simply by strengthening or weakening the solution. Thus any adjustments that may become necessary can be made on the site without trouble.

We describe herewith one or two patterns of Westinghouse liquid control apparatus. We may first mention a reversible haulage motor liquid controller with handwheel operating gear. The design of this apparatus is such that the rotor circuit is never broken, all the circuit breaking being done on the stator by oil immersed dust-proof reversing switches. All parts of the controller are entirely enclosed, and one operating handwheel performs all operations of reversing and bringing up to speed. Ten turns of the hand wheel are sufficient to move the controller from the "off" to full "on" position in either direction, thus enabling the operator to start or stop quickly. Cooling water is circulated through pipes immersed in the resistance liquid. Fig. 1 shows a reversing liquid controller for use with large winding gear motors, and in cases where exceptional speed variations with widely varying loads are likely to be met with. The particular controller illustrated is suitable for use with a 1,500 H.P. winding engine motor. The controller is of the sluice gate type, that is, it consists of two tanks through which the resistance liquid is kept in continuous circulation by a small motor-driven pump. The three electrodes connected to the slip-rings of the motor are in the upper tank, and the level of the resistance liquid in this is raised or lowered by the operator raising or lowering the sluice gate which is worked through rods and links from a lever or handwheel on the driver's platform. The stator reversing switches are also operated from the same lever. The operating lever is not shown in the illustration, the two handwheels shown at the left hand side being one for the valve in the delivery pipe for the circulating pump, and the lowering gear for the oil tanks and the reversing switches. It will be noted that with this arrangement of controller the maximum speed of acceleration is entirely out of the driver's hands, and is regulated by the rate of flow of the liquid into the upper tank. This can be adjusted to suit conditions by the valve mentioned above, which can be set on site and then locked. The whole of the cooling coils for the resistance liquid are arranged in the lower of the two tanks.

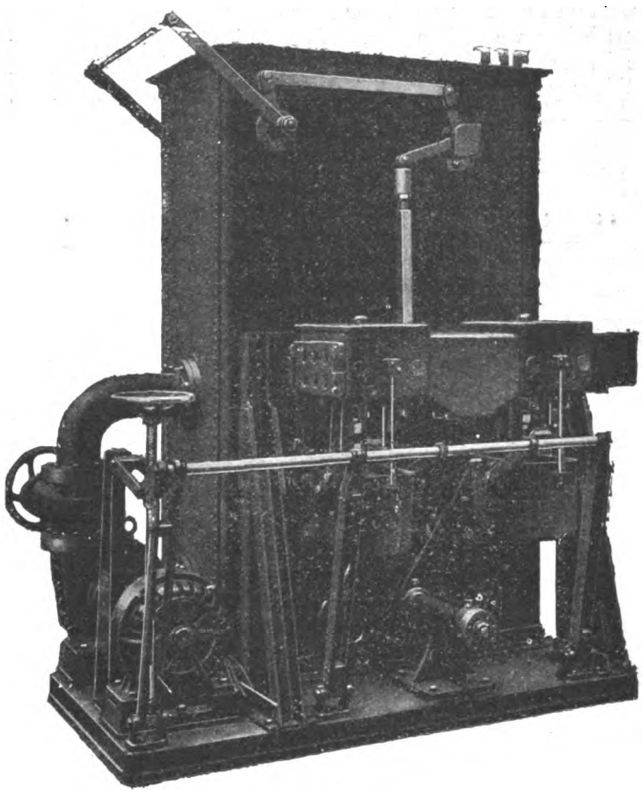

FIG. 2.—AUTOMATIC SLIP REGULATOR FOR WINDING MOTORS.

With regard to the stator reversing switches which are used with all these controllers, they are of the oil break type and are enclosed in dust-proof cases. Owing to the frequent and heavy service ordinary oil switches are not suitable, and those used have been specially designed for the controllers. They are of the strongest possible type to withstand the very heavy

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service. The contacts are of the copper butt pattern, and are supplemented by laminated copper brushes where very heavy currents are likely to be employed. The final break is always taken on the copper butts which are easily and cheaply renewable. As mentioned above, the switches are operated from the same lever or handwheel as the rotor electrodes or sluice gate, and are fully interlocked.

Fig. 2 shows an automatic slip regulator for use with winding or rolling mill motors where some form of load equalising is in use. The apparatus consists of a liquid resistance connected in the rotor circuit of the motor, and a small auxiliary motor, or "motor magnet" as it is called, for cutting this resistance in and out of circuit. The motor magnet is supplied from transformers in the stator circuit of the main motor, these transformers being shown in the illustration. The apparatus is employed in cases where a flywheel is used on the main motor shaft. The motor magnet is so adjusted that when the load exceeds a predetermined value the liquid resistance is inserted in the rotor circuit by the motor magnet raising the electrodes. Thus the slip of the motor is increased and the excess load is thrown on to the flywheel. On the other hand, when the load drops below a certain value, resistance is cut out of the rotor circuit, the motor speeds up, and energy is stored in the flywheel. In this way the load on the line can be kept practically constant, all fluctuations being taken by the flywheel.

"Vickers" Oil-immersed Controller.

The accompanying illustrations show a 180 H.P. 2,000 volt, three-phase oil-immersed controller recently manufactured by the Electric & Ordnance Accessories Co., of Birmingham, for the control of a main haulage gear in a South Wales colliery. The controller consists of a high-tension reversing switch for breaking the main stator circuit on all three phases, and of a rotor switch of the barrel type for cutting out resistance in the rotor circuit.

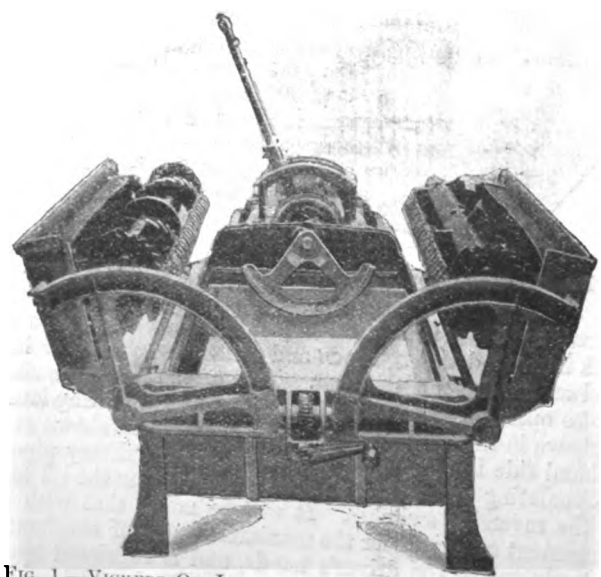

FIG. 1.—VICKERS OIL-IMMERSED CONTROLLER OPEN, SHOWING OPERATING HANDLE.

The rotor switch consists of two barrels mechanically coupled together. These barrels, with their fingers, are mounted on the cast-iron lids, which cannot be shut down unless both barrels are in the "off" position—although when the lids are open, either barrel may be moved quite freely. These lids are hinged to the main frame so as to form a cover for this portion of the controller, and are raised and lowered by means of the handle and worm-gearing shown in Fig. 1. All the contacts and fingers on the rotor barrels are readily accessible for cleaning and adjustment when the lids are raised.

The controller gives 14 running positions in each direction, the resistance being cut out equally in all three phases at each step. The controller is operated by means of the vertical handle, which is provided with a spring catch to prevent unintentionally reversing or starting the motor when returning to the "off" position.

The high-tension reversing switch is of the oil-immersed type, is insulated throughout with porcelain, and is so fixed to the framework that its tank can be readily lowered for cleaning and adjusting the contacts. Although the reversing switch is fully capable of breaking the full-load current, it is so coupled to the rotor barrels that the stator circuit is made before, and broken after, the rotor circuit, so that the reversing switch is never called upon to deal with the full-load current.

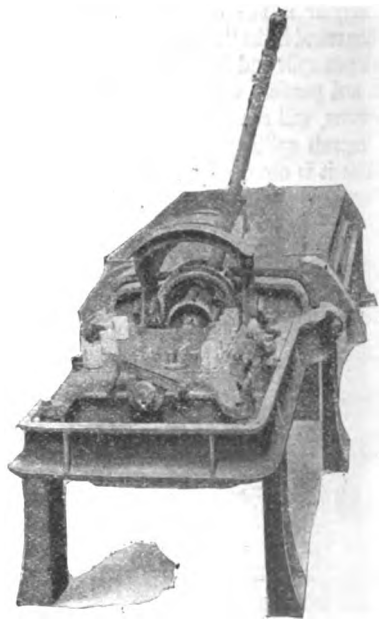

FIG. 2.—VIEW OF THE CONTROLLER IN WORKING POSITION.

The oil tank for the rotor barrel is of welded sheet-iron construction. It is slung by bolts from the framework and is capable of being lowered if required. This, however, should not be necessary, as a plug is provided in the bottom for draining off the oil. To prevent an excess of oil in the tank an overflow pipe is also fitted.

In general, the construction is very substantial and, therefore, specially suitable for its particular duty. Parts liable to wear quickly, such as contacts and fingers, are readily renewable at small cost. Fig. 2 shows the controller in the working position.

New Three-phase Motor Switch Panel.

Following the example of their well-known "Salford" iron-clad gear, the General Electric Co. have now put on the market the switch pillar shown in the accompanying illustration. The pillar has been specially designed for the control of reversing three-phase motors employed for industrial purposes, but is, of course, with slight modifications, equally suitable for continuous-current motors.

The switch is of the drum or controller type and is very substantial, mica insulation being used throughout. It is contained in a strong water-proof cast-iron case, which is provided with an earthing screw. Another cast-iron box mounted above the switch contains the fuses. This box is also made very strong and its cover is interlocked with the switch handle below in such a way that it can only be opened when the

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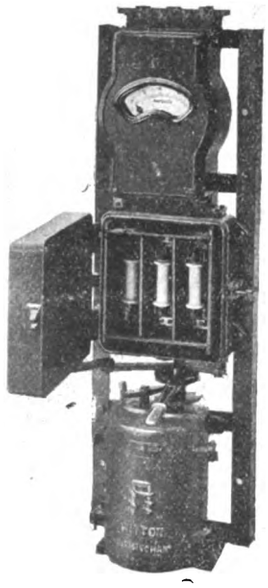
switch is in the "off" position, while it locks in its turn the switch handle as long as the box is open. This interlocking is effected by a strong lever pivoted on the fuse box and linked with the cover so that it swings outwards when the cover is opened and inward when it is closed. The lever is provided on its lower side with a strong steel pin which engages with a cam on the switch handle. This cam prevents the pin from moving outward in any but the "off" position. In the "off" position a slot in the cam is opposite the pin and this latter enters the slot when the cover of the fuse box is opened thus locking the switch handle. The interior of the fuse box is partitioned off into three separate compartments by heavy "Megorine" partitions, thus each fuse is effectively isolated and a "short"-circuit or an "earth" cannot take place. The fuses themselves are the standard G.E.C. porcelain handle Bobbin pattern. The bases which carry the contact clips are of vitreous porcelain. To the upper part of the fuse box an ammeter case is bolted, the joint being water-tight. This ammeter case is as substantial as the rest of the apparatus and ample allowance is made for easy connecting up. The ammeter is



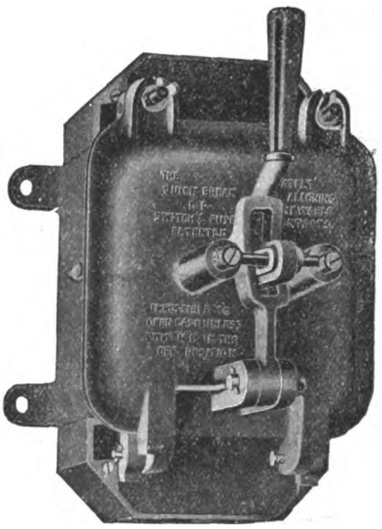
VIEW OF G.E.C. MOTOR SWITCH PANEL.

thus enclosed in an additional cast-iron box and supported on insulation so as to make the clearances of the ammeter equal the clearances of the switch. The whole pillar is of pleasant appearance and it will be agreed that it not only looks, but also is, a thoroughly sound job.

Iron-clad Quick-break Lever Switch.

The ironclad combined quick-break lever switch and fuses made by the Electric & Ordnance Accessories Co. has been specially designed for house service and motor work, but it is equally applicable to mining. Its purpose is to replace the more or less unsatisfactory arrangements hitherto employed, and in itself it is said to be a substitute for the three separate devices almost invariably used for controlling and protecting lighting and motor installations, viz.:—the double-pole open or semi-enclosed main switch and the two single-pole main fuses with their necessary connecting cables. For motor work particularly, the switch has effected a great change in the hitherto generally accepted practice, since first it was put on the market some two years ago. Its water-tight, gas-tight, dust-proof, fire-proof, and fool-proof features are what might be termed critical points in a switch intended for general industrial work, or installed in difficult and perhaps dangerous situations in factories, mills, and it is considered by the makers that the claim that these features are possessed by their switch, is a perfectly reasonable one.

The case of the switch, which we illustrate herewith, is of a fine grain cast iron, asbestos lined, and is provided with inlet and outlet glands, tapped for simplex or other screwed conduit, or untapped and specially rimered to receive the leads. Four lugs are provided for fixing to wall or panel runner. Separate slate bases are provided for each pole, on which are mounted renewable copper contacts and sweating sockets, the bases being thoroughly well insulated from the iron case, and the poles separated by a substantial insulating fillet. The switch lever and all the outside parts are insulated, an earthing terminal being provided. The resistance of the switch is low, all current-carrying parts are of ample capacity, thereby obviating any possibility of heating. The make-and-break mechanism is simple in design, the actual quick-make and break being operated by inclined angle pieces cast solid with the bottom case in conjunction with two special plungers fitted with steel pulleys on the brass switch blade and fuse carrying body. In closing the switch each plunger engages with one of the angle pieces, and is under compression until the apex



VICKERS Q.B. LEVER SWITCH.

of the angle piece is reached; when the compression is released and, due to the inclined surface of the angle piece, the switch blades are rapidly driven home on to the contacts, and a quick-make effected. A quick break is similarly obtained when opening the switch. The lever operates in a loose link; the cover is hinged and asbestos lined, and the switch made water-tight by a rubber gland inserted in the top of bottom case.

The switch, we understand, is mechanically and electrically strong, all working parts being well protected, therefore capable of withstanding hard wear and tear.

Electric Pulley Blocks and Hoists.—A useful serie of equipment for hoisting and transporting loads is that made by the Electric Pulley Block Co. The pulley block used has been specially designed to provide lifting power in positions where, owing to lack of head room or floor space, a crane is not admissible. The block is so designed with worm and wheel that the braking appliances are, it is claimed, unusually simple, reliable and automatic in action. It is supported on a single girder run-way, and the current is supplied from plugs at places where power is likely to be required. Arrangements can, of course, also be made to have the pulley block permanently connected to the mains. It will readily be gathered that this apparatus is both simple and useful, and should find a wide application in all branches of engineering work.

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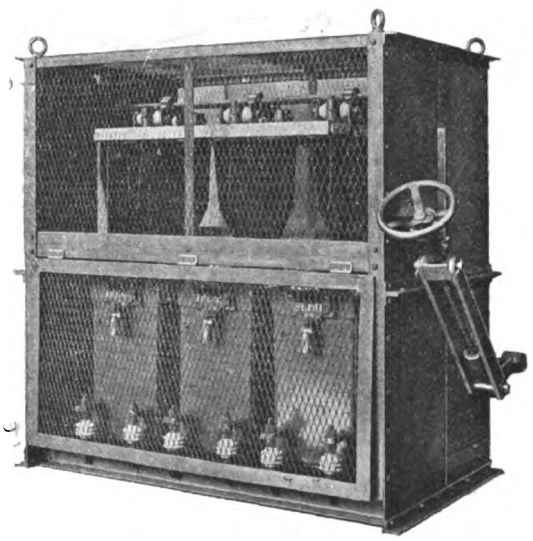
G.E.C. Liquid Starter.

The type of liquid starter made by the General Electric Co. consists of three rectangular tanks each 1 ft. wide, 2 ft. long and 2 ft. high, giving a cubic content of 4 cubic ft. for each pole, or 12 cubic ft. in all. The starter is rated to start a motor which absorbs 400 H.P. during the starting period; this gives, if the starting period is 1 minute, a temperature rise of approximately 25°F. This may seem a very low value, but the fact that starting time as well as starting current are quantities which can by no means be pre-determined must be taken into consideration. For instance, a transmission shaft might be out of alignment or bearings screwed down too tightly or a heavy piece of work might be left in a machine with the tool dead up against the metal which it has to shear off. Any of these or many similar circumstances would cause an appreciable increase of both the starting current and the time taken to start. It is, therefore, absolutely essential that starters, particularly for heavy motors, should be liberally dimensioned.

The three tanks are mounted on strong ribbed vitreous porcelain insulators in such a way that an accurate adjustment is possible. The insulators in their turn are mounted on the channel irons forming the bottom frame. On this bottom frame is built up a complete square framework of angle irons,



G.E.C. LIQUID STARTER FOR USE IN OVERGROUND ENGINE ROOMS.

which is covered with expanded metal screens, while the two short sides are covered with steel boiler plate. The dippers are mounted on another angle-iron framework, which is suspended from a mild steel shaft running the whole length of the starter, and terminating in guide shoes. These latter are guided in slots in the end boiler plates. The whole movable system is counterbalanced with weights by means of steel ropes running over rollers mounted on the operating shaft above. The operating shaft is worked by a 14 in. hand-wheel.

At the bottom of each tank two metal wings are mounted forming a V. The angle of the V is adjustable and the dippers move inside this angle. In this way a very uniform rate of acceleration is maintained through the whole starting period up to the very last, because, as the dippers nearly touch the wings just before the final short-circuiting brushes meet, the last resistance step is very small. This is not so in ordinary liquid starters.

The short-circuiting brushes are of the controller finger type, and are mounted on the short ends of the tanks on bases which also take the cable terminals. The brushes are short-circuited by brass rails fixed to the dipper frame.

The type of starter illustrated is not intended for use down a pit. For this purpose it is totally enclosed in steel to prevent dust getting in. The type illustrated herewith is for use in surface engine rooms.

Fool-proof Fused Switchgear for Mining Service.

Many alarmist reports have been circulated recently regarding the dangers of electricity in the underground workings of mines and collieries. In one of the most recent fatal accidents on record the evidence as to the cause of the explosion centred around one of the switches employed in the mine. For many days this piece of electrical apparatus was held under suspicion, but in spite of the efforts of many of the witnesses to fasten

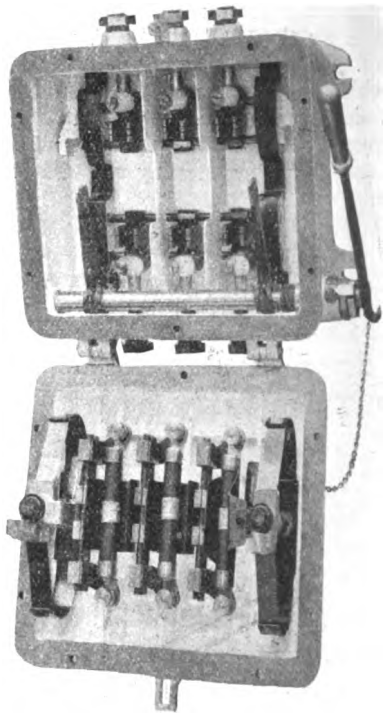


FIG. 1.

upon it the blame for the accident, it was subsequently proved that the switch had operated satisfactorily and was in no way responsible for the disaster. This fact has served to ventilate the subject of electrical control gear for mining circuits. It has brought out into the open the majority of the makers of electrical apparatus who have done their utmost to refute the statement made against their manufactures as a whole,

FIG. 2.

In this particular connection it is of interest to note that the fool-proof fused switchgear of Messrs. Berry, Skinner & Co. has been developed upon lines affording the maximum of safety to the operator in so far as shock is concerned, and almost complete immunity from fire risk due to external or internal sparking. The Berry fused switch has been before the electrical industry for many years, and is well known as an efficient and satisfactory circuit-controlling device. It has been installed to work under almost every conceivable condition and in situations

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where it is subjected to the attacks of damp or has to resist the effect of fiery or gaseous atmospheres, the latter particularly in chemical works and textile mills. It has also passed the severe tests imposed by the Admiralty and is in use for the control of important circuits on battleships and also on vessels of the mercantile marine.

For colliery and mining service the Berry fused switch goes under the trade name of "Firimine," and we reproduce general views of this in Figs. 1 and 2. These views show a triple-pole switch having a capacity of 100 amperes per way. This switch is suitable for circuit pressures up to 600. The fixed and moving contacts are contained in a substantial cast-iron case. The fixed contacts are of the spring clip adjustable type and are carried in substantial castings which are clipped to mica-insulated steel bars suitably supported at the base of the box. This class of insulation is both fire and damp-proof and has been

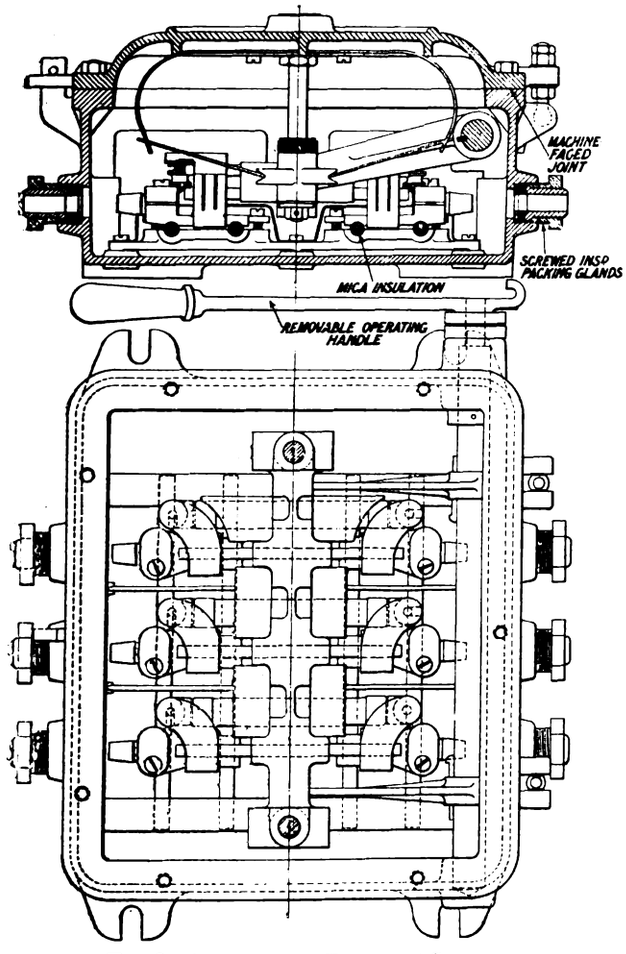

FIG. 3.—DETAILS OF "FIRIMINE" SWITCH.

found to give satisfaction over long periods under severe service conditions. The fixed contacts are separated by uralite partitions. The moving contacts are attached to a carrier which is fitted to guides passing through the lid of the box. Attached to the ends of these guides are flat bow springs with adjustable end pieces. These ensure a quick make and break for the switch. The moving parts are of the solid type and, as in the case of the fixed contacts, mica and steel insulation is employed. The contact blocks are bridged by enclosed non-arcing fuses held in position by milled nuts. This is the standard "Berry" construction.

Special attention has been paid in this switch to the glands for the incoming and outgoing cables, and the switch spindle which comes through to the outside of the box. These glands can all be satisfactorily packed so as to exclude moisture and also the entrance of explosive gas. The joint between the lid and the box has a wide machined surface and 7/8 in. bolts secure these in close contact.

We understand that some tests were recently carried out with this switch at the Armstrong College, Newcastle, due to the courtesy of Dr. Thornton. The interior of the box was filled with a highly explosive mixture, and this was fired by an internal high-tension spark. Although the explosion was severe there was no sign of escaping flame either round the joint between the lid and the box or from the various glands.

The switch is actuated by two swing levers which are securely attached to the operating spindle and engage at their free

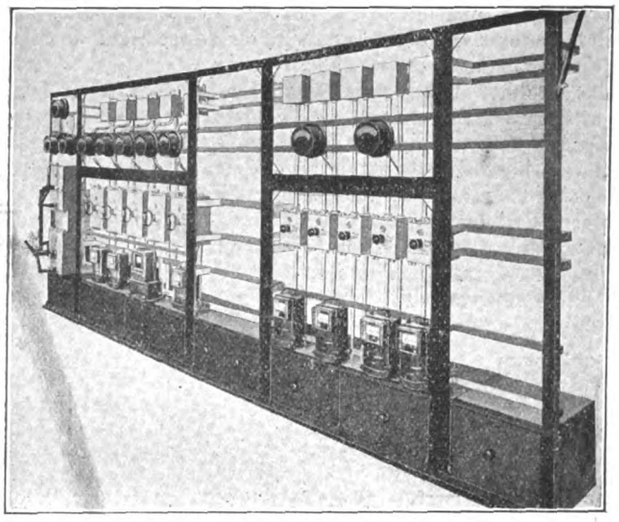

FIG. 4.—TOTALLY ENCLOSED IRONCLAD SWITCHGEAR FOR MINES.

ends with slots in the main carrier. The standard Berry box cover arrangement is included whereby it is impossible to open the lid of the switch when the circuit is made. It is only after the circuit has been broken that the switch can be opened. Fig. 3 is a line drawing showing the general structural details of this switch, and we are sure that it will be of general interest to mining electrical engineers.

Messrs. Berry, Skinner & Co. also make a speciality of totally enclosed ironclad switchgear for the control of low-tension sub-circuits in mines. Illustrations of this are given in Figs.

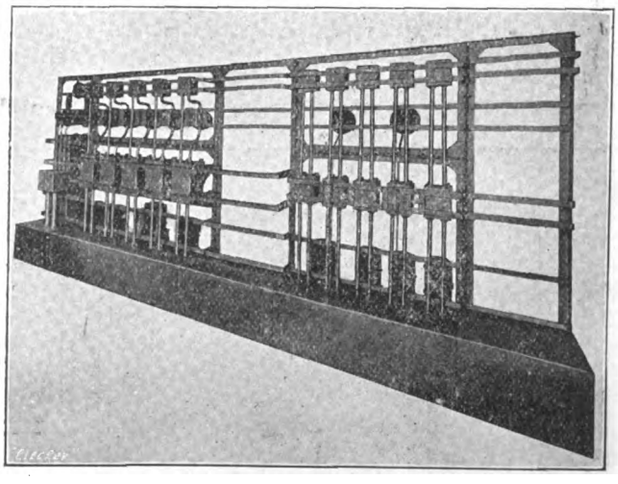

FIG. 5.—BACK VIEW OF TOTALLY ENCLOSED SWITCHGEAR.

4 and 5. It will be noticed that the framework of the board is of angle iron and that the various switches, instruments and meters are bolted up to iron bars at the back of the frame. All the connecting cables are enclosed in steel conduit, which is screwed into the cases forming various portions of the gear. There are no live connections exposed at any point. The connecting cables enter at the top of the board and the 'bus bars are placed in the chamber which will be noticed at the foot. This type of gear is being rapidly developed for use in collieries.

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Automatic Pressure Regulator for A.C. and D.C. Circuits.

An interesting apparatus which should be specially useful in mining work is the Brown Boveri pressure regulator, which we illustrate herewith. The principle employed in the construction of this regulator is as follows: The variations in the pressure of the machine to which the regulator is connected are utilised to disturb the equilibrium of a light pivoted armature, which is acted upon by an electromagnet connected across the machine circuit, and the strength of whose field is consequently dependent upon the pressure of this circuit. The torque exerted by the armature with a certain definite field strength is counterbalanced by a spring, so that the armature turns in one or the other direction immediately the pressure, and the field strength corresponding to it, varies from a certain predetermined value. This movement is utilised to vary an adjustable resistance having frictionless contacts in the field

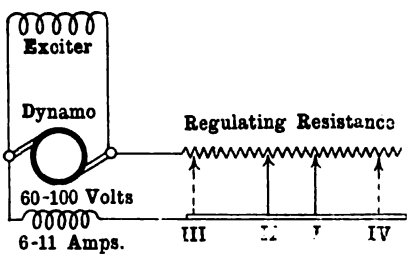

FIG. 1.—DIAGRAM ILLUSTRATING ACTION OF THE REGULATOR UPON CHANGE OF LOAD.

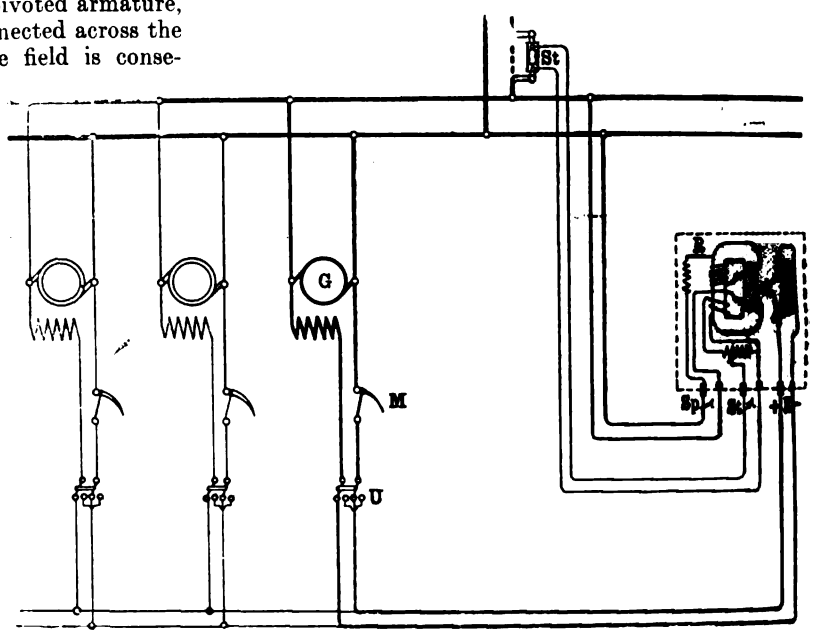

FIG. 3.—DIAGRAM OF CONNECTIONS FOR SELF-EXCITING D.C. GENERATORS.

circuit of the exciter or (for the case of a direct-current machine) in the exciting circuit of the generator, thus regulating the pressure up or down to the required constant value. A damping arrangement is provided, but in order that the retarding effect of the electromagnetic inertia of the field circuit may be as far as possible eliminated, the moving parts of the regulator (which are made as light as possible) are not connected rigidly

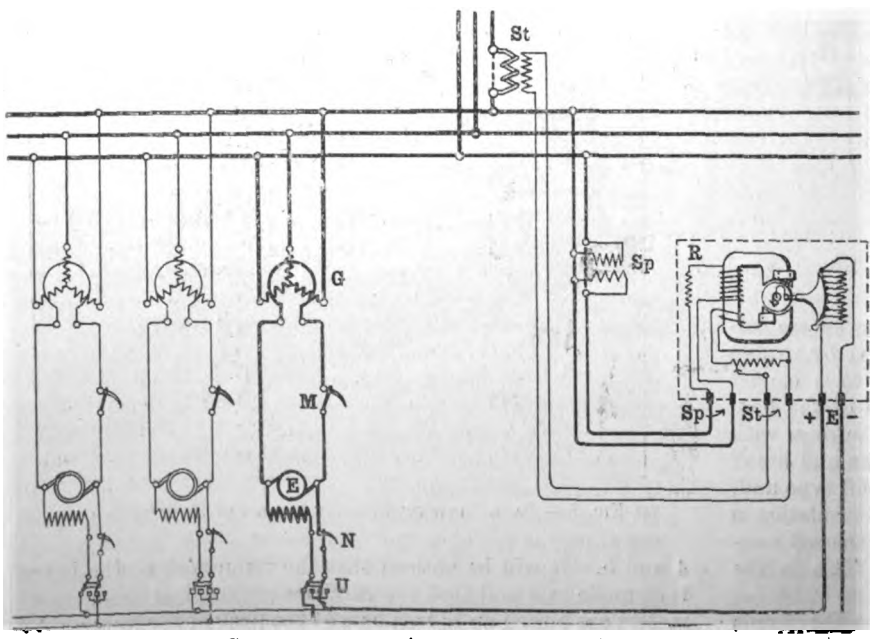

FIG. 2.—DIAGRAM OF CONNECTIONS FOR ALTERNATORS WITH DIRECT-COUPLED EXCITERS.

to the damping system, but are coupled to the latter by a spring. This permits the armature to carry the sectors ahead of the required new position at the moment the generator pressure changes, after which it quickly adjusts itself in such a manner that the field current is brought to the correct value corresponding to the load. These regulators are built in two different patterns—namely, for alternating current (single or polyphase) and for direct current.

The regulator for alternating current consists of a "shaded pole" electromagnet (Fig. 4) which acts upon a cylindrical armature, the latter being pivotted in jewelled bearings. The electromagnet is wound with a fine wire winding, which is connected in series with an external resistance to a pressure transformer. This transformer is placed across the mains; if it is desired to over-compound the generator the electromagnet is provided with an additional winding of thicker wire, which is connected to the secondary of a current transformer, the primary of which is in series with the generator or with the 'bus bars, as the case may be. The magnetic field produced by the electromagnet is dependent upon the pressure on the circuit, and for a definite value of pressure a certain definite torque is, in consequence, produced on the moving system, due to the electromagnetic action between this magnetic field and the armature. This torque is opposed by a flat spiral spring, and as the tension of the latter is dependent upon the extent to which it is wound up, an additional spring is provided, so adjusted that the resisting torque has a constant value for any position of the armature.

The cylindrical armature is made of aluminium for the purpose of reducing its weight and inertia to a minimum, and because of this and because of the lightness of the other moving parts below referred to, the armature immediately follows every variation in the pressure, so that the regulation is carried out almost instantaneously.

The movements of the armature brought about by the pressure variations in the circuit are communicated to a frictionless contact system, consisting of the sectors which *roll* over the contacts, thereby inserting more or less resistance into the field circuit of the exciter. As the exciter field resistances are in series, and the two sectors work together, the amount of movement required to insert or take out a given resistance is reduced by one-half. In order to reduce the amount of friction to a minimum the pivots of the contact sectors are so arranged

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that the pressures of the springs which carry the jewels neutralise one another, so that in reality the whole contact system is practically frictionless.

With alterations of pressure the spring-controlled armature naturally possesses a tendency to oscillate about the required new position, and in order to prevent these oscillations and yet to allow the armature to carry the sectors momentarily ahead of the required new position a special system of damping is provided, consisting of an aluminium disc, arranged to rotate between the poles of permanent magnets. This disc is driven from the armature by means of a pinion and sector, and a special feature of the damping arrangements is that the connection between the armature and the sector is a flexible one—that is, the sector is mounted upon a sleeve which is coupled to the armature by a flat spiral spring. When the moving parts are in a condition of equilibrium this spring is not in tension, but as soon as the pressure on the circuits alters then, according to the magnitude and direction of the alteration, the spring pulls in one or the other direction according to the direction of movement of the armature, and in this way carries the sector with it. It follows that just at the moment the pressure variation takes place the damping is not operative, thus allowing the armature to carry the regulation farther than is actually required, but almost immediately afterwards the sector follows up the movement of the armature, thus causing the suppression of the oscillatory movements which would otherwise take place.

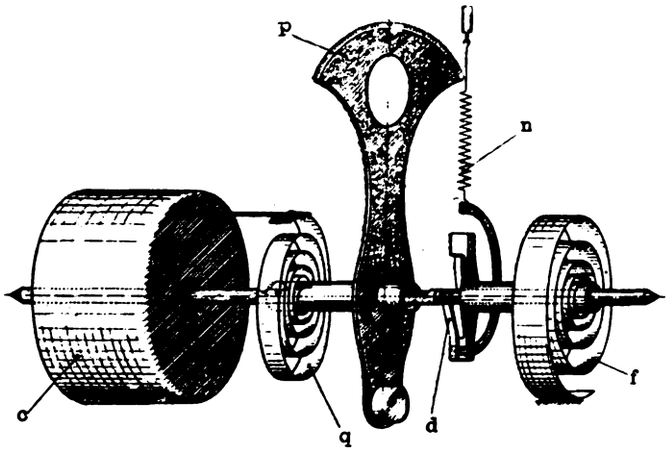

FIG. 4.—DIAGRAM OF MOVEMENT IN BROWN-BOVERI REGULATOR.

This exceedingly valuable feature of the design may be perhaps better understood from the following example. Fig. 1 represents diagrammatically the excitation circuit of the alternator and exciter. Suppose that at no-load the regulator is at the position marked I corresponding to an exciter field current of, say, 6 amperes at 60 volts; at the full load and normal pressure of the alternator the exciter field current has to be increased to 11 amperes at 100 volts and for this the regulator has to be at position II. When the entire load is suddenly thrown on the generator the exciter field current is brought by the regulator to a higher value than that corresponding to full-load by the quick short-circuiting of the resistance, the regulator momentarily taking up the position III. It is necessary for the regulator to take up this latter position at the first moment, because, owing to the self-induction of the exciting circuit and the inertia of the turbine or engine governor, it is necessary to increase the exciter pressure (by cutting out the whole of the resistance) by an amount which more than corresponds to the actual requirements when the steady state has been reached. But immediately afterwards, as the pressure of the generator increases, resistance is automatically and successively inserted into the exciter field circuit until the regulator takes up the correct position II., at which point the period of regulation is at an end. In a similar manner when the whole load is suddenly thrown off the alternator the regulator first takes up the position IV., thus throwing the whole of the resistance into the exciter field circuit, after which it goes back to the correct position I. In each case the effective damping enables the regulator to move into the final position steadily and without oscillation. Such a regulator can also be used for over compounding the machine if desired by providing the shaded pole electromagnet with an additional winding as mentioned above. Fig. 2 shows a diagram of connections for alternators with direct-coupled exciters. With the help of the switches V the regulator can be made to control any one of the machines or one regulator can be arranged to control two or more machines in parallel.

In the direct-current regulator the driving system consists of a wound armature which moves between the poles of a magnet. This magnet is provided with two windings, one of which is in series with the winding of the armature and with the fixed external resistance across the circuit; while the other is provided with an adjustable shunt, and is traversed by a current proportional to the load current. The electromagnetic torque between the armature and the magnetic field is balanced by the resisting torque of a flat spiral spring, and the movement is communicated to contact sectors and a damping sector exactly as in the alternating current case. But it is unnecessary in this case to provide an auxiliary spring to compensate the increase in torque of the spiral spring, as the latter becomes wound up, because the electromagnetic system of the regulator is so designed that the torque on the armature increases by the correct amount, as the angle through which it turns increases. The connections for the direct current regulator are shown in Fig. 3, the current transformer used for the over-compounding winding in the alternating current case being replaced by a shunt *St* in the main circuit.

Liquid Starters and Controllers.

It is usually the opinion of those who have knowledge at all of liquid starters and controllers that such appliances are dirty, bulky and require a great deal of attention, whereas, in properly designed apparatus, the exact opposite is the case. A striking point which will commend itself immediately to users of electric motors is the *smooth* and *even acceleration* obtained by employing liquid starters and controllers. In any other type of starter this essential feature is not found, since a metallic starter has a number of contacts, there are bound to be slight jumps as the resistance is cut out, and therefore slight irregularity in "torque." Another point which is well worth considering, and which is beneficial to the motors and the driven machinery, is the absence of jerks. Furthermore, the upkeep of a liquid starter or controller is practically infinitesimal, as there are no arcing contacts to replace or resistances to burn out. All that is necessary is the occasional supply of clean water when the correct strength of electrolyte has been ascertained. An illustration of switch is given herewith.

This solution is usually made up of a saturated solution of common washing soda, mixed with ½ oz. to the gallon of caustic potash, diluted down to the correct strength, depending upon the function of the motor. A sufficiently near strength for average starting conditions is one part of saturated solution to six parts of pure water; but the exact strength is best determined by actual trial. The solution is correct if a slight sparking is noticeable when the blades come in contact with the liquid, and there is no appreciable sparking at the short-circuit switch.

The most essential feature in the design and manufacture of liquid starters and resistances to secure the best results is the low current-density of all current carrying parts. This should not exceed 20 amperes per square inch of sectional area. Messrs. Tetley inform us that they have tested and seen in use starters calculated at considerably over 100 amperes per square

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inch density, especially in the blade. Such parts consequently require renewing very quickly, owing to the electrolytic action and burning. Other salient points which should be borne in mind in the design of such starters are simplicity and strength in construction, reliability in operation, safety in manipulation, the provision of slow motion gear as a protective device against starting up too quickly, and automatic features for tripping the blades out of solution.

First cost is a serious item when installing electric plant, and therefore it is necessary to keep expenses down to a minimum in units of 50 H.P. and over; therefore the liquid starter is an item which should receive attention. Below are given a few comparisons between starters of metallic and of liquid types for use with three-phase slip-ring motors.

The price of a 100 B.H.P. three-phase liquid motor starter of capacity up to 150 amperes per phase and enclosed, with a

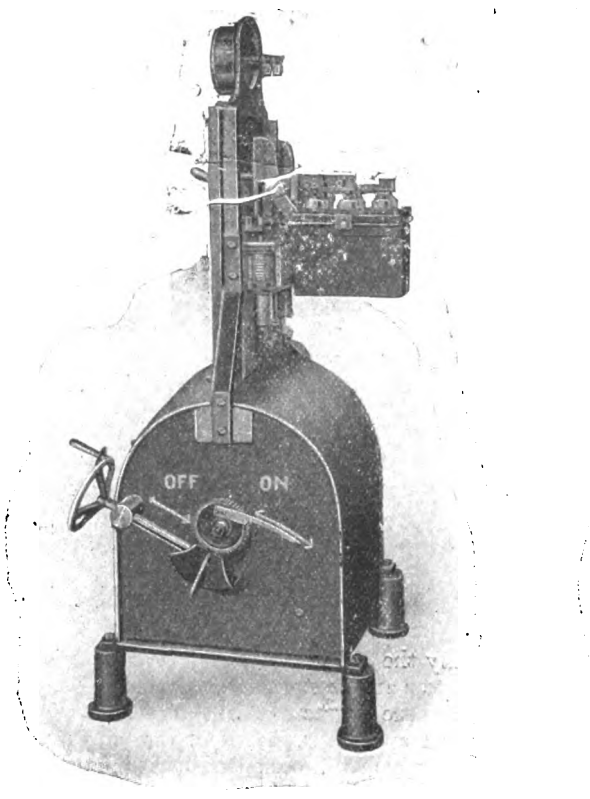

FIG. 1.—TETLEY'S LIQUID STARTER.

maximum rotor voltage of 800, is £10. 15s. A metallic starter costs £20 for 150 amperes, £25 for 200 amperes and £34 for 300 amperes, the price in the two latter cases for a liquid starter being £15.

The construction of a direct-current liquid starter consists of either one or two iron tanks, insulated with porcelain or other suitable material from a substantial iron frame, which holds the resistance liquid, and two electrodes. These latter are slowly lowered or raised from their respective tanks by means of a hand wheel actuated by a worm and wheel. For three-phase starters three tanks and three blades are, of course, required.

The blades are usually insulated from the shaft by porcelain or vulcanite. In the latter case they are painted over with an acid-resisting varnish. The method of securing the blades to the shafts is by the use of a split boss, which is held together by four bolts. *If* it is necessary to renew any of the blades it is only the operation of a few minutes to insert a new one.

Particularly attention is called to the peculiar shape of the blades, which has been decided upon after great experience and a large number of experiments in this direction, the result being that a graduated and a more even passage of current is obtained; consequently the torque of the motors is more constant, owing to the action of this peculiar shaped blade in place of the angular electrode, which, after first making contact, presents too great an area to the electrolyte, and consequently there is too sudden a rush of current to the motor, instead of an evenly increasing flow. The tanks are also tapered to further "balance" the resistance, the idea of which is obvious.

For direct-current work the starter is connected in series with the armature, and in the case of compound or shunt wound motors a resistance switch and discharge resistance is arranged for to take up the field discharge. In the case of polyphase slip-ring motors the starter is connected in the rotor circuit only, and when all resistance is cut out it forms the neutral point of the rotor circuit. It is also usual to fix on the blade a short-circuit switch, so that current will not pass through the liquid (when the motor is running at synchronous speed.) This saves any heating of the liquid and minimising evaporation.

Starters are also fitted with automatic cut-out arrangements, so that if the current fails the blades are automatically tripped from the electrolyte, making the starters practically fool-proof. This arrangement is especially adaptable for textile mills and mines, where the motors and starting gear are remote from the generating station.

The mining starters made by Messrs. Tetley are totally enclosed, and all the flanges are machined and are of broad design. A special outlet is provided for the escape of gases

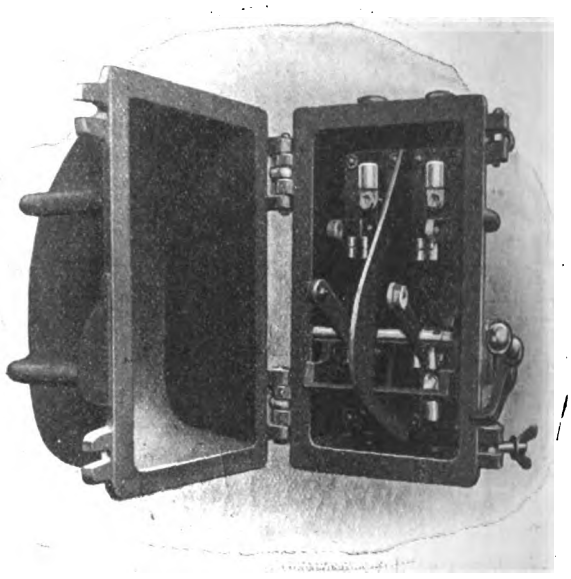

FIG. 2.—TETLEY'S IRONCLAD KNIFE SWITCH.

generated during operation. The circuit is never broken, so that risk of flame is eliminated. In the case of the main rotor switch being connected, this would be oil-immersed and interlocked with the starter or controller by means of a simple brush device, so that the starter cannot be opened unless the switch is in the "on" position, thus doubly protecting the motor and making the starter, it is claimed, "fool-proof."

In the case of large controllers it is necessary to cool the liquid during the operation. This is done by an arrangement of coils in the tanks, through which a constant flow of cold water is pumped or syphoned, the amount approximately being 3 gallons per hour per horse-power controlled. This keeps the temperature as far as possible between 70°C. and 80°C.

In case of an auto-starter it is operated through a slow-speed worm and wheel or ratchet. The worm is always out of gear unless in operation, thereby leaving a free movement to the shaft carrying the blades. All the electrodes are balanced by a suitable weight, and are arranged in such a position that the tendency is to bring the electrodes to the "off" or neutral position, the usual method in adoption for the trips. For large motors, liquid controllers, Messrs. Tetley consider, have a great advantage over the iron type, and they would be more universally adopted by mining engineers if this class of gear was fully appreciated. We are obliged for the above information to Mr. T. R. H. Tetley, of Leeds.

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Ellison's Switchgear.

Among mining electrical engineers Ellison's switchgear has a reputation for sound construction combined with reliability and efficiency. The firm has given special attention to the requirements of colliery mining work by designing and placing on the market starting gear as far as possible mistake proof, thereby limiting the risk of accident. A few Ellison specialities are briefly described below.

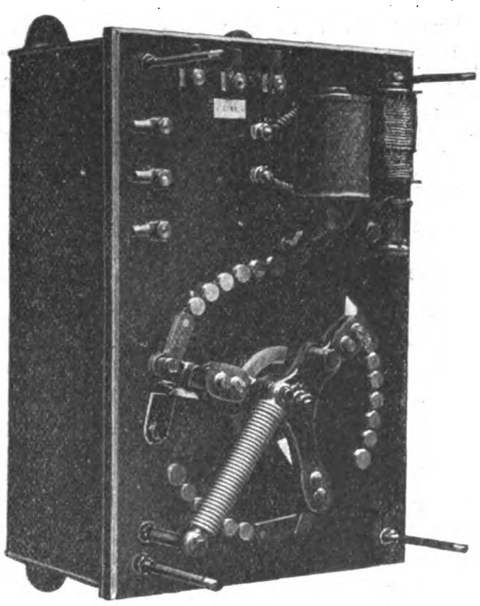

FIG. 1. – THREE-PHASE STARTER WITH OVERLOAD AND NO-VOLTAGE RELEASES.

Fig. 1 shows a rheostatic starter fitted with overload and no-voltage releases for a three-phase squirrel-cage alternating-current motor. These starters are fitted with totally-enclosed covers, glass inspection window, and as they control the three phases of the circuit a separate switch and fuse or circuit-breaker is not required. This type of starter is eminently suitable for colliery surface work.

Fig. 2 shows a totally-enclosed triple-pole air-break circuit-breaker fitted with two overload and one no-voltage releases.

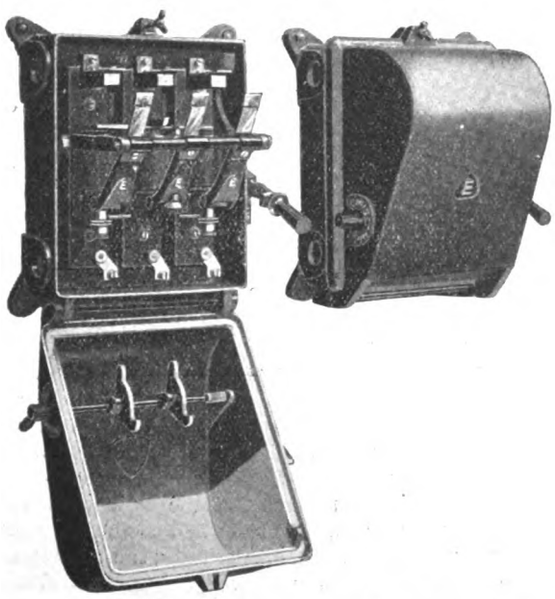

FIG. 2.—TOTALLY ENCLOSED TRIPLE-POLE AIR BREAK CIRCUIT-BREAKER.

This also is designed for surface work. The totally-enclosed overload and no-volt release oil-immersed star delta starter illustrated in Fig. 3 is fitted with patent "Gradatim" safety device. This device prevents the operator putting the starter handle in the running position unless he has first put it at the starting side and held it there a certain length of time to enable the motor to get up speed. As will be seen from the illustration, an ammeter

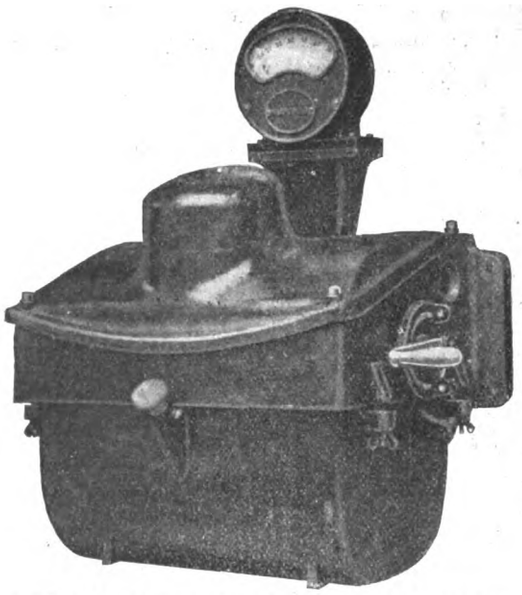

FIG. 3.—TOTALLY-ENCLOSED OIL-IMMERSED STARTER, FITTED WITH "GRADATIM" SAFETY DEVICE.

and bracket can be fixed and also adjustable time lags, if desired. This gear is suitable for installation either above or below the surface. Fig. 4 shows a standard mining panel consisting of a triple-pole totally-enclosed oil-immersed circuit-breaker, fitted with two overload and one no-voltage releases, ammeter and

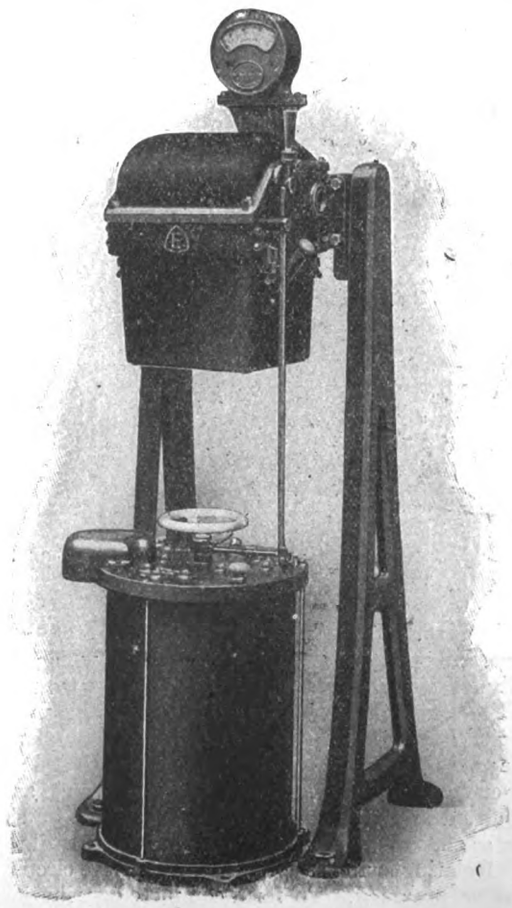

FIG. 4.—STANDARD MINING PANEL.

bracket, mechanically interlocked with a totally-enclosed oil-immersed rheostatic starter. An order has recently been completed by Messrs. Ellisons for 52 of these mining panels.

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Protected Switchgear for Mines.

In the Report of the Departmental Committee appointed to consider the working of the existing special rules for the use of electricity in mines, considerable stress is laid upon the protection of switchgear from coal dust, and a recommendation is made that the gear should be enclosed. This gear is evidently to be used in situations where there is no danger of gas and where gastight apparatus would not be necessary.

We illustrate herewith a 50 H.P. continuous-current motor control pillar (Fig. 1) which has been specially designed by Messrs. Engineering Instruments, of Skerne Works, Darlington, to comply with these conditions. This particular pillar provides, it is claimed, complete control of the motor, and is fitted with main switch, fuses, ammeter, heavy duty pattern starter and shunt regulator.

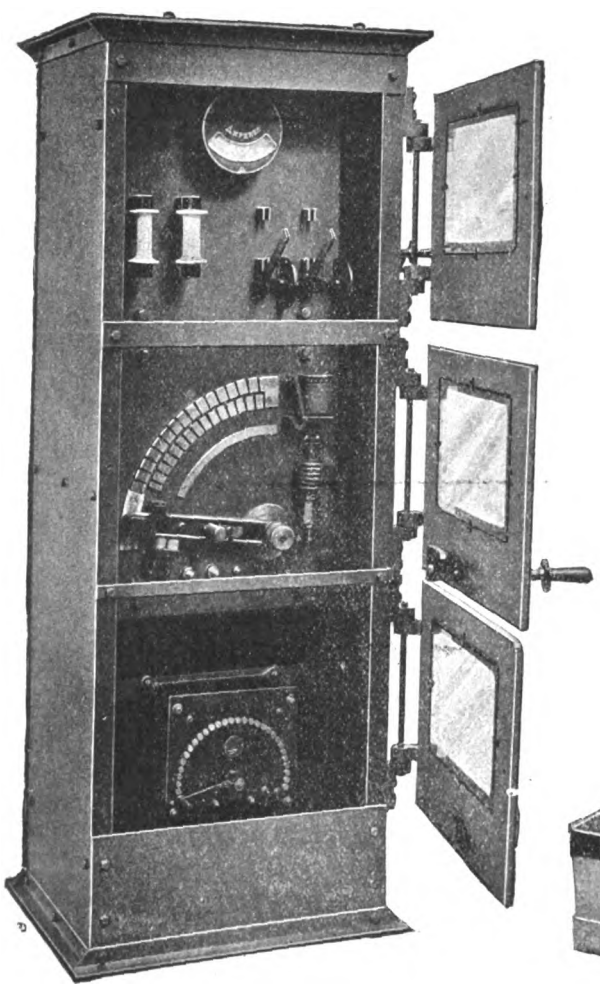

FIG. 1.—50 H.P. DIRECT CURRENT MOTOR CONTROL PILLAR.

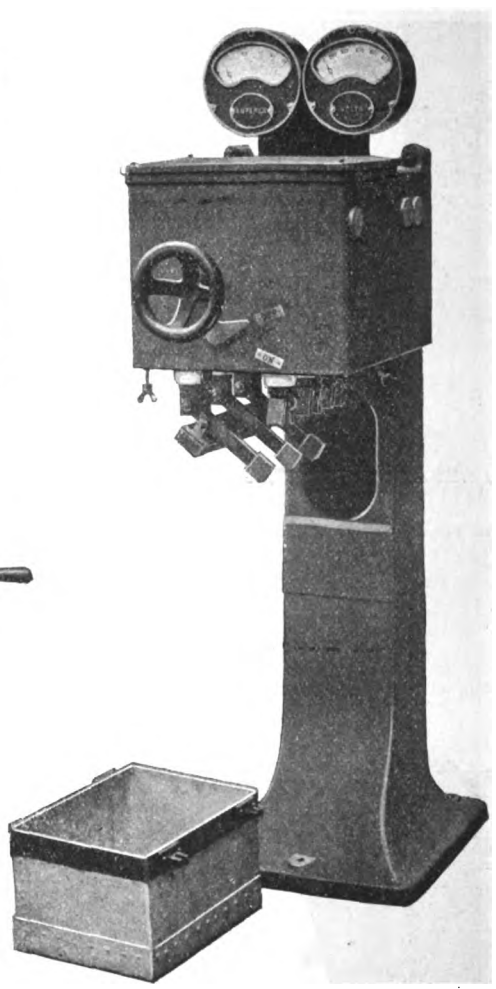

FIG. 2.—THREE-PHASE OIL-IMMERSED MOTOR CONTROL PILLAR.

We also give an illustration of a three-phase totally-enclosed oil-immersed motor control pillar (Fig. 2), which has been specially designed and can be supplied to comply with the special rules. The three-phase oil circuit breaker on this pillar can be fitted with a loose handle no-volt release and overload release in three phases with a time limit, all the trip coils and gear being totally enclosed in the switch casing. Instruments as required can be fitted and an interlock can be provided on the circuit breaker so that the oil tank cannot be removed until the switch is off. Isolating switches interlocked with the circuit breaker can also be provided. To form complete distribution boards the pillars are arranged for bolting together and a 'bus bar chamber is then provided at the back. Trifucating boxes with armour clamping rings are also fitted for the incoming and outgoing cables when required.

Thames Automatic Tumbler Switches.

The Thames Iron Works, Shipbuilding & Engineering Co., have put on the market a special type of switch, known as their "Snap" pattern, having a quick make and quick break action and double contacts. The whole of the working parts are made from hard phosphor bronze and the contact springs of special bronze. The standard design of single, two and three-pole switches are fitted in either brass or cast-iron boxes: the single-pole having a pull and push operating spindle, and the double and triple-pole a turn movement with an exterior lever.

For ordinary voltages up to 250, this switch has, we are informed, a break of such length and speed as to be quite as satisfactory as an open switch, but for high voltages the cases are sealed and partly filled with oil, so that the break is effectively protected by this means. For mine work and for currents up to 10 amperes this little switch is admirably suited, as it is neat and compact and has no flimsy springs or parts to get out of order.

To meet the demand for small automatic circuit breakers, and with a view to offering to the trade something which can be relied upon to open an electric circuit immediately an overload occurs, the Thames Ironworks Shipbuilding & Engineering Co. are now placing on the market what is claimed to be the smallest circuit breaker extant. This they consider should be of great use in places where at present fuses are exclusively used owing to the small currents to be dealt with.

It is a well-known fact that some of the recent disastrous shop fires, such as that which occurred at Brixton, were attributed to the fusing of flexible wires, and as the safety of all electric circuits depends entirely upon an open fuse, which can be tampered with or increased in size by almost anyone, it will be seen at a glance that an automatic switch which operates at the predetermined current for which it is permanently calibrated free of any time element, is a step in advance of any other protecting device. These switches are manufactured under Denny's patents, and we illustrate in the accompanying figures two types of this apparatus.

Fig. 1 shows the switch in section, the magnet being protected by a porcelain covering, and Fig. 2 shows an outside view of the switch with its porcelain covering; the latter type is more suitable for distribution boards and conduit boxes. The object of these switches is to provide a reliable automatic switch for small powers up to 5 amperes and suitable for voltages up to 500. To a large extent these switches replace the ordinary small porcelain bridge-fuses and cut-outs for lighting and small power circuits, and, incidentally, the trouble and inconvenience of replacing blown fuses.

These switches are also admirably adapted for controlling lights either from a distribution board or from separate points. In the former case the distribution board can be fitted with double-pole auto tumblers, or single-pole auto tumblers and single-pole fuses, the fuses being rated about 50 per cent.

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above the current necessary to trip the switches. In either case the size of the distribution board is considerably reduced and greater efficiency results; should the switches be used at different points in a building a small distribution board is used containing auto tumblers or fuses as the case may be.

In size and appearance the switches are very similar to the ordinary tumbler switch, and are self-contained. They include

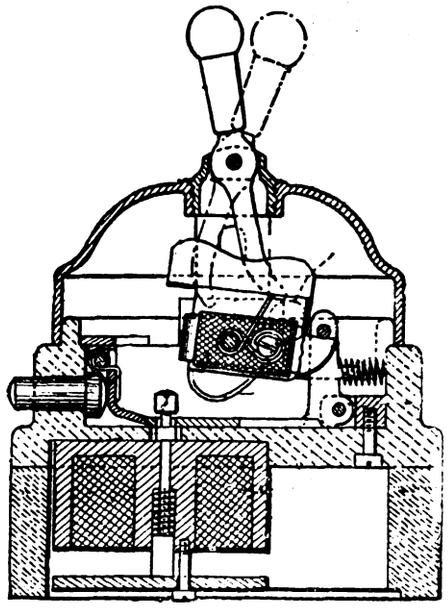

FIG. 1.—SECTION OF DENNY'S AUTOMATIC TUMPLER SWITCH.

a special type of electric magnet, the winding of which is in series with the switch. The armature of the magnet is in direct mechanical connection with a tripping lever, which in turn retains the switch circuit closed in the "on" position. Should an overload occur the armature is attracted by the magnet, and the tripping lever thereby operated, thus releasing the

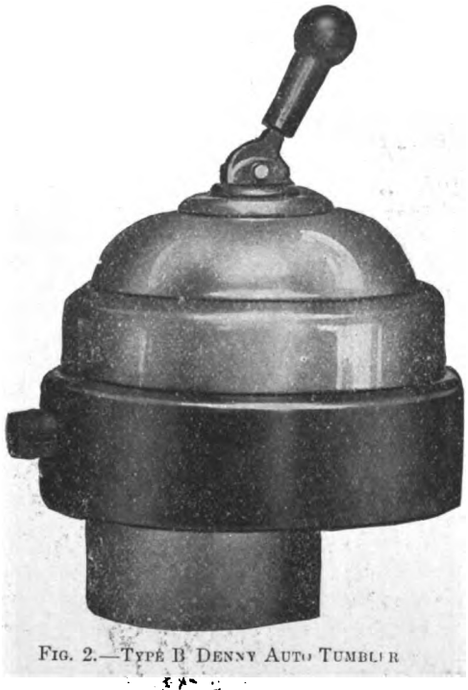

FIG. 2.—TYPE B DENNY AUTO TUMBLER

switch which opens instantaneously, as it has no time element like a fuse. The operating lever is not fixed in any way to the switch parts, so it is therefore impossible to close the switch on a short circuit. To release the switch by hand a push button is provided at the bottom of the switch, which, on being depressed, operates the tripping lever, giving a quick break to the switch independent of the operator.

The use of these switches on high voltage installations, such as electric railways, mines and tramways, should prove economical, as the outlay on cartridge fuses for replacements on these circuits is generally very heavy. The auto switches are also quite suitable and reliable for use as limit switches on a flat rate system of lighting, and can be supplied in various designs and finishes.

"Victoria" Turbo-Pumps.

A comparison between a catalogue of "Victoria" turbo-pumps, issued by Messrs. Jens Orten-Böving & Co. about July, 1909, and one issued by the same firm about 14 months later, makes an interesting study. The first forms, as it were, a "book of prophecy," while the new list just issued, though based on the old, is full of illustrations in the nature of concrete fulfilments of promises.

In the matter of turbo-pumps especially a comparison between guarantees and performance is always exceedingly interesting. The failures of such pumps in the past, especially those for which a high efficiency has been claimed, not only to come up to their guarantees but also to work with any degree of reliability has given rise to a very serious mistrust in the minds of mine managers for whom reliability is a *sine qua non*. Turbo pumps to deal satisfactorily with water under a high head have been very hard to obtain. As a proof of this state-

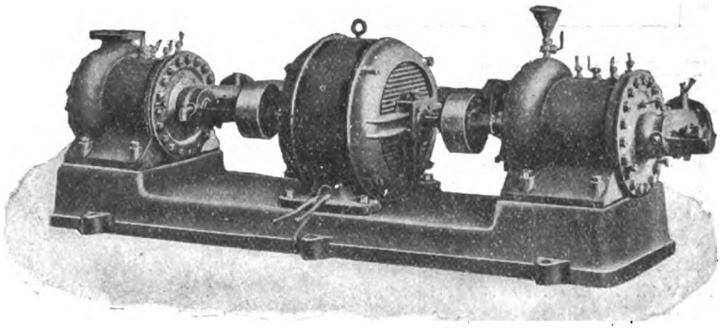

FIG. 1.—TURBO-PUMP SUPPLIED TO THE EAST INDIAN RAILWAY.

ment one need only instance the strong prejudice against turbo-pumps to be found amongst Cornish mine managers, and it is safe to say that hitherto the majority of the orders have been placed on the Continent; at any rate there is no doubt that in cases where price has not been a serious consideration the most notable orders have been placed abroad.

Messrs. Böving & Co.'s new list opens with an illustration of a pump delivered to the Lady Durham Pit of the Lambton Collieries (Fig. 2). Incidentally this was the first order which they obtained in England, and the fact that they were able to secure this order in competition with a well-known Continental firm, is a proof of the confidence which a close study of their designs inspires. The pump delivers 2,900 gals. per min. against a head of 315 ft. when running at 1,170 revs. per min., and although the order was obtained on a guaranteed efficiency of 78 per cent., the actual efficiency obtained on official tests after three months' running reached the remarkable figure of 86 per cent.

The main feature of this pump is that the end thrust is automatically balanced by a simple means which has proved itself during 15 months' work to be absolutely reliable. The secret of the high efficiency lies, of course, primarily in the design of the impellers and guide wheels and casing, which is the outcome of a careful study of the ways of water under pressure as seen in pumps and water turbines; full advantage of this knowledge is taken by the employment of bronze for impellers and guide wheels, as by means of the use of this metal a much smoother surface is secured and consequently a much

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higher efficiency is obtained owing to the reduced skin friction, and, moreover, this high efficiency is not only obtained but maintained, as the surfaces do not become pitted. The secret of the reliability of the high pressure "Victoria" pumps, in which the pressure is not equalised by double inlets, lies, Messrs. Böving inform us, in the absence of pressure stuffing boxes and thrust bearings. This absence is possible owing to the method of balancing the thrust. There are in this way no bearings to get out of order and no glands which require frequent tightening, which tightening it is well known often results in the cutting through of a large proportion of the pump shaft.

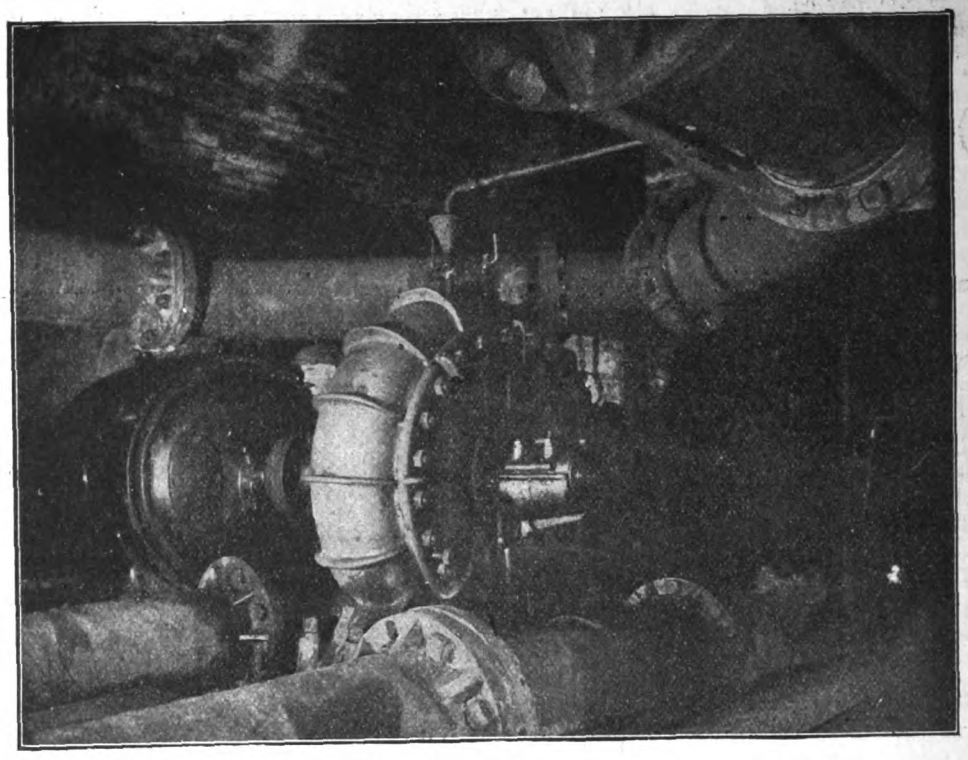

FIG. 2.—PUMP SUPPLIED FOR THE LADY DURHAM PIT, LAMBTON COLLIERIES, TO DELIVER 2,900 GALLONS PER MINUTE AGAINST 315 FT. HEAD AT 1,170 REVS. PER MIN. EFFICIENCY, 86 PER CENT.

Another interesting "Victoria" Pump which has been installed by Messrs. Böving & Co. is one for the Lothian Coal Co. (Fig. 3). It is a well-known axiom for turbo pumps that at a given head the larger the quantity of water delivered the higher the efficiency. The pump referred to is placed at a point 255 ft. below the surface, at which point there is a flow of 680 galls. per min. In the same shaft there is a flow of 150 galls. per min. at a level 155 ft. below the surface. The water at the higher level is collected and passed through the pump 100 ft. below, and is then raised by its own pressure to its own level, and thence raised to the surface by the one pump working at an efficiency of 74 per cent., whereas, if a separate pump were installed at the higher level, the efficiency of this pump dealing with such a small quantity as 150 galls. per min. would be approximately only 65 per cent.

The pump in Fig. 1, which was supplied to the East Indian Railways is another example of solving a difficulty which is frequently met with in cases where it is otherwise desired to employ a centrifugal pump. The difficulty referred to is that of dealing with a small quantity of water against a high head with an economically efficient consumption of power. In the present case, to lift 200 galls. a minute against a head of 535 ft., twelve stages are required, but to supply a shaft of such small dimensions so as not to interfere with the efficient design of the impellers would entail very serious risks from breakage at a critical speed, and even if it did not break the shaft would be "whippy" and cause serious wear. To obviate this, two separate six-stage pumps are installed on either side of the motor, that on the suction side delivering at half pressure and that on the delivery side at full pressure. The efficiency of the pumps so installed is exceptionally high for such conditions, namely, 70 per cent.

A repeat order has just been received from the East Indian Railway for a second pump for the same duties, the first supplied having given every satisfaction. The list also contains

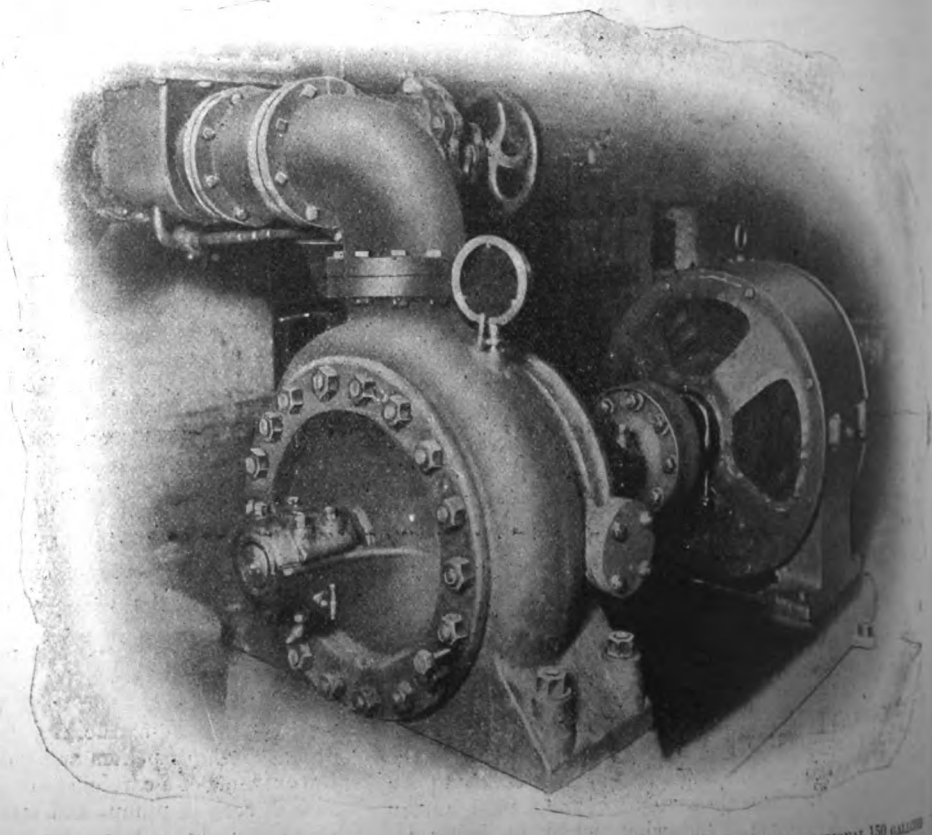

FIG. 3.—PUMP TO DELIVER 680 GALLONS PER MINUTE AGAINST 255 FT. HEAD, AND AN ADDITIONAL 150 GALLONS PER MINUTE BROUGHT DOWN FROM THE 155 FT. LEVEL AND PASSED THROUGH THE PUMP. SUPPLIED TO THE LOTHIAN COAL CO.

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illustrations of a pumping plant for the City of Toronto (Fig. 4), which consists of four pumps to deliver 9,800 galls. per min. against 250 ft. head and four to deliver 7,000 galls. per min. against 100 ft. head.

A further use for centrifugal pumps for mining purposes is their employment for hydraulicing, and Messrs. Böving & Co. are now supplying a large single-stage Victoria pump to the

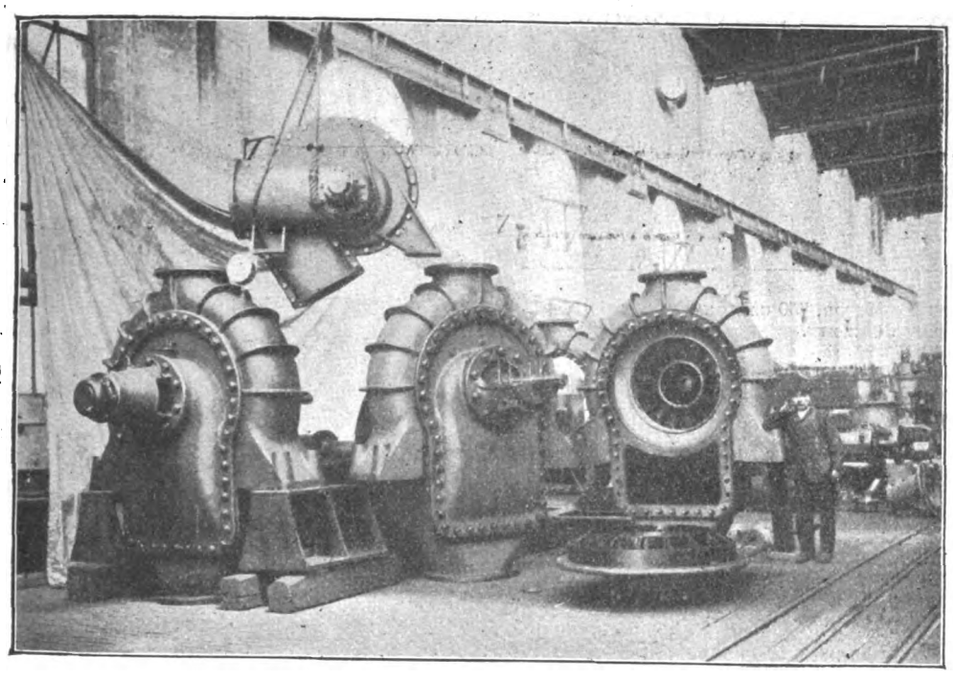

FIG. 4.—PUMPS FOR TORONTO CITY, FOUR TO DELIVER 9,800 GALLONS PER MINUTE AGAINST 250 FT., FOUR TO DELIVER 7,000 GALLONS PER MINUTE AGAINST 100 FT.

Nipissing Mining Co., Canada, to deliver 4,800 galls. per min. at a pressure equal to a head of 415 ft. And in view of the fact that water power is now being much more widely used in generating power in mines, it is interesting to note that this firm have orders in hand or under erection totalling some 120,000 H.P., including six turbines of a capacity of 1,500 H.P. each for the Waihi Gold Mining Co. Being interested in water power, Messrs. Böving & Co. are in a very favourable position to deal with the problems met with in arranging pipe systems in mines, and they have recently put on the market a patented double muff joint, which makes it possible to employ pipes of the same diameter throughout without sockets or flanges and naturally exceedingly simple to erect, while at the same time acting as expansion joints. A large contract for 7½ miles piping fitted with these double muff joints is just being shipped to Mexico, and six of seven complete lines have been shipped to mines on the West Coast of Africa and New Zealand, among other countries. From the above notes it will therefore be gathered that during the period between the issue of the two catalogues referred to in the opening paragraph great practical progress has been made by Messrs. Böving.

B.E.P. Pumps.

The B.E.P. centrifugal or turbo-pumps which are made by the British Electric Plant Co. have been developed along what are usually accepted as standard lines; that is to say, they consist of one or more impellers revolving in a suitable chamber, a guide or diffusion plate being used to reduce the velocity of the water at its discharge from the periphery of the impeller. Thus far the design follows the usual practice, but in the embodiment of the principle of generating pressure by the transformation of the energy of velocity, several very interesting and important deviations are noticeable, chief among which is the patented system of balancing that is employed. An important feature of this system is the entire absence of mechanical means for meeting the great difficulty of axial thrust, which has in the past been a fruitful source of ingenuity to the manufacturer, some of the devices employed being rather of the freak nature, while others have stood the test of practice in a thoroughly satisfactory manner.

When it is remembered that one of the strongest claims made by the advocates of centrifugal pumps is the small number of working parts and the simplicity of the pump as a whole, any means by which this very just claim can be strengthened must go a long way towards bringing this comparatively new style of pump into more general use. As the presence of axial or end thrust has been a retarding factor in its progress by necessitating the presence of what are, in the B.E.P. pump, superfluous parts, the removal of this weak point strengthens its hand in its struggle against its older rival, the displacement

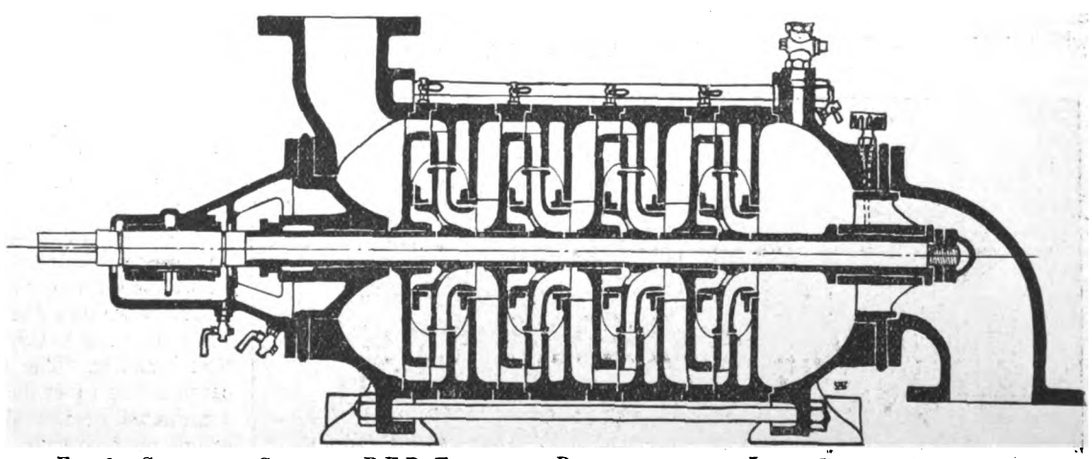

FIG. 1.—SECTION OF STANDARD B.E.P. FOUR-STAGE PUMP SHOWING THE LARGE BEARING SURFACES OF THE IMPELLER NECK RINGS, RENEWABLE NECK RING BUSHES, ABSENCE OF MECHANICAL BALANCING ARRANGEMENTS AND GENERAL SIMPLICITY OF DESIGN.

type of pump, and should materially assist in bringing it into more general favour.

The method by which this result is attained is the acme of simplicity and undoubtedly this is one of its strongest recommendations, as simplicity, as a rule, is synonymous with reliability. The simplicity of the pump is at once apparent

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at a glance (*see* Fig. 1) at its composite parts. Very noticeable is the absence of ball or thrust bearings or balance pistons such as are usually fitted, their place being taken by very unpretentious looking collars which serve the purpose of controlling the end play of the shaft, and keeping the impellers exactly opposite their respective ports on the diffusion plates.

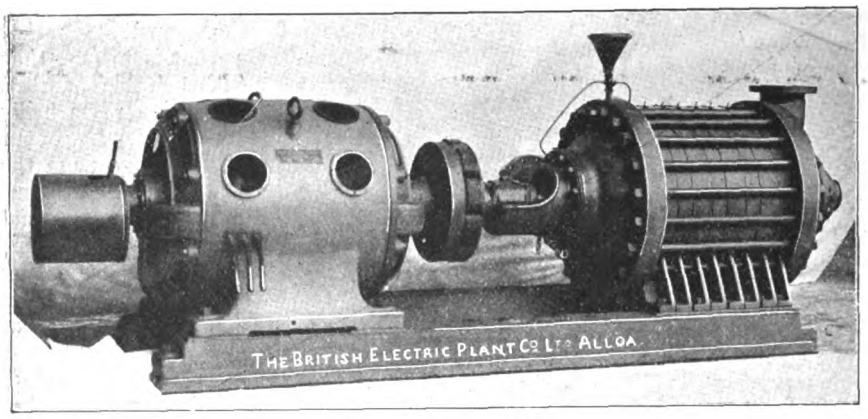

FIG. 2.—B.E.P. FOUR-STAGE PUMP AND SLIP-RING MOTOR, 750 GALLONS PER MINUTE, 660 FT., 240 H.P., 1,470 REVS. PER MIN.

The arrangement of the waterways in the castings is also worthy of note as they are so placed that the entire path of the water is in view for inspection. This is accomplished by making all castings, with the exception of the impeller, open, *i.e.*, without cored passages, and consequently all channels are exposed on dismantling the pump. The simplicity of the castings is striking, and this point should appeal to all engineers who have to deal with the repair and upkeep of machinery underground. A further advantage attendant on this design is the extent of the bearing surfaces, these being specially long, thus ensuring a maximum volumetric efficiency by reducing to a negligible quantity leakage between volumes of water which are at widely different pressures.

Special attention has also been directed to the making of vulnerable parts renewable, and it is possible to fit spare parts, which will practically renew the life of the pump, an indefinite number of times, or at least, till such time as the chamber castings are no longer in a fit state to continue in service, corrosion so reducing them in thickness that they are unable to withstand the working pressure. Even under these, the worst conditions so far as life is concerned, the efficiency of the pump can be maintained at its maximum with only a trifling cost in renewals. These renewals comprise, as a rule, the following parts, some of them of course being more susceptible to wear than others:—Impellers, diffusion plates, impeller neck ring bushes, chamber centre bushes, and shaft sleeves, the last named acting as distance pieces between the impellers and serving to protect the shaft from corrosion and from wear in bearings, no part of the shaft whatever being exposed to the water or being in immediate contact with supporting bearings.

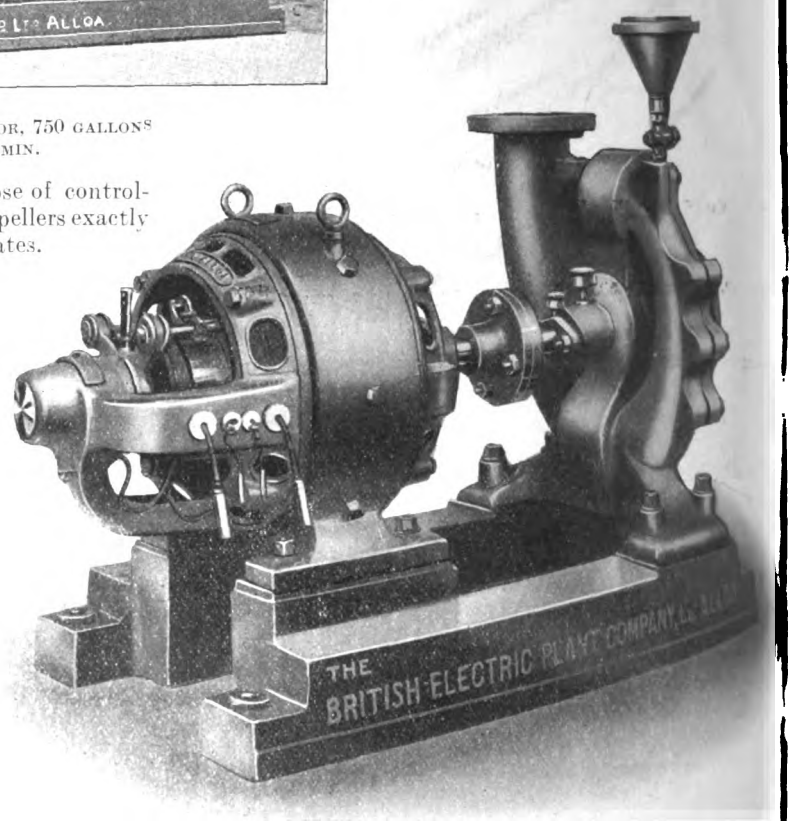

FIG. 3.—B.E.P. MOTOR-DRIVEN SINGLE-STAGE PUMP. OUTPUT 233 GALLONS PER MINUTE, 35 FT. HD.

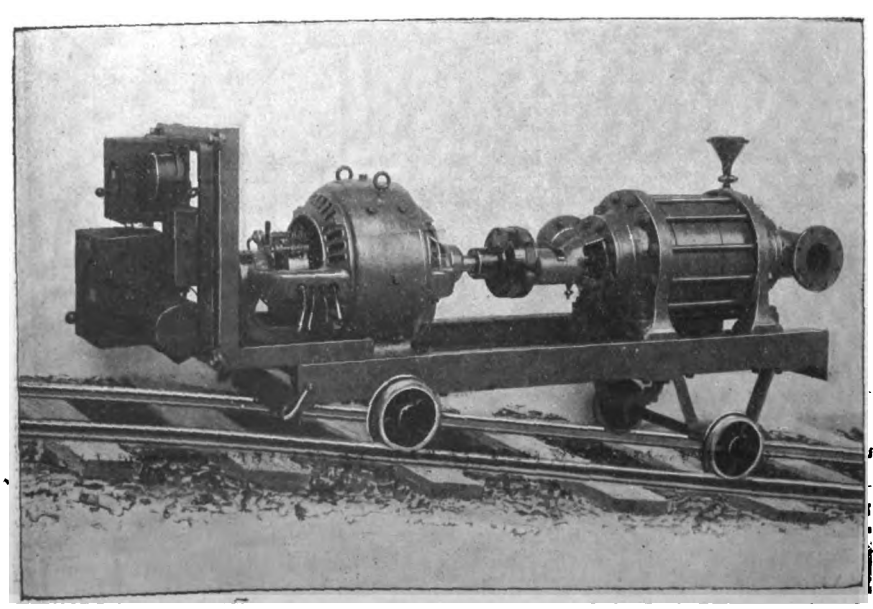

FIG. 4.—MOTOR-DRIVEN PUMP FOR WORKING ON AN INCLINE OF 1 IN 6. DUTY 400 GALLONS PER MINUTE. HEAD VARYING UP TO 220 FT.

By reference to the sectional drawing, Fig. 1, it will further be noticed that the B.E.P. pump is specially suitable for dealing with high-suction lifts, as there is no gland at the suction end of the pump by which air might gain access and so spoil the vacuum necessary to raise the water into the first impeller. The shaft end, protected by a capped nut to exclude water from the thread, terminates in the interior of a tapered bend which may be swivelled into various positions to suit local conditions or requirements of piping. Our illustration, Fig. 2, is of a B.E.P. centrifugal pumping set supplied to one of the principal Scotch coal companies. The 240 H.P. motor is operated from a three-phase, 650 volt, 50 frequency supply, and the pump discharges 750 galls. per min. against a head of 660 ft., the speed of the set being 1,470 revs. per min. Fig. 3 illustrates another B.E.P. standard horizontal pumping set, while Fig. 4 indicates

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the adaptability of the centrifugal pump to meet special conditions. This illustration shows a three-stage pump and direct-current motor with complete control gear, mounted on a channel iron bogie, this plant being success-fully used for unwatering a dook. By means of special speed regulation and internal arrangement of the pump, the quantity of the water discharged at no time exceeds 400 galls. per min., no matter what the head may be.

Submersible Electric Motor and Pump for Mining Work.

Great trouble has hitherto been experienced in working electric motors in damp places. Particularly has this been so in marine salvage operations, where, naturally, it is an impossibility to keep the plant dry, while often the same difficulty is met with in mines. The Macdonald patent motor, it is claimed, overcomes all these difficulties, for it not only works in damp places, but it will actually work in water without an enclosing case. Messrs. Gwynnes have secured the sole rights of this motor so far as all pumping installations are concerned, and are offering it in connection with their "Invincible" centrifugal pump for marine salvage undertakings, for use on board war vessels and ocean liners; also with the "Invincible" centrifugal pressure or turbine pumps for mines and collieries. There is no need to emphasise the benefits of such a motor in a mine, as with it. sparking is practically impossible, and should the workings become flooded the pumping will not be interfered with.

A typical submersible motor and pump is shown herewith, The motor itself differs from those of the ordinary type in that the stator winding is enclosed in rubber insulation. No attempt is made to prevent the water from getting into the motor; in fact, it is used as a cooling agent, and the permissible temperature rise of the motor is regulated with this in view. A small pipe is also taken from the pump to the motor, and a jet of water, when the motor is not submerged, then plays on the stator laminations in the air-gap. The rotor conductors are so arranged that at no part does the pressure differ by more than 1½ volts from any other part. This also prevents electrolysis.

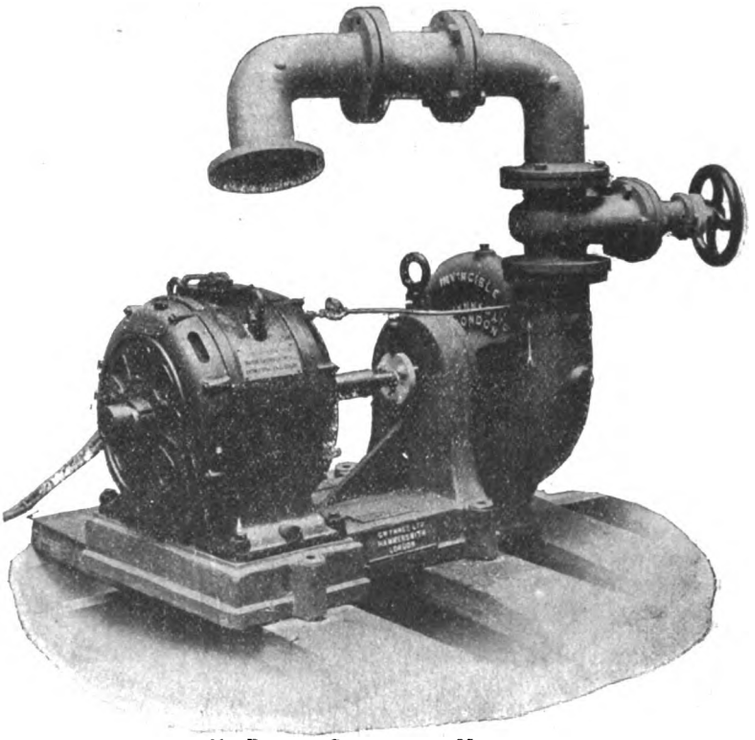
Turning to the application of this arrangement, it is practically impossible to foresee the manifold uses to which this invention can be adapted for mining works. By its means the dangers of mines being flooded and the attendant loss of life are reduced to a minimum. Its usefulness will appeal, we think, at once to all mine owners, civil engineers, contractors and others throughout the world.

For mining work the motor would be connected to a centrifugal or other type of pump of any dimensions and on the same bed-plate or foundation, any sized air compressor can be fitted and connected with the motor. Air pipes can then be led to any part of the workings, however distant, and the operation of a switch at the pit mouth will supply air to any particular place in the mine, although the motor and compressor may be many feet under water. At the same time the pumps can be kept running full bore. Under ordinary conditions the compressor can be utilised to work every kind of pneumatic rock or other drilling appliances and will keep the air perfectly pure in confined spaces where there is the smallest possible outlet.

Another and most important feature of this plant is that, while hitherto it has been impossible to operate electric drills or other electric tools in damp or wet places, the new electric tools constructed with a smaller type of the submersible electric motor can be manipulated under running water, or even entirely submerged, and will run direct from the main motor at any distance from it. This feature will be easily recognised as a great advance and improvement on the present electric tools. The plant is placed at the bottom of the mine or in any convenient position, and the pump need have no lift, simply a delivery to the next stage. In all cases, where possible, the pumping set and motor are submerged in water and, therefore, no suction hose is necessary, simply a delivery pipe, and no priming is required; the pump, being under water, is always primed, ready to start immediately the current is switched on.

In a flooded mine it is only necessary to suspend the pumps by ordinary chain slings from a tackle overhead and immerse them a few feet under water. They require no staging or platforms, there is no vibration, extra lengths of delivery hose are connected up as the water is pumped out and the pump lowered down. It can be pulled up at any time for examination and started again immediately it reaches the water when lowered down. For exploring mines or workings where deadly gases exist, a special helmet and connection from the motor have been devised, enabling the explorer to proceed any distance from the machine in perfect safety. Also by starting the motor pumps by the switches at the pit mouth it will draw out the gas and discharge it at the top of the mine shaft. The recent terrible colliery disasters will conclusively prove the value of a machine of this description, whereby pure air can be delivered to any part of the mine and the deadly gas pumped out at the same time.

Again, if the present type of ordinary electric motors now placed in the mines are flooded from some cause they become



MACDONALD SUBMERSIBLE MOTOR.

useless, the mine is stopped and enormous expense incurred until it can be pumped out again and the motors renewed and replaced; the submersible can be left until an opportunity arises to start the dynamos again and pump the mine out. Probably the greatest feature of the submersible at the present day is that it can be employed for working the coal cutting machines in mines without the slightest danger of any sparking arising from it. Both the motor and switches controlling the cutting gear are simply immersed in a tank of water, the tank being covered in to keep out the coal dust, and the whole arrangement placed on a trolley.

The attention of mine owners, &c., is especially directed to this feature as it will be the means of saving them vast amounts of money. There is at the present time a great feeling of anxiety amongst miners regarding the electrical power appliances in coal mines, which will in all probability develop into an agitation for the complete removal of these appliances except in such cases where submersible motors are employed. The safety of this type of electrical energy can be demonstrated in the simplest possible manner, and will be quite clear to any man possessing ordinary intelligence. The motor or switch being under water cannot spark and, therefore, cannot fire, no matter how gassy the mine may be.

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Pumps for Mining Purposes.

Perhaps one of the most important parts of the machinery installed in a mine is the pumping plant. Apart from the question of actually unwatering the mine there are numerous other duties for which pumps are required. The very first steam engines constructed were for this important work, and pumping engines have always commanded a great deal of attention from mining engineers and designers, in order that the best and most efficient results might be obtained from them. Of late years the steam-driven direct-acting plunger pump has been displaced by the centrifugal or turbine pump. Originally the centrifugal pump was only constructed for low lifts, and came into use very largely as a suitable circulating pump for marine engines, owing to its small weight and compactness for the duty performed.

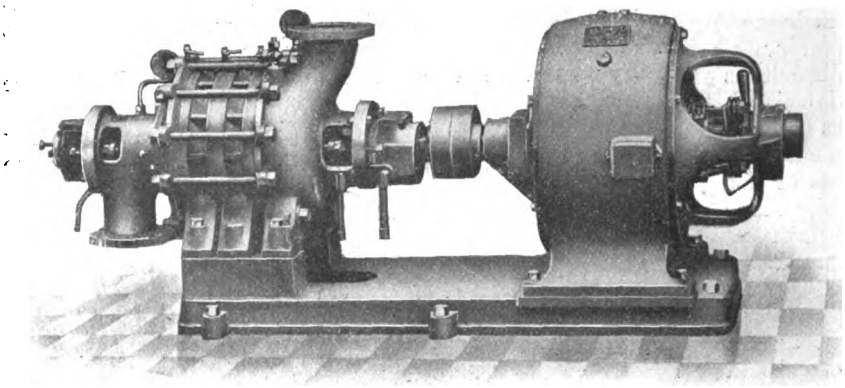

FIG. 1.—"CONQUEROR" HIGH-LIFT TURBINE PUMP.

The last few years, however, have seen the centrifugal pump entering the field of mining, and there taking the place of the reciprocating pump for various purposes in and around the mine, for unwatering, in the power station, in the coal washery, and as a sinking pump during the construction of mine shafts. In conjunction with an electric motor as its prime mover the centrifugal pump, Messrs. W. H. Allen & Co. find, forms an exceedingly portable and compact plant, well adapted for mines as it only occupies a very small space and, moreover, is easily placed in the required position.

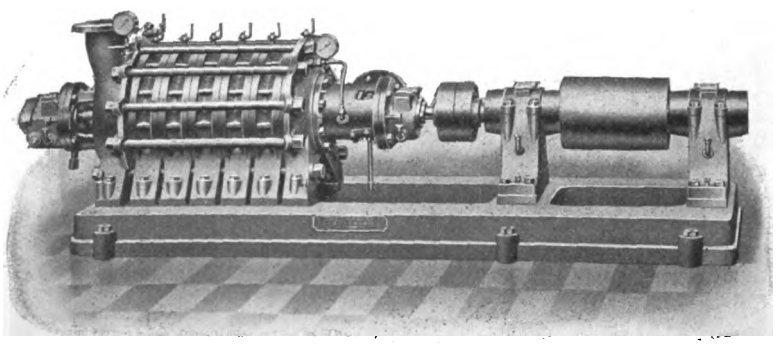

FIG. 2.—"CONQUEROR" PUMP ARRANGED FOR BELT DRIVING.

It might prove of interest to the mining electrical engineer to consider a few of the most recent applications of this class of machinery to mining work. Perhaps the most important class is that of fixed pumps for unwatering pits. Provided that the quantity of water to be raised does not bear too small a relation to the head against which it is to be delivered, the motor-driven centrifugal turbine pump has many advantages over its competitor—the direct-acting plunger pump. The space required is less, the power is applied direct instead of through one or more gear reductions, with their corresponding losses of power, and the water is delivered in a continuous stream: moreover, gritty water may be dealt with, which would soon cause heavy wear on the plungers and glands of a reciprocating pump.

The turbine pump is far more suitable for driving electrically than a reciprocating pump, which is an important point seeing that electricity is the motive power most usually available for driving at the present time.

Fig. 1 shows a "Conqueror" high-lift turbine pump made by Messrs. W. H. Allen, Son & Co., of Bedford. This pump is

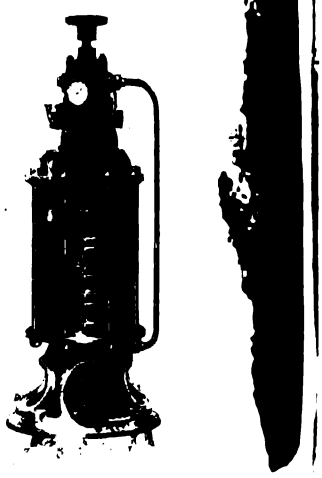

FIG. 3.—VERTICAL FEED PUMP.

capable of delivering 200 gallons per minute, against a head of 290 ft. The pump is constructed in accordance with this firm's usual practice, the outer casing being of cast-iron, the revolving discs and stationary guide-blades being of special tough high-tension bronze, and the spindle of nickel steel. The spindle is fitted with gun-metal liners where it passes through the pump glands, and runs in ring-lubricated bearings which are arranged entirely outside the casing. The spindle is connected to the motor shaft by means of a flexible coupling, and the pump and motor together are mounted on a cast-iron base-plate forming a compact and rigid arrangement. The end-thrust on the spindle is counteracted by means of the firm's patented balancing arrangement, in which the water running to waste is reduced to a minimum; this water moreover serves to cool the pump and motor bearings when necessary. Fig. 2 illustrates a pump of the above type arranged for belt-driving to deliver against 610 ft. head.

The centrifugal pump is now almost invariably used in power stations for circulating the water through the condensers when these are of the surface type, or for extracting the injection water and condensed steam from condensers of the jet type. Messrs. Allen have supplied a great number of their centrifugal pumps, both steam and motor-driven for this purpose. They have paid a great deal of attention during the last few years to the combination of a turbine pump driven by an electric motor, the latter being assisted by a water turbine. This particular arrangement is very suitable for collieries, mines, steel and other works, where water is pumped up to a considerable height, for condensing and other purposes where it is returned to the same level as the source of supply, the water turbine driving the turbine pump by utilising the energy of the water returning from the condenser to its original level. This combination reduces the running cost by a large percentage, and can be economically employed where there is a considerable difference in the levels of the source of supply and the position where the pumping plant is situated.

Figs. 4 and 5 show a combined set consisting of a "Conqueror" turbine high-efficiency pump coupled to an electric motor, and a water turbine, all working on the same shaft. The output of these sets is as follows: turbine pump 2,500 gallons

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per minute at a 120 ft. head, water-turbine 2,500 gallons per minute at a 101 ft. head. The electrical input does not exceed 54 kw. In this plant the test results were well above the guaranteed figures.

For boiler feeding purposes, in the case of boiler installations where a total quantity of 50 gallons and upwards per minute is required, the turbine centrifugal pump, Messrs. Allen consider,

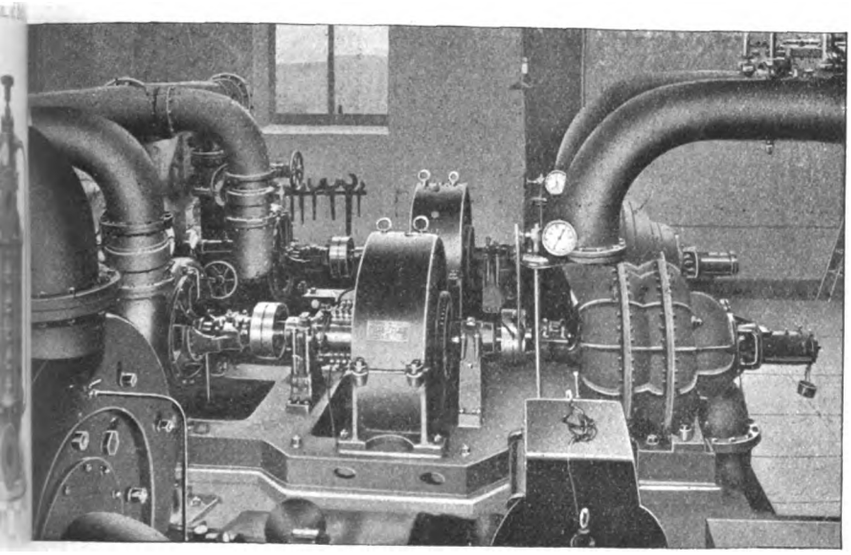

FIG. 4.—THE SAME SET AT WORK.

is eminently suited. The pump can be driven direct either by an electric motor of the continuous or alternating-current type, or direct coupled to a steam turbine. The centrifugal type of pump has many advantages over both injectors and reciprocating pumps. When the water flows to the pump under a small head, it is capable of dealing with the hot feed, and the quantity can be regulated over the widest range necessary, either by a slight variation in speed, or simply by throttling the delivery. Injectors are not only difficult to start, but cannot be used with hot feed water, and require a considerable amount of attention when working. Reciprocating pumps, if of the direct-driven type consume a large amount of steam for

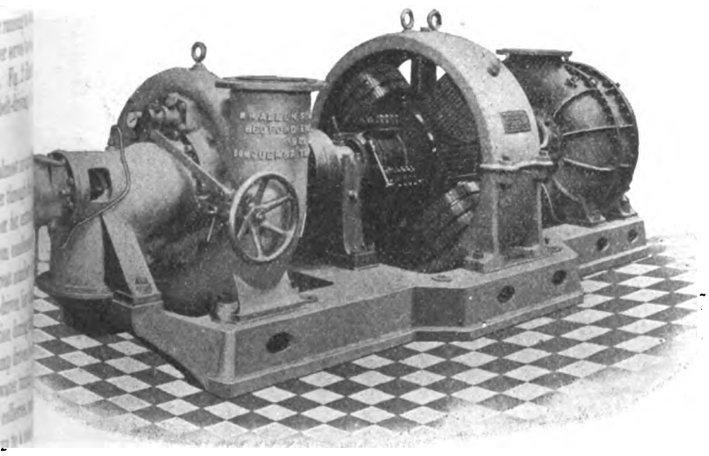

FIG. 5.—COMBINED MOTOR PUMP—WATER TURBINE SET.

the work done; or if of the gear-driven type, are noisy in working, and special arrangements have to be made for a wide variation in speed to enable the quantity to be varied, or some complicated arrangements of gearing have to be introduced to vary the stroke of the plungers. The turbine centrifugal pump is quite silent in working, and delivers a continuous stream of water without pulsation. The amount of floor space taken by this type of pump is very small indeed, especially if made with vertical spindle, as illustrated in Fig. 3, and it will run continuously with a minimum amount of attention, while the efficiency at both full load and reduced load is very high.

Fig. 3 shows a boiler feed pump of the vertical spindle type, motor-driven, which delivers 60,000 lb. of water per hour, against a pressure of 210 lb. per sq. in.

Fig. 6 shows a turbine pump completely dismantled, from which the arrangement and method of construction may be seen.

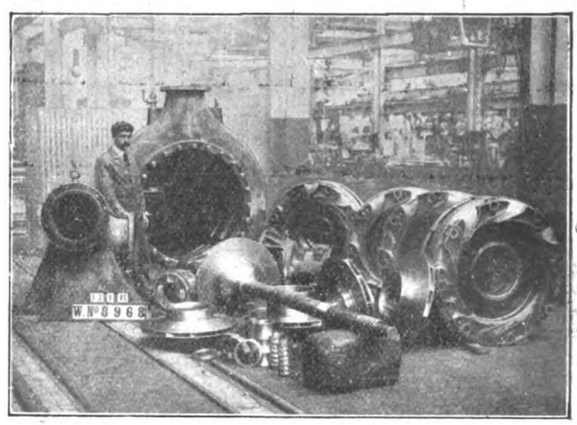

FIG. 6.—DISMANTLED TURBINE PUMP.

Messrs. Allen have also supplied a great many of their high-speed enclosed forced-lubrication engines, and their "Conqueror" counter-current surface condensing plants to many power stations, both for collieries and other purposes.

Electrically-driven Power Pumps.

Owing to the progress recently made in the electrification of machinery in mines there has been a considerable demand for large pumping units driven by electric motors. In this country and on the Continent the development of this class of pumping machinery has taken different lines. On the Continent there has been developed a class of reciprocating pump wherein the motor is mounted direct on the pump crank shaft, driving the latter direct without the intervention of gearing of any kind. This naturally means that the pumps must run at the highest possible speed, and this varies from anything between 100 and 400 revs. per min., depending largely on the size of the pump and the limit the purchaser feels inclined to go to in regard to speed. These high-speed pumps in themselves have very great wear and tear, the various reciprocating parts wearing very rapidly leading to frequent renewal and large expenditure on general up-keep, whilst at the same time the volumetric efficiency of this type of pump is not very high; consequently, the mechanical efficiency is not so good as might be expected. Again, the motors for driving these pumps, seeing that they have, when three-phase current is used, to run at a relatively low speed to obtain the best results, have generally a rather low efficiency and power factor.

In this country, and in our colonies generally, the development has been more on the lines of slow-speed machines. These are very often of the ordinary three-throw type, driven through double reduction of gearing from an electric motor. In a few cases, which we shall refer to later on, slow-speed pumps have been installed driven through single-reduction gearing, this being of the double helical machine cut type, usually arranged to run in oil, the drive being from a motor running at a speed of 400–600 revs. per min. This class of pump has the wear and

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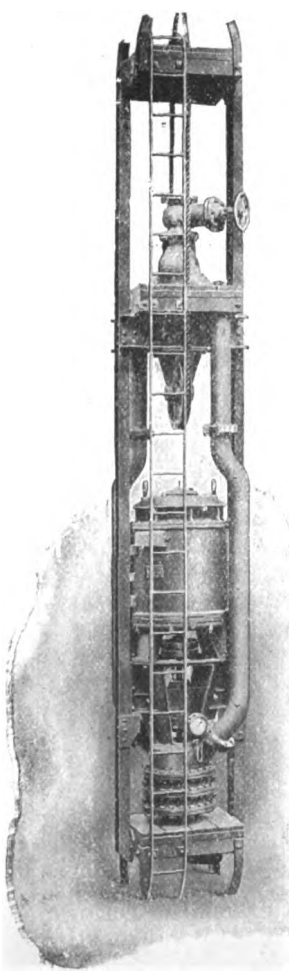

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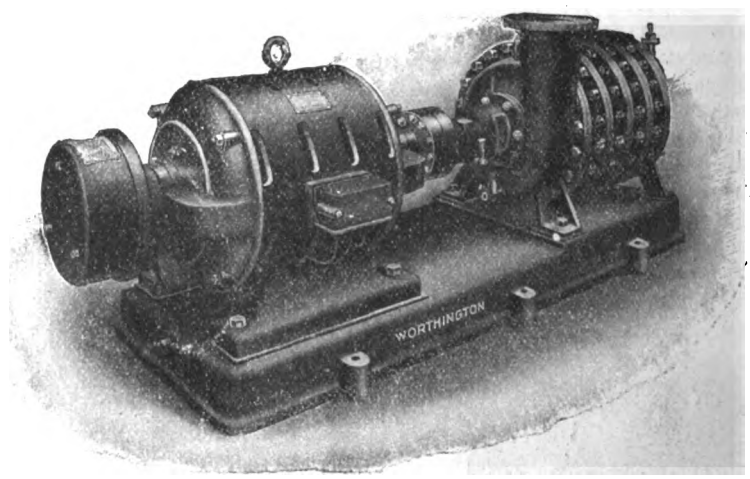

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tear on it reduced to a minimum; the volumetric and also the mechanical efficiency are very high, owing to the small loss there is between the motor and the pump; the motors running at a normal speed give very much higher efficiencies and power factors than can be obtained with slow running machines, so that on the whole this latter class of pumping plant gives much better results than can be obtained with a high-speed pump driven by a slow-speed motor. Another factor which enters

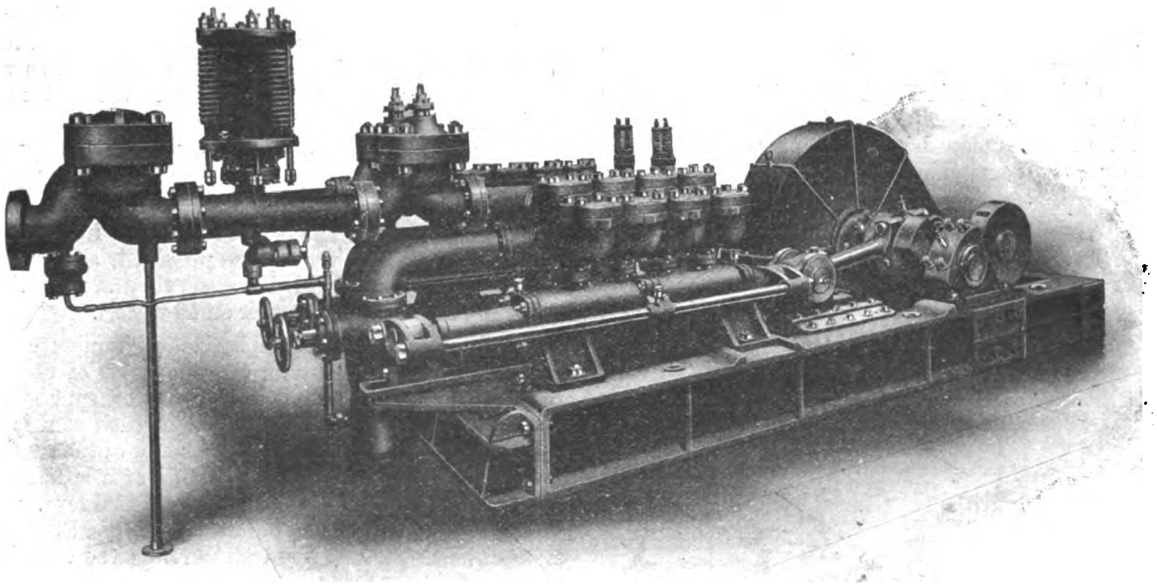

FIG. 1.—WORTHINGTON HORIZONTAL PUMP.

largely into the question of efficiency is that of workmanship. It is a well-known fact that where there is bad workmanship there is also low efficiency, and consequently great wear and tear. With a machine having a high efficiency it may be taken for granted that the wear and tear on it is reduced to a minimum, conditions that can only be obtained by high-class workmanship.

There has recently been built by the Worthington Pump Co., for the Rhymney Iron Co., a type of pump which is considered one of the best for mine service. This machine is of

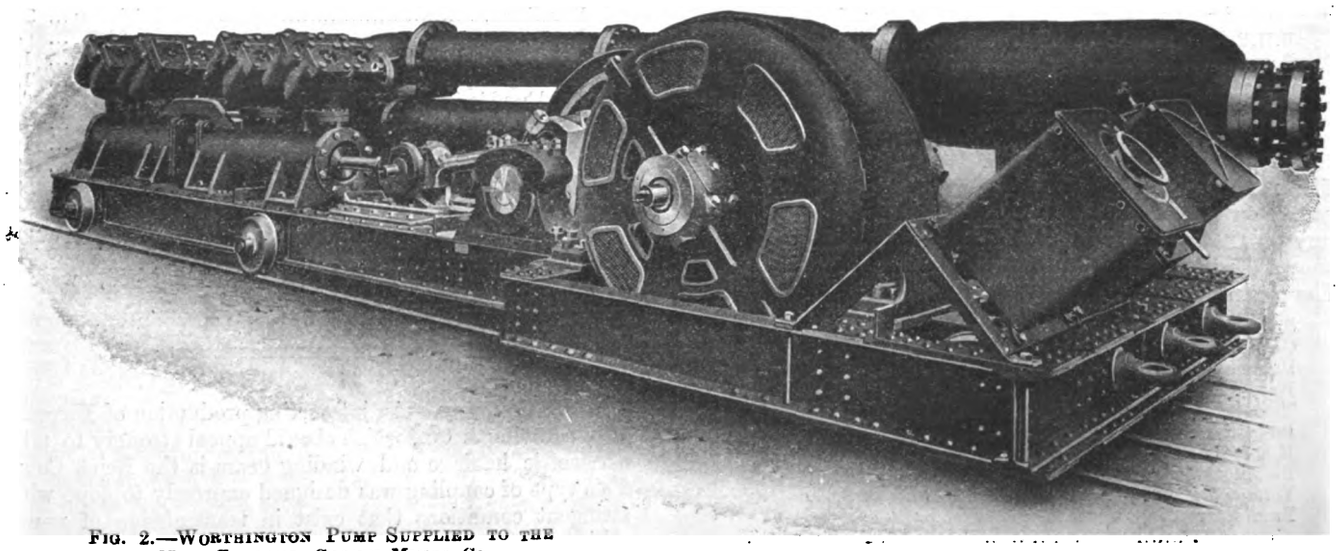

FIG. 2.—WORTHINGTON PUMP SUPPLIED TO THE NEW ZEALAND CROWN MINES CO.

the horizontal duplex outside-packed plunger type, having four single-acting plungers driven, through single reduction double helical machine-cut gear, from a three-phase electric motor. The connection between motor and pinion shaft is through the medium of a flexible coupling. This pump is fully capable of delivering continuously 400 gallons per minute against a total head of 1,815 ft. The pump speed is 38½ revs. per min.

The gear wheel is of heavy construction, having the teeth accurately machine-cut throughout and arranged for a single reduction of gear. The pinion is of chrome nickel steel. The whole of the gearing is totally enclosed in a cast-iron case, which forms an oil bath, the bottom half being securely fixed to the pump bedplate and the upper half being left free so that it can be easily removed at any time for giving access to the gear wheels. The two halves are joined together by means of a suitable planed joint and flanges bolted together. To prevent the creeping of the oil along the crank shaft, two oil-throwing rings of a special construction are provided, and these are so arranged that the oil is thrown into suitable channels formed in the casing and prevent it escaping on to the crank shaft. This casing is also provided with suitable inspection hand holes to enable the gears to be inspected from time to time without having to remove the upper half. On one end of the pinion shaft a flexible coupling is secured, through which this pump is driven from an electric motor.

The pump plungers are of chilled cast iron, accurately ground and polished up to a dead surface. They are securely attached to the respective cross-heads by means of a suitable arrangement of set screws. The pump barrels and valve boxes

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are of semi-steel, and are made interchangeable, the valve boxes being of the "pot" pattern, having suction and delivery openings joined together into common suction and delivery pipes 8 in. and 6 in. in diameter respectively. In the pump barrels are formed deep stuffing boxes fitted with semi-steel glands and steel studs. The necks of the pump barrels and the glands—that is the parts which come into contact with the plungers—are bushed with gunmetal.

The pump valves are of gunmetal fitted with fibre beats carefully let into grooves formed in them, and they work on gunmetal seats. The valves are efficiently guided and controlled by phosphor-bronze springs.

This machine is illustrated in Fig. 1 herewith, which shows an elevation of this pump.

The guarantee for the motor driving this pump provided that it was to be capable of sustaining a full load run for 24 hours, the temperature rise not to exceed 43°C. It was also to be capable of sustaining an overload of 25 per cent. for two hours and a momentary overload at starting of 80 per cent. without injurious heating of the windings. The full load efficiency of

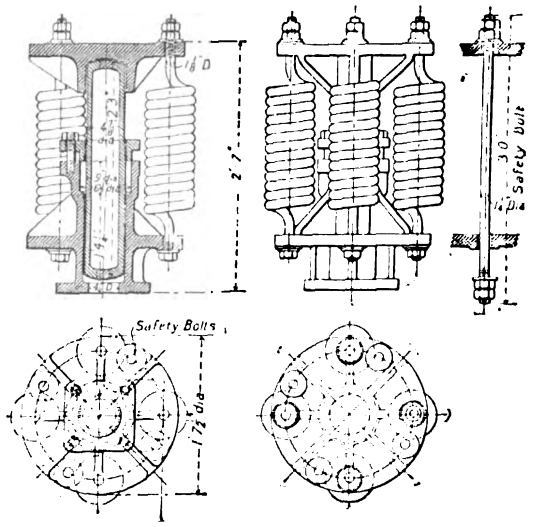

Fig. 3.—Diagram of Alleviator.

the motor was guaranteed to be not less than 91 per cent.

This motor was tested at the British Westinghouse Co.'s works, the following results being obtained :—

B.H.P.	252 ...	276 ...	300
Power factor ...	87 per cent. ...	87·1 per cent. ...	87·2 per cent.
Real H.P.	270 ...	296 ...	322
Real efficiency ...	93·2 per cent. ...	93·2 per cent. ...	93·15 per cent.
Revs per min. ...	420 ...	419 ...	418

The power was measured by an integrating watt-meter. The pressure against the pump was taken by a pressure gauge on the delivery side, corrected for the slight pressure on the suction. This pressure was also checked by the known depth of the mine, so that the figures are very reliable. The pump details were as follows :—

Speed of pump	39 revs. per min.
Gallons pumped per minute	412 gallons per min.
Pressure on the delivery gauge	785 lb. per sq. in.
Head on the suction side.....	4·6 ft.
Total head against the pump	1,808·73 ft.
Pump horse-power	226
Kilowatts	201·6
Electrical horse-power.....	270·24
Voltage (constant)	3,000
From the readings taken the power factor came out at	87 per cent.
which agrees with the test made on the motor as given above.	

Taking the efficiency of the motor as 93·2 per cent., as obtained on the test above, the motor was consequently developing 251·8 B.H.P.

Therefore the pump efficiency was 89·8 per cent., the overall efficiency of the motor and pump being 83·6 per cent.

The alleviator shown in Fig. 3 is a mechanical substitute that has been developed by the Worthington Co. during the last 10 years for the purpose of taking the place of air vessels on pumps working against high pressure. Air vessels for pressures above 600 ft. are difficult to keep properly charged, and mean a separate air compressor to do the work efficiently. The adoption of this apparatus gets over the trouble very effectively, and such apparatus is now working up to a pressure of 3 tons to the square inch with the best possible results. The ram of the alleviator reacting on the steel springs with which it is fitted takes up the pulsations communicated to the water due to inequality of flow or other cause, and so relieves the shock on the pumps and transmits to the motor much more uniform turning moment.

Another machine of practically the same type, but modified in some particular respects to meet the conditions in regard to the capacity and head against which it works, was built by the Worthington Pump Co. recently for the New Zealand Crown Mines Co. Two of these were provided, and from the illustration (Fig. 2) it will be seen they are of the portable type and supported altogether on 16 wheels.

These pumps are of the horizontal duplex centre-packed plunger type, driven by an electric motor of the three-phase induction type through double reduction spur gearing. The stroke is 18 in., and the diameter of each ram is 12 in., the speed 42·6 revs. per min. The diameter of the suction is 14 in. and delivery 12 in. The motor runs at a speed of 364 revs. per min. and the speed is reduced to 42·6 revs. per min. by two trains of gears. The pumps are designed to work against a total head of 500 ft., and all parts on the two sides of each pump are interchangeable.

Each pump and motor with switch and starting appliance is self-contained, and is mounted on a substantial underframe provided with wheels or rollers, to run on rails 2⅝ in. high and a tread of 2 in., so that the whole may be hauled up the shaft in case of accidents.

The following are the particulars of a test that was carried out at the maker's Newark works on these pumps. Each pump was designed to deliver 1,135 gallons per minute against a total head of 500 ft. They were submitted to a running test, one pump being tested when running at half-speed and discharging the water at the maximum head, whilst the other one was tested running at full speed and discharging at half the head. Particulars of these tests are as follows :—

Duration	5 hours ...	3 hours
Revs. per min of pump	21·7 ...	43·0
Gallons per minute (measured over weir)	600·0 ...	1,200
Ditto (by displacement)	613·0 ...	1,213
Total head in feet.....	499·71 ...	261·5
Pump horse-power	90·9 ...	95·15
B.H.P. developed by motor	107·6 ...	106·5
Volumetric efficiency, per cent.	97·8 ...	98·9
Pump efficiency, per cent.	84·5 ...	87·8

The whole of the above figures are mean values of a series of readings taken every quarter of an hour during the process of the trial. The conditions, once established, were very uniform and varied very slightly throughout.

Reich Coupling.—An interesting production of Messrs. Jens Orten Böving & Co., which should appeal strongly to all users of electric haulage and winding gears is the Reich Coupling. This type of coupling was designed expressly to cope with the stringent conditions that exist in transmission of power for rolling mills, haulage gears, and, in fact, for all cases where heavy shocks and frequent reversals are to be expected. The coupling consists of an inner and an outer half together with a detachable ring. The inner half has large claws which fit into recesses in the ring. Between these claws and the outer ring are fitted especially elastic blocks. These are found to fulfil every requirement as regards flexibility, and are at the same time the best medium for transmitting the large powers present.

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Common Sense Boiler Design.

BY W. H. CASMEY.
(Of the Yorkshire Boiler Co., Ltd.)

The materials used in the production of steam are coal, air and water, and the reason why greater scientific progress has not been made in steam generators is entirely due to believing that our predecessors had studied the subject, and we have unquestioningly followed their lead.

We were faced with the following questions three years ago: Can we increase our boiler duty per unit of space occupied and also increase the weight of water evaporated per pound of coal burned? The answer to the above has now been discovered, and boilers 20 ft. long are to-day giving equal hourly evaporations to boilers 30 ft. long, thus saving floor space and brickwork and first cost of boiler, and not only so, but giving higher thermal efficiencies. A very elementary examination of the subject points out how this apparent paradox is possible, and also indicates how very small is the attention we have paid to the principles which are brought into play in making and using steam boilers.

The first element to consider is coal. That in general use for steam raising contains from 60 to 70 per cent. of fixed carbon or coke, the heat of which is given off radiantly and absorbed by the boiler and brickwork in the immediate neighbourhood of the furnaces—*i.e.*, the front end of the boiler, the gaseous portion passing away as smoke or flame dependent on the conditions of the fires. When air and coal are used proportionately, say 16 lb. of air to 1 lb. of coal, the temperature of the fire surface is approximately 3,000 deg.; but if 24 lb. of air be supplied per pound of coal, and this is the proportion generally adopted, the furnace temperature will not exceed 2,000 deg., the transmission of heat being less than one-third that secured with the smaller air supply.

The third element in steam production is water, and it is well to remember it is a poor conductor of heat, and must either by location or circulation be brought in direct contact with the hot furnace flues. In fact, a flue surrounded with water in a state of active ebullition will transmit over twice as much heat in a unit of time as when water is not moving; hence the reason why a small active heating surface is more effective than a large sluggish one.

The next point to consider in connection with the subject is heat transmission, and, as this is proportional to the temperature difference between the two sides of the boiler plate, it is at once apparent there must be a greater transmission of heat near the furnaces where the heat is generated than further along the flues. The whole position is one of centralisation; coal gives the bulk of its heat off radiantly. The more perfect the mixture of coal and air the higher the furnace temperature, and the greater this temperature the greater is the transmission of heat per foot of surface.

In the Lancashire boiler we have a most interesting case of how the above laws and conditions are not taken advantage of. The boiler is, as a rule, 30 ft. long, and for about the first 25 ft. the flues are parallel and then taper to the rear end, the outlet being as a rule smaller by 6 in. than any other part of the flues, thus reducing the sectional area at the downtake, in the case of a 9 ft. diameter boiler, 34 per cent. Under the above conditions we have a boiler with 44 sq. ft. of grate and which will transmit to 10 per cent. of the boiler heating surface, say, the first 7 ft. of the furnace flues, over 50 per cent. of the total heat contained in the fuel burned and over and around such heating surface is located 200 gallons less water than over the same lineal length of boiler at the rear; also at the latter point the temperature of the gases is the lowest and the heating surface is the smallest and the weight of water per foot run of boiler the greatest.

Such conditions cannot with present-day knowledge be understood as if the temperature of the gases falls 1,000 deg. from the furnace to the downtake. This indicates each square foot of heating surface at the front end of the boiler transmits as much heat to the water as 4 sq. ft. at the rear, and where, as previously stated, is located the smallest heating surface, the lowest temperature of gases, but the larger quantity of water. Without taking account of the increased temperature of the gases at the rear, if the velocity at the downtake is 1,500 ft., the velocity through the furnaces can only be 1,000 ft.; but if we consider the temperature of the gases at the rear we shall find the velocity through the furnaces falls to probably less than one-half the figure just mentioned. There is not the least doubt that the Lancashire boiler would give 10 to 12 per cent. greater evaporation per hour if worked with the furnaces at the opposite end; in fact, the boiler would then be scientifically correct, whereas at present it is quite the opposite.

The Yorkshire boiler, introduced a little over three years ago, has, like the Lancashire, two furnace flues; but here the similarity ceases, as such flues expand from the end of the furnaces to the rear end of the boiler in the ratio of 2 to 3, the total effect being that the water and heat are more proportionately distributed than is the case with the Lancashire.

In a 24 ft. by 9 ft. Yorkshire the first 7 lineal ft. up to working level contains 13,230 lb. of water, and is served by 73 sq. ft. of flue heating surface. In the last 7 ft. the boiler only contains 11,403 lb. of water, but has 163 sq. ft. of heating surface. In the front end, where the heat transmission is four times as rapid as at the rear, there is 195 lb. of water per square foot of heating surface, and at the back end of the boiler 70 lb. per square foot, a ratio of nearly 3 to 1; in the Lancashire the ratio is only 1·6 to 1.

Consider, now, the larger sectional area of the furnace flues at the rear is acted on by the suction of the chimney, and that the smallest sectional area is at the front end, where the furnaces are; we have then through the Yorkshire fires an air velocity 33 per cent. greater than through the fires of the Lancashire boiler of equal shell diameter and working with equal chimney draught at the downtake.

It is scarcely necessary to point out that this increased draught makes it possible to work with thicker fires and to secure more perfect combustion, and also to burn more fuel per square foot of grate; consequently more heat is generated over a limited area to meet the demands of the greater volume of water located over and around the furnace flues; also that it is possible to burn a much inferior class of fuel.

To give a practicable illustration of the above, there is given below some particulars of the actual comparative boiler test carried out at Frickley Colliery by the National Boiler Insurance Co. A careful examination of the three columns of figures in the report of the above test will satisfy the most sceptical as to the utility of expanding the furnace flues. The following particulars of the three boilers above referred to will enable readers to make their own calculations.

—	Lancashire boiler, crown covered.	Lancashire boiler, not covered.	Yorkshire boiler, not covered.
Size of boiler	30ft. by 9ft.	24ft. by 9ft.	24ft. by 9ft.
Sectional area of flues at the front end, square feet	21	22¼	15·6
Sectional area of flues at rear	15·6	19·2	21·0
Draught at end of side flues	0·5in. W.G.	0·5in. W.G.	0·5in. W.G.
Calculated air velocities per minute through furnaces, discarding corrections for temperature	1,411	1,639	1,900
Actual evaporations secured per square foot of grate per hour during test	279·5 lb.	281·5 lb.	306·4 lb.

Assuming each of the above boilers had been fitted with 45 sq. ft. of grate, as was the case with the 24 ft. Lancashire, and that the two short boilers had been covered with non-conducting composition like the long boiler, and the same rate of coal consumption per foot of grate maintained, the respective hourly evaporations would have been as follows:—

24 ft. Yorkshire ..... 15,235 lb. per hour
24 ft. Lancashire ..... 14,000 lb. per hour
30 ft. Lancashire ..... 12,677 lb. per hour

The size of grate area of the Yorkshire was specified as 44 sq. ft., but when the test was made it had only a grate area

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of 39 sq. ft., and it is interesting to note that even under such unequal conditions the actual evaporations of the three boilers during the last three hours of the six hours' test were as follows :—

24 ft. Yorkshire	37,925 lb., grate area 39 sq. ft.
24 ft. Lancashire	36,700 lb., grate area 45 sq. ft.
30 ft. Lancashire	27,700 lb., grate area 36·6 sq. ft.

Apart from scientific reasoning, it is only everyday common sense to expect the above results, for if we consider the 30 ft. Lancashire, including its water, up to working level as weighing 54 tons, that of the Yorkshire will only weigh 45 tons, and naturally it would not only take more fuel to raise the temperature of the larger boiler to steam generating point, but also proportionately more to maintain it there. From the figures given above it will be seen the Lancashire could not burn sufficient fuel to maintain its temperature in comparison with the Yorkshire, the coal consumption per square foot of grate being 39·8 lb. and that of the Yorkshire 47·8 lb. ; consequently, its evaporation fell proportionately.

It is well worth careful thought that the 24 ft. Yorkshire weighing 20 per cent. less, and with crown uncovered, gave an actual evaporation per hour 16·8 per cent. greater than the 30 ft. Lancashire, or within 3 per cent. of the calculated results given above, and had it been covered with composition its evaporation would have been 27 per cent. greater than the Lancashire.

A 1,000 H.P. engine taking 15 lb. of steam per indicated horse-power, if supplied with steam by two 30 ft. by 8 ft. 6 in. Lancashire boilers, efficiency 58 per cent. using fuel with a calorific value of 12,600 B.Th. U.s, would give an evaporation of 7·5 lb. of water per pound of coal, or 2 lb. of coal per indicated horse-power. Taking, on the other hand, two 24 ft. by 8 ft. 6 in. Yorkshire boilers in place of the above, this type of boiler, for equal evaporation, has 9 per cent. higher efficiency ; therefore the cost in fuel per horse-power would be only 1·72 lb., or a saving of 280 lb. of coal per hour, or, on a week of 56 hours, 7 tons, costing approximately £3, therefore a direct saving of £150 per year.

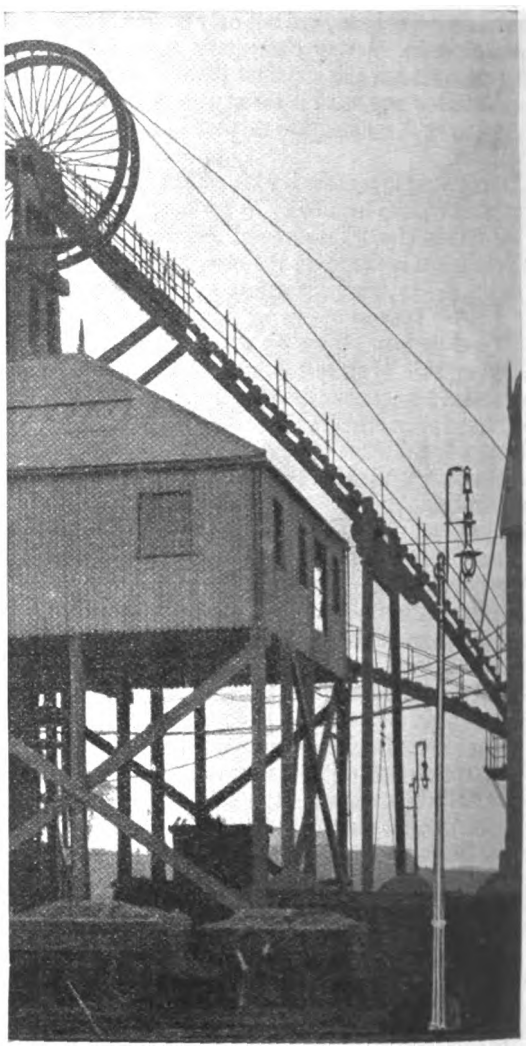
In the production of steam the first essential is a strong draught ; this, as mentioned, enables inferior fuel to be readily consumed ; it also assists in producing a maximum furnace temperature, consequently, a maximum heat transmission, and, such being secured at the front end, a long boiler is unnecessary. One of the greatest authorities on steam at the present time recently stated : "Nothing has hindered the understanding of the law of heat transmission in boilers so much as this fallacious notion that the greater the heating surface the greater the amount of heat transmitted and the higher the efficiency."

Colliery Lighting.

Legislation of recent times, when applied to colliery practice, has, in general, given rise to more efficient artificial lighting for night work. This increased illumination is, of course, necessary in order to produce the best possible results as regards the cleanliness of coal. The introduction of the three-shift system has also involved a very much greater amount of night work, and, as is well known, there has arisen in numerous instances, complaints from buyers as to "dirty" coal. The cause of these complaints has, in many cases, been traced to the inadequate quantity and quality of artificial light used during the dark hours, in lighting up belts and screen houses. This has called for investigation and consequent improvement in the lighting system.

The Jandus Co. has met this demand on various mines by supplying the Jandus regenerative flame arc lamp for lighting. This lamp, with its high efficiency, long burning hours, absence of clockwork, total enclosure and necessitating a minimum amount of attention, has, we are informed, adequately met the somewhat severe conditions under which colliery lighting must be carried out.

For pit head, and large area lighting generally, the light coming off horizontally is important, in order to give even illumination with a small number of lamps. For screen-house and belt lighting, the all important factor is the colour of the artificial light ; the requirements here are exacting on account of the vital nature of the work involved in differentiating between the coal and stone on the belt. In coping with these problems the Jandus Co. have supplied their patent regenerative lamp with chemical carbons to several collieries, among which we may mention the following :—The Washington Collieries, Co. Durham ; The Ryhope Colliery, Co. Durham ; Ouston E. Colliery, Birtley, Co. Durham ; Harton Coal Co., South Shields, Co. Durham ; Chatterley-Whitfield Collieries, Stoke, Staffordshire ; and Sneyd Collieries, Stoke, Staffordshire.



JANDUS REGENERATIVE LAMPS AT OUSTON "E" PIT, BIRTLEY & Co., CO. DURHAM.

The results there obtained have, we understand, fully warranted the owners of these collieries adopting this form of lighting.

The principle upon which the type of lamp at the foregoing collieries operates is that of the use of chemically treated carbons burning in a double enclosure, the chemical vapours being made to circulate again and again through the arc, thus resulting in long-burning hours at one trimming. This action is obtained with entire absence of complicated mechanism, thus involving a minimum amount of attention to the upkeep of the lamp. This lamp has been fully described in our columns and is well known to our readers, while full particulars can be obtained from the makers, the Jandus Arc Lamp & Electric Co., Hartham Works, Holloway, London, N.

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FOR
Pithead,
Screen,
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Belt Lighting.

It is impossible during dark hours to secure the Best Possible Work in the Screen House without having the Best Possible quality of artificial light.

The Jandus Regenerative Arc Lamp, due to its unique characteristics, provides a quality of light peculiarly suitable for the lighting of Coal Screens and Belts.

The Jandus Arc Lamp & Electric Co., Ltd., are prepared to offer full particulars to Colliery Managers and Engineers who are invited to write for information.

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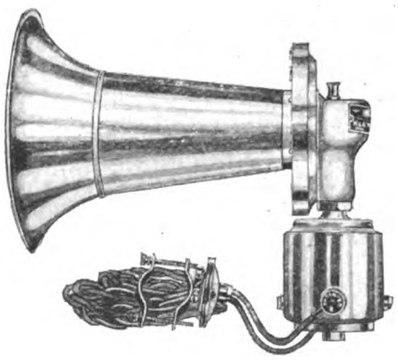

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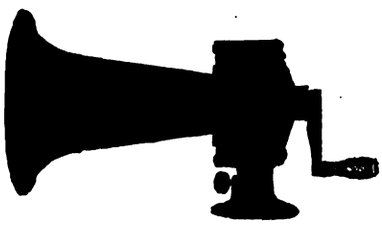

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Siemens Luminous Mine-shaft Signalling.

Siemens luminous mine-shaft signalling apparatus has been designed to provide a safe and rapid means of communication of orders from the different levels of the mine to the engine house by the addition of visual indications of the orders to the bell signals usually employed. The apparatus consists of sets of indicators and bells for the pit bank, engine room and levels. These parts are illustrated in Figs. 1, 2, and 3, and the method of operating them is as follows :—When it is required to wind men from the level, the onsetter turns the top switch on his indicator to "men," and then gives the customary rings on the bells at the bank and engine-room by means of the bell switch provided. If the banksman concurs with the signal from the onsetter, he replies by means of the bell and turns his switch to "men," whereupon the signal "men" is illuminated in the engine-room, at the bank and at the level. This indicates to the engineman that the men are to be carried, and this order remains in force for all the subsequent windings until it is altered when some other operation has to be carried out, such as "coal" or "shaft," the former being used when coal is to be carried, and the latter when it is required to examine the shaft.

The operations of winding are controlled by the lower switches on the bank and level instruments in the following manner :—If the cages are provided with one deck only and are loaded ready for raising and lowering, the onsetter and banksmen turn their respective switches to "ready," and give the usual rings on the bells. When both have turned their switches the signal appears illuminated at the engine-room, bank and level. It will be seen that the visual indication of the order does not appear in the engine-room until both the onsetter and banksman are ready for the order to be executed. When the engine has started, a switch is actuated which releases the "ready" switches at both the bank and level, thus extinguishing the lamps and the order on the indicators and leaving them clear for further orders. In cases where the cages have two or more decks which are loaded from one staging, necessitating the moving of the cage a short distance after one deck has been loaded, the operation is controlled by turning the switch to "change decks," with the same procedure as for "ready." The signal "change decks" is obliterated by the movement of the engine, in the same manner as the order "ready." When all the decks are filled, the signal "ready" can be given in the same manner as for one-deck cages, as described above.

Messrs. Siemens inform us that any system of bell signals can be used in conjunction with the luminous signals. The circuits for illuminating the indicators being separate from the bells, the indicators form independent corroboration of the bell signals, and as it is necessary for both the onsetter and banksman to operate their switches before the orders are illuminated, it is clearly indicated to the engineman that he may proceed without any possibility of doubt as to the bell signals given. The emergency or "stop" signal can, however, be operated independently by either the onsetter or the banksman, to stop the cage at any point. An important feature of the system is that the bell signals required by the rules are not interfered and can be performed in the ordinary manner. In cases where the bell signalling apparatus already exists, the luminous indicators can be supplied without the bells. In addition to the safety provided by having a visual indication of the order, further security is obtained by the arrangement that the visual indication does not appear until both the men concerned, the onsetter and the banksman, have concurred and performed their part of the signalling. It is also impossible for more than one order to appear at the same time, the changing of an order by either man extinguishing automatically the previous indications.

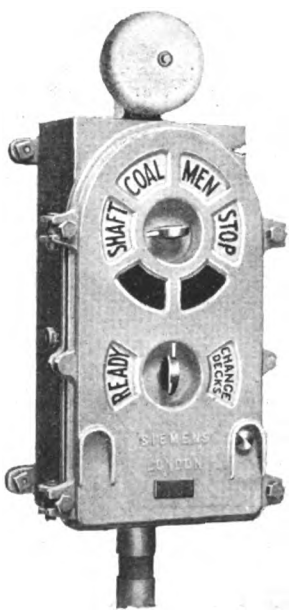

FIG. 1.—PIT BANK INSTRUMENT.

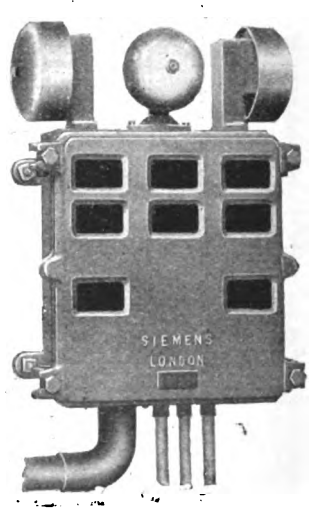

FIG. 2.—ENGINE ROOM INDICATOR.

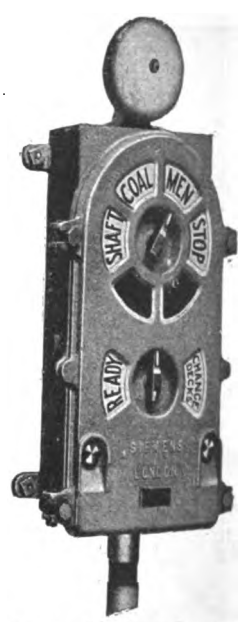

FIG. 3.—PIT LEVEL INSTRUMENT.

A considerable advantage in the direction of simplification and speed of working is, it is claimed, obtained by dividing the visual indications of the orders into two groups, one group comprising such orders as will be standing orders and are required to be in force for a considerable time, extending over several operations of winding, such as "men riding," "coal," &c. The other group consists of the orders on which the engineman acts to raise or lower the cage, and comprises "change decks" (when required) and "ready." The indications of the latter group of orders are extinguished automatically immediately the engine is moved to change the decks or to raise the cage, whereby it is impossible for an order which has been executed to remain and thus to cause confusion.

Visual indications are provided by illuminated windows, on which the orders appear as soon as the lamps, which are arranged behind them, are lit by the operation of the switches at the levels and pit bank. Although the bell signals are independent of the luminous indicators, practically no time is lost in working the latter, since it only requires the operating of the "ready" switch at each winding. The moving of the switch for the standing orders is only required at long intervals. The "stop" or emergency order, when operated at either the pit bank or the levels, immediately illuminates the order on all

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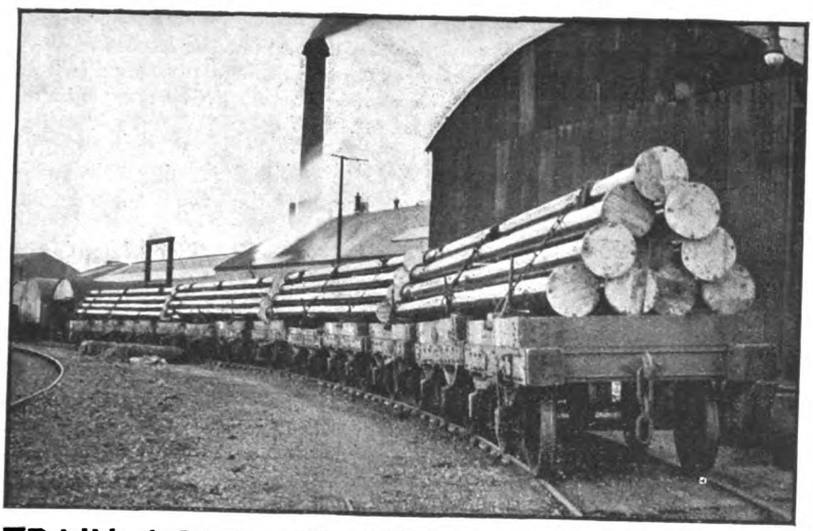

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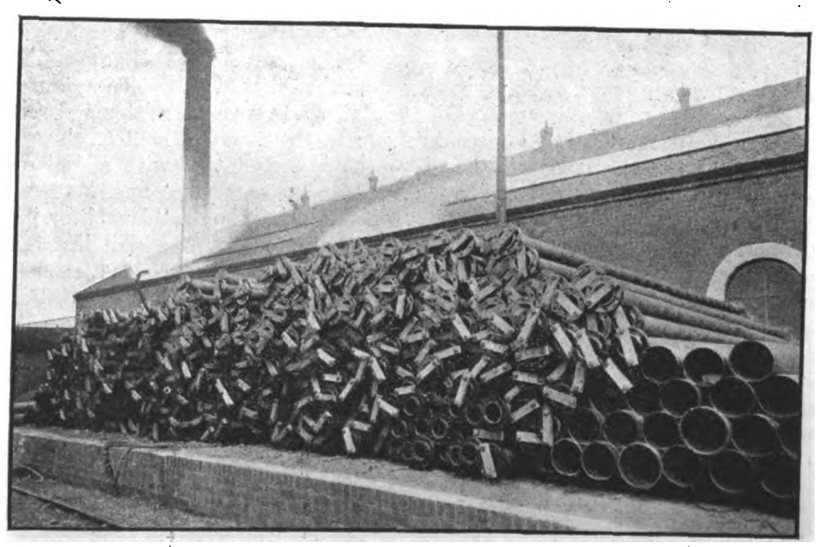
THEY ARE ABOUT ONE FOURTH THE WEIGHT OF CAST IRON; CAN BE SUPPLIED IN LENGTHS UP TO 40 FEET; FOR ANY PRESSURE; AND NEITHER LEAK NOR FRACTURE.



PART OF AN ORDER OF 75 MILES OF STEEL PIPES WITH STEWARTS' Nº 1 JOINT.

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instruments and at the same time rings a trembler bell in the engine-room. For this signal it is not necessary for onsetter and the banksman to operate their switches together, as in the case of the other standing orders.

For mines in which there are two or more levels from which it is required to communicate with the engine house, additional sets of indicators are installed under the control of the banksman, to indicate to the onsetters which level to use, and to the engineman to which level to work the cage. Means are also provided in this apparatus whereby only the level to which the cage is working can send orders to the engine house. Each onsetter can communicate to the banksman in order to indicate when he requires the cage to stop at his level. The apparatus is contained in substantial water-tight cast-iron cases, with separate windows for each order. The press switches and the order-sending switches are securely protected, so that it is impossible for them to be accidentally closed.

Messrs. Siemens also make a series of signalling instruments which are adaptable to mining work. A typical transmitter (Fig. 4) and receiver (Fig. 5) are illustrated herewith

An installation of dial instruments in its simplest form consists of a transmitter and a receiver; one transmitter can, however, actuate any number of receivers simultaneously, or, in case every apparatus is provided with a transmitter, orders can be transmitted with each apparatus. The orders to be transmitted, which may be of any number, are marked upon a circular dial over which a pointer is moved electrically. To send any particular order, the pointer of the transmitter is moved, by a handle projecting from the front of the instrument, to the respective section of the dial, whereupon the pointers of all the other instruments move to the same section; at the same time the bells fitted to the instrument ring, announcing a fresh position of the pointer.

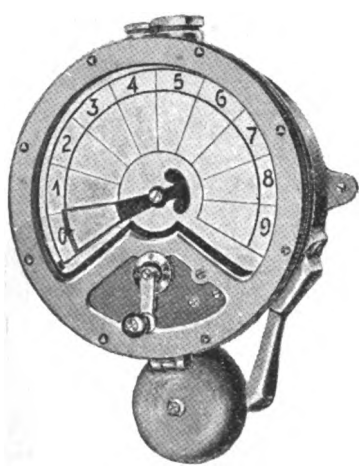

FIG. 4.—SIEMENS TRANSMITTING INSTRUMENT.

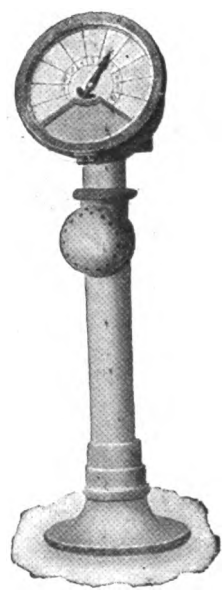

FIG. 5.—SIEMENS DIAL RECEIVING INSTRUMENT.

Each pointer is actuated by a small motor which, during the transmission of an order, receives current and is excited by means of the controller-switch actuated by the handle of the transmitting instrument. The bell fitted to each instrument can be employed, in accordance with the system of connections, either to draw attention to an order or to give a bell signal corresponding with the transmitted order. In the first case the bells ring continuously so long as the handle is turned; in the second case, however, every movement of the handle or each step forward of the pointer by one section of the dial produces a sharply defined bell signal or, if single-stroke bells are employed, a single stroke on the bell; so that the transmitted order can be understood, not only by the position of the pointer, but by the number of bell signals or strokes respectively. This double method of transmitting signals offers, it is claimed, the greatest security in working; it is, however, necessary always to start from the zero section of the dial, as otherwise the number of bell strokes would not coincide with the numbers on the corresponding sections of the dial.

Before sending a fresh order, therefore, the pointers must first be put back to zero by turning the handle of the transmitter to the left and at the same time depressing a switch next to the handle, which causes the bells to be short-circuited so as to prevent them from ringing and thereby causing misunderstandings.

It is impossible to avoid depressing this switch, because, when it is in the normal position, the transmitter handle cannot be turned to the left.

Should the installation consist of two signalling stations only an apparatus with reply-signalling device can be used. This apparatus is fitted with a red and a black pointer; the former is coupled mechanically with the transmitting handle, while the latter is actuated by the electro-magnetic movement. To transmit an order, the red pointer of the transmitter is set by turning the handle to the correct section of the dial, whereupon the black pointer of the receiver takes up its position on the corresponding section. In order to send a reply, the red pointer on the receiver is set over the black pointer, whereupon the black pointer on the transmitter moves under the red pointer. The person who gives the order is therefore assured of the fact that his order has been transmitted and received correctly.

A four-core cable is required for instruments without reply gear, but for those with reply gear a seven-core cable is necessary. The number of different signals that can be transmitted is entirely independent of the number of cores in the cable. Primary or secondary batteries can be employed as the source of current, the apparatus being worked on the open-circuit system. Should a continuous-current plant be available, the signalling current can be taken from this by interposing a suitable series resistance.

The apparatus is of simple and substantial construction in all its parts and is water and gas-tight, so that it is quite suitable for use in mines. As a proof of the efficiency of the system, we may mention that it has been used largely for over 10 years not only in many mines and other industrial concerns, but also on railways and for the transmission of all kinds of signals.

The "Adnil" Automatic Shaft Signalling System.

An interesting apparatus which has been designed to assist in the safe operation of shafts is that invented by the Deutsch Telephonwerke of Berlin, for whom the Adnil Electric Co. are sole agents. For giving signals for winding men and materials this automatic system is claimed to be perfectly "fool-proof."

The equipment for each seam comprises a combined transmitter and receiver (Fig. 1) and a single stroke bell or electric hooter. The combined transmitter and receiver is furnished with a dial over which moves a pointer, a signalling lever, "level" or "seam" indicator push, an emergency push and "level" or "seam" indicator. At the heapstead is installed a dial instrument similar to Fig. 1, but fitted with a further contact maker called the "carry out" push. A single stroke bell or electric hooter is provided for ordinary signals and a trembling bell for emergency signals.

The engine driver is supplied with receiving apparatus as shown in Fig. 2. The central switching mechanism, for setting up and automatically passing on the signals to the engine man, is contained in a small oak case having a glass front. This apparatus can be installed in some suitable situation in the engine-room. If a signal is to be transmitted by the miner at say No. 1 level, he would first of all cause the words "No. 2 Level" to appear behind the small pane in the upper part of the receiving instrument. This is done by depressing the level indicator push. At each depression the level indicators of *all* the instruments step round and display the words "No. 1 Level," "No. 2 Level," "No. 3 Level," or "Bank," as the case may be.

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The stepping round of the level indicator causes an alarm bell inside the apparatus to ring. The bankman and engine driver will thus understand that all signals are to come from the level indicated as all the intermediate instruments are cut out of circuit, so far at least as the giving of ordinary signals is concerned.

The miner now moves forward his signalling lever. For every forward movement of the lever the pointer of all the instruments, excepting the engine driver's, makes one step forward and the single stroke bells or hooters sound once at every step. The signal thus given is stored up in the central switching mechanism until the bankman depresses once only his "carry out" push when the pointer of the engine driver's instrument immediately flies back to the zero position and then automatically steps round to the original signal given by the miner. The single stroke bell or hooter will also sound a number of times corresponding to the steps made by the pointer. As the pointer of the engine man's instrument steps round to the desired signal the pointers on all the other instruments return automatically to the normal position unaccompanied by any audible signal. It may be stated that the signalling

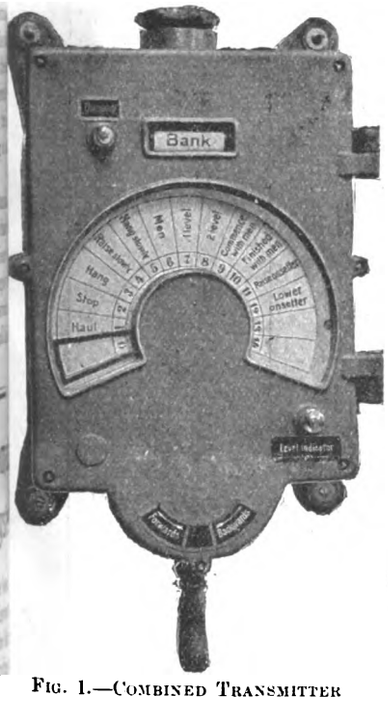

FIG. 1.—COMBINED TRANSMITTER AND RECEIVER.

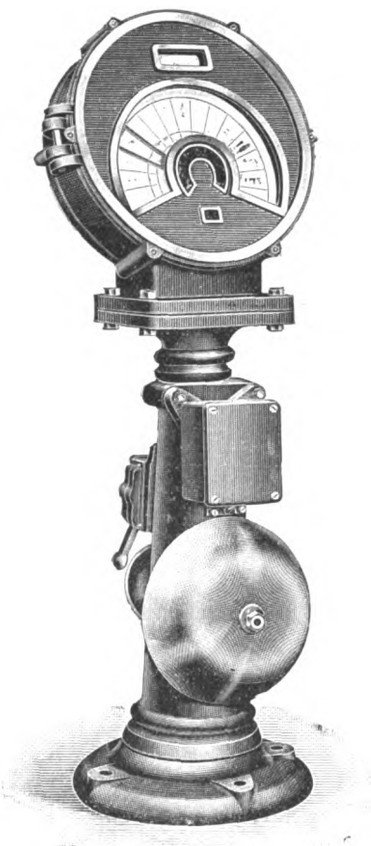

FIG. 2.—ENGINE DRIVER'S RECEIVING APPARATUS.

lever and pointer can be moved either forward or backward, but no matter how it is shifted about the engine driver receives only the signal on which the pointer is resting when the bankman presses the "carry out" push. The signal last given remains on the engine driver's instrument until a fresh signal is sent through by the bankman. The emergency push and bell is provided for use in case of danger or accident.

In addition to the apparatus above described, the "Adnil" system is sometimes fitted with a device for keeping a constant record of the last six signals given to the engine man and it can also be fitted with printing mechanism for recording the number of each signal and the time it was given. We are informed that this system is very popular in Germany and has been installed in over twenty mines, including several controlled by the German Government. We also understand that the Adnil Electric Co. have received an order to equip the William's shaft of the Dolgoath mine with this system of signalling. Copper ore is drawn from this shaft which is in Cornwall and is said to be one of the deepest in the world.

A High-Tension Telephone.

An interesting instrument which has been designed by Messrs. Siemens Bros. & Co. for use on telephone lines, running in proximity to high-tension circuits, thus often enabling one pole to be used for both high tension and telephone lines is the high-tension telephone illustrated in the accompanying photographs

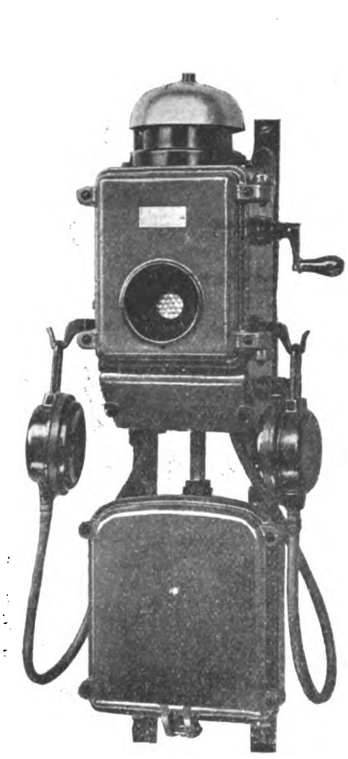

FIG. 1.—GENERAL VIEW OF HIGH-TENSION TELEPHONE.

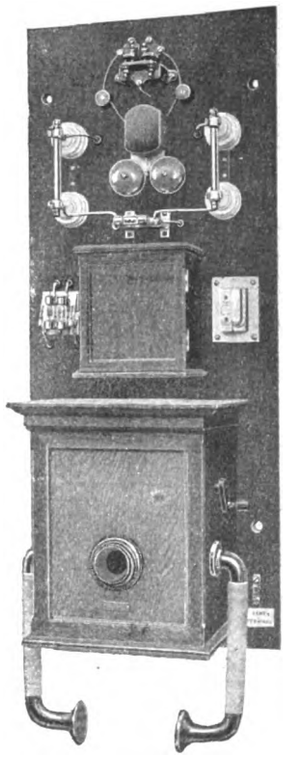

FIG. 2.—VIEW OF PROTECTIVE APPARATUS.

(Figs. 1 and 2). This instrument, which is of the "bridging" type and can be used therefore as a terminal station or "bridged" across the line, is fitted with the latest most sensitive and efficient protective devices for ensuring the safety of both user and instrument. The telephone itself is so arranged that the user is not brought into contact with any current-carrying part of it, the sound being transmitted by means of insulated hearing tubes. Fig. 3 shows a portable type of instrument.

FIG. 3.—PORTABLE HIGH-TENSION TELEPHONE SET.

The following (Fig. 4) are details of the different protective devices, with their several uses. The lines enter at a point arrester designed to conduct heavy lightning discharges to earth; they then pass through two retardation coils which effectually bar the way to a possible residual discharge, and

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continue through two high-tension non-arcing fuses which cut off the apparatus in case of a cross with a power circuit. A vacuum arrester, which is bridged across these fuses, serves to short-circuit the instrument in the event of a difference of potential arising between the lines. Each line then traverses a combined spark-gap and vacuum arrester fitted with a heat coil. These arresters, being contained in a vacuum, are so sensitive that they will actuate at 300 volts and thus afford protection against every power circuit. The heat coil comprised in this type of vacuum arrester is arranged to fuse at

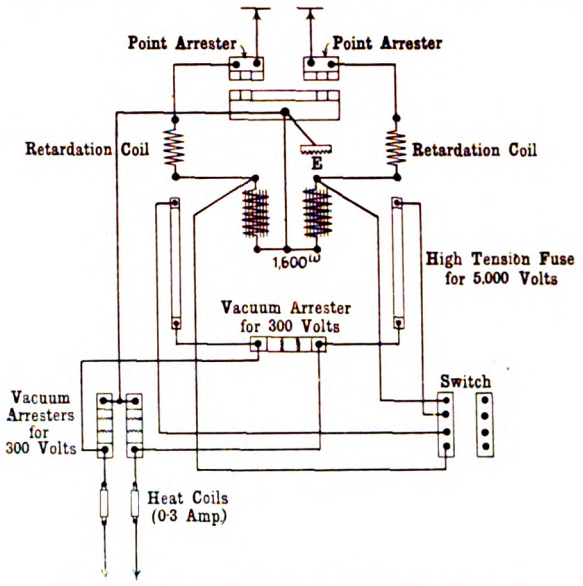

FIG. 4.—DIAGRAM OF SIEMENS H.T. TELEPHONE.

0·3 ampere, thereby protecting the instrument from "sneak" currents, which, though only small, may, by flowing for a prolonged period, do serious damage.

Sterling Mining Telephones.

In the following article we give some details of the telephones designed and manufactured by the Sterling Telephone & Electric Co. for mining work.

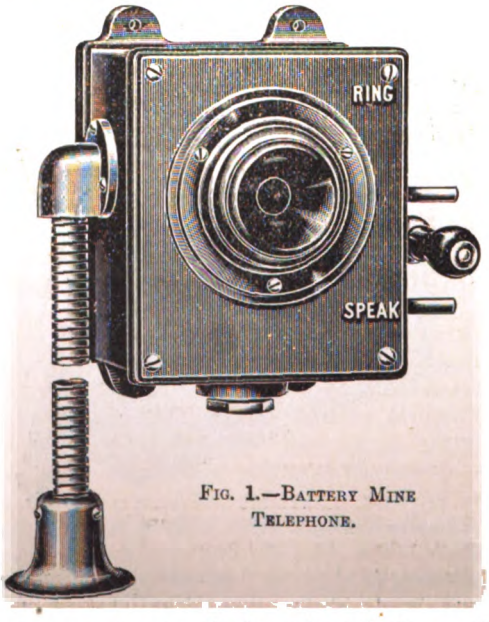

FIG. 1.—BATTERY MINE TELEPHONE.

Fig. 2 shows a magneto ringing mine telephone. It is contained in a waterproof iron case, and comprises a horizontal granular carbon transmitter fitted inside the box, an induction coil, triple-magnet generator, two double-pole receivers with cords encased in leather tubing, a 2,000-ohm polarised call bell with the movement enclosed in a waterproof iron box mounted separately on the backboard, an automatic switch hook provided with a stuffing box, backboard, and battery box of paraffined oak for two Leclanché cells.

Fig. 1 shows a battery ringing mining telephone. This is also enclosed in a waterproof iron case. It comprises a capsule "inset" shot carbon transmitter, an induction coil, a large pattern powerful double-pole receiver, a hand ringing and speaking switch, a hearing tube, and substantial connecting terminals. The whole of the above parts are fitted in a cast-iron waterproof case, provided with a stuffing gland through which the line wires are led to the interior.

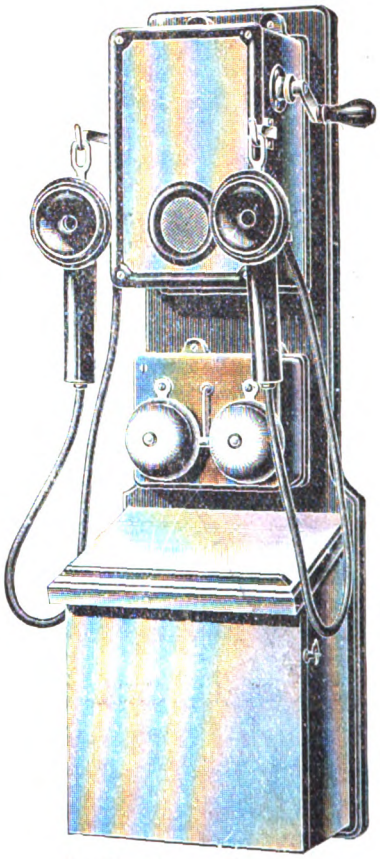

FIG. 2.—MAGNETO RINGING MINE TELEPHONE.

FIG. 3.—ANOTHER MAGNETO MINE TELEPHONE.

Another magneto instrument specially designed for use in mines is that shown in Fig. 3. It consists of a complete pole telephone for the magneto ringing type of local speaking battery systems. It comprises an aluminium damp-proof hand-combination of great mechanical strength with a loud-speaking receiver. This receiver is fitted with a leather ear-pad. There is also a loud-speaking interchangeable inset transmitter with a folding leather mouthpiece and battery key in the handle an induction coil, powerful triple-magnet generator, which is fixed on the base to facilitate removal for inspection, a large double dry cell, a carbon lightning arrester, line fuses and terminals. The whole of the parts are mounted in a solid teak case and are enclosed in a watertight iron box with a brass

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lock and key and glass-fronted receptacle for emergency key. The whole set is complete with four strong wrought-iron fixing straps, bolts and nuts.

Fig. 4 shows a telephone which has been arranged for use on telephone lines which run in the neighbourhood of high-tension circuits. The receiver, transmitter and generator are

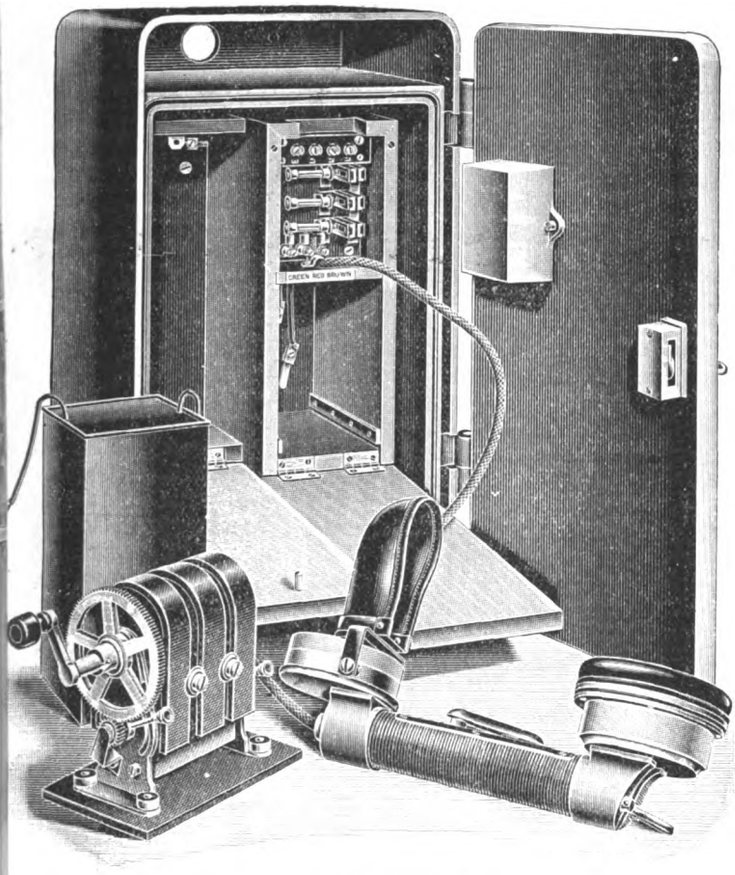

FIG. 4.—TELEPHONE FOR USE NEAR HIGH-TENSION LINES.

insulated so as to exclude completely any danger which might arise by contact between the telephone lines of high-tension conductors.

Warning Notes for Mines.

The extension of mining operations to points which, in some cases, are several miles removed from the main shafts has occasional demand for a means of giving audible warning to miners of approaching danger or for other reasons. At the same time, the extension of electric circuits in collieries and mines has been responsible for the introduction of electric warning signals and bells.

The piercing sounds emitted by such a device as the "Klaxon horn are admirably suited to give warning to miners at almost any point of the workings. The "Klaxon" horn is an extremely simple device, and it has the merit of being of substantial construction, so that it should be capable of meeting the most severe conditions in mining service. The "Klaxon" horn is well known in the motor car and motor boat world, and has, we understand, successfully withstood the most severe tests.

The horn depends for its sound on a small motor, the armature of which is placed in a vertical plane, and the upper end of its shaft is extended a matter of 6 in., and fitted at the extremity with a steel disc having a regular number of projecting teeth. These are revolved at a high rate of speed—the motor runs at 3,000 revs. per min.—and in turning they strike against a vanadium steel anvil, which is firmly secured in the centre of a thin steel diaphragm. This diaphragm is securely fixed round the circumference of the disc with an annular clamp. Fig. 1 makes this construction perfectly clear. The horn for the dispersion of the sound is placed immediately in front of the diaphragm, and it may be of any desired length according to the purpose for which the horn is required. Fig. 2 is an illustration of the complete instrument with a long pattern of horn for the transmission of sound over long distances. The motor can be operated from a battery circuit of 4 or 8 volts, but the motors can be supplied for operation on 110-volt circuits.

FIG. 1.—CONSTRUCTION OF "KLAXON" HORN.

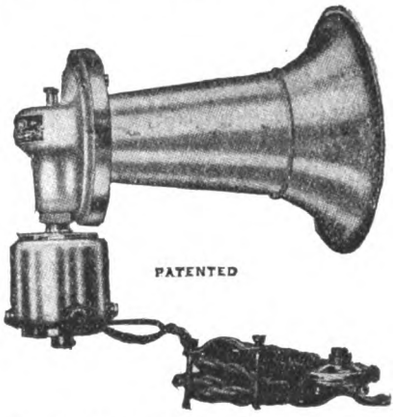

FIG. 2.—COMPLETE INSTRUMENT WITH LONG HORN.

For industrial service the "Klaxon" can be employed as a hooter for sounding the hours for the workmen. We understand that some experiments were recently carried out in the rivetting shop of a large boiler works where the fiendish din has rendered the men practically deaf. Previous to the introduction of the "Klaxon" horn it was next door to impossible to ring off the men. By the use of two "Klaxon" horns, one at each end of the shop, the men understand when it is time to go to dinner or to knock off work.

In addition to the electrically-operated pattern referred to above, a hand-worked design has been got out. Illustrations of the interior and exterior of this are given in Figs. 3 and 4.

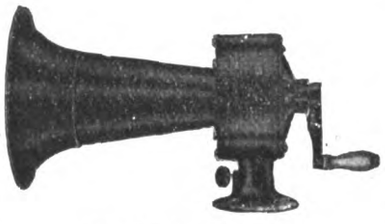

FIG. 3.—HAND WORKED HORN

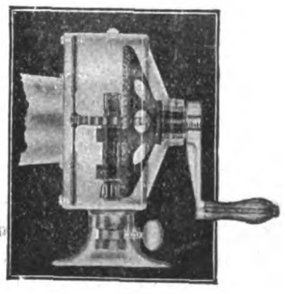

FIG. 4.—SECTION OF HAND WORKED HORN.

This is sufficiently light to be carried about and it would be found useful to take into the workings and in case of a fall or the imprisonment of the men, they would be able to give indication of their whereabouts or welfare. Further details and prices of this horn can be obtained from the Motor Accessories Co., Gt. Marlborough-street, London, W.C.

Electric Winding for Collieries.—With reference to the article dealing with the electric winding engine at South Kenmuir Colliery which appears on p. 128 of this issue, we are asked by Messrs. Crompton to state that the figures of efficiency given therein refer to the 140-fathom depth, and not to the 90-fathom depth which is at present being worked.

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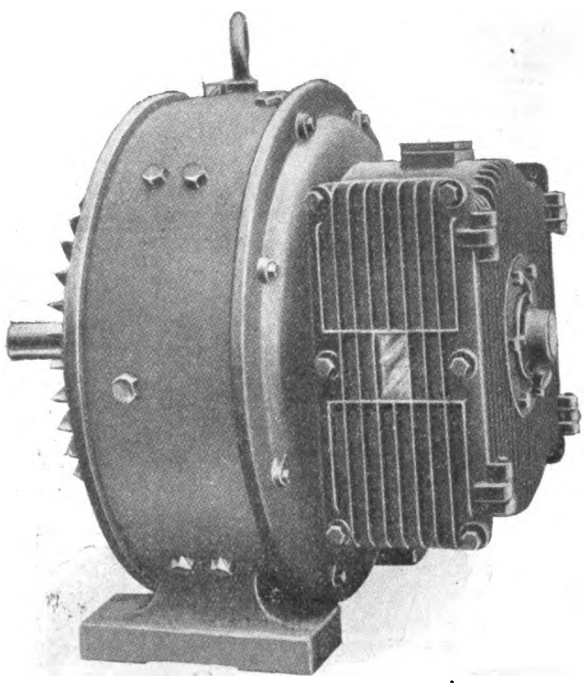
"Phœnix" Mining Motor.

The Phœnix Dynamo Manufacturing Co. inform us that in the ordinary course of a large business in colliery work they are repeatedly asked for a motor which shall be perfectly and permanently flame-proof under working conditions, and at the same time be simple in design and construction. In attempting to solve this problem, they realised from the beginning that the best results could only be obtained by co-operation with prospective users of such plant, and they are greatly indebted to several well-known mining engineers, whose advice was given during the period occupied by the design and experimental perfection of the new type. As a result of repeated conferences, a certain number of essential conditions was first of all laid down, and the finally completed design is shown in the accompanying illustration. They claim that this machine is undoubtedly a mining motor designed by mining men.

The following conclusions were the outcome of their investigations previous to the design of the motor :—1. The machine must be absolutely explosion-proof. The Phœnix mining motor is absolutely flame-proof under explosion pressures. Total immunity from the passage of flame is achieved by making



PHŒNIX FLAME-PROOF MOTOR.

each joint on the surface of great length. There are no oil chambers or passages, and the bearings, which are placed outside the motor proper, have no direct communication with the interior of the machine. Where the shaft passes through the casings, cooling glands are fitted, the efficacy of which glands is fully established by the tests described lower down. 2. Its working parts must be easily accessible; its doors must be easily sealed, and the brushes in the case of direct-current motors must be easily visible without breaking any seals. The Phœnix mining motor has two large doors of very adequate size for adjustments. These doors are sealed in a very simple manner so that the motor cannot be opened by any unauthorised person without it being detected. The machine is fitted with observations windows, consisting of ½ in. plate glass suitably protected. The leads are all brought out at the top of the machine and arranged in such a position as to prevent, as far as possible, damage by abrasion. 3. Its rating must be very ample to avoid overheating and its capacity for overloads great. The clearances between live parts and the carcase or castings to be very ample. The Phœnix mining motor is designed to give its full output at a specified temperature rise. Further it will give 25 per cent. overload without sparking and 50 per cent. overload without injurious sparking. The clearance between the brush holders and the carcase is unusually large. 4. Its lubrication must be automatic and require only the minimum amount of attention. If oil wells are eliminated much less attention will be necessary. The Phœnix mining motor is fitted with heavy type ball or roller bearings; the housings are perfectly (not commercially) dust-tight. There are no oil wells, and the machine will run for three months without a renewal of the grease being necessary. The bearings are of a special type, manufactured to withstand shock and are guaranteed for two years. It should be noted that the following causes of serious trouble in the usual type of machine—oil creeping and leaking, overfilling of oil chambers, and any chance of hot or "seized" bearings are totally eliminated. 5. The insulation must be moisture proof and of exceptional quality and robustness. The Phœnix mining motor is insulated by a special process; each coil is subjected to a high-pressure test—(*a*) After winding; (*b*) After fitting into the core; (*c*) On the completion of the armature. The windings are impregnated under vacuum on two separate occasions, and during the last operation they are subjected to a pressure of 50 lb. per square inch, thus assuring that all the the interstices are filled with insulating materials. No insulating material or varnish is put into the machine unless it is capable of standing, without damage, a temperature of 250° F.

A series of explosion tests has been repeatedly made on this motor in the presence of mining experts. The motor was placed inside a chamber made of heavy wood, zinc-lined, and suitable connections were made to a device for passing into the case a mixture of gas and air, previously tested by an explosion meter so as to ensure its being of the most explosive character procurable. Sparking plugs were fitted, one inside the motor itself and the other inside the case.

The motor was first lifted out of the case, filled with gas and air mixture, and exploded electrically by means of a sparking plug. After five or six similar explosions, no detrimental effect or any signs of the explosion were visible on the motor itself, thus proving, that it was quite suitable for withstanding explosion pressures. The discharged gases were then blown out of the motor, which was again filled with gas and air, and the complete machine was placed inside the wooden explosion chamber, which chamber was in turn filled with the correct mixture of gas and air. The mixture inside the motor was then fired, and the gas in the explosion chamber itself was not exploded. Then as a proof that this outside mixture was actually explosive, the sparking plug fitted therein was fired and a complete explosion followed.

The whole object of this test was to reproduce as nearly as possible the actual conditions which would obtain in a mine. It is obvious that the first time the doors were opened below ground, the motor itself would become full of the gaseous atmosphere surrounding it, so that in the case of a short circuit or spark occurring in the machine, this internal mixture would be exploded, and the claim which was established during the test described above was that in the event of this taking place in a Phœnix flame-proof motor, there could be no resultant explosion of the outside atmosphere. These tests have been frequently conducted in the presence of mine owners and experts and have been pronounced to be quite conclusive.

Miners' Safety Lamps.

For a great many years this country has been in the position of having a large proportion of its safety lamps manufactured in a haphazard manner by firms of general brass workers, who make specialities of water or steam valves or the like, filling any spare time with safety lamps; as a result of this nondescript method of manufacture, and the ignorance of the makers of the essentials of a safety lamp, there have been placed on the market a great variety of odd size lamps, many of which can be shown to be quite unsafe, either from original defects in the type of lamp or in its manufacture, or from defects brought about by

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lack of standard size and consequent bad fitting of the renewals. Having made a scientific study of miners' safety lamps and appliances connected therewith, and having spent large sums of money in experiments and improvements thereon, and in the purchase of the best and most up-to-date machinery for their production, Messrs. Ackroyd & Best feel they are in a position to turn out the very best article, and to give every satisfaction under the most trying circumstances. Their lamps and apparatus are now and have been in use at some collieries for close upon 20 years, and although they have something like 200,000 lamps in use in good, bad and indifferent mines in this country, they have never yet heard of a single instance where they have been the cause of a mine gas explosion.

There is no doubt that the electrically ignited oil lamp, furnished with an automatic lock, which can only be opened by

FIG. 1.—ACKROYD & BEST MINERS' SAFETY LAMP.

an electromagnet in the lamphouse, is now considered the standard mining lamp, one reason being that with it relighting in the mine is absolutely safe, which cannot be said of lamps fitted with self-contained igniters, these latter having many objectionable features, amongst which may be mentioned the ease with which such igniter may be operated by the aid of a common nail roughened or chipped by a wedge or chisel on one side, near the end, this being readily inserted so as to catch and grip the operating spindle of the igniter of the lamp, and so easily operated by any lad or man in any part of the mine, such, for instance, as the coal face or in the comparatively dangerous return airways, and possibly a light may be formed in a lamp having a damaged glass, and, of course, if gas be about, an explosion would consequently ensue. Seeing, therefore, the ease with which this igniter may be operated in an unauthorised manner in the mine, it appears to us that a false sense of security is created by the provision of screwed special keys in the custody of the deputy, or by chaining the key to a prop some distance from the coal face. In the latter event it is highly probable the key would be stolen.

With self-contained igniter lamps, an air inlet underneath the glass is generally employed. This is, Messrs. Ackroyd & Best consider, not only mechanically bad, but it is highly probable that just at a critical moment, when the lamp is required to withstand an unusual influx of gas, the gas flame which would burn at this inlet would so heat the glass that it would crack, and the mine gas be ignited and an explosion ensue; furthermore, highly volatile spirit is generally used in these lamps, and their experience is that there is a general movement taking place to cast out spirit lamps owing to the risk in the mine and also on the surface of burning down the lamp cabin and the whole pit head gear. They have, therefore, concentrated their attention more and more on high-flash oil lamps and apparatus. It is impossible to open the lamps with the means available to a miner in the mine, and it is only possible to relight them at the safe relighting machines fixed at convenient positions in the pit, the relighting machines being too heavy to be moved surreptitiously from the position

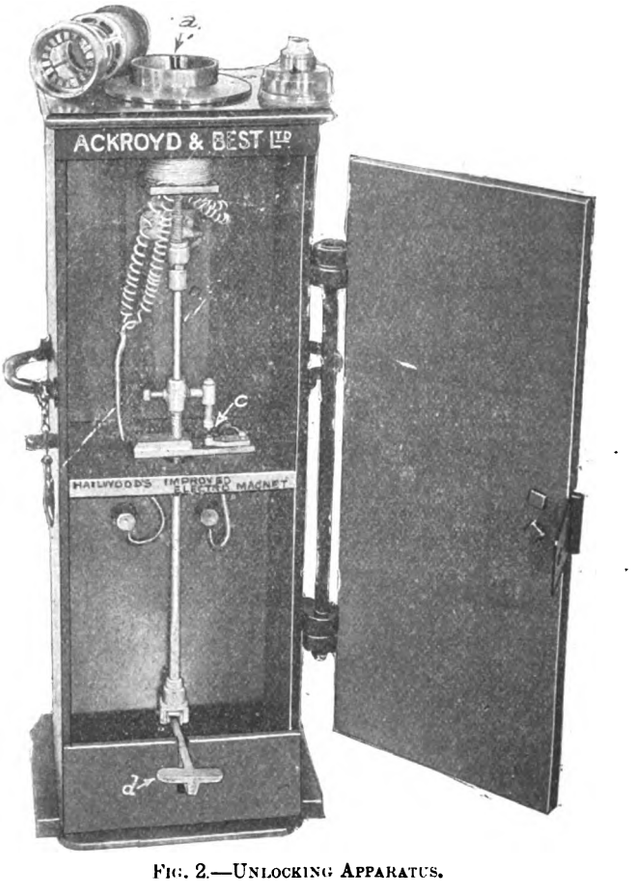

FIG. 2.—UNLOCKING APPARATUS.

assigned them by the officials, and yet not too heavy to prevent their being moved forward by the proper authorities as the coal face advances.

Under the Ackroyd & Best system, the miner receives a perfectly clean lamp which is only lighted when called for by him, and has not had to stand burning for hours on the lamp-stand, as is the case with the old style of lamps, which are lit by a torch and then locked, necessitating the commencement of the lighting-up process hours before the miners arrive. If the light goes out in the mine, it may be quickly and safely recovered on one of the safety underground relighters, which are placed at convenient positions in the pit. The miner, therefore, has no incentive to open his lamp, but if he should have such a desire he is faced with the insurmountable barrier, *i.e.*, the magnetic lock.

With these lamps and apparatus the lampmen, it is claimed, are able to do their work well and quickly, because all the parts

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of the lamp are so arranged as to enable the cleaners to manipulate them in the least possible time. A special feature of this lamp is that if the gauze be absent the lock at once demonstrates the fact by refusing to act, so that it is unlikely a lamp can be sent into the mine without being provided with a gauze. This, Messrs. Ackroyd & Best submit, is far better than the employment of a detector in the bonnet, seeing the latter invariably gets dented, thus preventing the detector acting.

The magnetic lock described below has withstood the severest possible tests, and it has been proved to be impossible for anyone to make it fail or to tamper successfully with it in the mine.

The lamp shown in Fig. 1 is fitted with Ackroyd & Best's patent glass ring and oil filling valve, and Hailwood's patent automatic magnetic lock, combined electric igniting pin, wick snuffer, and removable wick tube. The vessel is cast in one piece, thus doing away with the soldered bottom plate. Platinum is not used in the lamp. All the parts are simple and strong, the bonnet is formed of one piece of seamless and jointless steel, the crown being an additional plate for extra safety. The lamp burns oil having a flash point of over 250°F., and is very sensitive to gas.

Fig. 3 illustrates the lamp in which part of the vessel and bush have been cut away so as to show the interior of the Hailwood patent lock; it will be seen that the glass-holding ring *a* is provided on the underside with ratchet teeth into which engages the iron lock bolt *b*, which is held in the up position by means of a strong spring *d* resting on a slidable iron guard plug, *e*; the latter resting on a solid shoulder formed in a recess in the lamp bottom. This guard plug effectively prevents any tampering with the lock. Anyone pressing the guard upwards compresses the spring *d*, and causes it to hold up the lock bolt *b* even more effectively, making it impossible to tamper with the lock by means of a permanent magnet, whereas, when the lamp is placed on the electromagnet described below, the nose of the magnet will press upwards the guard plug *e*, magnetise it, and get a strong magnetic grip of the lock bolt *b* immediately the plug comes into contact with it. The depression of the electromagnet pedal drawing down the guard plug, and with it the lock bolt *b*, thereby releases it from the teeth of the glass ring, so that the lamp top may be unscrewed from the oil vessel, all of which is the work of only a moment. To lock the lamp, the mere act of screwing on the vessel will cause the lock bolt *b* to click over the ratchet teeth of the glass ring until the oil vessel has been screwed home, and the vessel then cannot be again removed until opened by the electromagnet.

Particular attention may be drawn to the fact that all the lock parts are inserted from the upper face of the lamp vessel, and are held in position by a detachable screwed bush, *c*, so that if at any time it is desired by the surface officials to take out and renew the lock parts, this operation may be performed in a moment, as there are no pins to drill, out and unsolder and to re-solder. A further most important point is that if dirt should wash down into the lock it will not interfere with the opening of the lock in the lamp-house because the nose of the magnet presses the guard plug up and squeezes out any dirt, thus getting a strong magnetic grip of the lock bolt *b*. This enables the strongest possible spring to be employed. It will be obvious that this method is far superior to that in which the guard plug is inserted from the bottom of the vessel, and is secured in position by a screwed and soldered pin, which may be surreptitiously forced out, the lock parts abstracted and the lamp opened. This latter type of lock (and, in fact, most locks intended to be opened by a hand or permanent magnet) is also subject to the great objection that the lock bolt is attracted to the plug through an air gap. It will, therefore, be seen that it is only possible to employ a very weak spring with such locks, and this in course of time allows the lock bolt to lag or stick in the open position. And again, when dirt washes down into the lock parts in the lock in question, the dirt effectively prevents the magnetism penetrating it and drawing the lock bolt down. The result is that the only way in the cabin to open such a lamp is to break it or drill out the lock, thereby creating confusion and delay in the lamp-house. On the other hand, lads of 14 or 15 years of age can open these lamps on the electromagnet in the lamp-house as fast as lamps can be handed to them, and at a rate quicker than the old lead plug locks can be knocked off.

The illuminating power of this lamp in English standard candles is 0·67, as compared with 0·71 standard candle power of the ordinary tallow dip candle, and 0·66, the highest standard candle-power of the open flame lamp burning seal oil (the height of flame in the open lamp does not continue long, for rapidly decreases).

The absence of means for completely snuffing the wick of a lamp during a shift has long been recognised as a great grievance; this trouble was particularly acute with the electrically-ignited oil lamp, because of the difficulty in getting the current to penetrate the hard crust which formed on the top of the wick of an extinguished lamp, this crust often preventing the relighting of the lamp in the mine. Hailwood's patent snuffer provides, it is claimed, a simple remedy for a long-felt want. An insulated brass wire which passes through the lamp vessel is provided at its upper end with a cross-head, one end of which acts as a sparking point for throwing on to the wick the electric spark which ignites it, whilst the other end of the cross-head is thinned out so as to form a snuffer arm. When the igniting point is in position the snuffer arm is directed away from the burner, and therefore cannot interfere with the igniting process, as would be the case if the snuffer was on a separate pin. The bottom end of the brass wire is provided with a brass button, between which and the underside of the lamp vessel is

FIG. 3.—LAMP CUT AWAY TO SHOW PATENT LOCK.

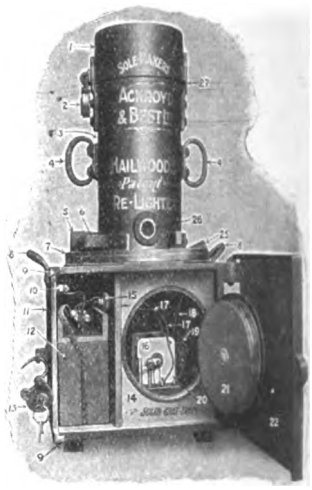

FIG. 4.—UNDERGROUND RELIGHTING APPARATUS.

a small spiral spring, tending to keep the igniting pin and snuffer depressed below the height of the flame, so as to avoid forming shadows. In the centre of the porcelain part of the burner a nick is formed, into which the igniting pin falls when the above-mentioned button is operated, and thus ensures the lighting pin always being in the best position for relighting.

For unlocking, the lamp is placed in a brass dish on the top of the apparatus (Fig. 2), the lock of the lamp being over the magnet rod *a*. The foot-treadle *d* is then depressed, thereby closing the switch *c* and simultaneously causing the current to flow round the coil, this transforming the iron core rod into a powerful magnet, which seizes hold of the lock-bolt. The continued depression of the treadle and magnet core rod withdraws the lock of the lamp, so that the latter may be opened, the whole operation being the work of an instant. These machines are simple and strong and unlikely to get out of order, cast or wrought iron being employed in the construction of the box and door portions.

The underground relighting apparatus consists essentially of a large rectangular iron box 11 (Fig. 4), having a subsidiary chamber, 14, cast solid with it. This latter chamber carries the induction coil 16. The coil chamber is closed by a circular door, 21, having a flange 1¼ in. deep, which is provided with screw threads over its entire surface, and which engages with

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similar threads provided on the circular aperture in chamber 14, so that when the door is closed it automatically makes a gas-tight joint, which cannot get out of order. This circular door is firmly hinged to the side of the box 11. It cannot be misplaced, it is claimed, and must, in fact, be closed completely before the flat door 22 can be closed and padlocked. Accumulators are placed in a compartment of box 11. To allow of the easy escape of the small quantity of accumulator gas which may form, ventilation gaps 9 are formed between the front of box 11 and the inside of the flat door 22, the flange of which door guards the gaps. On the top of the box 11 is placed the lamp chamber formed of two iron cylinders, the outer one 3 being capable of revolving round the fixed inner one 30. In the base of the fixed inner cylinder an iron lamp dish having an insulated electric contact is arranged. Lamp admission openings are formed in the walls of the two cylinders. To enable the lamp to be passed into the inner chamber the outer cylinder is revolved until the opening in it coincides with the opening of the inner cylinder, the lamp being then completely enclosed by the reverse rotation of the outer cylinder, somewhat after the manner of the well-known policeman's lamp. Above the crown of the lamp chamber is a further chamber, which, when all the parts are assembled, is closed in by a deep iron cap. In this latter chamber is arranged a switch device in such a manner that the lamp chamber must be closed before the current can be switched through the lamp, and also that the lamp must be in position before the electric circuit can be closed. The current from the accumulators and the induction coil is conveyed by a cable to the switch chamber through steel tubes in the walls of the inner lamp chamber, and terminate in a protected terminal. Directly above the terminal there is arranged a spring contact carried by a push bracket. The upper end of the contact is in electrical connection by means of the flexible cable with a spring contact plunger push carried by the push bracket. The lowest end of the push is directly over a corresponding aperture in the crown of the lamp chamber. This latter push is also provided with a steel roller, supported on the upper face of a circular steel cam plate attached to the upper part of the cylinder. When the lamp chamber is open the roller and push bracket are kept in the upper position, and the circuit is consequently broken. But as the outer chamber is revolved into the closed position the roller will descend and cause the contacts to engage. Current then passes to the spring contact plunger, which latter will, on its descent, penetrate into the lamp chamber and come into contact with the lamp placed therein, the current being conveyed through the lamp to the vicinity of the wick tube, while sparking across the wick effects the ignition. It then passes to the insulated contact in the base of the lamp chamber and back to the induction coil and accumulators. When the lamp chamber doors are open an iron guard plate connected to the outer chamber lies in front of the aperture through which spring contact push enters the lamp chamber, and this guard plate automatically moves clear of the push as the lamp chamber is closed. So that whilst the lamp chamber is open it is impossible to tamper with the electric circuit.

The machine is also provided with a device which ensures that only a safety lamp may be placed in the lamp chamber. The lamp chamber can be locked by a spring lock operated by a peculiarly shaped left-hand threaded key, which may be placed in the care of some person or persons in the respective districts of the mine, although from this description of the apparatus it will be obvious that even if this chamber be left unlocked no harm can result, as the lamp must be in its position and the chamber closed before any electric current can be caused to flow, and in this position the man can do no tampering with it. The switch chamber is closed in by a cap, 1, provided with a strong padlock, 2, which is a duplicate of the padlock 13 of the accumulator chamber, the keys of which are in the care of the lampman or some other official appointed for the purpose. A buffer, 5, and buffer block, 6, are provided to reduce the force of a too violent rotation of the chamber 3.

The operation of relighting a lamp is very simple, as it is only necessary to insert it into the lamp chamber and rotate the outer cylinder, which automatically encloses the lamp and automatically causes the switch to close on the lamp, and the electric current to ignite it, and this without having opened the lamp, the whole operation being only the work of a moment, while every function of the apparatus must invariably follow in its correct sequence from the simple rotation of the outer cylinder. The wearing parts are made of steel, and all joints are either automatically gas-tight, as in the coil chamber, or automatically flame-tight, as in the lamp chamber and switch chamber.

A combined lamp (the Allott, Hailwood & Dean) has been specially designed by Messrs. Ackroyd & Best to suit the requirements of officials and firemen. It combines not only a ready means for testing for firedamp—viz., the standard oil flame—but is also provided with a powerful electric incandescent lamp, the light from which enables a critical examination of the roof to be made. In the event of a disaster in the mine it is possible that the person provided with such a lamp might survive the first effects of the explosion, and if so he would no doubt be able by means of the electric light to reach a place of safety and assist other survivors likewise. In everyday use in the mine he would find this electric lamp useful in reaching a re-lighting station if he should have the misfortune to lose his oil flame light.

In this lamp a long tube-like oil container is surrounded by an annular accumulator in a case, the negative terminal being connected to the case, whilst the other terminal is secured to a plate to which a terminal is attached. The oil container is provided with a shoulder having an insulated contact roller connected to one terminal of a small electric incandescent lamp. The oil container is placed in a circular recess formed by the inner wall of the accumulator, the square base of the oil vessel entering a similar opening in a base plate in connection with a revolvable flange loosely attached to the accumulator case. When it is desired to employ the electric light, say, for instance, if the oil light has been lost, or as an additional light for inspection of the roof, &c., the flange is rotated until roller of the electric lamp rests on the contact plate. The circuit is then completed. The light may be quickly cut out by simply rotating the flange in the opposite direction. When recharging the accumulator with current the wires of the generator are connected to terminals on the base of the lamp. This lamp is very compact and strong, and all the parts are easily accessible to the lamp cleaner.

A Machine which Uses Pit Rubbish as Fuel.

A study of British collieries brings into prominence many important and interesting features in their conduct and management. One of the most interesting of these is the way in which economy may be obtained by the installation of efficient and suitable machinery and labour-saving devices. Yet, often there remains at least one department of the British colliery that is not as efficiently equipped as it should be if the best commercial results are to be obtained. This is the more surprising, for full credit may be accorded to its indispensability. The department indicated is that containing the steam raising plant.

It is not unusual, Messrs. Bennis & Co. inform us, for those responsible for colliery management willingly to expend a considerable sum on the purchase of boilers and engines of the type judged most suitable for the work to be accomplished, and yet to hesitate and haggle over the price of machines for boiler firing, although the use of such machines leads to an extension in the boiler life, and increases the output of steam. At many of the leading collieries the whole of the coal used in hand-firing the furnaces is of considerable market value, and might yield no mean profit if added to the year's sales, instead of which it is withdrawn from possible markets and used in the manufacture of the requisite steam for consumption by the colliery.

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Were there no alternative there could, of course, be no objection so to employ a marketable commodity, but there is an obvious alternative in using pit rubbish and other unmarketable stuff by the means of adequately designed machine stokers. This being the case, it seems extraordinary that such machines should be ignored. In collieries sufficiently wide-awake to have made the substitution, the results obtained by adopting such equipment have been extremely encouraging.

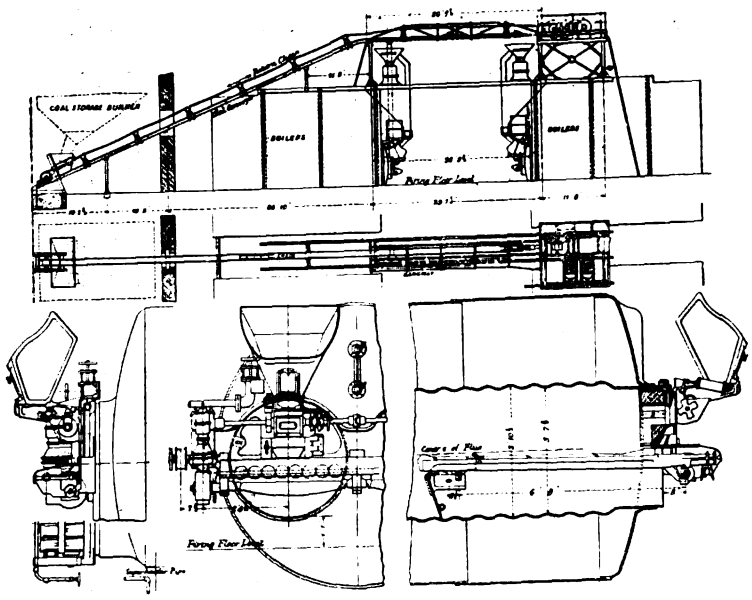

FIG. 1.—"BENNIS" CONVEYOR PLANT AND MACHINE STOKERS INSTALLED IN A CONTINENTAL BOILER HOUSE.

It may not, therefore, be altogether devoid of interest in this connection if we here record a few facts pertaining to boiler houses where this system of boiler-firing is in vogue. These particulars have been kindly supplied by Messrs. Ed. Bennis & Co. In three of the best-known collieries in Yorkshire, whose increase in profits are the envy of others, the ranges of Lancashire boilers are fired by means of "Bennis" machine

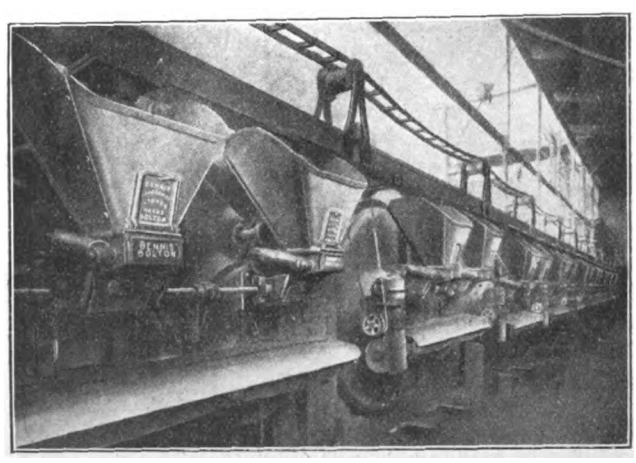

FIG. 2.—A "BENNIS" U-LINK CHAIN CONVEYOR DISTRIBUTING COAL INTO THE HOPPERS OF THE "BENNIS" MACHINE STOKERS AND SELF-CLEANING COMPRESSED AIR FURNACES INSTALLED IN THE BOILER HOUSE OF ONE OF THE BEST KNOWN COLLIERY COMPANIES IN THE WORLD.

stokers and self-cleaning compressed air furnaces. It is generally admitted that for colliery purposes no boiler is superior to the Lancashire type; owing to its hard driving capacity, low costs for repairs and long life, the Lancashire boiler of 8 ft. by 9 ft. diameter is difficult to surpass. These boilers can be made with flanged dished ends so that the tubes may be renewed without the removal of the end-plate. The evaporation of a Lancashire boiler when hand-fired with fairly good coal may be from 7 lb. to 9 lb. of water per lb. of coal, whereas when fired with pit rubbish by means of a "Bennis" machine the evaporation, we are informed, is increased by 25 to 35 per cent.—a very good result, it will be agreed, from material that under ordinary conditions it is necessary to pay to remove as waste.

Nor is the increased evaporation by means of unmarketable refuse the only advantage which Messrs. Bennis find is due to the substitution of machine stoking for hand firing with costly fuels. The boiler life is considerably increased owing to the fact that it is not necessary to open the fire doors, an operation which admits draughts of cold air, thus causing sudden contraction of the boiler front as well as the rapid cooling down of the steam. The machines are fed automatically, without the opening and shutting of the fire doors, by means of an adjustable spring which scatters the fuel on the fire where it is required with a nicety that almost amounts to intelligence. Nor is it requisite that expensive manual labour should be constantly employed in feeding the machines or bringing the coal from remote parts of the colliery to the boiler house. On the contrary, all this is done by a well-designed system of elevating and conveying plant. By means of this mechanical distribution the rubbish is brought from that part of the colliery where it is collected and conveyed thence, elevated and distributed into

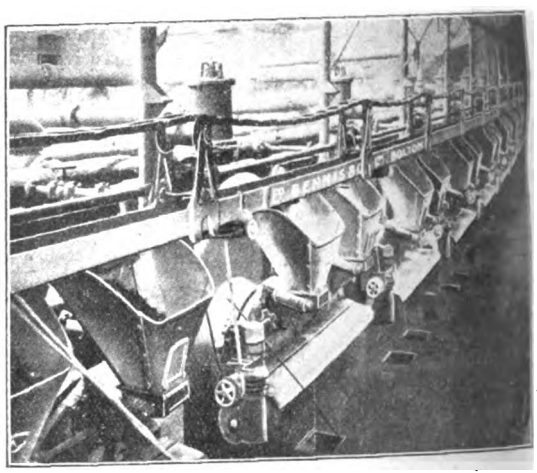

FIG. 3.—A RANGE OF "BENNIS" STOKERS INSTALLED IN THE BOILER HOUSE OF A LEADING SOUTH WALES STEAM COAL COLLIERY COMPANY.

the stoker hoppers by delivery shoots, the cost working out at a figure that is expressed by a decimal of a penny per ton. Such a system it is claimed pays for itself again and yet again within a brief period of its erection. Our illustrations show examples of Bennis equipment suitable for these.

The "Niphan" Couplings and Plugs for Electric Cables.

An interesting arrangement for connecting cables together is that known as the "Niphan." It is due to Messrs. Simmonds Bros. and consists of twin cables with rubber insulation. These cables are enclosed in flexible steel tubes or are armoured in the ordinary way. Suitable lengths of this cable can then be made up and connected together by means of a special mechanical coupling, so that any length of run can thereby be obtained.

The tubing forms, with the couplings, a continuous metallic armouring easily connected to earth, so that accidental shock is practically impossible, and it is thus quite suitable for use in mining. The most important feature of the system is the coup-

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ling (Fig. 1.) The case is of brass, in two parts connected by a screwed and milled ring. The insulating material is ebonite, and the plugs are of gun-metal. Each socket is provided with a small tapered pin which enters a hole in the plug, which is split, thus spreading out the latter when home, and pressing it against the sides of the interior of the socket hole. This ensures, it is claimed, an increased area of contact, and consequently an enhanced carrying capacity. Occasionally it is desired to wire lamps in series, and for this purpose a series connector can be inserted between the two halves of the coupling, or a series coupling used.

Fig. 2 shows an ironclad double-pole fuse board fitted on the top with sockets for connecting to the circuits and a terminal at side for earthing the armouring. The large coupling at the bottom is for the mains. This arrangement is very simple for fitting up or removing, and can be fixed in a few minutes. For works, buildings, shipyards, temporary buildings, field plants and mines a strong coupling is essential to stand the rough usage they would be subjected to, and the patterns which are made with the screw-on sides and water-tight packing ring will fulfil, the

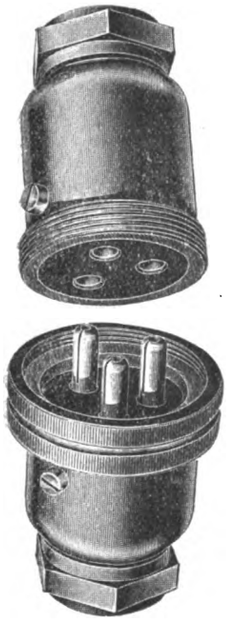


FIG. 1.—"NIPHAN" COUPLING.

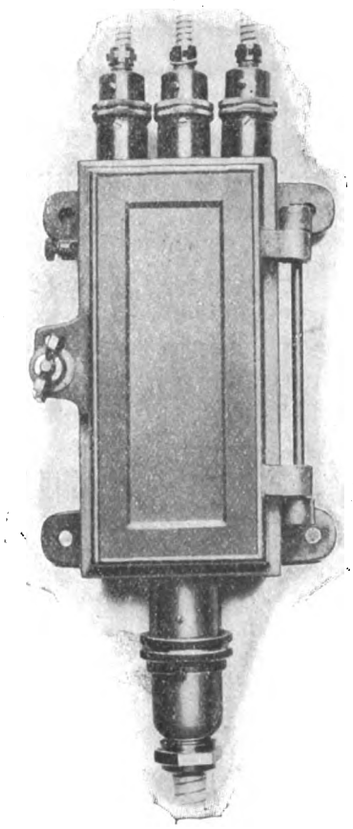
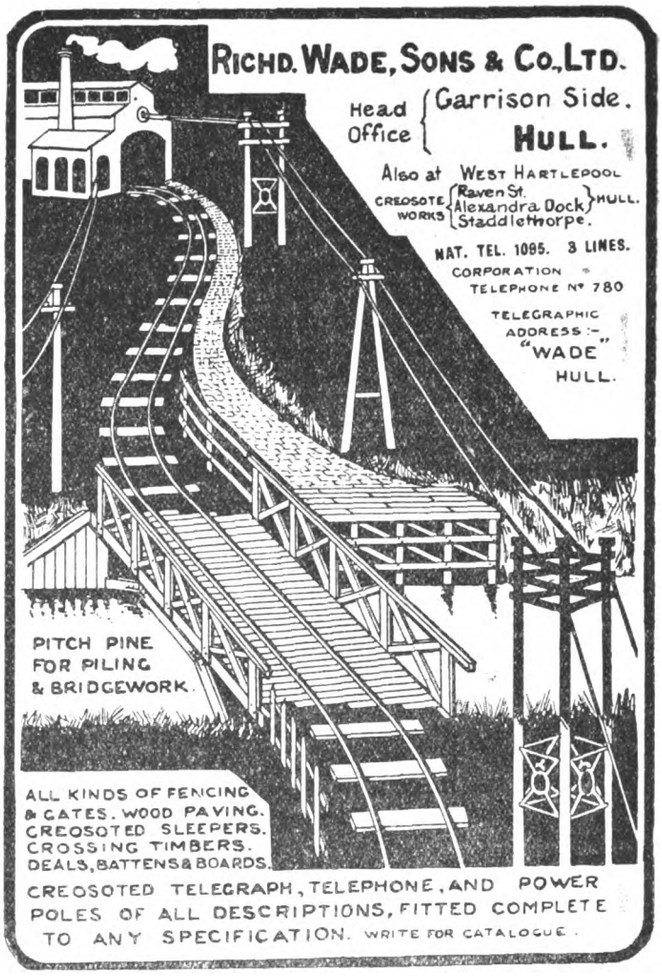


FIG. 2.—PORTABLE FUSEBOARD.

maker claims, any conditions required. For lighting circuits 8 yd. lengths of 60/30 flex in ⅜ in. tube are found the most suitable, with tappings in smaller sizes 10 to 14 yd. long, attached direct to the fittings.

The plug shown in Fig. 1 is made in cast brass with steel bronze finish and ebonite interiors. They are fitted with turned brass terminals and plugs made in one piece with steel set screws. Rubber washers are fixed on the end of the plug couplings, as well as glands for gripping cables or tubes. Plugs with a capacity of 50 amperes and upwards have spokes of unequal size to prevent reversal and the socket holes are sunk. The three-pole in all sizes are unequally spaced and can only be put together in one way. In the 15-ampere couplings, the plugs are of equal size and fit the ordinary simplex and Lundberg wall sockets. Cables enter straight into the terminals without bending.



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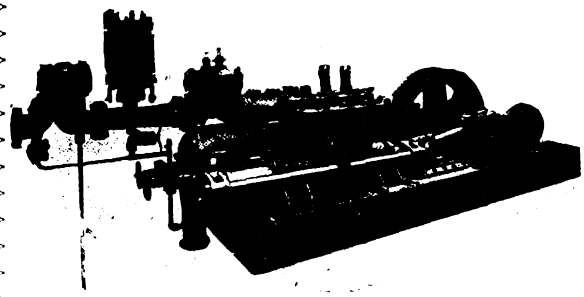

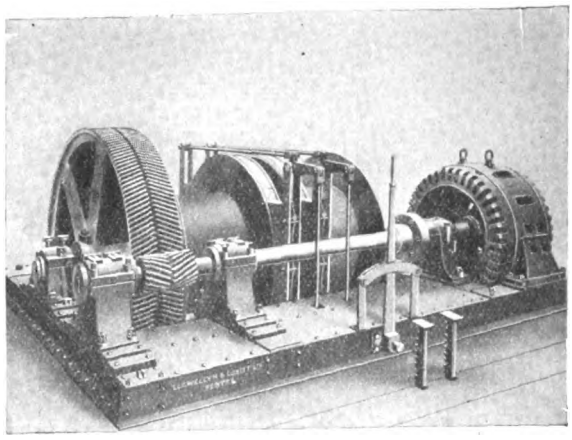

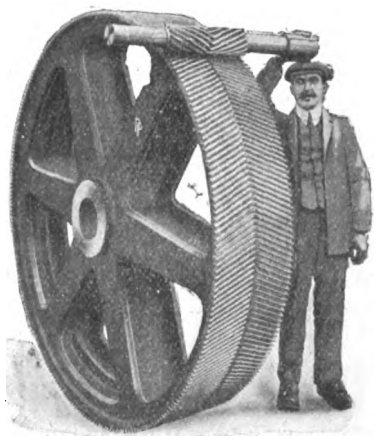

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Influence of Cut Double Helical Gearing on the Design of Electrically-driven Mining Machinery.

BY B. WIESENGRUND, PH.D., A.M.I.E.E.

In a general survey of the application of electric drives to mining machinery it is impossible to overlook the influence exercised on designs during the last few years by the introduction of machine cut double helical gearing. When electric driving was introduced into mines it was quite customary to adapt mining machinery, such as winders, underground haulages, pumps, ventilating fans, coal washing machinery, screening plant, &c., to the drive from electric motors by simply increasing the number of gear trains until a normal motor speed was reached. With this method it was not at all unusual to find slow running machines with three, or even with four, trains of gears, and sometimes a belt or rope drive in addition. It was soon felt that this method was not desirable; the large number of intermediate gears between working machine and motor not only reduced the efficiency, but it also introduced a large number of additional wearing parts and possible sources of breakdowns. Further, it was impossible to make such arrangements compact, so that, particularly for underground work, additional expense had to be incurred to provide the necessary accommodation. As the necessity for simplification became more and more apparent to manufacturing engineers and mine managers, various types of reducing gears were tried, with varying degrees of success. Some five or six years ago the totally enclosed worm reduction gear, the manufacture of which had attained a fairly high degree of perfection, came into favour, and was adopted by a number of firms both for the drive of haulage gears and pumps. The results obtained were far from uniform: whilst in a number of instances such gears proved very satisfactory, in others, particularly in those in which it was attempted to reduce the cost by using comparatively small gears, they proved costly failures. It is now generally understood that for low final speeds worm gears are not suitable, unless made in dimensions, which, both from the point of view of space required and first cost, cannot be regarded as commercial.

A great change was gradually brought about after machine cut double helical spur gearing, made from solid blanks, became available. This type of gearing admits of ratios in a single train which particularly well meet the requirements of electrically-driven mining machinery. Whilst, as recently as five years ago, a gear ratio of six or seven to one was regarded as the upper limit for spur gearing for large powers, it has been found practicable, with the double helical system, to effect much larger ratios in a single train, without any limitation in the power to be transmitted.

The explanation of the high ratio possibilities of double helical gearing is to be found in the continuity of the engagement obtained with spiral teeth. The engagement conditions of double helical teeth are such that the strains set up in the teeth are much smaller than in straight teeth; consequently, for a given power at a given speed, much finer pitches can be employed. With fine pitches it is always possible, by merely choosing a suitable face width, to bring two, three or more of the spiral teeth into simultaneous contact. The pinion diameter for double helical gears is, therefore, determined by the necessary shaft diameter to transmit the power; the pitch diameter of the pinion merely being so much larger than the shaft diameter that the root diameter of the pinion does not become smaller than the shaft diameter, the pinion being cut on its own shaft; *e.g.*, a pinion to transmit 100 H.P. at 400 revs. per min. can be made with a pitch circle of 3¾ in., and, therefore, for a ratio of 20 to 1 a wheel with a pitch diameter of 75 in. is required. This gives a final speed of 20 revs. per min., such as is frequently required for haulage gears. A haulage in which such a gear is used is reduced to the smallest possible number of parts, whilst the reduction gear itself gives the highest possible efficiency, and is more reliable than an ordinary spur gear of smaller ratio, owing to the load being distributed over a large number of teeth in simultaneous engagement, so that no single tooth of the gear has to meet shocks or hammer blows, under which straight cut gearing suffers so severely in mining machinery, which has to be started and stopped quickly and frequently.

A ratio of 20 to 1 is by no means a limit for this type of gear, the possible ratio being in each instance determined by the largest wheel which can be conveniently accommodated. Such high ratio gears doubtlessly call for a pinion material which has a high resistance against wear, not because the load on the pinion is particularly heavy, but on account of the larger number of engagements of each individual tooth. The manufacture of alloyed steels has, however, made such rapid progress during recent years, that no difficulty is experienced in obtaining thoroughly satisfactory pinion material.

The continuity of engagement in accurately cut double helical gears renders them sufficiently silent for mining work, that there is no longer any necessity, or even justification, for the use of soft pinion materials, such as raw hide, fibre or compressed paper, which with straight cut gears have been employed to reduce the very objectionable noise.

By the extensive use of high ratio gears, as described, the design of mining machinery has been changed in a marked manner. Drum haulages, with drum speeds as low as 20 revs. per min., are now regularly and almost universally made by all haulage gear manufacturers with single trains of gearing, where double and treble trains used to be employed. The same effect is noticeable in a marked degree with the design of pumping machinery, with the result that efficiencies have been greatly improved, and by a considerable reduction in the number of wearing parts the number of repairs has fallen off.

It is not surprising that, in view of the serious inconvenience and, in many cases, even danger, caused by the breakdown of underground machinery, mine managers approach this new departure with the utmost caution. Doubts with regard to the durability of the small pinions employed were frequently expressed. Three or four years' practice, however, has abundantly proved that such pinions not only have a very satisfactory life, but the entire absence of shocks and vibration has a very beneficial effect on the working machines, and breakages of gears, with which mine managers and engineers were only too well acquainted with straight cut gearing, have become a thing of the past. Mines which have had the most extensive experience with this class of gear do not find it at all necessary to keep spare gears in stock.

It is gratifying to notice that British engineering firms have doubtlessly led the way in making use of double helical gearing to modernize and simplify their machines. Amongst the large number of representative installations of double helical gears for mines carried out during the last few years, it is perhaps particularly noteworthy that for the electrification of existing main winders such gears have been exclusively adopted by the Rand Mines in South Africa. Although not a single breakdown of a double helical gear fitted to electric winders or haulages has come to the writer's knowledge, the application of such gears to electric main winders is making comparatively slow progress in this country. The reasons are not apparent, as the geared winder is a considerably cheaper proposition than the winder with a slow-speed motor coupled direct to the drum shaft, and double helical gears possess in every instance a safety factor which is probably larger than the safety factor it is customary to reckon with in general engineering practice, due to the fact that considerations of wear call for gear dimensions which lie far beyond what would be required by considerations of strength.

An entirely new field of the application of gearing is the drive of high lift centrifugal pumps. For small and medium powers electric motors can be easily built for the required pump speeds, but for large powers the most efficient high lift pump has generally to run at a speed which can no longer be

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regarded as normal or desirable for the electric motor. In such cases the use of a standard speed motor with speeding up gear offers the great advantage that a motor of size and speed can be selected which is also in use on other machinery in the mine, so that common spare parts may be kept. The loss in such gears, amounting to not more than 3 to 4 per cent., will hardly be more than the difference in efficiency between a standard motor and a motor of particularly small diameter running at an extreme speed, which necessitates efficient ventilation for cooling purposes.

Electric motor manufacturers used to deprecate direct gear drives for heavy powers, as the number of cases has not been few in which motors have suffered owing to straight cut pinions, mounted direct on the motor shaft. The vibration set up by the gearing and the continuous hammer blows, as tooth after tooth came into engagement, gradually affected the winding, and insulation troubles occurred which could not be accounted for in any other way than by such outside defects. No such trouble has occurred where double helical gearing has been applied, so that the electrical part of the installation has also become more reliable by the introduction of this type of gearing, which, in my opinion, is doubtlessly destined to ultimately oust straight cut gearing for all medium and heavy power drives.

Oerlikon Mine Motors.

A line of motors which have been specially developed for mining work are those made by the Maschinenfabrik Oerlikon.

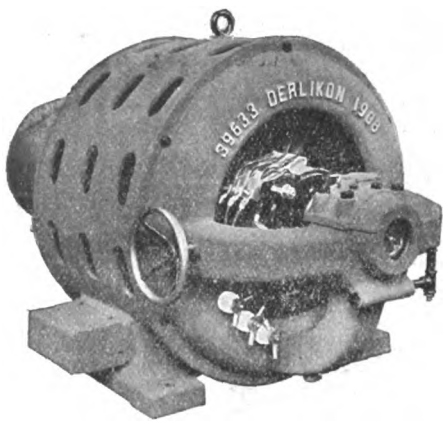

Fig. 1.—Open Type Three-phase Motor with Shield Bearings.

These motors may be divided into two classes—those in which the speed is less than 1,000 revs. per min., and those in which the speed exceeds that amount. The former class include a number of small motors fitted with slip-rings, whose outputs are in general less than 300 H.P. They have from 6 to 16 poles, or in cases where the frequency does not exceed 25, four poles. These motors are usually fitted with end plates, though in the case of those of heavy outputs or with a large number of poles, separate bearing blocks are provided.

A view of one of these motors is shown in Fig. 1. The end plate has a sufficiently large projection which covers up both the slip-rings and the brushes. The end shields can easily be turned through either 90 or 180 deg., so that the motor can be fixed to a vertical wall or on the ceiling if required. In the large size motors the casing is fixed on to the bed plate which carries the bearings.

The bearings are fitted with ring lubrication and can easily be examined by removal of a small plate. The iron of the stator is made up of single sheets which are insulated from one another by paper. The single sheets are held together by two rings which are tightened up by insulated bolts. In order that the cooling may be sufficient, special air channels are provided. The stator winding consists of coils which are suitably insulated according to the voltage and are placed in half-closed slots. Where the voltage exceeds 4,000 the coils themselves are insulated from the iron by means of shellac, or some other similar material. Where the bearings are not carried on the end plates a specially protected ring is provided to prevent the windings being damaged from outside. The rings are sufficiently wide to cover the rotor winding as well. In this class of motor the rotor is generally provided with slip-rings whatever the size of the motor may be. The motors are provided with arrangements for short-circuiting the rotor and for raising the brushes. To short-circuit the motor a sleeve carrying contact fingers is pushed under the slip rings and the arrangement for lifting the bushes is designed so that the brushes are raised as soon as the rotor is short-circuited. This arrangement is

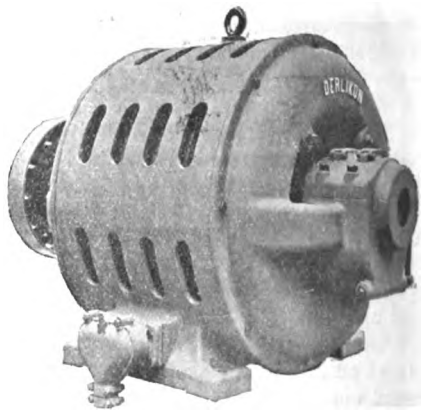

Fig. 2.—Type "A" Three-phase Motor, 2,000 Volts 1,450 Revs. per Min.

worked in the case of motors with the end plates by means of the hand wheel, and in the case of motors with separate bearings by means of a lever. This class of motor can either be provided with separate starters or with starters connected direct to the motor. In the latter case the starters are interlocked with the short-circuiting and the brush lifting equipment, so that cutting out the resistance, short-circuiting the rotor, and lifting the brushes both at starting and stopping can be effected by means of turning one hand wheel progressively in one or the other direction. It is, therefore, claimed to be quite impossible for the motor to be damaged through any mistake in the order of operations being made.

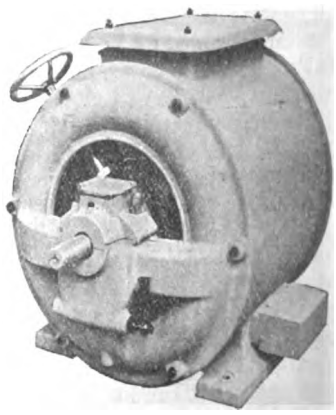

Fig. 3.—Three-phase Ventilated Motor, 100 H.P., 500 Volts 1,450 Revs per Min.

An example of the second class of motors is shown in Fig. 2. These motors have been specially designed for the driving of high-speed pumps and ventilators. These are relatively small in size, and are fitted with hand wheels and short-circuiting rotor, the speed varying between 1,450 and 3,000 revs. per min. In particular cases, however, slip-rings can be provided. Fig. 3 shows another motor of this class of the ventilated enclosed type. This motor, has a capacity of 100 H.P. and is fitted with slip-ring. Mr. G. Wuthrich, Oswaldestre House Norfolk-street, W.C., is the representative of Maschinenfabrik Oerlikon in this country.

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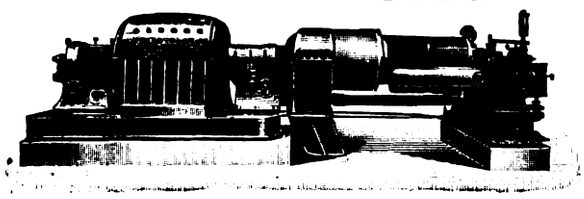

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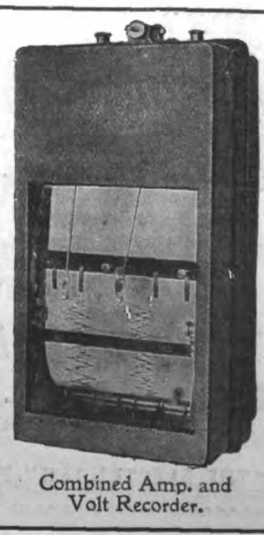

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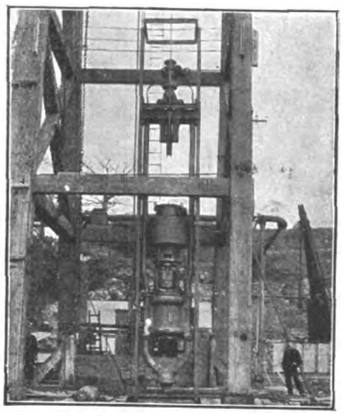

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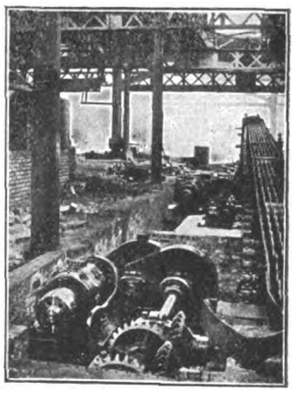

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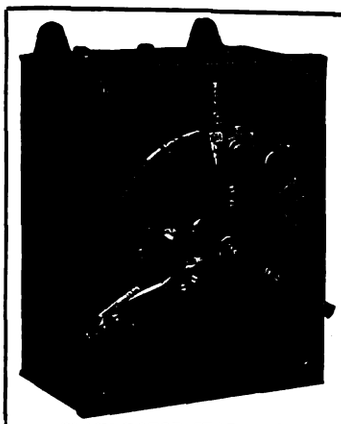

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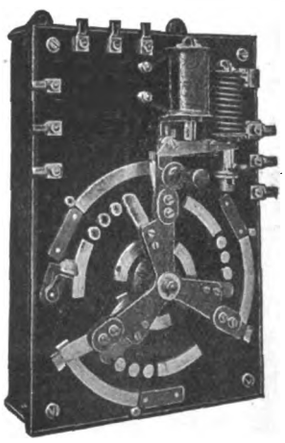

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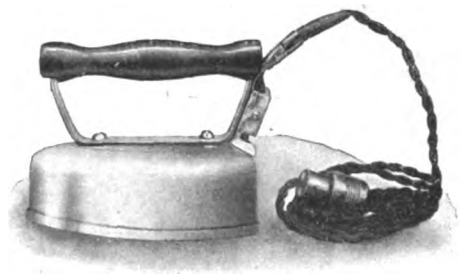

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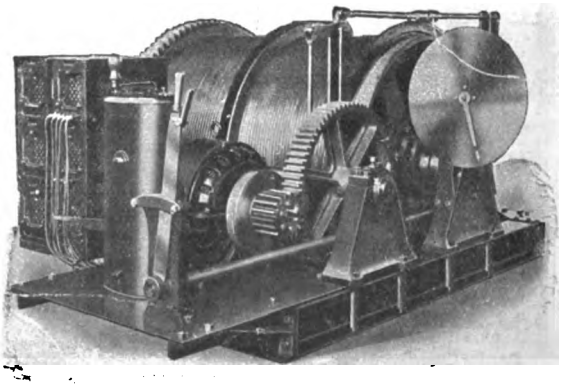

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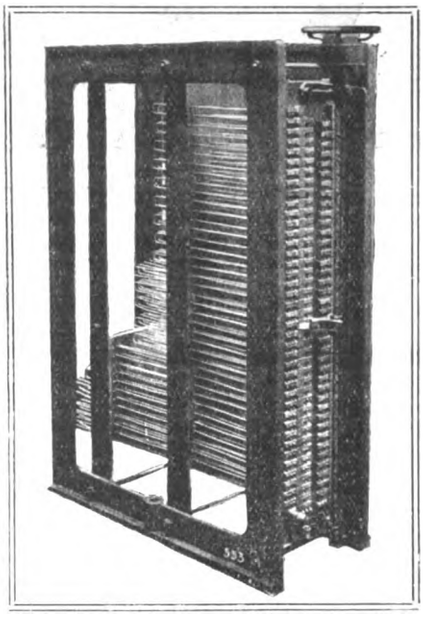

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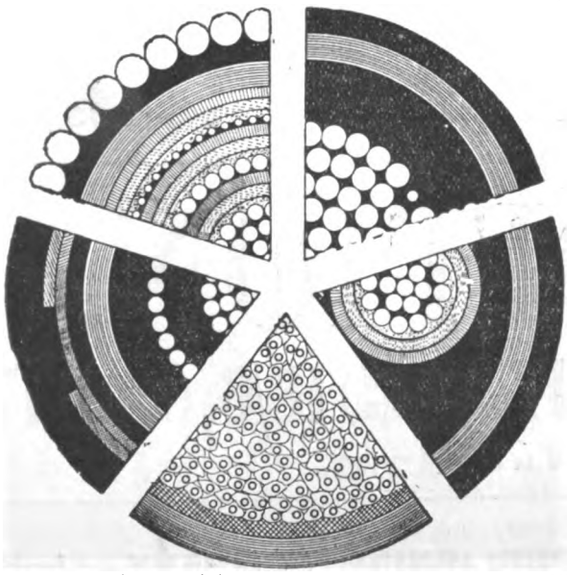

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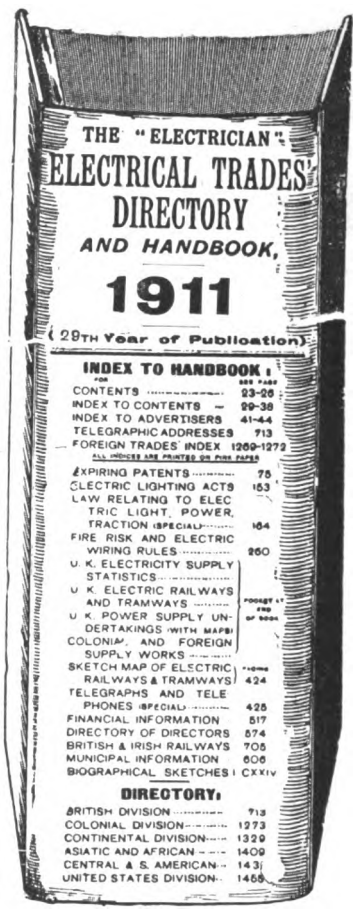

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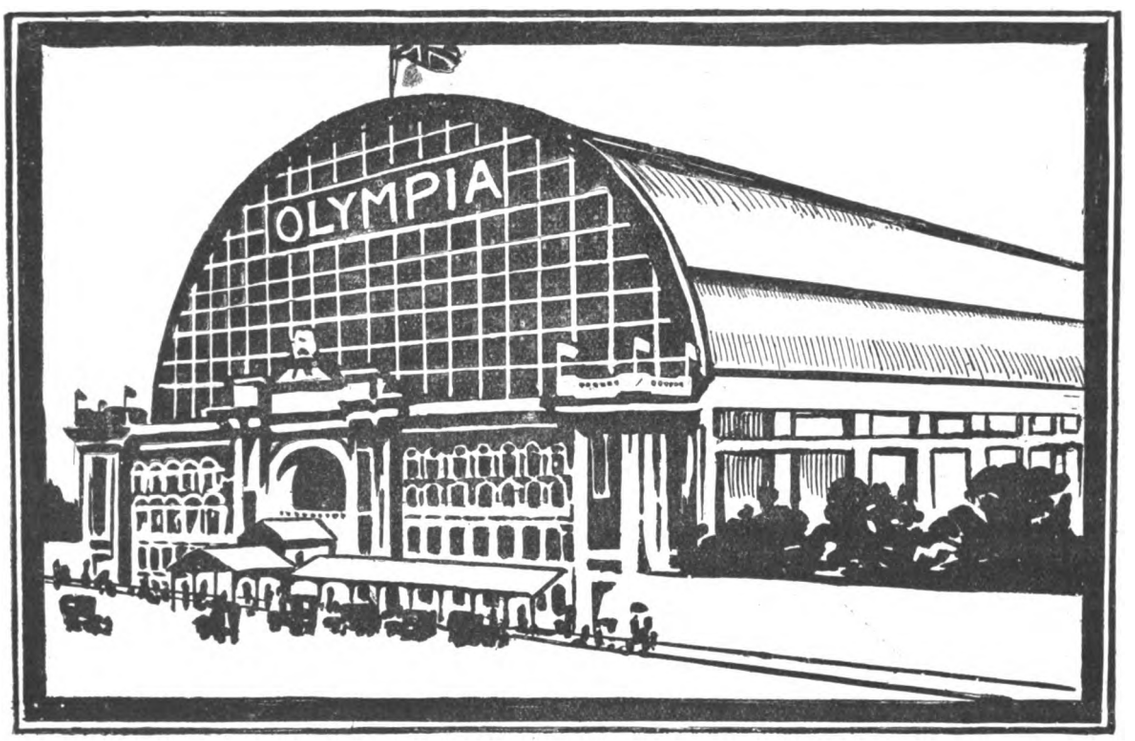

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TENDERS INVITED continued on next page

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W. MUSGROVE, Town Clerk.

Municipal Offices, Haslingden, April 13th, 1911.

DEATH.

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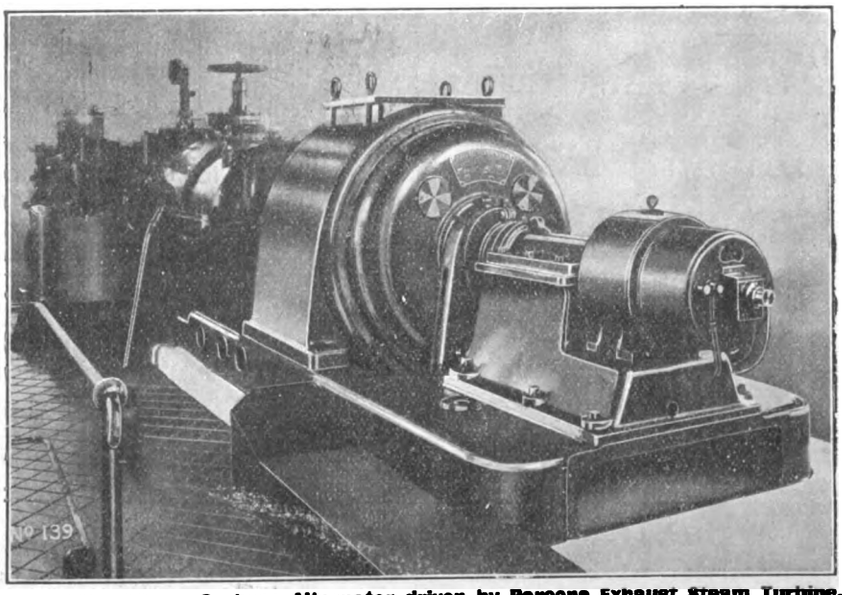

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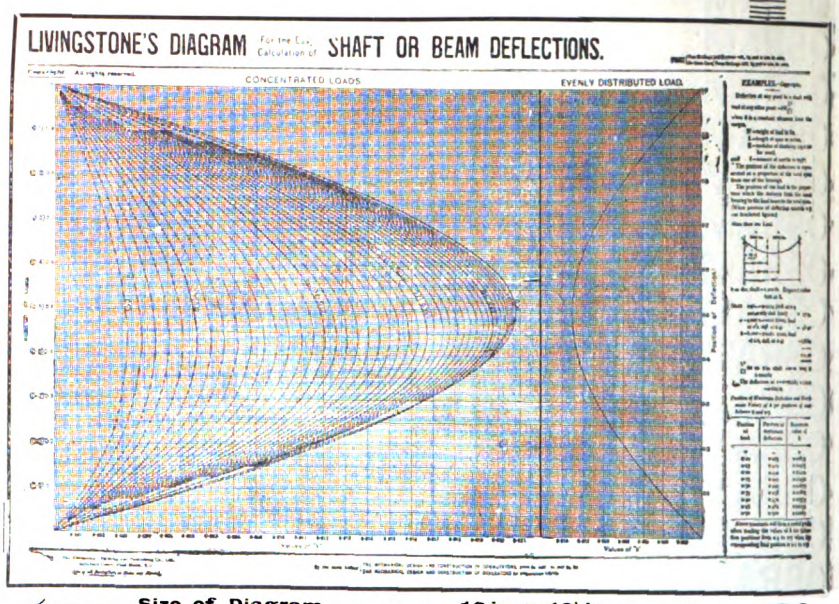

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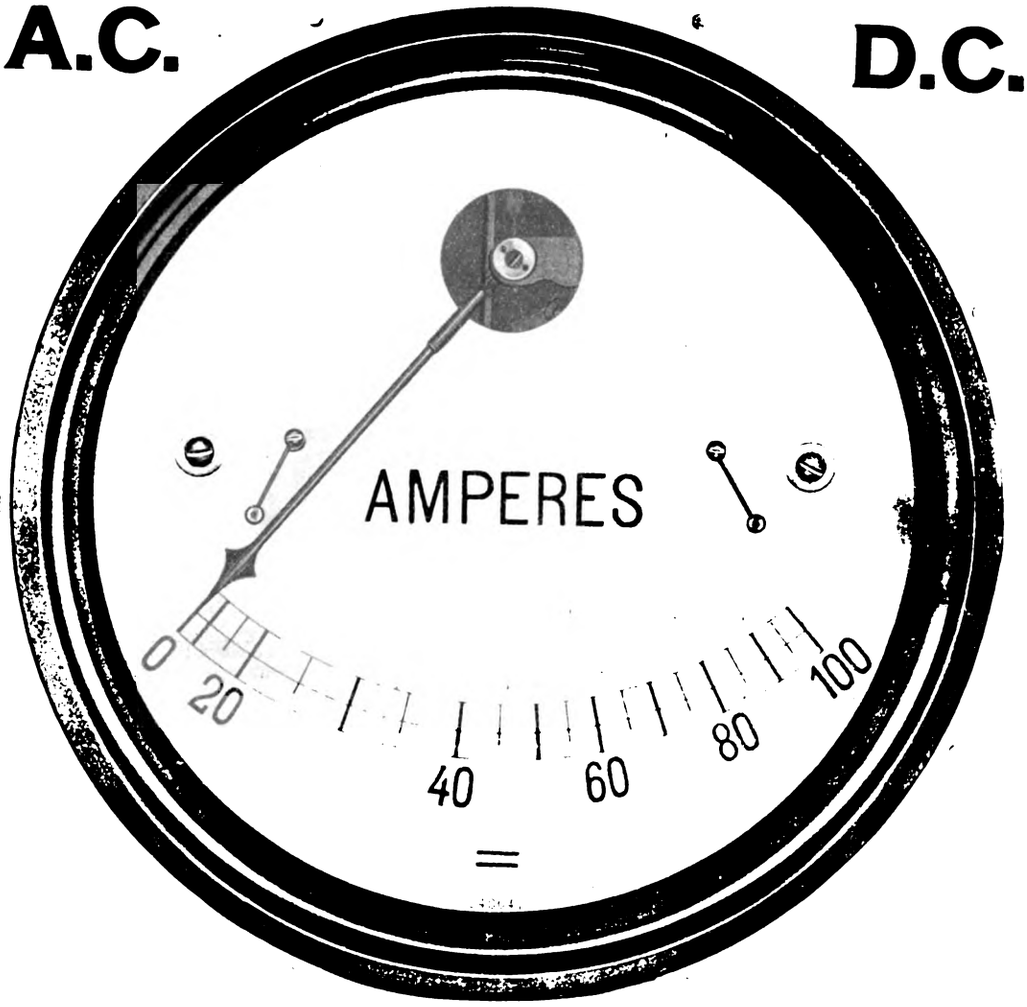

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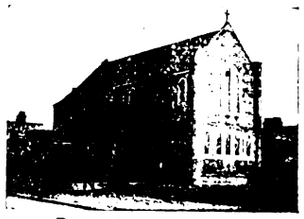
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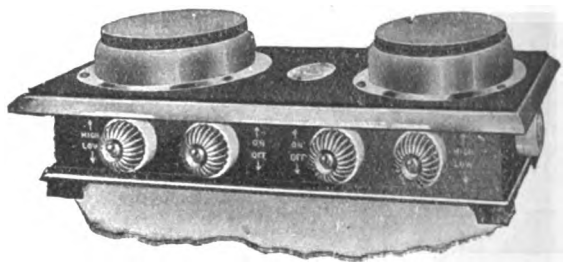

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